1. **GENERAL**
   1. RELATED DOCUMENTS
      1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this Section.
      2. Division 26 "Basic Materials and Methods" sections apply to work of this Section.
   2. DESCRIPTION OF WORK
      1. Extent of grounding work is indicated by the drawings and is specified herein.
      2. Applications of grounding work in this Section include the following:
         1. Underground Metal Piping
         2. Underground Metal Water Piping
         3. Metal Building Frames
         4. Ground Rods
         5. Separately Derived Systems
         6. Service Equipment
         7. Enclosures
         8. Equipment
         9. Ground Test Wells
      3. Requirements of this Section apply to electrical grounding work specified elsewhere in these specifications.
   3. QUALITY ASSURANCE
      1. Manufacturers: Firms regularly engaged in manufacture of electrical connectors, terminals and fittings, of types and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, ground rods and plate electrodes, whose products have been of satisfactory use in similar service for not less than three years.
      2. Installer: Qualified with at least three (3) years’ experience on projects with electrical grounding work similar to that required for this project.
   4. REFERENCES
      1. NEC Compliance: Comply with NEC requirements as applicable to materials and installation of electrical grounding systems, associated equipment and wiring. Provide grounding products which are UL listed and labeled.
      2. UL Compliance: Comply with applicable requirements of UL Standard Nos. 467 and 869 pertaining to electrical grounding and bonding.
      3. IEEE Compliance: Comply with applicable requirements of IEEE Standard 142 and 241 pertaining to electrical grounding.
      4. Utility: Grounding shall be done so as to comply with all applicable grounding requirements and rules of the serving utility.
      5. NECA Compliance: Comply with NECA's "Standard of Installation."
   5. SUBMITTALS
      1. Product Data: Submit manufacturers data on grounding systems and accessories.
      2. Shop Drawings: Submit layout drawings of grounding systems and accessories including, but not limited to, ground wiring, copper braid and bus, locations and connections to ground test wells, and ground rods.
      3. Provide instructions for periodic testing and inspection of grounding features at test wells, ground rings, and grounding connections for separately derived systems based on NEMA MTS and NFPA 70B requirements.

#### Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.

