

Electrical Conductors and Cables Specification

Specification 26 05 21

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Amendment Record Sheet

Amendment in Clause No.	Date of Amendment	Description of Changes
3.1.2, 3.1.4	Nov 2020	Wire bundling specifications update
3.2.2, 3.2.3	Nov 2020	Conductors and cables rating specifications update
1.3.5, 1.4	March 2023	Updated numbering on Electrical Identification and Nomenclature Specification and reference standards
2.4. 2.5, 2.7	March 2023	Added requirements for armoured cables and cable bus, Updated Identification requirements
3.7.6	March 2023	Added requirements for field quality control and commissioning

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1. GENERAL

1.1. SCOPE OF WORK

1.1.1. Labor, products, equipment, and services necessary for wires and cables 0 - 1000 V Work in accordance with the Contract Documents.

1.2. DESIGN REQUIREMENTS

1.2.1. Design electrical equipment and systems to the latest version of the GO DRM, Metrolinx standard specifications and Metrolinx standard drawings.

1.2.2. Cables, wires, and conductors shall be designed to withstand the environmental conditions to which they are exposed without damage or degradation of operating characteristics. in Refer to Section 26 05 00 for general environmental conditions.

1.2.3. The voltage drop in an installation shall not exceed:

- a) 2% in a feeder or branch circuit; and
- b) 4% from the supply side of the hydro service to the point of utilization.

1.2.4. The calculation of the size of conductors to downstream equipment shall be based on the full current rating of the downstream equipment. Calculation based on demand loads or a derated load is not allowed.

1.2.5. The minimum insulation temperature rating shall be 90 °C. All calculations and design shall be done using 75 °C.

1.2.6. The minimum Fire Test (FT) rating for all cables and wires shall be FT-4.

1.2.7. Cables and wires exposed to sunlight shall be sunlight resistant.

1.2.8. There are to be no cable splices allowed below grade.

1.2.9. Control cables shall be provided with a minimum quantity of 25% spare and unused conductors per cable (rounded up to nearest single conductor value).

1.2.10. Provide and install shielded cables where required and or recommended by the manufacturer of the electronic equipment. Refer to MX-ELEC EMI-SPEC for Metrolinx requirements related to rail electrification.

1.3. RELATED WORKS

1.3.1. Section 26 05 00 - Electrical General Requirements.

1.3.2. Section 26 05 13 - Medium-Voltage Cables.

1.3.3. Section 26 05 31 - Splitter Boxes, Junction Boxes and Pullboxes.

- 1.3.4. Section 26 05 34 - Raceway for Electrical Systems.
- 1.3.5. Section 26 05 53 - Electrical Identification and Nomenclature

1.4. REFERENCE STANDARDS

- 1.4.1. Ontario Electrical Safety Code (OESC).
- 1.4.2. Ontario Building Code (OBC).
- 1.4.3. Metrolinx Standards, Drawings and Specifications.
- 1.4.4. GO Design Requirement Manual (DRM).
- 1.4.5. Interim Standards for the Selection of New Electronic Devices and Cables in Metrolinx Facilities to Mitigate Potential EMI Effects Generated by the RER Electric Traction System MX-ELEC EMI-SPEC
- 1.4.6. Metrolinx Electrical Safety Document.
- 1.4.7. CSA Z462, Workplace Electrical Safety.
- 1.4.8. CAN3 C235, Preferred Voltage Levels for AC Systems, 0 to 50,000V.
- 1.4.9. ASTM B3, Standard Specification for Soft or Annealed Copper Wire.
- 1.4.10. ASTM B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
- 1.4.11. ASTM D1047, Standard Specification for Poly (Vinyl Chloride) Jacket for Wire and Cable.
- 1.4.12. CSA C22.2 No. 0.3, Test Methods for Electrical Wires and Cables.
- 1.4.13. CSA C22.2 No. 38, Thermoset Insulated Wires and Cables.
- 1.4.14. CSA C22.2 No. 49, Flexible cords and Cables.
- 1.4.15. CSA C22.2 No. 74, Cables and Cable Glands for use in Hazardous Locations.
- 1.4.16. CSA C22.2 No. 75, Thermoplastic-Insulated Wires and Cables.
- 1.4.17. CSA C22.2 No. 123, Aluminum Sheathed Cables.
- 1.4.18. CSA C22.2 No. 51, Armoured Cables.
- 1.4.19. CSA C22.2 No. 273, Cable Bus
- 1.4.20. CAN/CSA C22.2 No.131, Type TECK 90 Cable.

