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# JOINT STANDARD

# Commercial Building Grounding (Earthing) and Bonding Requirements For Telecommunications

## J-STD-607-A

OCTOBER 2002

Jointly Developed By:

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The Telecommunications Industry Association represents the communications sector of

Electronic Industries Alliance

Sponsored by the

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Standards & Technology Department
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1200 G Street, NW
Suite 500
Washington, DC 20005
(202) 628-6380

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# CONTENTS

FOREWORD ..... iv
1 INTRODUCTION ..... 1
1.1 General ..... 1
1.2 Purpose ..... 2
1.3 Expected usefulness ..... 2
1.4 Code-related sources ..... 3
1.5 Normative and supplementary elements ..... 3
1.6 Mandatory and advisory terms ..... 3
1.7 Metric equivalents of U.S. customary units ..... 3
1.8 Life of this Standard ..... 3
2 SCOPE ..... 5
2.1 General ..... 5
2.2 Exclusions from this Standard ..... 7
2.3 Normative references ..... 7
2.4 Other references ..... 8
3 DEFINITIONS ..... 9
3.1 General ..... 9
3.2 Definition of terms ..... 9
3.3 Abbreviations and acronyms ..... 11
3.4 Units of measure ..... 12
4 OVERVIEW OF TELECOMMUNICATIONS GROUNDING (EARTHING) AND BONDING SYSTEMS ..... 13
4.1 General ..... 13
4.2 Overview of the telecommunications grounding and bonding infrastructure ..... 13
5 COMPONENTS OF THE TELECOMMUNICATIONS GROUNDING (EARTHING) AND BONDING INFRASTRUCTURE ..... 15
5.1 General ..... 15
5.2 The telecommunications main grounding busbar (TMGB) ..... 16
5.3 Bonding conductor for telecommunications ..... 18
5.4 The telecommunications bonding backbone (TBB) and the grounding equalizer (GE) ..... 18
5.5 The telecommunications grounding busbar (TGB) ..... 20
5.6 Bonding to the metal building frame ..... 21
6 TELECOMMUNICATIONS ENTRANCE FACILITY ..... 23
6.1 General ..... 23
6.2 Placing the telecommunications main grounding busbar (TMGB) ..... 23
6.3 Other attachments to the telecommunications main grounding busbar (TMGB) 23
6.4 Other grounding busbars ..... 24
6.5 Other service entrances ..... 24
7 TELECOMMUNICATIONS ROOM AND EQUIPMENT ROOM ..... 25
7.1 General ..... 25
7.2 Multiple telecommunications grounding busbars (TGBs) ..... 25
7.3 Placing the telecommunications grounding busbar (TGB) ..... 25
7.4 Other connections to telecommunications grounding busbar (TGB) ..... 25
8 WORK AREA ..... 26
9 TOWERS AND ANTENNAS ..... 27

9.1 General ..... 27
Annex A (informative) ..... 28
Cross-Reference of Terms ..... 28
Annex B (informative) ..... 29
Telecommunications electrical protection – primary protector grounding ..... 29
Annex C (informative) ..... 31
Towers and antennas ..... 31
C.1 General ..... 31
C.2 Antenna Locations ..... 31
C.3 Types of Support Structures ..... 31
C.4 Structure grounding requirements ..... 32
C.5 Sites with Wood Poles ..... 32
C.6 Roof-Mounted Towers ..... 33
C.7 Down Conductors ..... 33
C.8 Roof Conductors ..... 34
C.9 Radial Grounding Conductors ..... 34
C.10 Waveguide and coaxial cable grounding requirements ..... 34
C.11 Equipment Building Grounding Requirements ..... 35
Annex D (informative) ..... 37
Work Area ..... 37
D.1 Co-location of electrical power and telecommunications grounding facilities ..... 37
D.2 Electrical protection for operator-type equipment positions ..... 37
Annex E (informative) ..... 39
References ..... 39

**FIGURES**

Figure 2.1-1 Scope of standard for large commercial buildings ..... 6
Figure 2.1-2 Scope of standard for smaller commercial buildings ..... 7
Figure 5.1-1 Label for grounding and bonding conductors ..... 15
Figure 5.2-1 Typical main grounding busbar (TMGB) ..... 16
Figure 5.3-1 Bonding to the service equipment (power) ground ..... 18
Figure 5.5-1 Typical grounding busbar (GB) ..... 19
Figure D.2-1 Electrical protection for operator-type equipment positions ..... 36

# FOREWORD

(This foreword is not part of this Standard)

This joint TIA/T1 Standard was produced by TIA/EIA Working Group 41.7.2 in close coordination with ATIS T1E1.5 and T1E1.7. This joint Standard is published in accordance with the TIA Style Manual.

### Approval of Standard

This Standard was approved by TIA/EIA Technical Committees TR-41, ATIS Committee T1 and the American National Standards Institute (ANSI).

### Contributing Organizations

During the development of the original Standard, subject matter experts were gathered under the auspices of the Electronic Industries Alliance / Telecommunications Industry Association (EIA/TIA) to determine the minimum commercial building grounding and bonding infrastructure necessary to support, from a functional perspective, the variety of telecommunications equipment and systems found in many of today's commercial buildings. This Standard has been revised as an ongoing effort between TIA Engineering Committee TR 41, Environmental Considerations Technical Subcommittee TR 41.7, and the Alliance for Telecommunications Industry Solutions (ATIS), Committee T1, Technical Subcommittee T1E1, Power Systems Working Group T1E1.5 and Electrical Protection Working Group T1E1.7. Through this joint revision process, a broader telecommunications industry perspective has been achieved by bringing together telecommunications subject matter experts in the areas of central office and customer location grounding and bonding, representing manufacturers, users, and individuals active in other standards organizations.

### Documents Superceded

This Standard replaces the first edition of ANSI/EIA/TIA 607, originally published in August 1994.

Significant technical changes and additions from the previous edition include:

-- Greater grounding busbar detail.

-- Tower and antenna grounding and bonding recommendations.

-- Work area and personal operator-type equipment position grounding and bonding recommendations.

