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**Part 1        General**

**1.1        RELATED REQUIREMENTS**

- .1        Section 01 33 00 - Submittal Procedures.
- .2        Section 01 45 00 - Quality Requirements.
- .3        Section 01 61 00 - Product Requirements.
- .4        Section 01 70 00 - Contract Closeout.
- .5        Section 01 74 11 - Cleaning.
- .6        Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .7        Section 01 78 00 - Closeout Submittals.

**1.2        REFERENCE STANDARDS**

- .1        Canadian Standards Association (CSA International)
  - .1        CSA C22.1-18, Canadian Electrical Code, Part 1 (24<sup>th</sup> Edition), Safety Standard for Electrical Installations.
  - .2        CAN3-C235, Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
- .1        Institute of Electrical and Electronics Engineers (IEEE)/National Electrical Safety Code Product Line (NESC).
  - .1        IEEE SP1122, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

**1.3        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.

**1.4        ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Submit in accordance with the following sections unless superseded by more stringent specifications included elsewhere.
- .3        Product Data:
  - .1        Submit manufacturer's instructions, printed product literature and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2        Submit:
    - .1        Functional description of equipment.
    - .2        Technical data for all devices.
    - .3        Device location plans and cable lists.
    - .4        Devices mounting location detail drawings.
    - .5        Typical devices connection detail drawings.

- .4 Shop drawings:
  - .1 Submit drawings, wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.
  - .2 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
  - .3 Indicate of drawings clearances for operation, maintenance, and replacement of operating equipment devices.
  - .4 Submit two copies of 24 in. x 24 in. (600 mm x 600 mm) minimum size drawings to inspection authorities.
  - .5 If changes are required, notify Departmental Representative of these changes before they are made.
- .5 Certificates:
  - .1 Provide CSA certified equipment and material.
  - .2 Where CSA certified equipment or material is not available, submit such equipment or 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 General Conditions of contract.
  - .5 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Departmental Representative.
- .6 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.

## **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 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 Description of system operation.
  - .3 Description of each subsystem operation.
  - .4 Operation 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.

- .5 List showing each piece of equipment in system or subsystem by its original manufacturer name and model number.
  - .6 Part list showing parts used in equipment by identification numbers that are standard to electronics industry.
  - .7 Print or engrave operating instructions and frame under glass or in approved laminated plastic.
  - .8 Post instructions where directed.
  - .9 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.
  - .10 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.
- .3 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.
- .1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
- .4 As-Built Record Drawings.
- .1 General:
    - .1 The Contractor shall keep an accurate record of as-built conditions. Record any variations from the contract documents, showing all changes made on site, including but not limited to, actual dimensions, elevations, inverts, sizes and other description notations.
  - .2 Hard copy submission:
    - .1 Hard copies to be submitted in conjunction with required electronic files.
    - .2 All as-built drawings are to be prints of the electronic version and are to be identical to the CAD drawings. All electronic copies of as built record drawings are to bear the electronic seal of the designer as per the hard copy.

## 1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance 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, well-ventilated area.
  - .2 Store and protect from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return of pallets, crates, packaging materials.

**Part 2        Products**

**2.1        DESIGN REQUIREMENTS**

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

**2.2        MATERIALS AND EQUIPMENT**

- .1        Provide material and equipment in accordance with Section 01 61 00 - Common Product Requirements.
- .2        Material and equipment to be CSA certified. Where CSA certified equipment or material is not available, submit such equipment or material to inspection authorities for special approval before delivery to site as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .3        Factory assemble control panels and component assemblies.
- .4        All devices, equipment, and systems must be capable of off-season storage in-place without supplemental heat, and without the need to "winterize" any item(s).
- .5        Deviations from or substitutions of electrical equipment, appliances, luminaires and mechanical equipment that utilises electricity shall not be permitted without written approval of the Departmental Representative.

**2.3        ELECTRIC MOTORS, EQUIPMENT AND CONTROLS**

- .1        Verify installation and co-ordination responsibilities related to motors, equipment, and controls, as indicated.
- .2        Verify coordination of overload and overcurrent protective devices for coordination as required by the Canadian Electrical Code (CSA22.1-2018) rule 38-062.

