

## SECTION 16450

### GROUNDING

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. The general provisions of the contract including General and Special Conditions and General Requirements shall apply to all work under this Section.

##### 1.2 DESCRIPTION OF WORK

- A. Provide grounding electrodes, conductors, connections and equipment to provide a solidly grounded electrical system.
- B. Provide additional bonding and grounding to reduce radio frequency (RF) and electromagnetic interference (EMI) to sensitive electronic systems.

##### 1.3 RELATED WORK IN OTHER SECTIONS

- A. Related work in other sections:

1. Electrical General Provisions	Section 16010
2. Raceways and Boxes	Section 16110
3. Cable Trays	Section 16115
4. Wire and Cable	Section 16120
5. Wiring Devices	Section 16140
6. Electrical Identification	Section 16195
7. Switchboards	Section 16425
8. Dry Type Transformers	Section 16460
9. Panelboards	Section 16470
10. Disconnect Switches	Section 16476
11. Motor Control Centers	Section 16480
12. Individual Motor Controllers	Section 16481
13. Luminaries and Accessories	Section 16500

##### 1.4 STANDARDS

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
  - 1. Underwriters Laboratory Standard No. U.L. 467.
  - 2. ANSI C-1 1978.
  - 3. IEEE Standards No. 142-1982, 1100-1992 and No. 80.
  - 4. National Electrical Safety Code.
  - 5. NFPA.
  - 6. Federal Information Processing Standards, Publication #94.

##### 1.5 SUBMITTALS

- A. Submit test reports certifying resistance values for buried or driven grounds and water pipe grounds.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Ground Cables: green color coded, insulated, annealed stranded tinned copper wire as indicated on Drawings; insulated wire to conform with requirements of Section 16120.
- B. Mechanical Connectors: Tin-plated aluminum alloy, UL approved and stamped for use with aluminum or copper conductors.
- C. Ground Rods:
  - 1. Copper-clad steel fabricated by molten welding process.
  - 2. Diameter: 5/8 Inch. Use 3/4" for rocky soil.
  - 3. Length: 8 feet.
- D. Ground Lugs and Connectors for Cable Tray: Tin-plated aluminum alloy suitable for use with aluminum or copper conductors.

### **2.2 GENERAL**

- A. Grounding systems shall be installed in accordance with the requirements of the local authorities, and subject to the approval of the Architect/Engineer.
- B. All ground wires and bonding jumpers shall be stranded copper installed in conduit. All ground wires shall be without joints and splices over its entire length.
- C. The system neutral shall be grounded at the service entrance only, and kept isolated for grounding systems throughout the building.
- D. Each system of continuous metallic piping and ductwork shall be grounded in accordance with the requirements of the National Electrical Code.
- E. Mechanical equipment shall be bonded to the building equipment grounding system. This shall include but is not limited to, fans, pumps, chillers, etc.
- F. PVC conduits and portions of metallic piping and duct systems which are isolated by flexible connections, insulated couplings, etc., shall be bonded to the equipment ground with a flexible bonding jumper, or separate grounding conductor.
- G. Metal raceways, cable trays, cable armor, cable sheath, enclosures, frames, fittings and other metal noncurrent-carrying parts that are to serve as grounding conductors shall be effectively bonded where necessary to assure electrical continuity and the capacity to conduct safely any fault current likely to be imposed on them. Any nonconductive paint, enamel, or similar coating shall be removed at threads, contact points, and contact surfaces or be connected by means of fittings so designed as to make such removal unnecessary.

### **2.3 SEPARATELY DERIVED SYSTEMS**

- A. Equipment grounding conductors shall be provided for separately derived systems and shall be grounded to building steel, cold water pipes, etc., or an alternate grounding means.

### **2.4 RECEPTACLES**

- A. Receptacles shall be grounded to the outlet box by means of a bonding jumper between the outlet box and the receptacle grounding terminal.

## 2.5 ISOLATED GROUND RECEPTACLES

- A. Isolated ground receptacles ground lug shall not be connected to the respective outlet boxes.
- B. Provide insulated ground wire for each isolated ground receptacle. Ground wire shall serve only those receptacles which are isolated. Route ground conductor together with phase and neutral conductors in a common raceway.
- C. Terminate isolated ground wire at the ground from the separately derived system serving the receptacles. Where not supplied by a transformer, run the isolated ground wire to the service ground bus.

