

SECTION 27 05 26
GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Material and Components
 - 2. Telecommunications Main Grounding Busbar.
 - 3. Telecommunications Grounding Busbar.
- B. Meet the Following Performance Requirements:
 - 1. Unless specified elsewhere, the ohmic values for grounds and grounding systems shall be as follows:
 - a. For grounding metal enclosures and frames for electrical and electronically operated equipment--5 ohms maximum.
 - b. For grounding systems to which electrical utilization equipment and appliances are connected--5 ohms maximum.
 - c. For grounding secondary distribution systems, neutrals, noncurrent carrying metal parts associated with distribution systems, and enclosures of electrical equipment not normally within reach of other than authorized and qualified electrical operating and maintenance personnel -- 5 ohms maximum.
 - d. All Telecom Ground Busbars' resistance must be under 3 ohms to the main electrical service ground bar.
- C. System Description:
 - 1. The primary objective of this section is to provide guidance around the issue of bonding and grounding as it relates to building telecommunications infrastructure. Before reviewing the highlights of this standard, it is important to understand a few basic terms used throughout the bonding and grounding specifications.
 - 2. Telecommunications grounding and bonding is additional grounding and bonding specifically for telecommunications systems and serves to minimize electrical effects and hazards, augment electrical bonding, and lower the system ground reference potential. The grounding backbone, cable, and busbars shall be installed as specified in the drawings and specifications and shall strictly adhere to ANSI/EIA/TIA - 607.
 - 3. The information provided in this document for the design of telecommunications grounding and bonding system does not replace national, state, local or other applicable codes, laws, or regulations.
 - 4. Furnish all labor, materials, tools, equipment and services for all grounding as indicated, in accordance with provisions of the Contract Documents.
 - 5. Grounding connections from telecommunications equipment to TGBs in telecommunications rooms shall be installed as shown on the design drawings.
 - 6. In existing buildings or structures without an electrical service installed, a ground rod that is 8 feet long and 1/2" in diameter shall be driven into the ground.
 - 7. Completely coordinate with work of all other trades.
 - 8. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a complete installation.
- D. The completed equipment grounding system shall be subjected to a metered test at the switchboard ground to ensure that the ground resistance, without chemical or other artificial enhancement, does not exceed 5-ohms to earth.

1.2 RELATED WORK

- A. Section 26 00 10 – Basic Electrical Requirements, is an integral part of this Section. Requirements and work indicated in 26 00 10 are not repeated in this Section.
- B. Section 26 08 00 – Electrical General Commissioning Requirements. Provide Installer's and Manufacturer's support as required to coordinate with the Commissioning Agent and support all commissioning efforts and paperwork, Acceptance and Integrated Systems Testing.
- C. Section 26 05 26 – Grounding

1.3 COORDINATION

- A. Coordinate work under provisions indicated in Section 26 00 10.

1.4 QUALIFICATIONS / QUALITY ASSURANCE

- A. Conform to requirements indicated in Section 26 00 10.

1.5 REGULATORY REQUIREMENTS AND STANDARDS

- A. Conform to requirements indicated in Section 26 00 10.
- B. A uniform telecommunications grounding and bonding infrastructure shall be provided for the protection of personnel and equipment conforming to all applicable codes and standards including but not limited to following:
- C. ANSI/TIA/EIA - 607: Commercial Building Grounding and Bonding Requirements for Telecommunications.
- D. ANSI/TIA/EIA - 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
- E. ANSI/EIA/TIA – 568: Telecommunications Wiring Standard.
- F. ANSI/EIA/TIA – 569: Telecommunications Pathways and Spaces Standard.
- G. ANSI/IEEE Standards 142-1991: Recommended Practice for Grounding of Industrial Commercial Power Systems, also known as the "Green Book"
- H. ANSI/IEEE Standards 241-1990: Recommended Practice for Electric Power Systems in Commercial Buildings.
- I. ANSI/IEEE Standards 1100-1999: Recommended Practice for Powering and Grounding Electronic Equipment, also known as the "Emerald Book"
- J. UL Standard 96: Lightning Protection Components.
- K. UL Standard 96A: Installation Standards for Lightning Protection Systems.
- L. UL Standard 467: Grounding and Bonding Equipment
- M. National Electrical Safety Code (NESC)
- N. NFPA 70 - The current National Electric Code (NEC)
 - 1. Article 250 (Grounding)
 - 2. Article 800 (Communications Circuits)
 - 3. Article 645 (Information Technology Equipment)

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- O. NFPA 70E (Electrical Safety Requirements for Employee Workplaces).
- P. NFPA 75 (Protection of Electronic Computer/Data Processing Equipment).
- Q. NFPA 780 (Lightning Protection Code).
- R. All other applicable Federal, State, and local laws and regulations.