**2.4        WARNING SIGNS**

- .1        Warning Signs: in accordance with requirements of CSA C22.1, the authority having jurisdiction and the Departmental Representative.
- .2        Decal signs, minimum size 175 mm 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 All switchboards, panels, disconnect switches, power/voice/data/ outlets, transformers, control panels, and motor starters are to be provided with lamicoïd nameplates. Nameplates shall be affixed true and level, and plumb in all instances.
- .2 Identify electrical equipment with nameplates as follows:
  - .1 Nameplates: lamicoïd, matt white finish face, black core, mechanically attached with self tapping screws lettering accurately aligned and engraved into core.
  - .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
- .3 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.
- .4 Wording on nameplates to be approved by Departmental Representative prior to manufacture.
- .5 Allow for minimum of twenty-five (25) letters per nameplate.
- .6 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .7 Terminal cabinets and pull boxes: indicate system and voltage.
- .8 Transformers: indicate capacity, primary and secondary voltages.

**2.7 WIRING IDENTIFICATION**

- .1 Identify wiring with permanent indelible identifying markings, numbered, 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 FINISHES**

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

**Part 3 Execution**

**3.1 ADMINISTRATION**

- .1 Obtain and pay for all necessary permits required to perform the work. Comply with all permit requirements and conditions.

**3.2 MANUFACTURER'S INSTRUCTIONS**

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

**3.3 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 the 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.

**3.4 INSTALLATION**

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.
- .2 Do complete installation in accordance with the National Building Code of Canada 2015 Edition except where specified otherwise.
- .3 Do underground systems in accordance with CAN/CSA-C22.3 No.1 except where specified otherwise.
- .4 All drawings, diagrams, sketches, raceway locations and routings, cable locations and routings, etc. illustrate intent only. Symbols on drawings indicate approximate locations. Refer to architectural plans and details. The contractor shall make all necessary adjustments to suit supplied equipment and shall achieve the required functionality.
- .5 Establish a detailed work plan with the general contractor. Submit the workplan to the Departmental Representative for approval.
- .6 Coordinate electrical work requirements with all other trades on site to avoid conflict. Report any conflicts to the Departmental Representative. All electrical and control circuits provided for mechanical equipment shall be coordinated with the mechanical contractor. Verify equipment nameplate ratings prior to installation and connection and report any discrepancies to the Departmental Representative. Coordinate routing and final installation locations on site with mechanical trades. Provide all necessary equipment, raceways, fittings, fasteners and device boxes to provide a complete system. Coordinate all routing of data/communications raceways with communications contractor.
- .7 Coordinate the sealing of all penetrations created by new installation with the general contractor. Fire-rated CSA approved compound required upon entering or exiting data/server rooms. Fire rating integrity in all other areas shall be maintained.

### **3.5 NAMEPLATES AND LABELS**

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

### **3.6 LOCATION OF OUTLETS**

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

### **3.7 MOUNTING HEIGHTS**

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 Install electrical equipment at following heights unless indicated otherwise or superseded by other Codes or Standards.
  - .1 Local switches: 1420 mm.
  - .2 Light switches: 1420 mm.
  - .3 Wall receptacles:
    - .1 General: 300 mm.
    - .2 Exterior: 450 mm.
    - .3 Above top of counters or counter splash backs: 175 mm.
  - .4 Panelboards: as required by Code or as indicated.
- .3 If mounting height of equipment is not specified or indicated, verify with Departmental Representative before proceeding with installation.

### **3.8 CO-ORDINATION OF PROTECTIVE DEVICES**

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

### **3.9 FIELD QUALITY CONTROL**

- .1 Load Balance:
  - .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
  - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
  - .3 Provide upon completion of work, load balance report as directed in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS, phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.



- .2 Conduct following tests in accordance with Section 01 45 00 - Quality Control.
  - .1 Power distribution system including phasing, voltage, grounding and load balancing.
  - .2 Circuits originating from branch distribution panels.
  - .3 Lighting and its control.
  - .4 Motors, heaters, and associated control equipment including sequenced operation of systems where applicable.
  - .5 Insulation resistance testing:
    - .1 Test circuits, feeders and equipment rated up to 350 V with a 500 V instrument.
    - .2 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.

### **3.10 SYSTEM STARTUP**

- .1 Instruct Departmental Representative 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.

### **3.11 CLEANING**

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

**END OF SECTION**

**Part 1        General**

**1.1        RELATED REQUIREMENTS**

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

**1.2        REFERENCE STANDARDS**

- .1        CSA International
  - .1        CAN/CSA-C22.2 No.18.1-13, Metallic Outlet Boxes.
  - .2        CAN/CSA-C22.2 No.65-13, Wire Connectors (Tri-National Standard with UL 486A-486B and NMX-J-543-ANCE-03).

