CONSTRUCTION SPECIFICATION FOR INSTALLATION OF CABLE

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604.01 SCOPE

This specification covers the requirements for the installation of high-voltage, low-voltage, and extra low-voltage cables, including cable splicing and terminations.

604.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

604.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

604.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 603	Installation of Ducts
OPSS 609	Grounding
OPSS 610	Removal of Electrical Equipment and Material

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 2409	Traffic Signal Cable
OPSS 2410	Extra Low Voltage Cable

CSA Standards

C22.2 No. 38-14	Thermoset-Insulated Wires and Cables
C22.2 No. 65-13	Wire Connectors
C22.2 No. 129-10 (R2014)	Neutral-Supported Cable
C22.2 No. 197-M1983 (R2013)	PVC Insulating Tape
C22.2 No. 239-09 (R2014)	Control and Instrumentation Cables
C22.3 No. 1-15	Overhead Systems
C57-16	Electric Power Connectors for Use in Overhead Line Conductors
C83-96 (R2016)	Communication and Power Line Hardware
G12-14	Zinc-Coated Steel Wire Strand

Insulated Cable Engineers Association (ICEA)

S-81-570-2005	600 Volt Rated Cables of Ruggedized Design for Direct Burial Installations as Single Conductors or Assemblies of Single Conductors
S-93-639-2000/NEMA WC 74-2006	5 - 46 kV Shielded Power Cables for Use in the Transmission and Distribution of Electrical Energy
S-94-649-2004	Concentric Neutral Cables Rated 5 - 46 kV
S-95-658-2000/NEMA WC70-2009	Power Cables Rated 2000 V or Less for the Distribution of Electrical Energy
S-96-659-2000/NEMA WC71-1999	Non Shielded Power Cables Rated 2001 - 5000 V
S-97-682-2007	Utility Shielded Power Cables Rated 5 - 46 kV
S-105-692-2011	600 Volt Single Layer Thermoset Insulated Utility Underground Distribution Cables

International Municipal Signal Association (IMSA)

19-2-1997	Paired Polyethylene-Insulated Polyvinyl Chloride-Jacketed Communication Cable with Electrical Shield

Electrical Safety Authority (ESA)

Ontario Electrical Safety Code

Others

Electrical and Utilities Safety Association of Ontario Rule Book

604.05 MATERIALS

604.05.01 General

All cables exposed to direct rays of the sun shall be approved for exposure to direct rays of the sun and shall be marked as such according to the Ontario Electrical Safety Code (e.g., SR and Sunlight Resistant).

604.05.02 High-Voltage Cables

604.05.02.01 General

High-voltage cables shall be as specified in the Contract Documents.

604.05.03 Low-Voltage Cables

604.05.03.01 General

Low-voltage multiconductor cables shall be according to CAN/CSA C22.2 No. 239.

Low-voltage single conductor cables shall be type RWU90 according to CSA C22.2 No. 38.

Low-voltage neutral supported cables with one, two, or three insulated aluminum conductors and ACSR neutral shall be 600 V type NS-90 and shall be according to CSA C22.2 No. 129.

Low-voltage multiconductor traffic signal cable shall be according to OPSS 2409.

604.05.03.02 Conductors

Conductors shall be insulated stranded copper and be according to CAN/CSA C22.2 No. 239.

604.05.04 Extra Low-Voltage Cables

Extra low-voltage cables for use with traffic signal interconnection systems shall be according to IMSA No. 19-2.

Extra low-voltage cables for use with traffic signal actuation devices shall be according to OPSS 2410.

604.05.05 Messenger Cables

Messenger cables shall be stranded galvanized steel according to CAN/CSA G12.

604.05.06 Hardware and Fittings

Hardware and fittings for aerial cable installations shall be according to CAN/CSA C83.

604.05.07 Connectors

Cable connectors shall be according to CSA C22.2 No. 65 and CSA C57.

604.05.08 Electrical Insulating Tape

Electrical insulating tape shall be according to CSA C22.2 No. 197 and rated for 600 V and -10 to 90 °C working temperatures.

