ADVANCING GLOBAL COMMUNICATIONS

Approved American National Standard

ANSI/TIA-607-B-2011
APPROVED: AUGUST 26, 2011

TIA STANDARD

Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

TIA-607-B

September 2011

TELECOMMUNICATIONS
INDUSTRY ASSOCIATION

tiaonline.org

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(From Standard Proposal No. 3-4351-RV2-2, formulated under the cognizance of the TIA TR-42 Telecommunications Cabling Systems, TR-42.16 Subcommittee on Premises Telecommunications Bonding & Grounding).

Published by
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Standards and Technology Department
2500 Wilson Boulevard
Arlington, VA 22201 U.S.A.

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Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

Table of Contents

List of Figures

List of Tables

FOREWORD

(This foreword is not part of this Standard)

This Standard was developed by Telecommunications Industry Association (TIA) Subcommittee TR-42.16.

Approval of Standard

This Standard was approved by TIA Subcommittee TR-42.16, TIA Engineering Committee TR-42, and the American National Standards Institute (ANSI).

ANSI/TIA reviews standards every 5 years. At that time, standards are reaffirmed, withdrawn, or revised according to the submitted updates. Updates to be included in the next revision should be sent to the committee chair or to ANSI/TIA.

Contributing organizations

More than 60 organizations within the telecommunications industry contributed their expertise to the development of this Standard (including manufacturers, consultants, end users, and other organizations).

Documents superseded

This Standard replaces ANSI-J-STD-607-A, published in October, 2002.

Significant technical changes

Significant technical changes and additions from the previous edition include:

- Bonding and grounding requirements for “generic” premises. Requirements for specific types of premises (e.g., commercial buildings, residential) can be found in corresponding TR-42 developed premises standards.

Relationship to other TIA standards and documents

The following are related standards regarding various aspects of structured cabling that were developed and are maintained by Engineering Committee TIA TR-42. A diagram of the relationship between the TIA cabling standards is illustrated in figure 1.

a) *Generic Telecommunications Cabling for Customer Premises* (ANSI/TIA-568-C.0);
b) *Commercial Building Telecommunications Cabling Standard* (ANSI/TIA-568-C.1);
c) *Balanced Twisted-Pair Telecommunications Cabling and Components Standard* (ANSI/TIA 568 C.2);
d) *Optical Fiber Cabling Components Standard* (ANSI/TIA-568-C.3);
e) *Broadband Coaxial Cabling and Components Standard* (ANSI/TIA-568-C.4);
f) *Commercial Building Standard for Telecommunications Pathways and Spaces* (TIA-569-B);
g) *Residential Telecommunications Infrastructure Standard* (ANSI/TIA-570-B);
h) *Administration Standard for Commercial Telecommunications Infrastructure* (ANSI/TIA/EIA-606-A);
i) *Customer-Owned Outside Plant Telecommunications Infrastructure Standard* (ANSI/TIA-758-B);
j) *Building Automation Systems Cabling Standard* (ANSI/TIA/EIA-862-A);
k) *Telecommunications Infrastructure Standard for Data Centers* (ANSI/TIA-942); and,
l) *Telecommunications Infrastructure Standard for Industrial Premises* (ANSI/TIA-1005).

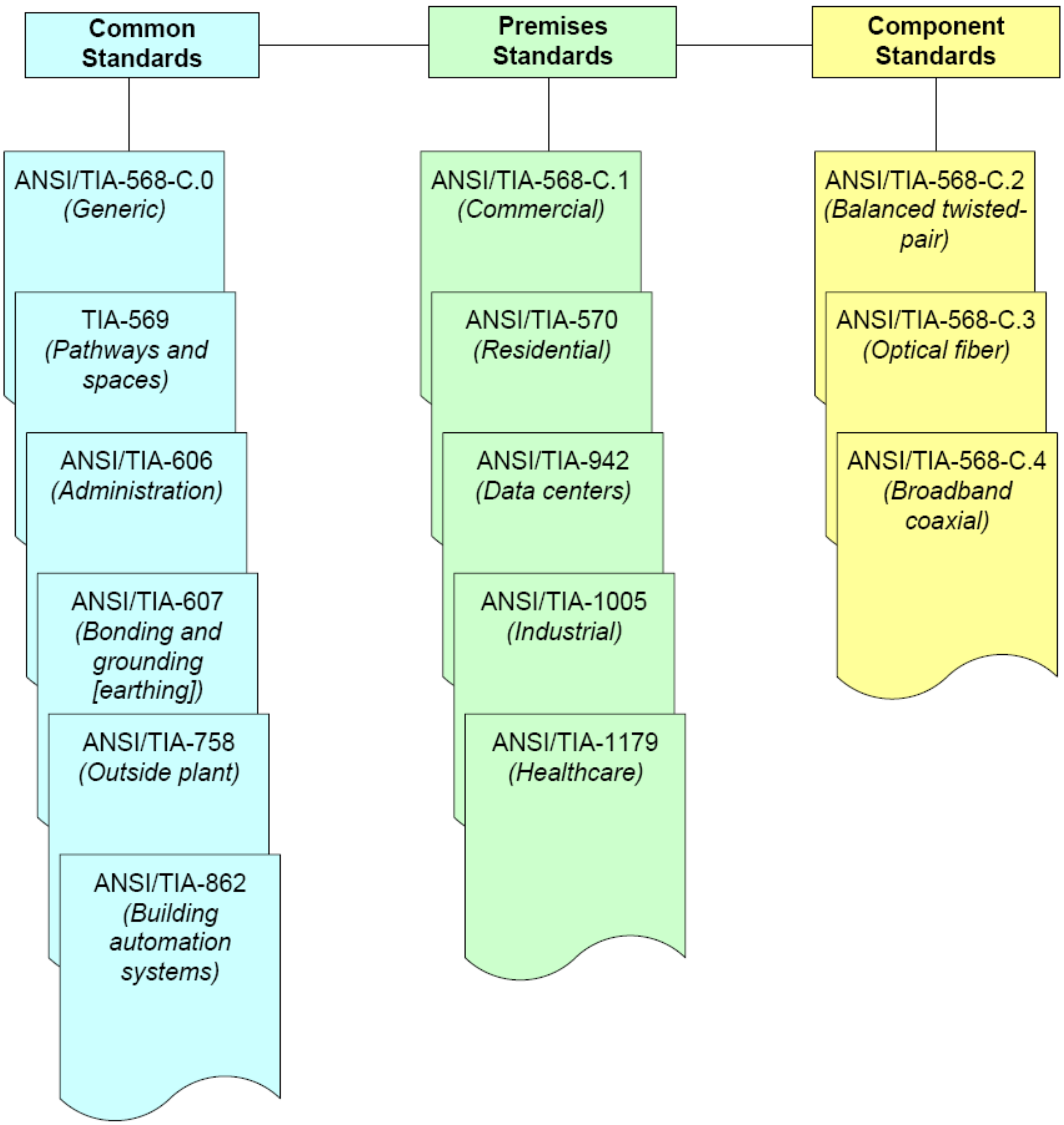

Figure 1 – Relationship between TIA cabling standards

The following documents may be useful to the reader:

a) *National Electrical Safety Code®* (*NESC®*) (ANSI/IEEE C2-2007)
b) *National Electrical Code®* (*NEC®*) (ANSI/NFPA-70-2011)

Other references are listed in annex F.

Annexes

Annexes A through F are informative and not considered a requirement of this Standard.

Introduction

General

Telecommunications, as used in this Standard, refers to the transmission of all forms of information (e.g., voice, data, video, security, audio, industrial, building control). Telecommunications equipment used to support these wide varieties of systems that rely on the electronic transport of information require an effective building infrastructure. This infrastructure encompasses spaces, pathways, cables, connecting hardware, and a bonding and grounding system. For reliable operation of any telecommunications equipment or system, bonding and grounding (earthing) is essential – regardless of the cabling technology or media. This Standard focuses on the bonding and grounding portion of this infrastructure.

NOTE – The North American term “grounding” that is used in this Standard is equivalent to the international term “earthing”.

The bonding and grounding approach in this Standard is intended to work in concert with premises cabling specified within TIA Engineering Committee TR-42. The requirements specified in this Standard in conjunction with a basic understanding of bonding and grounding concepts and methodologies will aid in achieving a reliable solution when applied to telecommunications installations.

Several sources of bonding and grounding information exist within the telecommunications industry. For example, the *NEC*® specifies requirements regarding the safety aspects of bonding and grounding of equipment and systems. Yet another example is that of ATIS 0600318, *Electrical Protection Applied to Telecommunications Network Plant at Entrances to Customer Structures or Buildings,* which provides information on bonding and grounding to support electrical protection considerations.

Purpose

The purpose of this Standard is to enable and encourage the planning, design, and installation of generic telecommunications bonding and grounding systems within premises with or without prior knowledge of the telecommunications systems that will subsequently be installed. While primarily intended to provide direction for the design of new buildings, this Standard may be used for existing building renovations or retrofit treatment. Design requirements and choices are provided to enable the designer to make informed design decisions.

Stewardship

Telecommunications infrastructure affects raw material consumption. The infrastructure design and installation methods also influence product life and sustainability of electronic equipment life cycling. These aspects of telecommunications infrastructure impact our environment. Since building life cycles are typically planned for decades, technological electronic equipment upgrades are necessary. The telecommunications infrastructure design and installation process magnifies the need for sustainable infrastructures with respect to building life, electronic equipment life cycling and considerations of effects on environmental waste. Telecommunications designers are encouraged to research local building practices for a sustainable environment and conservation of fossil fuels as part of the design process.

Specification of criteria

Two categories of criteria are specified; mandatory and advisory. The mandatory requirements are designated by the word "shall"; advisory requirements are designated by the words "should”, "may", or "desirable" which are used interchangeably in this Standard.

Mandatory criteria generally apply to protection, performance, administration and compatibility; they specify minimally acceptable requirements. Advisory criteria are presented when their attainment may enhance the general performance of the cabling system in all its contemplated applications.

A note in the text, table, or figure is used for emphasis or offering informative suggestions, or providing additional information.

Metric equivalents of United States (US) customary units

The units in this Standard are metric or US customary with soft conversion to the other.

Life of this Standard

This Standard is a living document. The criteria contained in this Standard are subject to revisions and updating as warranted by advances in building construction techniques and telecommunications technology.

1 SCOPE

This Standard specifies requirements for a generic telecommunications bonding and grounding infrastructure and its interconnection to electrical systems and telecommunications systems. This Standard may also be used as a guide for the renovation or retrofit of existing systems.

2 NORMATIVE REFERENCES

The following standards contain provisions that, through reference in this text, constitute provisions of this Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. The American National Standards Institute (ANSI) and the Telecommunications Industry Association (TIA) maintain registers of currently valid national standards published by them.

a) ANSI/IEEE 1100, 2005, *Recommended Practice for Powering and Grounding Electronic Equipment*
b) ANSI/IEEE C2, 2007, *National Electrical Safety Code (NESC®)*
c) ANSI/NECA/BICSI-607, 2010, *Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings*
d) ANSI/NFPA-70, 2008, *National Electrical Code (NEC®)*
e) ANSI/ATIS 0600333, *Grounding And Bonding Of Telecommunications Equipment*
f) ANSI/ATIS 0600334, 2008, *Electrical Protection Of Communications Towers And Associated Structures*
g) ANSI/TIA-568-C.0, 2008, *Generic Telecommunications Cabling for Customer Premises*
h) ANSI/TIA/EIA-606-A, 2007, *Administration Standard for the Telecommunications Infrastructure of Commercial Buildings*
i) FIPS PUBS 94, 1983, Guideline on Electrical Power for ADP Installations, 1983 (USA Federal Information Processing Standards Publications)
j) ITU-T K.27, 1996, *Bonding Configuration And Earthing Inside A Telecommunication Building*

3 DEFINITIONS

3.1 General

For the purpose of this Standard the following definitions, acronyms, abbreviations and units of measure apply.

3.2 Definition of terms

For the purposes of this Standard, the following definitions apply:

access floor: A system consisting of completely removable and interchangeable floor panels that are supported on adjustable pedestals or stringers (or both) to allow access to the area beneath.

access provider: The operator of any facility that is used to convey telecommunications signals to and from a customer premises.

administration: The method for labeling, identification, documentation and usage needed for installation, moves, additions and changes of the telecommunications infrastructure.

backbone: A facility (e.g. pathway, cable or bonding conductor) for cabling Subsystem 2 and Cabling Subsystem 3.

bonding: The joining of metallic parts to form an electrically conductive path.

bonding conductor: A conductor that joins metallic parts to form an electrically conductive path.

bonding conductor for telecommunications: A conductor that interconnects the telecommunications bonding infrastructure to the building's service equipment (power) ground.

bonding network (telecommunications): A set of interconnected conductive structures that provides a low impedance path for the associated telecommunications infrastructure.

building backbone: 1) Pathways or cabling between telecommunications service entrance rooms, equipment rooms, telecommunications rooms, or telecommunications enclosures within a building. 2) Cabling for interconnecting telecommunications spaces from the telecommunications entrance facility to a horizontal cross-connect within a building.

cabinet: A container that may enclose connection devices, terminations, apparatus, wiring, and equipment.

cable: An assembly of one or more insulated conductors or optical fibers, within an enveloping sheath.

cable sheath: A covering over the optical fiber or conductor assembly that may include one or more metallic members, strength members, or jackets.

cabling: A combination of all cables, jumpers, cords, and connecting hardware.

Cabling Subsystem 1: Cabling from the equipment outlet to Distributor A, Distributor B, or Distributor C.

Cabling Subsystem 2: Cabling between Distributor A and either Distributor B or Distributor C (if Distributor B is not implemented).

Cabling Subsystem 3: Cabling between Distributor B and Distributor C.

campus: The buildings and grounds having legal contiguous interconnection.

coaxial cable: A telecommunications cable consisting of a round center conductor surrounded by a dielectric surrounded by a concentric cylindrical conductor (shield) and an optional insulating sheath.

commercial building: A building or portion thereof that is intended for office use.

common bonding network: The set of metallic components that are interconnected to form the principle means for effectively bonding equipment inside a building to the grounding electrode system

computer room: An architectural space whose primary function is to accommodate data processing equipment.

conduit: (1) A raceway of circular cross-section. (2) A structure containing one or more ducts.

customer premises: Building(s), grounds and appurtenances (belongings) under the control of the customer.

Distributor A: Optional connection facility in a hierarchical star topology that is cabled between the equipment outlet and Distributor B or Distributor C.

Distributor B: Optional intermediate connection facility in a hierarchical star topology that is cabled to Distributor C.

Distributor C: Central connection facility in a hierarchical star topology.

earth: See **ground**.

earthing: See grounding.

electromagnetic interference: Radiated or conducted electromagnetic energy that has an undesirable effect on electronic equipment or signal transmissions.

entrance facility (telecommunications): An entrance to a building for both public and private network service cables (including wireless) including the entrance point of the building and continuing to the entrance room or space.

entrance point (telecommunications): The point of emergence for telecommunications cabling through an exterior wall, a floor, or from a conduit.

equipment outlet: Outermost connection facility in a hierarchical star topology.

equipotential bonding: Bonding between metallic components to achieve a substantially equal potential.

exothermic weld: A method of permanently bonding two metals together by a controlled heat reaction resulting in a molecular bond.

grid: A collection of adjacent cells.

ground: A conducting connection, whether intentional or accidental, between an electrical circuit (e.g., telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.

grounding: The act of creating a ground.

grounding conductor: A conductor used to connect the grounding electrode to the building's main grounding busbar.

grounding electrode: A conductor, usually a rod, pipe or plate (or group of conductors) in direct contact with the earth for the purpose of providing a low-impedance connection to the earth.

grounding electrode conductor: The conductor used to connect the grounding electrode to the equipment grounding conductor, or to the grounded conductor of the circuit at the service equipment, or at the source of a separately derived system.

grounding electrode system: One or more grounding electrodes that are connected together.

grounding equalizer: The conductor that interconnects elements of the telecommunications grounding infrastructure

infrastructure (telecommunications): A collection of those telecommunications components, excluding equipment, that together provide the basic support for the distribution of information within a building or campus.

Listed: Equipment included in a list published by an organization, acceptable to the authority having jurisdiction, that maintains periodic inspection of production of listed equipment, and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

mesh bonding network: A bonding network to which all associated equipment (e.g., cabinets, frames, racks, trays, pathways) are connected using a bonding grid, which is connected to multiple points on the common bonding network.

pathway: A facility for the placement of telecommunications cable.

primary protector: The protector located at the building telecommunications entrance point.

primary protector grounding conductor: The conductor connecting the primary protector to ground.

protector: A device consisting of one or more protector units and associated mounting assemblies intended to limit abnormal voltages or currents on metallic telecommunications circuits.

secondary protector: A device that protects against electrical transients passed through the primary protector or generated within the customer premises.

sheath: See **cable sheath**.

shield: 1) A metallic layer placed around a conductor or group of conductors. 2) The cylindrical outer conductor with the same axis as the center conductor that together form a coaxial transmission line.

sleeve: An opening, usually circular, through the wall, ceiling, or floor to allow the passage of cables.

splice: A joining of conductors, meant to be permanent.

supplementary bonding grid: A set of conductors or conductive elements formed into a grid or provided as a conductive plate that is part of a bonding network.

telecommunications: Any transmission, emission, and reception of signs, signals, writings, images, and sounds, that is, information of any nature by cable, radio, optical, or other electromagnetic systems.

telecommunications bonding backbone: A conductor that interconnects the telecommunications main grounding busbar (TMGB) to the telecommunications grounding busbar (TGB).

telecommunications equipment bonding conductor: A conductor that connects the telecommunications main grounding busbar (TMGB) or telecommunications grounding busbar (TGB) to equipment racks or cabinets

telecommunications grounding busbar (TGB): A common point of connection for telecommunications system and equipment bonding to ground, and located in the telecommunications room or equipment room.

telecommunications infrastructure: See **infrastructure (telecommunications)**.

telecommunications main grounding busbar: A busbar placed in a convenient and accessible location and bonded by means of the bonding conductor for telecommunications, to the building service equipment (power) ground.

wire: An individually insulated solid or stranded metallic conductor.

3.3 Abbreviations and acronyms

ac alternating current

ACEG alternating current equipment ground

AHJ authority having jurisdiction

ANSI American National Standards Institute

ATIS Alliance for Telecommunications Industry Solutions

AWG American Wire Gage

BCT	bonding conductor for telecommunications
BN	bonding network
CBC	coupled bonding conductor
CBN	common bonding network
dc	direct current
EIA	Electronic Industries Alliance
EMI	electromagnetic interference
ENT	electrical nonmetallic tubing
EO	equipment outlet
ESD	electrostatic discharge
FCC	Federal Communications Commission
GE	grounding equalizer
HVAC	heating, ventilating and air conditioning
IACS	International Annealed Copper Standard
IBN	isolated bonding network
ITE	information technology equipment
ITU-T	International Telecommunication Union- Telecommunication
mesh-BN	mesh bonding network
mesh-IBN	mesh isolated bonding network
NEC®	*National Electrical Code®*
NECA	National Electrical Contractors Association
NESC®	*National Electrical Safety Code®*
NFPA	National Fire Protection Association
NRTL	nationally recognized testing laboratory
PDU	power distribution unit
RBC	rack bonding conductor
RF	radio frequency
RGB	rack grounding busbar
SPC	single point connection
SBG	supplementary bonding grid
TBB	telecommunications bonding backbone
TEBC	telecommunications equipment bonding conductor
TEF	telecommunications entrance facility
TGB	telecommunications grounding busbar
TIA	Telecommunications Industry Association
TMGB	telecommunications main grounding busbar

3.4 Units of measure

ft	feet, foot
in	inch
kcmil	thousand circular mil
km	kilometer
m	meter
mm	millimeter
ohms-cm	ohms centimeter
V	volt

4 REGULATORY

4.1 National requirements

This Standard is intended to conform to the *National Electrical Code*® (*NEC*®; ANSI/NFPA-70) and the *National Electrical Safety Code*® (*NESC*®; ANSI/IEEE C2).

4.2 Local code requirements

This Standard does not replace any code, either partially or wholly. Local code requirements shall be followed. The local code requirements should be reviewed with the local authority having jurisdiction (AHJ). The review should confirm the currently adopted code and edition and any exceptions to the code that are adopted by the governing authority (the AHJ). If no code has been adopted locally, consult with the fire marshal's office to determine what agency is responsible for code enforcement in that geographic area.