1.6 SUBMITTALS

- A. Submit as required here in and under Section 26 00 10.

1.7 EXTRA MATERIALS

- A. Furnish under provisions indicated in Section 26 00 10.

1.8 PROJECT RECORD DOCUMENTS

- A. Submit under provisions indicated in Section 26 00 10.

1.9 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions indicated in Section 26 00 10.

1.10 WARRANTY

- A. Provide under provisions indicated in Section 26 00 10.

1.11 DEFINITIONS

1. Bonding - Means to permanent joining of metallic parts for the purpose of forming an electrically conductive path to ensure electrical continuity and capacity to safely conduct any current likely to be imposed.
2. Effectively grounded - Refers to an intentional connection to earth through a ground connection of sufficiently low impedance. It must have sufficient current-carrying capacity to be able to prevent the buildup of voltages that could potentially result in unnecessary hazard to connected equipment or persons.
3. Ground - an intentional or accidental conducting connection between an electrical circuit or equipment and earth or conducting body serving in place of earth.
4. Grounding electrode conductor (GEC)- a conductor used to connect the grounding electrode to:
 - a. The equipment grounding conductor
 - b. The grounded conductor of the circuit at the service equipment
 - c. The source of a separate system.
5. The telecommunications entrance facility (TEF) - includes the entrance point at the telecommunications service and also the space where the inter- and intra-building backbone facilities join. Telecommunication-related antenna entrances and electronic equipment may be located in the TEF.
6. Telecommunications bonding backbone (TBB) - an insulated copper conductor used to connect the telecommunications main grounding busbar (TMGB) with all telecommunications grounding busbars (TGBs).
 - a. The TBB starts at the TMGB and extends throughout the building using telecommunications backbone pathways.
 - b. The TBB connects to TGB's in all telecommunication rooms and the equipment room.
 - c. The primary function of the TBB is to reduce or equalize differences between telecommunications systems bonded to it.

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7. Telecommunications bonding backbone interconnecting bonding conductor (TBBIBC) - a conductor used to interconnect telecommunications bonding backbones TBB.
8. Bonding Conductor for Telecommunications - A conductor used to bond the TMGB to the service equipment (power) ground which is in turn connected to the grounding electrode conductor.
9. Telecommunications main grounding busbar (TMGB) - refers to a busbar bonded to the service equipment (power) ground by the bonding conductor for telecommunications. The TMGB should be placed in a location that is convenient and accessible. The TMGB serves as a dedicated extension of the building grounding electrode system for the telecommunications infrastructure. It also acts as the central connection point for TBBs and equipment.
10. Telecommunications Grounding Busbar (TGB) - Located in a telecommunications room or equipment room, it serves as a common central point of connection for telecommunications systems and equipment in the area served by that TR or equipment room.

PART 2 - PRODUCTS

2.1 MATERIAL AND COMPONENTS

A. Manufacturers

1. Acceptable connector providers:
 - a. T & B
 - b. Burndy
2. Acceptable ground busbars
 - a. B-Line (Part #SB476)
 - b. Erico

