

## COMMON WORK RESULTS FOR ELECTRICAL

---

### 1. GENERAL

#### 1.1 References

- .1 Canadian Standards Association (CSA)
  - .1 CSA C22.1, Canadian Electrical Code, Part 1), Safety Standard for Electrical Installations.
  - .2 CSA C22.3 No.7, Underground Systems.
  - .3 CAN/CSA-C22.3 No. 1, Overhead Systems.
  - .4 CAN3-C235, Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
- .2 Institute of Electrical and Electronics Engineers (IEEE)
  - .1 IEEE 100, The Authoritative Dictionary of IEEE Standards Terms.

#### 1.2 Definitions

- .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these Specifications, and on Drawings, are those defined by IEEE 100.

#### 1.3 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.

#### 1.4 Submittals

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
  - .1 In accordance with Section 01 33 00 - Submittal Procedures.
  - .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 coordinated 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 of Drawings clearances for operation, maintenance, and replacement of operating equipment devices.

### **COMMON WORK RESULTS FOR ELECTRICAL**

---

- .5 If changes are required, notify Contract Administrator of these changes before they are made.
- .6 Contract Administrator will not assume the responsibility for searching out deviations in the Contractor's drawings.
- .3 Quality Control:
  - .1 Provide CSA certified equipment and material. Where CSA certified equipment and material is not available, submit such equipment and material inspection authorities for special acceptance approval before delivery to Site.
  - .2 Submit test results of installed electrical systems and instrumentation.
  - .3 Permits and fees: in accordance with General Conditions of Contract.
  - .4 Submit, upon completion of Work, load balance report as described in Part 3.13.1 - Load Balance.
  - .5 Submit certificate of acceptance from Authority Having Jurisdiction upon completion of Work to Contract Administrator.
- .4 Manufacturer's Field Reports: submit to Contract Administrator Manufacturer's written report, within three (3) days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in Part 3.13 Field Quality Control.

#### **1.5 Quality Assurance**

- .1 Qualifications: electrical Work to be carried out by qualified, licensed electricians who hold valid license in accordance with Authorities Having Jurisdiction.

#### **1.6 System Start-up**

- .1 Instruct Contract Administrator 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 Contract Administrator to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.
- .3 Arrange and pay for services of an instrumentation technician to check, adjust, balance and calibrate components and instruct operating personnel.
- .4 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 will aspects of its care and operation.

#### **1.7 Operating Instructions**

- .1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.

## COMMON WORK RESULTS FOR ELECTRICAL

---

- .2 Operating instructions as per Section 01 77 00 - Closeout Submittals 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.

## **2. PRODUCTS**

### **2.1 General**

- .1 All tagging nomenclature to be in accordance with the City of Winnipeg, Water & Waste Department Identification Standard, Document 510276-0000-40ER-0002.

### **2.2 Materials and Equipment**

- .1 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 Section 01 33 00 - Submittals.
- .2 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 - Wire and Cables (0-1000V) and Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

### **2.4 Warning Signs**

- .1 Warning Signs: in accordance with requirements of Authority Having Jurisdiction, inspection authorities, and Contract Administrator.

## COMMON WORK RESULTS FOR ELECTRICAL

---

- .2 Lamacoid, red with white lettering, 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 and devices with nameplates as follows:
  - .1 Nameplates: lamicoid 3 mm thick plastic engraving sheet, white face, black core, lettering accurately aligned and engraved into core mechanically attached with self-tapping stainless steel 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 All essential power labelling to be red face nameplate with white letters.
- .3 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.
- .4 Wording on nameplates and labels to be approved by Contract Administrator prior to manufacture.
- .5 Allow for minimum of twenty-five (25) letters per nameplate and label.
- .6 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .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 All distributions, panelboard, transfer switches, MCC's, Splitters, transformers, VFD's, reactors, filters, etc. provide circuit panel designations and where fed from.

### 2.7 Wiring Identification

- .1 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders, branch circuit wiring and neutrals.

## COMMON WORK RESULTS FOR ELECTRICAL

---

- .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 600 V	Yellow	
up to 250 V	Black	
Control wiring (120 V)	Black	Orange
Telephone/LAN	Blue	
Other Communication Systems	Blue	Blue
Fire Alarm	Red	

### 2.9 Finishes

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two (2) coats of finish enamel.
  - .1 Paint outdoor electrical equipment "light gray" finish.
  - .2 Paint indoor switchgear and distribution enclosures light gray to EEMAC 2Y-1.

## 3. EXECUTION

### 3.1 Installation

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

### 3.2 Grounding

- .1 All circuits shall be installed with dedicated green insulated ground wire.

### 3.3 Dedicated Neutrals

- .1 Each circuit shall have its own dedicated neutral wire. Shared neutral for more than 1 circuit shall not be permitted.

## COMMON WORK RESULTS FOR ELECTRICAL

---

### 3.4 Area Category and Classifications

- .1 The areas have electrical categories and classifications as defined on the Drawings according, and as indicated below, according to the CEC:
  - .1 Outside Wet, NEMA 4X Rated.

### 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 Conduit and Cable Installation

- .1 Install conduit and sleeves prior to pouring of concrete.
  - .1 Sleeves through concrete: schedule 40 galvanized steel pipe, or schedule 80 PVC pipe, sized for free passage of conduit, and protruding 50 mm.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.
- .4 Do not mix wiring and/or cables from different panels within the same conduit runs or pull boxes. Provide equipment barriers where acceptable and where applicable.

