

**SECTION 26 05 26**  
**GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL**

**1.1 SUMMARY**

- A. Section Includes: Grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

**1.2 SUBMITTALS**

- A. General: Comply with Section 01 33 23, SOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Product Data: For each type of product indicated.
- C. Product Data: For following:
  - 1. Ground rods.
- D. Informational Submittals: Submit following:
  - 1. Qualification Data: For firms and persons specified in Quality Assurance Article.
  - 2. Field Test Reports: Submit written test reports to include following:
    - a. Test procedures used.
    - b. Test results that comply with requirements.
    - c. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

**1.3 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: In addition to Section 01 45 29, TESTING LABORATORY SERVICES requirements, meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907; or be full-member company of InterNational Electrical Testing Association.
  - 1. Testing Agency's Field Supervisor: Currently certified by InterNational Electrical Testing Association or National Institute for Certification in Engineering Technologies, to supervise on-site testing.
- B. Electrical Components, Devices, and Accessories: Listed and labeled, NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.
  - 1. Comply with UL 467.
- C. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system devices.

**PART 2 PRODUCTS**

**2.1 MANUFACTURERS**

- A. Acceptable Manufacturers:
  - 1. Grounding Conductors, Cables, Connectors, and Rods:
    - a. Chance/Hubbell.
    - b. Heary Brothers Lightning Protection Co.
    - c. Kearney/Cooper Power Systems.
    - d. Korns: C. C. Korns Co.; Division of Robroy Industries.
    - e. Lyncole XIT Grounding.
    - f. Racor, Inc.; Division of Hubbell.
    - g. Thomas & Betts, Electrical.
    - h. Accepted Substitute in accordance with Section 01600.

## **2.2 GROUNDING CONDUCTORS**

- A. For insulated conductors, comply with Section 26 05 21 - Low Voltage electrical Power Conductors and Cables (600V and below).
- B. Material: Copper.
- C. Equipment Grounding Conductors: Insulated with green-colored insulation.
- D. Grounding Electrode Conductors: Stranded cable.
- E. Underground Conductors: #2 AWG Bare, tinned, stranded, unless otherwise indicated.
- F. Bare Copper Conductors: Comply with:
  - 1. Solid Conductors: ASTM B3.
  - 2. Assembly of Stranded Conductors: ASTM B8.
  - 3. Tinned Conductors: ASTM B33.
- G. Copper Bonding Conductors:
  - 1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
  - 2. Bonding Conductor: No. 4 AWG or larger, stranded copper conductor.
  - 3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
  - 4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- H. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

## **2.3 CONNECTOR PRODUCTS**

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.
- C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

## **2.4 GROUNDING ELECTRODES**

- A. Ground Rods: Copper-clad steel.

## **PART 3 EXECUTION**

### **3.1 APPLICATION**

- A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- B. In raceways, use insulated equipment grounding conductors.
- C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections.
- D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.
- E. Underground Grounding Conductors: Use tinned-copper conductor, No. 2 AWG minimum. Bury at least 30 inches below grade.

### **3.2 EQUIPMENT GROUNDING CONDUCTORS**

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install equipment grounding conductors in all feeders and circuits.
- C. Nonmetallic Raceways: Install equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
- D. Air-Duct Equipment Circuits: Install equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.
- E. Water Heater and Heat-Tracing Cables: Install separate equipment grounding conductor to each electric water heater and heat-tracing heating cable. Bond conductor to heater units, piping, connected equipment, and components.
- F. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

### **3.3 COUNTERPOISE**

- A. Ground steel framework of building with driven ground rod at base of every corner column and at intermediate exterior columns at distances not more than 60 feet apart. Provide grounding conductor (counterpoise), electrically connected to each ground rod and to each steel column, extending around perimeter of building. Use tinned-copper conductor not less than No. 2 AWG for counterpoise and for tap to building steel. Bury counterpoise not less than 30 inches below grade and 36 inches from building foundation.

### **3.4 INSTALLATION**

- A. Ground Rods: Install at least three rods spaced at least one-rod length from each other and located at least same distance from other grounding electrodes.
  - 1. Drive ground rods until tops are 30 inches below finished floor or final grade, unless otherwise indicated.
  - 2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.
- B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless disconnect-type connection is required; then, use bolted clamp. Bond straps directly to basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

- D. Metal Water Service Pipe: Provide 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 by grounding clamp connectors. Where dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
- E. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.
- F. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.
- G. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.
- H. Install one test well for each service at ground rod electrically closest to service entrance. Set top of well flush with finished grade or floor.
- I. Under Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, Paragraph 250-81(c), using minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

### 3.5 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
  - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
  - 2. Make connections with clean, bare metal at points of contact.
  - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
  - 4. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with grounding bushing. Connect grounding bushings with bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

- E. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and ground rods.
- F. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- G. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make visible indication that connector has been adequately compressed on grounding conductor.
- H. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

### 3.6 FIELD QUALITY CONTROL

- A. Testing: Perform following field quality-control testing:
  - 1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
  - 2. Test completed grounding system at each location where maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. 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. Perform tests, by fall-of-potential method according to IEEE 81.
  - 3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to record of tests and observations. Include number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
    - a. Building Grounding System: Less than 25 ohms.
  - 4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

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