B. General:

1. Except where indicated otherwise, each electrical grounding system shall include, but not be limited to, the following components: cables/wires, connectors, terminals, ground rods, bonding jumper braid and additional accessories needed for a complete installation. Where material or components are not specified, comply with NEC, UL and established industry standards for the applications indicated.
2. Joints in grounding conductors below grade shall be made with exothermic welding process or hydraulically-crimped fittings listed for direct burial. Terminations above grade shall be made with solderless lugs, securely bolted in place.
3. Clamps, lugs, connectors, bonding bushings, bus bars and all other such grounding and bonding items must ANSI/EIA/TIA – 607 specifications and meet all the following:
 - a. Labeled or listed for the purpose.
 - b. Shall be made (both body and hardware) of hot-dip galvanized steel, bronze, or other corrosion-resistant alloy (except bushing throats shall be plastic).
 - c. In outdoor, damp, or corrosive environments, metals for these items shall be copper (with or without tin-plating), bronze, or other corrosion-resistant alloys only.
4. Mounted per manufacturer specs.
5. ALL Ground conductors 3/0 or smaller must be green insulated and Type THHN or RHH/RHW equivalent except in cable tray provided extra flexible type RHH/RHW.
6. Conductors bigger than 3/0 can be green insulated or marked with green electrical tapes on both ends and be type THHN, RHH/RHW, except in cable tray provided extra flexible type RHH/RHW.
7. All grounding conductors and equipment required for ground systems shall be listed for the purpose intended and approved by a Nationally Recognized Testing Laboratory (NRTL), and be in accordance with UL 467.
8. Connectors, terminals and clamps shall be UL listed and shall be provided as recommended by the manufacturer for the indicated applications.

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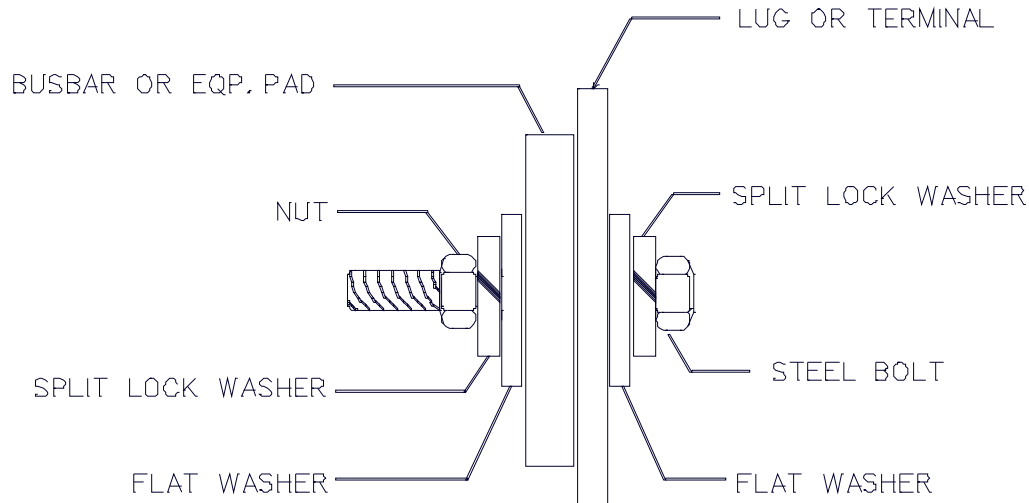
9. Electrical Grounding Connection Accessories including electrical insulating tape, heat shrinkable tubing, welding material, bonding straps and other appurtenances shall be provided as required for each application.
- C. Bonding Conductor Terminations:
 1. Two hole long barrel compression lugs with an inspection window, high conductivity wrought copper, electro tin plated.
- D. The TMGB and TGB
 1. Constructed of copper or alloy and be capable of multiple, appropriately sized NEMA 2 hole connections.
 2. The TMGB and TGB must meet ANSI/EIA/TIA – 607 specifications.
- E. Telecommunications Main Grounding Busbar (TMGB):
 1. The grounding backbone is comprised of (1) TMGB located in the equipment or Main Cross-connect room and TGB's located in the telecommunications service entrance room as well as in each of the telecommunications rooms and customer premises equipment rooms.
 2. TMGB must be located so that it is accessible to telecommunications personnel. A location should be chosen that minimizes the bonding conductor length for telecommunication connections.
 3. An appropriately sized TBB shall be routed between the ground bars as shown on the construction documents.
 4. The cable from the electrical service entrance facility to the TMGB shall be a single contiguous cable with no form of splices, sized as shown in the TBB sizing requirements table.
 5. From TMGB to TGB's located in each telecommunications room: green insulated stranded copper sized per TBB Sizing Requirements table.
 6. Within a telecommunications space, bonding from metallic raceways, cable trays, cable runways, wire mesh partitions, cabinets, racks and terminal boxes to TMGB: #6 AWG green insulated stranded copper.
 7. The TMGB must be a pre-drilled copper busbar with standard NEMA bolt hole sizing and spacing for the type and size of conductor being used.
 8. TMGBs are a minimum of 6 mm (0.23 in.) in thickness, 100 mm (4 in.) wide and of variable length.
 9. Ensure the size of the bar allows for future growth.
- F. Telecommunications Grounding Busbar (TGB):
 1. Pre-drilled copper busbar provided with standard NEMA bolt hole sizing and spacing for type of connectors to be used.
 2. Minimum size 6 mm (0.23 in.) thick by 50 mm (2 in.) wide, variable length.
 3. TBBs and other TGBs located in same space must be bonded to the TGB.
 4. Bonding conductors used between a TBB and TGB must be continuous and routed in the shortest, straight-line path possible.
 5. Install the TGB as close as practical to the panelboard.
 6. When a panelboard for telecommunications is located in the same room as the TGB, bond the panelboard's Equipment Ground bus (when equipped) or the enclosure to the TGB.
 7. Bond the TGB to the TBBIBC where required.
- G. Plexiglass Cover
 1. Provide a plexiglass cover over the ground bar terminations. Provide the ground bar identification nameplate on the face of the plexiglass.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Because the bonding backbone from the electrical service entrance facility to the TMGB shall be continuous, bonding shall be accomplished either by two hole “color keyed” type compression connectors or exothermic welded connections of the proper size for the wire and bus bar are required on all ground bus bars.
2. All compression connectors lugs shall have an inspection “window” for viewing the end of the wire inside of the lug.
3. One hole compression connectors may be used to ground equipment shelves when required by the manufacturer.
4. Two fasteners shall be used to secure all two hole connectors.
5. The proper wire size, connector, crimping tool, and die shall be used as a system to complete an acceptable crimp. All crimping tools must have a positive locking feature to ensure complete compression.
6. All crimps shall be hexagonal or circular and emboss the die code sharply into the connector. Indent crimps are not acceptable.
7. If the die generates corners or flashing, they must be thin and uniform. Excess flashing shall be removed. Circular crimps shall be symmetrical.
8. Ground conductors to be run in free air unless otherwise specified.
 - a. If it is necessary to install bonding conductors in ferrous metallic conduit that exceeds 3 ft. in length, the conductors shall be bonded to each end of the conduit with a #6 AWG solid copper conductor.
 - B. If conductors are required to be run in conduit, the conduit must also be bonded to the TGB.
9. All ground wires shall be continuous runs between terminations, no splices of any kind will be allowed.
 - a. For this requirement, H-taps are not considered splices.
10. This fastening hardware must be a minimum of Grade 5 and Bronze in color. (See Figure T-1).



