

Part 1 General

1.1 SECTION INCLUDES

- .1 This Section covers items common to Sections of Division 26. This Section also supplements requirements of Division 1.

1.2 RELATED SECTIONS

- .1 Section 01 00 10 *General Instructions*

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.1-15, Canadian Electrical Code, Part 1 (23rd edition), Safety Standard for Electrical Installations.
 - .2 CSA C22.2 No. 1-M1987.
 - .3 CAN3-C235-83 (R2000), Preferred Voltage Levels for AC Systems, 0 to 50 kV.
- .2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
- .3 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
 - .1 IEEE SP1122-2000 *The Authoritative Dictionary of IEEE Standards Terms*, 7th Edition.

1.4 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.

1.5 DESIGN REQUIREMENTS

- .1 Operating voltages: to CAN3-C235-83.
- .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 for control items in English and French.
- .4 Use one nameplate for each language.

1.6 SUBMITTALS

- .1 Submit shop drawings and product data for new devices and material in accordance with Section 01 33 00 *Submittal Procedures*.
- .2 Shop drawings:
 - .1 Submit wiring diagrams and installation details of equipment indicating proposed layout and arrangement, control panels, accessories and other items that must be shown to ensure co-ordinated installation, as applicable.

- .3 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment, as applicable.
- .4 Indicate of drawings clearances for operation, maintenance and replacement of operating equipment devices.
- .5 Submit drawings and product data to Authority Having Jurisdiction (AHJ) and Electrical Safety Authority (ESA) and acknowledge the receipt.
- .6 If changes are required, notify Departmental Representative of these changes before they are made and obtain approval.
- .3 Quality Control: in accordance with Section 01 45 00 *Quality Control*.
 - .1 Provide CSA certified equipment and material.
 - .2 Where CSA certified equipment and material is not available, submit such equipment and material to inspection authorities for special approval before delivery to site.
 - .3 Submit test results of installed electrical systems and instrumentation.
 - .4 Permits and fees: in accordance with General Conditions of contract. Pay all associated fees.
 - .5 Submit, upon completion of Work, load balance report as described in PART 3 - LOAD BALANCE.
 - .6 Submit certificate of acceptance from Electrical Safety Authority (ESA) and authority having jurisdiction upon completion of work to Departmental Representative.
- .4 Manufacturer's Field Reports: submit to Departmental Representative manufacturer's written report, within 2 days of review, verifying compliance of work and electrical system and instrumentation testing, as described in PART 3 - FIELD QUALITY CONTROL.

1.7 QUALITY ASSURANCE

- .1 Quality Assurance: in accordance with Section 01 45 00 *Quality Control*.
- .2 Qualifications: electrical Work to be carried out by qualified, licensed electricians who hold valid Master Electrical Contractor license or apprentices in accordance with authorities having jurisdiction as per the conditions of Provincial Act respecting manpower vocational training and qualification.
 - .1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.
 - .2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.
- .3 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 *Health and Safety Requirements*.

1.8 SYSTEM STARTUP

- .1 Instruct Departmental Representative and operating personnel in operation, care and maintenance of systems, system equipment and components, as applicable.
- .2 Arrange and pay for services of manufacturer's factory service personnel 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.

1.9 OPERATING INSTRUCTIONS

- .1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
- .2 Operating instructions to include following, but not limited to:
 - .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 in English and French, frame under glass or in approved laminated plastic.

1.10 PROGRAM OF WORK

- .1 Following is the program of works, but not limited to:
 - .1 **For Portage gate 1:**
 - .1 Remove the existing indicator lights in the existing main and local control panels (approx.. 20), and replace them with new total of 4 Watt comprised of 6 LED lamps and driver to operate LED lamps – voltage for new LEDs to match the existing voltage of respective panels. Re-install indicator colour caps as existing colour type to match.
 - .2 Disconnect and remove existing four limit switches (LS-1 to LS-4) and replace and reconnect them (refer to manufacturer's instructions and recommendations for installation, setting, and adjustments) with four new limit switches to match existing, with the function and location of limit switches LS-1 to LS-4 as follows:
 - .1 **Rotary limit switch LS-1:** The rotary limit switch is to act as a back-up limit switch on gate closing in case the slack rope limit switch (LS-2) fails, it stops the gate in the fully open position, also, it operates the pilot light indicating gate fully lowered on the main control panel with the indicator light.
 - .2 **Slack rope limit switch LS-2:** The slack rope limit switch is located under the left hand rope drum, which is lever type switch that stops the gate at the sill, also, stops the motor should the gate become jammed while lowering, thus preventing excessive unwinding of the main rope from the hoist drum.
 - .3 **Hand crank safety limit switch LS-3:** The hand crank safety limit switch is located on the hand drive support. This limit switch automatically disconnects the motor control circuit when the drive is connected and ready for use.