### 3.7 Location of Outlets and Luminaires

- .1 Electrical Drawings are, unless otherwise indicated, drawn to scale and approximate distances and dimensions may be obtained by scaling. Figured dimensions shall govern over scaled dimensions. Where exact dimensions and details are required, refer to Architectural and Structural Drawings.
- .2 Outlet and equipment locations shown on the Drawings are approximate. Locations may be revised up to 3 m to suit construction and equipment arrangements without additional cost, provided that the Contractor is notified prior to the installation of the outlets, or equipment.
- .3 Maintain luminaire locations wherever possible. Notify the Contract Administrator of conflicts with other services.
- .4 Unless otherwise specified or shown, install products in accordance with recommendations and ratings of Manufacturer's.
- .5 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .6 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.
- .7 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.

## COMMON WORK RESULTS FOR ELECTRICAL

---

- .8 Locate light switches on latch side of doors.

### 3.8 Separation of Services

- .1 Maintain separation between electrical wiring system and building piping, ductwork, etc. so that wiring system is isolated (except at approved connections to such systems) to prevent galvanic corrosion.
- .2 In particular, contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is not permitted.
- .3 Do not support wiring from pipes, ductwork, etc. Hangers for suspended ceilings may be used for the support of wiring only when approval is obtained from the Contract Administrator and the ceiling installer, and approved clips or hangers are used.

### 3.9 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. Install electrical equipment at following heights unless indicated otherwise.
  - .1 Local switches: 1400 mm.
  - .2 Wall receptacles:
    - .1 General: 300 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: 1400 mm.
  - .3 Panelboards: as required by Code or as indicated.
  - .4 Telephone and LAN outlets:
    - .1 General: 300 mm.
    - .2 Above top of counters or desk: 175 mm.
  - .5 Wall mounted telephone outlets: 1500 mm.
  - .6 Fire alarm stations: 1200 mm.
  - .7 Fire alarm bells: 2100 mm.
  - .8 Horn/Strobe: 2100 mm.

---

**COMMON WORK RESULTS FOR ELECTRICAL**

---

**3.10 Housekeeping Pads**

- .1 All floor mounted electrical equipment installed by this Division shall be mounted on concrete housekeeping pads which, unless otherwise noted, shall be the responsibility of the Contractor.
- .2 The Contractor shall determine the extent of the housekeeping pads required and supply all information and details as to size and locations to the Contract Administrator within thirty (30) days after the award of the Contract.

**3.11 Sleeves**

- .1 Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.
- .2 For wall, partitions and ceilings the ends shall be flush with the finish on both sides but for floors they shall extend 4" above finished floor level.
- .3 The space between the sleeve and the conduit shall be filled with Dow Corning silicone RTV foam for fire stop and caulked around the top and bottom with approved permanently resilient, non-flammable and weatherproof silicone base compound and ensure that the seal is compatible with the floor and ceiling finishes.
- .4 Locate and position sleeves exactly prior to construction of walls, floors.

**3.12 Coordination of Protective Devices**

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

**3.13 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 Section 01 33 00 - 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:
  - .1 Power generation and distribution system including phasing, voltage, grounding and load balancing.
  - .2 Circuits originating from branch distribution panels.

**COMMON WORK RESULTS FOR ELECTRICAL**

---

- .3 Lighting and its control.
- .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
- .5 Systems: fire alarm system.
- .6 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 the Contract Administrator.
- .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 Section 01 33 00 - 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 Schedule site visits, to review Work, as directed in Section 1.5 - Quality Assurance.

**END OF SECTION**

## SCOPE OF ELECTRICAL WORK

---

### 1. GENERAL

- .1 Provide (supply and install) all material, equipment, wiring, and labour necessary for the installation of the systems detailed on the Drawings in accordance with the latest edition of the Manitoba Electrical Code.

### 1.2 Work Included

- .1 General Requirements
  - .1 General clean-up.
  - .2 All inspections and obtaining all permits, licenses required by various Inspection Agencies and local regulations related to Electrical Trade.
  - .3 Scaffolding.
  - .4 All necessary tools, equipment, and supplies.
  - .5 Shop Drawings.
  - .6 Project Record Documents (As-constructed Drawings).
  - .7 Operating and Maintenance Data, where specified.
- .2 Specific Requirements Included but not Limited to Scope of Work
  - .1 Electrical equipment in the new Lift Station building, including site underground and above ground services and cabling.
- .3 Additional Requirements
  - .1 Provision of all necessary testing, detailed wiring continuity checks, wiring completion checks, installation integrity checks, functional equipment operation checks and written system verification reports to provide a complete system that is ready for commissioning and start-up (refer also to Section 01 91 13 - General Facility Operational Review).
  - .2 Provision of commissioning and start-up of all systems included in the Scope of Work as per Section.
  - .3 General
    - .1 Provide all electrical works required to make a complete and operational facility.
    - .2 Provide raceway systems to allow installation for all cables.
    - .3 Provide complete grounding as herein specified and indicated on the Drawings. All grounding shall also comply with the Canadian Electrical Code and local amendments to this code.

### SCOPE OF ELECTRICAL WORK

---

- .4 Provide new electrical panel PNL-A510 and install as shown on the drawings.
- .5 Provide new 60A, 3 pole breaker to existing panel No.PL-3. Provide electrical wiring, conduit and other appurtenances required to provide power connections as required from the existing electrical panel No.PL-3 to new panel PNL-A510.
- .6 Provide exterior lighting fixture and pole as shown on the Drawings.
- .7 All devices mounted in wet areas, Category 1 and 2 areas or outdoors shall be Nema 4X rated or as shown on Drawings.

