SECTION 16060
GROUNDING AND BONDING

PART 1 – GENERAL

1.01 DESCRIPTION
A. Section includes requirements for an electrical grounding system, including electrodes, grounding rods, connectors, insulators, equipment grounding and bonding conductors, and wire and cable grounding conductors and joints.

1.02 REFERENCE STANDARDS
A. American National Standards Institute (ANSI):
   1. J-STD-607 A Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.

B. American Society of Testing and Materials (ASTM International):
   1. B3 Standard Specification for Soft or Annealed Copper Wire
   2. B187 Standard Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes

C. California Code of Regulations (CCR):
   1. Title 24, Part 3, California Electrical Code

D. National Fire Protection Association (NFPA):
   1. NFPA 70 National Electrical Code (NEC)

E. Underwriters Laboratories Inc. (UL):
   1. UL 467 Grounding and Bonding Equipment

1.03 SUBMITTALS
A. Refer to Section 16000, Basic Electrical Requirements, for additional submittals and submittal requirements.

B. Submit shop drawings showing locations of ground rods, grounding connections, and embedded and buried grounding conductors.

C. Submit product data including manufacturer’s catalog cuts showing all specified items.

D. Submit test procedures. Include description of method of measuring grounding resistance. Include plan showing locations of test points to measure grounding resistance items.
E. Submit report of test results of grounding resistance.

PART 2 – PRODUCTS

2.01 GROUNDING AND BONDING EQUIPMENT

A. Equipment: Conform to UL 467, with additional requirements as specified herein.

2.02 GROUNDING CONDUCTORS

A. Grounding conductors shall comply with NEC Articles 250.118, 250.119 and 250.122.

2.03 GROUND RODS

A. Material: ASTM B187, medium carbon steel core, copper-clad by the molten weld casting process.

B. Size: 3/4 inch diameter; 10 feet long

2.04 MECHANICAL CONNECTORS

A. Material: Bronze

2.05 COMPRESSION CONNECTORS

A. Material: High conductivity electrolytic copper tubing, heavy wall

B. Manufacturer: Burndy Electrical, Thomas & Betts, or Engineer approved equal

2.06 EXOTHERMIC CONNECTIONS

A. Manufacturer: Cadweld, Division of Erico, or Engineer approved equal.

2.07 WIRE

A. Material: ASTM B3, bare soft drawn stranded copper

B. Grounding Electrode Conductor: Size to meet NFPA 70 requirements and the requirements of Section 16100, Wiring Methods.

C. Insulated general wiring: Type THHN/THWN for grounds routed in conduit with feeders. Size as noted on the Contract Drawings. Insulation: Green in color or taped ends as allowed by code.

2.08 BARE CONDUCTORS

A. Bare Conductors: ASTM B3, Class B stranded annealed copper conductor unless otherwise indicated.

B. Bare Copper Cables for Direct Burial in Earth: No smaller than No. 2 AWG, having stranding no smaller than No. 12 AWG.
C. Bare Copper Cables for Use for Concrete Encased Grounds: No smaller than No. 2 AWG, having stranding no smaller than No. 14 AWG.

D. Flexible copper braid, minimum cross-sectional area 24,000 cir. Mils (No. 6 AWG), minimum strand size No. 30 AWG.

E. Copper ground bus assembly, minimum 1/4 inch x 3 inches x 12 inches drilled and tapped every 2 inches on center for two-hole lugs.

F. Bus bar insulators shall be fibrous glass reinforced polyester.

G. Terminals, two-hole lug, compression type.

H. Counterpoised Grounding Electrode Conductor: #4/0 AWG bare soft drawn stranded copper.

2.09 JUMPERS

A. Tin-plated copper, braided, flexible jumper.

2.10 SINGLE CONDUCTOR INSULATED WIRE

A. As specified in Section 16100, Wiring Methods.

PART 3 – EXECUTION

3.01 GENERAL REQUIREMENTS

A. Install products as indicated on the Contract Drawings.

B. Provide grounding and bonding to meet NEC and ANSI/J-STD-607 A requirements.

C. Use continuous ground conductor without splices.

D. Install counterposed grounding electrode system for OCS (Overhead Catenary System) system and bond to platform reinforcement as indicated on the Contract Drawings.

3.02 GROUND CONNECTIONS

A. Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

B. For above ground connections, install compression type terminal lugs or mechanical bolted connectors.

C. Exothermic weld buried and embedded ground connections: Make welds in accordance with manufacturer’s requirements.

D. Make connections to ground bus assembly in the following manner:
1. Bond cable to two-hole lug using exothermic welding process
2. Bolt two-hole lug to ground bus assembly

3.03 GROUND RODS
A. Install rod electrodes for electrical service panel and in handholes as indicated. Install and tie-in additional rods as required to achieve the resistance to ground specified under “Field Quality Control” in this Section.
B. Verify that final grading has been completed before driving rod electrodes. Coordinate with the work performed under Section 02300, Earthwork.
C. Bury ground rods vertically with rod top a minimum two feet below grade or with rod top exposed a minimum of 3 inches in handholes. Use ground rod for main grounding system. If extensive rock formation is encountered, relocate ground rods as approved by the Engineer.

3.04 SERVICE EQUIPMENT
A. Ground neutral bus to ground bus and ground bus to ground rod.
B. Run insulated ground conductor in conduit with all feeder and branch circuits.

3.05 EQUIPMENT GROUNDING
A. Ground stationary equipment enclosures as required by the applicable codes.
B. Ground metallic conduits, raceways, boxes, cabinets, cable trays, panelboards, disconnect switches, exposed expansion joints, receptacles, and lighting fixtures in accordance with NEC.
C. Ground outdoor light poles as indicated on the Contract Drawings.
D. Ground frames of motors by ground conductor carried in power conduit. Provide ground conductor sized in accordance with NEC.
E. Bond all conduits that are used for parallel feeders.
F. Feeders: Install ground conductor for the feeder rating in each conduit.
G. All metallic structures, including station shelters, station lighting poles, metallic equipment cabinets, metal benches, railings, metal fences, and other metallic structures within a 10 ft distance to the centerline of an OCS line or supporting structure, shall be bonded to the OCS system counterpoise ground with a #2 AWG bare copper wire.

3.06 FIELD QUALITY CONTROL
A. Refer to Section 16000, Basic Electrical Requirements, for basic test procedures, as augmented by test procedures submitted under this Section.
B. Perform tests in accordance with approved test procedures in coordination with the Field Engineer.

C. In the presence of the Engineer, test the grounding system by the fall-of-potential method to demonstrate that total ground resistance does not exceed the value specified in the Contract Documents. If necessary, install additional ground rods to meet this resistance requirement.

D. Test equipment enclosures, conduit, raceways and lighting fixtures for continuity to the ground system.

E. Test counterpoise grounding electrode system resistance to remote ground using the 3-point fall of potential method. Counterpose grounding electrode resistance shall not exceed 5 ohms.

END OF SECTION