-- Revised, harmonized terminology. Terminology from the National Electrical Code® (NEC®) has been retained.

There are five annexes to this Standard. All annexes are informative and are not considered part of this Standard.

This standard replaces *ANSI/EIA/TIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications.* ANSI/EIA/TIA-607 is hereby rescinded.

Suggestions for improvement of this Standard are welcome. They should be addressed to:

Telecommunications Industry Association
Engineering Department
2500 Wilson Blvd. Suite 300
Arlington, VA 22201-3834

At the time this Standard was approved, the joint TIA TR-41.7.2 Commercial Building Grounding and Bonding / T1E1 DC Power (T1E1.5) and Electrical Protection (T1E1.7) Working Groups had the following members:

Jim Romlein, MIS Labs, Chair TR 41.7.2
P. E. Pool, Chair - T1E1.7
J. E. Brunssen, Vice-Chair - T1E1.7
R. Witherill, Chair - T1E1.5
N. Tullius, Vice-Chair - T1E1.5

Gregory Bain
Donna Ballast
Goeran Benjamin
Steven Bipes
George Borkowicz
William Bush
Marshall L. Cain
G.W. Crane
T. G. Croda
Phillip Havens
Bob Jensen
Ralph E. Jensen
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Joe O'Brien
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Tom Varga
Chris Wellborn
Larry Young

# COMMERCIAL BUILDING GROUNDING (EARTHING) AND BONDING REQUIREMENTS FOR TELECOMMUNICATIONS

## 1 INTRODUCTION

### 1.1 General

1.1.1 Grounding (earthing) and bonding is important for reliable operation of telecommunications equipment and systems. Commercial buildings are often planned and constructed with incomplete knowledge of eventual building telecommunications equipment and systems. The telecommunications grounding and bonding system infrastructure is frequently designed and installed long before occupant and equipment needs are established. Despite these unknowns, the building grounding and bonding infrastructure is frequently placed during original building construction. It must be capable of supporting a multivendor, multiproduct environment and not be specific to particular equipment or systems.

1.1.2 Modern telecommunications requires an effective building infrastructure to support the wide variety of systems that rely on the electronic transport of information. This infrastructure encompasses telecommunications spaces, pathways, cables, connecting hardware, and the telecommunications grounding and bonding system. This infrastructure provides the basic support for the distribution of electronic information within the building. This Standard provides guidelines for the grounding and bonding portion of this infrastructure. Telecommunications, as used in this Standard, refers to all forms of information that are conveyed within the building (e.g., voice, data, video, environmental control, security, audio, etc.)

1.1.3 The grounding and bonding approach recommended in this Standard is intended to work in concert with the cabling topology as specified in ANSI/TIA/EIA-568-B.1-B.3 (Commercial Building Telecommunications Cabling Standard), pathways as specified in ANSI/TIA/EIA-569-A (Commercial Building Standard for Telecommunications Pathways and Spaces), administration as specified in ANSI/EIA/TIA-606 (Administration Standard for the Telecommunications Infrastructure of Commercial Buildings), and customer owned outside plant as specified in ANSI/TIA/EIA-758 (Customer Owned Outside Plant). The requirements specified in this Standard, in conjunction with a basic understanding of grounding and bonding concepts and methodologies will aid the user in achieving a reliable electrical solution when applied to specific telecommunications installations.

1.1.4 Compliance with the National Electrical Code (NEC) and local codes mandated by the authority having jurisdiction is essential for the proper application of this Standard.

1.1.5 The North American term "grounding" used in this Standard is equivalent to the accepted international term "earthing".

## 1.2 Purpose

1.2.1 The purpose of this Standard is to enable the planning, design, and installation of telecommunications grounding and bonding systems within a building with or without prior knowledge of the telecommunications systems that will subsequently be installed. This Standard also provides recommendations for grounding and bonding of customer owned towers and antennas. This telecommunications grounding and bonding infrastructure supports a multivendor, multiproduct environment as well as various system installation practices.

1.2.2 A large resource of information exists within the telephone industry in the form of telephone utility company guidelines and proprietary practices. The NEC covers the safety aspects of grounding and bonding of telecommunications equipment and systems; ANSI T1.318, *Electrical Protection Applied to Telecommunications Network Plant and Entrances to Customer Structures or Buildings*, provides information on grounding and bonding as necessary to support electrical protection considerations. However, prior to the original release of ANSI/TIA/EIA 607, there were no U. S. standards for telecommunications grounding and bonding in commercial buildings. This reissued Standard continues to provide a uniform telecommunications grounding and bonding infrastructure that supports simple and reliable deployment of telecommunications equipment and systems in a commercial building environment.

## 1.3 Expected usefulness

1.3.1 This Standard will be useful to anyone engaged in the design, maintenance, renovation, or retrofit of new or existing commercial buildings.

1.3.2 This Standard will be useful to manufacturers of telecommunications equipment.

1.3.3 This Standard will be useful to service providers or others purchasing, installing, or operating telecommunications equipment and devices.

1.3.4 This Standard may be used for specification of the exact interface points between the building electrical systems and the telecommunications grounding and bonding system. It may be used for specifying exact building grounding and bonding system configurations.

1.3.5 This Standard will be useful to building owners and developers who want to build an advanced technology structure that is compatible with modern telecommunications equipment.

1.3.6 A benefit of a telecommunications grounding and bonding infrastructure, as described in this Standard, is a reliable ground reference for telecommunications systems.

## 1.4 Code-related sources

This Standard does not replace any code, either partially or wholly. The reader should also be aware of local codes that might impact the use of this Standard.

## 1.5 Normative and supplementary elements

TIA standards differentiate between normative and supplementary elements. Normative elements are those elements setting out the provisions with which it is necessary to comply in order to be able to claim conformity with this Standard. Supplementary elements are informative elements that provide additional information intended to assist in the understanding or use of this Standard.