604.05.09 High-Voltage Splices and Terminations

High-voltage splices, stress relief termination kits, potheads, and cable terminations shall be suitable for indoor or outdoor application as required; shall suit the size, type, and rating of cable used; and shall be according to the requirements of the power supply authority.

604.05.10 Low-Voltage Splices

Low-voltage splices shall be of the type specified in the Contract Documents.

604.05.11 Sand Bedding

Sand bedding shall consist of sand conforming to the gradation requirements of mortar sand according to OPSS 1004.

604.05.12 Fish Line

Fish line shall be nylon or polypropylene material with minimum test strength of 400 N.

604.05.13 Cable Marking

Minimum markings shall consist of manufacturer's name, size of conductor, voltage rating, temperature rating, and type of insulation.

Coloured coded SR rated cables shall be solid coloured or tri-stripe coloured cable and shall be approved according to the Ontario Electrical Safety Code.

604.07 CONSTRUCTION

604.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

604.07.02 Removals

Removal shall be according to OPSS 610.

604.07.03 Excavation, Sand Bedding, Backfill, and Compaction

Earth and rock excavation, sand bedding, backfill, and compaction for the installation of direct buried cables shall be according to OPSS 603.

604.07.04 Cable Protection Bricks

Cable protection bricks for direct buried cables shall be installed according to OPSS 603.

604.07.05 Fish Line

A fish line shall be installed in all ducts or conduits when traffic signal cables are installed. A 1.5 m length of fish line shall remain coiled, tied, and accessible in each pole handhole, electrical maintenance hole, junction box, and controller.

604.07.06 Coils and Slack Cable

When specified in the Contract Documents, coils of cable and slack cable shall remain for future extension by others. Coils shall be neatly taped and remain in a readily accessible location. Cable ends shall be sealed with heat shrink tubing boots.

A minimum 300 mm length of lighting and power cables shall remain at all accessible pulling points, splicing points, or cable termination points. A coil length of low-voltage, traffic signal, and extra low-voltage cables shall remain at all electrical maintenance holes and underground junction boxes so that a minimum of 1.0 m total length of cable may be pulled out above finished grade.

604.07.07 Mechanical Support

High-voltage cables passing through electrical maintenance holes shall be wall-mounted on porcelain saddles with galvanized steel cable racks and installed in locations specified in the Contract Documents.

Low-voltage and extra low-voltage cables passing through electrical maintenance holes shall be wall-mounted on galvanized steel cable racks where unsupported lengths of cable exceed 1.2 m. Bend radii shall be kept greater than the minimum recommended by the cable manufacturer and fastened with mechanical supports, where required. All cable and duct expansion joints shall be accurately formed and mechanically supported as specified in the Contract Documents.

Cable splices shall be supported in a similar manner with racks positioned approximately 150 mm on each side of the splice and mounted between 400 and 600 mm below finished grade.

All cables shall be trained to the maintenance hole walls and supported on cable racks. Sufficient rack arms shall be provided to adequately support the cables. All cables shall be bundled neatly with black outdoor nylon cable ties and each circuit identified with vinyl marking bands.

Nylon or stainless steel mesh cable grips shall be installed to support vertical cable runs when the unsupported cable mass exceeds 25 kg.

604.07.08 Barriers

When specified in the Contract Documents, barriers shall be installed between high-voltage and low-voltage cables, between communication and power cables, and between cables with different disconnecting means. Barriers shall be according to the Ontario Electrical Safety Code.

604.07.09 Low Temperature Handling

Cables shall be warmed to at least 0 °C at point of installation prior to installation. Cable shall not be installed when the ambient temperate is below -25 °C.

604.07.10 Cables in Ducts

Cable shall be pulled through ducts using compatible cable lubricant, mechanical aids, and pulling cables or ropes as required. The pulling tension and sidewall bearing pressure (SWBP) shall not exceed the safe tension recommended by the cable manufacturer.