5 OVERVIEW OF TELECOMMUNICATIONS BONDING AND GROUNDING SYSTEMS

5.1 General

The basic principles, components, and design of telecommunications bonding and grounding infrastructure specified in this Standard shall be followed amongst buildings of differing designs and structures.

> NOTE – The requirements in this Standard differ from utility service provider requirements, which are specified in ATIS-0600313. ATIS-0600313 specifications support a robust level of service appropriate to a service provider. Users of this Standard are encouraged to refer to ATIS-0600313 where robust service requirements exist.

Bonding and grounding systems within a building are intended to have one electrical potential. While the bonding and grounding of the electrical service entrance is outside the scope of this Standard, coordination between electrical and telecommunications bonding and grounding systems is essential for the proper application of this Standard. For example, electrical room and associated electrical panelboard(s) are not part of the telecommunications infrastructure, but they are depicted in this Standard because they are integral to the telecommunications bonding and grounding system. See subclauses 7.2.1, 7.2.2, 7.3.1 and 7.3.2 for more information regarding bonding to electrical panelboards.

When installed, the lightning protection system should meet the requirements of the authority having jurisdiction (AHJ).

Where a tower or antenna is installed, the installation shall meet the bonding and grounding requirements of ANSI/ATIS 0600334. See annex B for information regarding bonding and grounding of towers and antennas.

5.2 Overview of the telecommunications bonding and grounding infrastructure

5.2.1 General

Within a building (see illustrative examples figure 2 and figure 3), the generic telecommunications bonding and grounding infrastructure originates at the electrical entrance facility ground and extends throughout the building. It includes the following major components:

a) telecommunications main grounding busbar (TMGB);
b) bonding conductor for telecommunications (BCT);

and may also include the following:

c) telecommunications bonding backbone (TBB);
d) telecommunications grounding busbar (TGB); and,
e) grounding equalizer (GE).

These telecommunications bonding and grounding components are intended to work with a building’s telecommunications pathways and spaces, installed cabling, and administration system.

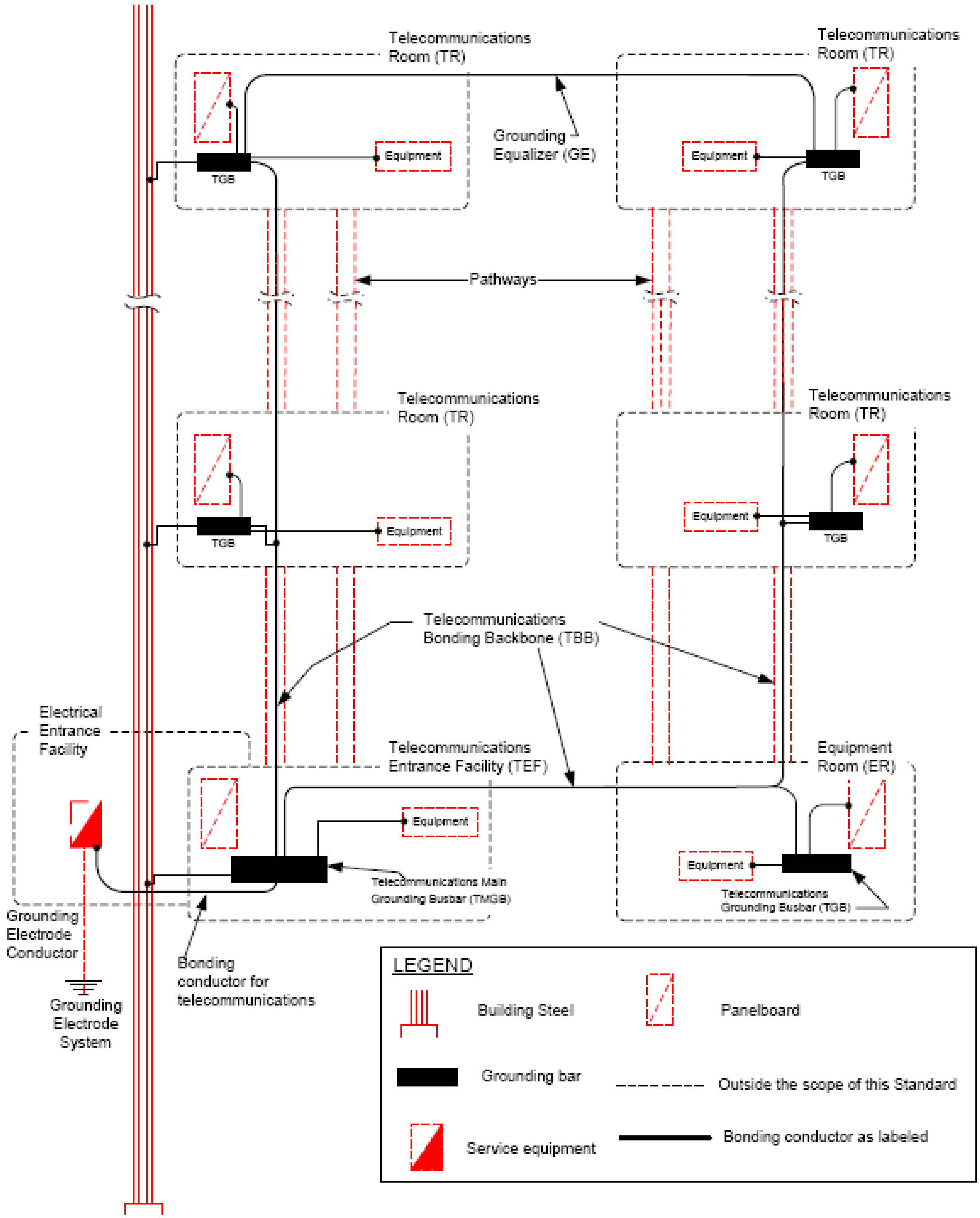

Figure 2 – Illustrative example of a larger building

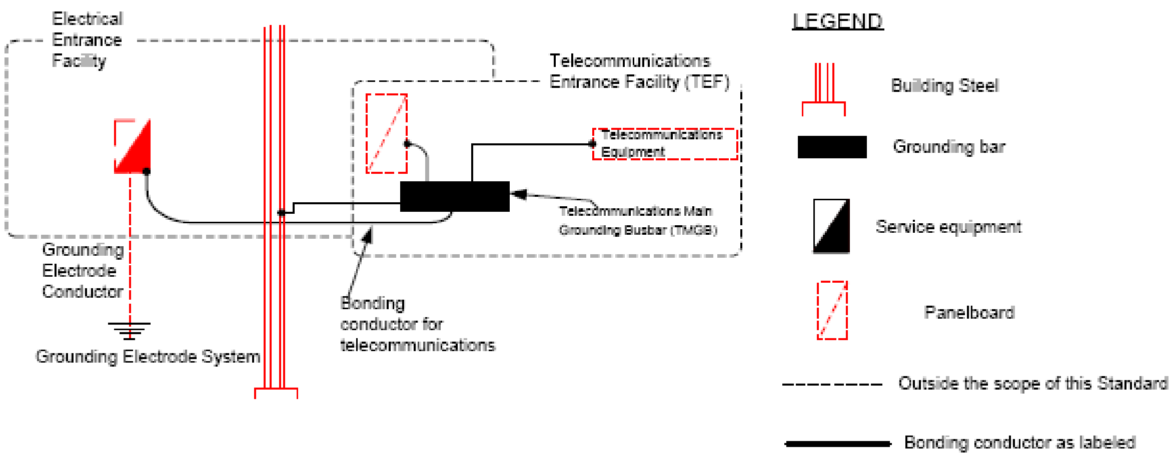

Figure 3 – Illustrative example of a smaller building

5.2.2 Telecommunications main grounding busbar (TMGB)

The TMGB serves as the dedicated extension of the building grounding electrode system for the telecommunications infrastructure. The TMGB also serves as the central attachment point for the TBB(s) and equipment. See subclauses 6.2.1 and 7.1.3.

5.2.3 Bonding conductor for telecommunications (BCT)

The BCT bonds the TMGB to the service equipment (power) ground. See subclauses 6.3.3 and 7.4.2.

5.2.4 Telecommunications bonding backbone (TBB)

The TBB is a conductor that interconnects all TGBs with the TMGB. The intended function of a TBB is to reduce or equalize potential differences. A TBB is not intended to serve as the only conductor providing a ground fault current return path. The TBB originates at the TMGB extends throughout the building using the telecommunications backbone pathways, and connects to the TGBs in distributors. See subclauses 6.3.2 and 7.4.3.

5.2.5 Telecommunications grounding busbar (TGB)

The TGB is the grounding connection point for telecommunications systems and equipment in the area served by a distributor. See subclauses 6.2.2 and 7.3.

5.2.6 Grounding equalizer (GE)

The GE is typically employed in a multistory building to interconnect multiple TBBs on the same floor. See subclauses 6.3.4 and 7.4.4.

6 TELECOMMUNICATIONS BONDING AND GROUNDING COMPONENTS

6.1 General

This clause specifies components of the telecommunications bonding and grounding infrastructure. Where the word "Listed" is used as a requirement for a component, the component shall be Listed to the applicable standard(s) through a nationally recognized testing laboratory (NRTL).

6.2 Busbars

6.2.1 Telecommunications main grounding busbar (TMGB)

The TMGB shall:

a) be a busbar provided with holes for use with correctly matched Listed lugs and hardware;
b) be made of copper, or copper alloys having a minimum of 95% conductivity when annealed as specified by the International Annealed Copper Standard (IACS);
c) have minimum dimensions of 6.35 mm (0.25 in) thick x 100 mm (4 in) wide and variable in length; and,
d) be Listed.

Figure 4 illustrates dimensions typical of a TMGB.

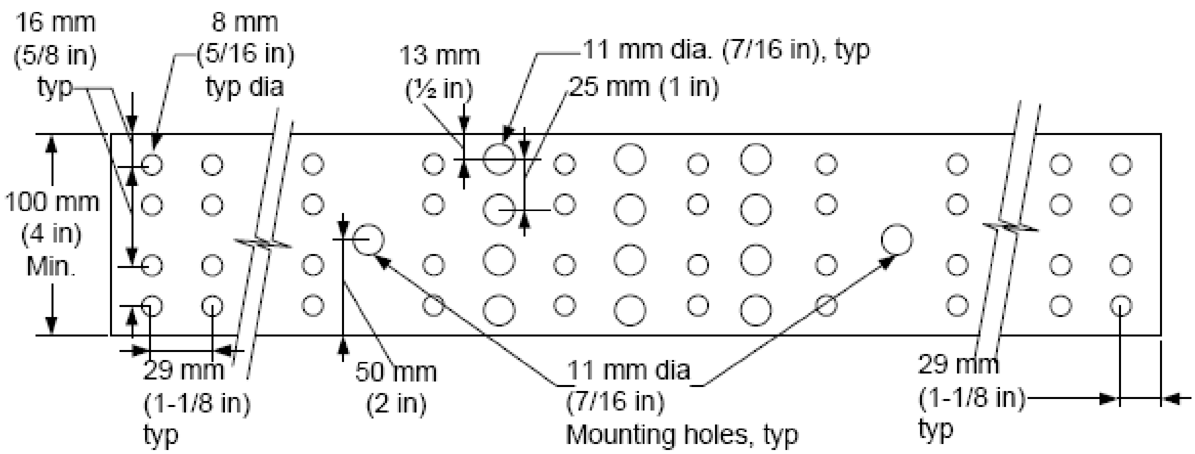

Figure 4 – Typical TMGB

6.2.2 Telecommunications grounding busbar (TGB)

The TGB shall:

a) be a busbar provided with holes for use with correctly matched Listed lugs and hardware;
b) be made of copper, or copper alloys having a minimum of 95% conductivity when annealed as specified by the IACS;
c) have minimum dimensions of 6.35 mm (0.25 in) thick x 50.8 mm (2 in) wide and variable in length; and,
d) be Listed.

Figure 5 illustrates dimensions typical of a TGB.

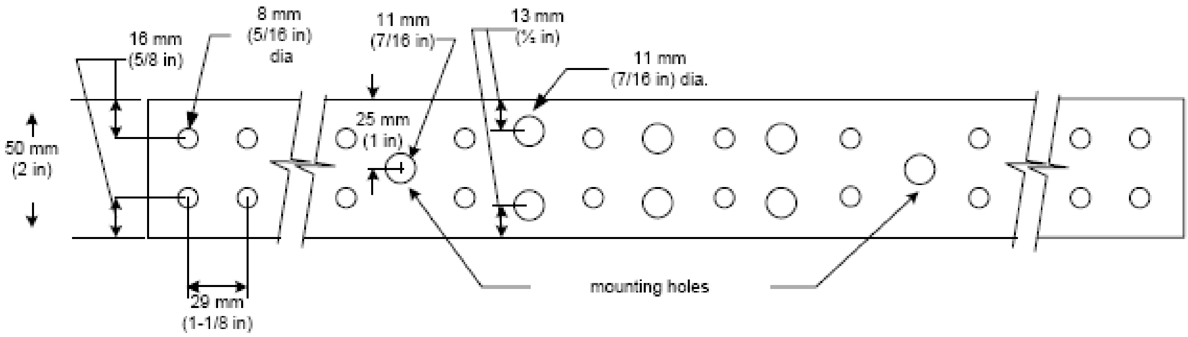

Figure 5 – Typical TGB

6.3 Conductors

6.3.1 General

All bonding and grounding conductors shall be copper and may be insulated. When conductors are insulated, they shall be Listed for the application. The size of the conductor is not intended to account for the reduction or control of electromagnetic interference (EMI). The grounding conductors shall not decrease in size as the grounding path moves closer to earth.

6.3.2 Sizing the telecommunications bonding backbone (TBB)

The minimum TBB conductor size shall be a No. 6 American Wire Gauge (AWG). The TBB should be sized at 2 kcmil per linear foot of conductor length up to a maximum size of 750 kcmil.

> NOTE – The previous edition of this Standard sized the TBB conductor up to 3/0 AWG. This Standard allows the TBB conductor to be sized up to 750 kcmil. Bonding conductors used for telecommunications should be sized using engineered calculations.

Table 1 –TBB conductor size vs length

TBB/GE linear length m (ft)	TBB/GE size (AWG)
less than 4 (13)	6
4 – 6 (14 – 20)	4
6 – 8 (21 – 26)	3
8 – 10 (27 – 33)	2
10 – 13 (34 – 41)	1
13 – 16 (42 – 52)	1/0
16 – 20 (53 – 66)	2/0
20 – 26 (67 – 84)	3/0
26 – 32 (85 – 105)	4/0
32 – 38 (106 – 125)	250 kcmil
38 – 46 (126 – 150)	300 kcmil
46 – 53 (151 – 175)	350 kcmil
53 – 76 (176 – 250)	500 kcmil
76 – 91 (251 – 300)	600 kcmil
Greater than 91 (301)	750 kcmil

6.3.3 Sizing the bonding conductor for telecommunications (BCT)

The BCT shall be, as a minimum, the same size as the largest TBB.

6.3.4 Sizing the grounding equalizer (GE)

The GE shall be, as a minimum, the same size as the largest TBB.

6.4 Connectors

All bonding and grounding connectors shall be Listed for the application.

> NOTE – Connectors are Listed for the application (e.g., above ground, direct buried, bonding to the metal frame of a building).

The surface of all bonding and grounding connectors used on a TMGB and a TGB shall be of a material that provides an electro-chemical potential of $<30 \times 10^{-2}$ V between connector and grounding busbar.

6.5 Identification

6.5.1 Conductors

The BCT, each TBB, and each GE, shall be green or marked with a distinctive green color.

6.5.2 Labels

Labels shall be nonmetallic and include the information depicted in figure 6.

Figure 6 – Label for bonding and grounding conductors

7 DESIGN REQUIREMENTS

7.1 General

All exposed cables in a telecommunications facility shall be bonded to ground as close as practical to the point of entrance. This includes bonding to ground the cable shields and metallic sheath members according to manufacturer's installation instructions.

Where the building backbone telecommunications cabling incorporates a shield or metallic member, this shield or metallic member shall be bonded to the telecommunications main grounding busbar (TMGB) or the telecommunications grounding busbar (TGB) where the cables are terminated or where pairs are "broken out" from the cable sheath.

When secondary protection is provided, the secondary protector grounding conductor shall be connected to the nearest TMGB or TGB using the shortest grounding conductor practical.

Grounding through the equipment alternating current (ac) power cord does not meet the intent of this Standard. It is intended that the information technology equipment (ITE) be provided a supplementary and specific ground path for the equipment over and above the required ac or direct current (dc) power ground path. While the ac or dc powered equipment typically has a power cord that contains a grounding/bonding wire, the integrity of this path to ground cannot be easily verified. Rather than relying wholly on the ac or dc power cord grounding/bonding wire, it is desirable that equipment be grounded in a verifiable "supplementary" manner as described in this Standard.

> NOTE – Many types of equipment do not require individual bonding conductors and as such do not have an attachment point for bonding conductors. Equipment that does not have attachment points for bonding conductors may be bonded either through the equipment rail or the power cord. Refer to the manufacturer's documentation for guidelines.

Short metallic pathways (e.g., wall and floor sleeves, J-hooks) are not required to be bonded. Additionally, this Standard does not require bonding of the steel bars of a reinforced concrete building.

See ANSI/NECA/BICSI-607 for installation information on telecommunications bonding and grounding.

7.1.1 Telecommunications entrance facility (TEF)

The TEF is the entrance point (room or space within a building) where:

a) the telecommunications facilities enter;
b) the joining of campus and building backbone facilities takes place; and,
c) the grounding of these facilities is accomplished.

The TEF may also include antenna cable entrances (see annex B), and electronic equipment serving telecommunications functions.

It is desirable that all utilities enter the building in close proximity to each other.

7.1.2 Distributors (see ANSI/TIA-568-C.0)

Distributor C shall contain either a TMGB or a minimum of one TGB. Distributor A and Distributor B shall contain a minimum of one TGB. The TMGB and the TGB shall be located within the Distributor so as to provide the greatest flexibility and accessibility for telecommunications system grounding (minimizing practical lengths and number of bends of bonding conductors to the TGB).

7.1.3 Computer rooms

Each computer room shall contain a TGB (or TMGB when specified in the design) and should also contain a supplementary bonding network that is bonded (and thus becomes grounded) to the TGB or TMGB. This supplementary bonding network may be in a form as identified in subclause 7.7 but is typically a mesh-bonding network (mesh-BN).

Typically, the ITE cabinets and racks within the computer room are arranged into a holistic (single system block) mesh-BN by manufacturer's equipment design, user deployment guidelines, or both. For computer rooms, the holistic mesh-BN is a recommended practice since it simplifies installation procedures, most ITE is powered by ac branch circuits, and most ITE employed for a computer room is suitable for placement directly into the common bonding network (CBN).

However, under certain circumstances such as a manufacturer's requirement or access provider recommendations, the ITE may also be arranged into certain segregated "functional system blocks" of either mesh-BN, mesh isolated bonding network (mesh-IBN), or other form of bonding network (BN), within the same room. The supplementary bonding conductor network for the holistic or any segregated mesh-BN, mesh-IBN or other BN must also be directly bonded to the room's TGB or TMGB since the BN must always be grounded. The BN may also provide for electromagnetic shielding in varying degrees based upon its design and installation.

A recommended augmentation to a BN (especially a mesh-BN) is a supplementary bonding grid (SBG). Upon installation and connection of the SBG to the BN (primary components are cabinets, racks and frames), the SBG becomes part of the overall BN. The SBG typically covers the entire computer room or a local area within a room.

The historical spacing for the SBG pattern is between 0.61 m to 1.22 m (2 ft to 4 ft) and was historically stated in Guideline on Electrical Power for ADP Installations, 1983 (USA Federal Information Processing Standards Publications - FIPS PUBS 94) to aid in reducing the effect of resonance on ac branch circuit equipment grounding conductors.

The minimum density of the bonding grid is 3 m (9.8 ft) centers or one that corresponds to the computer room cold-or-hot aisles and the aisles running perpendicular to the cold-and-hot aisles.

7.1.4 Cabinets and racks

Metallic enclosures, including telecommunications cabinets and racks, shall be bonded to the mesh-BN, TGB, or TMGB using a minimum sized conductor of No. 6 AWG.

Cabinets, racks, and other enclosures in computer rooms shall not be bonded serially; each shall have their own dedicated bonding conductor to the mesh-BN, TGB, or TMGB.

Equipment containing metallic parts in cabinets and racks shall be bonded to the telecommunications grounding system in accordance with the manufacturer instructions. Where instructions are not given, all bonding jumpers that ground installed equipment shall be a minimum sized conductor of No. 12 AWG. Rack grounding busbars (RGBs) are recommended for cabinets and racks that need to support multiple unit bonding conductors. There are three methods to bond the equipment located in the equipment rack or cabinet to the telecommunications bonding system, see figure 7.

