CONSTRUCTION SPECIFICATION FOR GROUNDING

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609.01 SCOPE

This specification covers the requirements for the installation of electrical grounding equipment and grounding systems.

609.02 REFERENCES

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 501 Compacting
OPSS 603 Installation of Ducts
OPSS 610 Removal of Electrical Equipment and Materials

Ontario Provincial Standard Specifications, Material

OPSS 1004 Aggregates - Miscellaneous

CSA Standards

C22.2 No. 38-18	Thermoset-Insulated Wires and Cables
C22.2 No. 41-13 (R2017)	Grounding and Bonding Equipment
G40.20/G40.21- 13 (R2018)	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
G164-18	Hot Dip Galvanizing of Irregularly Shaped Articles

ASTM International

B 3-13 (R2018) Soft or Annealed Copper Wire

Electrical Safety Authority (ESA)

Ontario Electrical Safety Code

Underwriters Laboratories (UL)

UL 467-March 2013 Grounding and Bonding Equipment

Others

IEEE 837-2002 Standard for Qualifying Permanent Connections Used in Substation Grounding

609.05 MATERIALS

609.05.01 Ground Rods

Ground rods shall be solid steel, 19 mm diameter, 3 m long, copper clad for the full length and shall be according to CSA C22.2 No 41.

609.05.02 Ground Plates

Ground plates shall be hot dip galvanized solid steel, 600 x 600 x 10 mm minimum dimensions. Steel shall be according to CAN/CSA G40.20/G40.21, Grade 260W, and shall be galvanized according to CAN/CSA G164.

609.05.03 Bare Ground Wire

Bare ground wire shall be soft drawn stranded copper and shall be according to ASTM B 3.

609.05.04 Insulated Ground Wire

Insulated ground wire shall be stranded copper, insulation colour green and shall be according to CSA C22.2 No. 38, type RWU 90 - cross-link.

609.05.05 Ground Connectors

Moulded connectors shall consist of metallic alloys and fusible powder mixtures held in place by suitable moulds and connected using an exothermic type welding process. Physical requirements of the connection shall be according to CSA C22.2 No. 41.

Mechanical connectors shall be according to CSA C22.2 No. 41 or UL 467.

High pressure irreversible compression connectors shall be:

a) Made of pure wrought copper extrusion.

b) Made of the same material as the conductors.

c) According to CSA 22.2 No. 41, UL 467, and IEEE 837.

d) Connected according to the manufacturer's recommendations.

e) Connected using a minimum compressive force of 100 kN and a minimum compressive pressure of 70 MPa.

High pressure irreversible compression connectors shall have crimp verification for the inspection and verification of CSA and UL compliance markings.

609.05.06 Solder

Solder shall be 60/40, tin/lead mix, resin core type.

609.05.07 Sand Bedding

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

609.05.08 Ducts and Fittings

Ducts and fittings shall be as specified in the Contract Documents and approved according to the Ontario Electrical Safety Code.

609.07 CONSTRUCTION

609.07.01 General

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

All metallic components shall be connected to system ground.

All compaction shall be according to OPSS 501.

609.07.02 Removals

Removals shall be according to OPSS 610.

609.07.03 Excavation and Backfill

Earth and rock excavation and backfill shall be according to OPSS 603.

609.07.04 Ground Wire in Ducts

Ground wire shall be pulled through ducts using cable lubricant, mechanical aids, and pulling cables or ropes as required. The pulling tension shall be according to the cable manufacturer's specifications.

609.07.05 Ground Wire, Direct Buried

When ground wire crosses over direct buried cables, a minimum depth of 100 mm of sand bedding material shall be placed between the ground wire and the buried cables at the point of crossing.

When ground wire does not share a common trench with ducts or direct buried cable, the ground wire shall be installed at a minimum depth of 600 mm below finished grade.

609.07.06 Ground Wire on Poles or Open Surfaces

Ground wire installed on concrete or metal poles shall be run in rigid duct. Ground wire installed on wooden poles shall be run in protective moulding or in rigid duct. In both cases, the conduit or moulding shall be aligned in straight runs complementing the taper of the pole.

Conduit shall be mechanically fastened to wooden poles using PVC conduit clamps and galvanized lag screws. Moulding shall be mechanically fastened to wooden poles using galvanized steel staples. Stainless steel strapping shall be installed to secure conduit on concrete or metal poles.

When ground wire is to be installed on a concrete surface, the concrete shall be drilled to accommodate expandable metal anchors for nylon cable clamps held in place with stainless steel bolts. For installation on wooden surfaces, galvanized steel staples shall be installed. For installation on metal surfaces, nylon cable clamps and stainless steel screws or bolts, nuts, and washers shall be installed. The ground wire shall be installed in straight, neat lines and shall be supported at maximum intervals of 450 mm.

