SECTION 17060

GROUNDING OF COMMUNICATIONS EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for grounding and bonding for communications systems.

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 for Testing and Materials (ASTM International):

1. B187 Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar and Shapes

2. B3 Specification for Soft or Annealed Copper Wire

3. B8 Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

4. B8 Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

5. C653 Guide for Determination of the Thermal Resistance of Low-Density Blanket-Type Mineral Fiber Insulation

6. D5 Test Method for Penetration of Bituminous Materials

7. D149 Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

8. D257 Test Methods for DC Resistance or Conductance of Insulating Materials

9. D570 Test Method for Water Absorption of Plastics

C. Institute of Electrical & Electronics Engineers (IEEE):

1. 80/81 Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

2. 142 Recommended Practice for Grounding of Industrial and Commercial Power Systems

3. 1100 Recommended Practice for Power Grounding Sensitive Electronic Equipment

D. Lightning Protection Institute (LPI):

1. 175 Standard of Practice

2. 176 Standard of Materials

E. National Fire Protection Association (NFPA):

1. 70 National Electrical Code (NEC)

2. 130 Fixed Guideway Transit and Passenger Rail Systems

3. 780 Standard for the Installation of Lighting Protection Systems

F. National Electrical Safety Code (NESC)

G. California Electric Code (CEC):

1. Title 24 California Electrical Code Part 3

D. Underwriters Laboratories (UL):

1. 467 Safety Grounding and Bonding Equipment

1.03 SUBMITTALS

A. Refer to Section 17000, Basic Communications Technical Requirements, for related and additional submittal requirements.

B. Preliminary Design Technical Requirements: Include the following information as part of the Preliminary Design for the Grounding and Bonding of communications systems

1. Manufacturer's catalog data for all proposed materials with installation recommendations. Product data sheets shall include, but not limited to, the following:

a. Ground conductors

b. Connectors, bushings, and fittings

c. Exothermic welding process, materials, and molds

d. Ground rods

e. Ground test stations and Bus Bars

f. Ground Well Boxes (where applicable)

g. Lightning/Surge protection and arrestor equipment

2. Master Drawing Index

3. Drawings showing grounding arrangement for communications facility and cabinets, including locations of ground rods, cables and connectors.

4. Drawings showing details of ground connections, ground test stations, ground risers, terminations and access points, including details of connections of panels and their end connections to the Main Grounding Bus-bars (MGB); and typical grounding details showing electrical systems, equipment, metallic conduit/cable tray and non-current carrying conductive entity grounding and bonding connection.

5. Drawing showing mounting details of all ground bus-bars.

6. Grounding calculations to demonstrate the installation meets the Specification requirement of the 3 ohms.

C. Final Design Technical Requirements: Shall include the following information as part of the Final Design submittal package for the Grounding and Bonding of communications systems.

1. Updated Preliminary Design information. All drawings, calculations and design information shall reflect a final design.

2. Final installation details.

D. Installation Work Plans: Shall include the following installation documents for each site with scheduled installation activity in accordance with these Specifications.

1. Locations of ground rods, connectors, cables, and details of connections, terminations and access points.

2. Manufacturer's installation recommendations.

E. Certifications: Certified test reports verifying that ground resistance of each ground grid when installed and each ground bus when connected to the ground grid does not exceed specified values.

F. Product Samples: Submit and demonstrate product samples when requested by the Engineer.

G. Test Plan and Procedures: Submit procedures and equipment for testing resistances and electrical continuity for each location.

H. Test Records: Submit test records including Test Records and Results for Engineer review no later than one week after the completion of each test.

I. As-Built Documentation: Refer to Section 17000, General Communications Technical Requirements, for requirements. Include complete As-Built documentation and drawings for the Grounding and Bonding of all communications systems completed.

1.04 QUALITY ASSURANCE

A. Design, fabrication, inspection, installation and testing shall comply with all applicable Standards and Codes as listed under Reference Standards.

B. Material and Workmanship Requirements:

1. All equipment and material provided under this Section shall be UL listed.

2. All grounding shall be in accordance with local standards, except as modified herein. Each piece of equipment shall be grounded in accordance with the recommendations of the manufacturer.

3. Use no discontinued product models, refurbished equipment, products at their end-of-life, end-of-sale, or end-of-service.