- 1.4.21. NFPA 130, National Fire Protection Association Standard for Fixed Guideway Transit and Passenger Rail System.
- 1.4.22. CSA, Canadian Standards Association.
- 1.4.23. ESA, Electrical Safety Authority and Bulletins.
- 1.4.24. IEEE, Institute of Electrical and Electronics Engineers.
- 1.4.25. NEMA, National Electronic Manufacturers Association.
- 1.4.26. OPS, Ontario Provincial Standards.
- 1.4.27. ULC, Underwriters' Laboratories of Canada.
- 1.4.28. SSPC, Surface Preparation Standards.
- 1.4.29. ANSI/NETA, Acceptance Testing Specifications for Electrical Power Equipment & Systems

1.5. SPARE PARTS

- 1.5.1. Not applicable.

1.6. TRAINING

- 1.6.1. Not applicable

1.7. WARRANTY

- 1.7.1. The contractor shall provide a manufacturer warranty for the work of this section with a minimum warranty period of two years after acceptance by Metrolinx.

1.8. DELIVERY, STORAGE AND HANDLING

- 1.8.1. Site examination
 - a) Supply and install conductors and cables as detailed in Contract Documents and as required and as recommended by the manufacturer to ensure proper operation of all control panels and peripheral devices. Use pathways (by Division 26) to distribute the cables throughout the facility.
 - b) Verify cable end factory temporary seals have remained intact, insulation has not been exposed to air and no moisture has entered cable insulation.
 - c) Ensure that all cable lengths are sufficient to allow for slack, vertical runs, wastage, connectorization, allow enough wire to permit at least additional 3 terminations and future moves.

- d) Make any necessary changes or additions to routing of cables and pathways to accommodate structural, mechanical, electrical, and architectural conditions. Where pathways or cables are shown diagrammatically install them in straight lines making 90 degree turns where required
- e) Verify completion of Work by other trades likely to damage cable.

1.8.2. Storage

- a) Cables shipped from manufacturer with ends temporarily sealed against moisture ingress.
- b) When cables cut in field, seal exposed end using standard sealing compound and PVC tape in accordance with cable manufacturer's recommendation.
- c) Store cable in clean dry location.

1.8.3. Handling

- a) Uncoil cable by rolling or rotating supply reel (available from manufacturer) to ease handling and prevent possible snarling and kinking. Do not pull from coil periphery or centre.
- b) Take precautions necessary to prevent damage to cable from contact with sharp objects, including pulling over foreign objects or sheaves.

1.9. SUBMITTALS

1.9.1. Product Data and Shop Drawings Package:

- a) Submit manufacturer's Product data indicating:
 - 1) Technical data, supplemented by bulletins, component illustrations, detailed views, technical descriptions of items, and parts lists;
 - 2) Performance criteria, compliance with appropriate reference standards, characteristics, limitations, and troubleshooting protocol;
 - 3) Product transportation, storage, handling, and installation requirements; and
 - 4) Product identification.

1.9.2. Shop Drawings:

- a) Submit Shop Drawings indicating:
 - 1) All cables used on Contract;
 - 2) All cable terminations used on Contract;

- 3) All cable supports used on Contract; and
- 4) Identification.

1.9.3. Commissioning Closeout Package:

- a) Submit the following:
 - 1) Commissioning Plan;
 - 2) Commissioning Procedures;
 - 3) Certificate of Readiness;
 - 4) Performance criteria and maintenance data; and
 - 5) Safety precautions.

1.10. QUALITY ASSURANCE

1.10.1. Refer to Section 26 05 00.

1.10.2. Manufacturers Qualifications Company specializing in manufacturing products specified in this Section with minimum 10 years documented experience.