**Part 2        Products**

**2.1        MATERIALS**

- .1        Pressure type wire connectors 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 TECK cable, flexible conduit, armoured cable, as required to: CAN/CSA-C22.2 No.18.

**Part 3        Execution**

**3.1        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 to CAN/CSA-C22.2 No.65. Replace insulating cap.
- .2        The use of bushing stud connectors is not acceptable.

**END OF SECTION**

**Part 1            General**

**1.1                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 26 05 00 - Common Work Results for Electrical.

**Part 2            Products**

**2.1                BUILDING WIRES**

- .1    Conductors: copper, stranded for #12 AWG and larger. Minimum size: #12 AWG.
- .2    Copper conductors: size as indicated
  - .1    600V insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE Non Jacketed.
  - .2    600V insulation of cross-linked thermosetting polyethylene material rated RWU90 XLPE Non Jacketed.

**2.2                ARMOURED CABLES**

- .1    Conductors: insulated, copper, size as indicated.
- .2    Type: AC90. Minimum size: #12 AWG.
- .3    Armour: interlocking type fabricated from aluminum strip.
- .4    Connectors: anti short connectors.

**2.3                NON-METALLIC SHIELDED CABLES**

- .1    The use of non-metallic shielded cables (NMD 90, NMWU 90, etc.) is not permitted.

**2.4                CONTROL CABLES**

- .1    Type: low energy 300 V control cable: solid annealed copper conductors sized as required or as indicated:
  - .1    Insulation: thermoplastic.
  - .2    Sheath: thermoplastic jacket.
  - .3    Shielding: metallized tapes over conductors.

**2.5                TECK90 CABLE**

- .1    Cable: in accordance with Section 26 05 00 - Common Work Results for Electrical.

- .2 Conductors:
  - .1 Grounding conductor: copper.
  - .2 Circuit conductors: copper.
  - .3 Size as indicated, minimum size: #12 AWG.
- .3 Insulation:
  - .1 Cross-linked polyethylene XLPE.
  - .2 Rating: 600V.
- .4 Armour: interlocking aluminum.
  - .1 Overall covering: thermoplastic polyvinyl chloride, compliant to applicable Building Code classification for this project, UV rated, suitable for use at -40 Degrees C.
- .5 Fastenings:
  - .1 One-hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
  - .2 Channel type supports for two or more cables
  - .3 Threaded rods: 6 mm diameter to support suspended channels.
- .6 Connectors:
  - .1 Watertight, approved for TECK cable.

### **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 before energizing electrical system.

#### **3.2 GENERAL CABLE INSTALLATION**

- .1 Cables connecting to devices located external to buildings, or where exposed to damp or wet conditions shall be type TECK90.
- .2 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - (0-1000 V).
- .3 Cable Colour Coding: to Section 26 05 00 - Common Work Results for Electrical.
- .4 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Wiring from below, and horizontal wiring in walls to be avoided unless indicated.
- .5 Shared neutrals shall not be used in 2-wire branch circuit wiring.
- .6 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.

**3.3 INSTALLATION OF BUILDING WIRES**

- .1 Install wiring as follows:
  - .1 In conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
  - .2 Install pull string in all unused conduits intended for the future installation of building wires.
  - .3 Install insulated bonding conductors in all conduits containing building wires.

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

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

**3.5 INSTALLATION OF ARMoured CABLES**

- .1 AC-90 shall only be permitted for branch circuit wiring drops from ceiling junction boxes to light fixtures, receptacles and other equipment in the same room requiring electrical power. The installation of AC-90 cable for branch circuit wiring home runs or runs between rooms is not acceptable. Raceway and building wire shall be used for this purpose unless otherwise noted.
- .2 AC-90 shall not be used where the cable remains exposed, following completion of construction, at any point between the finished floor level to a point 2m above finished floor.
- .3 All AC-90 fixture or device feeds shall originate from the sides of outlet boxes and not from the box cover.
- .4 Termination of AC90 cable is to utilize steel connections with accompanying lock nuts similar to or equal to T&B 3301 series, or reviewed equal.

**3.6 INSTALLATION OF CONTROL CABLES**

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

**END OF SECTION**

**Part 1        General**

**1.1            RELATED REQUIREMENTS**

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

**1.2            REFERENCE STANDARDS**

- .1        Canadian Standards Association (CSA International)
  - .1        CSA C22.2 No.41-13, Grounding and Bonding Equipment (Tri-National Standard, with NMX-J-590ANCE and UL 467).
  - .2        CSA C22.2 No.65-13, Wire connectors (Tri-National Standard, with UL 486A-486B NMX-J-543-ANCE).