C. All products specified herein shall be subject to the Engineer approval based on whether Contractor demonstrates adherence to the specified requirement and Engineer approval of the manufacturer's quality process.

PART 2 - PRODUCTS

2.01 GENERAL DESIGN REQUIREMENTS

A. Grounding/bonding systems shell provide for the following three primary functions:

1. Personnel safety

2. Equipment and building protection

3. Electrical noise reduction

B. Subsystem: Facilities Lightning Protection

1. A lightning/surge protection system shall be provided for all communications and wayside facilities including Communications Facilities, outdoor Public Address/Visual Message System (PA/VMS) equipment, Ticket Vending Machines (TVMs), Closed Circuit Televisions (CCTVs), Card Interface Devices (CIDs) or Clipper, Communications Equipment Rooms (CERs) and Distribution Cabinets (DCs). The lightning protection system shall be in accordance with the requirements of ANSI/NFPA 780, Lightning Protection Code. The lightning protection system shall consist of multiple facility/equipment air (lightning) terminals, lightning/surge arrestors, down conductors, equalizing conductors, and ground terminals. This hardware shall provided for the Communications Facility for the purposes of intercepting, diverting, and dissipating direct lightning strikes or adjacent power lines faults, electrical ground faults, short circuits, and transients.

2. The spacing and interconnection of the lightning protection system with the communications system grounds shall be in accordance with ANSI/NFPA 780. Communications grounds shall be bonded to the

lightning protection system grounding within 12 feet of the base of the building. Communications conductors shall not be routed closer than 6 feet from any lightning protection system conductors. The grounding and bonding design scheme shall include an assessment for Lightning Protection System and bonding requirements as part of the Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC) Control and Test Plan.

3. Lightning protection systems and installers shall be certified to LPI-175 and LPI-176 standards.

2.02 GROUND RODS

A. Ground rods shall be medium carbon steel core, copper-clad by the molten weld casting process, of the non-rusting type as manufactured by Copperweld Corporation, or approved equal. The rod shall be at least 1 inch in diameter by 10 feet long, UL listed. Where the deign calculations show as required, rod installations of more than 10 feet length shall utilize sectional type ground rods joined by threaded copper alloy couplings.

B. Ground rod clamps shall be made of a cast bronze clamp body with non-ferrous setscrews as manufactured by Copperweld Corporation or an Engineer approved equal.

2.03 EXOTHERMIC WELDS

A. Welding material shall consist of copper exothermic mixture employing tin-metal in an amount to effectively constitute 4.5 percent to 5.5 percent of the resulting weld metal. The resulting weld metal shall be of high electrical conductivity and shall have a minimum tensile strength of 39,000 pounds per square inch (psi).

B. Coating Materials for Welded Connections: Use black, rubber based compound coating materials, which are soft, permanently pliable, moldable, and unbacked, not less than 1/8 inch thick, with properties as follows:

1. Solids: 100 percent

2. Density: 12.0 pounds per gallon minimum

3. Penetration: 90-130 ASTM D5

4. Water Absorption: 0.10 percent maximum ASTM D570

5. Dielectric Strength: 500 volts/mil ASTM D149

6. Volume Resistivity: 2,000 megohms-inches ASTM D257 5,000 megohms-cm ASTM D257

7. Service Temperature: - 10 degrees F to +160 degrees F

8. Chemical Resistance: Melting point, none; flammability, slow burning (ASTM C653); resists alcohol, water, aqueous hydrochloride and sodium

hydroxide; dissolved by carbon tetrachloride, naphtha gasoline, mineral, spirits, and benzene.

C. Highly cohesive and adheres strongly to metals and adhesive concrete and to itself.

D. Compression or mechanical type grounding connections are not equal to exothermic welded connections for applications in concealed, underground, wet or damp location, and are not permitted.

2.04 GROUND GRID CONDUCTORS

A. No. 2 AWG bare solid tinned copper conductor, or as shown on Contract Drawings.

2.05 GROUND ELECTRODE CONDUCTORS

A. Insulated stranded copper conductor, as shown on Contract Drawings, in accordance with these Specification, for single-conductor cable, 600 volts.

B. Size unless otherwise shown:

1. When connecting ground grid to Telecommunications Main Grounding Bus-bars (MGB) at Communications Facilities, insulated No. 2 AWG will be used. Use green color insulation for such conductors.