#### 1.3 Materials

- .1 Bus systems including all forms of buses integral with the electrical power system, together with their associated insulation, supports, bus ducts and protective devices.
- .2 Conductors, including all types of wires, conductors, cables, which form an integral part of the electrical power system.
- .3 Cables and bus support systems which are intended to enclose or support all forms of electrical conductors used for any purpose covered by this scope. This includes cable trays, raceways and all forms of rigid, flexible, metallic and non-metallic conduit, and including conduit for communication systems or others, which may be installed at a later date, or buried conduit for wiring work by others, only when such buried conduit is indicated in the Contract.
- .4 Control panels associated with any electrical equipment covered under this Section of Work unless otherwise noted.
- .5 Circuit breakers of all types and for all applications associated with electrical equipment, which receives its power supply from the main, auxiliary or emergency (including battery) system.
- .6 Grounding systems, as required by the Canadian Electrical Code, or as otherwise specified in the Contract.
- .7 Control and instrumentation systems - electrical or electronic instrumentation systems, with auxiliary equipment and components, unless specified otherwise.
- .8 Transformers of various types, dry, encapsulated etc., and for all applications, except control transformers supplied with Mechanical Equipment included in Division 23.
- .9 Electronic data processing and transmission systems, including auxiliary equipment, interface and components.

#### 1.4 Units of Measure

- .1 The following three (3) conversion methods were used in product and location dimensions:
  - .1 Hard Conversion: industry available products which are manufactured in metric measurements.

### **SCOPE OF ELECTRICAL WORK**

---

- .2 Soft Conversion: products which are still manufactured in Imperial units and are converted in Specifications using arithmetic conversion factors.
- .3 Rationalized Conversion: dimensions which are soft converted and rounded off for ease of measurements.
- .2 In cases where measurements may be open for interpretation, dual dimensions have been incorporated until hard conversions can be used exclusively.

#### **1.5 Definitions**

- .1 All terminologies, abbreviations, and acronyms used in this Document are as listed in the various Standards, Codes, Rules, and Bulletins used herein.
- .2 Where the word *install* is used, unless specifically specified, is also meant to include the supply of the equipment.

#### **2. PRODUCTS (NOT USED)**

#### **3. EXECUTION (NOT USED)**

**END OF SECTION**

## CONNECTIONS TO HVAC AND PROCESS EQUIPMENT

---

### 1. GENERAL

#### 1.1 Requirements

- .1 Wiring provided by all Divisions shall meet the requirements of Division 26.
- .2 Provide a complete system of wiring to HVAC, motors and controls as specified herein and as shown on the Drawings.
- .3 Unless specifically noted otherwise, wire and leave in operation all electrically operated equipment supplied under all Contracts related to this project. Examine the Drawings and Shop Drawings of all Divisions for the extent of electrically operated equipment supplied under other Contracts.
- .4 All control-wiring diagrams shown on the Drawings illustrate typical control circuits applicable to the equipment. Control circuits may vary with different Manufacturers of equipment. Verify all control circuits with the suppliers of the equipment and make any corrections that may be required.
- .5 Unless specifically noted otherwise, supply all pushbuttons, relays, starters, etc., necessary for the operation of equipment. Check all starters, relay coils and thermal elements to ensure that they provide the necessary protection for motors.
- .6 Do not operate motors and controls until approval is obtained from the trade providing equipment.
- .7 Examine Drawings and Shop Drawings of other Divisions to obtain exact location of motors and equipment shown on Drawings. Where necessary, obtain conduit locations from other trades' drawings and Shop Drawings.
- .8 Assist in placing in operation all mechanical equipment having electrical connections.
- .9 Provide all power wiring for all motors and control wiring as indicated on the Drawings.
- .10 Where 120 V power is required for mechanical equipment, i.e., roll type filters, refrigerated aftercoolers, control cabinets, etc., wiring to the equipment terminals is the Work of this Division.

#### 1.2 References

- .1 National Electrical Manufacturers Association (NEMA)
  - .1 NEMA ICS 6, Industrial Control and Systems: Enclosures.

### 2. PRODUCTS

#### 2.1 3-Phase Motor Disconnect Switches

- .1 Industrial Type "A", having quick make, quick break visible blade mechanism, cover interlocks and padlocking switch in the closed or open position. Use NEMA 12 enclosures for indoor dry areas, NEMA 4X for wet, Category 2 areas or outdoor. Switches to be H.P. rated.

**CONNECTIONS TO HVAC AND PROCESS EQUIPMENT**

---

**2.2 120 V, 1-Phase Disconnect Switches**

- .1 Manual starter without overload relay or as specified.

**2.3 208 V, 1-Phase Motor Disconnect Switches**

- .1 Manual starter without overload relay or as specified.

**3. EXECUTION**

**3.1 Installation**

- .1 Provide all wiring to all force flow and unit heaters and their thermostats. Unit heaters and baseboard heaters shall be provided by Division 23 and handed over to Division 26 for installation.
- .2 Do control wiring as indicated on the Drawings and the motor control schedules.

**END OF SECTION**

**STARTING OF ELECTRICAL EQUIPMENT AND SYSTEM**

---

**1. GENERAL**

**1.1 Coordination**

- .1 Coordinate starting of electrical equipment and systems with testing, adjusting, and balancing, and demonstration and instruction of:
  - .1 Electrical equipment and systems specified in Division 26.
  - .2 HVAC equipment and systems specified in Division 23.
  - .3 Other equipment and systems specified in other Divisions.
- .2 Where any equipment or system requires testing, adjusting or balancing prior to starting, ensure that such Work has been completed prior to starting of electrical equipment and systems.

**2. PRODUCT (NOT USED)**

**3. EXECUTION**

**3.1 Energizing Electrical System**

- .1 Prior to energizing the new electrical system:
  - .1 Verify supply authority voltage and phase rotation.
  - .2 Close and open all devices to ensure proper mechanical operation.