**Part 2        Products**

**2.1            CONNECTORS AND TERMINATIONS**

- .1        Long barrel Copper compression connectors to CSA C22.2 No.65 as required sized for conductors and according to application.
  - .1        Copper, two-hole, long barrel (dual crimp) type lugs are to be used for all wire sizes #4 AWG and larger.
- .2        One-hole short-barrel compression connectors to CSA C22.2 No.65 as required sized for conductors and according to application.
  - .1        Copper, one-hole, short barrel (single crimp) type lugs are to be used for all wire sizes up to, and including #6 AWG.

**2.2            INSTALLATION**

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

**Part 3        Execution**

**3.1            NOT USED**

- .1        Not used.

**END OF SECTION**

**Part 1           General**

**1.1             RELATED REQUIREMENTS**

- .1     Section 26 05 00 - Common Work Results for Electrical.
- .2     Section 26 05 22 - Connectors and Terminations.

**Part 2           Products**

**2.1             EQUIPMENT**

- .1     Grounding conductors: bare stranded copper, soft annealed, size as indicated.
- .2     Grounding and bonding conductors sized up to and including #10 AWG, are to have green coloured RW90 X-link insulation. Type TW75 is not acceptable.
- .3     Insulated grounding conductors: green, copper conductors, size as indicated.
- .4     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     Crimp type conductor connectors.
  - .4     Thermit welded type conductor connectors.
  - .5     Bonding jumpers, straps.
  - .6     Pressure wire connectors.
  - .7     The use of U-bolt, split bolt, servit or similar connectors are not permitted.

**Part 3           Execution**

**3.1             INSTALLATION GENERAL**

- .1     Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories.
- .2     Install connectors in accordance with manufacturer's instructions.
- .3     Protect exposed grounding conductors from mechanical injury.
- .4     Use mechanical connectors for grounding connections to equipment provided with lugs.
- .5     Soldered joints are not permitted.
- .6     All cables, feeder and branch circuit conductors installed in conduit are to be complete with a separate minimum size #12 AWG copper, insulated bond/ground wire as follows:
  - .1     Bond wire sized as required by Canadian Electrical Code Table 16, or as otherwise noted.
  - .2     No.12 AWG and larger size ground or bond conductors shall be of soft drawn stranded copper of 98% conductivity, and of full size and AWG gauge.

- .3 Size of grounding conductor is to be based upon the Canadian Electrical Code.
- .7 The “feed” bonding conductor shall be secured (wrapped around unbroken) to the grounding screw of each outlet/device box, before connecting to the other grounding conductors, and/or providing a “pig-tail” lead for device terminations.
- .8 All ground wires are to be twisted together with a screw-on type wire connector, and then placed in rear of outlet box in such manner as to minimize obstructions.

### **3.2 EQUIPMENT GROUNDING/BONDING**

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

### **3.3 CONDUITS AND RACEWAYS**

- .1 All conduit and EMT raceways for all electrical systems are to contain a minimum #12 AWG insulated copper bond wire. All metallic conduit stubs shall be bonded regardless of length.

**END OF SECTION**



**Part 1           General**

**1.1           RELATED REQUIREMENTS**

- .1   Section 26 05 00 – Common Work Results for Electrical.
- .2   Section 26 05 34 – Conduits, Conduit Fastenings and Conduit Fittings.

**Part 2           Products**

**2.1           SUPPORT CHANNELS**

- .1   U shape, size 41 x 41 mm, 41 x 82 mm, 2.5 mm thick, supported from concrete base.
- .2   Galvanised steel (HDG) or stainless steel for exterior use.
- .3   Corrosion resistant hardware.

**Part 3           Execution**

**3.1           INSTALLATION**

- .1   Support channel independent of building structure cladding and surface finishes.
- .2   Secure to poured concrete with expandable inserts.
- .3   Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members. Coordinate with carpentry trades in order to install conductors and raceways in the least visible manner as possible.
- .4   Hollow columns and beams may be used to contain raceways. Raceways shall be supported in accordance with CSA 22.1.
- .5   Fasten exposed conduit or cables to support system using straps.
  - .1   One-hole galvanised steel straps to secure surface conduits and cables 50 mm and smaller.
  - .2   Two-hole galvanised steel straps for conduits and cables larger than 50 mm.
- .6   Provide metal brackets, frames and related types of support structures where indicated or as required to support conduit and cable runs.
- .7   Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .8   Do not use supports or equipment installed for other trades for conduit or cable support.
- .9   Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.
- .10   Apply zinc paint or manufacturer approved equivalent to cut and blemished surfaces to prevent corrosion.

