

SECTION 16060 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. All sections of Division 16 apply to this section

1.2 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment for electrical.
- B. Furnish and install complete grounding and bonding system as shown or as implied in the Contract Documents:
 - 1. Equipment grounding.
 - 2. Wiring device grounding.
 - 3. Panelboard grounding.
 - 4. Switchboard grounding.
 - 5. Isolated grounding.
 - 6. Grounding/Earthing System
 - 7. Telecommunications Grounding Busbar (TGB)
 - 8. Telecommunications Main Grounding Busbar (TMGB)
 - 9. Telecommunications Bonding Backbone (TBB)
 - 10. Basic Grounding/Earthing and Bonding
- C. Furnish and install a complete equipotential ground system for data processing systems in strict conformance with City of Chicago Electrical Code, Section 250.

1.3 DEFINITIONS

- A. Equipment Grounding Conductor: (EGC):
 - 1. The conductor that connects the non-current-carrying metal parts of equipment to the grounding electrode conductor or ground bus.
- B. Grounding Electrode Conductor: (GEC)
 - 1. The conductor that connects the grounding electrodes to the grounded circuit conductor and/or the equipment grounding conductor.
- C. Grounded Circuit Conductor: (GCC)

1. A circuit conductor, usually the neutral that is intentionally connected to ground.

D. Made Electrode: (ME)

1. Any item, such as a ground rod, which is used to provide a ground connection.

E. Isolated Ground: (IE)

1. A conductor or system that connects equipment directly to the grounding electrode. Also referred to as single point ground.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:

1. Ground rods.
2. Grounding arrangements and connections for separately derived systems.
3. Grounding for sensitive electronic equipment.

C. Field quality-control test reports. Indicate overall resistance to ground.

D. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:

1. Instructions for periodic testing and inspection of grounding features at grounding connections for separately derived systems based on NETA MTS.
 - a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
 - b. Include recommended testing intervals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the Chicago Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Manufacturer's Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Comply with UL 467 for grounding and bonding materials and equipment.

D. Comply with City of Chicago Electrical Code.

E. Comply with ANSI-T-STD-607-A for grounding and bonding of Telecommunication Systems.

- F. A licensed electrical contractor shall perform installation and termination of the main bonding conductor to the building service entrance ground. The contractor must also be approved by the Chicago Public Schools.
- G. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 - 1. The Terms “Listed” and “Labeled”: As defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A “Nationally Recognized Testing Laboratory” (NRTL) as defined in OSHA Regulation 1910.7.

1.6 DELIVERY, STORAGE AND HANDLING – NOT APPLICABLE

1.7 REFERENCES

- A. IEEE 1100 - Recommend Practice for Powering and Grounding Electronic Equipment (IEEE Emerald Book).
- B. TIA/EIA-606 – Administration Standard for the Telecommunications Infrastructure.
- C. TIA J-STD-607 – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications; Rev A. 2002.
- D. TIA-942 – Telecommunications Infrastructure Standard for Data Centers.

1.8 WARRANTY – NOT APPLICABLE

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. Electrodes:
 - a. Burndy.
 - b. Harger.
 - c. NSI Industries.
 - d. Thomas and Betts.
 - 2. Mechanical Connectors: Bronze
 - a. Burndy.
 - b. Harger.
 - c. NSI Industries.
 - d. Thomas and Betts.

3. Exothermic Connections:
 - a. Burndy.
 - b. Cadweld.
 - c. Ultraweld (Harger).

2.2 CONDUCTORS

- A. Equipment Grounding Conductors: Insulated with green color insulation.
- B. Grounding-Electrode Conductors: Stranded cable.
- C. Underground Conductors: Bare, tinned, stranded, except as otherwise indicated.
- D. Insulated Conductors: wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- E. Bare Copper Conductors:
 1. Solid Conductors: ASTM B 3.
 2. Stranded Conductors: ASTM B 8.
 3. Tinned Conductors: ASTM B 33.
 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
- F. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches in cross section, unless otherwise indicated; with insulators.
- G. Bonding Straps: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.
- H. Cable assemblies shall be UL Listed and CSA Certified. Cables shall be a distinctive green (equipment ground) or green/yellow tracer (isolated ground) in color, and all jackets shall be UL, VW-1 flame rated.

2.3 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
 1. Heavy duty Pipe Clamps: Pipe clamps shall be high copper alloy or cast bronze with silicon bronze threaded fasteners; saddle type designed for the size of conductor indicated or required by Contract Documents.

2. Beam Clamps: Beam clamps shall be compression type; heavy duty bronze construction; provide a minimum of 8 square inches of bonding surface; and designed for copper rope-lay cable.
 3. Grounding Bushings: Groundings bushings shall be malleable iron, threaded, with insulated liner and solderless lug.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Pressure Connectors: High –conductivity plated units.
- E. Terminating Lugs:
1. Exothermic weld or crimp compression type.