TERMINATION HARDWARE

FIGURE T-1

11. Wire shall be fully inserted into the barrel of the connector, not to exceed 1/8" under inserted.
12. When multiple crimps are required, the first crimp shall be towards the tang (blade) area of the connector and shall crimp the wire end.
13. Maximum exposed conductor (shiner) consisting of no more than 1/16" between the cable insulation and the end of the barrel portion of the lug shall be acceptable. Clear heat shrink tubing shall cover the barrel portion of the lug and between 1 and 2 inches of the wire insulation.
14. Clean ground bars prior to terminating conductors. A "Scotch-Brite" pad or similar low abrasion device shall be used to clean both surfaces of the connection.
15. Anti-corrosion compound (e.g. NO-OX-ID "A Special") is required on all ground connections.
16. Powder coating used on enclosures and some racks is an excellent insulator that can prevent the enclosure or rack from being grounded. To properly ground powder-coated enclosures and racks, use paint piercing washers when making connections, install rack-mounted ground bars, and run a strap from a lug to the ground bar.
17. Install clamp on connectors only on thoroughly cleaned metal surfaces to ensure electrical conductivity and circuit integrity.
18. Scrape the connection location to remove any paint, enamel, lacquer, or other nonconductive coating, and then use an antioxidant to reduce corrosion that increases resistance.
19. All conduits that stub into the equipment/Main Cross-connect room and telecommunication room shall be bonded to ground. At each conduit end, a #6 AWG solid conductor shall be bonded to the conduit's grounding bushing, and the other end of the #6 AWG solid copper conductors shall be bonded to the TMGB. Each conduit is to have a dedicated ground wire (e.g. daisy chaining from conduit to conduit shall not be permitted)
20. When routing bonding conductors, use a short direct path that minimizes bends.