**END OF SECTION**

**Part 1           General**

**1.1           RELATED REQUIREMENTS**

- .1   Section 26 05 00 – Common Work Results for Electrical.
- .2   Section 26 05 29 – Hangers and Supports for Electrical Systems.

**Part 2           Products**

**2.1           JUNCTION AND PULL BOXES**

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

**2.2           CABINETS**

- .1   Construction: welded sheet steel, hinged door, lockable.
- .2   Sized to suit device(s) within.

**Part 3           Execution**

**3.1           JUNCTION, PULL BOXES AND CABINETS INSTALLATION**

- .1   Install pull boxes and cabinets in inconspicuous but accessible locations.
- .2   Mount cabinets with top not higher than 2 m above finished floor except where indicated otherwise. Provide padlock with two keys. Turn keys over to Departmental Representative.
- .3   Only main junction and pull boxes are indicated. Install additional pull boxes as required by CSA C22.1.

**3.2           IDENTIFICATION**

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

**END OF SECTION**

**Part 1            General**

**1.1                RELATED REQUIREMENTS**

- .1    Section 26 05 00 - Common Work Results for Electrical.
- .2    Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
- .3    Section 26 27 26 - Wiring Devices.

**Part 2            Products**

**2.1                OUTLET AND CONDUIT BOXES GENERAL**

- .1    Size boxes in accordance with CSA C22.1.
- .2    102 mm square or larger outlet boxes as required.
- .3    Gang boxes where wiring devices are grouped.
- .4    Blank cover plates for boxes without wiring devices.
- .5    Combination boxes with barriers where outlets for more than one system are grouped.
- .6    Use metallic aesthetic/decorative type surface raceways, outlet boxes and cover plates in finished areas where it is impossible to conceal conduits. Standard of acceptance: Legrand Wiremold series V500 or V700, or reviewed alternative.

**2.2                COUNTERTOP RECEPTACLES**

- .1    Refer to section 26 27 26 - Wiring Devices.

**2.3                GALVANIZED STEEL OUTLET BOXES**

- .1    4 in. (102 mm) square or octagonal outlet boxes for lighting fixture outlets.
- .2    Extension and plaster rings for flush mounting devices in finished plaster walls.

**2.4                CONDUIT BOXES**

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

**2.5                FITTINGS - GENERAL**

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

**Part 3 Execution**

**3.1 INSTALLATION**

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

**END OF SECTION**

**Part 1           General**

**1.1           RELATED REQUIREMENTS**

- .1   Section 26 05 00 – Common Work Results for Electrical.
- .2   Section 26 05 29 – Hangers and Supports for Electrical Systems.

**1.2           REFERENCE STANDARDS**

- .1   Canadian Standards Association (CSA International)
  - .1   CAN/CSA C22.2 No. 18.1-13 Metallic Outlet Boxes.
  - .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. 211.1-06(R2016), Rigid Types EB1 and DB2/EB2 PVC Conduit.
  - .5   CSA C22.2 No. 211.2-06(R2016), Rigid PVC (Unplasticized) Conduit.

**Part 2           Products**

**2.1           RACEWAYS**

- .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   Aesthetic/decorative surface-mount one-piece steel raceway. Standard of acceptance: Legrand Wiremold series V500 or V700.

**2.2           CONDUIT FASTENINGS**

- .1   One-hole steel straps to secure round-section metallic surface conduits 35 mm and smaller.
  - .1   Two-hole steel straps for conduits larger than 35 mm.
- .2   Two-hole PVC straps to secure PVC surface conduits.
- .3   Threaded rods, 6 mm diameter, to support suspended channels.
- .4   Corrosion resistant hardware and fasteners.
- .5   Proprietary raceway attachment system for aesthetic/decorative surface-mount one-piece steel raceways.

**2.3           CONDUIT FITTINGS**

- .1   Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified.  
Coating: same as conduit.

- .2 Use of factory "ells" is not permitted.
- .3 Watertight connectors and couplings for EMT.
  - .1 Setscrews are not acceptable.

## **2.4 FISH CORD**

- .1 Polypropylene.

