

PART 1      GENERAL1.1      RELATED REQUIREMENTS

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

1.2      REFERENCES

- .1      Definitions:
  - .1      Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.
- .2      Reference Standards:
  - .1      CSA Group
    - .1      CSA C22.1-15, Canadian Electrical Code, Part 1 (23rd Edition), Safety Standard for Electrical Installations, With Ontario Amendments, the Ontario Electrical Safety Code (OESC).
    - .2      CSA C22.2.
    - .3      CAN/CSA-C22.3 No.1-10, Overhead Systems.
    - .4      CAN3-C235-83(R2010), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
    - .5      CSA Z462-15, Workplace Electrical Safety.
  - .2      Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
    - .1      IEEE 100 SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

1.3      ACTION AND INFORMATIONAL SUBMITTALS

- .1      Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2      Product Data:
  - .1      Submit manufacturer's instructions, printed product literature and data sheets for all new installations and include product characteristics, performance criteria, physical size, finish and limitations.
- .3      Shop drawings:
  - .1      Submit drawings stamped as reviewed by both General and Electrical Contractor.
  - .2      Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.
  - .3      Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.

- .4 Indicate on drawings clearances for operation, maintenance, and replacement of operating equipment devices.
  - .5 Submit electronic copies of drawings and product data to Departmental Representative.
  - .6 If changes are required, notify Departmental Representative of these changes before they are made.
- .4 Certificates:
- .1 Provide CSA certified equipment and material.
  - .2 Where CSA certified equipment and material is not available, submit such equipment and material to inspection authorities for special approval before delivery to site.
  - .3 Submit test results of installed electrical systems and instrumentation.
  - .4 Permits and fees: in accordance with Section 01 00 10 - General Instructions.
  - .5 Submit, upon completion of Work, load balance report as described in PART 3 - LOAD BALANCE.
  - .6 Submit certificate of acceptance from Authority Having Jurisdiction upon completion of Work to Departmental Representative.
- .5 Manufacturer's Field Reports: submit to Departmental Representative manufacturer's written report, within 3 days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in PART 3 - FIELD QUALITY CONTROL.
- .6 Provide Arc Flash Study complete with Short Circuit, Device Evaluation, and Protection Coordination Study in accordance with CSA Z462 for entire facility (including new and existing equipment).
- .1 Study to be provided with or before submission of equipment shop drawings.
  - .2 All equipment to meet the minimum interrupting capacities indicated in study or those indicated on drawings, whichever is higher.
  - .3 Provide updated bilingual arc flash labelling for all existing equipment where hazard level has changed.
  - .4 Provide bilingual arc flash labelling on all new equipment.
  - .5 Stamped and signed by Professional Engineer registered in Ontario.

#### 1.4 CLOSEOUT SUBMITTALS

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

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

## 1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Instructions and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Waste Reduction Workplan related to Work of this Section and in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Waste Reduction Workplan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

## PART 2 PRODUCTS

### 2.1 DESIGN REQUIREMENTS

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

- .3 Language operating requirements: provide identification nameplates and labels for control items in English and French.
- .4 Use one nameplate or label for each language.

## 2.2 MATERIALS AND EQUIPMENT

- .1 Provide material and equipment in accordance with Section 01 00 10 - General Instructions.
- .2 Material and equipment to be CSA certified. Where CSA certified material and equipment are not available, obtain special approval from inspection authorities before delivery to site and submit such approval as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .3 Factory assemble control panels and component assemblies.

## 2.3 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.
- .2 Control wiring and conduit: in accordance with Section 26 05 21 - Wires and Cables (0-1000 V) except for conduit, wiring and connections below 50 V which are related to control systems specified in mechanical sections and as shown on mechanical drawings.

## 2.4 WARNING SIGNS

- .1 Warning Signs: in accordance with requirements of Departmental Representative.
- .2 Decal signs, minimum size 175 x 250 mm.

## 2.5 WIRING TERMINATIONS

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

## 2.6 EQUIPMENT IDENTIFICATION

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

- .2 Sizes as follows:

NAMEPLATE SIZES			
Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

- .2 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.
- .3 Wording on nameplates and labels to be approved by Departmental Representative prior to manufacture.
- .4 Allow for minimum of twenty-five (25) letters per nameplate and label.
- .5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .6 Identify equipment with Size 3 labels engraved "ASSET INVENTORY NO. " as approved by Departmental Representative.
- .7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .8 Terminal cabinets and pull boxes: indicate system and voltage.
- .9 Transformers: indicate capacity, primary and secondary voltages.
- .10 End devices labeled with circuit number and source panel.

## 2.7 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, numbered coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.

- .4 Use colour coded wires in communication cables, matched throughout system.

## 2.8 CONDUIT AND CABLE IDENTIFICATION

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

	Prime	Auxiliary
up to 250 V	Yellow	
up to 600 V	Yellow	Green
up to 5 kV	Yellow	Blue
up to 15 kV	Yellow	Red
Telephone	Green	
Other	Green	Blue
Communication Systems		
Fire Alarm	Red	
Emergency	Red	Blue
Voice		
Other Security	Red	Yellow
Systems		

## 2.9 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.
- .2 Paint indoor switchgear and distribution enclosures light gray.

## PART 3 EXECUTION

### 3.1 EXAMINATION

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

### 3.2 INSTALLATION

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.
- .2 Do overhead and underground systems in accordance with CAN/CSA-C22.3 No.1 except where specified otherwise.

### 3.3 NAMEPLATES AND LABELS

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

### 3.4 CONDUIT AND CABLE INSTALLATION

- .1 Install cables, conduits and fittings, close to building structure so furring can be kept to minimum.

### 3.5 MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
  - .1 Local switches: 1200 mm.
  - .2 Wall receptacles:
    - .1 General: 400 mm.
    - .2 Above top of continuous baseboard heater: 200 mm.
    - .3 Above top of counters or counter splash backs: 175 mm.
    - .4 In mechanical rooms: 1200 mm.
  - .3 Panelboards: as required by Code or as indicated.
  - .4 Telephone and interphone outlets: 300 mm.
  - .5 Wall mounted telephone and interphone outlets: 1500 mm.
  - .6 Fire alarm stations: 1200 mm.
  - .7 Fire alarm bells: 2100 mm.
  - .8 Television outlets: 300 mm.
  - .9 Wall mounted speakers: 2100 mm.
  - .10 Clocks: 2100 mm.
  - .11 Door bell pushbuttons: 1500 mm.

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### 3.6 CO-ORDINATION OF PROTECTIVE DEVICES

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.
- .2 Provide Short Circuit and Protection Coordination Study for all equipment installed under this contract.
- .3 Equipment interrupting ratings are to meet the requirements of the study or the values indicated in the specification, whichever is higher.

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### 3.7 FIELD QUALITY CONTROL

- .1 Load Balance:
  - .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
  - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
  - .3 Provide upon completion of work, load balance report as directed in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS, phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .2 Conduct following tests in accordance with Section 01 45 00 - Quality Control.
  - .1 Power generation and distribution system including phasing, voltage, grounding and load balancing.
  - .2 Circuits originating from branch distribution panels.
  - .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.
- .3 Carry out tests in presence of Departmental Representative.
- .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .5 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

### 3.8 SYSTEM STARTUP

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

### 3.9 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

PART 1 GENERAL1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
  - .1 CAN/CSA C22.2 No.18-98(R2003), Outlet Boxes, Conduit Boxes, and Fittings.
  - .2 CAN/CSA-C22.2 No.65-13, Wire Connectors (Tri-National Standard, with UL 486A-486B and NMX-J-543-ANCE). Includes Update No. 1 (2013).
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
  - .1 EEMAC 1Y-2, 1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).
- .3 National Electrical Manufacturers Association (NEMA)

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Reduction Workplan.
- .4 Divert unused wiring materials from landfill to metal recycling facility as approved by Departmental Representative.

PART 2 PRODUCTS2.1 MATERIALS

- .1 Pressure type wire connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of copper sized to fit copper conductors as required.
- .2 Fixture type splicing connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of copper sized to fit copper conductors 10 AWG or less.
- .3 Clamps or connectors for armoured cable, mineral insulated cable, flexible conduit, as required to: CAN/CSA C22.2 No.18.

PART 3      EXECUTION3.1          INSTALLATION

- .1 Remove insulation carefully from ends of conductors and:
  - .1 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CAN/CSA-C22.2 No.65.
  - .2 Install fixture type connectors and tighten. Replace insulating cap.

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END OF SECTION

PART 1      GENERAL1.1      RELATED REQUIREMENTS

- .1      Section 26 05 00 - Common Work Results for Electrical.
- .2      Section 26 05 20 - Wire and Box Connectors - (0-1000 V).
- .3      Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

1.2      PRODUCT DATA

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

1.3      DELIVERY, STORAGE AND HANDLING

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

PART 2      PRODUCTS2.1      BUILDING WIRES

- .1      Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- .2      Copper conductors: size as indicated, with 600 V insulation of cross-linked thermosetting polyethylene material rated RWU90 XLPE, Jacketted.

2.2      TECK 90 CABLE

- .1      Cable: in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2      Conductors:
  - .1      Grounding conductor: copper as indicated.
  - .2      Circuit conductors: copper as indicated, size as indicated.
- .3      Insulation:
  - .1      Cross-linked polyethylene XLPE.
  - .2      Rating: 600 V.
- .4      Inner jacket: polyvinyl chloride material.

- .5 Armour: interlocking aluminum.
- .6 Overall covering: thermoplastic polyvinyl chloride, compliant to applicable Building Code classification for this project.
- .7 Fastenings:
  - .1 One hole aluminum straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
  - .2 Channel type supports for two or more cables at 900 mm centers.
  - .3 Threaded rods: 6 mm diameter to support suspended channels.
- .8 Connectors:
  - .1 Watertight, approved for TECK cable.