When intermediate pulling points are required for the installation of cables in flexible duct, the flexible duct shall be cut and spliced according to OPSS 603.

604.07.11 Cables, Direct Buried

Cables shall be installed in sand bedding using the cable spacing and depth specified in the Contract Documents. When it is necessary for cables to cross over other cables, a minimum depth of 100 mm of sand bedding material shall be placed between the cables at the point of crossing. When it is necessary for cables to cross Utilities, a minimum separation of 300 mm shall be maintained, above or below the Utility. Such separation shall be backfilled with sand bedding material and a minimum of three cable protection bricks shall be installed over the cables according to OPSS 603.

Marker tape shall be installed along the centreline of all trenches.

604.07.12 Cables, Aerial

Cables shall be tensioned to obtain the sag, clearance, and tension values specified in the Contract Documents for the particular installation temperature.

When specified in the Contract Documents, cables shall be installed on messenger cables. When lashing of cable to a messenger strand is required, a mechanical lashing machine shall be used to install single wound 1.14 mm diameter stainless steel lashing wires. In lieu of lashing wires, and when specified in the Contract Documents, black outdoor nylon cable ties may be used.

Drip loops and expansion loops shall be formed at each pole or conduit entry and held free of the pole or other cables and connections.

Cables shall be re-tensioned, as necessary, to maintain the required cable clearances.

All work shall be according to CAN/CSA C22.3 No. 1, the Ontario Electrical Safety Code, and the Electrical and Utilities Safety Association of Ontario Rule Book.

604.07.13 Splices and Terminations

Cable splices and terminations shall be made at locations specified in the Contract Documents.

Ends of all insulated cables shall be sealed or capped to prevent the ingress of moisture prior to splicing or termination.

High-voltage cable splices and terminations shall be according to the manufacturer's recommendations for the rating and type of cable used.

Low-voltage cable splices for single-stranded conductors installed in electrical chambers shall be made with compression connectors and protected with waterproof covers. Waterproof splices shall be installed according to the manufacturer's recommendations.

Low-voltage and extra low-voltage cable splices for cable installed aerially or above ground shall be made with compression connectors protected with insulating covers.

Low-voltage and extra low-voltage cable splices shall be made by twisting the conductors together with a minimum 12 mm length overlap and connected by the installation of solderless connectors as specified in the Contract Documents. For inductive loop applications, connections shall be soldered. Above ground soldered splices shall be insulated with insulated boots.

All conductors, insulation, and jackets shall be carefully cleaned prior to installing connections, splices, or terminations. All ground shields, braids, or tapes shall be securely connected to a ground wire according to OPSS 609.

Low-voltage and extra low-voltage splices shall be made only in accessible locations such as electrical maintenance holes, junction boxes, and pole handholes.

Traffic signal conductors terminated in pole handholes shall be twisted together and provided with a watertight spring connector. Stranded conductors shall be connected to the terminal strips using the insulated fork tongue compression connectors. Solid conductors shall be connected directly to the terminal board.

604.07.14 Cable Systems

The work of cable systems shall be as described in the Cables in Ducts; Cables, Direct Buried; Cables, Aerial; and Splices and Terminations subsections.

604.07.15 Quality Control

604.07.15.01 General

The Contract Administrator shall be given 24 hours notice of when tests are to be performed. The Contract Administrator may witness all tests and all splice installations.

Tests shall be performed at 500 V for cable insulation rated at less than 600 V and at 1,000 V for cable installation rated 600 V or greater.

604.07.15.02 Pre-Installation Testing and Inspection

Cables, splicing, and connection components shall be inspected prior to installation to ensure that they meet the requirements of the Contract Documents.

604.07.15.03 Proof of Performance Testing and Inspection

The Contractor shall ensure that all cables are installed, tested, and spliced as specified in the Contract Documents and that all cables are energized and in working order.

The test results shall be submitted to the Contract Administrator.

604.07.15.04 High-Voltage Systems

All high-voltage cable systems shall be checked upon completion of the installation of cables, splices, and terminations and prior to connection to switch gear or the source of energy. High potential tests shall be performed on all cables according to Table 1.