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

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

### **3.2 INSTALLATION**

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits where possible except in service rooms and in unfinished areas. Do not penetrate structural insulated panels (SIP).
- .3 Use electrical metallic tubing (EMT) for concealed installations in dry locations.
- .4 Use aesthetic/decorative surface-mount one-piece steel raceway for exposed installations in dry locations.
- .5 Use rigid PVC conduit underground and in wet areas.
- .6 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment.
- .7 Minimum conduit size for lighting and power circuits: size 21.
  - .1 Size 16 EMT may be used for final connection to countertop receptacles.
- .8 Minimum conduit size for communications circuits: size 27.
- .9 Bend conduit cold:
  - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .10 Mechanically bend steel conduit over 21 mm diameter.
- .11 Install fish cord in all empty conduits.
- .12 Remove and replace blocked conduit sections.
  - .1 Do not use liquids to clean out conduits.
- .13 Dry conduits out before installing wire.
- .14 Flexible Conduit:
  - .1 Liquid-tight flexible conduit, not smaller than 21 mm shall be used for final connections to all vibrating and/or mechanical equipment, including various systems' controls and related devices.

- .2 Steel type connectors are to be used on flexible type conduits. Malleable type connectors are not permitted.
- .3 A bonding conductor shall be installed inside each length of flexible conduit and terminated at each end to ensure bonding continuity through the flexible conduit.
- .15 EMT:
  - .1 Screw-on metal (malleable) type bushings are to be installed on all EMT connectors sized 1-¼ in. (35 mm) and larger. (To be installed prior to drawing-in conductors)
  - .2 EMT connectors sized 1 in. (27 mm) and smaller do not require insulated throats nor any types of screw-on type bushings.
  - .3 Rain-tight EMT connectors and couplings are to be used. The use of “set-screw” connectors is not permitted.
  - .4 EMT raceway stub is to be off-set out of wall into accessible ceiling space of room containing flush installed device box and have steel EMT connector complete with plastic or grounding type bushings screwed on same. EMT plastic end cap bushings that are CSA approved may also be used.
  - .5 All EMT raceway wall stubs and associated boxes are to be adequately bonded to ground as per CEC requirements.
- .16 All various types of systems, including lighting and power, whose wiring is to be installed on any exposed types of surfaces are always to be completely installed in raceway as per the following guidelines:
  - .1 Use EMT raceway in unfinished areas.
  - .2 Use metallic aesthetic/decorative type surface raceway in finished areas where it is impossible to conceal conduits.
  - .3 Ceiling mounted conduit/raceway is to be secured directly to overhead structure.
  - .4 Wall mounted conduit/raceway is to be secured directly to, or directly on, exposed walls.

### **3.3 SURFACE RACEWAYS**

- .1 Run parallel or perpendicular to building lines.
- .2 Group conduits wherever possible on surface channels.
- .3 Do not pass conduits through structural members except as indicated.
- .4 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 RACEWAYS**

- .1 Run parallel or perpendicular to building lines.

### **3.5 CONDUITS UNDERGROUND**

- .1 Slope conduits to provide drainage.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED REQUIREMENTS**

- .1        Section 26 05 00 – Common Work Results for Electrical.
- .2        Section 26 28 16.02 – Moulded Case Circuit Breakers.
- .3        Section 06 10 00 – Rough Carpentry.
- .4        CSA International
  - .1        CSA C22.2 No.29-15, Panelboards and Enclosed Panelboards.
- .5        Institute of Electrical and Electronics Engineers
  - .1        IEEE C62.41-1991, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits
  - .2        IEEE C62.45-1987, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and less) AC Power Circuits.

**Part 2            Products**

**2.1                PANELBOARDS**

- .1        Panelboards: to CSA C22.2 No.29 and product of one manufacturer.
  - .1        Install circuit breakers in panelboards before shipment.
  - .2        In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.
- .2        250V panelboards: bus and breakers rated for 10 kA<sub>Ic</sub>.
- .3        Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- .4        Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated on the drawings.
- .5        Minimum of 2 flush locks for each panel board.
- .6        Two keys for each panelboard and key panelboards alike.
- .7        Copper bus with neutral of same ampere rating of mains.
- .8        Copper ground bus, isolated, extending full width and located at bottom.
- .9        Mains: suitable for bolt-on breakers.
- .10       Trim with concealed front bolts and hinges.
- .11       Trim and door finish: baked enamel.
- .12       Include bonding busbar with 3 terminals for bonding conductor equal to breaker capacity of the panel board.