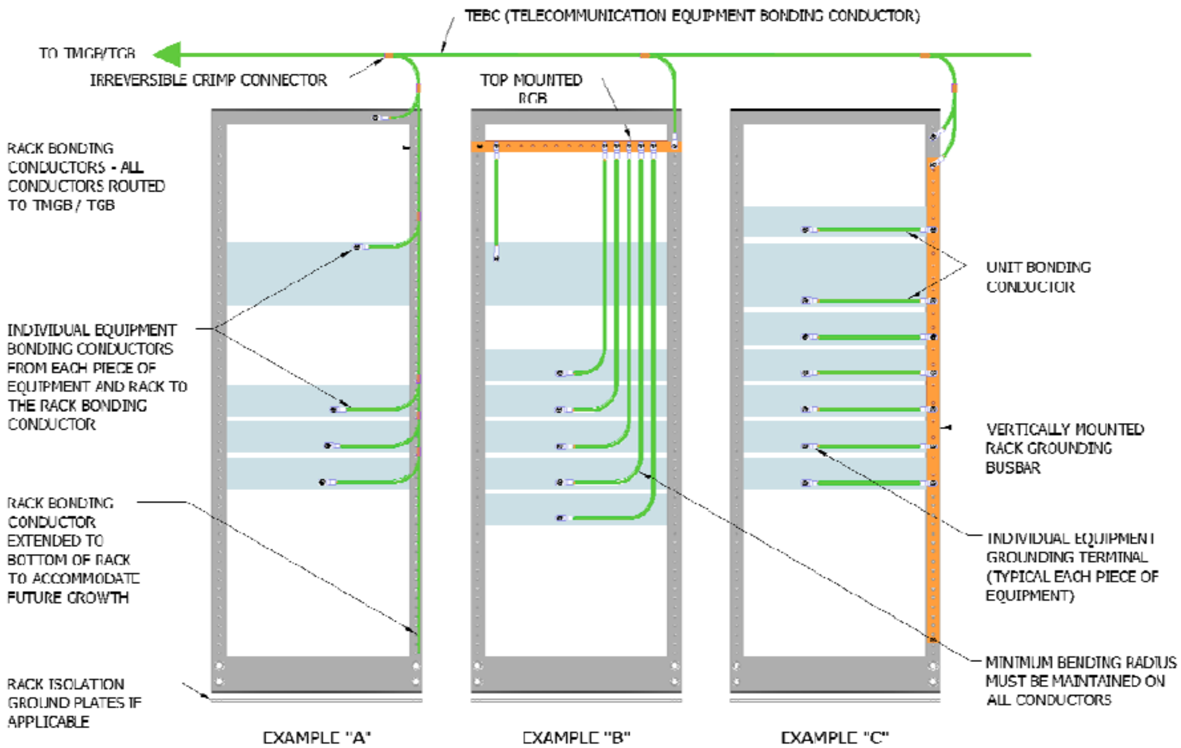

Figure 7 – Example of three methods to bond equipment and racks to ground

7.1.5 Cable ladders, cable runways, conduits, pipes, and building steel

In order to limit the potential difference between telecommunications conduits or between telecommunications conduits and power conduits, the telecommunications conduits shall be bonded to the TMGB/TGB. Additionally, to achieve the objectives of potential equalization, ensure that cable runway/ladder sections are bonded together and that they are bonded to the TMGB/TGB.

Where building steel is accessible and in the same room as the TMGB/TGB, the TMGB/TGB shall be bonded to building steel using a minimum sized conductor of No. 6 AWG. When practical, because of shorter distances and where horizontal steel members are permanently electrically bonded to vertical column members, the TMGB/TGB may be bonded to these horizontal members in lieu of the vertical column members. When the building steel is external to the room, but readily accessible, it should be bonded to the TMGB/TGB using a minimum sized conductor of No. 6 AWG. Building steel should be tested to verify its ground conductivity to earth.

NOTE – Modern building construction techniques will ground building steel to the main ac power entrance or another grounding source. Ensure that when working in existing buildings that the building steel is bonded to a suitable ground source (e.g., electrical power grounding electrode[s], building ground ring).

7.2 Telecommunications main grounding busbar (TMGB)

7.2.1 General

The length of the TMGB is not specified within this Standard. It is desirable that the busbar be electrotin-plated for reduced contact resistance. The busbar shall be cleaned and an anti-oxidant should be applied prior to fastening connectors to the busbar.

The desirable location of the TMGB is in the TEF. Typically, there should be a single TMGB per building.

NOTE – For buildings with more than one electrical service entrance, each of which serves telecommunications equipment, the user is urged to consult with a licensed engineer for guidance on locating the TMGB.

The TMGB shall be as close as practical to the panelboard (electrical power panel) and shall be installed to maintain clearances required by applicable electrical codes. A practical location for the TMGB is to the side of the panelboard (where provided). The vertical location of the TMGB should be determined by considering whether the bonding conductors are routed in an access floor or overhead cable support. Its placement should provide for the shortest and straightest practical routing of the bonding conductor for telecommunications (BCT) and the primary protector grounding conductor (see annex C for more information on telecommunications electrical protection – primary protector grounding). Additionally, the TMGB shall be insulated from its support using an insulator that is Listed for the purpose by a nationally recognized testing laboratory (NRTL). A minimum of 50.8 mm (2 in) separation from the wall is recommended to allow access to the rear of the busbar.

When a panelboard for telecommunications equipment is not installed in the TEF, the TMGB should be located near the backbone cabling and associated terminations. In addition, the TMGB should be located so that the BCT is as short and straight as practical.

The TMGB should serve telecommunications equipment that is located within the same room or space. The TMGB is intended to be the location for connecting grounding busbars incorporated in telecommunications equipment located in the TEF. Extensions of the TMGB (i.e., other telecommunications busbars in other telecommunications spaces) shall be TGBs.

7.2.2 Bonds to the TMGB

When a panelboard is located in the same room or space as the TMGB that panelboard's alternating current equipment ground (ACEG) bus (when equipped) or the panelboard enclosure shall be bonded to the TMGB.

The primary protector grounding conductor shall be connected to the TMGB. This conductor is intended to conduct lightning and ac fault currents from the telecommunication primary protectors. A minimum of 0.3 m (1 ft) separation shall be maintained between this conductor and any dc power cables, switchboard cable, or high frequency cables, even when placed in metal conduit.

When the outside plant cables in the TEF incorporate a cable shield isolation gap, the cable shield on the building side of the gap shall be bonded to the TMGB.

All metallic raceways for telecommunications cabling located within the same room or space as the TMGB shall be bonded to the TMGB. However for metallic pathways containing grounding conductors where the pathway is bonded to the grounding conductor, no additional bond to the TMGB is required.

7.2.3 Connections to the TMGB

The connections of the BCT and the telecommunications bonding backbone (TBB) to the TMGB shall utilize exothermic welding, Listed compression two-hole lugs, or two-hole exothermic lugs.

The connection of conductors for bonding telecommunications equipment and telecommunications pathways to the TMGB shall utilize exothermic welding, Listed compression two-hole lugs, or two-hole exothermic lugs.

7.3 Telecommunications grounding busbar (TGB)

7.3.1 General

The length of the TGB is not specified within this Standard. It is desirable that the busbar be electrotin-plated for reduced contact resistance. The busbar shall be cleaned and an anti-oxidant should be applied prior to fastening connectors to the busbar.

The TGB shall be as close as practical to the panelboard and shall be installed to maintain clearances required by applicable electrical codes. A practical location for the TGB is to the side of the panelboard (where provided). The vertical location of the TGB should be determined by considering whether the bonding conductors are routed in an access floor or overhead cable support. Additionally, the TGB shall be insulated from its support using an insulator that is Listed for the purpose by a NRTL. A minimum of 50.8 mm (2 in) separation from the wall is recommended to allow access to the rear of the busbar.

When a panelboard for telecommunications equipment is not installed in the same room or space as the TGB, that TGB should be located near the backbone cabling and associated terminations.

The bonding conductor between a TBB and a TGB shall be continuous and routed in the shortest practical straight-line path.

Multiple TGBs may be installed within the same Distributor to aid in minimizing bonding conductor lengths and minimizing terminating space.

7.3.2 Bonds to the TGB

Where a panelboard is located in the same room or space as the TGB that panelboard's ACEG bus (when equipped) or the panelboard enclosure shall be bonded to the TGB.

When a panelboard for telecommunications equipment is not in the same room or space as the TGB, that TGB should be bonded to the panelboard that feeds the distributor.

The TBBs and other TGBs within the same space shall be bonded to the TGB with a conductor the same size as the TBB. In all cases, multiple TGBs within a room shall be bonded together with a conductor the same size as the TBB or with splice bars.

Where a grounding equalizer (GE) is required, it shall be bonded to the TGB.

All metallic pathways for telecommunications cabling located within the same room or space as the TGB shall be bonded to the TGB. However, for metallic pathways containing grounding conductors where the pathway is bonded to the grounding conductor, no additional bond to the TGB is required.

7.3.3 Connections to the TGB

The connection of the TBB to the TGB shall utilize exothermic welding, Listed compression two-hole lugs, or two-hole exothermic lugs.

The connection of conductors for bonding telecommunications equipment and telecommunications pathways to the TGB shall utilize exothermic welding, Listed compression two-hole lugs, or two-hole exothermic lugs.

7.4 Conductors

7.4.1 General

Bonding and grounding conductors for telecommunications should not be placed in ferrous metallic conduit. If it is necessary to place bonding and grounding conductors in ferrous metallic conduit the conductors shall be bonded to each end of the conduit using a grounding bushing or using a minimum sized conductor of No. 6 AWG at both ends of the conduit.

7.4.2 Bonding conductor for telecommunications (BCT)

The BCT shall bond the TMGB to the service equipment (power) ground. Figure 8 schematically depicts this connection to the service equipment (power) ground.

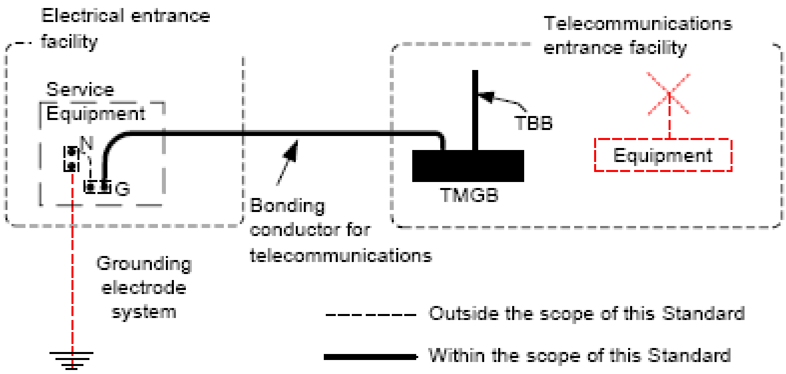

Figure 8 – Bonding to the service equipment (power) ground

7.4.3 Telecommunications bonding backbone (TBB)

The type of building construction, building size, general telecommunications requirements, and the configuration of the telecommunications pathways and spaces should be considered when designing the TBB. Specifically, the design of a TBB shall:

a) be connected to the TMGB;
b) be consistent with the design of the telecommunications backbone cabling system (e.g., follow the backbone pathways);
c) permit multiple TBBs as necessary (e.g., multiple distributors per floor; see figure 2); and,
d) minimize, to the extent practical, the lengths of the TBB(s).

TBB conductors shall be protected from physical and mechanical damage. The TBB conductors should be installed without splices, however, where splices are necessary, there should be a minimum number of splices, they shall be accessible and be located in telecommunications spaces. Joined segments of a TBB shall be joined by means of an exothermic weld, Listed irreversible compression-type connectors, or equivalent. All joints shall be adequately supported and protected from damage.

Metallic cable shield(s) shall not be used as a TBB nor shall water piping systems be used as a TBB.

7.4.4 Grounding equalizer (GE)

Whenever two or more TBBs are used within a multistory building, the TBBs shall be bonded together with a GE at the top floor and at a minimum of every third floor in between to the lowest floor level (see figure 2).

7.4.5 Coupled bonding conductor (CBC)

CBCs provide protection against electromagnetic interference (EMI) through close proximity and may be integral to the cabling system. The CBC:

a) may be part of a cable's shield;
b) may be separate conductors that are tie wrapped to communication cables; and,
c) are typically sized at No. 10 AWG, although No. 6 AWG is recommended.

7.4.6 Bonding conductors for connections to the mesh-BN or RGB

Bonding conductors used to bond components to the mesh-BN or RGB shall:

a) be stranded copper conductors;
b) be neatly routed and no longer than practical to bond the component to the mesh-BN or RGB;
c) be secured at no greater than 0.9 m (3 ft) intervals;
d) not be routed where it creates a tripping hazard, impairs access to equipment, nor attached with staples or other method that could damage the conductors;
e) be Listed as suitable for grounding applications;
f) be available for use in the space in which they will be placed;

g) have a green jacket or green jacket with yellow stripe, or where bare conductors are deployed, they must be supported by standoff insulators at intervals no greater than 0.61 m (2 ft) or be contained in electrical nonmetallic tubing (ENT). Bare bonding conductors shall not be in contact with metallic surfaces or other conductors that are not part of the telecommunications grounding system;
h) be installed using low-emission exothermic welds, where exothermic welds are specified and within a room with electronics; and,
i) where placed in ferrous metallic conduit that is greater than 0.9 m (3 ft), be bonded to each end of the conduit using a grounding bushing or with a minimum sized conductor of No. 6 AWG.

7.4.7 Telecommunications equipment bonding conductor (TEBC)

7.4.7.1 General

The TEBC connects the TMGB/TGB to equipment racks/cabinets. More than one TEBC may be installed from the TMGB/TBG (e.g., a separate TEBC per rack). The TEBC shall be a continuous copper conductor that is sized not less than a No. 6 AWG or as the largest size equipment grounding conductor in the ac branch power circuit(s) serving the racks/cabinet lineup.

NOTE – Cable shields do not satisfy the requirements for a TEBC.

Connections to the TEBC shall be made with Listed irreversible compression connectors and with the rack bonding conductors (RBCs) routed toward the TMGB/TGB, see figure 9.

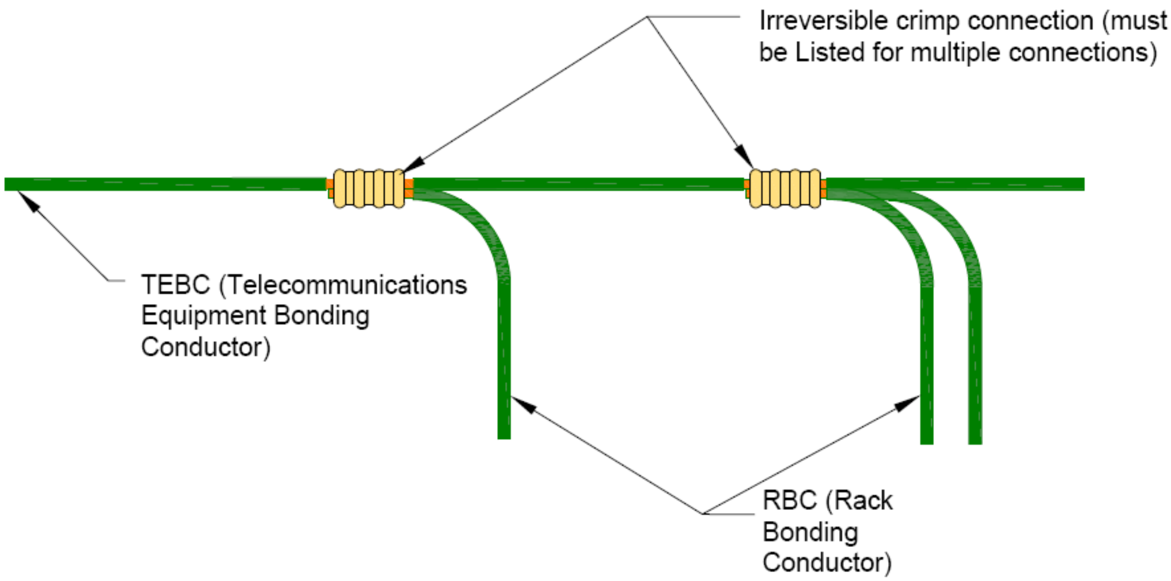

Figure 9 – Example TEBC to rack bonding conductor connection

The TEBCs may be routed within cable trays, on the outside of ladder rack, tray supported at no greater than 0.9 m (3 ft) intervals, or along equipment platforms, see figure 10. Examples of acceptable means of supporting the TEBCs include the use of lay-in lugs, cable brackets, and other brackets designed for this purpose.

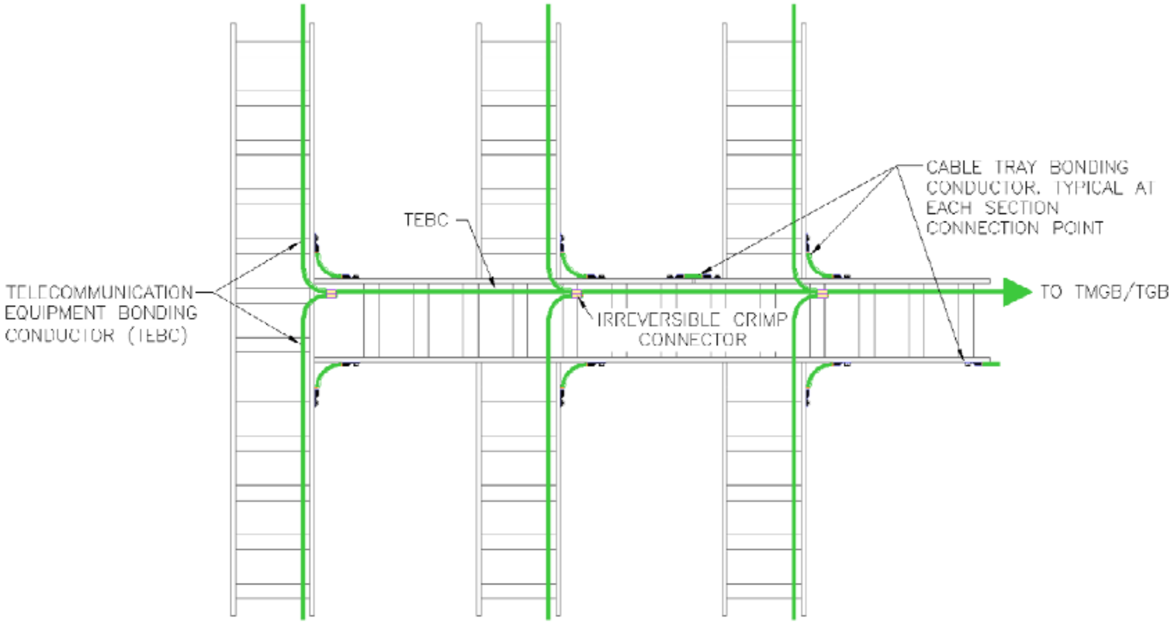

Figure 10 – Example of a TEBC routed on cable tray

An alternative method to running TEBCs overhead is to route them under an access floor. All requirements set forth for running the bonding conductors specified in this Standard shall apply.

7.4.7.2 Separation

TEBCs shall be separated a minimum of 50.8 mm (2 in) from conductors of other cable groups such as power or telecommunications cables. For example, TEBC's may be suspended 50.8 mm (2 in) under or off the side of a cable tray. An exception may be when conductors are grouped together to enter or exit a cabinet or enclosure. Grouping only at this point is acceptable, provided the conductors are suitably separated on either side of the opening.

TEBCs shall be separated from ferrous material by a distance of at least 50.8 mm (2 in) where achievable, or be effectively bonded to the ferrous material.

7.5 Bonding equipment cabinets/equipment racks to the TEBC

The TEBC shall be connected to the cabinets/equipment racks, to a RBC or to a vertical/horizontal RGB. Each cabinet or equipment rack shall have a suitable connection point to which the bonding conductor can be terminated. Properly sized Listed two-hole compression lugs or ground terminal blocks with internal hex screw or equivalent torque characteristics shall be used at this connection point, see figure 11.