## 2.3 MINERAL-INSULATED CABLES

- .1 Conductors: solid bare soft-annealed copper, size as indicated.
- .2 Insulation: compressed powdered magnesium oxide or silicon dioxide to form compact homogeneous mass throughout entire length of cable.
- .3 Outer covering: annealed seamless copper sheath, Type MI rated 600 V, 250°C.
- .4 Overall jacket: none.
- .5 Two hour fire rating.
- .6 Connectors: watertight factory installed and tested, approved for MI cable.
- .7 Termination kits: factory installed approved for MI cable

## 2.4 ARMOURED CABLES

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

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## 2.5 CONTROL CABLES

- .1 Type: LVT: 2 soft annealed copper conductors, sized as indicated:
  - .1 Insulation: thermoplastic.
  - .2 Sheath: thermoplastic jacket.
- .2 Type: low energy 300 V control cable: stranded annealed copper conductors sized as indicated LVT: 2 soft annealed copper conductors, sized as indicated:
  - .1 Insulation: TW.
  - .2 Shielding: tape coated with diamagnetic material over each pair.
  - .3 Overall covering: PVC jackets.

## PART 3 EXECUTION

### 3.1 FIELD QUALITY CONTROL

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

### 3.2 GENERAL CABLE INSTALLATION

- .1 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - (0-1000 V).
- .2 Cable Colour Coding: to Section 26 05 00 - Common Work Results for Electrical.
- .3 Conductor length for parallel feeders to be identical.
- .4 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .5 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.
- .6 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.

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### 3.3            INSTALLATION OF BUILDING WIRES

- .1     Install wiring as follows:
  - .1       In conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

### 3.4            INSTALLATION OF TECK90 CABLE (0 -1000 V)

- .1     Group cables wherever possible on channels.
- .2     Install cable concealed, where possible, securely supported by straps and hangers.
- .3     Where cables cannot be concealed neatly, install parallel to building lines, conserving space and headroom.

### 3.5            INSTALLATION OF MINERAL-INSULATED CABLES

- .1     Install cable concealed, securely supported by straps and hangers.
- .2     Support 2 hour fire rated cables at 1 m intervals.
- .3     Make cable terminations by using factory-made kits.
- .4     Cable terminations: use thermoplastic sleeving over bare conductors.
- .5     Do not splice cables unless indicated.

### 3.6            INSTALLATION OF ARMOURED CABLES

- .1     Group cables wherever possible on channels.

### 3.7            INSTALLATION OF CONTROL CABLES

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

PART 1      GENERAL1.1      RELATED REQUIREMENTS

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

1.2      REFERENCES

- .1      American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)
  - .1      ANSI/IEEE 837-2014, IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.
- .2      Canadian Standards Association, (CSA International)
  - .1      CSA Z32-09 (R2014), Electrical Safety and Essential Electrical Systems in Health Care Facilities, Includes Update No. 1 (2010), Update No. 2 (2010).

1.3      WASTE MANAGEMENT AND DISPOSAL

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

PART 2      PRODUCTS2.1      EQUIPMENT

- .1      Clamps for grounding of conductor: size as required.
- .2      Grounding conductors: bare stranded copper, tinned, soft annealed, size as indicated or as per OESC.

- .3 Insulated grounding conductors: green, type RW90.
- .4 Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.
- .5 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
  - .1 Grounding and bonding bushings.
  - .2 Protective type clamps.
  - .3 Bolted type conductor connectors.
  - .4 Thermit welded type conductor connectors.
  - .5 Bonding jumpers, straps.
  - .6 Pressure wire connectors.

### PART 3 EXECUTION

#### 3.1 INSTALLATION GENERAL

- .1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. Where EMT is used, run ground wire in conduit.
- .2 Install connectors in accordance with manufacturer's instructions.
- .3 Protect exposed grounding conductors from mechanical injury.
- .4 Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermit process, permanent mechanical connectors or inspectable wrought copper compression connectors to ANSI/IEEE 837.
- .5 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .6 Soldered joints not permitted.
- .7 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
- .8 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.
- .9 Connect building structural steel and metal siding to ground by welding copper to steel.
- .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.

### 3.2 EQUIPMENT GROUNDING

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

### 3.3 GROUNDING BUS

- .1 Install copper grounding bus mounted on insulated supports on wall of electrical room.
- .2 Ground items of electrical equipment in electrical room to ground bus with individual bare stranded copper connections size 2/0 AWG.

### 3.4 FIELD QUALITY CONTROL

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

PART 1      GENERAL1.1      ACTION AND INFORMATIONAL SUBMITTALS

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

1.2      DELIVERY, STORAGE AND HANDLING

- .1      Deliver, store and handle materials in accordance with Section 01 00 10 - General Instructions and with manufacturer's written instructions.
- .2      Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3      Storage and Handling Requirements:
  - .1      Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2      Store and protect hangers and supports from nicks, scratches, and blemishes.
  - .3      Replace defective or damaged materials with new.
- .4      Develop Waste Reduction Workplan related to Work of this Section.
- .5      Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, and packaging materials as specified in Waste Reduction Workplan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2      PRODUCTS2.1      SUPPORT CHANNELS

- .1      U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted or suspended.

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**PART 3      EXECUTION****3.1          EXAMINATION**

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

**3.2          INSTALLATION**

- .1 Secure equipment to masonry, tile and plaster surfaces with lead anchors.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4 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 to building construction or support system using straps.
  - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
  - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
  - .3 Beam clamps to secure conduit to exposed steel work.
- .6 Suspended support systems.
  - .1 Support individual cable or conduit runs with 6 mm diameter threaded rods and spring clips.
  - .2 Support 2 or more cables or conduits on channels supported by 6 mm diameter threaded rod hangers where direct fastening to building construction is impractical.
- .7 For surface mounting of two or more conduits use channels at 900 mm on centre 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 Ensure 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 except with permission of other trade and approval of Departmental Representative.
- .12 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

### 3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

PART 1      GENERAL1.1      RELATED REQUIREMENTS

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

1.2      REFERENCES

- .1      Canadian Standards Association (CSA International)
  - .1      CSA C22.1-15, Canadian Electrical Code, Part 1 (23rd Edition), Safety Standard for Electrical Installations, With Ontario Amendments, the Ontario Electrical Safety Code (OESC).

1.3      ACTION AND INFORMATIONAL SUBMITTALS

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

1.4      DELIVERY, STORAGE AND HANDLING

- .1      Waste Management and Disposal:
  - .1      Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2      PRODUCTS2.1      SPLITTERS

- .1      Construction: sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- .2      Terminations: main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.

- .3 Spare Terminals: minimum three spare terminals or lugs on each connection or lug block sized less than 400 A.

## 2.2 JUNCTION AND PULL BOXES

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

## 2.3 CABINETS

- .1 Construction: welded sheet steel as indicated hinged door, latch and catch.
- .2 Surface return flange mounting as indicated.

## PART 3 EXECUTION

### 3.1 SPLITTER INSTALLATION

- .1 Mount plumb, true and square to 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 2 m above finished floor except where indicated otherwise.
- .3 Only main junction and pull boxes are indicated. Install additional pull boxes as required by CSA C22.1.

### 3.3 IDENTIFICATION

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

PART 1      GENERAL1.1      REFERENCES

- .1 Canadian Standards Association (CSA International)
  - .1 CAN/CSA C22.2 No. 18-98(R2003), Outlet Boxes, Conduit Boxes, and Fittings.
  - .2 CSA C22.2 No. 56-13, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .3 CSA C22.2 No. 83-M1985 (R2013), Electrical Metallic Tubing.
  - .4 CSA C22.2 No. 211.2-06 (R2011), Rigid PVC (Unplasticized) Conduit, Update No. 1 (2011).
  - .5 CAN/CSA C22.2 No. 227.3-05 (R2010), Nonmetallic Mechanical Protection Tubing (NMPT), (Bi-National Standard, with UL 1696).

1.2      ACTION AND INFORMATIONAL SUBMITTALS

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

1.3      WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .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.

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## PART 2      PRODUCTS

### 2.1            CABLES AND REELS

- .1      Provide cables on reels or coils.
  - .1          Mark or tag each cable and outside of each reel or coil, to indicate cable length, voltage rating, conductor size, and manufacturer's lot number and reel number.
- .2      Each coil or reel of cable to contain only one continuous cable without splices.
- .3      Identify cables for exclusively dc applications.
- .4      Reel and mark shielded cables rated 2,001 volts and above.

### 2.2            CONDUITS

- .1      Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.
- .2      Rigid pvc conduit: to CSA C22.2 No. 211.2.
- .3      Flexible metal conduit: to CSA C22.2 No. 56, liquid-tight flexible metal.
- .4      Flexible pvc conduit: to CAN/CSA-C22.2 No. 227.3.

### 2.3            CONDUIT FASTENINGS

- .1      One hole steel straps to secure surface conduits 50 mm and smaller.
  - .1          Two hole steel straps for conduits larger than 50 mm.
- .2      Beam clamps to secure conduits to exposed steel work.
- .3      Channel type supports for two or more conduits at 900 mm on centre.
- .4      Threaded rods, 6 mm diameter, to support suspended channels.

### 2.4            CONDUIT FITTINGS

- .1      Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified.  
Coating: same as conduit.
- .2      Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits.
- .3      Steel set screw couplings.

2.5 FISH CORD

- .1 Polypropylene.

PART 3 EXECUTION3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas.
- .3 Use electrical metallic tubing (EMT) except where specified otherwise.
- .4 Use rigid pvc conduit underground and outdoors.
- .5 Use flexible metal conduit for connection to motors/ transformers in dry areas.
- .6 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.
- .7 Minimum conduit size for lighting and power circuits: 19 mm.
- .8 Bend conduit cold:
  - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .9 Mechanically bend steel conduit over 19 mm diameter.
- .10 Install fish cord in empty conduits.
- .11 Remove and replace blocked conduit sections.
  - .1 Do not use liquids to clean out conduits.
- .12 Dry conduits out before installing wire.