1.10.3. Regulatory Requirements: Furnish products listed and classified by CSA and ULc, as suitable for application, and shall be stamped accordingly

1.10.4. Coordination

- a) Coordinate Work specified in this Section with work provided under other electrical work and work of other trades.
- b) Determine required separation between cable and other work.
- c) Determine cable routing to avoid interference with other work.
- d) Provide core drilling where required prior to commencing Work.
- e) Coordinate alternate cable routing with Metrolinx prior to proceeding with the Work.

2. PRODUCTS

2.1. POWER WIRE AND CABLE

2.1.1. All conductors shall be stranded copper.

- 2.1.2. Conductors smaller than No. 12 AWG shall not be permitted for lighting or motor branch circuit wiring, except that No. 14 AWG multi-strand type conductors may be used for control circuits only. All conductors larger than No. 14 AWG shall be multi-stranded.
- 2.1.3. The insulation shall be one level higher than required by Code. I.e. if 300 V insulation is required by Code then 600 V insulation shall be provided. The minimum insulation ratings shall be 600 V.
- 2.1.4. Insulation shall be chemically cross-linked thermosetting polyethylene material rated RW90, and RWU90 for underground installation or as indicated on Contract Drawings.
- 2.1.5. All wires shall be free of splices between terminations. If physical constraints of installation prevent this, details of splicing are subject to Metrolinx's approval.
- 2.1.6. Colour coding and identification of wiring shall be in accordance with Metrolinx Electrical Identification and Nomenclature Specification.

2.2. CONTROL WIRE AND CABLE

2.2.1. Insulation

- a) RW90 or RWU90 thermosetting XLPE insulated
- b) Minimum 600 V insulation.

2.2.2. Conductors

- a) Soft annealed copper having physical characteristics in accordance with ASTM B3.
- b) Minimum conductor size No.14 AWG, unless otherwise indicated on the Contract Drawings.
- c) No.8 AWG, No.10 AWG, No.12 AWG, and No.14 AWG conductors stranded with 7 concentric strands per conductor, conforming to CSA C22.2 No. 38.

2.2.3. Identification

- a) Colour coding shall be in accordance with Metrolinx Electrical Identification and Nomenclature Specification 26 05 53.
- b) Individual conductors of multi-conductor cable identified by a unique solid coloured insulation.

2.2.4. Multi-conductor control cables

- a) Assembly of multi-conductor cable

- 1) Length of lay of cabled conductors per Table 28 of CSA C22.2 No. 38.
 - 2) Interstices between conductors filled with non-hygroscopic material, where necessary.
 - 3) Conductor assembly taped together with one layer of mylar tape, lapped minimum 6 mm.
- b) Multi-conductor cable sheath
- 1) Taped conductor assembly with continuously extruded thermoplastic jacket applied, to meet requirements for polyvinylchloride jacket as specified in ASTM D1047, except minimum elongation 150%. Sheath thickness 2 mm average, with minimum thickness at any point 80% of average.

2.2.5. Tests

- a) Dielectric strength and insulation resistance tests performed on finished cable per CSA C22.2 No. 75.

2.3. TECK CABLE

- 2.3.1. Conductor: Single or Multi-conductor, stranded soft copper in accordance with ASTM B3, Class B stranding in accordance with ASTM B8.
- 2.3.2. Insulation: XLPE, Type RW90 or RWU90.
- 2.3.3. Grounding conductor: Uninsulated Class B stranded grounding conductor included in cable assembly.
- 2.3.4. Multiple conductor cables assembled with suitable fillers and binder tape.
- 2.3.5. Inner jacket: Flame-retardant and moisture resistant Polyvinyl Chloride (PVC).
- 2.3.6. Armour: Aluminum Interlocked Armour (AIA) or Galvanized Steel Interlocking Armour (GSIA).
- 2.3.7. Outer jacket: Low-temperature, moisture and sunlight resistant Polyvinyl Chloride (PVC).
- 2.3.8. Connectors: Watertight, approved for Teck cable.