- .4 **Over travel limit switch LS-4:** Over travel limit switch is located at the center of the hoist bridge, which is lever-type switch that stops the gate 30 mm above the fully open position, should the rotary limit switch (LS-1) fail.
- .3 Remove, replace and reconnect the heaters in the remote local control panel.
- .4 Disconnect, re-install and reconnect with appropriate numbering system the existing power and control wires in the main and local control panels as per control diagram.
- .2 **For Portage gate 2:**
 - .1 Disconnect and remove the existing indicator lights in the existing main and local control panels (approx. 20), and replace them with new total of 4 watt comprised of 6 LED lamps and driver to operate LED lamps – voltage for new LEDs to match the existing voltage of respective panels. Re-install indicator colour caps.
 - .2 Disconnect and remove existing four limit switches (LS-1 to LS-4) and replace and reconnect them (refer to manufacturer's instructions and recommendations for installation, setting, and adjustments) with four new limit switches to match existing, with the function and location of limit switches LS-1 to LS-4 as follows:
 - .1 **Rotary limit switch LS-1:** The rotary limit switch is to act as a back-up limit switch on gate closing in case the slack rope limit switch (LS-2) fails, it stops the gate in the fully open position, also, it operates the pilot light indicating gate fully lowered on the main control panel with the indicator light.
 - .2 **Slack rope limit switch LS-2:** The slack rope limit switch is located under the left hand rope drum, which is lever type switch that stops the gate at the sill, also, stops the motor should the gate become jammed while lowering, thus preventing excessive unwinding of the main rope from the hoist drum.
 - .3 **Hand crank safety limit switch LS-3:** The hand crank safety limit switch is located on the hand drive support. This limit switch automatically disconnects the motor control circuit when the drive is connected and ready for use.
 - .4 **Over travel limit switch LS-4:** Over travel limit switch is located at the center of the hoist bridge, which is lever-type switch that stops the gate 30 mm above the fully open position, should the rotary limit switch (LS-1) fail.
 - .3 Remove, replace and reconnect the heaters in the remote local control panel.
 - .4 Disconnect, re-install and reconnect with appropriate numbering system the existing power and control wires in the main and local control panels as per control diagram.
 - .5 Contractor is to check, test and correct the existing field controls complete with alarm system that are not functioning while the gate no. 2 opens and/or closes. Provide new required devices and/or parts to match existing to make the field controls and alarm operable.
- .3 **For Portage gate 3:**
 - .1 Disconnect and remove the existing indicator lights in the existing main and local control panels (approx.. 20), and replace them with new total of 4 watt comprised

- of 6 LED lamps and driver to operate LED lamps – voltage for new LEDs to match the existing voltage of respective panels. Re-install indicator colour caps.
- .2 Disconnect and remove existing four limit switches (LS-1 to LS-4) and replace and reconnect them (refer to manufacturer's instructions and recommendations for installation, setting, and adjustments) with four new limit switches to match existing, with the function and location of limit switches LS-1 to LS-4 as follows:
- .1 **Rotary limit switch LS-1:** The rotary limit switch is to act as a back-up limit switch on gate closing in case the slack rope limit switch (LS-2) fails, it stops the gate in the fully open position, also, it operates the pilot light indicating gate fully lowered on the main control panel with the indicator light.
- .2 **Slack rope limit switch LS-2:** The slack rope limit switch is located under the left hand rope drum, which is lever type switch that stops the gate at the sill, also, stops the motor should the gate become jammed while lowering, thus preventing excessive unwinding of the main rope from the hoist drum.
- .3 **Hand crank safety limit switch LS-3:** The hand crank safety limit switch is located on the hand drive support. This limit switch automatically disconnects the motor control circuit when the drive is connected and ready for use.
- .4 **Over travel limit switch LS-4:** Over travel limit switch is located at the center of the hoist bridge, which is lever-type switch that stops the gate 30 mm above the fully open position, should the rotary limit switch (LS-1) fail.
- .3 Remove, replace and reconnect the heaters in the remote local control panel.
- .4 Disconnect, re-install and reconnect with appropriate numbering system the existing power and control wires in the main and local control panels as per control diagram.
- .2 Supply, install, test and commission the equipment and/or devices installed and/or replaced new in this project. Coordinate with Authorities Having Jurisdiction (AHJ), Electrical Safety Authority (ESA) and the Departmental Representative at least 15 days in advanced notice with the approvals.
- .3 The project site is occupied by the client and must be operational during the construction period. Coordinate with the Departmental Representative.
- .4 All existing equipment, devices, conduits and wires that are removed during the demolition phase of the project, shall be removed up to their respective source of power. Update the panel legend directories and lamicoid name plates to reflect the removal of devices, and provide the summary sheet to Departmental Representative.
- .5 At the completion of the project, provide the Departmental Representative the 'As-Built' and shop drawings, final inspection certificate from ESA, each control panel test reports, warranty, manufacturer's contact numbers for parts, and include them in the updated operation manual (ref. Section 31 20 16 .51 *Overhaul Vertical Lift Gates* for requirements for updating existing operation manual).
- .6 Contractor is to provide the following items as spare parts to the Departmental Representative and acknowledge with the receipt at the completion of the project:

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- .1 20 total bulb units, each of 4 Watts and comprised of 6 individual LED lamps within the bulb, for each type of bulb that are installed in this project.
- .2 One - each of new replaced limit switches: LS-1, LS-2, LS-3 and LS-4 that are installed in this project if they are identical and of same type, otherwise provide one each type of limit switches if they are not identical.
- .7 The electrical contractor must conduct his/her work as as noted, specified, and described in the mechanical, civil, painting and electrical tendered documents.
- .8 All work above shall be conducted as per Canadian Electrical Code, 23rd edition.

Part 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- .1 Material and equipment to be CSA certified. Where CSA certified material and equipment are not available, obtain special approval from authority having jurisdiction, and ESA inspection authorities before delivery to site and submit such approval as described in PART 1 - SUBMITTALS.

2.2 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as per manufacturer's instructions and as per their recommendations.

2.3 WARNING SIGNS

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

2.4 WIRING TERMINATIONS

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

2.5 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with nameplates as follows:
 - .1 Nameplates: Lamicoid 3 mm thick plastic engraving sheet, black finish face with white lettering for normal power, and red finish face with white lettering for emergency power and life safety system, bilingual (English and French) lettering accurately aligned and engraved into core, mechanically attached with self tapping screws.
 - .2 Sizes as follows:

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

NAMEPLATE SIZES			
Size 6	25 mm x 100 mm	1 line	12 mm high letters
Size 7	25 mm x 100 mm	2 lines	6 mm high letters

- .2 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.
- .3 Wording on nameplates to be approved by Departmental Representative prior to manufacture.
- .4 Allow for minimum of twenty-five (25) letters per nameplate.
- .5 Nameplates for terminal cabinets and junction boxes to indicate system, circuit number and/or voltage characteristics.
- .6 Identify equipment with Size 3 labels engraved "ASSET INVENTORY NO. [____]" as directed by Departmental Representative.
- .7 Disconnect and limit switches: indicate equipment being controlled.
- .8 Terminal cabinets and pull boxes: indicate system and voltage.

2.6 WIRING IDENTIFICATION

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

2.7 CONDUIT AND CABLE IDENTIFICATION

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

	Prime	Auxiliary
up to 250 V	Yellow	

2.8 FINISHES

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

Part 3 Execution

3.1 INSTALLATION

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.

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

3.2 NAMEPLATES AND LABELS

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

3.3 CONDUIT AND CABLE INSTALLATION

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

3.4 LOCATION OF OUTLETS

- .1 Provide outlets in accordance with Section 26 05 32 *Outlet Boxes, Conduit Boxes and Fittings*.
- .2 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.
- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 1500 mm, and information is given before installation.

3.5 MOUNTING LOCATIONS

- .1 Measure mounting locations of existing equipment scheduled for replacement. Measure from dam deck or other fixed datums to centreline of equipment. Submit drawings.
- .2 Install new equipment in same location as previous equipment as per drawing prepared in .1 above..

3.6 CO-ORDINATION OF PROTECTIVE DEVICES

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.
- .2 Coordination shall be in accordance with requirements of the Canadian Electrical Code (23rd edition) and the recommendations of IEEE standard 399-1997.