### 3.3 SURFACE CONDUITS

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

### 3.4 CONCEALED CONDUITS

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

### 3.5 CONDUITS UNDERGROUND

- .1 Slope conduits to provide drainage.
- .2 Waterproof joints (pvc excepted) with heavy coat of bituminous paint.

### 3.6 CLEANING

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

PART 1      GENERAL1.1      RELATED REQUIREMENTS

- .1      Section 26 05 00 - Common Work Results for Electrical.
- .2      Section 26 05 29 - Hangers and Supports for Electrical Systems.
- .3      Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

1.2      REFERENCES

- .1      Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1      Material Safety Data Sheets (MSDS).
- .2      National Building Code of Canada (NBC) - 2010.
- .3      National Fire Protection Association (NFPA)
  - .1      NFPA 13-2013, Standard for the Installation of Sprinkler Systems.
- .4      Ontario Building Code (OBC) - 2012.

1.3      DEFINITIONS

- .1      Priority Two (P2) Buildings: buildings in which life safety is of paramount concern. It is not necessary that P2 buildings remain operative during or after earthquake activity.
- .2      SRS: acronym for Seismic Restraint System.

1.4      SEISMIC RESTRAINT SYSTEM DESCRIPTION

- .1      SRS fully integrated into, and compatible with:
  - .1      Noise and vibration controls specified in this specification section.
  - .2      Structural, mechanical, electrical design of project.
- .2      Systems, equipment not required to be operational during and after seismic event.
- .3      During seismic event, SRS to prevent systems and equipment from causing personal injury and from moving from normal position.
- .4      Designed by Professional Engineer specializing in design of seismic restraint systems and registered in the Province of Ontario.

- .5 Refer to architectural drawings for spatial limitations imposed by order picker route.
- .6 SRS to be designed to most stringent requirements of NBC 2010 or OBC 2012.

#### 1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .2 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Provide system shop drawings complete with performance and product data.
  - .2 Provide detailed drawings of seismic control measures for equipment and piping.
- .3 Shop drawings for seismic restraint systems: submit drawings stamped and signed by professional engineer registered or licensed in the Province of Ontario.
- .4 Submit design data including:
  - .1 Full details of design criteria.
  - .2 Design calculations (including restraint loads resulting from seismic forces in accordance with National Building Code, detailed work sheets, tables).
  - .3 Separate shop drawings for each SRS and devices for each system.
  - .4 Identification of location of devices.
  - .5 Schedules of types of SRS equipment and devices.
  - .6 Details of fasteners and attachments to structure, anchorage loadings, attachment methods.
  - .7 Installation procedures and instructions.
- .5 Submit additional copy of shop drawings and product data to Departmental Representative for review of connection points to building structure.
- .6 Closeout Submittals:
  - .1 Provide maintenance data including monitoring requirements for incorporation into manuals specified in Section 01 78 00 - Closeout Submittals.

#### 1.6 QUALITY ASSURANCE

- .1 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Section 01 00 10 - General Instructions.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management.

PART 2 PRODUCTS2.1 SEISMIC CONTROL MEASURES

- .1 SRS Manufacturer
  - .1 SRS from one manufacturer regularly engaged in SRS production.
- .2 General
  - .1 SRS to provide gentle and steady cushioning action and avoid high impact loads.
  - .2 SRS to restrain seismic forces in every direction.
  - .3 Fasteners and attachment points to resist same load as seismic restraints.
  - .4 SRS of conduit support systems compatible with:
    - .1 Expansion, anchoring and guiding requirements.
    - .2 Equipment vibration isolation and equipment SRS.
  - .5 SRS utilizing cast iron, threaded pipe, other brittle materials not permitted.
  - .6 Seismic control measures not to interfere with integrity of firestopping.
  - .7 Attachments to RC structure:
    - .1 Use high strength mechanical expansion anchors.
    - .2 Drilled or power driven anchors not permitted.
- .3 SRS for Static Equipment, Systems
  - .1 Floor-mounted equipment, systems:
    - .1 Anchor equipment to equipment supports.
    - .2 Anchor equipment supports to structure.
    - .3 Use size of bolts scheduled in approved shop drawings.
  - .2 Suspended equipment, systems:
    - .1 Use one or combination of following methods:
      - .1 Install tight to structure.
      - .2 Cross-brace in every direction.
      - .3 Brace back to structure.
      - .4 Slack cable restraint system.
    - .2 SCS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.
    - .3 Hanger rods to withstand compressive loading and buckling.

- .3 Seismic restraints:
  - .1 Cushioning action gentle and steady.
  - .2 Never reach metal-like stiffness.
- .4 SRS for Vibration Isolated Equipment
  - .1 Floor mounted equipment, systems:
    - .1 Use one or combination of following methods:
      - .1 Vibration isolators with built-in snubbers.
      - .2 Vibration isolators and separate snubbers.
      - .3 Built-up snubber system approved by Departmental Representative, consisting of structural elements and elastomeric layer.
    - .2 Incorporate seismic restraints into vibration isolation system to resist complete isolator unloading.
    - .3 SRS not to jeopardize noise and vibration isolation systems. Provide 4-8 mm clearance between seismic restraint snubbers and equipment during normal operation of equipment and systems.
    - .4 Cushioning action: gentle and steady by utilizing elastomeric material or other means in order to avoid high impact loads.
  - .2 Suspended equipment, systems:
    - .1 Use one or combination of following methods:
      - .1 Slack cable restraint system.
      - .2 Brace back to structure via vibration isolators and snubbers.

### PART 3 EXECUTION

#### 3.1 MANUFACTURER'S INSTRUCTIONS

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

#### 3.2 INSTALLATION

- .1 Seismic control measures to meet requirements of NBC.
- .2 Install vibration isolation equipment in accordance with manufacturer's instructions and adjust mountings to level equipment.
- .3 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.
- .4 Where isolation is bolted to floor use vibration isolation rubber washers.

- .5 Attachment points and fasteners:
  - .1 To withstand same maximum load that seismic restraint is to resist and in every direction.
- .6 Install SRS at least 25 mm from equipment, systems, services.
- .7 Co-ordinate connections with other disciplines.

### 3.3 FIELD QUALITY CONTROL

- .1 Inspection and Certification:
  - .1 SRS: inspected and certified by Contractor's Seismic Engineer upon completion of installation.
  - .2 Provide written report to Departmental Representative with certificate of compliance.
  - .3 Provide Departmental Representative with notice 24 h in advance of commencement of tests.
  - .4 Establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, remedial recommendations (including sound curves).
  - .5 Submit complete report of test results including sound curves.
  - .6 Commissioning Documentation:
    - .1 Upon completion and acceptance of certification, hand over to Departmental Representative complete set of construction documents, revised to show "as-built" conditions.
- .2 Manufacturer's Field Services:
  - .1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.
  - .2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:
    - .1 After delivery and storage of products.
    - .2 After preparatory work is complete but before installation commences.
    - .3 Twice during the installation, at 25% and 60% completion stages.
    - .4 Upon completion of installation.
  - .3 Submit manufacturer's reports to Departmental Representative within 3 days of manufacturer representative's review.
  - .4 Make adjustments and corrections in accordance with written report.

### 3.4 CLEANING

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

PART 1      GENERAL1.1      RELATED REQUIREMENTS

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

1.2      REFERENCES

- .1      CSA International
  - .1      CSA C9-02(R2011), Dry-Type Transformers.
  - .2      CSA C22.1-15, Canadian Electrical Code, Part 1 (23rd Edition), Safety Standard for Electrical Installations, With Ontario Amendments, the Ontario Electric Safety Code (OESC).
  - .3      CAN/CSA-C802.2-12, Minimum Efficiency Values for Dry Type Transformers, Includes Update No. 1 (2013).
- .2      Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
  - .1      EEMAC GL1-3-1988, Transformer and Reactor Bushings.
- .3      National Electrical Manufacturers Association (NEMA)

1.3      ACTION AND INFORMATIONAL SUBMITTALS

- .1      Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2      Product Data:
  - .1      Submit manufacturer's instructions, printed product literature and data sheets for transformers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3      Shop Drawings:
  - .1      Submit drawings stamped as reviewed by both General and Electrical Contractor.
  - .2      Indicate on drawings:
    - .1      Dimensions showing enclosure, mounting devices, terminals, taps, internal and external component layout.
    - .2      Technical data:
      - .1      kVA rating.
      - .2      Primary and secondary voltages.
      - .3      Frequency.
      - .4      Three phase.
      - .5      Polarity or angular displacement.
      - .6      Full load efficiency.
      - .7      Regulation at unity pf.
      - .8      BIL.

- .9 Insulation type.
  - .10 Sound rating.
- .4 Factory Test Submittals: submit standard factory test certificates of each transformer and type test of each transformer in accordance with CSA C9.

#### 1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for dry type transformers for incorporation into manual.
- .3 Operation and maintenance instructions to include:
  - .1 Tap changing.
  - .2 Recommended environmental conditions.
  - .3 Recommended periodic inspection and maintenance.
  - .4 Bushing replacement.

#### 1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Instructions and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect transformers from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

### PART 2 PRODUCTS

#### 2.1 MATERIALS

- .1 Dry-type transformers: to CSA C9.
- .2 Bushings: to EEMAC GL1-3, NEMA (1).

#### 2.2 TRANSFORMER CHARACTERISTICS

- .1 Type: ANN.