## 1.6 Mandatory and advisory terms

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

1.6.2 Mandatory criteria generally apply to protection, performance, and compatibility; they specify the absolute minimum acceptable requirements. Advisory or desirable criteria generally represent product goals. In some instances, these criteria are included in an effort to ensure product compatibility and universal facilities. In other cases, advisory criteria are presented when their attainment will enhance the general performance of the product in all its contemplated applications.

1.6.3 Where both a mandatory and an advisory level are specified for the same criterion, the advisory level represents a goal currently identifiable as having distinct compatibility or performance advantages, or both, toward which future designs should strive.

1.6.4 A note in a table or figure is an official part of this Standard. A note in the text is used only for giving information.

1.6.5 Citations of other documents refer to the latest revision unless specifically dated or otherwise noted.

## 1.7 Metric equivalents of U.S. customary units

The majority of metric dimensions in this Standard are soft conversions of U.S. customary units; e.g., 4 inches equals 100 mm.

## 1.8 Life of this Standard

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

1.8.2 TIA reviews most standards every five years. At that time standards are reaffirmed, rescinded, or revised according to the submitted updates. Update recommendations for inclusion in the next revision should be sent to the secretariat of TIA at the address shown in the forward.

# 2 SCOPE

## 2.1 General

2.1.1 This Standard specifies the requirements for a uniform telecommunications grounding and bonding infrastructure that shall be followed within commercial buildings where telecommunications equipment will be installed.

2.1.2 This Standard specifies a telecommunications grounding and bonding infrastructure and its interconnection to other building systems.

2.1.3 Figure 2.1-1 depicts the scope of the telecommunications grounding and bonding infrastructure for larger, multi-story commercial buildings with multiple telecommunications backbones. Figure 2.1-2 depicts a smaller commercial building where telecommunications spaces are combined. This Standard specifies the requirements for:

--A ground (earth) reference for telecommunications systems within the telecommunications entrance facility, the telecommunications room, and equipment room;

--Bonding of metallic pathways, cable shields, conductors, and hardware at telecommunications rooms, equipment rooms, and entrance facilities.

2.1.4 This Standard is intended to encourage planning, which should include grounding and bonding arrangements to accommodate telecommunications equipment installation.

2.1.5 While primarily intended to provide direction for design of new commercial buildings, this Standard may be used as a guide for the renovation or retrofit of existing buildings.