**3.2 Starting Motors**

- .1 Prior to starting motors:
  - .1 Confirm motor nameplate data with motor starter heater overloads.

**3.3 Energizing Equipment**

- .1 Prior to energizing equipment provided under other Sections and equipment provided by the Contract Administrator, confirm equipment nameplate with characteristics of power supply.

**END OF SECTION**

**WIRE AND BOX CONNECTORS 0-1000 V**

---

**1. GENERAL**

**1.1 References**

- .1 Canadian Standards Association (CSA)
  - .1 CSA C22.2 No.65, Wire Connectors.

**2. PRODUCTS**

**2.1 Materials**

- .1 Pressure type wire connectors to: CSA C22.2 No.65, with current carrying parts of copper sized to fit copper conductors as required.
- .2 Fixture type splicing connectors to: 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, aluminum sheathed cable, mineral insulated cable, flexible conduit, non-metallic sheathed cable as required to: CSA-C22.2 No.18.3, 18.4 and 18.5.

**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 CSA C22.2 No.65.
  - .2 Install fixture type connectors and tighten. Replace insulating cap.

**END OF SECTION**

**WIRES AND CABLES 0 - 1000 V**

---

**1. GENERAL**

**1.1 References, Codes, and Standards**

- .1 Canadian Standards Association (CSA)
  - .1 CSA C22.2 No. 0.3, Test Methods for Electrical Wires and Cables.
  - .2 CSA-C22.2 No. 131, Type TECK 90 Cable.

**1.2 Product Data**

- .1 Submit product data in accordance with Section 26 05 00.

**2. PRODUCTS**

**2.1 Building Wires**

- .1 Conductors: stranded for #10 AWG and larger, minimum power conductor size #12 AWG.
- .2 Copper conductors: size as indicated, with 600 V insulation of chemically cross-linked thermosetting polyethylene (XLPE) material rated RW90.
- .3 All underground wiring in conduit and wet locations be RWU90 type.

**2.2 Teck Cable**

- .1 Conductors:
  - .1 Grounding conductor: copper.
  - .2 Circuit conductors: copper, minimum size #12 AWG or as indicated.
- .2 Armour: interlocking aluminum.
- .3 Fastenings:
  - .1 One-hole malleable iron 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 (2) or more cables at 1,500 mm centers.
  - .3 Six (6) mm diameter threaded rods to support suspended channels.
- .4 Connectors:
  - .1 Watertight, approved for TECK cable.

**2.3 Control Cables**

- .1 Single conductor wire to be 98% conductivity copper type TEW or TBS insulation rated at 600 V, solid or stranded conductor as required, size as noted on Drawings and specified herein, minimum #14 AWG with 90°C.

**WIRES AND CABLES 0 - 1000 V**

---

- .2 Cable for power and control shall be based on Teck 90 armoured cable, with stranded copper conductors, 90°C insulation, rated at 600 VAC, integral copper ground wire, PVC inner jacket, aluminum interlocking armour, and PVC outer jacket having heat, flame, and moisture retardant properties. Flame retardancy of outer jacket to be rated in accordance with CSA C22.2, No. 0.3. Conductor size shall be minimum #14 AWG or as noted on the Drawings.
- .3 Analog instrumentation cable shall use single or multiple pair, seven (7) strand copper conductor, individually twisted and shielded, individual tinned copper drain wire, complete electrical isolation between shields, overall multi-conductor cable shield with drain wire, XLPE inner jacket, interlocking aluminum armour, and FT4 flame retardant rated outer PVC jacket. Cable shall be provided with a black, white, colour code and number code for each pair. Cable and conductor insulation to be rated for 105°C (dry) and 600 V. Conductor size shall be minimum #18 AWG or as noted on the Drawings.

**3. EXECUTION**

**3.1 General**

- .1 Install and rate power cables in accordance with the Canadian Electrical Code requirements.
- .2 Minimum power conductor including luminaire drops to be #12 AWG.
- .3 Minimum conductor size #14 AWG for all discrete control cables.
- .4 Minimum conductor size #18 AWG for twisted pair analog signal cables.

**3.2 Installation of Building Wires**

- .1 Install wiring as follows:
  - .1 In conduit systems in accordance with Section 26 05 25.
  - .2 In cabletroughs in accordance with Section 26 05 37.
  - .3 In wire ways and auxiliary gutters.

**3.3 Installation of Teck Cable 0 - 1000 V**

- .1 Install cables.
- .2 Group cables wherever possible on channels.
- .3 Lay cable in cabletroughs in accordance with Section 26 05 37.
- .4 Terminate cables in accordance with Section 26 05 20.

**3.4 Installation of Control Cables**

- .1 Install control cables in conduit or cable troughs.
- .2 Ground control cable shield at one end only. Shields to be continuous over entire run.

**WIRES AND CABLES 0 - 1000 V**

---

**3.5 Workmanship**

- .1 Before pulling wire, ensure conduit is dry and clean. If moisture is present, thoroughly dry out conduits; vacuum if necessary. To facilitate pulling, recognized specially manufactured wire pulling lubricants may be used. Do not use grease. Employ suitable techniques to prevent damage to wire when ambient temperature is below the minimum permitted for each insulation type. Do not pull wires into incomplete conduit runs.
- .2 Installation to be free of opens and grounds. Before energization, measure insulation resistance and comply with the Manitoba Electrical Code. Submit data sheet with values measured.
- .3 Do not install any power conductor smaller than #12 AWG, except where specifically indicated otherwise, i.e., for fire alarm system station circuits, P.A. wiring, etc.
- .4 Provide conductors as shown on Drawings and cable schedule. Minimum conductor sizes are indicated. Voltage drop from lighting panels to farthest outlet must not exceed 2% at full load in any case. Advise Contract Administrator if problem is foreseen.
- .5 Exercise care in stripping insulation from wire. Do not nick conductors.