604.07.15.05 Low-Voltage Systems

Tests shall be limited to approximately 10% of the total cable system and shall be completed at random locations selected by the Contract Administrator. In the event of failure of any test, the Contract Administrator may choose another 10% of the system for further testing.

The following tests shall be performed prior to energizing the system:

a) The continuity of selected cables shall be checked by means of an ohmmeter test.

   Accumulated resistance shall not exceed the nominal resistance of the cable length, as specified by the cable manufacturer, plus an allowable resistance of 20% per splice or connection.

b) Resistance to ground tests.

   Leakage to ground of selected cables shall be checked by means of a megger test. Resistance to ground shall be 10 megohm or greater.

604.07.15.06 Extra Low-Voltage Systems

Continuity of all cables and connections shall be checked by means of an ohmmeter test prior to energizing the system. This test shall be completed with temporary jumpers installed to by-pass any active system elements or any passive DC blocking devices.

Cables shall be tested for leakage to ground by means of a megger test. Resistance to ground shall be 10 megohm or greater.

604.07.16 Temporary Electrical Work

The work for temporary electrical installations shall be the same as for permanent installations of the same type of work, except that the work shall include the removal of the installations when they are no longer required.

604.07.17 Site Restoration

Site restoration shall be according to OPSS 492.

604.07.18 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

604.09 MEASUREMENT FOR PAYMENT

604.09.01 Actual Measurement

604.09.01.01 Cable

Measurement for cable shall be by length in metres horizontally along the longitudinal axis of the duct, trench, or aerial cable; from centre to centre of poles, pole footings, electrical chambers, junction boxes, sign footings, and traffic signal controller cabinet pads; and to the face of bridge structures, retaining walls, and substation pads.

604.09.01.02 High-Voltage Terminations and Splices

For measurement purposes, a count shall be made of the number of high-voltage splices and terminations completed, regardless of the type, size, or rating.

604.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

604.10 BASIS OF PAYMENT

604.10.01

High-Voltage Cables, Direct Buried - Item
Low-Voltage Cables, Direct Buried - Item
Extra Low-Voltage Cables, Direct Buried - Item
Traffic Signal Cables, Direct Buried - Item
Co-Axial Cables, Direct Buried - Item
High-Voltage Cables, in Ducts - Item
Low-Voltage Cables, in Ducts - Item
Extra Low-Voltage Cables, in Ducts - Item
Traffic Signal Cables, in Ducts - Item
Co-Axial Cables, in Ducts - Item
Communication Cables, in Ducts - Item
Low-Voltage Cables, Aerial - Item
Low-Voltage Cables, Aerial with ACSR Neutral - Item
Low-Voltage Cables, Aerial on Messenger Cable - Item
Extra Low-Voltage Cables, Aerial - Item
Extra Low-Voltage Cables, Aerial on Messenger Cable - Item
Traffic Signal Cables, Aerial - Item
Traffic Signal Cables, Aerial on Messenger Cable - Item
Co-Axial Cables, Aerial - Item
Co-Axial Cables, Aerial on Messenger Cable - Item
Communication Cables, Aerial - Item
Steel Messenger Cables, Aerial - Item
ACSR Cables, Aerial - Item
Cable Systems - Item
High-Voltage Terminations and Splices - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