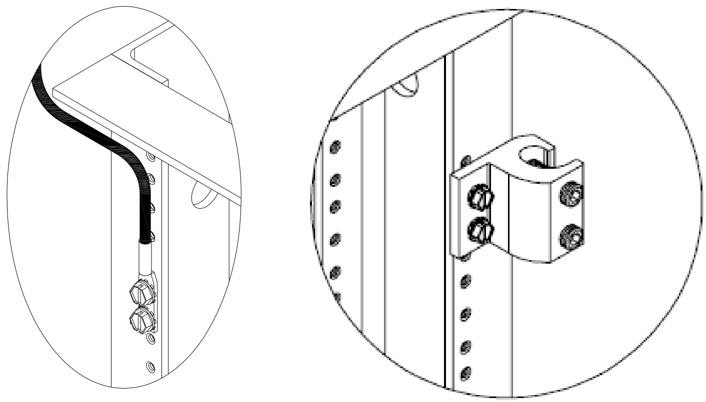

Figure 11 – Illustration of connection point to a rack from a TEBC

7.6 Structural bonding of equipment cabinets/equipment racks

For a welded cabinet/equipment rack, the welded construction serves as the method of bonding the structural members of the cabinet/rack together.

For a bolted cabinet/equipment rack, ground continuity cannot be assumed through the use of normal frame bolts used to build or stabilize equipment cabinets and racks. Bonding hardware, such as bolts, washers, nuts and screws, specifically designed to accomplish integral bonding of the cabinet and rack assembly, frame and support, and tested to meet applicable NRTL requirements are an acceptable bonding means. However, if bolts, nuts and screws for cabinet and rack assembly and support are not specifically designed for grounding purposes, the paint shall be removed from all bonding contact areas. In any case, removal of the paint from all bonding contact areas is recommended.

All detachable, metallic parts of equipment cabinets (e.g. frame, door, side panel, top panel) shall be connected to ground, either directly by means of grounding/bonding jumpers or through the cabinet frame, to the connection point on the cabinet where the cabinet bonding conductor connects to the cabinet.

When a detachable, metallic part of an equipment cabinet is connected to ground by a grounding bonding jumper, the jumper shall be a minimum sized conductor of No. 12 AWG stranded, high strand count, insulated copper conductor with green or green with yellow stripe jacket. Also, the grounding/bonding jumper should have an easily visible quick connect to facilitate detaching and attaching the panel or door, see figure 12.

Figure 12 – Illustration of a bond connection from a cabinet to the cabinet door

7.7 Supplementary bonding networks

The supplementary bonding network is in addition to the infrastructure bonding network specified in clause 6. The supplementary bonding network provides for a greater degree of equipotential bonding to that provided by the required grounding/bonding conductors. Supplementary bonding networks are always grounded to the CBN within the building. Equipotential bonding may help mitigate issues caused by steady-state and transient voltages and currents generated by lightning, power systems, power circuit ground faults and EMI.

Supplementary bonding networks are described in detail in ITU-T K.27, ANSI/ATIS0600333 and ANSI/IEEE 1100 and identified for ITE as the following primary topologies:

- mesh-BN – Generally, the default topology as most ITE has intra/inter intentional and unintentional metallic interconnections. A mesh-BN augments the CBN by increasing the local density of conductors and functions by attempting to diversify and limit the radio frequency (RF) capture-loop area of the current paths such that the current density on any conductor or conductive loop is reduced to an acceptable level.

  NOTE – ANSI/IEEE 1100 uses the terms “mesh common bonding network” (M-CBN) “signal reference grid” (SRG) and “mesh-BN” as somewhat interchangeable, depending on application and context. However, within this Standard, the term mesh-BN is used.

- mesh-isolated bonding network (IBN) – Generally can be described as a mesh-BN functional system block that is arranged into a single point bonding and grounding entity that is isolated from the CBN except for at one controlled location – a single point connection (SPC) window . The IBN topology is known to provide high robustness to building lightning and power fault currents. The star topology is amenable to “current mapping” for troubleshooting within the IBN. The IBN topology functions by attempting to block extraneous currents (such as lightning) from flowing within the CBN and then entering and traversing through the IBN. This topology is especially robust to transients occurring in the CBN.

- Star IBN – An IBN deployed into a star network instead of a mesh network.

  NOTE – Earthing networks are described in a draft of EN 50310 – 2009 and include CBN, Mesh-BN, Mesh-IBN, Local Mesh, Star and Ring.

7.7.1 Mesh-BN

A mesh-BN is a bonding network to which all associated equipment cabinets, frames and racks and cabling pathways are bonded together as well as at multiple points to the CBN (see figure 13).

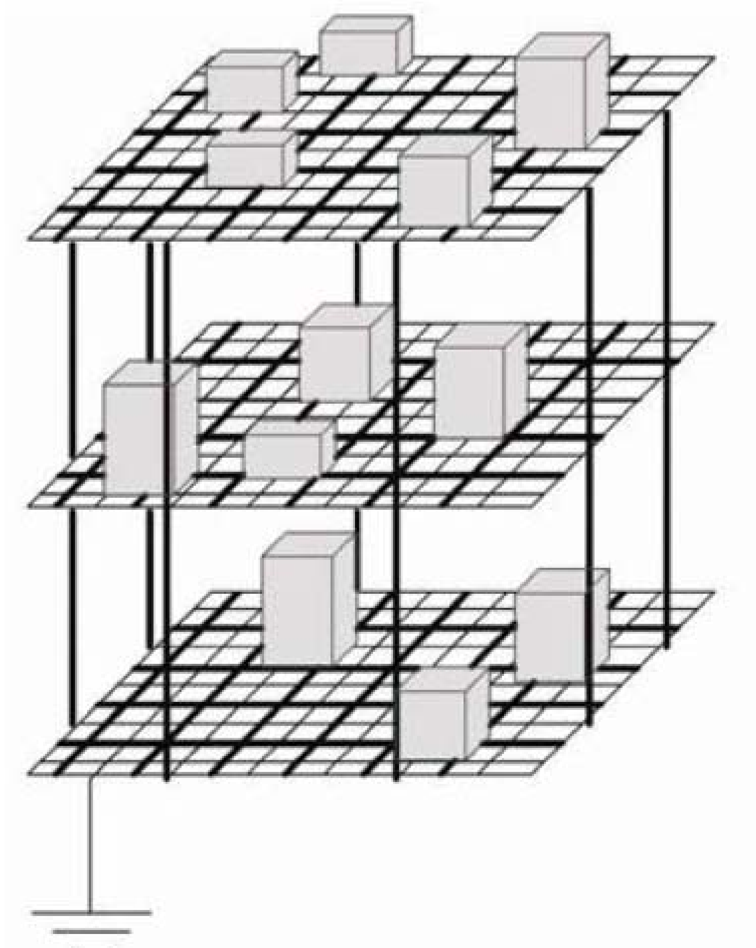

Figure 13 – A mesh-BN with equipment cabinets, frames, racks and CBN bonded together

If the mesh-BN is constructed from flat conductors, the mesh-BN should be prefabricated of minimum 0.4 mm (0.0159 in; 26 gauge) x 50.8 mm (2 in) wide copper strips with all crossings and joined sections properly welded.

Where the mesh-BN is constructed from standard, bare round wire, the conductors shall be a minimum sized conductor of No. 6 AWG stranded copper conductors joined together via proper welding, brazing, listed compression connectors, or listed grounding clamps at each of the crossing points.

If the mesh-BN is constructed using the access-floor pedestals, the flooring system must be electrically continuous and must be bonded together every 4 to 6 pedestals in each direction using a minimum sized conductor of No. 6 AWG stranded copper conductors and listed pedestal grounding clamps.

The mesh-BN shall have the following connections:

a) No. 1/0 AWG or larger bonding conductor to the TMGB or TGB in the computer room:
b) No. 6 AWG or larger bonding conductor to each ITE cabinet and rack – cabinets and racks shall not be bonded serially;

c) A bonding conductor to the ground bus for each power distribution unit (PDU) or panel board serving the room, sized per NEC 250.122 and per manufacturers' recommendations;
d) No. 6 AWG or larger bonding conductor to heating, ventilating, and air-conditioning (HVAC) equipment – HVAC equipment shall not be bonded to the bonding mat/grid serially, each must have its own connection to the mesh-BN;
e) No. 4 AWG or larger bonding conductor to each building steel column in the computer room;
f) No. 6 AWG or larger bonding conductor to each metallic cable tray and cable runway in the room – they may be bonded in series;
g) No. 6 AWG or larger bonding conductor to each metallic conduit, water pipe, metallic air duct in the room – they may be bonded in series;
h) No. 6 AWG or larger bonding conductor to every 4 to 6 access floor pedestal in each direction.

7.7.2 Mesh-IBN

A mesh-IBN is a mesh-topology bonding network that has a SPC to either the CBN or another IBN (see figure 14). The mesh-IBN is typically limited to a restricted area within a building such as in a computer room. The mesh-IBN is not typical (but can be utilized) for a commercial environment or computer room but is recognized and sometimes utilized in the access provider central office and computer room. The primary benefit of the IBN is the blocking of building currents, such as lightning and power faults, from entering into the IBN.

NOTE – Other topological versions of IBNs (such as "star" and "sparse-mesh") are described in ITU-T K.27 and ANSI/IEEE 1100.

The mesh-IBN components such as associated equipment cabinets, frames, racks and cabling pathways are insulated from the CBN except for one controlled SPC location (window) to the CBN. The SPC location applies to all grounding conductors (including power circuits) entering or exiting the mesh-IBN. Due to insulation from the CBN, except at the controlled SPC, the mesh-IBN is said to be "insulated or isolated" from the CBN.

For a mesh-IBN, an under-access-floor, the SBG is typically only directly connected to the serving TMGB or TGB in order to not violate the insulation requirements for the mesh-IBN. An above cabinet/rack SBG can be more easily incorporated where desirable into the mesh-IBN by means of insulating devices between the bonding grid and any nearby CBN components.

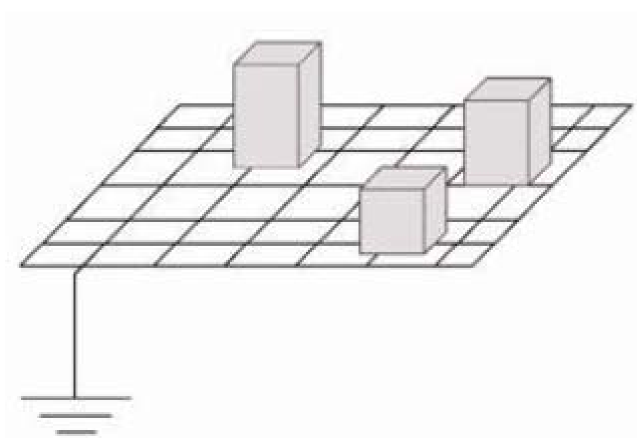

Figure 14 – A mesh-IBN having a single point of connection

7.7.3 Bonding conductor for connections to the supplementary bonding network

Bonding conductors used to bond components to the supplementary bonding network shall:

a) Be stranded copper conductors;
b) Be neatly routed in a straight a line as practical and be no longer than required to bond the component to the supplementary bonding network;
c) Be secured at no greater than 0.9 m (3 ft) intervals;

d) Not be routed where it creates a tripping hazard, impairs access to equipment, nor attached with staples or other methods that could damage the conductors;
e) Be Listed as suitable for bonding/grounding applications;
f) As available for use in space in which they will be placed, have a green jacket or green jacket with yellow stripe, or where bare conductors are deployed, they must be supported by standoff insulators at intervals no greater than 0.61 m (2 ft) or be contained in electrical non-metallic tubing (ENT). Bare bonding conductors shall not be in contact with metallic surfaces that are not part of the telecommunications grounding system;
g) Be installed using low-emission exothermic welds, where exothermic welds are specified and within a room with electronics; and,
h) Where placed in ferrous metallic conduit that is greater than 0.9 m (3 ft), be bonded to each end of the conduit using a grounding bushing or with a minimum No. 6 AWG conductor.

7.8 Administration

Each telecommunications bonding and grounding conductor shall be labeled at its points of termination. Labels shall be located on conductors as close as practical to their points of termination in a readable position. Refer to ANSI/TIA/EIA-606-A for additional labeling requirements.

8 PERFORMANCE AND TEST REQUIREMENTS

8.1 Two-point ground/continuity testing

This procedure will help determine if there is an acceptable maximum level of resistance between any point in the telecommunications bonding and grounding system and the building's electrical grounding electrode system. The test is performed using an earth ground resistance tester that is configured for a continuity test, otherwise known as a two-point test or a "dead earth" test.

The earth ground resistance tester generates a specific alternating current (ac) test current; this current is less susceptible to the influences of stray currents in the grounding system. This makes the ground resistance test a more accurate testing device than a standard volt-ohm-milliammeter.

Prior to two-point ground testing, a visual inspection shall be performed to verify that the bonding and grounding system is installed according to the guidelines in this Standard. Due to the possibilities of ground faults traveling through the telecommunications bonding and grounding system, a voltage test should be performed prior to conducting the two-point continuity test and verified with the test equipment manufacturer's instructions. Consult with other contractors to ensure other electrical work does not interfere with this test.

The test is typically performed by connecting one meter lead to the nearest building's electrical grounding electrode and a specific point on the telecommunications bonding and grounding system such as the TMGB. This same test can also verify continuity between any two points of the telecommunications bonding and grounding system such as between the TMGB and a TGB.

It is recommended that this test be performed in the following areas:

a) TMGB/TGB to the electrical ground in Distributors
b) TMGB/TGB to the building steel (if present)
c) TMGB to TGB
d) Building steel (if present) to the electrical ground.

In order for this test to be valid it must be done before the telecommunications equipment is installed otherwise parallel paths may invalidate test results.

The recommended maximum value for resistance between any point in the telecommunications bonding and grounding system and the building's electrical grounding electrode system is 100 milliohms. In the case of long TBB and GE conductor runs, the resistance of the conductor must be factored into the total resistance. For example 1 km of a No. 3/0 conductor has a resistance of 0.2028 ohms. (0.06180 ohms per 1000 ft).

ANNEX A (INFORMATIVE) GROUNDING ELECTRODES

A.1 General

Grounding electrodes connect electrical systems and equipment to earth. Grounding electrodes may be ground rods, metal plates, concrete encased electrodes, ground rings, electrolytic ground rods, the metal frame of the building or structure, and metal underground water pipes. Metallic underground gas piping is not used as a grounding electrode, but is bonded upstream from the equipment shutoff valve to the grounding electrode (see ANSI/NFPA-70 [*NEC*®] and ANSI/NFPA-780).

A.2 Ground rods

Ground rods should be constructed from copper clad steel, solid copper, hot-dipped galvanized steel or stainless steel and be Listed by a nationally recognized testing laboratory (NRTL). The rods should be a minimum of 2.4 m (8 ft) in length and 12.7 mm (0.5 in) in diameter. For areas highly prone to lightning, a minimum rod length of 3 m (10 ft) should be used. Ground rods should not have a non-conductive coating. Typical ground rods are illustrated in figure 15.

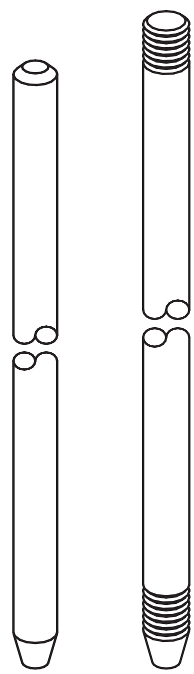

Figure 15 – Illustrative views of typical ground rods

A.3 Electrolytic ground rods

Electrolytic ground rods are Listed products that are available in vertical and horizontal configurations (see figure 16) and in various lengths, typically 3 m (10 ft) to 6.1 m (20 ft) but may be longer. Electrolytic ground rods are constructed of 54 mm (2.125 in) diameter hollow (tube) copper or stainless steel. This tube is filled with a mixture of hygroscopic electrolytic salts; typically 60-percent sodium chloride and 40-percent calcium chloride. Electrolytic grounds rods help lower soil resistance by absorbing moisture out of the air and forming an electrolytic solution within the tube, then leaching out the rod into the surrounding soil. Additionally, the rod is encased in a conductive non-corrosive carbon based backfill material.

Electrolytic ground rods should be considered for use where standard ground rods do not produce an acceptable grounding electrode system resistance; typically 5 ohms in telecommunications applications. Unacceptable grounding electrode system resistance may be found at sites where there is high soil resistivity, (i.e., above 25,000 ohms-cm), areas with limited space or areas where the grounding electrode system is covered by non-porous materials such as concrete or asphalt. In all cases, manufacturer recommendations should be followed when installing electrolytic ground rods.

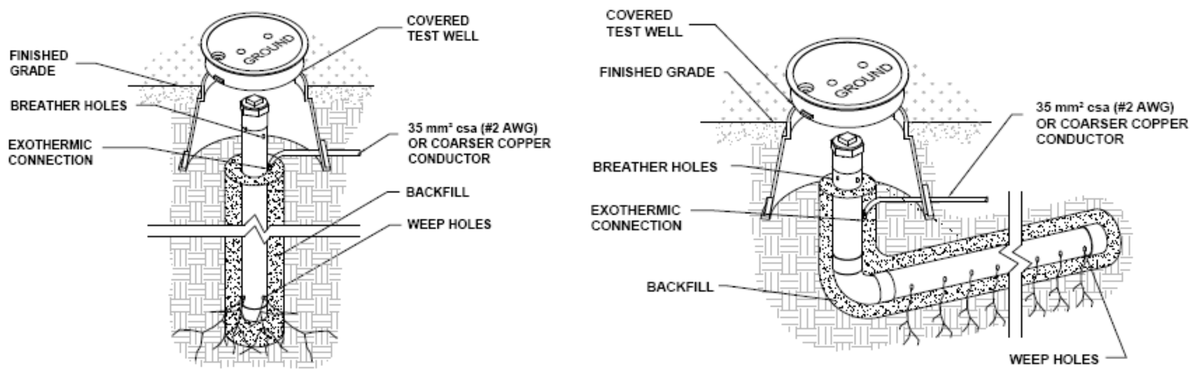

Figure 16 – Illustrations of a vertical and horizontal electrolytic ground rod

A.4 Ground plate electrodes

Ground plate electrodes are Listed products that are constructed from copper having a minimum thickness of 1.5 mm (0.06 in) or from steel having a minimum thickness of 6.35 mm (0.25 in).

The ground plate electrode should be installed 0.76 m (2.5 ft) below grade and below permanent moisture level if practical. If soil conditions do not allow the ground plate electrode to be buried at this depth, they should be buried as deep as practical.

Ground plate electrodes should only be used if soil conditions prohibit the use of standard ground rods, or is specifically engineered into the grounding electrode system.

A.5 Wire mesh

Wire mesh is a Listed product typically fabricated from solid copper or copper clad steel wire, ranging from No. 6 AWG to No. 12 AWG. The wires are brazed together in a grid form with spacing between conductors ranging from 50.8 mm (2 in) through 1.22 m (4 ft). All joints should be silver brazed or equivalent.

Wire mesh should be used where ground rod electrodes cannot be driven or are ineffective because of soil conditions or where it is desirable to establish a superior ground plane.

A.6 Concrete encased electrode

A concrete encased electrode is an electrode encased by at least 50.8 mm (2 in) of concrete and located horizontally or vertically near the bottom of a concrete foundation or footing that is in direct contact with the earth. It consists of at least 6.1 m (20 ft) of one or more bare or zinc galvanized or other electrically conductive coated steel reinforcing bars or rods of not less than 12.7 mm (0.5 in) diameter or of at least 6.1 m (20 ft) of bare copper conductor not smaller than No. 4 AWG. (See figure 17). See ANSI/NFPA-70 (*NEC*®) Article 250.