**3.6 Identification, Coding and Balancing**

- .1 For branch circuit wiring, follow identification system shown on the Drawings and as specified in Section 26 05 00.
- .2 Connect single phase equipment to minimize imbalance on feeders. Adjust branch circuiting shown as required for optimum balancing. Record all changes on As-Constructed Drawings.
- .3 Colour code all feeders at all terminations, at all points where taps are made, and at all panelboards, switchboards, motor control centres, etc. Use two wraps of 3M #471 plastic film tape 48 mm wide.
- .4 Conductors sized No. 10 and smaller are required to be factory coloured or numbered, not taped on Site.
- .5 For direct current wiring use red for positive and black for negative.

**3.7 Testing**

- .1 All power and control wiring shall be tested for insulation resistance value with a megger. Resistance values shall be as recommended by the cable manufacturer.
- .2 All wire test results shall be properly tabulated, signed, dated, and submitted to the Contract Administrator.

**END OF SECTION**

**CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS**

---

**1. GENERAL**

**1.1 References**

- .1 Canadian Standards Association (CSA)
  - .1 CSA C22.2 No. 18.1 Metallic Outlet Boxes.
  - .2 CSA C22.2 No. 18.2 Non-Metallic Outlet Boxes.
  - .3 CSA C22.2 No. 18.3 Conduit, Tubing, and Cable Fittings.
  - .4 CSA C22.2 No. 18.4 Hardware for the Support of Conduit, Tubing, and Cable.
  - .5 CSA C22.2 No. 18.5 Positioning Devices.
  - .6 CSA C22.2 No. 45.1 Electrical Rigid Metal Conduit – Steel.
  - .7 CSA C22.2 No. 45.2 Electrical Rigid Metal Conduit — Aluminum, Red Brass, and Stainless Steel.
  - .8 CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .9 CSA C22.2 No. 83, Electrical Metallic Tubing.
  - .10 CSA C22.2 No. 227.3, Non-Metallic Mechanical Protection Tubing (NMPT).

**2. PRODUCTS**

**2.1 Conduits**

- .1 Rigid metal conduit: to CSA C22.2 No. 45.2, aluminum threaded.
- .2 Epoxy coated conduit: to CSA C22.2 No. 45.1, with zinc coating and corrosion resistant epoxy finish inside and outside.
- .3 Flexible metal conduit: to CSA C22.2 No. 56, aluminum liquid-tight flexible metal.

**2.2 Conduit Fastenings**

- .1 One hole stainless steel straps to secure surface conduits 50 mm and smaller.
  - .1 Two hole stainless 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 1 m on centre.
- .4 Threaded stainless steel rods, 9 mm diameter, to support suspended channels.

## **CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS**

---

### **2.3 Conduit Fittings**

- .1 Fittings: to CSA C22.2 No. 18.3, No. 18.4, and No. 18.5, manufactured for use with conduit specified. Coating: same as conduit.
- .2 Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits.

### **2.4 Fish Cord**

- .1 Polypropylene.

## **3. EXECUTION**

### **3.1 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 rigid aluminum threaded conduit in Ordinary and Category 1 locations.
- .4 Use epoxy coated conduit underground, in concrete, and in Category 2 locations.
- .5 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment.
- .6 Use explosion proof flexible connection for connection to explosion proof motors.
- .7 Install conduit sealing fittings in hazardous areas.
  - .1 Fill with compound.
- .8 Minimum conduit size for lighting and power circuits: 19 mm.
- .9 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .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.

### **3.2 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 or surface mounted aluminum channels.

**CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS**

---

- .5 Do not pass conduits through structural members except as indicated. Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

**3.3 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.

**3.4 Conduits in Cast-In-Place Concrete**

- .1 Use epoxy coated rigid steel conduits.
- .2 Locate to suit reinforcing steel.
  - .1 Install in centre one third of slab.
- .3 Protect conduits from damage where they stub out of concrete.
- .4 Install sleeves where conduits pass through slab or wall.
- .5 Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed.
  - .1 Use cold mastic between sleeve and conduit.
- .6 Conduits in slabs: minimum slab thickness 4 times conduit diameter.
- .7 Encase conduits completely in concrete with minimum 25 mm concrete cover.
- .8 Organize conduits in slab to minimize cross-overs.

**3.5 Conduits in Cast-In-Place Slabs on Grade**

- .1 Use epoxy coated rigid steel conduits.
- .2 Run conduits 25 mm and larger below slab and encase in 75 mm concrete envelope.
  - .1 Provide 50 mm of sand over concrete envelope below floor slab.

**3.6 Conduits Underground**

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

**END OF SECTION**

## **FASTENINGS AND SUPPORTS**

---

### **1. GENERAL**

#### **1.1 Work Included**

- .1 Supply and install all hangers, supports and inserts for the installation shown on the Drawings and specified herein, as necessary to fasten electrical equipment securely to the building structure.

### **2. PRODUCT**

#### **2.1 Framing and Support System**

- .1 Materials:
  - .1 Intermediate duty supporting structures shall employ 41 mm square strut channel together with the Manufacturer's connecting components and fasteners for a complete system.
  - .2 Heavy duty supporting structures to be fabricated and welded from steel structural members and prime painted before installation.
  - .3 Shall be rated for use in hazardous locations and category environments as necessary.
- .2 Finishes:
  - .1 Hot dipped galvanized.
  - .2 Nuts, bolts, machine screws: cadmium plated.
- .3 Square strut channel:
  - .1 Section 41 mm square strut channel or as required for load and span, with mounting screws, or approved. 41 mm square strut channel is a minimum standard for supporting conduits 50 mm and larger.