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21. The connectivity of the TBB through the TGBs shall be accomplished with an exothermic weld or other non mechanical connection to ensure that the TBB does not separate from any given TGB.
22. All insulated ground bars must be isolated from the structural support by a 2" minimum separation, using manufacturer's recommended insulating stand-offs and hardware.
23. Size the TBB per TBB sizing requirements table.
24. Coordinate work with other electrical work for proper interfacing.
25. The TMGB and TGB shall be mounted at 18 inch above finished floor, unless noted otherwise.

3.2 TELECOMMUNICATIONS SYSTEM BONDING

- A. Bond all telecommunication equipment chassis, ladder racks, cable trays, conduits, equipment frames, cabinets, and all other telecommunications room and equipment room metallic components to a local TGB with a #6 AWG, 600 volt, insulated green copper conductor.
- B. Bonding of grounding conductors shall be with the following methods as specified herein:
 1. Connections to grounding busses: "Cool Amp" plating, field applied to both surfaces for all bolted and compression connections.
 2. Approved gas tight two hole copper grounding compression lugs two hole, crimp "Cool Amp" plated compression type for connection to grounding busses.
 3. Fasteners shall be nickel plated steel nuts, bolts and lock washers.
 4. Whenever two or more TBBs are used in a multi-story building, they shall be bonded together on the top floor, and at every third floor, at a minimum, using the bonding conductor size specified.
 5. All bonds below grade shall be Cadweld exothermic welds.

3.3 TELECOMMUNICATIONS GROUNDING SYSTEM

- A. Telecommunications Main Grounding Busbar (TMGB)
 1. Equipment and metallic raceways located in the same room as the TMGB shall be bonded to the TMGB.
 2. When an electrical power panel is located in the same space as the TMGB, that [panelboard's] Alternating Current Equipment Ground (ACEG) bus or the panelboard enclosure should also be bonded to the TMGB.
 3. Connections should be made using listed two-hole compression lugs, but exothermic welding is also acceptable.
- B. Telecommunications Grounding Busbar (TGB)
 1. Any metallic component in the same space as the TGB that is part of the telecommunications infrastructure must be bonded to the TGB, including racks, ladders, enclosures, equipment, surge protection devices, cable trays, TBBs, other TGBs, electrical power panels for telecommunications equipment (either enclosure or ACEG bus), and the GE if present.
 2. Each connection is made using a conductor that is sized the same as the TBB.
 3. Each rack or piece of equipment must be tied directly to the TGB, not daisy chained. The conductor between the TGB and TBB should be continuous and routed in the shortest possible straight-line path.
 4. Mount per Manufacturer's recommendations and per Drawings on insulated standoff supports

3.4 TELECOMMUNICATIONS BONDING BACKBONE (TBB)

1. The TBB between each TGB and the TMGB is connected in a star configuration to minimize ground loops.
2. TBB connections to the TMGB and TGB shall be made with listed two hole compression connectors or exothermic type welded connections.
3. Consistency in the design of the telecommunications backbone cabling system

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4. Permit multiple TBBs as dictated by building size
5. Plan route to minimize TBB length
6. Do not use interior water pipe system of the building as a TBB
7. Do not use metallic cable shield as a TBB in new installations
8. Minimum conductor size is No. 6 AWG.
9. Multiple, vertical TBBs must be bonded together at the top floor and at a minimum of every third floor in between using a TBB interconnecting bonding conductor
10. TBBs shall be installed without splices
11. TBB minimum sizing requirements: See following chart

TBB Sizing Requirements	
Linear route footage from Electrical Service Entrance to TMGB	AWG Requirement
≤ 13	6
14 – 20	4
21 – 26	3
27 – 33	2
34 – 41	1
42 – 52	1/0
53 – 65	2/0
66 - 72	3/0
≥ 73	4/0

3.5 ROUTING, SUPPORTING, AND SECURING CONDUCTORS

- A. Conductors shall not be installed on cable racks next to power or switchboard cable and shall be installed so that they can be inspected.
- B. Conductors shall take the most direct and straight path possible without any sudden changes in direction.
- C. Conductors shall never be installed through the rungs of a cable rack or any other completely enclosed metallic area that could possibly cause a choke hazard.
- D. Conductors shall have a minimum bending radius of 1-foot.
- E. The direction of bend in a grounding conductor shall point towards the grounding busbar.
 1. This applies to #6 AWG or smaller conductors used for framework bonding.
- F. Grounding conductors shall be supported and secured at intervals of no more than 18".
- G. The only approved means of supporting cable on ladder racking is by appropriate sized waxed lacing cord.