2. When connecting ground grid to Telecommunications Grounding Bus-bars at cabinets, insulated No. 6 AWG will be used. Use green color insulation for such conductors.

3. For other grounding electrode conductors: In accordance with NEC Table 250 94.

C. Equipment Grounding Conductors

1. Size in accordance with NEC article 250-95, unless otherwise shown on Contract Drawings.

2. Equipment grounding insulated conductor: No. 6 AWG single conductor stranded copper as specified in these Specifications. Use green color insulation for such conductors.

D. Static Dissipative Tile: Static Dissipative Tile (SDT) shall be used in Communications Facilities to prevent equipment damage due to static discharge. Ground SDT ground strips to the MGB in accordance with the manufacturer's instructions using a minimum of No. 12 AWG copper wire.

2.06 TELECOMMUNICATIONS MAIN GROUNDING BUSBARS

A. Telecommunications Main Grounding Bus-bars (MGB), located in Communications Facilities shall be as follows:

1. ASTM B187, 98 percent conductivity copper.

2. Predrilled electro-tin plated copper bus-bar provided with standard NEMA bolt-hole sizing and spacing for the type of connectors to be used.

3. Sized in accordance with the immediate requirements of the application and with consideration for future growth (provide approximately 50 percent spare holes).

4. Minimum dimensions shall be ¼ inch thick x 4 inches wide and variable in length.

B. Communications Ground Buss-bar (CGB) located in communication cabinets shall be as follows:

1. ASTM B187, 98 percent conductivity copper.

2. Predrilled electro-tin plated copper bus-bar provided with standard NEMA bolt-hole sizing and spacing for the type of connectors to be used.

3. Sized in accordance with the immediate requirements of the application and with consideration for future growth (provide approximately 50 percent spare holes).

4. Minimum dimensions shall be ¼ inch thick x 2 inches wide and variable in length, or as shown on site specific drawings.

2.07 TERMINAL LUGS

A. Lugs shall be suitable for attaching a ground conductor to equipment or metallic surfaces, and shall be NEMA 2-hole, compression type chosen as follows:

1. For No. 4/0 AWG and smaller conductors, use copper compression terminal lugs.

2. For No. 250 MCM and larger, use long barrel, copper, double-compression terminal lugs.

2.08 GROUND CONNECTOR

A. Mechanical connectors shall be used for grounding connections above ground in dry locations only, and for attachments to equipment, boxes, or finished electrical devices

B. O-Z Gedney, Type KG or Engineer approved equal.

C. Two-piece, designed for connecting grounding conductor to bus bar.

D. Copper alloy body and silicon bronze bolt, nut and washer with interlocking clamp.

E. Exothermic weld: Size and type per manufacturer's recommendations. See also subpart 2.03 above.

2.09 JUMPERS

A. Jumpers shall be insulated copper braided or leaf-type flexible jumper, size as required.

2.10 BUSBAR INSULATORS

A. Fibrous glass reinforced polyester insulator with ½ inch diameter by 2 inches length, threaded holes at both ends for MGB and CGB installation.

2.11 COAL TAR EPOXY

A. Polyamide cured coal tar epoxy, Dupant Coriar 823 CTE, Koppers Company No. 300M, PPG Industries 97-640 or 97-641 or Engineer approved equal, applied to a dry film thickness of 15 mils, per coat.

B. Coal tar epoxy coating products shall have the following minimum properties:

1. Minimum volume resistivity of 1010 ohm-centimeters.

2. Thickness as recommended by the manufacturer for the specified system but not less than 15 mils.

3. Provide a chemical or mechanical bond to the metal. Pressure sensitive or nonbonding systems are not acceptable.

4. Mechanical characteristics capable of withstanding reasonable abuse during handling and installation and earth stresses after installation for the design life of the system

2.12 EPOXY RESIN ENCAPSULATION

A. Two-component epoxy resin type with plastic snap mold, as manufactured by Duriron Company, 3-M Company or Engineer approved equal.

2.13 COMMUNICATIONS FACILITY ROOM HALO GROUND RING

A. The halo shall be No. 4 AWG bare stranded copper conductor. It shall encircle the perimeter of the interior walls of the Communications Facility at a uniform height of 3 inches to 12 inches from the ceiling. The halo shall be bonded to the MGB also using a No. 4 AWG bare stranded copper conductor and Engineer approved ground connector.