2.4. ARMoured CABLES

- 2.4.1. Conductor: insulated, copper conductor, size as indicated
- 2.4.2. Type: AC90, 600V 90C to CSA C22.2 No 51
- 2.4.3. Insulation: XLPE, Type RW90

2.4.4. Armour: interlocking type fabricated from galvanized steel or aluminum strip.

2.4.5. Connectors: anti short connectors

2.5. CABLE BUS

2.5.1. The cable feeder dual level enclosure shall be constructed of high strength, high conductivity, corrosion resistant aluminum alloy meeting the requirements of CSA C22.2 #126.1, unless otherwise specified.

2.5.2. The enclosure shall be completely enclosed on both sides, and both top and bottom of the enclosure shall be ventilated with vents that do not expose the cable bus system nor allow mechanical penetration at 90 degree from each surface.

2.5.3. Cables shall be supported within the enclosure and on each level by metal supports. The metal cable support shall be repeated throughout the cable enclosure at regular intervals not exceeding 305mm.

2.5.4. Cable clamps shall be clamped to the metal supports at intervals not exceeding 1000mm. Cables shall be secured to a cable support using a non-piece non-ferrous metal clamp, of width equal to the underlying cable support, providing a trefoil cable arrangement. Each clamp shall be formed to provide enough cable ports to secure the designated number of feeder cables.

2.5.5. The bus system shall be suitable for indoor or outdoor use with conductor spacing and ventilation maintained throughout the system.

2.5.6. Each individual power cable shall be single, continuous length between terminals

2.5.7. Conductor: Insulated, copper conductor, size as indicated

2.5.8. Insulation: XLPE, type RW90 or RWU90.

2.5.9. Shielding: Stand and insulations shields shall be provided on all cables rated 1000 volts or greater. Non-metallic semiconducting shields shall be of thermosetting material, compatible with the insulation material. Metallic shielding shall consist of overlapped copper tape which is annealed and uncoated.

2.5.10. Jackets: FT-4 rated and shall include a protective jacket

2.5.11. The enclosure system shall be certified as a continuous bonding conductor, with provisions for a ground clamp at each end of each enclosure section.

2.5.12. A bonding conductor shall be connected at a single point to the inside wall of the enclosure system's top level within each longitudinal section of the enclosure and considered to be an equipment bond.

- 2.5.13. For outdoor or non-condition space cable bus system, a weatherproof plate shall be provided to prevent water from penetrating the termination housing. The plate shall be supplied completed by the cable bus manufacturer, pre-assembled with compatible weatherproof cable connectors and pre-drilled mounting holes with mounting hardware.
- 2.5.14. The conductors shall be arranged in a phasing pattern which exhibits minimal interphase and intra-phase imbalance.
- 2.5.15. Conductor temperature rise calculations shall be provided.

2.6. COMMUNICATION CABLES:

- 2.6.1. Provide and install shielded cables where required and or recommended by the manufacturer of the electronic safety and security systems.
- 2.6.2. All wiring shall be of proper gauge, type and quantity of conductors as required and as recommended by the manufacturer to ensure proper operation of electronic communication systems and peripheral devices.
- 2.6.3. Network cables
- a) Shielded Category 6 Cable for indoor and outdoor applications shall be:
- 1) Belden 2149A Multi-Conductor - Enhanced Category 6 Nonbonded-Pair ScTP Cable or approved equal;
 - 2) 23AWG, Solid bare copper conductor;
 - 3) polyolefin insulated and overall beldfoil shield;
 - 4) Jacket type: PVC;
 - 5) TIA / EIA 568; and
 - 6) Shielded system - high noise immunity and EMI protection
- 2.6.4. Fibre Optic Cable shall be:
- a) Single mode Fibre Optic Cable - up to 36 Strand. 36 strand cable shall be General Cable AP XX0361A1R.BK or approved equal, lower strand counts shall be selected from same product range; and
- b) Single Mode Fibre Optic Patch Cord: Belden duplex SC/SC single mode fibre optic patch cord or approved equal
- 2.6.5. PA Speaker Cable shall be:

- a) Belden 9312 or approved equivalent.

2.6.6. Ambient Noise Detection Microphone Cable shall be:

- a) Belden 9312 or approved equivalent.