#### **2.2 Concrete and Masonry Anchors**

- .1 Materials: hardened steel inserts, zinc plated for corrosion resistance. All anchor bolts must be galvanized.
- .2 Components: non-drilling anchors for use in predrilled holes, sized to safely support the applied load with a minimum safety factor of four (4).

#### **2.3 Non-Metallic Anchors**

- .1 Material: plastic anchors for sheet metal screws.

#### **2.4 Cable Supports and Clamps**

- .1 General: as per conduit supports, except that for single conductor cables, suitable non-ferrous, or approved stainless steel or aluminum clamps shall be used.

## **FASTENINGS AND SUPPORTS**

---

### **3. EXECUTION**

#### **3.1 General**

- .1 Do not cut or drill beams, joists or structural steel unless written permission of the Contract Administrator is obtained.
- .2 Distance between conduit or cable supports not to exceed code requirements.
- .3 Supports to be suitable for the real loads imposed by equipment.
- .4 Supports to be securely fastened, free from vibration and excessive deflection or rotation. Maximum deflections are 4 mm over a 1 m span and 8 mm over a 2 m span.
- .5 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.
- .6 Provide rack with 25% spare capacity for multiple runs.
- .7 Provide channel support with fittings for vertical runs of conduit and cables.

#### **3.2 Installation**

- .1 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors or nylon shields.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .5 Fasten exposed conduit or cables to building construction or support system using straps.
  - .1 One-hole malleable iron or 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 two (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 Use plastic anchors for light loads only. Use metal anchors for all other loads.
- .8 Shot driven pins may only be used with written approval of the Contract Administrator.

### **FASTENINGS AND SUPPORTS**

---

- .9 Use round or pan head screws for fastening straps, boxes, etc.
- .10 Support outlet boxes, junction boxes, panel tubs, etc., independent of conduits running to them. Support conduits within 600 mm of outlet boxes. Support surface mounted panel tubs with a minimum of four (4) 6 mm fasteners.
- .11 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .12 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .13 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .14 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of the Contract Administrator.

**END OF SECTION**

**SPLITTERS, JUNCTION BOXES, PULL BOXES AND CABINETS**

---

**1. GENERAL**

**1.1 References**

- .1 National Electrical Manufacturers Association (NEMA)
  - .1 NEMA ICS 6, Industrial Control and Systems: Enclosures.

**1.2 Shop Drawings and Product Data**

- .1 Submit Shop Drawings and product data for cabinets in accordance with Section 26 05 00.
- .2 Provide Manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Provide Drawings stamped and signed by Professional Engineer registered or licensed in the Province of Manitoba.

**2. PRODUCTS**

**2.1 Junction Boxes, Cabinets, and Pull Boxes**

- .1 Wet Location, Category 2 or Outdoor-NEMA 4X Rated.
- .2 Indoor Dry Locations, Category 1-NEMA 12 Rated.
- .3 Materials:
  - .1 Code gauge sheet steel, welded construction, phosphatized and factory paint finish.
  - .2 Components:
    - .1 For flush mounting, covers to overlap box by 25 mm minimum all around with flush head cover retaining screws.
    - .2 Use rolled edges for surface boxes.
  - .3 Junction boxes mounted in exterior walls shall be complete with box vapour barriers.

**2.2 Cabinets**

- .1 Materials:
  - .1 Locks: to match panelboards.
- .2 Components:
  - .1 With hinged door and return flange overlapping sides, with handle, lock and catch for surface mounting, size as indicated or to suit.
  - .2 Install a back mounting plate for DIN rail mounted terminal blocks. Plate to be painted white enamel.

**SPLITTERS, JUNCTION BOXES, PULL BOXES AND CABINETS**

---

- .3 Install metal divider in cabinets with more than one voltage.
- .4 Surface or flush with trim and hinged door, latch and lock and two (2) keys, size as indicated or to suit. Keyed to match panelboard keys 19 mm.

**3. EXECUTION**

**3.1 Installation**

- .1 Junction Boxes and Pull Boxes:
  - .1 Supply all pull boxes and junction boxes shown on the Drawings or required for the installation.
  - .2 Boxes installed in party walls to be offset by a minimum of one stud space.
  - .3 Install in inconspicuous but accessible locations, above removable ceilings or in electrical rooms, utility rooms or storage areas.
  - .4 Identify with system name and circuit designation as applicable.
  - .5 Size in accordance with the Canadian Electrical Code, as a minimum.
  - .6 Terminate cables and conductors as required.
  - .7 Make all necessary cable entry holes in junction boxes supplied by Contractor or others, regardless of material.
- .2 Cabinets:
  - .1 Mount cabinets with top not greater than 1980 mm above finished floor, coordinated with masonry, panelboards, fire hose cabinets and similar items.
  - .2 Install terminal block where indicated.
- .3 Identification
  - .1 Provide equipment identification in accordance with Section 26 05 00.

**END OF SECTION**

## **CABLE TRAYS FOR ELECTRICAL SYSTEMS**

---

### **1. GENERAL**

#### **1.1 Description**

- .1 Provide a complete system of cable trays required to fully support all cable and conduit throughout the facility. System shall provide separate trays or barriers for 600 VAC systems, 120 VAC systems, and 24 VDC systems. System shall be complete with all supports and hangers and necessary for the installation.
- .2 Coordinate the location of the support channels so as not to interfere with other services.
- .3 Not all cable trays required is indicated on the Drawings. Provide additional tray as required to fully support all cable and conduit throughout the facility.