- .2 Rating: 225 kVA, 3 phase, provisions only for fan forced air cooling, 60 Hz.
- .3 220 insulation system class, 150 degrees C temperature rise.
- .4 Impedance: 5% standard.
- .5 Primary winding: 600 V, delta, BIL 5 kV.
- .6 Secondary winding: 4,160 V, delta, BIL 5 kV.
- .7 No load and full load losses to exceed those indicated in CAN/CSA-C802.2.

### 2.3 ENCLOSURE

- .1 Fabricated from sheet steel with drip shield.
- .2 Bolted removable panels for access to tap connections, enclosed terminals fan brackets.
- .3 Conductor entry:
  - .1 Knockouts.
  - .2 Potheads.
  - .3 Junction boxes.
  - .4 Bushings.
  - .5 Clamping rings.
  - .6 Entry for busbars cable.
- .4 Designed for floor.
- .5 Indoor, ventilated, self cooled type. Temperature of exposed metal parts not to exceed 65 degrees C rise.

### 2.4 VOLTAGE TAPS

- .1 Standard.

### 2.5 TAP CHANGER

- .1 Bolted-link type.

### 2.6 WINDINGS

- .1 Primary and secondary coils:
  - .1 Copper.
  - .2 Open.

- .2 Coil and core assembly:
  - .1 Taps located at front of coils for accessibility.

## 2.7 ACCESSORIES

- .1 Winding temperature detector relay and sensing elements with 2 sets of SPDT contacts.
- .2 Wiring and terminal box for protective devices.
- .3 Grounding terminal: inside of enclosure.

## 2.8 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Equipment labels: nameplate size 7, labelled 225 kVA, 600 V - 4.16 kV.

## PART 3 EXECUTION

### 3.1 EXAMINATION

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

### 3.2 INSTALLATION

- .1 Locate, install and ground transformers in accordance with manufacturer's instructions.
- .2 Set and secure transformers in place, rigid plumb and square.
- .3 Connect primary terminals to high voltage circuit.
- .4 Connect secondary terminals to secondary feeder.
- .5 Use flexible conduit to make connections to transformer.

- .6 Energize transformers and check secondary no-load voltage.
- .7 Adjust primary taps as necessary to produce rated secondary voltage at no-load.
- .8 Use torque wrench to adjust internal connections in accordance with manufacturers' recommended values.
- .9 Check transformer for dryness before putting it into service and if it has not been energized for some considerable time.

### 3.3 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Energize transformers and apply incremental loads:
  - .1 0% for 4 hours.
  - .2 10% for next 1 hour.
  - .3 25% for next 2 hours.
  - .4 50% for next 3 hours.
  - .5 Full load.
  - .6 At each load change, check temperatures ambient enclosure ventilating air winding.
  - .7 Adjust cooling fan controls if required.

### 3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### 3.5 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by transformers installation.

PART 1      GENERAL1.1      RELATED REQUIREMENTS

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

1.2      REFERENCES

- .1      CSA International
  - .1      CAN/CSA-C22.2 No.47-13, Air-Cooled Transformers (Dry Type).
  - .2      CSA C9-02(R2011), Dry-Type Transformers.
  - .3      CAN/CSA-C802.2-12, Minimum Efficiency Values for Dry Type Transformers, Includes Update No. 1 (2013).
- .2      National Electrical Manufacturers Association (NEMA)

1.3      ACTION AND INFORMATIONAL SUBMITTALS

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

1.4      CLOSEOUT SUBMITTALS

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

1.5      DELIVERY, STORAGE AND HANDLING

- .1      Deliver, store and handle materials in accordance with Section 01 00 10 - General Instructions and with manufacturer's written instructions.
- .2      Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3      Storage and Handling Requirements:
  - .1      Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

- .2 Store and protect dry type transformers from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.

## PART 2 PRODUCTS

### 2.1 DESIGN DESCRIPTION

- .1 Design 1.
  - .1 Type: ANN.
  - .2 3 phase, 600 V input, 120/208V output, 60 Hz.
  - .3 Voltage taps: standard.
  - .4 Insulation: Class 100, 90 degrees C temperature rise.
  - .5 Basic Impulse Level (BIL): standard.
  - .6 Hipot: standard.
  - .7 Average sound level: standard
  - .8 Impedance at 17 degrees C: standard
  - .9 Enclosure: CSA, removable metal front panel.
  - .10 Mounting: floor.
  - .11 Finish: in accordance with Section 26 05 00 - Common Work Results for Electrical.
  - .12 Copper windings.
  - .13 Winding configuration to be as noted on drawings.
  - .14 Harmonic Mitigating Phase Shifting transformers as indicated on drawings.
  - .15 KL-Rated Transformers as indicated on drawings.
  - .16 Voltage Regulation to be 4% or better.

### 2.2 EQUIPMENT IDENTIFICATION

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

## PART 3 EXECUTION

### 3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for dry type transformers installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

### 3.2 INSTALLATION

- .1 Mount dry type transformers up to 75 kVA as indicated.
- .2 Mount dry type transformers above 75 kVA on floor.
- .3 Ensure 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.
- .7 Make primary and secondary connections in accordance with wiring diagram.
- .8 Energize transformers after installation is complete.
- .9 Make conduit entry into bottom 1/3 of transformer enclosure.

### 3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### 3.4 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by dry type transformers installation.

PART 1      GENERAL1.1      RELATED REQUIREMENTS

- .1      Section 26 05 00 - Common Work Results for Electrical.
- .2      Section 26 28 16.01 - Insulated Case Circuit Breakers.
- .3      Section 26 28 16.02 - Moulded Case Circuit Breakers.

1.2      REFERENCES

- .1      CSA Group
  - .1      CSA C22.2 No. 31-14, Switchgear Assemblies.

1.3      ACTION AND INFORMATIONAL SUBMITTALS

- .1      Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2      Product Data:
  - .1      Submit manufacturer's instructions, printed product literature and data sheets for service entrance board and include product characteristics, performance criteria, physical size, finish and limitations.
- .3      Shop Drawings:
  - .1      Submit drawings stamped as reviewed by both General and Electrical Contractor.
  - .2      Indicate on 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.
- .4      Test and Evaluation Reports:
  - .1      Submit 3 copies of certified test results.

1.4      MAINTENANCE MATERIAL SUBMITTALS

- .1      Extra Materials:
  - .1      Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

### 1.5 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for service entrance board for incorporation into manual.
- .3 Submit 3 copies of operation and maintenance manual.

### 1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Instructions and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect service entrance board from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Waste Reduction Workplan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, and packaging materials as specified in Waste Reduction Workplan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

## PART 2 PRODUCTS

### 2.1 MAIN SECONDARY SWITCHBOARD

- .1 Main secondary switchboard: to CSA C22.2 No.31.
- .2 Rating as indicated on drawings.
- .3 Cubicles: free standing, dead front, size as indicated.
- .4 Barrier metering section from adjoining Sections.
- .5 Provision for installation of power supply authority metering in barriered Section.

- .6 Departmental Representatives metering.
- .7 Distribution section.
- .8 Hinged access panels with captive knurled thumb screws.
- .9 Bus bars and main connections: 99.3% copper.
- .10 Bus from load terminals of main breaker via metering section to main lugs of distribution section.
- .11 Identify phases with colour coding.

## 2.2 INSULATED CASE BREAKERS

- .1 Provide insulated case circuit breakers in accordance with Section 26 28 16.01 - Insulated Case Circuit Breakers.

## 2.3 MOULDED CASE CIRCUIT BREAKERS

- .1 Provide moulded case circuit breakers in accordance with Section 26 28 16.02 - Moulded Case Circuit Breakers.

## 2.4 GROUNDING

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

## 2.5 GROUND FAULT UNIT

- .1 Main breaker to be supplied with ground fault protection in accordance with Section 26 28 16.01 - Insulated Case Circuit Breakers.

## 2.6 POWER SUPPLY AUTHORITY METERING

- .1 Separate compartment and metal raceway for exclusive use of power supply authority metering.
- .2 Mounting accessories and wiring for metering supplied by power supply authority:
  - .1 Potential transformers.
  - .2 Current transformers.
  - .3 Watthour meter.
  - .4 Demand meter with kWh register.
  - .5 Accessories installed by Division 26.

## 2.7 FINISHES

- .1 Apply finishes in accordance with Section 26 05 00 - Common Work Results for Electrical.
  - .1 Service entrance board exterior: gray.

## 2.8 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Nameplates:
  - .1 White plate, black letters, size 7.
  - .2 Complete board labelled: "600 V."
  - .3 Main disconnect labelled: "Main Breaker".
  - .4 Branch disconnects labelled: as indicated.

## 2.9 SOURCE QUALITY CONTROL

- .1 Departmental Representative to witness final factory tests.
- .2 Notify Departmental Representative in writing 5 days in advance that switchboard is ready for testing.

## PART 3 EXECUTION

### 3.1 EXAMINATION

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

### 3.2 INSTALLATION

- .1 Locate service entrance board.
- .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 Run one grounding conductor 4/0 AWG bare copper in 25 mm conduit from ground bus to building ground.
- .6 Check trip unit settings against co-ordination study to ensure proper working and protection of components.

### 3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

PART 1      GENERAL1.1            RELATED REQUIREMENTS

- .1      Section 26 05 00 - Common Work Results - Electrical.
- .2      Section 26 28 16.02 - Moulded Case Circuit Breakers.

1.2            REFERENCES

- .1      Canadian Standards Association (CSA International)
  - .1      CSA C22.2 No. 29-11, Panelboards and Enclosed Panelboards.

1.3            SHOP DRAWINGS

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

1.4            WASTE MANAGEMENT AND DISPOSAL

- .1      Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management.
- .2      Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3      Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Reduction Workplan.
- .4      Divert unused metal and wiring materials from landfill to metal recycling facility approved by Departmental Representative.

PART 2      PRODUCTS2.1            PANELBOARDS

- .1      Panelboards: to CSA C22.2 No.29 and product of one manufacturer.
  - .1      Install circuit breakers in panelboards before shipment.

