TENDER DOCUMENTS

SUBSECTION 6.52
ELECTRICAL CABLES

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SUBSECTION 6.52 ELECTRICAL CABLES

6.52.1 GENERAL

6.52.1.1 This subsection sets out the requirements relating to the supply and installation of electrical cables covered by this Contract.

6.52.1.2 Any specific requirements pertaining to the supply and installation of electrical cables covered by this Contract are set out on the drawings and in Section 4 *Special Technical Conditions*.

6.52.1.3 The general requirements relating to the supply and installation of conduit, junction boxes and pull boxes are set out in subsection 6.51 *Conduit, Junction Boxes and Pull Boxes.*

6.52.2 MEASUREMENT UNITS

6.52.2.1 The measurement units and respective symbols thereof used in this subsection are described as follows:

Measurement Unit	Designation	Symbol
length	meter	m
length	millimeter	mm
electric potential difference	kilovolt	kV
electric potential difference	volt	V
temperature	Celsius degree	°C
electric resistance	ohm	Ω
electric resistance	megohm	MΩ
electric current intensity	microampere	µA
force	kilonewton	kN

6.52.3 REFERENCE STANDARDS

6.52.3.1 The **Contractor** shall perform all work related to the supply and installation of electrical cables in accordance with the requirements of the following standards and documents to which the provisions of this Contract are added:

6.52.3.1.1 (CSA) Canadian Standards Association:

- CAN/CSA-C22.2 NO. 0 *General Requirements – Canadian Electrical Code, Part II*;
- CAN/CSA C22.2 NO. 0.3 *Test Methods for Electrical Wires and Cables*;
- CAN/CSA-C22.2 NO. 38 *Thermoset-Insulated Wires and Cables (Tri-National standard, with UL 44 and ANCE NMX-J-451-2014)*;

- CAN/CSA-C22.2 NO. 65 *Wire Connectors (Tri-National standard, with UL 486A-486B and NMX-J-543-ANCE)*;

- CAN/CSA C22.2 NO. 131 *Type TECK 90 Cable;*

- CSA C22.10 *Quebec Construction Code - Chapter V, Electricity - Canadian Electrical Code, Part I with Québec Amendments.*

6.52.3.1.2 (EEMAC) Electrical Equipment Manufacturers Association of Canada:

- 1Y-2 *CEMA Standard for Bushing Stud Connectors and Aluminium Adapters (1200 amp. max. rating)*.

6.52.3.1.3 (MTQ) Ministère des Transports du Québec:

- MTQ – *Cahier des charges et devis généraux (CCDG)*.

6.52.3.1.4 (NEMA) National Electrical Manufacturers Association:

- ANSI/NEMA WC70/ICEA S95-658 *Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy;*

- ANSI/NEMA WC71/ICEA S96-659 *Standards for Non-Shielded Cables Rated 2001-5000 Volts for Use in Distribution of Electric Energy.*

6.52.4 MATERIALS

6.52.4.1 GENERAL

6.52.4.1.1 The electrical cables shall be CSA approved.

6.52.4.1.2 All conductors shall consist of stranded copper wire conductors.

6.52.4.2 ELECTRICAL CABLES TO BE INSTALLED INTO CONDUIT

6.52.4.2.1 The electrical cables to be installed into conduit shall consist of stranded copper wire conductors, in the number and of the gauge according to the indications on the drawings, under a chemically cross-linked thermosetting polyethylene insulation designed to carry 1000 V and shall be Type RW90 or RWU90 - XLINK - 40˚C and compliant with standards CAN/CSA-C22.2 Nº 38, CAN/CSA-C22.2 Nº 0, CAN/CSA C22.10 and NEMA WC70.

6.52.4.2.2 Armoured cables shall not be installed in conduit.

6.52.4.3 TECK ELECTRICAL CABLES

6.52.4.3.1 The TECK electrical cables shall comply with standard CAN/CSA C22.2 Nº 131.

6.52.4.3.2 The TECK cables shall consist of stranded copper wire conductors, in the number and of the gauge according to the indications on the drawings, under a chemically cross-linked thermosetting polyethylene insulation designed to carry 1000 V and shall be Type RWU90 - XLINK -40˚C and compliant with standards CAN/CSA-C22.2 Nº 0, CAN/CSA C22.10 and NEMA WC70.

6.52.4.3.3 The TECK cables shall be coated with inner and outer polyvinyl chloride (PVC) protective sheaths reinforced with metal armour made of interlocked aluminum strips.