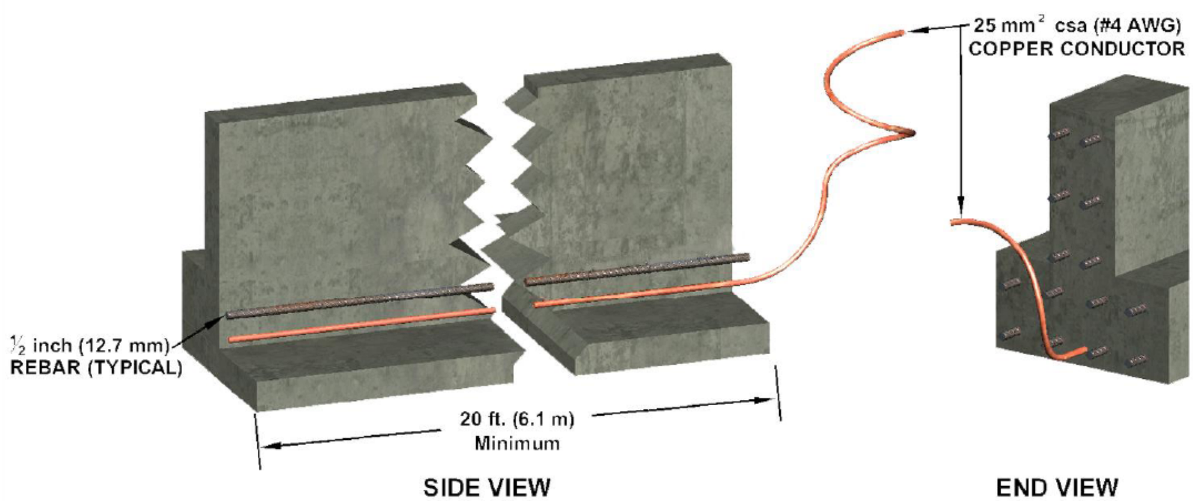

Figure 17 – Illustrative view of a concrete-encased electrode

A.7 Ground ring electrodes

Ground ring electrodes encircle the building or structure and are in direct contact with the earth. They should be installed to a depth of 0.76 m (2.5 ft) below grade or below the frost line, whichever is deeper. The ground ring conductor should be No. 2 AWG or larger bare, solid, tinned or un-tinned copper conductor (see ATIS-0600313 and ANSI/ATIS-0600334). For areas with high lightning events, larger conductors such as No. 1/0 AWG or larger should be considered (see MIL-HDBK-419A). Stranded conductors should be used with these larger sizes; tinned conductors are recommended. Ground rings encircling a building should be installed just beyond the drip line of the roof.

Ground ring electrodes may also incorporate the use of driven ground rods. When used, driven ground rods should have a minimum separation of at least one ground rod length not to exceed two ground rod lengths along the ground ring.

A.8 Ground radial electrodes

Radial grounding conductors should be a bare solid tinned or un-tinned copper No. 2 AWG conductor or bare tinned or un-tinned copper conductor not smaller than No. 1/0 AWG. There should be a minimum of three conductors of different lengths; equally spaced from one another as much as practical. The minimum length of each radial should be 7.6 m (25 ft) and a maximum of 24.4 m (80 ft). Radial grounding conductors should be installed in direct contact with the earth and should be installed to a depth of 0.76 m (2.5 ft) below grade or below the frost line, whichever is deeper.

Radial grounding conductors may also incorporate the use of driven ground rods. When used, driven ground rods should have a minimum separation of at least one ground rod length not to exceed two ground rod lengths along the ground ring.

Radial grounding conductors should be installed horizontally in the ground and radiate away from the building or structure (see figure 18).

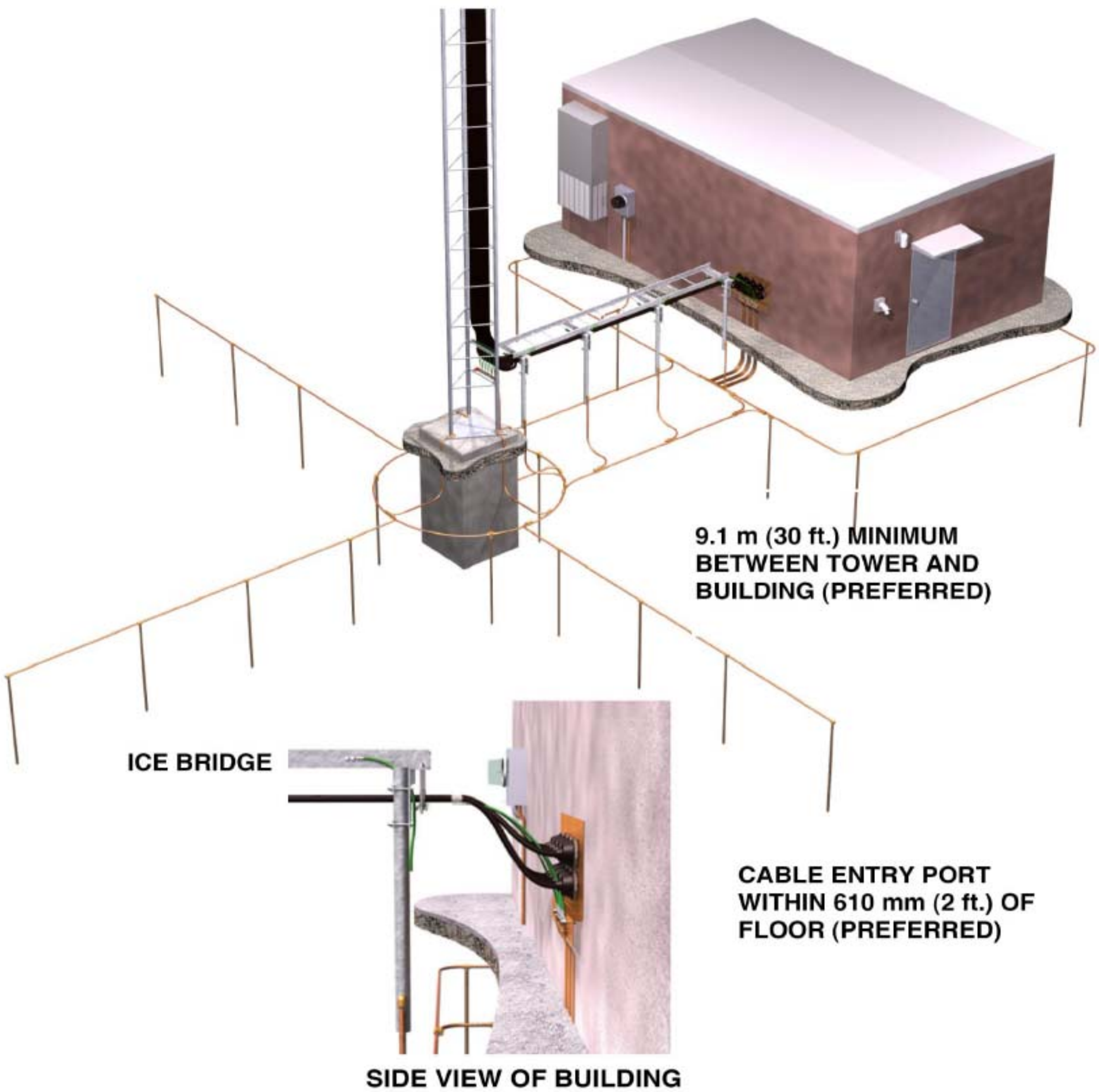

Figure 18 – Illustrative view of a ground radial electrode

A.9 Enhanced grounding materials

Enhanced grounding materials are high conductivity materials, which lower ground system resistance in high resistance soil conditions. These materials should be manufactured from a high quality relatively sulfur-free carbon source. Many lower grade carbons contain sulfur which is very corrosive especially when encased in concrete. Enhanced grounding materials should be environmentally safe and approved by the authority having jurisdiction (AHJ).

Enhanced grounding materials should be considered for use around ground rod electrodes and grounding electrode rings in high soil resistance conditions (see figure 19).

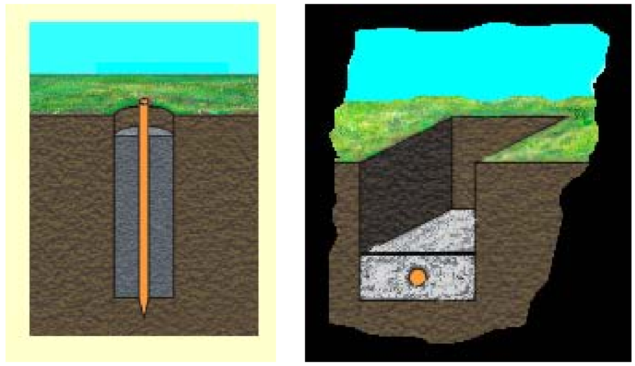

Figure 19 – Illustrative example of ground enhancement materials surrounding a grounding conductor and a ground rods

A.10 Grounding conductors

Grounding conductors are used to connect equipment or the grounded circuit of a wiring system to a grounding electrode of a grounding electrode system. These conductors should connect grounding electrodes together, form buried ground rings and connect objects to the grounding electrode system. Grounding conductors may be solid, stranded, tinned, or un-tinned and may be bare or insulated. Above ground conductors should be jacketed with green or green with yellow striping insulation.

Unless otherwise stated, all below-ground ground electrode conductors should be a bare solid copper conductor not smaller than No. 2 AWG. Bare stranded copper conductor not smaller than No. 1/0 AWG, tinned conductors is recommended. See ATIS-0600313, ANSI/ATIS-0600334 and MIL-HDBK-419A for reference.

When installing grounding electrode conductors, they should be installed in one continuous length without splices unless using exothermic connections or Listed irreversible compression-type connectors. The conductor runs should be as short and straight as practical. Bends in the conductor should be made toward the ground location and do not have a radius bend less than 203 mm (8 in) (see figure 20).

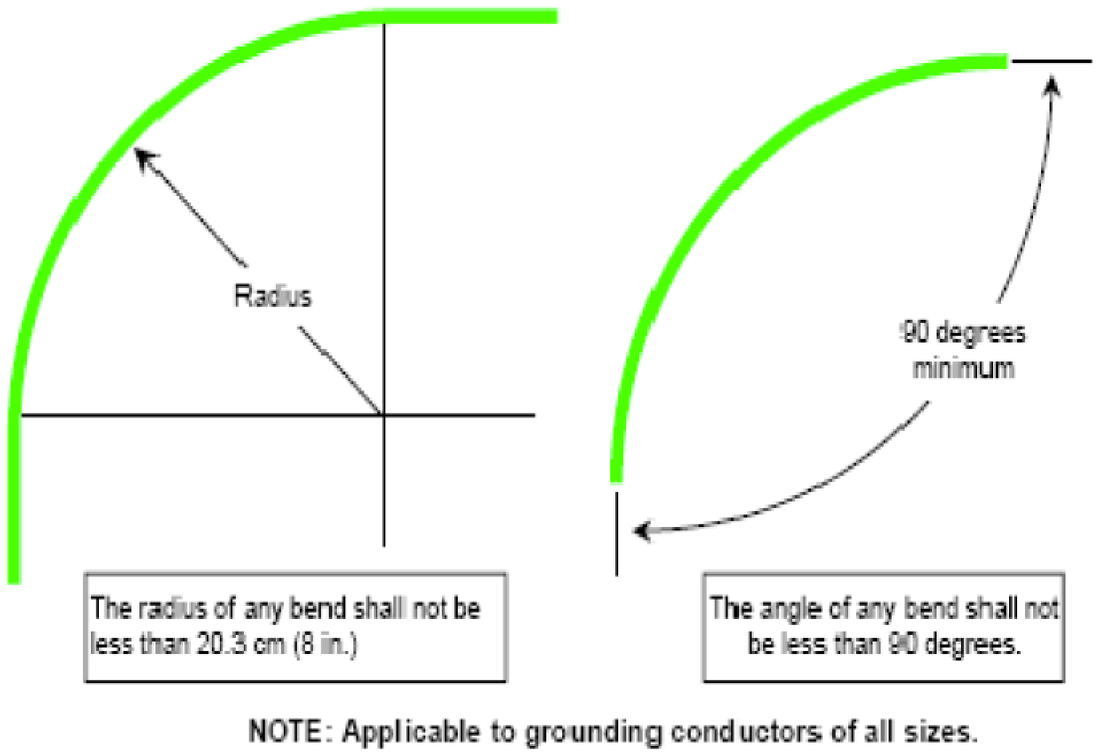

Figure 20 – Radius bend illustration

ANNEX B (INFORMATIVE) TOWERS AND ANTENNAS

B.1 General

This clause describes specific electrical protection considerations for antenna support structures (towers).

B.2 Grounding electrode system

B.2.1 External grounding

Figure 21 illustrates an example view of a tower and antenna site grounding electrode system.

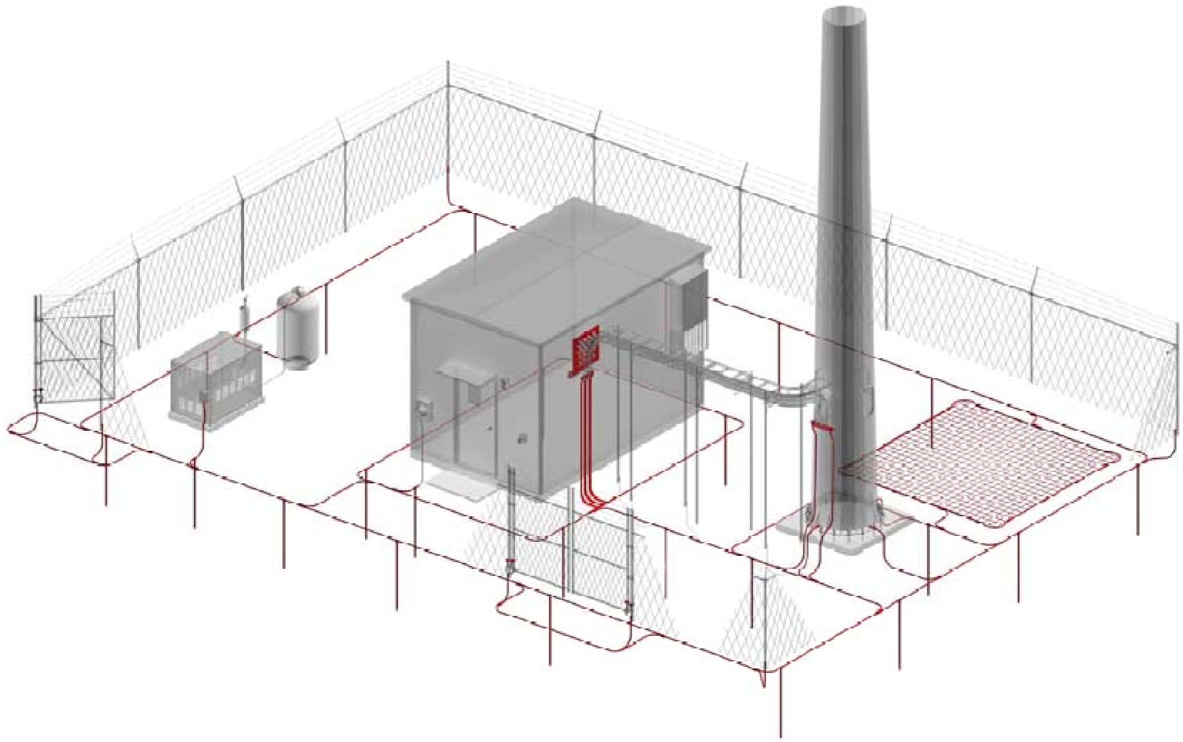

Figure 21 – Illustrative example view of a site grounding electrode system

B.2.2 Grounding busbars

The purpose of a grounding busbar is to provide convenient grounding points for various elements of a telecommunications system and ancillary support apparatus. There are several types of grounding busbars:

a) External grounding busbar
The purpose of the external grounding busbar is to provide convenient ground termination points for the sheath (shield) of antenna transmission lines and other telecommunications cables prior to their entry into a building or shelter.

b) Internal grounding busbar
The purpose of the internal grounding busbar is to provide convenient termination points all metallic items within a building or shelter in an effort to provide potential equalization.

c) Tower grounding busbar
The purpose of the tower grounding busbar is to provide a convenient termination point on the tower for multiple transmission lines with metallic sheaths (i.e. coaxial cable) grounding conductors.

Grounding busbars are sized to meet immediate application requirements while taking into consideration future growth.

The external grounding busbar is installed at the point where the antenna transmission lines and other telecommunications cables enter the building or shelter. It is connected directly to the grounding electrode system using a run of No. 2 AWG or larger bare, solid or stranded, tinned or un-tinned copper conductor. This conductor is installed in a direct manner with no sharp bends or narrow loops. Larger conductor sizes such as No. 4/0 AWG are recommended in high lightning prone areas. Connection of the grounding electrode conductor to the external grounding busbar is by an exothermic process or Listed irreversible compression connections.

The tower grounding busbar is installed below the transmission line ground kits, near the area of the tower at the point where the antenna transmission lines extend from the tower to the building or shelter. It is connected to the tower grounding electrode system with a No. 2 AWG or larger bare, solid tinned copper conductor. For reduced impedance to earth, the tower grounding busbar is directly bonded to the tower, thereby utilizing the tower as a down conductor. Care is also taken to select the proper materials so as to prevent a dissimilar metal reaction. To maintain equal potential between the transmission lines and the tower, busbars are installed at the top and bottom of the tower, providing termination points for bonding the transmission lines cable shields to the tower. If the tower is greater than 60.1 m (200 ft) in height, busbars are installed every 15.2 m (50 ft), they are bonded to the tower and to the transmission line cable shields.

B.2.3 Bonding connections

Bonding connections are made by means of exothermic welding or Listed irreversible compression connectors or mechanical connectors.

Exothermic welding is a method of making permanent welded electrical connections without external power, such as electricity or gas. It is an exothermic chemical reaction (exothermic means to release heat). The temperature of the molten metal created during the reaction is sufficient to fuse the metal of the conductors, resulting in a welded molecular bond. Exothermic welding can be used to produce welded connections of copper to copper and copper to steel. The advantage of exothermic connections over compression and mechanical connections is that exothermic connections produce a molecular bond with all the strands of the conductors, while compression or mechanical connectors do not. All underground connections are made following manufacturer recommendations with the exothermic welding process that use the proper mold and weld metal materials.

A Listed irreversible compression connection is made by using specific fittings and a high tonnage compression tool. These connections are considered maintenance free; however they are not when used underground. When making a Listed irreversible compression connection, all surfaces must be properly cleaned and the components properly sized for the conductors being bonded.

Mechanical connections are only to be used above ground and in areas where it is impractical to use either an exothermic or irreversible high compression connection. When making a mechanical connection, all surfaces must be properly cleaned and the components tighten to the correct torque rating of the hardware. Additionally, the correct material is used so as not to form a galvanic couple.

B.2.4 Grounding systems

B.2.4.1 Type 1 sites

Type 1 sites are considered non-critical to the operation of the telecommunications system.

> NOTE – The owner of the telecommunications equipment or the authority having jurisdiction (AHJ) determines whether or not the system is a Type 1 or Type 2 system.

Type 1 sites may not have a tower on the site, may be located in a commercial office or residence, and may not be part of a larger system. Type 1 sites should have a grounding system resistance of 25 ohms or less, (*NEC*®; Article 250). If 25 ohms or less cannot be achieved with one grounding electrode, another ground electrode should be installed no closer than 1.8 m (6 ft) (see figure 22). It is recommended to install at least two grounding electrodes even if the 25 ohms objective is achieved with one. In the case of new construction the rebar in the foundation should be bonded to the grounding electrode system.

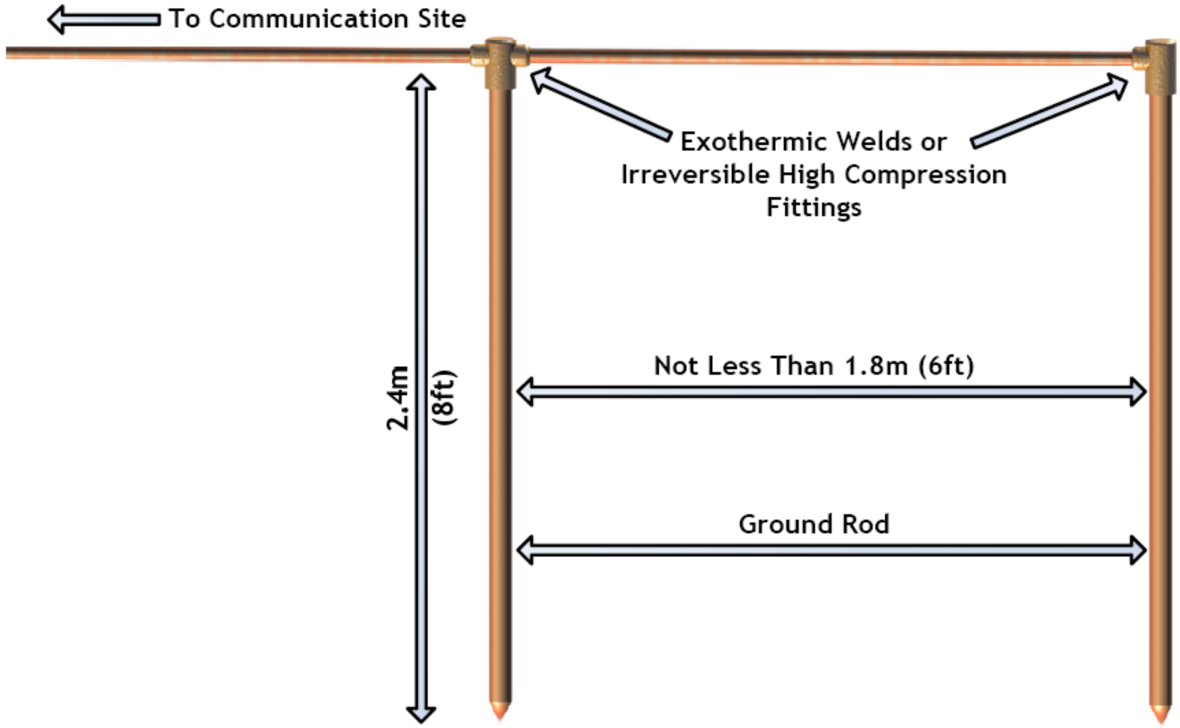

Figure 22 – Illustration of a parallel ground rod installation

B.2.4.2 Type 2 sites

Type 2 sites are considered critical to the operation of the telecommunications system.