2.14 COMMUNICATIONS CIRCUIT PROTECTION

A. Related to copper cables that enter all Communications Facilities and Distribution Cabinets (DCs). All signal/communications copper cables shall terminate on Protected Terminal Blocks (PTB) (rack-mounted, wall-mounted or at the Main Distribution Frame (MDF) as per Contract Drawings), and shall conform to these specifications. Where applicable, cable sheath shall be neatly trained and bonded to the MGB (or CGB) using a No. 6 AWG insulated ground conductor.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions for compliance with requirements for products specified in this Contract Specifications Section.

B. Note items that may infringe on the necessary clearances and other non-compliances. Promptly bring noted issues to the attention of the Engineer for direction and approval before proceeding

3.02 GENERAL GROUNDING AND BONDING REQUIREMENTS

A. Provide all grounding and bonding as specified. Where applicable, all building or outside enclosure grounded systems shall be interconnected with the lightning protection grounding system.

B. Grounding conductors shall be protected from physical and environmental damage. Wherever possible, grounding and bonding conductors routed in rooms shall be enclosed in a non-metallic raceway. Exposed conductors, which shall extend from a concrete surface, shall be located as close as possible to a corner. Where conductors are required to run exposed, as in the connection to the main ground bus, grounding conductors shall be supported by corrosion resistant metallic hardware at 4-foot intervals or less.

C. Completely remove all paint, dirt, or other surface coverings at grounding conductor connection points so that good metal-to-metal contact is made.

D. Service grounds and grounding or bonding of electrical service equipment shall be with continuous un-spliced grounding conductor.

E. If an existing facility or outdoor cabinet is being retrofitted, test and, if necessary, upgrade their grounding system to the level specified within these specifications.

3.03 INSTALLATION

A. Grounding Connections

1. Weld buried ground connections exothermically, in accordance with manufacturer's recommendations. Clean and coat with coal tar epoxy applied with a 32 mils dry film thickness using multiple coats. Allow drying between coats and before backfilling. Encapsulate with epoxy resin all buried ground connections of grounding electrode conductors running to ground buses.

2. Use terminal lug to connect grounding conductor to equipment enclosure. Secure connector or terminal lug to the conductor so as to engage all strands equally by using tools and pressure recommended by the manufacturer. Make connections with clean, bare metal at points of contact.

3. Exothermically weld connections for ground rods in manholes and hand-holes, or as shown.

4. Splices or soldering in grounding conductors are not permitted.

5. Bolted connections shall not be buried or embedded.

B. Ground Grid

1. Install ground grid consisting of bare solid tinned copper conductors and ground rods buried in earth in the pattern and at the locations shown on site drawings. Ground rods will be minimum 10 foot length, 1 inch diameter. Install ground rods vertically if possible. Where vertical burial is not possible, rods may be at an angle or (as a last resort) buried horizontally 30 inches (minimum) below grade.

2. Bury top of ground rod 30 inches minimum below grade or as shown on Contract Drawings. If extensive rock formation is encountered, relocate ground rods to a new location as approved by the Engineer.

3. Provide 24-inches minimum horizontal separation between ground rods and concrete structures.

4. Interconnect ground rods using bare solid tinned copper conductors as shown on site specific drawings.

5. For Communications Facilities provide two pigtails of grounding electrode conductor of sufficient length above finished floor for connection to the MGB. The two pigtails shall be exothermically welded or bonded in an Engineer approved manner to the grounding grid at a single point.

C. Grounding Bars

1. Install the Telecommunications Main Ground Buss-bar (MGB) as shown on Contract Drawings.

2. Mount the MGB on insulators 2 feet above finished floor using cap screws and expandable threaded anchors, unless shown otherwise on Contract Drawings.

3. Install the distribution cabinet CGB in the bottom of the cabinet, on insulated spacers which electrically isolate them from the cabinet.

4. Provide insulator support at each end of grounding bus-bars and at intervals not exceeding three feet.

5. Bond the grounding electrode conductors to the grounding bus-bar using an Engineer approved ground connector in accordance with this Section.

6. Grounding of Separately Derived ac Power System

7. Bond the safety ground conductor (green wire) to the MGB using a minimum of No. 4 AWG insulated stranded copper wire, as shown on Contract Drawings. For additional guidance refer to the NEC.