2.1.6 Design requirements and choices are described to enable the designer to make informed design decisions.

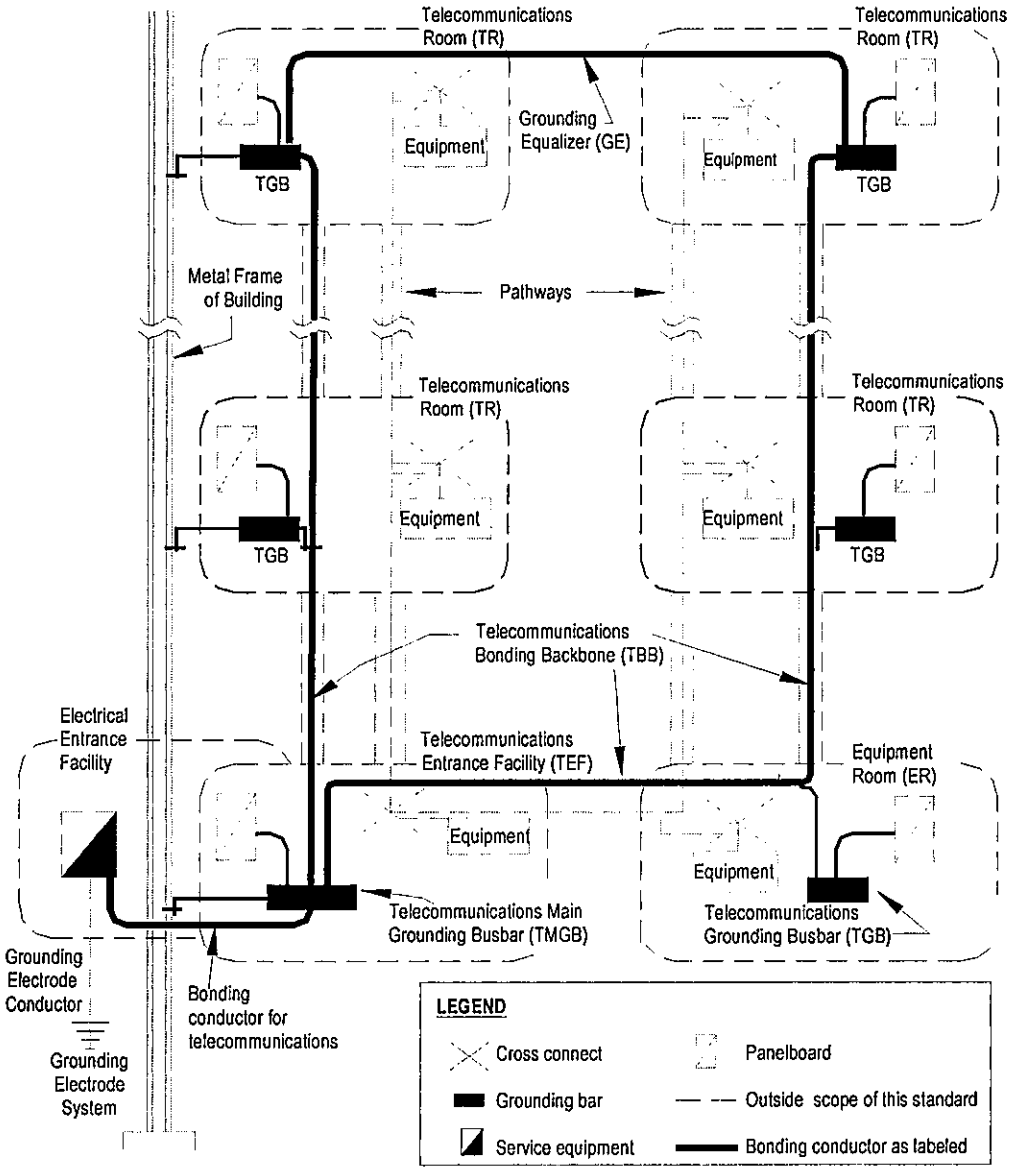


**Figure 2.1-1 Scope of the standard for large commercial buildings**

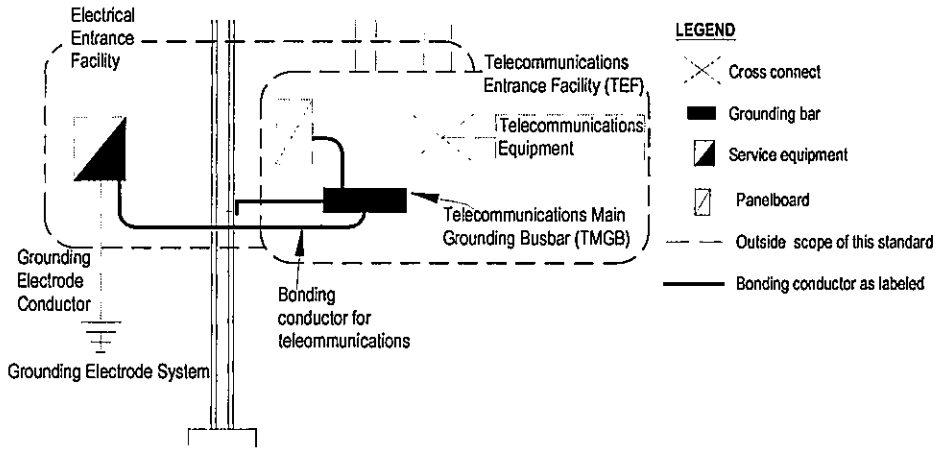


**Figure 2.1-2 Scope of standard for smaller commercial buildings**

## 2.2 Exclusions from this Standard

This Standard does not provide requirements for:

a) Specific grounding and bonding of any telecommunications equipment and associated wiring;
b) Values of surge current immunity and insulation withstand voltages;
c) Methods for verifying and maintaining grounding and bonding networks;
d) Specific methods for RFI/EMI mitigation for equipment or systems;
e) Primary protector/arrester specifications, applications and installation;
f) Secondary protector specifications and applications;
g) Specific user safety;
h) Grounding and bonding practices of the local telecommunications utilities;
i) Electrical service entrance;
j) Grounding of ac surge protection devices;
k) Buildings with more than one electrical service entrance.

## 2.3 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. ANSI and TIA maintain registers of currently valid national standards published by them.

-- ANSI/TIA/EIA 568-B.1-B.3, *Commercial Building Telecommunications Cabling Standard*;

-- ANSI/TIA/EIA 569-A, *Commercial Building Standard for Telecommunications Pathways and Spaces*;

configuration of the telecommunications pathways and spaces. Specifically, the design of a TBB shall:

--be consistent with the design of the telecommunications backbone cabling system;
--permit multiple TBBs as dictated by the building size;
--address routing to minimize the lengths of the TBBs.

5.4.3.2 The interior water piping system of the building shall not be used as a TBB.

5.4.3.3 The metallic cable shield shall not be used as a TBB.

5.4.3.4 Whenever two or more TBBs are used within a multistory building, the TBBs shall be bonded together with a GE (formerly known as telecommunications bonding backbone interconnecting bonding conductor) at the top floor and at a minimum of every third floor in between. The GE shall be sized as specified in 5.4.4.1.

5.4.4 Bonding and sizing the telecommunications bonding backbone (TBB)

5.4.4.1 The TBB shall be a copper conductor. The minimum TBB conductor size shall be a No. 6 AWG. The TBB should be sized at 2 kcmil per linear foot of conductor length up to a maximum size of 3/0 AWG. The TBB may be insulated. If the TBB is insulated, the insulation shall meet the fire ratings of its pathway. The sizing of the TBB is not intended to account for the reduction or control of electromagnetic interference.

| Sizing of the TBB | |
|---|---|
| **TBB length linear m (ft)** | **TBB 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 |
| greater than 20 (66) | 3/0 |

**Figure 5.4.4.1 - Sizing of the TBB**

5.4.4.2 The TBB shall be connected to the TMGB as specified in 5.2.7.1. The intended function of a TBB is to reduce or equalize potential differences between telecommunications systems. While the TBB will carry some current under ac power ground fault conditions, it is not intended to provide the only ground fault return path. A TBB is not intended to serve as the only conductor providing a ground fault current return path.

5.4.5 Installation considerations

5.4.5.1 The TBB conductors shall be installed and protected from physical and mechanical damage.

5.4.5.2 The TBB conductors should be installed without splices. Where splices are necessary, the number of splices should be a minimum and they shall be accessible and located in telecommunications spaces. Joined segments of a TBB shall be connected using exothermic welding, irreversible compression-type connectors, or equivalent. All joints shall be adequately supported and protected from damage.

## 5.5 The telecommunications grounding busbar (TGB)

The TGB is the grounding connection point for telecommunications systems and equipment in the area served by that telecommunications room or equipment room.

5.5.1 Description of the telecommunications grounding busbar (TGB)

5.5.1.1 The TGB shall:

--be a predrilled copper busbar provided with holes for use with standard sized lugs, and
--have minimum dimensions of 6 mm (0.25 in) thick x 50 mm (2 in) wide and variable length to meet the application requirements and with consideration of future growth.
-- be listed by a nationally recognized testing laboratory.

5.5.1.2 It is desirable that the busbar be electrotin-plated for reduced contact resistance. If not plated, the busbar shall be cleaned prior to fastening the conductors to the busbar, and an anti-oxidant should be applied to the contact area to control corrosion and reduce contact resistance.

Figure 5.5-1 depicts a typical telecommunications grounding busbar (TGB).