> NOTE – The owner of the telecommunications equipment or the AHJ determines whether or not the system is a Type 1 or Type 2 system.

Type 2 sites may have a tower on the site, may have a telecommunications dispatch center, may have a base station/repeater site, and may be critical to public safety or on a military installation. Type 2 sites should have a grounding system resistance of 5 ohms or less.

> NOTE – Equal-potential bonding and grounding is the most important consideration when designing a grounding electrode system to protect against lightning events.

B.2.5 Tower grounding

The tower grounding electrode system helps disperse lightning energy before it is able to enter the associated telecommunications structure and its related equipment. See figure 21.

There are several types of towers. Typical tower types include:

a) Guyed metallic towers
These are structures with upright support members (legs) mounted on a foundation or pier that require multiple anchors and down guys.
b) Self-supporting metallic towers
These are free-standing structures with upright support members (legs) mounted on a foundation or pier that need no other supporting elements.
c) Wooden structures (poles)
These are either free-standing or guyed structures either mounted on a foundation or partially buried.

The tower ground ring consists of a bare solid tinned or un-tinned copper No. 2 AWG conductor or bare tinned or un-tinned copper conductor not smaller than No. 1/0 AWG that is buried to a depth at least 0.76 m (2.5 ft) or 152 mm (6 in) below the frost line, whichever is deeper. It should be installed at least 0.61 m (2 ft) away from the tower base or footing using at least two ground rods, 2.4 m (8 ft) minimum length and 16 mm (0.625 in) diameter, driven to a depth of not less than 3 m (10 ft) below the depth of the tower ground ring and attached to the ground ring using an exothermic weld. The ground rods should be made from copper, copper clad steel, stainless steel or galvanized steel and be Listed for the purpose. The ground rods should be located at opposite ends of the ground ring. The tower ground ring should bonded to the equipment building/cabinet ground ring in at least two points using the same size conductor and buried to the same depth as the tower and equipment building/cabinet ground ring. The tower's support piers (concrete footings) should have the rebar electrically connected to the tower holding bolts.

B.2.5.1 Guyed metallic towers

The bottom plate of a guyed tower should be bonded to the tower ground ring using three equally spaced conductors, or each leg should be bonded to the tower grounding ring using a conductor of the same size as the tower ground ring (see figure 23). These conductors should be short and straight as practical. The connections should be made exothermically unless specifically directed otherwise by the tower manufacturer.

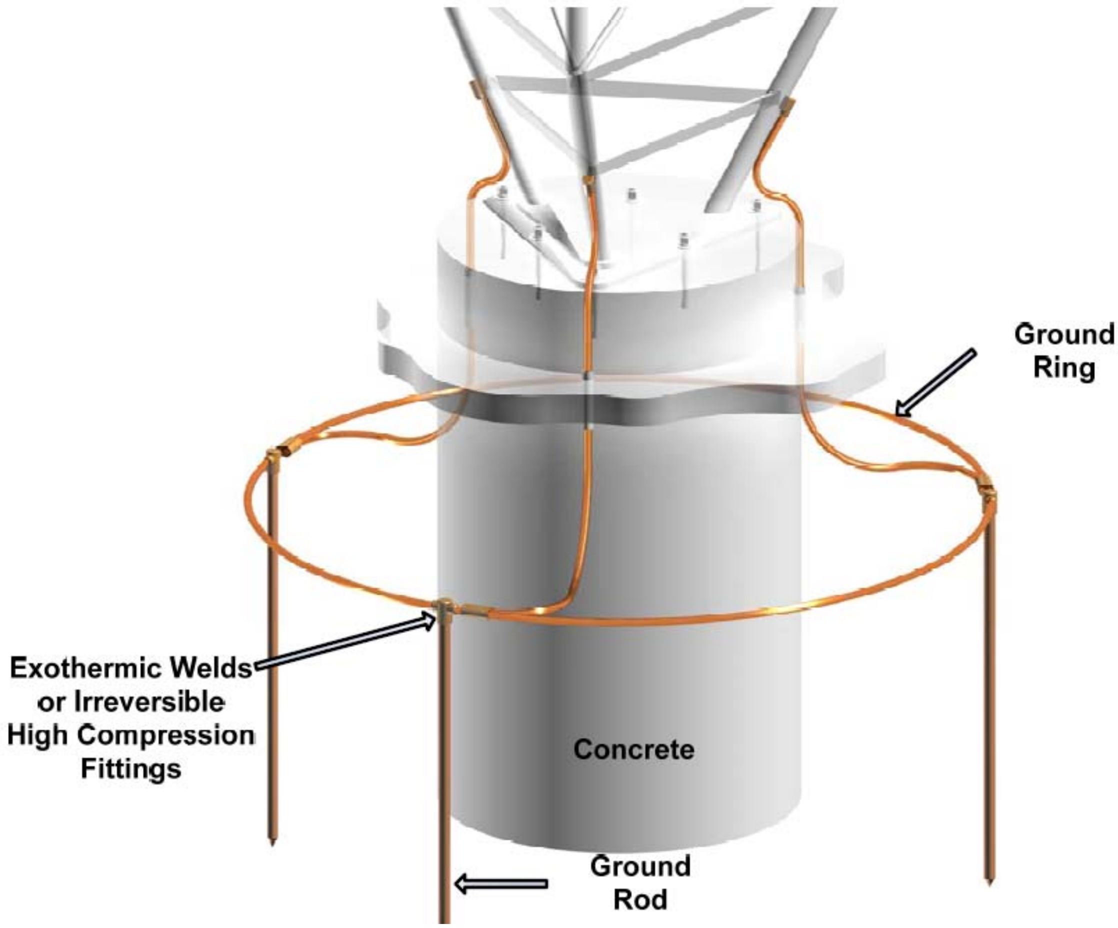

Figure 23 – Illustration of a guyed tower grounding example

A ground rod should be installed at each anchor point and connected to each guy wire using materials that help prevent the formation of a galvanic couple (See figure 24).

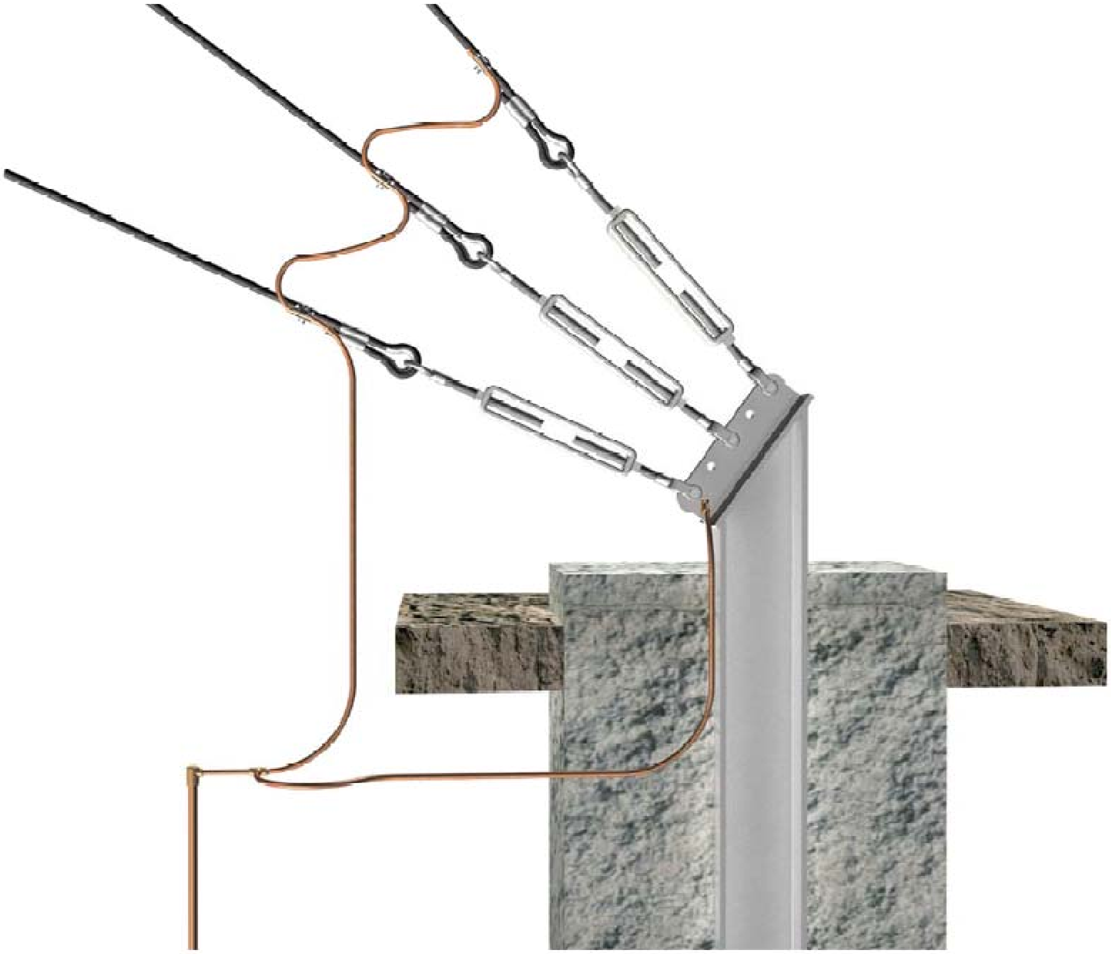

Figure 24 – Illustration of guy wire grounding

B.2.5.2 Self-supporting metallic towers

For towers not exceeding 1.5 m (5 ft) in base width (including monopoles), the tower ground ring should consist of at least two ground rods and grounding conductor and installed in accordance with subclause B.2.3.

For towers equal to or exceeding 1.5 m (5 ft) in base width, the tower ground ring should consist of at least one ground rod per tower leg and a grounding conductor sized and installed in accordance with subclause B.2.3. Each tower leg should be connected to the tower ground ring using the same size conductor as the tower ground ring. These conductors should be installed to be as short and straight as practical. The connections should be made exothermically unless specifically directed otherwise by the tower manufacturer.

For monopole towers equal to or exceeding 1.5 m (5 ft) in base width, the tower ground ring should consist of at least four equally spaced ground rods and a grounding conductor sized and installed according to subclause B.2.3. There should be four equally spaced bonding conductors connected to the monopole tower and to the tower ground ring using the same size conductor as the tower ground ring. These conductors should be installed to be as short and straight as practical. The connections should be made exothermically unless specifically directed otherwise by the tower manufacturer (see figure 25).

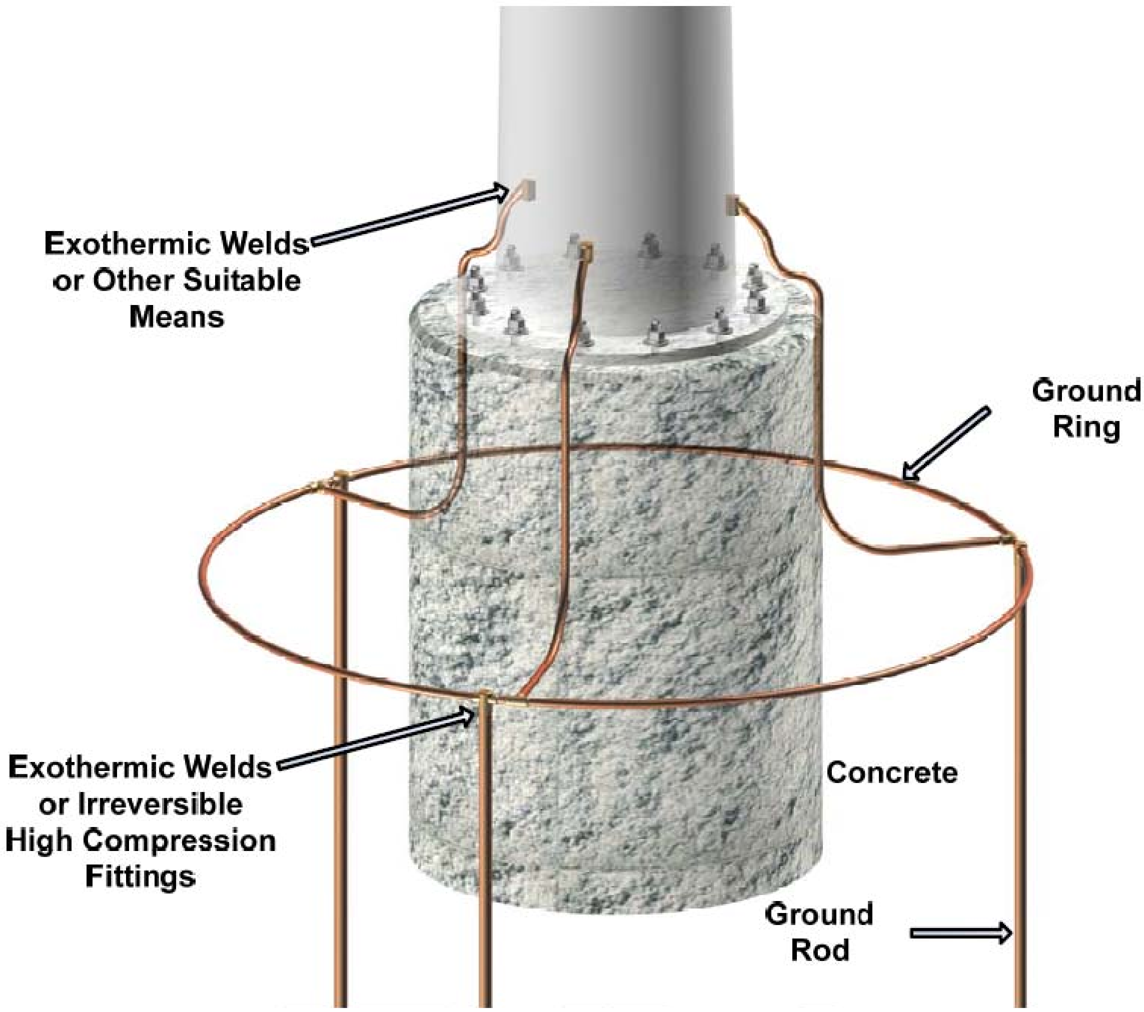

Figure 25 – Illustration of a monopole tower grounding example

B.2.5.3 Wooden structures (poles)

Wooden poles should be installed using a No. 2 AWG or larger solid bare tinned or un-tinned copper vertical down conductor for its entire length. This down conductor should be connected to two ground rods or a grounding radial conductor using exothermic welding or other fittings that are Listed for that purpose. These ground rods and conductors should be sized and installed according to subclause B.2.3 (see figure 26).

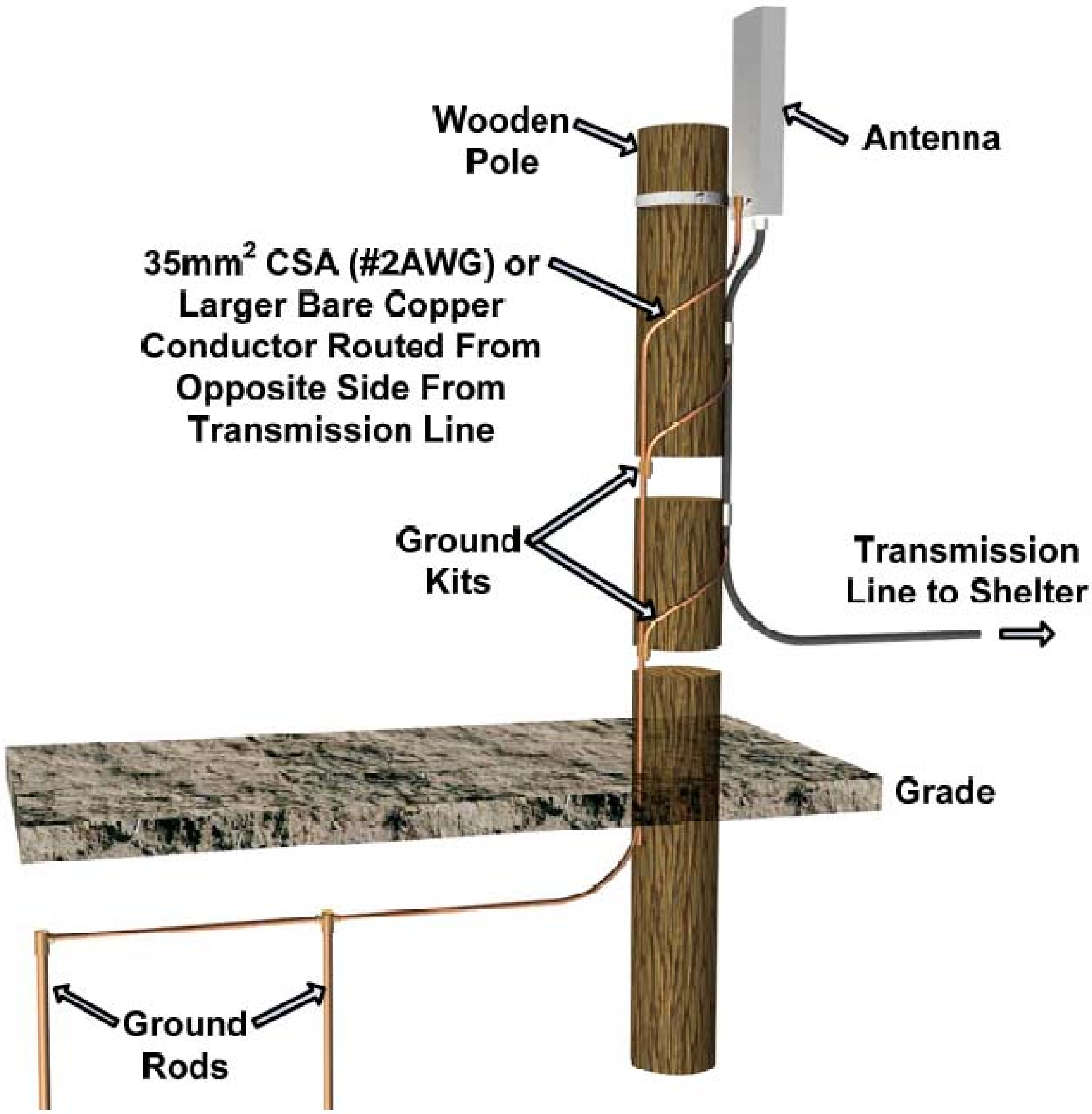

Figure 26 – Illustrative view of a wooden pole grounding example

Common bonding and grounding principles used on separate building and tower sites should also apply in this case. In addition, the following should apply to this type of installation.

a) Any electric power conduit should extend and terminate above any telephone attachment (cable, wire, or drop) at a point where the weatherhead is near the power circuit attachments or warning light.
b) The conduit from the weatherhead to the power meter should be at least 6.1 m (20 ft) long. This aids the operation of the power arrester at the weatherhead (poles).

B.2.6 Building/shelter and outdoor cabinet grounding

All dedicated telecommunications shelters and outdoor cabinets should have a properly installed external grounding electrode system that meet the ground resistance requirements listed in subclause B.2.2.1 or B.2.2.2 depending on what type of structure it is. Figure 27 illustrates an example of a cabinet grounding system.

The building/shelter and outdoor cabinet should be encircled by a ground ring consisting of a bare solid tinned or un-tinned copper No. 2 AWG conductor or bare tinned or un-tinned copper conductor not smaller than No. 1/0 AWG buried to a depth at least 0.76 m (2.5 ft) or 152 mm (6 in) below the frost line, whichever is deeper. It should be installed at least 0.9 m (3 ft) away from the building. Ground rods, 2.4 m (8 ft) minimum length and 16 mm (0.625 in) diameter should be driven to a depth of not less than 3 m (10 ft) below the depth of the ground ring and attached using exothermic connections. These ground rods should be made of copper, copper clad steel, stainless steel or galvanized steel and be Listed for the purpose. There should be a minimum of four grounding rods located at each corner of the building/shelter or outdoor cabinet. The building/shelter and outdoor cabinet ground ring should be bonded to the tower ground ring in at least two points using the same size conductor and buried to the same depth as the tower and equipment building/cabinet ground ring. Also, the building's foundation (concrete footings) should have the rebar electrically connected to the building ground ring.