#### **1.2 References**

- .1 Canadian Standards Association (CSA)
  - .1 CSA C22.2 No. 126.1, Metal Cable Tray Systems.
  - .2 CSA C22.2 No. 126.2, Non-Metallic Cable Tray Systems.

#### **1.3 Shop Drawings and Product Data**

- .1 Submit Shop Drawings and Product data in accordance with Section 26 05 00.
- .2 Provide detailed layout plans indicating cable tray locations, sizes, barriers and supports.
- .3 Prior to construction, submit design Drawings and calculations indicating all tray loading and seismic support designs have been reviewed by and bear the stamp of a Professional Engineer registered in the Province of Manitoba.

### **2. PRODUCTS**

#### **2.1 Cabletray**

- .1 All tray mounted indoor shall be galvanized steel ladder type, Class C1 to CSA C22.2 No. 126.1 with 300 mm rung spacing, 150 mm side rails and width as required to prevent cable de-rating. The Contractor is responsible for increasing cable sizes due to de-rating factors from cable spacing.
- .2 Use aluminum tray in outdoor areas. Class C1 to CSA C22.2 No. 126.1 with 300 mm rung spacing, 150 mm side rails and width as required to prevent cable de-rating. The Contractor is responsible for increasing cable sizes due to de-rating factors from cable spacing.
- .3 Horizontal elbows, end plates, drop outs, vertical risers and drops, tees, wyes, expansion joints, reducers and other fittings where required. Field fabricate only those fittings not available from Manufacturer.
- .4 Provide stainless steel rod hanger clamps, rod hangers, wall mounting support brackets and all necessary accessories for complete installation.

## **CABLE TRAYS FOR ELECTRICAL SYSTEMS**

---

- .5 Barriers where different voltage systems or electrical systems are in the same tray, or as indicated.
- .6 Unless otherwise approved by the Contract Administrator, provide cabletrays of the same manufacturer throughout the Work.

### **2.2 Supports**

- .1 Provide stainless steel rod hangers, rod hanger clamps and accessories as required.
- .2 Wall mounted support brackets: Provide aluminum channel strut supports mounted vertically in concrete wall complete with mounting brackets sized to suit cabletray width and loading.

### **3. EXECUTION**

#### **3.1 Installation**

- .1 Suspend cabletrays on rod hangers and hanger clamps or channels spaced as required by loading classification rating and not more than 3000 mm on centers. Fasten hangers to channels securely mounted to the structure.
- .2 Do not drill through wood ceiling trusses. Provide wood blocking on top of ceiling truss to anchor rod hangers and channels.
- .3 Install trays and raceways generally as indicated on Drawings. Coordinate this Work with the other trades to ensure adequate horizontal and vertical clearances.
- .4 Provide minimum vertical clearance above the trays as indicated on the Drawings.
- .5 Provide minimum 600 mm horizontal clearance on one side of cabletray throughout.
- .6 All trays are shown diagrammatically on the Drawings. Determine the exact location in the field. Install tray runs to prevent interference with process or service piping and ducting and to maintain clearance for tray access. Coordinate the exact location of tray supports and runs with the work of other Divisions.
- .7 Do not install tray routes and tray supports until the location of same has been reviewed by the Contract Administrator.
- .8 Install tray systems in such a manner as to conserve head-room and minimize the use of free space through which they pass. Maintain a minimum 2,100 mm clear head-room wherever possible.
- .9 Run trays parallel to building lines unless otherwise shown on the Drawings. Where two or more trays run the same route, make parallel and ensure offsets and bends are uniform.
- .10 When the ends on square strut channel type shelf brackets are below 2100 mm AFF in a walking area, cut flush with tray. Permanently cap the end of square strut channels, etc. with plastic caps. Suitably protect sharp corners and edges of tray to prevent personal hazard.
- .11 Where hanger rods are used, use stainless steel and not be smaller than 12 mm in diameter.

### **CABLE TRAYS FOR ELECTRICAL SYSTEMS**

---

- .12 Extend a stranded #2/0 tin plated bare, or green insulated, copper ground conductor the length of each tray route, and solidly connect sections of tray runs to the ground bus of the electrical room. Connect ground conductor to the tray every 15 m with approved grounding clamps suitable for connecting aluminum tray with copper conductor.
- .13 Generally run cables of different voltage classes in separate trays. Where a common tray is shown on Drawings, separate the cables for different voltage classes from each other by metal barriers as supplied by the tray Manufacturer.
- .14 Check all trays for surface smoothness prior to installation and remove all burrs, ridges, etc. on tray surfaces facing cables.
- .15 Size cabletrays as indicated on Drawings. If any discrepancies are found or changes in tray size are required, advise the Contract Administrator before installing the tray.

#### **3.2 Cables in Cabletray**

- .1 Install cables individually.
- .2 Lay cables into cabletray. Use rollers when necessary to pull cables.
- .3 Secure cables in tray at 5 m centers, with nylon ties.
- .4 Identify cables with nameplates in accordance with Section 26 05 00 - Common Work Results - For Electrical.
- .5 Mark power and communication runs in accordance with colour coding outlined in Section 26 05 00 - Common Work Results - For Electrical.

**END OF SECTION**

## **WIREWAYS AND AUXILIARY GUTTERS**

---

### **1. GENERAL**

#### **1.1 Description**

- .1 Supply and install wireways and auxiliary gutters and fittings as a means for flexible wiring system.
- .2 All wireways and auxiliary gutters to be 2-piece with removable cover to provide access to wiring.
- .3 Wireways, auxiliary gutters and fittings are based on CSA C22.2, No. 26.