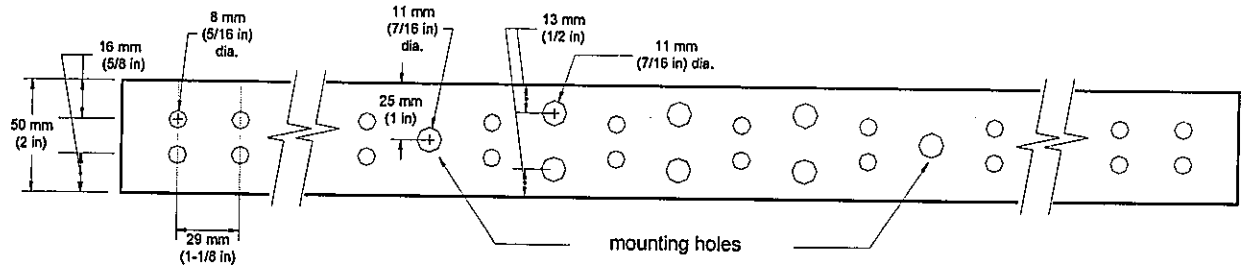


Figure 5.5-1 Typical telecommunications grounding busbar (TGB)

### 5.5.2 Bonds to the telecommunications grounding busbar (TGB)

5.5.2.1 The TBBs and other TGBs within the same space shall be bonded to the TGB with a conductor the same size as the TBB.

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

5.5.2.3 Where a panelboard (electrical power panel) for telecommunications equipment is located within 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.

5.5.2.4 The TGB shall be as close to the panelboard as is practicable and shall be installed to maintain clearances required by applicable electrical codes.

5.5.2.5 Where a panelboard for telecommunications equipment is not located within the same room or space as the TGB, consideration should be given to bonding the panelboard's ACEG bus (when equipped) or the enclosure to the TGB.

5.5.2.6 The TGB shall be bonded to the GE where required per 5.4.3.4.

5.5.2.7 All metallic raceways for telecommunications cabling located within the same room or space as the TGB shall be bonded to the TGB.

5.5.3 Connections to the telecommunications grounding busbar (TGB)

5.5.3.1 Connections of the TBB and the GE to the TGB shall utilize exothermic weld connections, listed compression two hole lugs connectors, suitable and equivalent one-hole non-twisting lugs or other irreversible compression type connectors. Two-hole connectors are preferred.

5.5.4 Installation considerations

5.5.4.1 The TGB shall be insulated from its support. A minimum of 50 mm (2 in) separation from the wall is recommended to allow access to the rear of the busbar.

5.5.4.2 A practical location for the TGB is to the side of the panelboard (where provided). The vertical location of the TGB should take into consideration whether the bonding conductors are routed in an access floor or overhead cable tray.

## 5.6 Bonding to the metal building frame

5.6.1 All connectors used for bonding to the metal frame of a building shall be listed for the intended purpose.

5.6.2 In a metal frame (structural steel) building, where the steel framework is readily accessible within the room; each TGB and TMGB shall be bonded to the vertical steel metal frame using a minimum No. 6 AWG conductor.

5.6.3 Where the metal frame is external to the room and readily accessible, the metal frame should be bonded to the TGB or TMGB with a minimum No. 6 AWG conductor.

5.6.4 When practicable because of shorter distances and, where horizontal steel members are permanently electrically bonded to vertical column members, the TGB may be bonded to these horizontal members in lieu of the vertical column members.

5.6.5 This Standard does not require bonding of the steel bars of a reinforced concrete building to the TGB or TBB.

# 6 TELECOMMUNICATIONS ENTRANCE FACILITY

## 6.1 General

6.1.1 The telecommunications entrance facility (TEF) is the entrance point (room or space within the building) where:

-- the telecommunications facilities enter,
-- the joining of inter- and intrabuilding backbone facilities takes place, and
-- the grounding (earthing) of these facilities is accomplished.

The TEF may also include antenna cable entrances, and electronic equipment serving telecommunications functions.

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

## 6.2 Placing the telecommunications main grounding busbar (TMGB)

6.2.1. The TEF is the desirable location for the telecommunications main grounding busbar (TMGB). The TMGB may also serve as the telecommunications grounding busbar (TGB) for equipment in the TEF.

6.2.2 The TMGB should be placed to provide for the shortest and straightest routing of the primary protector grounding conductor. See Annex B.

6.2.3 The TMGB is the common point in the TEF for all telecommunications grounding connections in that room or space.

6.2.4 The TMGB shall be placed as close as practicable to the panelboard for telecommunications equipment and shall be installed to maintain clearances required by applicable electrical codes.

6.2.5 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 bonding conductor for telecommunications is as short and straight as possible.

## 6.3 Other attachments to the telecommunications main grounding busbar (TMGB)

6.3.1 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 300 mm (1 ft) separation shall be maintained between this insulated conductor and any dc power cables, switchboard

cable, or high frequency cables, even when placed in rigid metal conduit or EMT. Also see 5.2.8.2.

6.3.2 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.

6.3.3 In buildings where the backbone cable incorporates a shield or metallic member, this shield or metallic member shall be bonded to the TMGB or TGB.

6.3.4 Telecommunications primary protectors for the interbuilding backbone cables shall be bonded to the TMGB.

6.3.5 All metallic pathways 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.

## 6.4 Other grounding busbars

The TMGB is intended to be the location for connecting grounding busbars incorporated in telecommunications equipment located in the TEF (e.g., multiplexer or optical fiber termination equipment).

## 6.5 Other service entrances

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 shall be provided in accordance with entrance facility requirements.

# 7 TELECOMMUNICATIONS ROOM AND EQUIPMENT ROOM

## 7.1 General

Each telecommunications room and equipment room shall contain a telecommunications grounding busbar (TGB). The TGB shall be located inside the room. The TGB shall be located so as to provide the greatest flexibility and accessibility for telecommunications system grounding, (minimizing lengths and number of bends of the bonding conductor to the TGB, but within the constraints of Clause 5).

## 7.2 Multiple telecommunications grounding busbars (TGBs)

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

## 7.3 Placing the telecommunications grounding busbar (TGB)

The TGB shall be placed per 5.5.2.4. Where a panelboard for telecommunications equipment is not installed in the telecommunications room, the TGB should be located near the backbone cabling and associated terminations. In addition, the TGB should be placed to provide for the shortest and straightest routing of the grounding conductors.