604.10.02 **High-Voltage Cables, Direct Buried (Temporary) - Item**
Low-Voltage Cables, Direct Buried (Temporary) - Item
Extra Low-Voltage Cables, Direct Buried (Temporary) - Item
Traffic Signal Cables, Direct Buried (Temporary) - Item
Co-Axial Cables, Direct Buried (Temporary) - Item
High-Voltage Cables, in Ducts (Temporary) - Item
Low-Voltage Cables, in Ducts (Temporary) - Item
Extra Low-Voltage Cables, in Ducts (Temporary) - Item
Traffic Signal Cables, in Ducts (Temporary) - Item
Co-Axial Cables, in Ducts (Temporary) - Item
Communication Cables, in Ducts (Temporary) - Item
Low-Voltage Cables, Aerial (Temporary) - Item
Low-Voltage Cables, Aerial with ACSR Neutral (Temporary) - Item
Low-Voltage Cables, Aerial on Messenger Cable (Temporary) - Item
Extra Low-Voltage Cables, Aerial (Temporary) - Item
Extra Low-Voltage Cables, Aerial on Messenger Cable (Temporary) - Item
Traffic Signal Cables, Aerial (Temporary) - Item
Traffic Signal Cables, Aerial on Messenger Cable (Temporary) - Item
Co-Axial Cables, Aerial (Temporary) - Item
Co-Axial Cables, Aerial on Messenger Cable (Temporary) - Item
Communication Cables, Aerial (Temporary) - Item
Steel Messenger Cables, Aerial (Temporary) - Item
ACSR Cables, Aerial (Temporary) - Item
High-Voltage Terminations and Splices (Temporary) - Item
Cable Systems (Temporary) - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Progress payment for temporary installation of the above tender items shall be based on the following percentages of the Contract price:

80% for supply and installation

20% for removal

604.10.03 **Rock Excavation**

Payment for rock excavation shall be according to OPSS 603.

TABLE 1
High-Voltage System Testing Requirements

Voltage Rating V	Cable Type	Test Specification
0 - 2,000	Nonshielded	ICEA S-95-658/NEMA WC70
2,001 - 5,000	Nonshielded	ICEA S-96-659/NEMA WC71
5,000 - 46,000	Shielded	ICEA S-93-639/NEMA WC74
5,000 - 46,000	Concentric Neutral	ICEA S-94-649
5,000 - 46,000	Utility Shielded	ICEA S-97-682
600	Single Layer Thermoset Insulated Utility Underground Distribution	ICEA S-105-692
600	Ruggedized Insulated Direct Burial	ICEA S-81-570

Notes:

A. The AC high-voltage test shall be according to ICEA publications, except that the applied test voltage and duration of the test shall be as specified by the power supply authority.

B. The DC high-voltage test shall be according to ICEA publications, except that the applied test voltage and duration of the test shall be as specified by the power supply authority and the cumulative testing time shall not exceed the time limit specified by the power supply authority. If re-testing is required, approval and re-test voltage value shall be obtained from the power supply authority.

Appendix 604-A, November 2017
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- High-voltage cable material requirements. (604.05.02.01)

- Type of low-voltage splices. (604.05.10)

- Location of porcelain saddles and galvanized steel cable racks. (604.07.07)

- Cable and duct expansion joints formed and mechanically supported. (604.07.07)

- Cable spacing and depth. (604.07.11)

- Cable sag, clearance, and tension values. (604.07.12)

- Cable splice and termination locations. (604.07.13)

- Solder or threaded seized-conductor connector. (604.07.13)

- Above ground soldered splices: insulated tubing or insulated boots. (604.07.13)

- Underground soldered splices insulation: waterproof heat shrink tubing or heat shrink boots. (604.07.13)

The designer should determine if the following are required and, if so, they should be specified in the Contract Documents:

- Coils of cable and slack cable. (604.07.06)

- Barriers. (604.07.08)

- Messenger cables. (604.07.12)

- Option of using black outdoor nylon cable ties. (604.07.12)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Appendix 604-A

Related Ontario Provincial Standard Drawings

OPSD 2100.010	Cable Installation in Trenches
OPSD 2100.050	Cable and Duct Protection and Marking
OPSD 2242.010	Wooden Pole with Neutral Supported Cable
OPSD 2242.020	Wooden Pole with Aerial Signal Cable Lashed on Messenger
OPSD 2245.010	Installation of Aerial Cable Systems
OPSD 2245.020	Minimum Vertical Clearances for Aerial Cable Systems
OPSD 2530.010	Splices for Traffic Signal Cable and Extra Low Voltage Cable
OPSD 2545.010	PVC Junction Box for Signal Cable Splicing