3.7 FIELD QUALITY CONTROL

- .1 **Load Balance:**
 - .1 Measure phase current to panel boards with normal loads from operation of gates as well as load from gain heaters. 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 - SUBMITTALS: phase and neutral currents on panel boards 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 distribution system including phasing, voltage, grounding and load balancing.
 - .2 Circuits originating from branch distribution panels.

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- .3 Lighting and its control.
- .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
- .5 Operation of limit switches LS-1 to LS-4 inclusive, as described herein, for each gate.
- .6 Insulation resistance testing:
 - .1 Megger circuits, feeders and equipment 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 Submit type written test results for the Departmental Representative's review, within 3 days after the test.
- .6 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 - SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.8 CLEANING

- .1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .2 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting. Submit proposed coating for Departmental Representative's review before purchase.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation for wire and box connectors.

1.2 RELATED SECTIONS

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

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-C22.2No.18-98, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
 - .2 CSA C22.2No.65-93 (R1999), Wire Connectors.
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
- .3 National Electrical Manufacturers Association (NEMA)

1.4 SUBMITTALS

- .1 Submit product data.

Part 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 to fit copper conductors 10 AWG or less.
- .3 Bushing stud connectors: to EEMAC 1Y-2 to consist of:
 - .1 Connector body and stud clamp for stranded copper conductors.
 - .2 Clamp for stranded copper conductors.
 - .3 Stud clamp bolts.
 - .4 Bolts for copper conductors.
 - .5 Sized for conductors as indicated.
- .4 Clamps or connectors for armoured cable, flexible conduit, non-metallic sheathed 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 CSA C22.2No.65.
 - .2 Install fixture type connectors and tighten. Replace insulating cap.
 - .3 Install bushing stud connectors in accordance with EEMAC 1Y-2.

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 28 *Grounding - Secondary*
- .4 Section 26 05 34 *Conduits, Conduit Fastenings and Conduit Fittings*

1.2 REFERENCES

- .1 CSA C22.2 No.3-01 Test Methods for Electrical Wires and Cables.
- .2 CAN/CSA-C22.2 No. 131-M89 (R1999) Type TECK Cable.

1.3 SUBMITTALS

- .1 Submit product data.

Part 2 Products

2.1 BUILDING WIRES

- .1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- .2 Ground wire: minimum size 12 AWG.
- .3 Copper conductors: size as required by Canadian Electrical Code 2015 (23rd edition), with 600 V insulation of cross-linked thermosetting polyethylene material rated RW90 and RWU90 for underground wiring.

2.2 TECK 90 CABLE

- .1 Cable: in accordance with Section 26 05 00 *Common Work Results for Electrical*.
- .2 Conductors:
 - .1 Grounding conductor: copper.
 - .2 Circuit conductors: copper, size as required by Canadian Electrical Code 2015 (23rd edition).
- .3 Insulation:
 - .1 Cross-linked polyethylene XLPE, type RW90 as per standard C22.2 No. 131.
 - .2 Rating: 600 V.
- .4 Inner jacket: polyvinyl chloride material.
- .5 Armour: interlocking aluminum.

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- .6 Overall covering: black polyvinyl chloride (PVC) heat flame and moisture resistant jacket suitable for installation in temperatures to -40 degree C.
- .7 Fastenings:
 - .1 One hole malleable aluminum straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
 - .2 Channel type supports for two or more cables; supports at 900 mm centres.
 - .3 Threaded rods: 12 mm diameter to support suspended channels.
- .8 Manufacturer to install pulling eye at one end of each cable.
- .9 Connectors:
 - .1 Watertight, approved for TECK cable.
 - .2 Manufactured from non-ferrous metals.

2.3 ARMoured CABLES

- .1 Conductors: insulated, copper, size as required by Canadian Electrical Code 2015.
- .2 Type: AC90 - lead sheath over cable assembly and under armour.
- .3 Armour: interlocking type fabricated from aluminum strip.
- .4 Connectors: anti short connectors.

2.4 CONTROL CABLES

- .1 Low energy 600 volts control cables: Stranded annealed copper conductors size as required by Canadian Electrical Code 2015 (23rd edition), with TW -40 degree C polyethylene insulation with shielding of tape coated with paramagnetic material braid metallized tapes over each conductor and overall covering of polyethylene jackets.

Part 3 Execution

3.1 FIELD QUALITY CONTROL

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

3.2 GENERAL CABLE INSTALLATION

- .1 Lay cable in cable trays, existing trenches and in conduits, as applicable.
- .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*.