## 7.4 Other connections to telecommunications grounding busbar (TGB)

7.4.1 In buildings where the backbone telecommunications cabling incorporates a shield or metallic member, this shield or metallic member shall be bonded to the TGB where the cables are terminated or where pairs are broken out.

7.4.2 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.

7.4.3 Short metallic pathways (e.g. wall and floor sleeves) are not required to be bonded.

# 8 WORK AREA

Work area grounding is beyond the scope of this Standard. For information, refer to Annex D.

# 9 TOWERS AND ANTENNAS

## 9.1 General

For minimum tower and antenna grounding specifications refer to Annex C (Informative). It is anticipated that the requirements in this Standard, which address grounding for commercial buildings, will differ from commercial service provider requirements, which are specified in T1.313-1998. The document T1.313-1998 specifications support a very robust level of service appropriate to a service provider. Users of this Standard are encouraged to refer to T1.313-1998 where robust service requirements exist.

## **Annex A** (informative)

## Cross-reference of terms

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

## Annex B (informative)

## Telecommunications electrical protection – primary protector grounding

B.1 Telecommunications network plant is often subject to electrical disturbances arising from lightning and commercial ac power line faults. 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 practicable 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. One exception is urban areas where tall, steel-framed buildings 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 is no lightning or power exposure.

B.2 A critical consideration when placing the primary protector is the length of the primary protector grounding conductor. The primary protector grounding (earthing) 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 lightning surge and the impedance of the grounding conductor which is directly proportional to conductor length. For this reason, network telecommunications utility practices recommend:

-- Locating the telecommunications entrance as close as practicable to the power entrance to minimize the length of the primary protector grounding conductor. The NEC also emphasizes this by requiring a means for intersystem bonding between power and other systems, such as telecommunications systems.

-- Placing the primary protector to allow for the shortest and most direct routing of the primary protector grounding conductor.

B.3 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), maximum effort should be made to keep the primary protector grounding conductor as short as possible. 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 possible. This path may include the *Bonding Conductor for Telecommunications* as illustrated in Figures 2.1-1 and 2.1-2 of

this Standard. The length of the *Bonding Conductor for Telecommunications* may be minimized by locating the telecommunications main grounding busbar (TMGB) as close as practicable to the electrical entrance facility.

B.4 Requirements for telecommunications electrical protection, grounding and bonding at building or structure entrances are contained in the NEC, Chapter 8, *Communications Systems*. Additional detailed electrical protection, grounding and bonding considerations and criteria are contained in ANSI T1.318-1994, *Electrical Protection Applied to Telecommunications Network Plant at Entrances to Customer Structures or Buildings*. 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 C (informative)

# Towers and antennas

## C.1 General

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

## C.2 Antenna locations

C.2.1 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.

C.2.2 Occasionally, the antenna might be mounted on the side wall of a building or on a parapet wall using special braces or supports.

C.2.3 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.

## C.3 Types of support structures

Typical antenna support structures (towers) include:

-- guyed metallic,
-- self-supporting metallic,
-- wooden structures (poles).

The towers can be installed at grade level (surface), on building roofs or side walls.

C.3.1 Guyed metallic towers

These are structures with upright support members (legs) mounted on a foundation or pier that require multiple anchors and down guys.

C.3.2 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.3.3 Wooden structures (poles)

These are either free-standing or guyed structures either mounted on a foundation or partially buried.

## C.4 Structure grounding requirements

C.4.1 All towers and satellite dish mountings should have a grounding electrode system consisting of a ground ring and ground rods.

C.4.2 A #2 AWG solid, bare copper (SBC) conductor should be buried around the tower at a minimum depth of 760 mm (30 in) below grade, and at least 610 mm (24 in) from the base of the tower or mounting. The ends of the #2 AWG conductor should be connected using exothermic welding or a listed connector to form a continuous ring.

C.4.3 Driven ground rods minimum 2.5 m (8 ft) in length and 16 mm (5/8 in) diameter should be placed at the base of each tower leg, a minimum of 460 mm (18 in) below grade. The connection of the ground rods to the ground ring should be accomplished using exothermic welding or listed connectors. Ground rods should be copper, copper clad steel, stainless steel, or zinc clad steel.

C.4.4 The base of each tower leg should be bonded to the ground ring with a #2 AWG conductor. The bonding conductor should be as short and straight as possible.

C.4.5 The metallic frame supporting a satellite dish should be bonded to the ground ring with a #2 AWG conductor, which should be as short and straight as possible.

C.4.6 For monopole or guyed towers, there should be at least two ground rods, driven a minimum of 25 mm (1 in) below grade, equally spaced, and connected to the ground ring using exothermic welding or listed connectors. Grounds of monopole tower mounted antennas should be connected to the ground ring with a #2 AWG SBC conductor using exothermic welding or listed connectors.

C.4.7 The tower ground ring should be bonded to the equipment building ground ring, described in clause C.11.1 with at least two #2 AWG SBC conductors buried at a minimum depth of 760 mm (30 in) between the tower and building ground rings.

C.4.8 If there is a metal fence within 1.8 m (6 ft) of the tower, the tower ground ring should be bonded to the fence with a #2 AWG SBC conductor.

C.4.9 Similar rules apply for bonding a monopole or satellite-mounting ground ring to the equipment building ground ring or fence.

## C.5 Sites with wood poles

C.5.1 In some cases, a site consists only of a wood pole supporting the antenna and the radio equipment cabinet.

C.5.2 All wood poles should have a #2 AWG SBC vertical ground wire terminating in either ground rods, or radials.

C.5.3 Common bonding and grounding principles used on separate building and tower sites also apply in this case. In addition, the following requirements must be met:

C.5.3.1 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.

C.5.4 The conduit from the weatherhead to the power meter should be at least 6 m (20 ft) long. This aids the operation of the power arrester at the weatherhead.

## C.6 Roof-mounted towers

C.6.1 When the antenna support or tower is mounted on the roof of a building, a grounding system should be designed that meets the following clauses:

C.6.1.1 Uses regular lightning protection cables and hardware following the recommendations of the NPFA-780 Standard for the Installation of Lightning Protection Systems.

