

## SECTION 26 05 26

### GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

- A. Grounding and bonding equipment.
- B. Grounding rods.
- C. Bare conductors.
- D. Bus bar.
- E. Single conductor insulated wire.
- F. Terminal lugs.
- G. Jumpers.
- H. BART Electrical Substations.  
(Definition: Where utility such as PG&E input voltages converted to BART standard voltages through BART transformer)
- I. This Section does not cover Traction Power Substations.

##### 1.02 RELATED SECTIONS

- A. Section 20 70 26 – Common Material and Methods for Electrical System.
- B. Section 26 05 24 – Low Voltage Wires and Cables.
- C. Section 26 42 00 – Cathodic Protection.
- D. Ground Test Stations – Standard Drawing ES41.
- E. Parking Structure Electrical Room Grounding Criteria – Standard Drawing ES73.
- F. Train Control and Communication Cabinets Power and Grounding Requirements – Standard Drawing K001.
- G. Automatic Electronic Identification (AEI) Layout and Installation Details – Standard Drawing K002.
- H. Single Lens Fixed Signal, Installation Details Sheet 1 of 2 – Standard Drawing NS27.
- I. Single Lens Fixed Signal, Installation Details Sheet 2 of 2 – Standard Drawing NS28.
- J. Grounding Requirements Train Control Rooms – Standard Drawing NS67.

- K. Grounding Requirements Train Control House/Rooms – Standard Drawing NS69.
- L. Grounding Details of Way Side Equipment Sheet 1 of 2 – Standard Drawing NS71.
- M. Grounding Details of Way Side Equipment Sheet 2 of 2 – Standard Drawing NS72.
- N. Cable Tray Section and Details – Standard Drawing NS87.
- O. Grounding Details Sheet 1 of 2 – Standard Drawing TPS84.
- P. Grounding Details Sheet 2 of 2 – Standard Drawing TPS85.

**1.03 MEASUREMENT AND PAYMENT**

- A. General: Grounding and bonding for electrical systems, as specified herein, will not be measured separately for payment but will be paid for as part of the Contract lump sum price for the related item of work as indicated in the Bid Schedule of the Bid Form.

**1.04 REFERENCES**

- A. American Society for Testing and Materials (ASTM):
  - 1. ASTM B3 Specification for Soft or Annealed Copper Wire
  - 2. ASTM B187 Specification for Copper Bar, Bus Bar, Rod and Shapes
- B. Institute of Electrical and Electronics Engineers (IEEE):
  - 1. IEEE 837 Qualifying Permanent Connections Used in Substation Grounding
  - 2. IEEE 142 IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems
- C. Underwriters Laboratories Inc. (UL):
  - 1. UL 467 Grounding and Bonding Equipment
- D. California Code of Regulations
  - 1. Title 24, Part 3 California Electrical Code
- E. National Fire Protection Association (NFPA) Standards
  - 1. NFPA 70 National Electrical Code
  - 2. NFPA 780 Standard for the Installation of Lightning Protection Systems.

### **1.05 REGULATORY REQUIREMENTS**

- A. Refer to Section 20 70 26 - Common Materials and Methods for Electrical Systems, for requirements.
- B. Refer to Section 01 45 24 – Testing Program Requirements, for requirements.
- C. Refer to Criteria Electrical – Stations and Wayside Systems Structures for Grounding and Electrical Isolation Requirements.

### **1.06 SUBMITTALS**

- A. General: Refer to Section 01 33 00 - Submittal Procedures, and Section 01 33 23 - Shop Drawings, Product Data, and Samples, for submittal requirements and procedures.
- B. Shop Drawings:
  - 1. Submit Shop Drawings showing locations of ground rods, grounding connections, locations of embedded and buried grounding conductors, and locations of stubouts and pigtails for future connections to the grounding system by others. Drawings shall also indicate locations of test points to measure grounding resistance.
  - 2. Submit Shop Drawings showing electrical systems and equipment grounding and bonding connection schematic diagrams.
- C. Submit grounding design calculations to meet the requirement of Article 2.02.
- D. Product Data: Submit manufacturers' product data of manufactured materials.
- E. Test Reports: Submit copies of certified test reports of grounding resistance tests, including method of measurement.

### **1.07 DELIVERY, STORAGE AND HANDLING**

- A. Provide marking on wire and cable in accordance with applicable standards. Each item shall be UL-labeled.
- B. Ship each item of equipment and materials securely wrapped, packaged, and labeled for safe handling in shipment and to avoid damage.
- C. Store equipment and materials in secure and dry storage facility.