2.4 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel.
1. Size: ¾ inch by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor.
1. Bury at least 24 inches below grade.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
1. Install bus on insulated spacers 1 inch minimum, from wall 6 inches above finished floor, unless otherwise indicated.
 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.
- E. Conductor Terminations and Connections:
1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater and Heat-Tracing: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- E. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.3 GROUNDING OF TELECOMMUNICATIONS SYSTEMS

- A. Install grounding electrodes at locations indicated only.
- B. Utilize equipment manufacturer furnished grounding terminals where provided.
- C. Thread-forming screws and paint piercing grounding washers will be used to ensure metal-to-metal contact.
- D. Lugs, HTAPs, grounding strips, and busbars shall be UL Listed and made of premium quality tin-plated electrolytic copper that provides low electrical resistance while inhibiting corrosion.
- E. In MDF/IDF telecommunication rooms mount an electrostatic discharge (ESD) port kit, PANDUIT part number RGEDS-1 (or OTS approved equal) directly to each side of the vertical mounting rail (of the center most rack) using thread-forming screws to form a bond to the rack. Mount at approximately 48 inches from the floor. Place the Electric Static Discharge (ESD) protection identification stickers directly above the ESD ports.
- F. In all concentrator enclosures mount an electrostatic discharge (ESD) port kit, PANDUIT part number RGEDS-1 (or OTS approved equal) directly to each side of the vertical mounting rail of the concentrator using thread-forming screws to form a bond.

- G. Provide an equipment grounding conductor from the Telecommunications Grounding Busbar (TGB) to each MDF/IDF rack grounding bar and ladder tray.
- H. Provide an equipment grounding conductor from the Telecommunications Grounding Busbar (TGB) to each.
- I. Each Concentrator Enclosure Telecommunications Grounding Busbar (TGB) will be terminated to the equipment ground terminal within the isolated ground receptacle outlet box.
- J. Each Concentrator Enclosure Telecommunications Grounding Busbar (TGB) will have a ground conductor to the enclosure door.
- K. Wherever possible, two-hole lugs shall be used to resist loosening. All lugs shall be irreversible compression type.
- L. The communications grounding system shall adhere to the recommendations of the ANSI/TIA-942 and J-STD-607-A standards, and shall be installed in accordance with best industry practice.
- M. The ground/earth system must be designed for high reliability. There the grounding/earthing system shall meet the following criteria:
 - 1. Antioxidant shall be used when making bonding connections in the field.
 - 2. The Telecommunications Grounding Busbar (TGB) in each telecommunications space shall be grounded (earthed) to the Telecommunications Main Grounding Busbar (TMGB) located at the electrical service entrance. The gauge of the connecting ground cable, known as the Telecommunications Bonding Backbone (TBB) shall follow J-STD-607-A and referenced in the table appendix for sizing the Telecommunications bonding Backbone (TBB).
 - 3. The Telecommunications Main Grounding Busbar (TMGB) shall be bonded to the electrical service grounding according to the BICSI TDMM rev. 10 and J-STD-607-A. Verify all requirements in Chicago Electrical Code 2005 (including all updates and addendum) as they may supersede the BICSI requirements. Where telecommunications spaces have only one rack, the jumper cables must be connected directly to the Telecommunications Grounding Busbar (TGB).
 - 4. Route the TBB to each TGB in straight pathways. The TBB shall be a continuous conductor. The TBB shall be bonded to the equipment ground bar in the IG Computer Panel to the TGB in the MDF and IDF's. Note: This will be the same IG Computer Panel providing IG circuits to that MDF/IDF.
 - 5. In the event of more than one TBB, the contractor will bond them together at the TBD on the top floor with a Grounding Equalizer (GE). Reference the J-STD-607-A standards for sizing TBB's for the GE.
 - 6. Building steel and metallic water piping must be bonded to the grounding system for safety; however neither may be utilized as the TBB.
 - 7. Equipment racks shall be bonded to the grounding system in accordance with ANSI/TIA EAI-942.
 - 8. To maintain continuity throughout each equipment rack where bonding to the grounding system paint or insulators must be ground away to expose bare, unpainted, and uncoated metal to insure metal to metal contact.

9. Paint piercing grounding washers and hardware shall be used where rack sections join together. Paint piercing hardware will be used on both sides when and where the hardware passes through the rack.
10. Any metallic components that part of the data equipment (equipment, racks, ladder racks, enclosures, cable runway, etc.) must be bonded to the grounding systems.
11. In retrofit applications where equipment is installed, grind away paint and insulators in such a way to avoid disruption of installed equipment and data cabling.
12. Direct all questions regarding the communications grounding system to the Office of Technology Service.

- N. Each of the Communications surge protection devices shall be grounded in accordance with manufacturers recommendations as presented in product installation instructions to the TGB.

3.4 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
1. Verify existing conditions prior to beginning work.
 2. Verify that final backfill and compaction has been completed before driving rod electrodes.
 3. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
 4. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

3.5 CLEANING

- A. Restore surface features, including vegetation, at areas disturbed by work of this section. Reestablish original grades, except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling has been completed. Restore areas disturbed by trenching of dirt, cable lying, and other activities to their original condition. Include trenching, storing of dirt, cable laying, and other areas to their original condition. Include topsoiling, fertilizing, liming, sodding, sprigging, and mulching. Comply with Division 2 section "Landscaping." Maintain restored surfaces. Restore disturbed paving as indicated.

3.6 CONTRACTOR STARTUP AND REPORTING

A. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.

B. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10ohms.
2. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3ohms.
3. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).

4. Substations and Pad-Mounted Equipment: 5 ohms.

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

3.7 COMMISSIONING AND DEMONSTRATION – NOT APPLICABLE

END OF SECTION 16060