- .13 All devices, equipment, and systems must be capable of off-season storage in-place without supplemental heat, and without the need to “winterize” any item(s).

## **2.2 BREAKERS**

- .1 Breakers: to Section 26 28 16.02 - Moulded Case Circuit Breakers.
  - .1 The manufacturer of the circuit breakers shall be the same as the manufacturer of the panelboard or switchboard.
  - .2 Breakers with thermal / magnetic tripping in panelboards except as indicated otherwise.
  - .3 The use of tandem circuit breakers is not acceptable.
  - .4 Lock-on devices for breakers installed as indicated.
  - .5 Lock-on devices for emergency and exit light circuits.
  - .6 Breakers shall be of a type such that the line-side of the breaker bolts to the panelboard’s bus. All other types shall not be acceptable.
  - .7 All devices, equipment, and systems must be capable of off-season storage in-place without supplemental heat, and without the need to “winterize” any item(s).

## **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 Complete circuit directory with typewritten legend showing location and load of each circuit, mounted in plastic envelope at inside of panel door.

## **2.4 ACCEPTABLE MANUFACTURERS**

- .1 Eaton.
- .2 Schneider Electric.
- .3 Siemens.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2 Install indoor surface mounted panelboards on plywood backboards in accordance with Section 06 10 00 - Rough Carpentry. Where practical, group panelboards on common backboard.
- .3 Install surface mounted panelboards in stainless steel enclosures where indicated.
- .4 Mount panelboards to height specified in Section 26 05 00 - Common Work Results for Electrical or as indicated.
- .5 Connect loads to circuits.

- .6 Connect neutral conductors to common neutral bus with respective neutral identified.
- .7 Remove system bonding jumper (neutral bonding screw) in panelboards where the neutral is not connected to a ground electrode.
- .8 Branch Circuit Panelboards (225A and smaller)
  - .1 Each branch circuit shall be clearly identified on a typewritten directory, with directory being protected by a clear plastic cover.
  - .2 Panelboards are to be complete with the following:
    - .1 Minimum of 10% spare spaces for 1 pole circuit breakers.

**END OF SECTION**

**Part 1        General**

**1.1        RELATED REQUIREMENTS**

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

**1.2        REFERENCE STANDARDS**

- .1        CSA International
  - .1        CSA C22.2 No.42-10(R2015), General Use Receptacles, Attachment Plugs and Similar Devices.
  - .2        CAN/CSA C22.2 No.42.1-13, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
  - .3        CSA C22.2 No.55-15, Special Use Switches.
  - .4        CSA C22.2 No.111-10(R2015), General-Use Snap Switches (Bi-national standard, with UL 20).

**Part 2        Products**

**2.1        SWITCHES**

- .1        15 A, 120 V, single pole switches to CSA C22.2 No.111.
- .2        Manually-operated general purpose AC switches with following features:
  - .1        Terminal holes approved for No. 10 AWG wire.
  - .2        Silver alloy contacts.
  - .3        Urea or melamine moulding for parts subject to carbon tracking.
  - .4        Suitable for back and side wiring.
  - .5        Ivory toggle.
- .3        Toggle operated, fully rated for tungsten filament, LED and fluorescent lamps, and up to 80% of rated capacity of motor loads.
- .4        Switches of one manufacturer throughout project.

**2.2        RECEPTACLES - GENERAL**

- .1        Duplex receptacles to CSA C22.2 No.42:
  - .1        Extra Heavy duty, spec grade.
  - .2        GFCI.
- .2        Ivory urea moulded housing.
- .3        Suitable for No. 10 AWG for back and side wiring.
- .4        Eight back wired entrances, four side wiring screws.
- .5        Triple wipe contacts and rivetted grounding contacts.
- .6        Other receptacles with ampacity and voltage as indicated.

- .7 GFCI receptacles as required.
- .8 Receptacles of one manufacturer throughout project.

### 2.3 COVER PLATES – GENERAL

- .1 Cover plates for wiring devices to CSA C22.2 No.42.1.
- .2 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- .3 Nylon ivory cover plates for wiring devices mounted in flush-mounted outlet box.
- .4 Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- .5 Heavy duty, weatherproof cover plates, complete with gaskets for duplex receptacles as indicated.
- .6 Cover plates from one manufacturer throughout project.