#### Include recommend testing intervals.

1. **PRODUCTS**
   1. Acceptable Manufacturers: Subject to compliance with the requirements, provide grounding products of one of the following:
      1. B-Line Systems
      2. Burndy Corporation
      3. Crouse Hinds
      4. Electrical Components Div.; Gould Inc.
      5. General Electric Supply Co.
      6. Ideal Industries, Inc.
      7. Thomas and Betts Corp.
      8. Western Electric Co.
   2. Grounding Systems: Except as otherwise indicated, provide electrical grounding systems indicated; with assembly of materials, including but not limited to cables/wires, connectors, terminals, ground rods/electrodes, bonding jumper braid, and additional accessories needed for a complete installation. Where more than one type unit meets indicated requirements, selection is installer's option. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE and established industry standards for applications indicated.
   3. Conductors: Unless otherwise indicated, provide electrical grounding conductors for grounding connections matching power supply wiring materials and sized according to NEC requirements.
   4. Bonding Jumper Braid: Provide copper braid tape, constructed of 30 gage bare copper wires and properly sized for indicated applications.
   5. Flexible Jumper Strap: Provide flexible flat conductor, 480 strands of 30 gage bare copper wire; 3/4" wide, 9-1/2" long; 48,250 cmil. Protect braid with copper bolt hole ends with hole sized for 3/8" dia. bolts.
   6. Bonding Plates, Connectors, Terminals and Clamps: Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by bonding plate, connector, terminal and clamp manufacturers for indicated applications.
   7. Ground Rods: Provide steel ground rods with copper welded exterior, 3/4" dia. x 10'. Provide additional rods or longer rods as needed to achieve system impedance levels required.
   8. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, and bonding straps as recommended by accessories manufacturers for types of service indicated.
   9. Ground Test Well: Provide a minimum of (1) ground test well tied to the main service panel for testing and verification of grounding system connection and impedance level.
2. **EXECUTION**
   1. GENERAL
      1. Inspection: Installer must examine areas and conditions under which electrical grounding connections are to be made and notify the Architect/Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the installer.
      2. General: Install electrical ground systems where shown, in accordance with applicable portions of the NEC, with NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements and serve intended functions.
      3. Coordinate with other electrical work as necessary to interface installation of electrical grounding systems with other work.
      4. Grounding and bonding of electrical installations and specific requirements for systems, circuits and equipment required to be grounded shall be accomplished for temporary and permanent construction.
      5. Grounding Electrode System Impedance: Per IEEE 142 recommendations, ensure a grounding system with an overall low impedance. See Section 3.2 for more on specific ohm level required. Verify this is achieved and provide test results prior to substantial completion.
      6. Provide a separate green equipment ground conductor in all electrical raceways to effectively ground all fixtures, panels, receptacles, controls, motors, disconnect switches, exterior lighting standards and noncurrent carrying metal enclosures. The ground wires shall be connected to the building system ground. NEC Table 250-95 shall be used to size the ground conductor if the size is not shown on the drawings. VFD cable shall include integral & fully rated ground conductor.
      7. To satisfy the "effective grounding" requirements of the NEC the path to ground from circuits, equipment, and conductor enclosures shall be permanent and continuous and shall have ample carrying capacity to conduct safely any currents liable to be imposed on it, and shall have impedance sufficiently low to limit the potential above ground and to facilitate the operation of the overcurrent devices in the circuit.
      8. At the service entrance equipment, bond the utility neutral, building neutral and building ground conductor to a common ground bus (or ground lug). Connect the ground bus to the building domestic cold water pipe with a grounding conductor and an approved clamp and connector. Install the grounding conductor in exposed PVC conduit and make connections readily accessible for inspection. Set and install ground testing well(s). The point of connection to the water service shall be as near the building entrance as possible. Provide a copper wire shunt of the same size as the ground conductor around the water meter and clamp to the water pipe with bronze fittings. Bond the water pipe to the structural steel system of the building and reinforcing bars in footings when such building construction occurs. Where applicable, the telecommunications main grounding bar (TMGB) shall also be connected at the service entrance.
      9. In addition to the requirements for service entrance grounding listed above, provide a supplemental grounding electrode consisting of driven ground rods (three 10 foot x 3/4 inch copper-clad steel ground rods).
      10. Clean the contact surfaces of all ground connections.
      11. Where separately derived systems occur, ground the system to a grounding electrode acceptable to the code. Dry type stepdown transformers within a system are considered separately derived and shall have a ground electrode tied in.
      12. Install metallic raceways mechanically and electrically secure at all joints and at all boxes, cabinets, fittings and equipment. At the point of electrical service entrance, bond all metallic raceways together, with a ground conductor, and connect to the system ground bus. Bond all boxes as specified for equipment.
      13. Receptacles: Permanently connect the ground terminal on each receptacle to the green ground conductor.
      14. Motors: Connect the ground conductor to the conduit with an approved grounding bushing, and to the metal frame with a bolted, solderless lug. Motor VFD cables grounds shall be positively connected from the motor wiring termination box to the motor frame. Maintain ground conductor size throughout connections.
      15. Provide a flexible ground strap (No. 6 AWG) at each flexible duct connection to air handlers, exhaust fans, and supply fans. Install straps to preclude vibration.
      16. Provide necessary ground connections to telephone service entrance equipment. Verify requirements with the local telephone company.
      17. Provide UFER ground or ground to rebar in existing structural wall or pipes.

## FIELD QUALITY CONTROL

### Perform tests and inspections.

### Tests and Inspections:

#### After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

#### Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench according to manufacturer’s written instructions.

#### 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.

##### Measure ground resistance no fewer 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.

##### Perform tests by fall-of-potential or signal-injection methods as appropriate for project constraints per IEEE 81 requirements.

#### Prepare dimensioned drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

### Grounding system will be considered defective if it does not pass tests and inspections.

### Prepare test and inspection reports.

### Report measured ground resistance the exceed the following values:

#### Power and Lighting Equipment or System with Capacity of 500 kVA and less: 10 ohms.

#### Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.

#### Power and Lighting Equipment or System with Capacity of more than 1000 kVA: 3 ohms.

#### Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohms.

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

#### Manhole Grounds: 10 ohms.

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

END OF SECTION 260526