

**Construction Specification for
Grounding and Bonding**

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TTS 813.100.01 SCOPE

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

TTS 813.100.02 REFERENCES

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

City of Toronto Standard Specifications

TS 2.10	Construction Specification for General Excavation
TS 501	Amendment to OPSS.MUNI 501 (Nov 2017) – Construction Specification for Compaction
TTS 815.100	Construction Specification for The Removal of Electrical Equipment

American Standards for Testing and Materials

B3-74	Soft or Annealed Copper Wire
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Canadian Standards Association

C22.2 No. 38-1986	Thermoset Insulated Wires and Cables
C22.2 No. 41-1987	Grounding and Bonding Equipment
CAN/CSA G40.20/	General Requirements for Rolled or Welded Structural Quality Steel
CAN/CSA G40.21	Structural Quality Steels
CSA G164-1981	Hot Dip Galvanizing of Irregularly Shaped Articles

Underwriters Laboratories Inc.

UL 467	Standard for Safety Grounding and Bonding Equipment
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Institute of Electrical and Electronics Engineers

IEEE 837	Standard for Qualifying Permanent Connections Used in Substation Grounding
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TTS 813.100.03 DEFINITIONS – Not Used

TTS 813.100.04 SUBMISSION AND DESIGN REQUIREMENTS – Not Used

TTS 813.100.05 MATERIALS

All electrical materials shall be new and of uniform pattern throughout the work.

TTS 813.100.05.01 Ground Wires

Insulated ground wires are to be used for the system bonding conductors. The ground wire shall be stranded copper, with green insulation and shall conform to CSA C22.2 No. 38, type RWU 90-cross link.

Bare ground wires shall be used for the power supply ground grid and handwell grounds. Bare ground wire shall be soft drawn stranded copper and shall be according to ASTM B 3.

TTS 813.100.05.02 Ground Electrodes

TTS 813.100.05.02.01 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.

TTS 813.100.05.02.02 Ground Plates

Ground plates shall be hot dip galvanized solid steel, 254 x 406 x 6 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.

TTS 813.100.05.03 Ground Wire 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.

TTS 813.100.05.04 Ducts and Fittings

Ducts and fittings shall be CSA approved and as specified in the Contract Documents.

TTS 813.100.06 EQUIPMENT – Not Used

TTS 813.100.07 CONSTRUCTION

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

TTS 813.100.07.01 Ground Wires

The work of ground wires, regardless of type, size or method of installation, shall include ground wire in ducts, ground wire direct buried, ground wire on poles, ground wire in handwells/chambers or enclosures, ground wire connections, vertical runs of ground wire, earth excavation and backfill, coils of ground wire, and removals and restoration.

TTS 813.100.07.01.01 Ground Wire in Ducts

Ground wire shall be pulled through ducts using any necessary cable lubricant, mechanical aids and pulling cables or ropes required. The pulling tension on the wire shall not exceed the cable manufacturer's specifications.

TTS 813.100.07.01.02 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 wood 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 wood poles using PVC conduit clamps and galvanized lag screws. Moulding shall be mechanically fastened to wood poles using galvanized steel staples. Stainless steel strapping shall be installed to secure conduit on concrete or metal poles.

The conduit with ground wire shall be installed in straight and neat lines and shall be supported at a maximum spacing of every 450 mm.

TTS 813.100.07.01.03 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.

TTS 813.100.07.02 Ground Electrodes

The work for ground electrodes, regardless of type, size or method of installation, shall include ground rods or ground plates and exothermic ground connection.

TTS 813.100.07.02.01 Ground Rods

Copper clad ground rods shall be driven in a vertical position where soil conditions allow. Where rocks, stones or similar materials are encountered, ground rods may be driven at a maximum angle of 45 degrees to the vertical.

Ground rods shall be driven so that the top of the ground rod is a minimum of 300 mm below finished grade.

TTS 813.100.07.02.02 Ground Plates

The Contractor shall excavate a minimum depth of 2.0 m at ground plate locations.

Ground plates shall be installed vertically – not flat – and shall be installed on a minimum 150 mm thick compacted bed of suitable native earth materials.

Native earth backfill or a minimum depth of 300 mm of the same materials shall be placed and compacted over the ground plate.

All earth and granular compacting shall be according to TS 501.

TTS 813.100.07.03 Ground Wire Connections

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

Moulded type ground connectors shall also be used on all ground wire-to ground rod connections.

Mechanical connectors shall conform to CSA C22.2 No. 41.

TTS 813.100.07.04 Earth Fill and Backfill

Where ground plates or rods are to be installed in asphalt boulevards, the dry cutting of the asphalt shall include all applicable measures and procedures as per the City measures and procedures for roadwork with asphalt containing asbestos fibers.

Earth excavation and backfill shall be according to TS 2.10.

TTS 813.100.07.05 Bonding Jumpers

Bonding jumpers shall be used for conductive connectivity between electrical equipment required to be electrically connected to ground.

TTS 813.100.07.06 Grounding Systems

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

TTS 813.100.07.07 Removals

Removals shall be according to TTS 815.100.

TTS 813.100.07.08 Quality Control

TTS 813.100.07.08.01 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 in the Contract Documents.

TTS 813.100.07.08.02 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 pole mounted power supply locations, the Contractor shall test the resistance to ground between the equipment enclosures and the grounding grid.

The Contract Administrator shall be notified 48 hours prior to resistance to ground measurements being taken. These measurements shall be undertaken with the Contract Administrator present under dry soil conditions, and when frost penetration has not exceeded 150 mm. Readings shall not exceed 25 Ω .

The test results shall be documented by the Contractor and a copy of the test results shall be given to the Contract Administrator.

TTS 813.100.07.09 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.

TTS 813.100.07.10 Restoration

Site restoration shall be according to TTS 815.100.

TTS 813.100.07.11 Management of Excess Material

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

TTS 813.100.08 QUALITY ASSURANCE – Not Used

TTS 813.100.09 MEASUREMENT OF PAYMENT

TTS 813.100.09.01 Actual Measurement

TTS 813.100.09.01.01 Ground Wires

Measurement for ground wire shall be made horizontally in metres, along the longitudinal axis of the duct, trench, on open surfaces and shall be from centre to centre of poles, pole footings, electrical chambers or enclosures, sign footings, controller cabinet pads and ground electrodes.

TTS 813.100.09.01.02 Ground Electrodes

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

TTS 813.100.09.01.03 Bonding Jumpers

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

TTS 813.100.09.02 Plan Quantity Measurement

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

TTS 813.100.10 BASIS OF PAYMENT

- TTS 813.100.10.01 Ground Wires – Item**
Ground Electrodes – Item
Bonding Jumpers – Item

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