2.7. IDENTIFICATION

- 2.7.1. Furnish colour coding in accordance with Metrolinx Electrical Identification and Nomenclature Specification 26 05 23.
- 2.7.2. Provide identification for equipment and the sub-components in accordance with Metrolinx Electrical Identification and Nomenclature Specification 26 05 23.
- 2.7.3. Provide nameplates, warning signs and labels as required by the authorities having jurisdiction (AHJ).

3. EXECUTION

3.1. WIRING METHODS

- 3.1.1. Use wiring methods required by the AHJ, the OESC, the OBC and as indicated on the Contract Drawings, manufacturer's instructions, and as specified herein.
- 3.1.2. Neatly bundle and tie-wrap all cables using tie-wraps. The tie-wrap shall meet UL 62275 or CSA C22.2 No. 62275 or NMX-J-623-ANCE used for electrical and communications installations.
- 3.1.3. When bundling cables, comply with manufacturer's recommended bundling practices for installation. Ensure that excess pressure is not placed on the cable at any point that may result in the compression or deformation of the cable jacket and internal pair/conductor geometry.
- 3.1.4. Cabling bundles shall be designed in a manner that will prevent overheating and result in exceeding the ampacity within the bundle. Follow the manufacturer's specifications.
- 3.1.5. Protect wire and cable from kinks.
- 3.1.6. Provide grommets and strain relief where required

3.2. INSTALLATION OF WIRES AND CABLES

- 3.2.1. Pull in all wires in any one conduit at same time directly from reels or coil carefully to avoid damage to conductors or insulation. In accordance with cable manufacturer's recommendations.
- 3.2.2. Conductors and cables shall be outdoor and sunlight resistant (SR) rated where installed outdoor and /or installed in locations where they will be exposed to weather elements.

- 3.2.3. Conductors and cables shall be underground rated where installed below grade.
- 3.2.4. No joints in any conductors between any boxes or outlets. Neutral conductors unbroken throughout their length. Feeders continuous without splices throughout their entire length unless Metrolinx's approval given to allow splices.
- 3.2.5. Use proper crimping tool on pressure applied specific connectors at conductor joints.
- 3.2.6. Properly designate wire and cable circuits at distribution panelboards and switchboards by specified fibre tag.
- 3.2.7. Use terminal lugs on conductors No.10 AWG or larger where they are terminated for connection to switchboard or other equipment. Apply lugs with proper tools.
- 3.2.8. Carefully unroll cable from reels and coil and run cable as complete from one outlet or junction box to next.
- 3.2.9. Seal space between cables and sleeves or wall or floor opening, with UL listed firestop putty, sealant, compound, or pillow, after wires and cables have been installed.
- 3.2.10. If necessary to splice cable, make splice in junction box of adequate size. Keep number of splices in any run of cable to absolute minimum consistent with available coil length and with installation conditions. If in opinion of Metrolinx excessive number of splices have been made in cable, remove cable and replace with proper number of splices.
- 3.2.11. Support cables on clips at maximum spacing of 1 m. Make bends in cable with proper tools (available from manufacturer), to following minimum radii measured inside bend.

Table 3-1: Cable Bending Radius

SHEATH DIAMETER (OD)	MINIMUM BENDING RADIUS
Above 19 mm and including 38 mm	12 x Sheath diameter
Above 38 mm	15 x Sheath diameter

- 3.2.12. Straighten cable runs to form neat and uniform appearance. Route cables, where possible, parallel to or at right angles to walls, ceilings, and floors. Where this is not possible seek permission from Metrolinx.
- 3.2.13. Carry out stripping, straightening, bending, supporting and termination in conformity with this Section and installation instructions of cable manufacturer. Consult Metrolinx regarding any discrepancy.
- 3.2.14. Carry conductors of branch circuits or feeders in same multi-conductor cable, unless otherwise noted or reviewed by Metrolinx.

- 3.2.15. Connectors: Wing nut type as manufactured by Thomas & Betts or equivalent approved by Metrolinx.
- 3.2.16. Terminal lugs: Solderless pressure-applied type lugs. Lugs to have conductivity not less than wire or cable to which they are attached.
- 3.2.17. Duct seal: Duct Seal Weatherproof Compound by Appleton Electric Products or equivalent approved by Metrolinx.
- 3.2.18. Soldering lugs: As recommended by cable manufacturer.