C.6.1.2 Places a wire ring (roof ring) around the antenna support or tower.

C.6.1.3 Connects the tower base footings to the:

-- Tower ground ring.
-- Waveguide, or coaxial, outer conductor.
-- Lighting AC branch circuit metallic conduit and green wire (ACEG).
-- Lightning arrester ground.

C.6.1.4 Connects:

-- Antenna metal members to the tower or antenna support structure.
-- Antenna support structure to ring.
-- Lightning protection system perimeter wires.
-- 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.*

## C.7 Down conductors

C.7.1 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.

C.7.2 Additional down conductors are needed for each 30 m (100 ft) of building length.

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

## C.8 Roof conductors

C.8.1 Roof conductors should be supported every 1 m (3 ft) using either no-nail paste down cable fasteners, or pan-type base ridge cable supporters.

## C.9 Radial grounding conductors

C.9.1 Radials should be provided if ground rods cannot be driven and it is not feasible to drill. When radial grounding conductors are necessary, the following should be used to determine requirements:

C.9.1.1 When towers are constructed on sites where bedrock prevents placing ground rods, a network of buried grounding conductors should be provided radiating from each base of the antenna and building corner and connecting to the ground rings.

C.9.2 When radial grounding conductors are required a #2 AWG SBC conductor connected to the ground ring and buried at least 760 mm (30 in) below grade level should be used.

C.9.3 If adequate contact cannot be reached with the soil at 7.6 m (25 ft), extend each radial wire as far as necessary to obtain the desired resistance. The conductor length should not be less than 7.6 m (25 ft).

*NOTE: Low resistance in radial grounding arrangements is desirable but not essential. Low resistance in the dissipating path of strike currents into the earth is of secondary importance when compared to the major objective of controlling voltage gradients and voltage differences between structures close to the radio equipment.*

## C.10 Waveguide and coaxial cable grounding requirements

C.10.1 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 m (200 ft) in height, the waveguide or coax shield should also be bonded at the tower midpoint or every 15 m (50 ft).

C.10.2 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 #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 #2 AWG conductor, as close as practical to the entrance.

C.10.3 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 #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 #2 AWG conductor.

C.10.4 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.

C.10.5 If the tower is lighted, the conduit for the lighting power conductors should be bonded and grounded as described for waveguide and coaxial cable shields.

## C.11 Equipment building grounding requirements

C.11.1 When the equipment building is located atop a building, grounding for externally mounted system metallic components including antennas, cabling, conduits, cable trays, entry ports, window frames and door frames is a critical requirement. Externally mounted wireless components should be grounded to the building lightning protection system, which may include bonding to down conductors or building steel, or may employ an independent system to achieve adequate grounding.

C.11.2 Special grounding procedures should be followed for buildings that house radio equipment. Radio equipment buildings should have an exterior ground ring consisting of #2 AWG bare wire buried a minimum of 760 mm (30 in) below grade and at least 610 mm (2 ft) from any portion of the structure. The ends of the wire should be joined with an exothermic connection or listed connectors to form a continuous ring.

C.11.3 Ground rods, driven to a minimum cover depth of 460 mm (18 in) should be placed at 3 - 4.5 m (10 – 15 ft) intervals and connected directly to the ground ring with exothermic connections or listed connectors.

C.11.4 The equipment building ground ring should be bonded to the tower ground ring, described in section C.4, with at least two #2 AWG SBC conductors.

C.11.5 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 #2 AWG SBC conductor.

C.11.6 Radio equipment buildings with nonmetallic walls should have an interior ground ring consisting of a #2 AWG conductor mounted, with nonmetallic connections, to the interior wall within 0.3 m (1 ft) of the ceiling.

C.11.7 Radio equipment buildings with metallic walls should have an interior ground ring consisting of a #2 AWG conductor mounted directly to the interior wall within 0.3 m (1 ft) of the ceiling.

C.11.8 The interior ground ring should be bonded to the exterior ground ring with #2 AWG conductor, routed as straight as possible, using exothermic connections or listed connectors.

# Annex D (informative)

# Work Area

## D.1 Co-location of electrical power and telecommunications grounding facilities

D.1.1 Telecommunications equipment is often connected to both the electrical power and telecommunications grounding systems. It is important that both grounding systems be at the same reference potential. This is critical for implementation of shielded/screened twisted pair cabling systems. ANSI/TIA/EIA 568-B.1-B.3 limits the potential difference between power and telecommunications ground references to a maximum of 1 volt for shielded/screened cable applications.

## D.2 Electrical protection for operator-type equipment positions

D.2.1 High technology devices are increasingly being implemented at the work area, including one or more computers, phones, printers, etc. In communications-intensive operations, personnel may wear voice headsets connected to headset interface equipment in addition to the typical work area 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 (VDT), 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. Refer to Figure D.2-1.

D.2.2 Operator-type equipment positions (workstations) should be grounded in accordance with T1.321-1995 *Electrical Protection for Network Operator-type Equipment Positions.*

D.2.3 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 ac power disturbances.

Standard T1.321-1995 *Electrical Protection for Network Operator-type Equipment Positions* 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 to control ESD in the network operator-type environment. Standard T1.321 also presents additional measures that are intended to help minimize the effects of lightning, surges from commercial 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 TEF and the power entrance facility (PEF), as well as for equipotential bonding and grounding, where necessary, and electrical protection at the network operator-type equipment positions. Although

standard T1.321 deals specifically with network locations, the measures outlined in the standard are applicable to non-network installations, as well as at existing installations.

D.2.4 The electrical protection measures included in standard T1.321 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.

D.2.5 General electrical safety and protection requirements that may be applied to work areas are contained in the NEC.