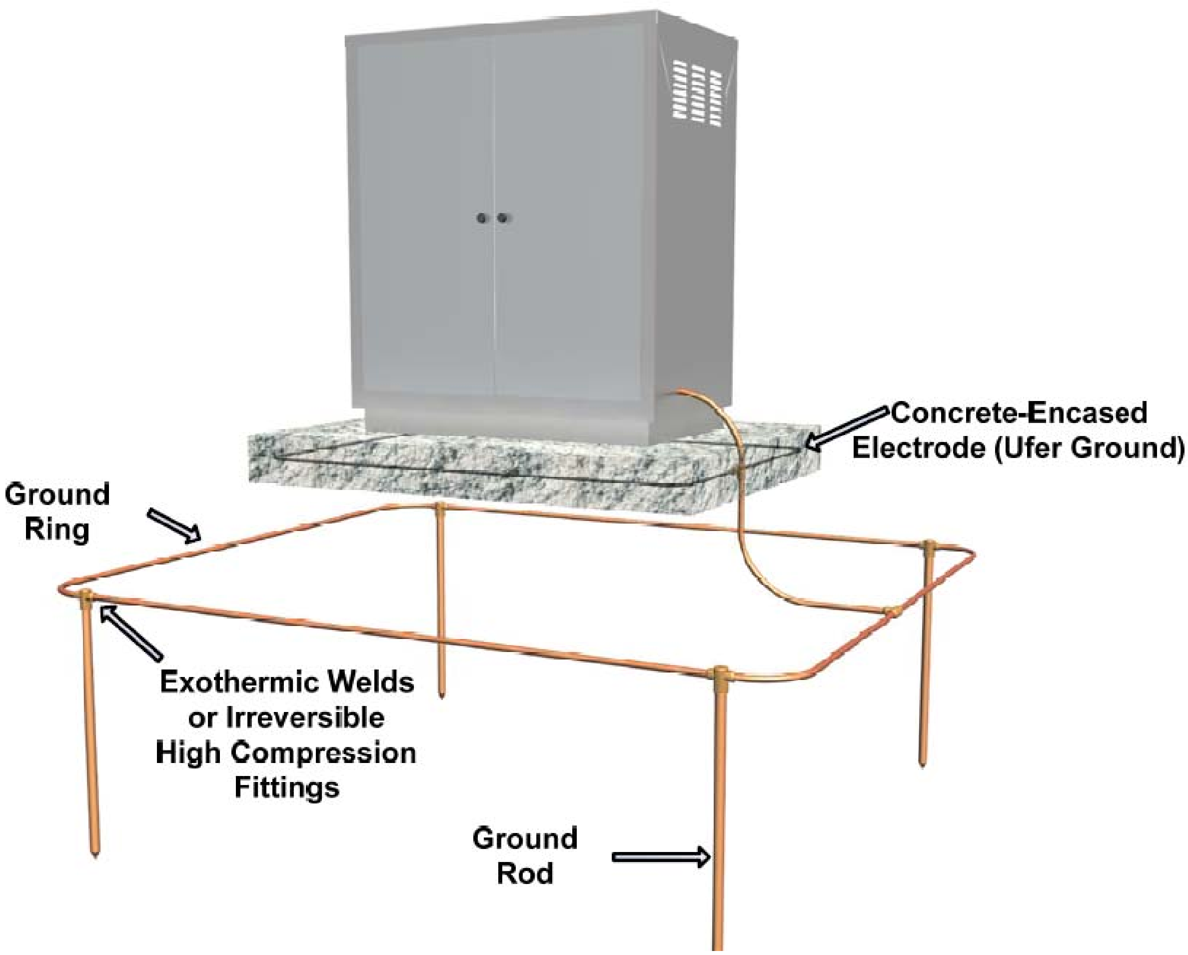

Figure 27 – Illustrative view of a cabinet grounding system

B.2.7 Rooftop sites grounding system

When the antenna support or tower is mounted on the roof of a building, a grounding system should be designed to:

a) use regular lightning protection conductors and hardware following the recommendations of ANSI/NFPA-780;
b) place a wire ring (roof ring) around the antenna support or tower;
c) connect the tower base footings to the:
   1) tower ground ring;

2) waveguide, or coaxial, outer conductor;
3) lighting alternating current (ac) branch circuit metallic conduit and green wire alternating current equipment ground (ACEG);
4) lightning arrester ground.

d) connect:
1) antenna metal members to the tower or antenna support structure;
2) antenna support structure to ring;
3) lightning protection system perimeter conductors;
4) ring to any other metallic object on the roof within flashover range.

NOTE – Coordinate the lightning protection system of the building and the grounding system for the tower.

See figure 28, figure 29, and figure 30 for examples of rooftop site grounding systems.

B.2.7.1 Down conductors

A roof-mounted tower or antenna mast of any size should have at least two down conductors from opposite sides of the roof ground ring down the building wall to connect to either a buried ground ring around the building (preferred), or two or more rods.

Additional down conductors should be used for each 30.5 m (100 ft) of building length.

NOTE – These down conductors are in addition to the ones used in the lightning protection system.

B.2.7.2 Roof conductors

Roof conductors should be supported every 0.9 m (3 ft) using either no-nail paste-down cable fasteners, or pan-type base ridge cable supporters.

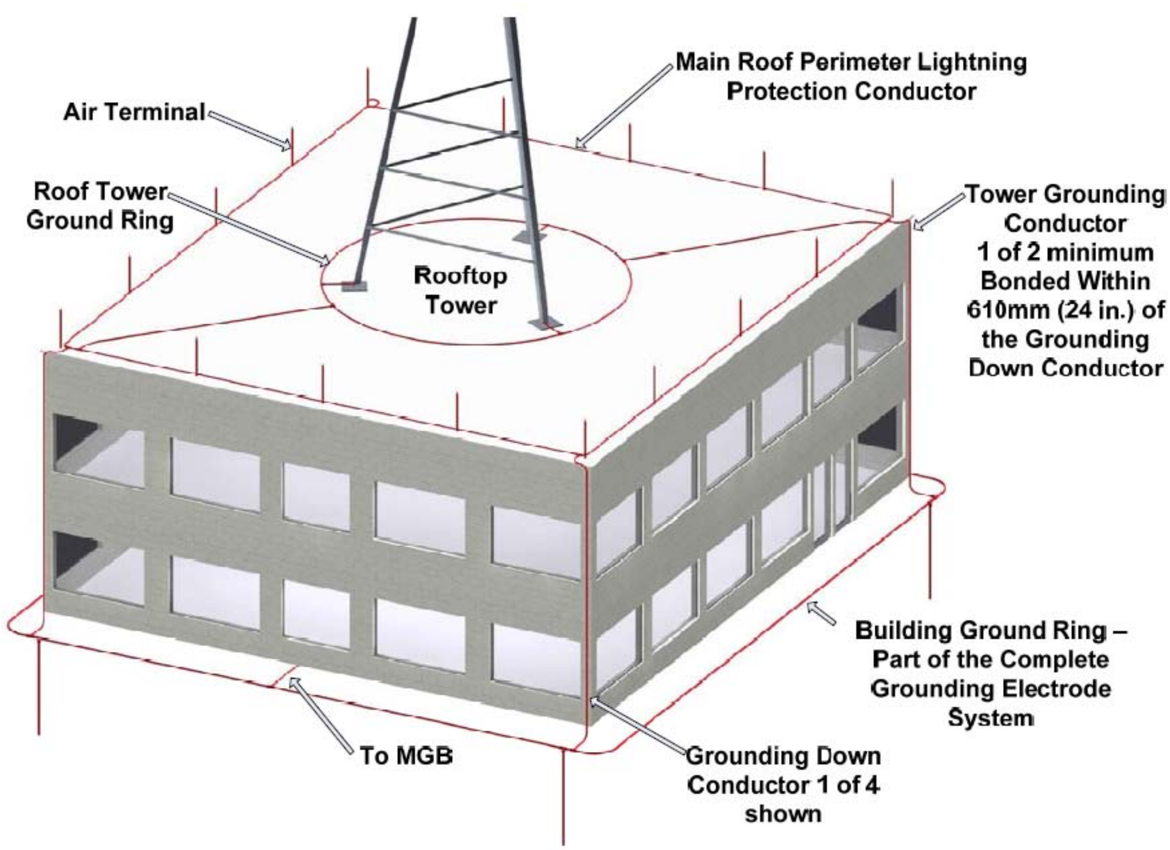

Figure 28 – Illustrative rooftop tower example

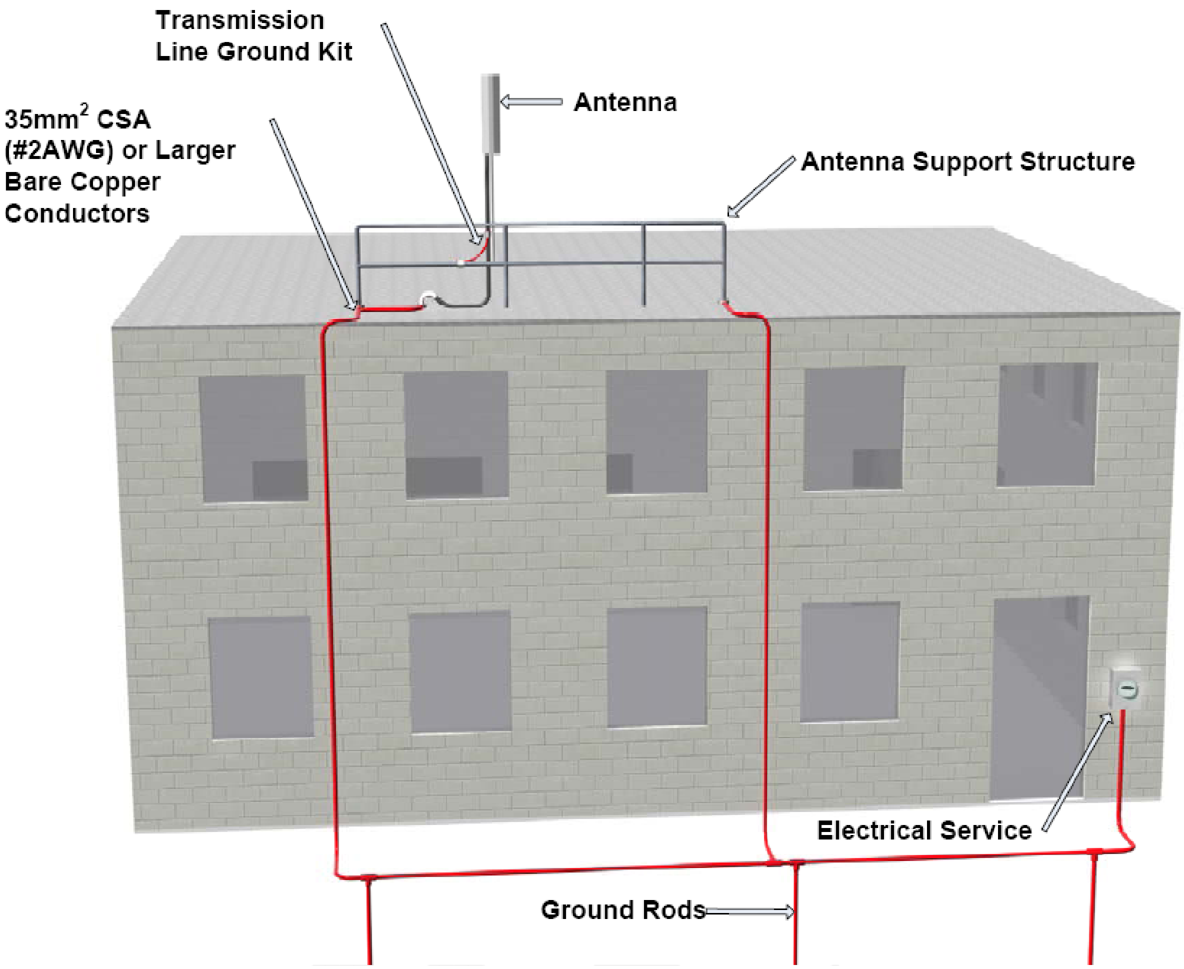

Figure 29 – Illustrative view of roof-mounted antenna mast grounding with a supplemental grounding electrode system

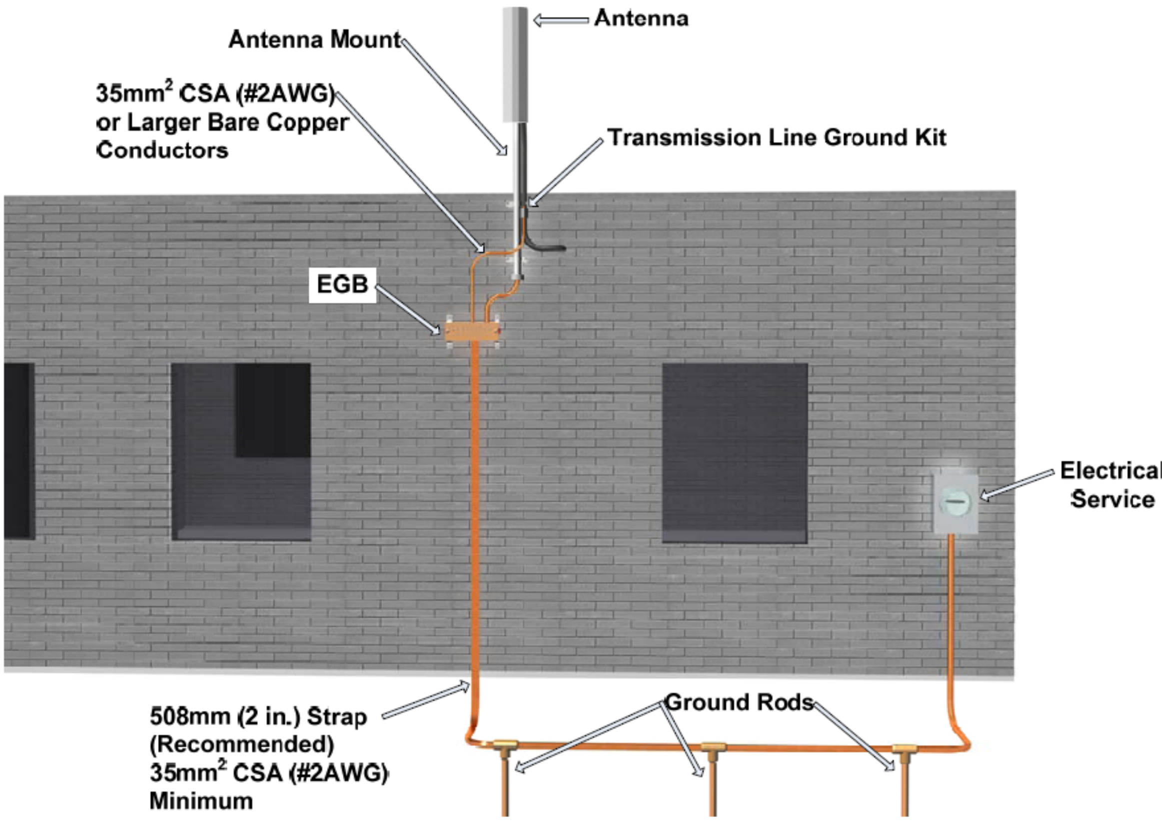

Figure 30 – Illustrative view of side-mounted antenna grounding using copper strap down conductor

B.2.8 Transmission line grounding at antenna locations

Antennas can be mounted on wood or metal supports. In some cases, the antenna support structures (towers) are mounted on the roof of a building. Mounting towers or antennas on a roof could damage the structural integrity of the building and/or void the warranty of the roof.

Occasionally, the antenna might be mounted on the side wall of a building or on a parapet wall using special braces or supports.

The presence of an antenna and its supporting structure on the roof of a building is not expected to significantly increase the probability of lightning striking the building. However, if lightning does strike, the antenna and its supporting tower may be the focal point of the strike.

Where antenna cables enter a building, the point of entry should be treated as an entrance facility. Where an entrance facility is located at the roof, a TGB should be provided.

Waveguide and coaxial cable shields should be bonded to the tower at the top and bottom of the tower. If the tower is greater than 60.1 m (200 ft) in height, the waveguide or coax shield should also be bonded at the tower midpoint or every 15.2 m (50 ft).

Where the waveguide or coaxial cable enters the building, the waveguide or coaxial shield should be bonded to the building's external grounding electrode system with a No. 2 AWG conductor. Once inside the building, the waveguide or coaxial cable shield should be bonded to the building's interior grounding electrode system, using a No. 2 AWG conductor, as close as practical to the entrance.

If there is a metallic waveguide or coaxial cable entrance plate, the entrance plate should be bonded to both the exterior and interior grounding system with a No. 2 AWG conductor. The waveguide or coaxial cable shield should be bonded to the metallic entrance plate on both the outside and inside of the building with a No. 2 AWG conductor.

The coaxial cable should be protected by a lightning surge arrester, which is bonded to the exterior grounding electrode system with the proper size grounding conductor specified by the manufacturer.

If the tower is lighted, the conduit for the lighting power conductors should be bonded to ground as described for waveguide and coaxial cable shields.

B.2.9 Ancillary objects requiring bonding and grounding

B.2.9.1 Fence grounding

If there is a metal fence within 1.8 m (6 ft) of the building, the building ground ring should be bonded to the fence with a No. 2 AWG solid bare copper conductor. Similar rules apply for bonding a monopole or satellite-mounting ground ring to the equipment building ground ring or fence (see figure 31, figure 32, and figure 33).