### 2.4 RECEPTACLES - COUNTERTOP

- .1 Table-top receptacles to CSA C22.2 No.42:
  - .1 Flip-up, recessed into countertop.
  - .2 Stainless steel.
  - .3 CSA type 5-15 R, 125 V, 15 A, U ground.
  - .4 USB ports, 3.1A, two per receptacle.
  - .5 Standard of acceptance: Wiremold deQuorum DQFF15UST, or reviewed equal.

## Part 3 Execution

### 3.1 INSTALLATION

- .1 Switches:
  - .1 Install single throw switches with handle in "UP" position when switch closed.
  - .2 Install switches in gang type outlet box when more than one switch is required in one location.
  - .3 Mount toggle switches at height in accordance with Section 26 05 00 - Common Work Results for Electrical.
  - .4 Connections to switches shall be made using the screw terminals on the switch. The use of push-in screw-less captive terminals is not permitted.
- .2 Receptacles:
  - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
  - .2 Install countertop receptacles flush in the surface of the countertop. Coordinate with carpentry trade and millwork provider.
  - .3 Mount receptacles at height in accordance with Section 26 05 00 - Common Work Results for Electrical.

- .4 Pig-tail type leads are to be installed on conductors in all device or outlet boxes where feeding through to other receptacles. Daisy-chain or looping through of conductors from one device to another is not acceptable. Provide separate pig-tail conductor leads for final termination to each receptacle for phase, neutral and bond conductors.
  - .5 The use of modular receptacles with snap-in pig-tail connectors is not permitted.
  - .6 Connections to receptacles shall be made using the screw terminals on the receptacle. The use of push-in screw-less captive terminals is not permitted.
  - .7 GFCI receptacles as indicated.
- .3 Cover plates:
- .1 Install suitable common cover plates where wiring devices are grouped.
  - .2 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

**END OF SECTION**

**Part 1        General**

**1.1            RELATED REQUIREMENTS**

- .1        Section 26 05 00 - Common Work Results for Electrical.
- .2        Section 26 24 16.01 - Panelboards Breaker Type.

**1.2            REFERENCE STANDARDS**

- .1        CSA International
  - .1        CSA C22.2 No. 5-16, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, and NMX-J-266-ANCE-2010).

**Part 2        Products**

**2.1            BREAKERS GENERAL**

- .1        Moulded-case circuit breakers: to CSA C22.2 No. 5.
- .2        Bolt-on moulded case circuit breaker: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
- .3        Common-trip breakers: with single handle for multi-pole applications.
- .4        The use of tandem circuit breakers is not acceptable.
- .5        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.
- .6        When installed in panelboards or switchboards, the manufacturer of the circuit breakers shall be the same as the manufacturer of the panelboard or switchboard.
- .7        All devices, equipment, and systems must be capable of off-season storage in-place without supplemental heat, and without the need to "winterize" any item(s).

**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            OPTIONAL FEATURES**

- .1        Include:
  - .1        On-off locking device.
  - .2        Handle mechanism.

**2.4 ACCEPTABLE MANUFACTURERS**

- .1 Eaton.
- .2 Schneider Electric.
- .3 Siemens.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install circuit breakers as indicated.

**END OF SECTION**

**Part 1        General**

**1.1        RELATED REQUIREMENTS**

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

**1.2        REFERENCE STANDARDS**

- .1        American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)
  - .1        ANSI/IEEE C62.41-1991, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- .2        ASTM International Inc.
  - .1        ASTM F1137-00(2006), Standard Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.
- .3        Canadian Standards Association (CSA International)
- .4        Underwriters' Laboratories of Canada (ULC)

**Part 2        Products**

**2.1        OPTICAL CONTROL DEVICES**

- .1        As indicated in luminaire schedule or elsewhere.

**2.2        LUMINAIRES**

- .1        As indicated in luminaire schedule.
- .2        Deviations from or substitutions of luminaires listed in the luminaire schedule shall not be permitted without written approval of the Departmental Representative.
- .3        Luminaires mounted on building exteriors shall be dark-sky compliant.

**Part 3        Execution**

**3.1        INSTALLATION**

- .1        Locate and install luminaires as indicated.
- .2        Provide adequate support to suit ceiling system.
- .3        Align luminaires parallel to or at right angles to building lines.

**3.2        WIRING**

- .1        Connect luminaires to lighting circuits.
- .2        Each light fixture is to have a separate fixture drop installed and connected to hard wired junction or outlet box located in ceiling/roof space.
- .3        A maximum of four drops is permitted from any single box, regardless of box size.



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**END OF SECTION**