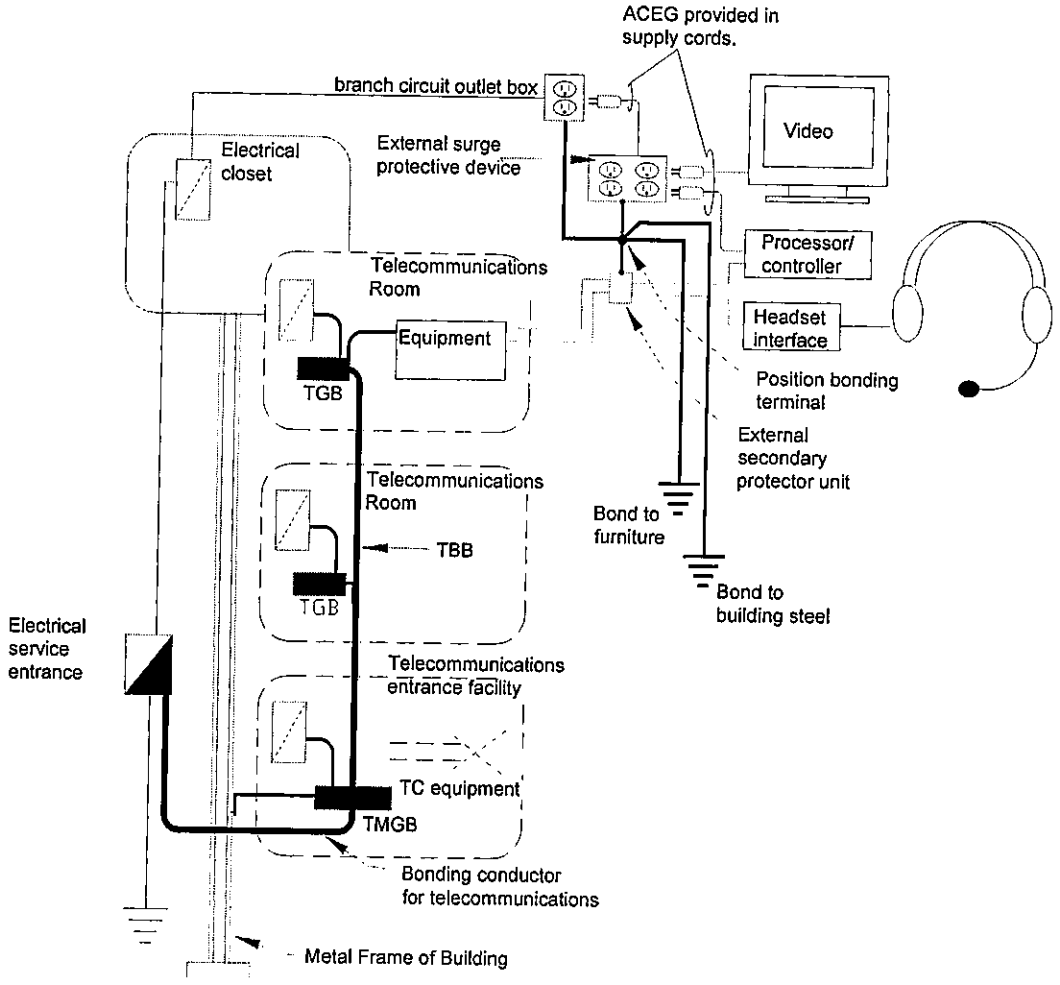


Fig.D.2-1 Electrical protection for operator-type equipment positions

## Annex E (informative)

## References

E.1 ANSI/IEEE 1100 *Recommended Practice for Power and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems* (also known as IEEE Emerald Book), Institute of Electrical and Electronic Engineers.

E.2 BICSI Telecommunications Distribution Methods Manual, BICSI.

E.3 EIA EP-7B, *Style Manual for Standards and Publications*, Electronic Industries Association.

E.4 T1.313-1998 *Electrical Protection for Telecommunications Central Offices and Similar Type Facilities*

E.5 CSA-T529-M91, *Design Guidelines for Telecommunications Wiring Systems in Commercial Buildings*;

E.6 CSA-T530-M90, *Building Facilities, Design Guidelines for Telecommunications*;

E.7 CSA-T528-M93, *Building Facilities and Wiring/Cabling for Telecommunications, Design Guidelines for Administration.*

E.8 The National Communications System (NCS), Technical Information Bulletin (TIB) 92.15, *Grounding and Bonding for Commercial and Government Buildings Conforming to Telecommunications Infrastructure Standards - A Background Report.*

E.9 MIL-STD-188-124B, *Military Standard Grounding, Bonding and Shielding.*

E.10 *Military Handbook 419A, Grounding, Bonding, and Shielding for Electronic Equipment and Facilities,* Volumes 1 & 2.

E.11 T1.318-1999 Electrical Protection Applied to Telecommunications Network Plant at Entrances to Customer Structures or Buildings.

E.12 International Special Committee on Radio Interference (CISPR) Publication 22.

E.13 T1.321-1995 (R 2000) Electrical Protection for Network Operator-type Equipment Positions.

E.14 ANSI/NPFA-780-1997 Standard for the Installation of Lightning Protection Systems

For additional information about references, contact the respective organizations at the following addresses:

ANSI
American National Standards Institute
430 Broadway
New York, NY 10018 USA
(212) 642-4900

ATIS
Alliance for Telecommunications Industry Solutions
1200 G Street, NW
Suite 500
Washington, D.C. 20005
(202)628-6380

BICSI
BICSI
8610 Hidden River Pkwy.
Tampa, FL 33637-1000 USA
(813) 979-1991

EIA
Electronic Industry Alliance
2500 Wilson Blvd., Suite 400
Arlington, VA 22201 USA
(703) 907-7500

IEEE
Institute of Electrical and Electronic Engineers
445 Hoes Lane
PO Box 1331
Piscataway, NJ 08855-1331 USA
(800) 678 IEEE

NFPA National Fire Protection Association
1 Batterymarch Park
Quincy, MA 02269 USA

TIA
Telecommunications Industry Association
2500 Wilson Blvd., Suite 300
Arlington, VA 22201 USA
(703) 907-7706

UL
Underwriters Laboratories, Inc.
333 Pfingsten Road
Northbrook, IL 60062 USA
(847) 272-8800