609.07.07 Ground Wire in Electrical Chambers or Enclosures

Ground wires in electrical chambers and enclosures shall be trained towards the structure walls with bend radii greater than the minimum recommended by the cable manufacturer. Ground wires shall be fastened with mechanical supports when required.

Ground wire in electrical chambers shall be connected to ground lugs attached to the frame. For electrical chambers with metallic covers and non-metallic frames, the ground wire shall be connected to the ground lugs attached to the cover. Ground wire in electrical enclosures shall be connected to the ground lug provided.

609.07.08 Ground Wire Connections

Ground connectors shall be used on all ground wire connections. All surfaces shall be cleaned to bare metal prior to making ground connections.

Moulded connectors or high pressure irreversible compression connectors shall be used at pad mounted electrical-electronic equipment, power supply locations, and all locations where the ground connectors are direct buried or inaccessible.

Messenger cables shall be grounded using compression connectors.

609.07.09 Coils of Ground Wire

Coiled ground wire shall be left at the locations shown in the Contract Documents. Coils shall be neatly taped and left in a safe readily accessible location.

609.07.10 Ground Electrodes

609.07.10.01 General

The installation of ground electrodes shall be according to the Ontario Electrical Safety Code.

The work for ground electrodes shall include the work to install ground rods, ground plates, and the associated work described in this specification.

When bedrock, rock fill, or similar materials unsuitable for driving ground rods are encountered at depths of 450 mm to 2.0 m below finished grade, the ground rod shall be replaced with a ground plate.

When bedrock, rock fill, or similar materials are encountered at less than 450 mm below finished grade, the ground electrode shall be installed at a different location when driving of a ground rod or installation of a ground plate is possible.

609.07.10.02 Ground Rods

Ground rods shall be driven in a vertical position when soil conditions allow. When rocks, stones, or similar materials are encountered, ground rods may be driven at a maximum angle of 45° to the vertical.

609.07.10.03 Ground Plates

Ground plates shall be installed on a minimum 150 mm thick compacted bed of suitable native earth material over rock.

609.07.11 Bonding Jumpers

The work for bonding jumpers shall include the work described for ground wire on poles or open surfaces, and ground wire connections.

609.07.12 Grounding Systems

The work included shall be as described for ground wires, ground electrodes, and bonding jumpers.

609.07.13 Quality Control

609.07.13.01 Pre-Installation Testing and Inspection

Grounding cables, bonding jumpers, ground electrodes, and connection components are to be inspected prior to and during installation to ensure that they meet the requirements of the Contract Documents.

609.07.13.02 Proof of Performance Testing and Inspection

All system and components grounding shall be inspected and tested to ensure that they meet the requirements of the Contract Documents. All electrical grounding connections and splices shall be inspected to ensure they have been properly installed.

At pad and pole mounted power supply locations, the resistance to ground of the grounding grid shall be tested and measured in the presence of the Contract Administrator. A written notice shall be submitted to the Contract Administrator five Business Days prior to the testing with the date, time and location for each testing.

The measurements shall be undertaken under dry soil conditions and when frost penetration does not exceed 150 mm. Readings shall not exceed 25 ohms. In soils of low conductivity, additional ground rods, ground plates, and ground wires shall be added, as required. Copies of all test documentation shall be submitted to the Contract Administrator.

A Request to Proceed shall be submitted to the Contract Administrator after completion of the proof of performance testing and inspection.

The next operation after the proof of performance testing and inspection shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

609.07.14 Temporary Electrical Work

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

609.07.15 Restoration

Site restoration shall be according to OPSS 492.

609.07.16 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

609.09 MEASUREMENT FOR PAYMENT

609.09.01 Actual Measurement

609.09.01.01 Ground Wires

Measurement for ground wire shall be by length in metres horizontally along the longitudinal axis of the duct or trench, or open surface, from centre to centre of poles, pole footings, electrical chambers, or enclosures; sign footings; controller cabinet pads, and ground electrodes; or the face of bridge structures, retaining walls, and substation pads.

609.09.01.02 Ground Electrodes

For measurement purposes, a count shall be made of the number of ground electrodes installed.

609.09.01.03 Bonding Jumpers

For measurement purposes, a count shall be made of the number of bonding jumpers installed.

609.09.02 Plan Quantity Measurement

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

609.10 BASIS OF PAYMENT

609.10.01 Ground Wires - Item
Ground Electrodes - Item
Bonding Jumpers - Item
Grounding Systems - 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.

When the Contract contains separate items for the work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

609.10.02 Ground Wires (Temporary) - Item
Ground Electrodes (Temporary) - Item
Bonding Jumpers (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

609.10.03 Rock Excavation for Electrical Installation

Payment for rock excavation for electrical installation shall be according to OPSS 603.