3.6 BONDING

- A. General:
 1. Exothermically weld all concealed or below grade connections.
 2. All compression connections shall be made using a hydraulic 4 way compression die.
 3. All compression connections shall be exposed.
 4. All insulated wire splices shall be insulated with preformed wire covers.

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5. Exothermic welding shall be used for connections that do not require frequent moving, such as bonding the TBB and BCT to the TMGB.

3.7 GROUNDING

- A. An equipotential plane for the grounding system at service entrance equipment must be created by connecting the following to the service entrance ground bus:
 1. All metallic water services to the building.
 2. The service entrance equipment and all conduits entering and leaving the equipment.
 3. The metallic piping systems in the building.
 4. The metallic gas piping system upstream from the equipment shutoff valve.
 5. Structural steel columns.
 - a. All columns in or adjacent to (within 50 feet of) existing electrical rooms with separately derived systems.
 - b. If the metal frame is external to the room but readily accessible, bond the TGB to the metal frame using a No. 6 AWG conductor.
 - c. Cadweld all connections to building steel.
- B. Access Floor:
 1. Locations that have raised floor must also be effectively bonded and grounded to the Telecommunication Grounding system to create an equipotential plane which must operate continuously at ground potential by means of a solidly grounded electrical system which provides a low impedance path for ground faults.
 2. The equipment grounding system shall consist of a ground grid consisting of a No. 2 AWG copper ground wire grid connected to the raised floor pedestals, within two inches of the top of the pedestal, on a 10' x 10' grid in both the x and y planes. This grid will then be connected to either the TMGB or TGB copper ground bar which had connections to the building main electrical service, building steel, and the water service.
 3. All metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, portable equipment and other conductive items in close proximity to electrical circuits shall be bonded to this grounding system.

3.8 INSPECTION AND TESTING

- A. Inspect areas and conditions under which electrical connections are to be made and notify the Owner's Representative in writing of conditions detrimental to proper completion of work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
- B. Grounding resistance testing shall be performed on all ground systems including
 1. Service ground
 2. Each ground bar
 3. Raised floor grid at SRG connection points.
 4. Submit written test results.
- C. Exterior ground resistance shall be tested using the four point fall of potential method.
- D. All Ground Testing must be performed by a certified tester in accordance with NETA specifications.
- E. This test is a NFPA 70 Ground Point Test and must be performed on all TGB's using a direct reading two point method.

3.9 LABELS

- A. Provide labels as recommended in TIA/EIA 606. Labels shall be permanent/legible typed. Handwritten labels are not acceptable. Labels are required for TMGBs, TGBs, TBBs, and grounding conductors.

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- B. Grounding conductors shall be identified with a fiber identification tag or equivalent. The tags shall be attached with waxed lacing cord near each end of the conductor and identify the location of the other end.
- C. Ground leads shall be identified at all common ground points, such as at the Telecom Main Grounding Busbar (TMGB) and or Telecom Grounding Busbar (TGB).
- D. Ground leads shall be identified when terminating on a bus bar of any power plant, Battery Distribution Fuse Board (BDFB), etc.
- E. Label all telecommunications bonding conductors as close as possible to their termination point.
- F. Labels shall be affixed at either end of the conductor interconnecting the all of the following:
 - 1. Electrical service entrance facility to the TMGB.
 - 2. Vertical risers and horizontal equalizers
 - 3. All grounding electrode conductors.
 - 4. All grounding conductors extending between the Central Office Ground Bar and the Office Principal Ground Point Bus.
- G. Show all conductors on neatly marked record drawings.
- H. Grounding conductors shall be marked per ANSI/TIA/EIA 606.

- I. The labels shall be nonmetallic and state:



WARNING

**IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE
BUILDING MANAGER**

END OF SECTION