## 2.6 CONCENTRIC KNOCKOUTS

- A. Provide grounding type bushings for conduits terminated through multiple concentric knockouts not fully knocked out, on inside of electrical enclosures. Install bonding jumper between ground bushing and enclosure

## 2.7 RAISED FLOORS

- A. Provide bonding of all raised floors.
- B. Provide insulated #4 ground from opposite ends of raised floor to panelboard serving that area.

## 2.8 TOGGLE SWITCHES

- A. Provide grounding clip on each toggle switch. Mount over device mounting strap such that contact is made between mounting strap, screw, faceplate and outlet box.
- B. Provide devices with ground screw and bond to switch box.

## 2.9 GROUNDING METHODS

- A. The metal frame of the building, where effectively grounded.
- B. A metal underground water piping system used for grounding shall be in direct contact with the earth for ten feet or more and shall be electrically continuous. Provide bonding jumpers at water meter and at insulated joints.
- C. Steel reinforcing bars used for grounding shall be encased by at least two inches of concrete, located within and near the bottom of a concrete foundation or footing that is in direct contact with the earth. Reinforcing bars shall be minimum 1/2 inch diameter and consisting of twenty feet of one or more steel reinforcing bars.
- D. All bonding jumpers for the above grounding systems shall be sized in accordance with National Electrical Code.

# **PART 3 - EXECUTION**

## 3.1 INSTALLATION

- A. Cold Water Pipe Grounding:
  - 1. Make connection with clamp type fitting; do not damage water pipe.
  - 2. Bond ground conductor and its conduit to water pipe.
  - 3. Install No. 4/0 AWG bonding jumper with ground clamps around water meter.

- B. Ground Conductors:
  - 1. Size as shown on Drawings or as required by National Electrical Code.
  - 2. Where ground cables are required, install insulated copper ground conductors in steel conduit, or as indicated.
  - 3. Where ground cable is installed in metallic conduit, bond cable to conduit at both ends.
  - 4. Connect ground conductors in cables and in conduit to appropriate ground buses (as in switchgear, motor control centers, and distribution panelboards) or directly to metallic enclosure if no ground bus is provided.
- C. Conduit Attachment to Electrical Equipment:
  - 1. Ground conduits to metal framework of electrical equipment with double locknuts or grounding bushings and bonding jumpers unless otherwise noted.
  - 2. Install bonding jumpers at all electrical equipment to provide continuous ground return path through conduit.
  - 3. Install bonding jumpers across expansion fittings between conduit sections for ground path continuity.
  - 4. Bond conduits to cable tray where conduit enters or exits tray.
- D. Receptacles and Switches:
  - 1. Install bonding jumpers between outlet box and receptacle grounding terminal except where contact device or yoke is provided for grounding purposes.
- E. Wireways: Install grounding jumpers for bonding between wireway and other panelboards, conduit, switchgear, motor control centers, and at any other point where solid connection would otherwise not provided in supporting system to insure continuous ground.
- F. Underfloor Duct: Install No. 8 AWG bare copper bonding jumper between underfloor duct sections on either side of expansion joint using pressure type lugs with embedding type bonding screws.
- G. Dry-Type Transformers:
  - 1. Perform grounding in accordance with N.E.C.
  - 2. Install bonding jumper across flexible conduit from transformer housing to rigid conduit.
- H. Pull Boxes, Junction Boxes and Enclosures:
  - 1. Connect all equipment grounding conductors together and connect to the box.

### 3.2 GROUNDING FOR RF/EMI CONTROL

- A. Install bonding jumpers to bond all conduit, cable trays, sleeves and equipment for low voltage signaling and data communications circuits. Bonding jumpers shall consist of 4" wide copper strip or two #10 copper conductors spaced minimum 4" apart. Use #6 copper where exposed and subject to damage.
- B. Comply with the following when shielded cable is used for data circuits.
  - 1. Shields shall be continuous throughout each circuit.
  - 2. Connect shield drain wires together at each circuit connection point and insulate from ground. Do not ground the shield.
  - 3. Do not connect shields from different circuits together.
  - 4. Shield shall be connected at one end only. Connect shield to signal reference at the origin of the circuit. Consult with equipment manufacturer to determine signal reference.

### 3.3 FIELD QUALITY CONTROL

- A. Resistance Values for System and Equipment Grounds: for each ground rod and ground grid.
  - 1. Acceptable Testing Equipment: Vibroground by Associated Research, Inc.; or Megger Earth Tester by James G. Biddle Co.
  - 2. Method: Three (3) electrode fall of potential as prescribed by instrument manufacturer.
  - 3. Drive additional ground rods spaced eight feet apart, if necessary, until total resistance of system is measured at five ohms or less.

-- End of Section --