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- .2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.
  - .2 600 V panelboards: bus and breakers rated for interrupting capacity, as indicated on drawings, or as per ratings identified in short circuit study, whichever is higher.
  - .3 250 V panelboards: bus and breakers rated for interrupting capacity, as indicated on drawings, or as per ratings identified in short circuit study, whichever is higher.
  - .4 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.
  - .5 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
  - .6 Two keys for each panelboard and key panelboards alike.
  - .7 Copper bus with neutral of same ampere rating as mains.
  - .8 Mains: suitable for bolt-on breakers.
  - .9 Recess trim with concealed front bolts and hinges.
  - .10 Trim and door finish: baked grey enamel.
  - .11 Main breaker where indicated on drawings.
  - .12 Sprinkler guards on all panels.
  - .13 Provide means to lock panel cover using existing padlocks on all panels to prevent unauthorized changes in panelboard.
  - .14 Panelboards with door locks top and bottom.

## 2.2 BREAKERS

- .1 Breakers: to Section 26 28 16.02 - 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, where indicated.
- .4 Lock-on devices for receptacles, fire alarm clock outlet, emergency, door supervisory, intercom, stairway, exit and night light circuits.

### 2.3 EQUIPMENT IDENTIFICATION

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

## PART 3 EXECUTION

### 3.1 INSTALLATION

- .1 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 - Common Work Results for Electrical or as indicated.
- .3 Connect loads to circuits.
- .4 Connect neutral conductors to common neutral bus with respective neutral identified.

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END OF SECTION

## PART 1      GENERAL

### 1.1      RELATED REQUIREMENTS

- .1      Section 26 05 00 - Common Work Results for Electrical.
- .2      Section 26 29 10 - Motor Starters to 600 V.

### 1.2      REFERENCES

- .1      Electrical Equipment Manufacturers Association of Canada (EEMAC)

### 1.3      ACTION AND INFORMATIONAL SUBMITTALS

- .1      Submit in accordance with Section 01 00 10 - General Instructions.
- .2      Product Data:
  - .1      Submit manufacturer's instructions, printed product literature and data sheets for motor control centres and include product characteristics, performance criteria, physical size, finish and limitations.
- .3      Shop Drawings:
  - .1      Submit drawings stamped as reviewed by both General and Electrical Contractor.
  - .2      Indicate on drawings:
    - .1      Outline dimensions.
    - .2      Configuration of identified compartments.
    - .3      Floor anchoring method and dimensioned foundation template.
    - .4      Cable entry and exit locations.
    - .5      Dimensioned position and size of busbars and details of provision for future extension.
    - .6      Schematic and wiring diagrams.
- .4      Manufacturer's Instructions: provide to indicate special handling criteria, installation sequence, and cleaning procedures.

### 1.4      CLOSEOUT SUBMITTALS

- .1      Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2      Operation and Maintenance Data: submit operation and maintenance data for motor control centre for incorporation into manual.
  - .1      Include data for each type and style of starter.

### 1.5 EXTRA STOCK MATERIALS

- .1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Refer to electrical drawings panel schedule.

### 1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Instructions and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect motor control centres from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Waste Reduction Workplan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Waste Reduction Workplan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

## PART 2 PRODUCTS

### 2.1 SUPPLY CHARACTERISTICS

- .1 600 V, 60 Hz, delta connected, 3 phase, 3 wire, grounded.

### 2.2 GENERAL DESCRIPTION

- .1 Compartmentalized vertical sections with common power busbars.
- .2 Floor mounting, free standing, enclosed dead front.
- .3 Indoor CSA 1 gasketed enclosure, front mounting.
- .4 Class I, Type C.

### 2.3 VERTICAL SECTION CONSTRUCTION

- .1 Independent vertical sections fabricated from rolled flat steel sheets bolted together to form rigid, completely enclosed assembly.
- .2 Each vertical section divided into compartment units, minimum 165 mm high, as indicated and to suit starter/ disconnect size.
- .3 Each unit to have complete top and bottom steel plate for isolation between units.
- .4 Horizontal wireways, equipped with cable supports, across top and bottom, extending full width of motor control centre, isolated from busbars by steel barriers.
- .5 Vertical wireways c/w doors for load and control conductors extending full height of vertical sections, and equipped with cable tie supports. Installation wiring to units accessible with doors open and units in place.
- .6 Openings, with removable cover plates, in side of vertical sections for horizontal wiring between sections.
- .7 Incoming cables to enter as indicated.
- .8 Provision for outgoing cables to exit via top or bottom with terminals.
- .9 Removable lifting means.
- .10 Provision for future extension of both ends of motor control centre including busbars without need for further drilling, cutting or preparation in field.
- .11 Divide assembly for shipment to site, as indicated complete with hardware and instructions for re-assembly.

### 2.4 SILLS

- .1 Continuous iron floor sills for mounting bases with 19 mm diameter holes for bolts.

### 2.5 BUSBARS

- .1 Main horizontal and branch vertical, three phase high conductivity tin plated copper busbars in separate compartment self-cooled, extending entire width and height of motor control centre, supported on insulators and rated:
  - .1 Main horizontal busbars: as indicated.
  - .2 Branch vertical busbars: as indicated.
- .2 Branch vertical busbars for distribution of power to units in vertical sections.
- .3 No other cables, wires, equipment in main and branch busbar compartments.

- .4 Brace buswork to withstand effects of short-circuit current as indicated on drawings or Short Circuit Study, whichever is higher.
- .5 Bus supports: with high dielectric strength, low moisture absorption, high impact material and long creepage surface designed to discourage collection of dust.

## 2.6 GROUND BUS

- .1 Copper ground bus extending entire width of motor control centre.
- .2 Vertical ground bus strap, full height of section, tied to horizontal ground bus, engaged by plug-in unit ground stab.

## 2.7 MOTOR STARTERS AND DEVICES

- .1 Refer to Section 26 29 10 - Motor Starters to 600 V.

## 2.8 STARTER UNIT COMPARTMENTS

- .1 Units EEMAC size 5 and smaller, circuit breaker units 225A and smaller, plug-in type with self-disconnect. Guide rail supports for units to ensure that stabs make positive contact with vertical bus. Provision for units to be installed or removed, off load, while buses energized.
- .2 Unit mounting:
  - .1 Engaged position - unit stabbed into vertical bus.
  - .2 Withdrawn position - unit isolated from vertical bus but supported by structure. Terminal block accessible for electrical testing of starter.
  - .3 Provision for positive latching in either engaged or withdrawn position and padlocking in withdrawn position.
  - .4 Stab-on connectors free floating tin plated clips, self-aligning, backed up with steel springs.
- .3 External operating handle of circuit switch interlocked with door to prevent door opening with switch in "on" position. Provision for 3 padlocks to lock operating handle in "off" position and lock door closed.
- .4 Hinge unit doors on same side.
- .5 Overload relays manually reset from front with door closed.
- .6 Pushbuttons and indicating lights mounted on door front.
- .7 Devices and components by one manufacturer to facilitate maintenance.

- .8 Pull-apart terminal blocks for power and control to allow removal of starter units without removal of field wiring.
- .9 Barriercd compartments for control wiring to permit site access without exposure to system line voltage.

## 2.9 WIRING IDENTIFICATION

- .1 Provide wiring identification in accordance with Section 26 05 00 - Common Work Results for Electrical.

## 2.10 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
  - .1 Motor control centre main nameplate: size No. 7, engraved as indicated.
  - .2 Individual compartment nameplates: size No. 5, engraved as indicated.

## 2.11 FINISHES

- .1 Apply finishes in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Paint motor control centre exterior light gray and interiors white.

## 2.12 SOURCE QUALITY CONTROL

- .1 Provide manufacturer's type test certificates including short circuit fault damage certification up to short circuit values specified under bus bracing.
- .2 Departmental Representative to witness standard factory testing of complete motor control centre including operation of switches, circuit breakers, starters and controls.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for motor control centres installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

### 3.2 INSTALLATION

- .1 Set and secure motor control centre in place on channel bases, rigid, plumb and square to building floor and wall.
- .2 Make field power and control connections as indicated.
- .3 Ensure correct overload heater elements are installed.

### 3.3 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Ensure moving and working parts are lubricated where required.
- .3 Operate starters in sequence to prove satisfactory performance of motor control centre during 8 hours period.

### 3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

PART 1      GENERAL1.1      ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide fuse performance data characteristics for each fuse type and size above 60 A. Performance data to include: average melting time-current characteristics.
- .3 Shop Drawings:
  - .1 Provide shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
  - .2 Submit drawings stamped as reviewed by both General and Electrical Contractor.

1.2      DELIVERY, STORAGE AND HANDLING

- .1 Ship fuses in original containers.
- .2 Do not ship fuses installed in switchboard.
- .3 Store fuses in original containers in moisture free location.
- .4 Waste Management and Disposal:
  - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management.

1.3      MAINTENANCE MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Three spare fuses of each type and size installed above 600 A.
- .3 Six spare fuses of each type and size installed up to and including 600 A.

PART 2      PRODUCTS2.1      FUSES - GENERAL

- .1 Fuse type references L1, L2, J1, R1, etc. have been adopted for use in this specification.

- .2 Fuses: product of one manufacturer.