D. Grounding for Personnel Safety

1. In Communications Facilities and cabinets, bond equipment enclosures and racks, ductwork, conduit, metal cable trays, the LDF ground bolt, PTB grounds, and the room halo ground ring to the local MGB or CGB using a minimum of No. 6 AWG insulated stranded copper conductor or as specified on Contract Drawings.

2. Wayside metal equipment including, but not limited to, cabinets, poles, pull-boxes, equipment enclosures, and junction boxes: bond and ground each item using No. 6 AWG (minimum) copper conductor to one or more ground rods to provide 3 ohms or less resistance to ground.

E. Electronic Equipment Signal Grounding

1. Electronic equipment shal have separate 'Signal' or 'Telecommunications' ground connections, which shall be implemented as a separate isolated 'Signaling' ground bar (as opposed to a 'Power' ground bar) in the equipment rack or enclosure. These connections shall be grounded to the 'Signaling' ground bar using a minimum of No. 10 AWG insulated stranded copper conductor and shall be separate from ground connections to the 'Power' ground bar. Each rack's (or enclosure's) 'Signal' and 'Power' ground bar shall have an individual connection of a minimum of No. 6 AWG insulated stranded copper conductor to the facility's or cabinet's corresponding 'Signal' and 'Power' TMGB (see below).

2. Where the Communications Equipment Room (CER) is shared with non-communications electronic equipment, a separate TMGB shall be provided. All individual equipment racks or enclosures shall be grounded to the TMGB using a minimum of No. 6 AWG insulated stranded copper conductor.

3. The TMGB shall be grounded to the same point on the ground grid (or to the structural steel) as the electrical service entrance to form a single-point building ground system.

F. Cable Shield Grounding: One end of all cable shields shall be grounded to the TMGB. Use the following guidelines to determine which end of the cable to ground:

1. When a cable goes between CER, ground the shield at the southern most facility.

2. When a cable goes between a CER, and any other facility (TPSS, Signal House, and Distribution Cabinet), ground the shield only at the Communications Facility.

3. Audio cable shield shall be grounded only at CER.

4. When a cable goes between the distribution cabinet and the station equipment, ground the shield at the station. If existing conditions make grounding of the entering cable shield challenging at the existing stations, as per approval by the Engineer the shield grounding can be executed at the distribution cabinet.

G. Fiber Optic Cable Jacket Grounding: Armored jackets (if used) on all fiber optic cables shall be grounded to the MGB using a minimum of No. 6 AWG insulated stranded copper conductor. Where possible, station communication design will use an all-dielectric fiber optic cable plant.

H. Copper Cables Lightning/Surge Suppression: Lightning/Surge Suppression Devices shall be installed at every electric, communication, or data copper cable entrance at the Communications Facility or Distribution Cabinet. The type of the protection device shall correspond to the application specifics of each protected copper cable (as per vendor recommendations) and shall ensure protection of not only 'working' conductors/pairs, but also the spares.

3.04 TESTING AND INSPECTION

A. Perform the following inspections and tests on Grounding and Bonding. Notify the Engineer in writing prior to each test and inspection so that the Engineer may be present as desired.

1. Factory Test and Inspection: Perform Factory inspection and testing of the ground terminations for each rack/enclosure 'Signal' and 'Power' ground bars' terminations.

2. Field Test and Inspection. Perform the following Field Inspections and Tests:

a. Inspect ground grid installation, installation depth, conductor sizes, connections to ground rods and foundation rebar prior to backfill, for conformance to Specification requirement.

b. Inspect installation of all ground bus-bars for proper mounting.

c. Test ground resistance of each ground grid after installation and each ground bus when connected to ground grid, using Engineer approved test procedure.

d. Resistance to ground for Communications Facilities and distribution cabinets shall not to exceed three ohms.

e. To meet resistance requirements, install additional ground rods. If resistance requirements can still not be met, install a sacrificial anode to be approved by the Engineer.

f. Test metal conduit and raceways, equipment enclosures, metal cable troughs, fences, metal structures, and light poles for ground resistance not to exceed three ohms.

g. Test all GFCI receptacles and circuit breakers for proper ground connections and protection operation with methods and instruments prescribed by the manufacturer.

B. End-To-End acceptance Test: Not required.

C. System Integration Test: Not required.

END OF SECTION