## **PART 2 - PRODUCTS**

### **2.01 EQUIPMENT AND MATERIALS**

- A. Grounding and Bonding Equipment: Conform to UL 467 and the additional requirements specified herein.

- B. Ground Rods: Medium carbon steel core, copper-clad by the molten weld casting process, size of 1"x10'-0" (one inch diameter by ten feet) long or as indicated, UL listed.
- C. Bare Conductors: ASTM B3, Class B stranded, annealed copper conductor, unless otherwise indicated, size as indicated.
- D. Bus Bar: ASTM B187, 98 percent conductivity copper, size as indicated.
- E. Single Conductor Insulated Wire: Refer to Section 26 05 24 - Low Voltage Wires and Cables. Use insulated ground wire for grounding communication and train control systems.
- F. Terminal Lugs: Refer to Section 20 70 26 - Common Materials and Methods for Electrical Systems
- G. Jumpers: Tin-plated copper, braided, flexible jumper.

## **2.02 GROUNDING DESIGN**

- A. Unless otherwise indicated, total ground resistance shall not exceed 5Ω.
- B. In train control room the resistance from the equipment rack to ground plate and from wayside devices to system ground shall not exceed 0.5Ω.
- C. BART electrical substations ground resistance shall not exceed 1Ω.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION OF GROUNDING SYSTEM**

- A. Ground Connections:
  - 1. Provide exothermically welded or compression-type terminal lugs for buried or embedded connections using materials qualified in accordance with IEEE 837. Bolted connections shall not be buried or embedded. For compression-type connectors, the tool for crimping shall emboss the die index number into the connector as the crimp is completed. Each compression-type connector shall have an inspection port for use in checking proper conductor insertion.
  - 2. All connections shall be made in accordance with the manufacturer's requirements. All connections shall be cleaned and coated with a bitumastic epoxy before backfilling.
  - 3. Above ground connections shall be made using materials qualified in accordance with IEEE 837. All connections shall be made in accordance with the California Electrical Code and the manufacturer's recommendations.
  - 4. Provide continuous ground conductor or splice using connections qualified in accordance with IEEE 837. All splice connections shall be made in accordance with the manufacturer's requirements.

5. Connect the bus bar to station ground system as indicated. Provide waterstops on ground cable risers, where the risers enter the structure.

B. Ground Rods:

1. Bury ground rods vertically with rod top a minimum of two feet below grade as indicated. Use ground rod as indicated for main grounding system. If extensive rock formation is encountered, relocate ground rods to a new location as approved by the Engineer.
2. Interconnect ground rods with minimum 250 kcmil stranded bare copper cable or as indicated.
3. Ground the frames of motors larger than 25 hp by a ground conductor carried in the power conduit. Provide a ground conductor sized in accordance with the California Electrical Code.
4. Ground the non-current-carrying metal enclosures of transformers with a conductor sized as indicated or as required by the California Electrical Code.
5. To minimize interference between adjacent rods, the minimum inter-rod distance shall not be less than two rod lengths.

C. Grounding Wires: All grounding wires shall be as indicated and sized to provide adequate conduction path for all possible faults and electrical interference currents.

D. Grounding Requirements: Provide separate systems and equipment grounding as indicated. Ground metallic conduits, raceways, under-floor ducts, cable trays, boxes, cabinets, exposed expansion joints, lighting fixtures, and receptacles in accordance with the California Electrical Code.

**3.02 FIELD QUALITY CONTROL**

A. Ground Resistance:

1. Test the grounding system by the fall-of-potential method under the observation of the Engineer. Ground resistance measurement test shall be made in normally dry conditions not less than 48 hours after the last rainfall. If the test is influenced by nearby ground grid, then the test shall be repeated by locating reference electrode to a longer distance until interference is minimized.
2. Each ground rod shall be tested individually per latest NEC requirements before connecting them together to make grid. Grid ground resistance shall be tested to verify it meets the grounding requirements.
3. Unless otherwise indicated, demonstrate that total ground resistance does not exceed 5Ω.
4. The ground resistance shall not exceed 0.5 Ω as measured from equipment racks to ground plate in train control rooms and from wayside devices to system ground bus or ground rod connection.

5. The ground resistance shall not exceed  $1\Omega$  in BART electrical substations.
  6. To meet these resistance requirements, bury additional ground rods or use electrolytic grounding electrodes, or soldier piles as grounding conductors.
- B. Ground System Continuity: Test equipment enclosures, conduit, raceways, exposed expansion joints, lighting fixtures, receptacles, light standards, and metal fencing for continuity to the ground system.

**END OF SECTION 26 05 26**