#### **1.2 References**

- .1 Canadian Standards Association (CSA)
  - .1 CSA C22.2 No. 26, Construction and Test of Wireways, Auxiliary Gutters, and Associated Fittings.

#### **1.3 Submittals**

- .1 Submit Shop Drawings in accordance with Section 26 05 00 - Electrical General Requirements.

### **2. PRODUCTS**

#### **2.1 Wireways**

- .1 Sheet steel with bolted cover to give uninterrupted access.
- .2 Finish: based gray enamel.
- .3 Elbows, tees, couplings, and hanger fittings manufactured as accessories to wireway supplied.

### **3. EXECUTION**

#### **3.1 Installation**

- .1 Install wireways and auxiliary gutters.
- .2 Keep number of elbows, offsets, and connections to minimum.
- .3 Install supports, elbows, tees, connectors, and fittings.
- .4 Install barriers to separate different voltages or to separate different systems.
- .5 Install gutter to full length of equipment.

**END OF SECTION**

## **INSTALLATION OF CABLES IN TRENCHES AND IN DUCTS**

---

### **1. GENERAL**

#### **1.1 References**

- .1 Canadian Standards Association (CSA)
  - .1 CSA O80 Series, Wood Preservation.

### **2. PRODUCTS**

#### **2.1 Cable Protection**

- .1 Install as per Drawing E-0007.

### **3. EXECUTION**

#### **3.1 Direct Burial of Cables**

- .1 After sand bed specified is in place, lay cables maintaining 75 mm clearance from each side of trench to nearest cable. Do not pull cable into trench.
- .2 Provide offsets for thermal action and minor earth movements. Offset cables 150 mm for each 60 m run, maintaining minimum cable separation and bending radius requirements.
- .3 Underground cable splices not acceptable.
- .4 Maintain 75 mm minimum separation between cables of different circuits. Maintain 300 mm horizontal separation between low and high voltage cables. When low voltage cables cross high voltage cables maintain 300 mm vertical separation with low voltage cables in upper position. At crossover, maintain 75 mm minimum vertical separation between low voltage cables and 150 mm between high voltage cables. Maintain 300 mm minimum lateral and vertical separation for fire alarm and control, cables when crossing other cables, with fire alarm and control cables in upper position. Install treated planks on lower cables 0.6 m in each direction at crossings. All weather wood is not acceptable.

#### **3.2 Cable Installation in Ducts**

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

**INSTALLATION OF CABLES IN TRENCHES AND IN DUCTS**

---

- .7 After installation of cables, seal duct ends with duct sealing compound.

**3.3 Markers**

- .1 Mark cable every 30 m along cable or duct runs and changes in direction or as indicated on the Drawings.
- .2 Where markers are removed to permit installation of additional cables, reinstall existing markers.

**3.4 Field Quality Control**

- .1 Perform tests in accordance with Section 26 05 00.
- .2 Check phase rotation and identify each phase conductor of each feeder.
- .3 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.
- .4 Pre-acceptance test.
  - .1 After installing power cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.
  - .2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.
  - .3 Provide Contract Administrator with list of test results showing location at which each test was made, circuit tested and result of each test.
  - .4 Remove and replace entire length of cable if cable fails to meet any of test criteria.

**END OF SECTION**

## **MOULDED CASE CIRCUIT BREAKERS**

---

### **1. GENERAL**

#### **1.1 References**

- .1 National Electrical Manufacturers Association (NEMA)
  - .1 NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
  - .2 NEMA ICS 6, Industrial Control and Systems: Enclosures.

#### **1.2 Product Data**

- .1 Submit product data in accordance with Section 26 05 00.
- .2 Include time-current characteristic curves for breakers with minimum symmetrical (rms) interrupting capacity as shown at system voltage.

### **2. PRODUCTS**

#### **2.1 Breakers General**

- .1 Bolt-On Moulded Case Circuit Breaker: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40°C ambient.
- .2 Common-Trip Breakers: with single handle for multi-pole applications.
- .3 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range from three (3) to eight (8) times current rating.
- .4 Circuit breakers with interchangeable trips as indicated.
- .5 Add Electronic trip unit with adjustable settings to meet co-ordination study requirements where applicable or as shown on the Drawings.
- .6 Approved Manufacturers:
  - .1 Schneider Electric.

#### **2.2 Thermal Magnetic Breakers**

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

#### **2.3 Magnetic Breakers**

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

## **MOULDED CASE CIRCUIT BREAKERS**

---

### **2.4 Moulded Case Switch**

- .1 Moulded case switch shall be complete with a high instantaneous magnetic fixed trip, factory set to trip at high fault currents.

### **2.5 Enclosure for Individually Mounted Breakers or Moulded Case Switch**

- .1 Enclosure shall be CSA code gauge galvanized steel, hinged door, front mounted external operating handle, lockable in "off" position, NEMA 1 unless shown otherwise. Use NEMA 4X for Category 1 and 2 or outdoor areas, for wet environment or as shown "WP" on Drawings. Increase enclosure size above standard for large cables.
- .2 Where distribution system has grounded neutral conductor, provide neutral bar, with ampere rating equal to breaker/switch rating in enclosure.

## **3. EXECUTION**

### **3.1 Installation**

- .1 Install circuit breakers as indicated on Drawings and specified herein.
- .2 Install circuit breakers in panelboards to satisfy branch circuit requirements under the Scope of Work of this Contract.
- .3 Identification: Provide lamacoid plate on each breaker as per The City requirements.

**END OF SECTION**