6.52.4.3.4 The cables used for the fire system shall be made of solid copper with PVC insulation and have an aluminum armor covered with a red PVC coating for a temperature of 105°C and a voltage of 300 V AC. These cables shall be CSA FAS FT4 class.

6.52.4.4 CABLE FITTINGS

6.52.4.4.1 The fittings for the cords, cables and TECK cables shall meet, without however being limited to, the following requirements:

6.52.4.4.1.1 be liquid tight;

6.52.4.4.1.2 be approved by the manufacturer, be suitable for the TECK cables and be compliant with standard CSA C22.2;

6.52.4.4.1.3 be equipped with an O-ring seal to ensure the tightness with the surface of the box and also be equipped with a grounding locknut;

6.52.4.4.1.4 be equipped with a beveled bushing, funnel entry and spline cap gland nut;

6.52.4.4.1.5 the fittings installed on NEMA 3, 3R, 4 and 4X boxes shall be made of stainless steel;

6.52.4.4.1.6 the fittings installed on NEMA 12 boxes shall be made of aluminum or stainless steel.

6.52.4.5 CONNECTORS

6.52.4.5.1 The connectors shall be snap-in connectors for 0-1000 V cables, of a gauge appropriate for the copper conductors used. They shall comply with the indications on the drawings and comply with standards CAN/CSA-C22.2 Nº 65 and 1Y-2 CEMA.

6.52.4.6 MARKING OF ELECTRICAL CABLES

6.52.4.6.1 The electrical cables shall, at the time of manufacture, be marked in indelible ink on the sheath, at regular intervals not exceeding 1 m. The following information shall appear: the certification logo (CSA), manufacturer's name or trademark, type of cables (RW90, RWU90 or TECK), 90°C, -40°C, 1000 V, gauge according to the scale of the American Wire Gauge and number of conductors.

6.52.4.7 ELECTRICAL CABLE IDENTIFIERS

6.52.4.7.1 The electrical cable identifiers shall consist of a black PVC support and yellow rings with an alphanumeric code written in black. The identifications shall be Thomas & Betts SMK or equivalent authorized by the Engineer.

6.52.4.8 FLEXIBLE ELECTRICAL CABLES FOR LANE SIGNALS

6.52.4.8.1 The flexible electrical cables for lane signals shall consist of ten (10) copper conductors with sixteen (16) 18 AWG stranded wires.

6.52.4.8.2 The flexible electrical cables for lane signals shall be VNTC Anixter 2A-1810 with a suitable watertight fitting of Type RD21NT Techspan or equivalent authorized by the Engineer.

6.52.4.9 GENIUS BUS NETWORK CABLES

6.52.4.9.1 The Genius Bus network cables shall consist of two (2) twisted pair copper conductors with a minimum of nineteen (19) AWG CMX 75°C 22 or 24 stranded wires.

6.52.4.9.2 The Genius Bus network cables shall have a "Shield" shielding sheath, a drain wire of the brand "Drain wire" and shall possess a typical impedance of 150 Ω.

6.52.4.9.3 The Genius Bus network cables shall be Manhattan 39240 or Belden 9841 or equivalent authorized by the Engineer.

6.52.5 EQUIPMENT AND TOOLS

6.52.5.1 Where a mechanical traction device is needed to install electrical cables into conduit, it shall be equipped with a dynamometer, a display, and a device to record the pulling tension applied in newtons.

6.52.6 EXECUTION OF WORK

6.52.6.1 PLANNING

6.52.6.1.1 At least fourteen (14) days before the installation of the cables begins, the **Contractor** shall submit to the Engineer, for review, the technical data sheets for the electrical cables, fittings, connectors and supports.

6.52.6.1.2 At least fourteen (14) days before the installation of the cables begins, the **Contractor** shall submit to the Engineer, for review, the procedure for the installation of cables.

6.52.6.2 INSTALLATION OF ELECTRICAL CABLES INTO CONDUIT

6.52.6.2.1 Before the electrical cables are installed, the conduit shall be proofed and cleaned with a brush.

6.52.6.2.2 At no time during the installation shall the radius of curvature of the electrical cables be below the minimum value recommended by the cable manufacturer. If pulleys must be used, the pulley diameter as well as that of the “U” shall comply with the electrical cable manufacturer’s recommendations.

6.52.6.2.3 Where a mechanical traction device is required to install the electrical cables into conduit, the applied traction tension shall not exceed the maximum tension recommended by the cable manufacturer. If necessary, intermediate pull points shall be planned.