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- .4 Conductor length for parallel feeders to be identical.
- .5 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .6 Branch circuit wiring for lighting, receptacles and permanently wired equipment to be 2 -wire circuits only, i.e. common neutrals not permitted.
- .7 Provide numbered wire collars for control wiring. Numbers to correspond to control drawing legend (drawing E2 of 1992 tender drawings for Portage Dam Reconstruction).

3.3 INSTALLATION OF BUILDING WIRES

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

3.4 INSTALLATION OF TECK90 CABLE (0 -1000 V)

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

3.5 INSTALLATION OF ARMOURED CABLES

- .1 Group cables wherever possible on channels.
- .2 Provide armoured cables for final connections only, where the length of armoured cable is not to exceed 2.5 m at each final connection.

3.6 INSTALLATION OF CONTROL CABLES

- .1 Install control cables in conduit, size as required.
- .2 Ground control cable shield.

END OF SECTION

Part 1 General**1.1 SECTION INCLUDES**

- .1 Materials and installation for connectors and terminations.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 *Submittal Procedures*

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2 No.41-M1987 (R1999), Grounding and Bonding Equipment.

1.4 SUBMITTALS

- .1 Submit product data.

Part 2 Products**2.1 CONNECTORS AND TERMINATIONS**

- .1 Copper compression connectors to CSA C22.2 as required sized for conductors.

Part 3 Execution**3.1 INSTALLATION**

- .1 Install terminations and splices in accordance with manufacturer's instructions, and as per Hydro One requirements.
- .2 Bond and ground as required to CSA C22.2 No.41.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 00 *Common Work Results For Electrical.*

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/Institute of Electrical and Electronics
Departmental Representatives (IEEE)
 - .1 ANSI/IEEE 837-1989 (R1996), Qualifying Permanent Connections Used in Substation
Grounding.
- .2 Canadian Standards Association, (CSA International)

Part 2 Products

2.1 EQUIPMENT

- .1 Clamps for grounding of conductor: size as per Canadian Electrical Code 2015 (23rd edition),
connected to existing building grounding system.
- .2 Copper conductors: Green insulated stranded copper conductor medium annealed, size as
required by Canadian Electrical Code 2015 (23rd edition).
- .3 Insulated grounding conductors: green, type RW90 and/or RWU90, XLPE. Minimum size bond
wire in main and branch distribution shall be #12 AWG or as required by code.
- .4 Non-corroding accessories necessary for grounding system, type, size and material as required,
but not necessarily limited to:
 - .1 Grounding and bonding bushings.
 - .2 Protective type clamps.
 - .3 Bolted type conductor connectors.
 - .4 Bonding jumpers, straps.
 - .5 Long barrel two holes compression wire connectors.

Part 3 Execution

3.1 INSTALLATION GENERAL

- .1 Install complete permanent, continuous grounding system including, electrodes if required,
conductors, connectors, accessories. Where EMT is used, run ground wire in conduit.
- .2 Install connectors in accordance with manufacturer's instructions.
- .3 Protect exposed grounding conductors from mechanical injury.
- .4 Use mechanical connectors for grounding connections to equipment provided with lugs.

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- .5 Soldered joints not permitted.
- .6 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
- .7 Install separate ground conductor to outdoor electrical equipment and devices.
- .8 Make grounding connections in radial configuration only, with connections terminating at a single grounding point. Avoid loop connections.
- .9 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end. Minimum bond size conductor shall be # 2/0 AWG.

3.2 EQUIPMENT GROUNDING

- .1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, cable raceway systems, frames of motors, disconnect and limit switches, starters, control panels, building and dam steel work, distribution panels, outdoor installed weather proof enclosure and metal supports.

3.3 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 *Common Work Results for Electrical*.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of AHJ, ESA and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.
- .4 Disconnect ground fault indicator during tests.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

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

Part 2 Products

2.1 SUPPORT CHANNELS

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

Part 3 Execution

3.1 INSTALLATION

- .1 Secure equipment to solid masonry, tile and plaster surfaces with 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 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 9 mm dia threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by 9 mm dia threaded rod hangers where direct fastening to building construction is impractical.
- .7 For surface mounting of two or more conduits use channels at 600 mm on centre spacing or as required by Code.
- .8 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .9 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .10 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .11 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Departmental Representative.

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

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

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

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
.1 CSA C22.1-15, Canadian Electrical Code, Part 1, 23rd edition.