## 2.2 FUSE TYPES

- .1 Class L fuses.
  - .1 Type L1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
  - .2 Type L2, fast acting.
- .2 Class J fuses.
  - .1 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
  - .2 Type J2, fast acting.
- .3 Class R -R fuses.
  - .1 Type R1, (UL Class RK1), time delay, capable of carrying 500% of its rated current for 10 s minimum, to meet UL Class RK1 maximum let-through limits.
  - .2 Type R2, time delay, capable of carrying 500% of its rated current for 10 s minimum.
  - .3 Type R3, (UL Class RK1), fast acting Class R, to meet UL Class RK1 maximum let-through limits.
- .4 Class C fuses.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- .1 Install fuses in mounting devices immediately before energizing circuit.
- .2 Ensure correct fuses fitted to physically matched mounting devices.
  - .1 Install rejection clips for Class R fuses.
- .3 Ensure correct fuses fitted to assigned electrical circuit.
- .4 Where UL Class RK1 fuses are specified, install warning label "Use only UL Class RK1 fuses for replacement" on equipment.
- .5 Install spare fuses in fuse storage cabinet.

## PART 1      GENERAL

### 1.1            REFERENCES

- .1 American National Standards Institute /Institute of Electrical and Electronics Engineers (ANSI/IEEE)
  - .1 ANSI/IEEE C37.13-2008, Low Voltage AC Power Circuit Breakers Used in Enclosures/C37.13a-2012, Amendment 1: Increase of Voltages to 1000 V AC and Below.
- .2 CSA International
  - .1 CSA C22.2 No. 5-13, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national Standard with UL 489, and NMJ-J-266-ANCE-2013), Update No. 1 (2014).

### 1.2            ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for insulated case circuit breakers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit drawings stamped as reviewed by both General and Electrical Contractor.
    - .1 Indicate on drawings:
      - .1 Time-current phase protection co-ordination characteristic curves for breakers.

### 1.3            CLOSEOUT SUBMITTALS

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

### 1.4            DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Instructions and with manufacturer's written instructions.

- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect insulated case circuit breakers from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Waste Reduction Workplan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Waste Reduction Workplan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

## PART 2 PRODUCTS

### 2.1 INSULATED CASE CIRCUIT BREAKERS

- .1 Insulated case circuit breaker: to ANSI/IEEE C37.13 and CSA C22.2 No.5.
- .2 Fixed type, 600 V class.
  - .1 Continuous current rating: as indicated on drawings.
  - .2 Trip rating: as indicated on drawings.
  - .3 Interrupting rating: as indicated on drawings.
- .3 Solid-state tripping system consisting of 1 current sensor per pole, 1 solid-state trip unit and self-powered trip actuator. Equipped with long, short, instantaneous, ground fault function and phase overload, short circuit, and ground fault indication as indicated on drawings.
- .4 Breakers with normal stored energy, closing mechanism to provide quick-make operation for all ratings.
- .5 Breakers with on-off indicator and spring charged/discharged indicator.
- .6 Interrupting capacity of breaker s to be met without current limiting fuses.
  - .1 Include anti-single-phasing coils which act on tripper bar in parallel with current limiting fuses to prevent single phasing.
  - .2 Co-ordinate time current limiting characteristics of fuses with time current tripping characteristics of circuit breaker.

## 2.2            OPTIONAL FEATURES

- .1        Shunt trip: as indicated on drawings.
- .2        Auxiliary switches: as indicated on drawings.
- .3        Undervoltage tripping device with instantaneous time delay: as indicated on drawings.
- .4        Alarm switch: as indicated on drawings.
- .5        Pilot light: as indicated on drawings.
- .6        Reverse power relay: as indicated on drawings.
- .7        Control switch: as indicated on drawings.
- .8        Electric/Key interlock: as indicated on drawings.
- .9        Lockout devices: as indicated on drawings.
- .10      Padlocking provision: as indicated on drawings.
- .11      Operation counter: as indicated on drawings.

## PART 3       EXECUTION

### 3.1           EXAMINATION

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

### 3.2           INSTALLATION

- .1        Install insulated case circuit breakers as indicated.

### 3.3            CLEANING

- .1      Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1          Leave Work area clean at end of each day.
- .2      Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3      Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .1          Remove recycling containers and bins from site and dispose of materials at appropriate facility.

---

END OF SECTION

PART 1 GENERAL1.1 REFERENCES

- .1 Canadian Standards Association (CSA International).
  - .1 CSA C22.2 No. 5-13, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national Standard with UL 489, and NMX-J-266-ANCE-2013), Update No. 1 (2014).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Include time-current characteristic curves for breakers with ampacity of 100 A and over or with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management.
- .2 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Reduction Workplan.
- .3 Separate for reuse and recycling and place in designated containers Steel, Metal, Plastic waste in accordance with Waste Reduction Workplan.

PART 2 PRODUCTS2.1 BREAKERS GENERAL

- .1 Moulded-case circuit breakers, Circuit breakers, and Ground-fault circuit-interrupters, and Accessory high-fault protectors: to CSA C22.2 No. 5.
- .2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40°C ambient.
- .3 Common-trip breakers: with single handle for multi-pole applications.

- .4 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.
  - .1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.
- .5 Circuit breakers to have minimum 22 kA symmetrical rms interrupting capacity rating.
- .6 Adjustable L, S, I trip settings where indicated.

## 2.2 THERMAL MAGNETIC BREAKERS DESIGN A

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

## 2.3 SOLID STATE TRIP BREAKERS DESIGN D

- .1 Moulded case circuit breaker to operate by means of solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition, and long time, short time, instantaneous tripping for phase ground fault short circuit protection.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- .1 Install circuit breakers as indicated.

PART 1      GENERAL1.1      RELATED REQUIREMENTS

- .1      Section 26 05 00 - Common Work Results for Electrical.
- .2      Section 26 28 13.01 - Fuses - Low Voltage.

1.2      REFERENCES

- .1      CSA Group
  - .1      CAN/CSA-C22.2 No. 4-04(2014), Enclosed and Dead-Front Switches (Tri-National Standard, with ANCE NMX-J-162-2004 and UL 98), Includes Updates No. 1 (2006), No. 2 (2006), No. 3 (2011), No. 4 (2012), No. 5 (2014).
  - .2      CSA C22.2 No.39-13, Fuseholder Assemblies.

1.3      ACTION AND INFORMATIONAL SUBMITTALS

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

1.4      DELIVERY, STORAGE AND HANDLING

- .1      Deliver, store and handle materials in accordance with Section 01 00 10 - General Instructions and with manufacturer's written instructions.
- .2      Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3      Storage and Handling Requirements:
  - .1      Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2      Store and protect disconnect switches - fused and non-fused from nicks, scratches, and blemishes.
  - .3      Replace defective or damaged materials with new.
- .4      Develop Waste Reduction Workplan related to Work of this Section.

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

## PART 2 PRODUCTS

### 2.1 DISCONNECT SWITCHES

- .1 Fusible and Non-fusible, Horsepower rated disconnect switch in CSA enclosure, to CAN/CSA-C22.2 No.4 size as indicated.
- .2 Provision for padlocking in on-off switch position by 3 locks.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Fuses: size as indicated, in accordance with Section 26 28 13.01 - Fuses - Low Voltage.
- .5 Fuseholders: to CSA C22.2 No.39, relocatable and suitable without adaptors, for type and size of fuse indicated.
- .6 Quick-make, quick-break action.
- .7 ON-OFF switch position indication on switch enclosure cover.

### 2.2 EQUIPMENT IDENTIFICATION

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

## PART 3 EXECUTION

### 3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for disconnect switches - fused and non-fused installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

### 3.2 INSTALLATION

- .1 Install disconnect switches complete with fuses if applicable.

### 3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.  
.1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.  
.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

## PART 1      GENERAL

### 1.1      RELATED REQUIREMENTS

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

### 1.2      REFERENCES

- .1      International Electrotechnical Commission (IEC)
  - .1      IEC 947-4-1 Ed. 3.1 b: 2012, Low-Voltage Switchgear and Controlgear - Part 4-1: Contactors and Motor-Starters - Electromechanical contactors and motor-starters.

### 1.3      ACTION AND INFORMATIONAL SUBMITTALS

- .1      Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2      Product Data:
  - .1      Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3      Shop Drawings:
  - .1      Provide shop drawings: in accordance with Section 01 33 00 - Submittal Procedures.
    - .1      Submit drawings stamped as reviewed by both General and Electrical Contractor.
    - .2      Provide shop drawings for each type of starter to indicate:
      - .1      Mounting method and dimensions.
      - .2      Starter size and type.
      - .3      Layout and components.
      - .4      Enclosure types.
      - .5      Wiring diagram.
      - .6      Interconnection diagrams.

### 1.4      CLOSEOUT SUBMITTALS

- .1      Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2      Submit operation and maintenance data for each type and style of motorstarter for incorporation into maintenance manual.

- .3 Extra Materials:
  - .1 Provide listed spare parts for each different size and type of starter.
    - .1 3 contacts, stationary.
    - .2 3 contacts, movable.
    - .3 1 contacts, auxiliary.
    - .4 1 control transformers.
    - .5 1 operating coil.
    - .6 2 fuses.
    - .7 10% indicating lamp bulbs used.

## 1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 00 10 - General Instructions.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding and packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- .1 Starters: to IEC 947-4 with AC4 utilization category.

### 2.2 MANUAL MOTOR STARTERS

- .1 Single and Three 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 One/Three overload heaters, manual reset, trip indicating handle.
- .2 Accessories:
  - .1 Toggle switch: standard duty labelled as indicated.
  - .2 Indicating light: standard type and colour as indicated.
  - .3 Locking tab to permit padlocking in "ON" or "OFF" position.

### 2.3 FULL VOLTAGE MAGNETIC STARTERS

- .1 Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:
  - .1 Contactor solenoid operated, rapid action type.

- .2 Motor overload protective device in each phase, manually reset from outside enclosure.
  - .3 Wiring and schematic diagram inside starter enclosure in visible location.
  - .4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
- .2 Combination type starters to include circuit breaker with operating lever on outside of enclosure to control circuit breaker, and provision for:
    - .1 Locking in "OFF" position with up to 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: standard labelled as indicated.
    - .2 Indicating lights: standard type and color as indicated.
    - .3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.