6.52.6.2.4 It is forbidden to pull spliced electrical cables through conduit.

6.52.6.2.5 All electrical cables running through the same conduit shall be pulled simultaneously.

6.52.6.2.6 To reduce the pulling tension, the **Contractor** shall use lubricants that are CSA approved and compatible with the outer sheath of the electrical cable, in accordance with the cable manufacturer’s recommendations.

6.52.6.2.7 A 6 mm twisted nylon pull rope with a tensile strength of 5 kN shall be left in each conduit after the electrical cables are installed.

6.52.6.3 INSTALLATION OF THE TECK ELECTRICAL CABLES

6.52.6.3.1 The **Contractor** shall securely fix the TECK electrical cables to the structure using a fixing system as specified on the drawings.

6.52.6.3.2 The TECK cables shall be installed at right angles and perpendicular to the structure components.

6.52.6.3.3 When cables are grouped, they shall be spaced by at least one (1) time the diameter of the largest cable in the group.

6.52.6.3.4 All TECK cables shall be equipped with fittings at the ends.

6.52.6.3.5 When the installation of the TECK cables produces a permanent curve, the radius of curvature shall comply with the manufacturer's specifications without however being less than seven (7) times the cable diameter.

6.52.6.3.6 The insertion of the TECK cables into boxes located in damp locations shall not be performed through the top of the boxes.

6.52.6.3.7 The TECK cable is recommended for the connection of new lane signal, since it allows greater flexibility during handling and maintenance.

6.52.6.4 INSTALLATION OF FLEXIBLE ELECTRICAL CABLES FOR LANE SIGNALS

6.52.6.4.1 The flexible cables are used to power and control the lane signal heads and shall be installed into conduit up to the junction boxes on the overhead signage structure and on the surface between the junction boxes and the lane signal heads.

6.52.6.4.2 The cable termination shall be carried out with a black heat shrinkable sleeve of a minimum length of 30 mm by overlapping half of the cable sheath.

6.52.6.5 IDENTIFICATION OF ELECTRICAL CABLES AND CONDUCTORS

6.52.6.5.1 The cables shall be identified with electrical cable identifiers at the time of the initial installation thereof and shall be designated as indicated on the drawings.

6.52.6.5.1.1 The identifiers shall be securely fixed with UV-resistant black cable ties.

6.52.6.5.1.2 The identifier shall be positioned in a way that allows the reading of the cable identification from the top down for the cables installed vertically and from left to right for the cables installed horizontally.

6.52.6.5.2 The cables shall be identified:

6.52.6.5.2.1 at both ends;

6.52.6.5.2.2 at all points where they cross an electrical box;

6.52.6.5.2.3 at all points where they cross a structure.

6.52.6.5.3 The **Contractor** shall identify the conductor ends that correspond to the circuit distribution in the junction boxes and in the pull boxes. To this end, the conductor ends shall be identified with a numbered and printed plastic tape with permanent indelible markings for each conductor.

6.52.6.5.4 The conductors shall be individually identified at both ends.

6.52.6.5.5 The colour code to be used for identifying the conductors shall be the following:

6.52.6.5.5.1 green for the ground wire;

6.52.6.5.5.2 white or grey for the neutral wire;

6.52.6.5.5.3 black for L1 and red for L2 when the voltage is 120/240 V;

6.52.6.5.5.4 red for phase A, black for phase B and blue for phase C when the voltage is 347/600 V.

6.52.6.6 INSTALLATION OF THE CONDUCTORS IN THE ELECTRICAL BOXES

6.52.6.6.1 The conductors installed in the electrical boxes shall be placed so as not to overlap the internal components of the electrical box. The conductors shall be carefully placed and grouped, and properly fixed.

6.52.6.7 CONNECTORS

6.52.6.7.1 The conductor ends shall be carefully stripped and, where necessary, compression connectors shall be installed. To this end, the **Contractor** shall tighten the connector screws with a compression tool recommended by the connector manufacturer. The installation shall comply with the tightening tests conducted in accordance with standard CAN/CSA C22.2 Nº 65.

6.52.7 QUALITY CONTROL

6.52.7.1 GENERAL

6.52.7.1.1 Any work that is not performed in accordance to the indications on the drawings and specifications shall be corrected by the **Contractor** at its expense and to the satisfaction of the Engineer.