1.3 SUBMITTALS

- .1 Provide shop drawings.

Part 2 Products

2.1 JUNCTION AND PULL BOXES

- .1 Construction: welded steel enclosure, minimum NEMA 3 type.
.2 Covers Flush Mounted: 25 mm minimum extension all around.
.3 Covers Surface Mounted: screw-on flat covers.
.4 All exterior and outdoor installed junction and pull boxes shall be NEMA 4R type.
.5 Colour finish to be reviewed by Departmental Representative.

Part 3 Execution

3.1 JUNCTION AND PULL BOXES INSTALLATION

- .1 Install pull boxes in inconspicuous but accessible locations.
.2 Install junction and pull boxes as required by CSA C22.1.
.3 Maintain respective box integrity for the outdoor installed boxes.

3.2 IDENTIFICATION

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

END OF SECTION

Part 1 General**1.1 RELATED SECTIONS**

- .1 Section 26 05 00 *Common Work Results For Electrical*
- .2 Section 26 05 28 *Grounding Secondary*

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.1-15 Canadian Electrical Code, Part 1, 23rd edition.
 - .2 CSA C22.2 18-98 Outlet boxes, conduit boxes and Fittings.

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 Weatherproof type for exterior and outdoor installations.
- .4 Gang boxes where wiring devices are grouped.
- .5 Blank cover plates for boxes without wiring devices.

2.2 GALVANIZED STEEL OUTLET BOXES

- .1 One-piece electro-galvanized construction. Weatherproof type for exterior and outdoor installations.
- .2 Electro-galvanized steel single or multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .3 Electro-Galvanized steel Utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.

2.3 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 32 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 Identify systems for outlet boxes as required.

END OF SECTION

Part 1 General**1.1 RELATED SECTIONS**

- .1 Section 26 05 00 *Common Work Results For Electrical*
- .2 Section 26 05 28 *Grounding Secondary*

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA C22.2 No. 18-98 (R2003), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
 - .2 CSA C22.2 No. 56-04, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .3 CSA C22.2 No. 83-M1985 (R2003), Electrical Metallic Tubing.
 - .4 CSA C22.2 No. 45(1999), Rigid metal conduit

1.3 SUBMITTALS

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

Part 2 Products**2.1 CABLES AND REELS**

- .1 Provide cables on reels or coils. Mark or tag each cable and outside of each reel or coil, to indicate cable length, voltage rating, conductor size, and manufacturer's lot number and reel number.
- .2 Each coil or reel of cable to contain only one continuous cable without splices.

2.2 CONDUITS

- .1 Rigid metal conduit: to CSA C22.2 No. 45(1999), hot dipped galvanized steel, threaded.
- .2 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with watertight couplings.
- .3 Flexible metal conduit: to CSA C22.2 No. 56, steel, liquid-tight, flexible metal.
- .4 Minimum conduit size to be used 20mm diameter.

2.3 CONDUIT FASTENINGS

- .1 One hole malleable steel straps to secure surface conduits 50 mm and smaller. Two hole steel straps for conduits larger than 50 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Threaded rods, 9 mm diameter, to support suspended channels.

2.4 CONDUIT FITTINGS

- .1 Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified. Coating: same as conduit.
- .2 Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits, the bends must be over a 30 degree radius.
- .3 Watertight connectors and couplings for EMT. Set-screws are not acceptable.

2.5 EXPANSION FITTINGS FOR RIGID CONDUIT

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 100 mm linear expansion.
- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel.

2.6 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 except in mechanical and electrical service rooms in unfinished areas.
- .3 Use liquid-tight flexible metal conduit for final connections only with maximum length of 2 meters, connection to motors or vibrating equipment in damp, wet or corrosive locations.
- .4 Minimum conduit size for electrical installations: 19 mm.

- .5 Bend conduit cold: Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .6 Mechanically bend steel conduit over 19 mm diameter.
- .7 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .8 Install fish cord and nylon bushings at each end of conduit in all empty conduits.
- .9 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- .10 Dry conduits out before installing wire.

3.3 SURFACE CONDUITS

- .1 Run parallel or perpendicular to building lines and in trenches.
- .2 Install wires and conduits with a minimum 1.5 m clearance from all obstructions or heat-generating items.
- .3 Group conduits wherever possible on suspended or surface channels.
- .4 Do not pass conduits through structural members except as indicated.

END OF SECTION