## 2.4 CONTROL TRANSFORMER

- .1 Single phase, dry type, control transformer with primary voltage as indicated and 120 V 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 ACCESSORIES

- .1 Pushbutton: heavy duty, oil tight as required.
- .2 Selector switches: heavy duty, oil tight as required.
- .3 Indicating lights: heavy duty, oil tight, type and colour as indicated.

## 2.6 FINISHES

- .1 Apply finishes to enclosure in accordance with Section 26 05 00 - Common Work Results for Electrical.

## 2.7 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.

- .3 Magnetic starter designation label, white plate, black letters.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

- .1 Install starters and control devices in accordance with manufacturer's instructions.
- .2 Install and wire starters and controls as indicated.
- .3 Ensure correct fuses installed.
- .4 Confirm motor nameplate and adjust overload device to suit.

#### 3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical and manufacturer's instructions.
- .2 Operate switches and 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 indicated.

#### 3.3 CLEANING

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

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## PART 1      GENERAL

### 1.1      RELATED REQUIREMENTS

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

### 1.2      REFERENCES

- .1      CSA International
  - .1      CSA C22.2 No. 5-13, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national Standard with UL 489, and NMJ-J-266-ANCE-2013), Update No. 1 (2014).
  - .2      CSA C22.2 No.178.1-12, Transfer Switch Equipment.
  - .3      CAN/CSA C60044-1-07 (R2011), Instrument Transformers - Part 1: Current Transformers (Adopted CEI/IEC 60044-1:1996 + A1:2000 + A2:2002, edition 1.2, 2003-02, with Canadian deviations), Includes Update No. 1 (July 2010).
- .2      National Electrical Manufacturers Association (NEMA)
  - .1      NEMA ICS 2-2000 (R2005), Controllers, Contactors, and Overload Relays, Rated 600 V.

### 1.3      ACTION AND INFORMATIONAL SUBMITTALS

- .1      Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2      Product Data:
  - .1      Submit manufacturer's instructions, printed product literature and data sheets for transfer switches and include product characteristics, performance criteria, physical size, finish and limitations.
- .3      Shop Drawings:
  - .1      Submit drawings stamped and reviewed by both General and Electrical Contractor.
    - .1      Indicate on drawings:
      - .1      Make, model and type.
      - .2      Single line diagram showing controls and relays.
      - .3      Description of equipment operation including:
        - .1      Automatic starting and transfer to standby unit and back to normal power.
        - .2      Test control.
        - .3      Manual control.
        - .4      Automatic shutdown.

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#### 1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for transfer switches for incorporation into manual.
- .3 Detailed instructions to permit effective operation, maintenance and repair.
- .4 Technical data:
  - .1 Schematic diagram of components, controls and relays.
  - .2 Illustrated parts lists with parts catalogue numbers.
  - .3 Certified copy of factory test results.

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#### 1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Instructions and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect transfer switches from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Waste Reduction Workplan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, and packaging materials as specified in Waste Reduction Workplan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

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### PART 2 PRODUCTS

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#### 2.1 SYSTEM DESCRIPTION

- .1 Automatic load transfer equipment to:
  - .1 Monitor voltage on phases of normal power supply.
  - .2 Initiate cranking of standby generator unit on normal power failure or abnormal voltage on any one phase below preset adjustable limits for adjustable period of time.
  - .3 Transfer load from normal supply to standby unit when standby unit reaches rated frequency and voltage pre-set adjustable limits.

.4 Transfer load from standby unit to normal power supply when normal power restored, confirmed by sensing of voltage on phases above adjustable pre-set limit for adjustable time period.

.5 Shut down standby unit after running unloaded to cool down using adjustable time delay relay.

## 2.2 MATERIALS

.1 Instrument transformers: to CAN/CSA C60044-1.

.2 Contactors: to NEMA ICS 2.

## 2.3 CONTACTOR TYPE TRANSFER EQUIPMENT

.1 Contact Type Transfer Equipment: to CSA C22.2 No. 178.1.

.2 Two-3 pole contactors mounted on common frame, in double throw arrangement, mechanically and electrically interlocked, solenoid, with CSA enclosure.

.3 Rated: 600 V, 60Hz, 400 A. 4 wire, solid neutral, size as indicated on drawings.

.4 Main contacts: silver surfaced, protected by arc disruption means.

.5 Switch and relay contacts, coils, spring and control elements accessible for inspection and maintenance from front of panel without removal of switch panel or disconnection of drive linkages and power conductors.

.6 Auxiliary contact: silver plated, to initiate emergency generator start-up on failure of normal power.

.7 Fault withstand rating: as per drawings.

.8 Lever to operate switch manually when switch is isolated.

.9 Neutral bar, solid rated: as same as switch mains, as indicated on drawings.

## 2.4 CONTROLS

.1 Selector switch -4 position Test Auto Manual Engine Start.

.1 Test position - normal power failure simulated. Engine starts and transfer takes place. Return switch to "Auto" to stop engine.

.2 Auto position - normal operation of transfer switch on failure of normal power; retransfers on return of normal voltage and shuts down engine.

.3 Manual position - transfer switch may be operated by manual handle but transfer switch will not operate automatically and engine will not start.

.4 Engine start position - engine starts but unit will not transfer unless normal power supply fails. Switch must be returned to "Auto" to stop engine.

- .2 Control transformers: dry type with 120 V secondary to isolate control circuits from:
  - .1 Normal power supply.
  - .2 Emergency power supply.
- .3 Relays: continuous duty, industrial control type, with wiping action contacts rated 10 A minimum:
  - .1 Voltage sensing: 3 phase for normal power and on one phase only for emergency, solid state type, adjustable drop out and pick up, close differential, 2 V minimum undervoltage and over voltage protection.
  - .2 Time delay: normal power to standby, adjustable solid state, 0 to 60 s.
  - .3 Time delay on engine starting to override momentary power outages or dips, adjustable solid state, 0 to 60 s delay.
  - .4 Time delay on retransfer from standby to normal power, adjustable 20 s to 10 minutes.
  - .5 Time delay for engine cool-off to permit standby set to run unloaded after retransfer to normal power, adjustable solid state, 20 s intervals to 10 minutes.
- .4 Solid state electronic in-phase monitor.

## 2.5 ACCESSORIES

- .1 Ensure pilot lights indicate power availability normal and standby, switch position, green for normal, red for standby, mounted in panel.
- .2 Plant exerciser: 168 hours timer to start standby unit once each week for selected interval but does not transfer load from normal supply transfers load to emergency supply and retransfers to normal supply on standby unit shutdown. Timer adjustable 0-168 hours in 15 minute intervals.
- .3 Auxiliary relay to provide 2 N.O. and 2 N.C. contacts for remote alarms.
- .4 Pre-transfer contacts to signal hot to hot transfer to elevator equipment.
- .5 Instruments:
  - .1 Digital true RMS, indicating type 2% accuracy, flush panel mounting:
    - .1 Voltmeter: ac, scale 0 to 1000 V.
    - .2 Ammeter: ac, scale 0 to 600 A.
    - .3 Frequency meter: scale 55 to 65 Hz.
- .6 Manual bypass and isolator: to both supplies.

## 2.6 EQUIPMENT IDENTIFICATION

- .1 Identify equipment in accordance with Section 26 05 00 - Common Work Results for Electrical.

- .2 Control panel:
  - .1 For selector switch and manual switch: size 5 nameplates.
  - .2 For meters, indicating lights, minor controls: use size 3 nameplates.

## 2.7 SOURCE QUALITY CONTROL

- .1 Complete equipment, including transfer mechanism, controls, relays and accessories factory assembled and tested in presence of Departmental Representative.
- .2 Notify Departmental Representative 5 days minimum in advance of date of factory test.
- .3 Tests:
  - .1 Operate equipment both mechanically and electrically to ensure proper performance.
  - .2 Check selector switch, in modes of operation Test, Auto, Manual, Engine Start and record results.
  - .3 Check voltage sensing and time delay relay settings.
  - .4 Check:
    - .1 Automatic starting and transfer of load on failure of normal power.
    - .2 Retransfer of load when normal power supply resumed.
    - .3 Automatic shutdown.
    - .4 In-phase monitor operation.

## PART 3 EXECUTION

### 3.1 EXAMINATION

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

### 3.2 INSTALLATION

- .1 Locate, install and connect transfer equipment as indicated.
- .2 Check relays/solid state monitors and adjust as required to ensure correct operation.

### 3.3 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Energize transfer equipment from normal power supply.
- .3 Set selector switch in "Test" position to ensure proper standby start, running, transfer, retransfer. Return selector switch to "Auto" position to ensure standby shuts down.
- .4 Set selector switch in "Manual" position and check to ensure proper performance.
- .5 Set selector switch in "Engine start" position and check to ensure proper performance. Return switch to "Auto" to stop engine.
- .6 Set selector switch in "Auto" position and open normal power supply disconnect. Standby should start, come up to rated voltage and frequency, and then load should transfer to standby. Allow to operate for 10 minutes, then close main power supply disconnect. Load should transfer back to normal power supply and standby should shutdown.
- .7 Repeat, at 1 hour intervals, 2 times, complete test with selector switch in each position, for each test.

### 3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

## PART 1      GENERAL

### 1.1      RELATED REQUIREMENTS

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

### 1.2      REFERENCES

- .1      Canadian Standards Association (CSA International)
  - .1      CSA Z462-12, Workplace Electrical Safety.
- .2      Institute of Electrical and Electronics (IEEE)
  - .1      IEEE Standard 399-1997, 'IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis'.
  - .2      IEEE Standard 242-2001, 'IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems'.
  - .3      IEEE Standard 1584-2002, 'IEEE Guide for Performing Arc-Flash Hazard Calculations'.