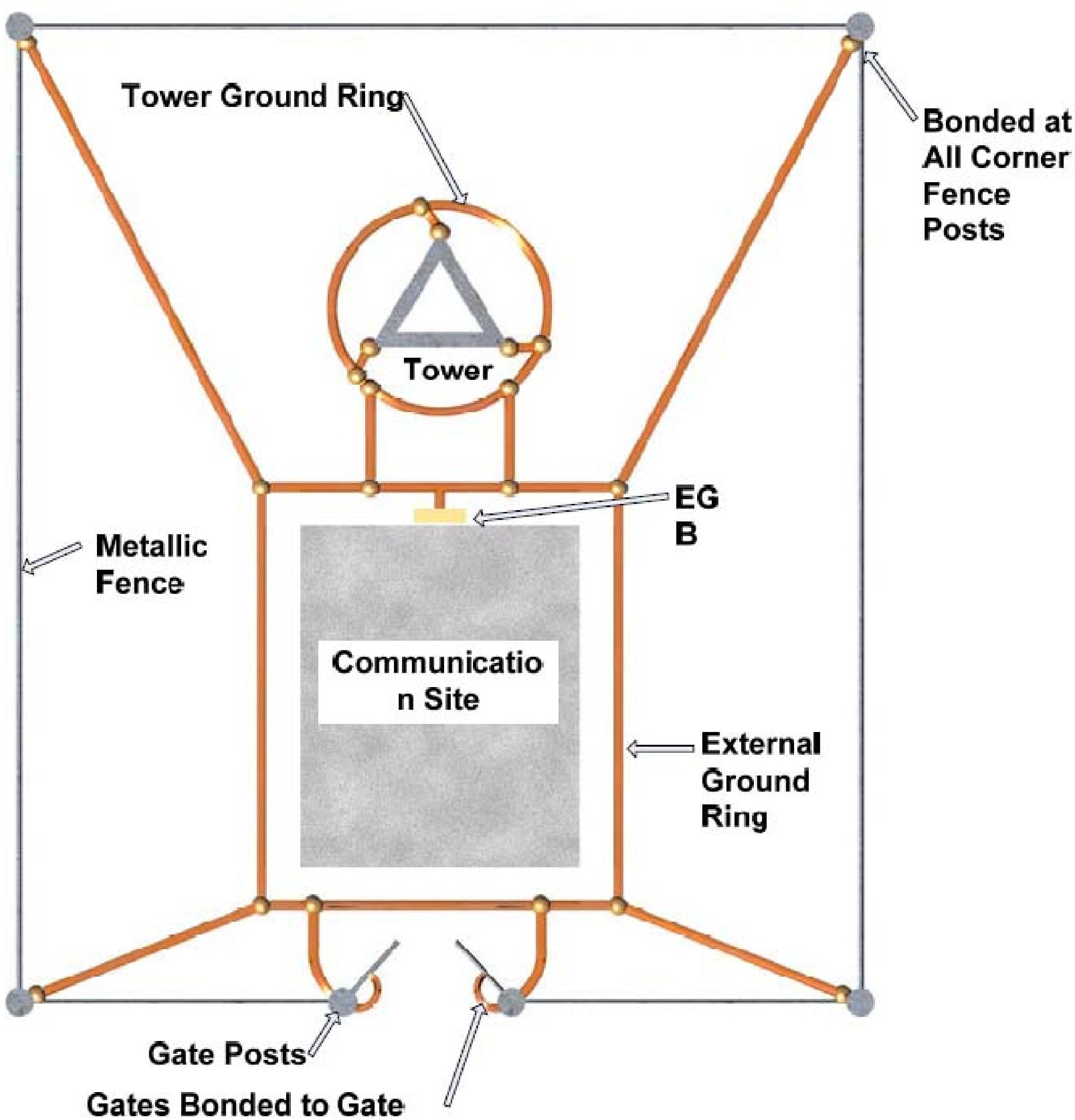

Figure 31 – Illustration of a fence bonding example

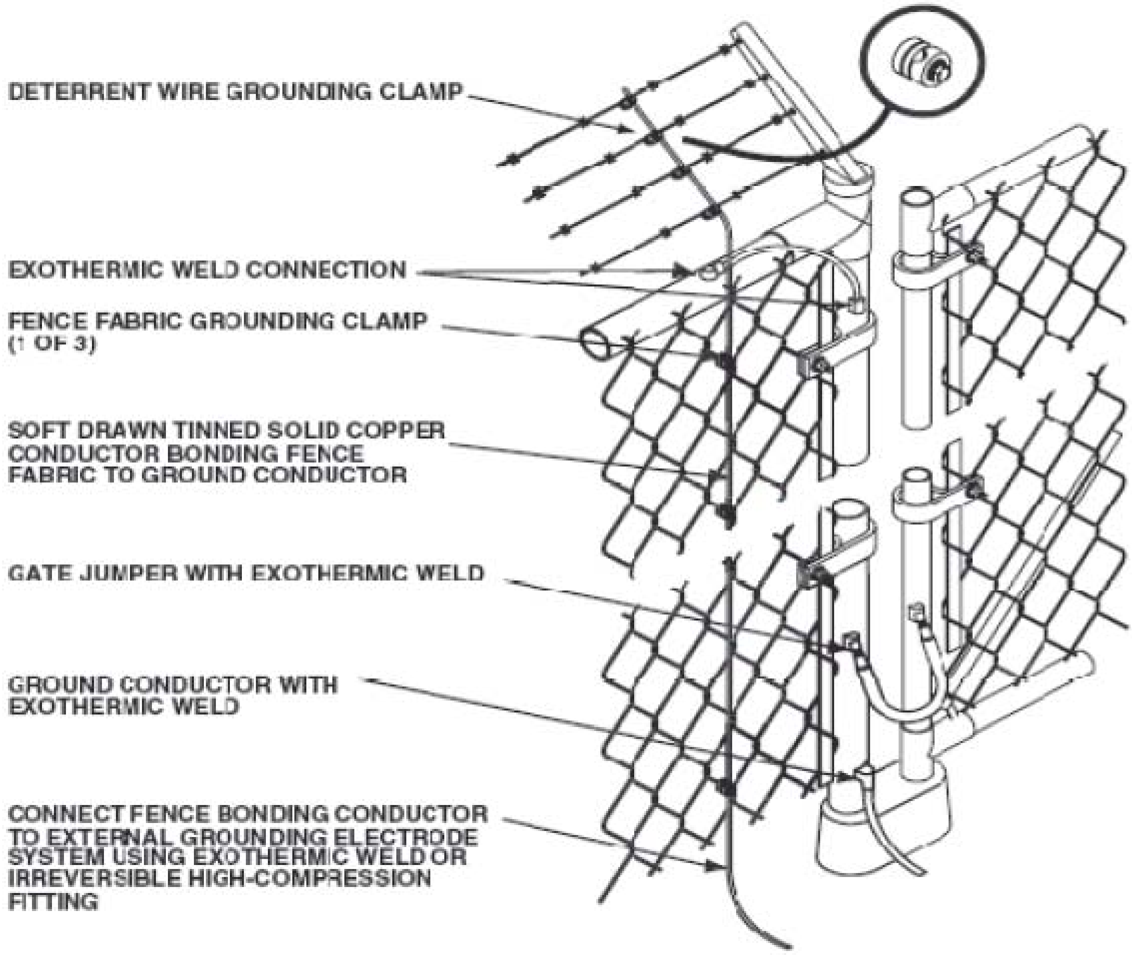

Figure 32 – Illustrative view of a fence fabric and deterrent wiring bonding example

B.2.9.2 Generators

Generators installed outside and within 1.8 m (6 ft) of the structure shall be bonded to the nearest point on the building's grounding electrode system using a No. 6 AWG copper conductor, see figure 33. If this conductor is placed underground, then the minimum conductor size shall be No. 2 AWG or larger.

Generators installed more than 1.8 m (6 ft) away from the structure shall have a ground rod driven near the generator and bonded to the generator and to the building's grounding electrode system using a No. 2 AWG or larger bare, solid, tinned or un-tinned copper conductor.

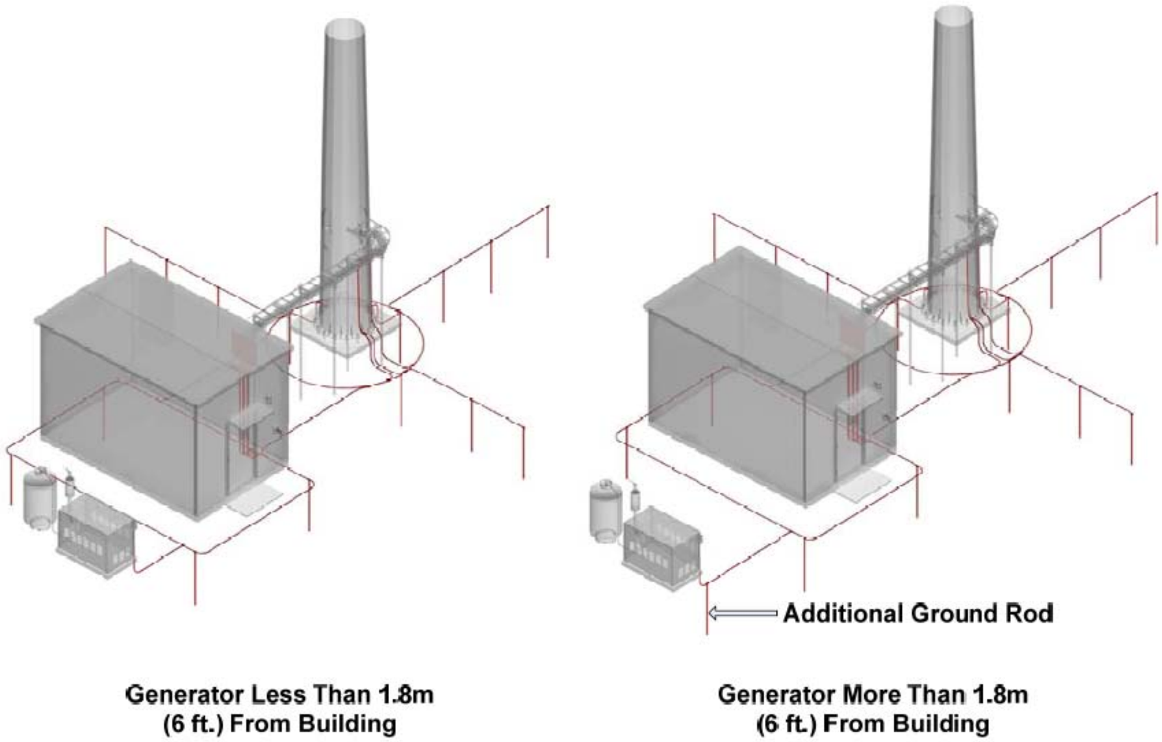

Figure 33 – Illustrative view of a generator grounding example

B.2.9.3 Satellite dishes

Satellite dish mountings should have a grounding electrode system consisting of a ground ring and ground rods. The metallic frame supporting a satellite dish should be bonded to the ground ring with a No. 2 AWG conductor, which should be as short and straight as practical.

B.2.10 Internal bonding and grounding

B.2.10.1 Components

B.2.10.2 Installation

Radio equipment buildings with nonmetallic walls should have an interior ground ring consisting of a No. 2 AWG conductor mounted, with nonmetallic connections, to the interior wall within 0.3 m (1 ft) of the ceiling.

Radio equipment buildings with metallic walls should have an interior ground ring consisting of a No. 2 AWG conductor mounted directly to the interior wall within 0.3 m (1 ft) of the ceiling.

B.2.10.3 Bonding to the external ground electrode system

The interior ground ring should be bonded to the exterior ground ring with No. 2 AWG conductor, routed as straight as practical, using exothermic connections or Listed connectors.

ANNEX C (INFORMATIVE) TELECOMMUNICATIONS ELECTRICAL PROTECTION

Telecommunications circuit protectors are used in telecommunications facilities to mitigate voltage and current transients. There are three basic types of telecommunications circuit protectors:

a) primary protectors;
b) secondary protectors; and,
c) data and fire alarm protectors.

The telecommunications network plant is often subject to electrical disturbances arising from lightning and commercial alternating current (ac) power line disturbances. To help safeguard persons and property from the effects of these disturbances, primary telecommunications electrical protection is placed at the telecommunications entrance to the building or structure by the network telecommunications utility access provider. The *National Electrical Code (NEC®)* specifies the minimum primary protection requirements, and states that "the primary protector shall be located in, on or immediately adjacent to the structure or building served and as close as practical to the point at which the exposed conductors enter or attach." The network telecommunications utilities, in addition to conforming to the *NEC®* requirements, also provide primary telecommunications electrical protection where they deem their network plant potentially exposed to lightning or commercial ac power disturbances. An exception to this may be in urban areas where tall, steel-framed buildings may provide shielding from lightning, the large mass of underground metallic structures dissipates lightning energy, and power conductors are placed underground in conduit separate from telecommunications conductors. In such areas, primary telecommunications electrical protection is generally not necessary as there may be limited lightning or power exposure.

A critical consideration when placing the primary protector is the length of the primary protector grounding conductor. The primary protector grounding conductor provides the grounding path between the primary protector ground terminal and the building or structure power grounding electrode system. During a lightning event to the network telecommunications plant, substantial voltages can be developed in the primary protector grounding conductor. The magnitude of the voltage is dependent both on the waveshape of the disturbance and the impedance of the grounding conductor which is directly proportional to conductor length. For this reason, network telecommunications utility practices recommend:

a) locating the telecommunications entrance as close as practicable to the power entrance to minimize the length of the primary protector grounding conductor. The *NEC®* emphasizes this by requiring a means for intersystem bonding between power and other systems, such as telecommunications systems.
b) placing the primary protector to allow for the shortest and most direct routing of the primary protector grounding conductor.

While the telecommunications network is only one means by which lightning voltages can be introduced into a building or structure (power phase conductors, the power neutral conductor, and a strike to the building itself are others), consideration should also be given to providing surge protection devices at the electrical entrance and direct strike lightning protection to the facility. The requirements for and the need to provide this broader protection is contained in ANSI/NFPA-780.

Maximum effort should be made to keep the primary protector grounding conductor as short as practical. This may be accomplished by locating the primary protector in close proximity to the power service entrance at the building or structure. In addition to the primary protector grounding conductor, the overall conductor path between the primary protector and the power service ground should be kept as short as practical. This path may include the bonding conductor for telecommunications (BCT) as illustrated in figure 2 and figure 3 of this Standard. The length of the BCT may be minimized by locating the telecommunications main grounding busbar (TMGB) as close as practicable to the electrical entrance facility.

Requirements for telecommunications electrical protection, bonding and grounding at building or structure entrances are contained in the *NEC*®, Chapter 8. Additional detailed electrical protection, bonding and grounding considerations and criteria are contained in ATIS 0600318. The reader is directed to these documents for guidance regarding the primary protector, and the placement, routing, and length of the primary protector grounding conductor.

ANNEX D (INFORMATIVE) ELECTRICAL PROTECTION FOR OPERATOR-TYPE EQUIPMENT POSITIONS

Technology devices are increasingly being deployed at the equipment outlet (EO), including one or more computers, phones, printers, etc. In telecommunications-intensive operations, personnel may wear voice headsets connected to headset interface equipment in addition to the typical EO devices.

At these locations, personnel use a variety of electronic equipment including a headset, headset interface equipment, other electronic equipment such as a computer keyboard and video display terminal, and the work station furniture. Frequently, workstations are arranged in clusters consisting of several positions. These positions are typically used at reservation bureaus, telemarketing agencies, and such.

Operator-type equipment positions (workstations) should be bonded to ground in accordance with ATIS 0600321.

Electrical disturbances may appear at operator-type equipment positions arising either from electrostatic discharge (ESD), or from sources that are internal or external to the building such as lightning or alternating current (ac) power disturbances.

ATIS 0600321 covers new installations of network operator-type equipment positions in which personnel are required to access a computer terminal keyboard while continually wearing a headset. This standard presents measures that are intended to help control ESD in the network operator-type environment. ATIS 0600321 also presents additional measures that are intended to help minimize the effects of lightning, surges from commercial alternating current (ac) power lines, and power switching operations, both at the facility (building) level and at the network operator-type equipment position. These measures provide for equipotential bonding and grounding at the telecommunications entrance facility (TEF) and the power entrance facility, as well as for equipotential bonding and grounding, where necessary, and electrical protection at the network operator-type equipment positions. Although ATIS 0600321 deals specifically with network locations, the measures outlined in the standard are applicable to non-network installations, as well as at existing installations.

The electrical protection measures included in ATIS 0600321 are intended to minimize potential differences at the network operator-type equipment position (work station) but are not intended to guarantee against damage or injury that may result from ESD or other similar occurrences. Refer to figure 34.

General electrical safety and protection requirements that may be applied to work areas are contained in the *NEC*®.

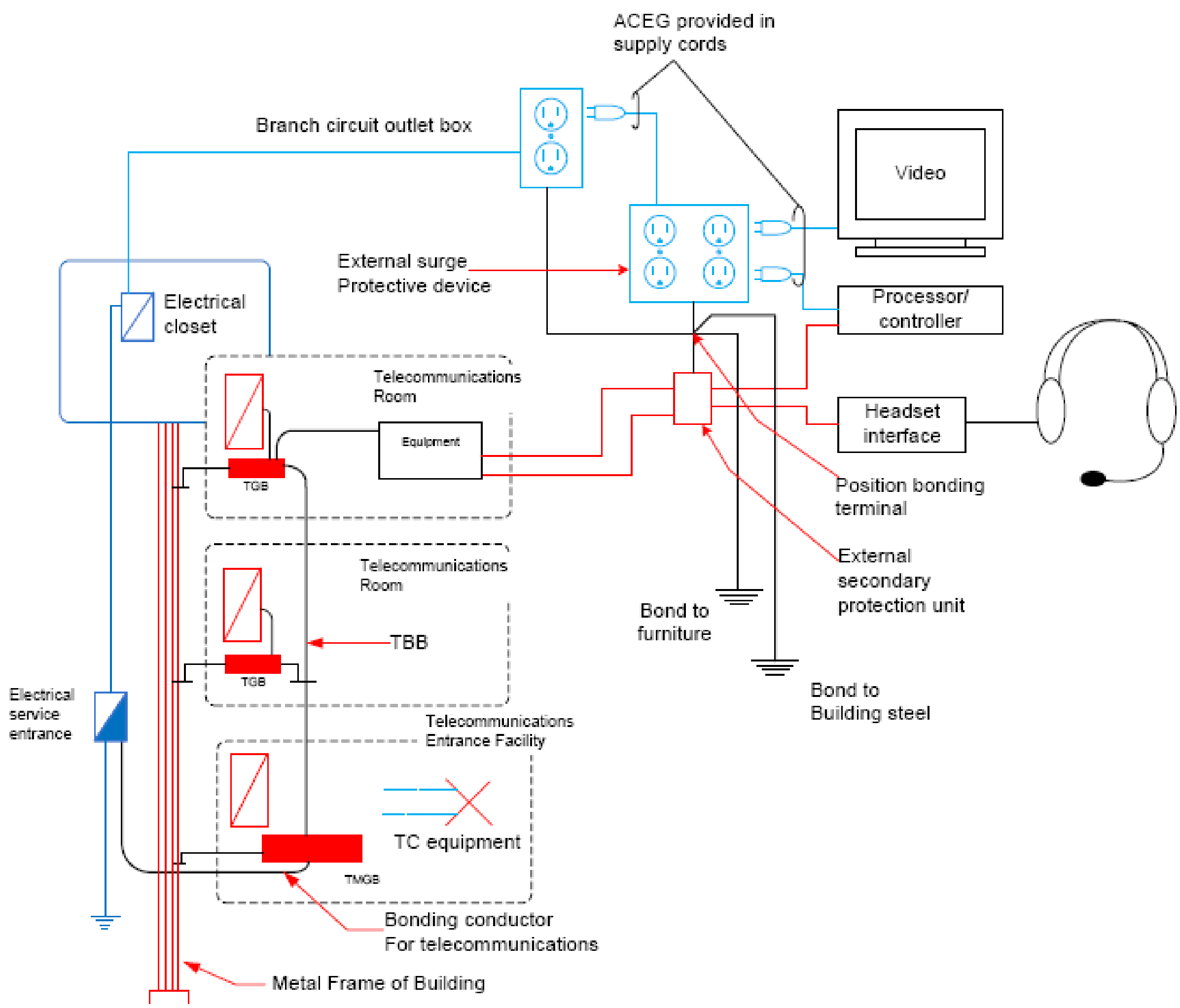

Figure 34 – Electrical protection for operator-type equipment positions

ANNEX E (INFORMATIVE) CROSS REFERENCE OF TERMS

Preferred terms used in this Standard	**Other industry terms**
Telecommunications Main Grounding Busbar (TMGB)	Building Principal Ground (BPG) CO GRD Bus COG Facility Ground Main Earthing Terminal (MET) Master Ground Bar (MGB) OPGPB PGP Bus Principal Ground Point (PGP) Reference Point 0 (RP0) Zero Potential Reference Point)
Telecommunications Grounding Busbar (TGB)	Extended Reference Point 0 (Extended RP0) Floor Ground Bar (FGB) Approved Floor Ground
Telecommunications Bonding Backbone (TBB)	Equalizer Equalizing Conductor Grounding Equalizer (GE) Vertical Equalizer Vertical Ground Riser
Grounding Equalizer (GE)	Horizontal Equalizer

ANNEX F (INFORMATIVE) REFERENCES

The following is a list of some generally applicable basic standards and guides that are relevant to the requirements of this Standard. Other American National Standards also may be relevant.

- ANSI/ATIS-0600334, *Electrical Protection Of Communications Towers And Associated Structures*
- ATIS 0600318, *Electrical Protection Applied to Telecommunications Network Plant at Entrances to Customer Structures or Buildings*
- ATIS 0600321, *Telecommunications – Electrical Protection For Network Operator-Type Equipment Positions*
- ATIS-0600313, *Electrical Protection for Telecommunications Central Offices and Similar Type Facilities*
- EN 50310, *Application Of Equipotential Bonding And Earthing In Buildings With Information Technology Equipment*
- MIL-HDBK-419A, Grounding, Bonding, And Shielding For Electronic Equipments And Facilities Basic Theory

The organizations listed below can be contacted to obtain reference information.

ANSI
American National Standards Institute (ANSI)
25 W 43rd Street, 4th floor
New York, NY 10036
USA
(212) 642-4900
www.ansi.org

ATIS
Alliance for Telecommunications Industry Solutions (ATIS)
1200 G Street, NW
Suite 500
Washington, DC 20005
USA
(202) 628-6380
www.atis.org

IEEE
IEEE Operations Center
445 Hoes Ln.
Piscataway, NJ 08854-4141
USA
(732) 981-0060
www.ieee.org

NFPA
National Fire Protection Association (NFPA)
1 Batterymarch Park
Quincy, MA 02169-7471
USA
(617) 770-3000
www.nfpa.org

TIA
Telecommunications Industry Association (TIA)
2500 Wilson Blvd., Suite 300
Arlington, VA 22201-3836
USA
(703) 907-7700
www.tiaonline.org

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