6.52.7.2 MEASUREMENT OF THE PULLING TENSION

6.52.7.2.1 Where a mechanical traction device is required to install electrical cables into conduit, the **Contractor** shall submit to the Engineer a copy of the tension measurements recorded using a dynamometer, a display, and a recording of the traction tension applied at the end of each workday during which cables were installed with the tool.

6.52.7.3 Electrical verifications

6.52.7.3.1 The **Contractor** shall proceed with the verification of the conductors.

6.52.7.3.2 The **Contractor** shall keep a record of the list of conductors and cables installed as well as the information relating to the verification performed.

6.52.7.3.3 Before the installation, the **Contractor** shall verify the cables and conductors in order to ensure the quality control thereof.

6.52.7.3.4 Prior to commissioning, the **Contractor** shall ensure that all system components installed are working well. He shall verify the insulation of the live electrical parts with a mega-ohm meter and obtain minimum readings of 100 MΩ at a voltage of 1000 V before carrying out the system verification.

6.52.7.3.5 All electrical verifications must be carried out by a laboratory member of the *Association des firmes de génie-conseil - Québec* (*AFG*) selected by the **Contractor**. All tests must be performed in the presence of the Engineer.

6.52.7.3.6 In the event of discrepancies between the measurements and the defined normal values, the **Contractor** shall make the necessary corrections to eliminate these discrepancies.

6.52.7.3.7 Once the corrections have been made, the **Contractor** shall carry out a second verification. If discrepancies are detected during this second verification, the **Contractor** shall correct them and carry out a third verification and so on.

6.52.7.3.8 During the different phases of these electrical verifications, the **Contractor** shall provide all the required technical assistance. This technical assistance includes, without being limited to, the services of an electrician, an electrician apprentice, the equipment, the supply of materials and all incidental expenses.

6.52.7.3.9 All costs to be incurred by the **Contractor** to carry out the verifications described in the above paragraphs shall be included in the overall price tendered by the **Contractor** in the Price.

6.52.7.4 TESTS AND MEASUREMENTS

6.52.7.4.1 Verification of the continuity of the grounding conductor

6.52.7.4.1.1 The verification of the continuity of the grounding conductor shall be carried out according to the indications of the drawings and specifications. This verification also comprises the verification of the fittings located inside metal parts that are not under voltage.

6.52.7.4.2 General verification of the cable, splice and ballast insulation

6.52.7.4.2.1 The general verification of the resistance of the cable, splice and ballast insulation shall be carried out by means of a mega-ohmmeter. The maximum voltage used shall be 1000 V. For each luminaire, readings greater than 100 MΩ are required.

6.52.7.4.3 Verification of underground cable and splice insulation

6.52.7.4.3.1 After the verification mentioned in paragraph 6.52.7.4.2 has been carried out, an additional verification shall be carried out, this time solely on the underground cables and splices. All cables shall be verified with a high voltage generator instrument. The verification voltages shall be applied on the wires in successive increments of 2 kV c.c., up to a maximum of 10 kV c.c. Leakage currents of 100 µA and less are required. A setting time of thirty (30) seconds shall be maintained at each level and the maximum voltage shall be maintained for two (2) minutes.

6.52.7.4.4 Measurement of the operating voltage

6.52.7.4.4.1 The operating voltage shall be measured with a voltmeter. The measurements shall be taken simultaneously between the power supply and the distribution, as well as between the distribution and the end of each distribution circuit, namely the structure located the farthest from the power supply. The reading deviation obtained for each measurement shall not exceed the values permitted by the CAN/CSA C22.10 standard.

6.52.7.4.5 Current measurement

6.52.7.4.5.1 Various measurements of the current intensity, effective output and power factor shall be taken for each circuit.

6.52.7.4.5.2 The results obtained shall comply with the technical data provided by the manufacturer.

6.52.7.4.6 Acceptance of the test results

6.52.7.4.6.1 The Engineer shall accept the test results when the **Contractor** will have corrected all defects and anomalies identified during the electrical verifications carried out in the presence of the Engineer.

6.52.7.4.7 Commissioning

6.52.7.4.7.1 At the time of commissioning, the **Contractor** shall ensure that the cables installed function properly.

6.52.7.4.8 Report on tests and measurements

6.5.2.7.4.8.1 When all defects and anomalies are corrected, the **Contractor** shall submit to the Engineer a written report on tests and measurements, signed and sealed by an engineer who is a member in good standing order of the *Ordre des ingénieurs du Québec (OIQ)*.

END OF SUBSECTION