### 1.3      DEFINITIONS

- .1      Bus or Busses: This implies an electrically significant node within the distribution system as defined within IEEE Standard 399 and 1584. Typically, this would include, but not be limited to, the following items:
  - .1      Switchgear and Switchboards
  - .2      Panelboards
  - .3      Motor Control Centres
  - .4      Medium-voltage loadbreak and disconnect switches
  - .5      Low-voltage disconnects, enclosed breakers
  - .6      Splitters and junction boxes
  - .7      Motor starters and variable speed drives
  - .8      Transfer switches (normal, emergency and load side busses)
  - .9      Generators and uninterruptible power supplies
  - .10     Transformers (primary and secondary busses)

### 1.4      SITE INVESTIGATION

- .1      Thorough site investigation is required to ascertain the required details of the existing equipment, system and infrastructure. No shutdowns will be permitted to conduct the required site investigation.

## 1.5 QUALITY ASSURANCE

- .1 Qualifications:
  - .1 The studies shall be prepared by an Engineering, Technical firm, or distribution equipment manufacturer that regularly performs these types of Power Systems Studies.
  - .2 The studies shall be performed or reviewed by a qualified Professional Engineer, licensed to practice in the Province of Ontario.
  - .3 Site Work:
    - .1 All required site work must be completed by two competent, qualified personnel, as defined by CSA Z462.
    - .2 Full Personal Protective Equipment (PPE) must be used when required, including but not limited to helmets, boots, safety glasses, face shields, arc flash suits, gloves, hearing protection, and other equipment suitably rated for the arc flash class, as defined by CSA Z462.
    - .3 All tools shall be fully insulated for the voltage class rating of the switchgear being accessed.
    - .4 All relevant non-contact boundaries must be maintained and appropriate tools shall be used as necessary to obtain all required information without contacting live conductors.

## 1.6 SOFTWARE

- .1 The power systems studies shall be performed using one of the following programs:
  - .1 SKM Power Tools for Windows
  - .2 ETAP
  - .3 Easy Power
  - .4 CYME

## 1.7 SYSTEM MODEL

- .1 The Short Circuit Study Model shall include:
  - .1 All existing and new busses within the Confederation Building from the incoming utility supply in the transformer vault, down through the new main low-voltage switchboard to all panelboards, splitters, motor control centres, disconnect switches, motor starters, and other distribution equipment.
  - .2 Motors making significant contributions to system fault levels (i.e. > 150HP)
  - .3 All emergency sources, including generators, and emergency distribution
  - .4 All significant sources of impedance, including:
    - .1 Utility and emergency sources
    - .2 Cables
    - .3 Transformers
    - .4 Filters and reactors
    - .5 Other devices impacting the fault levels.
  - .5 Cable types and sizes shall be visually confirmed. Estimated lengths shall be within 10% of actual.
  - .6 Transformer impedances shall be visually confirmed.

- .7 Generators shall be modelled using actual impedances, damage and decrement curves, wherever possible.
- .8 Liason with local supply authority is required in order to confirm fault levels available at the point of utility supply.
- .2 The Device Evaluation Study Model shall include:
  - .1 All of the unique protective devices directly connected to each bus within the scope of the Short Circuit Study, including:
    - .1 Circuit Breakers
    - .2 Motor Circuit Protectors
    - .3 Fuses
    - .4 Switches (withstand rating)
    - .5 Automatic Transfer Switches (withstand rating)
    - .6 Any other devices that may be required to make or break fault and/or load currents.
- .3 The Coordination Study Model shall include:
  - .1 All protective devices directly connected to each bus within the scope of the Short Circuit Study, complete with their existing settings, including:
    - .1 Circuit Breakers
    - .2 Motor Circuit Protectors
    - .3 Fuses
    - .4 Relays
    - .5 Overloads
  - .2 All equipment to be protected by the above-listed devices, including:
    - .1 Transformers
    - .2 Generators
    - .3 Cables
    - .4 Busses
    - .5 Motors
  - .3 Accurate trip curves for all protective devices, obtaining assistance from manufacturers as required.
  - .4 Accurate characteristics and settings for upstream relays, obtaining assistance from supply authority as required.
- .4 The Arc Flash Study Model shall include:
  - .1 All busses within the scope of the Short Circuit Study, with the exception of:
    - .1 Busses supplied by a circuit rated 240V or less, provided the circuit is fed from one transformer rated less than 125kVA.
    - .2 Isolation disconnects at loads that are confirmed to meet the requirements of CSA Z462 default Table 4 Hazard/Risk Categories.
  - .2 Note: busses excluded from model still must be labelled.

## 1.8 POWER SYSTEMS STUDY REQUIREMENTS

- .1 Short Circuit Study:
  - .1 Document maximum three phase and single line to ground fault currents for each bus.

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- .2 Multiple short circuit studies must be conducted for all applicable system configurations and modes of operation, including:
    - .1 Ultimate, maximum and minimum utility supplies
    - .2 Emergency sources, including single and paralleled generators, where applicable.
  - .3 For each short circuit study, the following must be tabulated for each bus:
    - .1 Interrupting duty
    - .2 Momentary duty
    - .3 RMS symmetrical and asymmetrical short circuit currents
    - .4 X/R ratios
    - .5 Source impedance
  - .2 Device Evaluation Study:
    - .1 For each evaluated protective device, include the actual and effective maximum fault duty. Actual and effective fault duties may differ depending on the X/R ratio at the bus.
    - .2 Device evaluation reports shall include a list of all busses complete with:
      - .1 Voltage
      - .2 Maximum fault current
      - .3 X/R ratio
      - .4 All unique protective devices with their:
        - .1 Rated voltage
        - .2 Test X/R ratio
        - .3 Fault duty
        - .4 Symmetrical rating
        - .5 Asymmetrical rating (where applicable)
        - .6 Series rating (where applicable)
        - .7 Pass or Fail
  - .3 Coordination Study:
    - .1 Provide time-current graphs for all components from the supply authority's protective devices and generator protection down through to the 2 largest protective devices at each bus supplied from a circuit breaker with an adjustable trip unit, either directly or through a transformer.
    - .2 Each building on the campus must be represented in at least one graph, even simple buildings having a small electrical service.
    - .3 Each time-current graph shall be printed in colour on a log log time vs current scale. Multiple colours and/or hatching patterns shall be used to allow the reader to easily discriminate between all devices represented on the graphs.
    - .4 Graphs shall include the following time-current curves, each terminating at the 3 phase symmetrical fault level calculated for the bus:
      - .1 Relay, fuse, static-trip breaker, thermal-magnetic circuit breaker, overload and motor circuit protector curves.
      - .2 Transformer inrush, damage, and overload curves.
      - .3 Cable, bus and conductor damage curves, where applicable.
      - .4 Motor starting curves and associated protective devices for motors larger than 150HP.

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- .5 Each graph should additionally contain:
    - .1 A single-line diagram depicting all of the device curves included in the graph, and how they are interconnected.
    - .2 Protective device details, including make, model, trip unit, ratings, sensor, plug, current-transformer, and settings, as applicable.
  - .6 Provide tabulated existing and recommended protective device settings, sorted logically by building, system, substation and electrical room. The location of all protective devices in the tables should be easy to determine, and tables should cross reference coordination graphs in which each protective device is shown.
- .4 Arc Flash Study:
- .1 Provide arc flash reports for all applicable system operation scenarios including, for each bus requiring detailed calculations under IEEE 1584:
    - .1 Incident energy level
    - .2 Arcing current
    - .3 Interrupting time
    - .4 Flash protection boundary
    - .5 Hazard/Risk category level
  - .2 Provide detailed IEEE 1584 labels as per CSA Z462 Annex Q.4.
  - .3 If using Table 4 methods for local isolation disconnects at loads, provide an Adobe Acrobat file providing the default CSA Z462 Table 4 label(s). Modified CSA Z462 Table 4 labels to include information as per CSA Z462 Table 4 for each type of switchgear element.
- .5 Single-Line Diagram(s):
- .1 Provide single-line diagram(s) extracted from the software program used to perform the power systems studies. Scale and quantity of drawing(s) to be chosen so that device details are clear and legible. Drawings to contain:
    - .1 Transformer ratings, including primary and secondary voltages, rated kVA and impedance.
    - .2 Cable and bus duct sizes/ratings and lengths.
    - .3 Bus names and nominal voltages.
    - .4 Protective device names, make, model and frame/trip ratings.
    - .5 Utility and generator parameters.
- .6 Final Report:
- .1 Shall contain all required information from Short Circuit, Device Evaluation, Coordination and Arc Flash Studies, as listed above.
  - .2 Report shall be submitted in Adobe Acrobat (pdf) format for review in conjunction with the shop drawings for the project. Shop drawings for new distribution equipment will not be reviewed or released until the final report is completed to the satisfaction of the Departmental Representative.
  - .3 A review of the report shall be conducted by the Departmental Representative. A formal written response to their comments shall be provided. If required, upon agreement of all parties, modifications to the report will be carried out, after which, the final report shall be published.
  - .4 Five (5) hardcopies of the final report shall be provided in binders.
  - .5 Five (5) CD's or DVD's shall be provided containing the complete report in Adobe Acrobat (pdf) format.

## PART 2 PRODUCTS

### 2.1 ARC FLASH AND SHOCK WARNING LABELS

- .1 Provide shock and arc flash warning labels and affix on all busses within the Confederation Building.
  - .1 All labels to be done in both English and French.
  - .2 Free-standing multi-cell switchgear and motor control centres to be provided with labels for the front and rear of each cell.
- .2 Labels to be:
  - .1 Self-adhesive, polyester.
  - .2 UV rated (suitable for installation outdoors)
  - .3 Printed using thermal transfer method.
  - .4 No handwritten labels will be permitted.

## PART 3 EXECUTION

### 3.1 NOT USED

- .1 Not used.