3.3. INSTALLATION OF TECK CABLE

- 3.3.1. Ground cable sheaths at supply end only with opposite cable end to be isolate from ground.
- 3.3.2. Provide isolating plate at load end where cables may be in contact with any metal enclosures. Isolate cable sheath or sheaths from metal enclosures.
- 3.3.3. Space cables to maintain air space minimum 100% of largest cable diameter.
- 3.3.4. Lay cable in cable troughs in accordance with the OESC.
- 3.3.5. Terminate cables in accordance with the OESC.
- 3.3.6. Identify at both ends utilizing permanent markers.
- 3.3.7. Installation of Teck Cable shall be limited to 3 m. Metrolinx approval is required to install Teck Cable longer than 3 m.
- 3.3.8. Outdoor installation shall have a drip loop.

3.4. INSTALLATION OF ARMOURED CABLES

- 3.4.1. Permitted to be used for drops to surface and recessed mounted luminaires provided that the length does not exceed 3 m on sizes smaller than #6 AWG unless approved by Metrolinx for that application.
- 3.4.2. Permitted to be used for devices concealed within walls provided that the length does not exceed 3 m on sizes smaller than #6 AWG unless approved by Metrolinx for that application.
- 3.4.3. Terminate cables in accordance with the OESC.
- 3.4.4. Identify at both ends utilizing permanent markers.
- 3.4.5. Outdoor installation shall have a drip loop.

3.5. INSTALLATION OF CABLE BUS

- 3.5.1. All installations of the cable bus system shall be in accordance with the manufacturer's installation procedures and recommendation.
- 3.5.2. Where a fire separation is pierced by the enclosure system, all openings around the enclosure and around each individual cable within the enclosure shall be properly closed or sealed with an three-hour rated sealing system in compliance with the building code.
- 3.5.3. For above grade system, provide cable bus supports as required.
- 3.5.4. For below grade system, provide the precast encasement as designed by the cable bus manufacturer to house the cable bus system. The power and off-set vents shall be positioned in accordance with the manufacturer's technical requirements. Provide drainage system in accordance with the manufacturer's recommendations.
- 3.5.5. Conductors shall be pulled in after the bus enclosure is in place. All electrical conductors shall be provided by the cable bus manufacturer.
- 3.5.6. Space cables to maintain air space minimum 100% of largest cable diameter.

3.6. INSTALLATION OF COMMUNICATIONS CABLE

- 3.6.1. Communications cables and wires shall be installed in accordance with Metrolinx standard "IT Telecommunication and Systems Document"

3.7. FIELD QUALITY CONTROL AND COMMISSIONING

- 3.7.1. Perform commissioning in accordance Section 26 05 00.
- 3.7.2. Inspect cable for physical damage and proper connection.
- 3.7.3. Verify continuity of each conductor.
- 3.7.4. Provide certification from cable manufacturer that installation is in accordance with their requirements.
- 3.7.5. Test all conductors for continuity, short circuits and grounds. Ensure resistance to ground not less than 50 megaohms.
- 3.7.6. Pre-acceptance Tests
 - a) After installing cable but before splicing and terminating perform insulation resistance test with 1000 V megger on each conductor.
 - b) Check insulation resistance after each splice and/or termination to ensure cable system ready for acceptance testing.

- c) After installing cable, verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 100.12 - US Standard Fasteners, Bolt Torque Values for Electrical Connections of the latest NETA ATS standard.

3.7.7. Acceptance Tests

- a) Test insulation resistance, conductor resistance and capacitance to ensure cable in accordance with Specifications.
- b) Verify wiring interconnections by ringing out to ensure interconnections are in accordance with Contract Drawings.
- c) During testing ensure terminations and accessory equipment are disconnected.
- d) During testing ground shields, ground wires and conductors not under test.
- e) Perform thermographic survey in accordance with Section 9 - Thermographic Survey of the latest NETA ATS standard.
- f) For parallel conductors, verify uniform resistance.

3.7.8. Test results shown on the test sheets shall show the location at which each test was made, the circuit tested, and the result of each test.

3.7.9. Remove and replace entire length of cable if cable fails to meet any of test criteria.

END OF SECTION