ATIS STANDARD

ATIS-0600321.2020

Electrical Protection For Network Operator-Type Equipment Positions

AMERICAN NATIONAL STANDARD FOR TELECOMMUNICATIONS

ATIS-0600321.2020, *Electrical Protection For Network Operator-Type Equipment Positions*
Is an American National Standard developed by the ATIS **Network Electrical Protection (NEP)** Subcommittee under the **ATIS Sustainability in Telecom: Energy and Protection Committee (STEP)**.

Published by
Alliance for Telecommunications Industry Solutions
1200 G Street, NW, Suite 500
Washington, DC 20005

ATIS-0600321.2020

[Revision of ATIS-0600321.2015]

American National Standard for Telecommunications

ELECTRICAL PROTECTION FOR NETWORK OPERATOR-TYPE EQUIPMENT POSITIONS

Alliance for Telecommunications Industry Solutions

Approved September 7, 2020

American National Standards Institute, Inc.

Abstract

This standard addresses electrical protection at new installations of network operator-type equipment positions, and at buildings housing such positions. Electrical disturbances may appear at network operator-type equipment positions arising either from Electrostatic Discharge (ESD), or from other sources that are internal or external to the building containing these positions, such as lightning or ac power disturbances. Measures are presented that are intended to help to control ESD in the network operator-type environment, and to provide electrical protection measures that are intended to minimize potential differences at the network operator-type equipment position.

Foreword

The information contained in this Foreword is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI's requirements for an ANS. As such, this Foreword may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the Standard.

The Alliance for Telecommunication Industry Solutions (ATIS) serves the public through improved understanding between providers, customers, and manufacturers. The Sustainability in Telecom: Energy and Protection (STEP) Committee – formerly the Network Interface, Power, and Protection Committee (NIPP) -- engages industry expertise to develop standards and technical reports for telecommunications equipment and environments in the areas of energy efficiency, environmental impacts, power and protection. The work products of STEP enable vendors, operators and their customers to deploy and operate reliable, environmentally sustainable, energy efficient communications technologies. STEP is committed to proactive engagement with national, regional and international standards development organizations and forums that share its scope of work.

Electrical disturbances may appear at network operator-type equipment positions arising either from Electrostatic Discharge (ESD), or from other sources that are internal or external to the building containing these positions, such as lightning or ac power disturbances. Measures are presented that are intended to help to control ESD in the network operator-type environment. Additional measures are presented 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. In no way is this standard intended, however, to guarantee against damage or injury that may result from ESD or other similar occurrences.

Although a large resource of information exists within the telecommunications industry regarding control of ESD, as well as the electrical protection, bonding, and grounding of telecommunications installations, there are presently no U.S. standards that are specific to the network operator-type equipment position environment. American National Standard National electrical code, NFPA 70® [Ref 10], as well as American National Standard for Telecommunications – Electrical protection applied to telecommunications network plant at entrances to customer structures or buildings, ATIS-0600318 [Ref 4] (formerly T1.318), contain basic safety and electrical protection requirements applicable to network operator-type equipment position installations. It is not intended that this standard supersede NFPA 70® [Ref 10] or ATIS-0600318 [Ref 4], but that it provide additional information to reduce electrical disturbances at network operator-type equipment installations.

The need for this standard was recognized by the Protection Engineers Group of the Alliance for Telecommunications Industry Solutions (ATIS) which submitted the initial project proposal and provided the seed documentation. Subject matter experts were gathered under the auspices of STEP to determine the necessary criteria to minimize electrical disturbances at network operator-type equipment positions.

There is one annex to this standard. Annex A is informative and is not considered a part of this standard.

Suggestions for improvement of this document are welcome. They should be sent to the Alliance for Telecommunications Industry Solutions, STEP, 1200 G Street NW, Suite 500, Washington, DC 20005.

At the time it approved this document, STEP, which is responsible for the development of this Standard, had the following members:

Ernie Gallo, STEP Chair (Ericsson)
John Fuller, STEP Vice-Chair and STEP NEP Vice-Chair (AT&T)
Dan Ashton, STEP NEP Chair (CenturyLink)

The NEP Subcommittee was responsible for the development of this document.

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Electrical Protection For Network Operator-Type Equipment Positions

1 Introduction

This standard addresses electrical protection at new installations[1] of network operator-type and Public Safety Access Points (PSAPs) equipment positions and at buildings housing such positions. At these locations, personnel are often situated at work positions containing a headset, headset interface equipment, other electronic equipment such as a computer keyboard and Video Display Terminal (VDT), and the work position furniture. Frequently, work positions are arranged in clusters consisting of several positions.

Electrical disturbances may appear at network 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.

1.1 Purpose

The purpose of this standard is to provide ESD-mitigative measures that are intended to control ESD in the operator-user environment, and to provide electrical protection measures that are intended to minimize potential differences at the network operator-type equipment position. It is not to guarantee against the occurrence of ESD or other electrical disturbances or their effects.

1.2 Scope

This standard covers new installations[1] of network and PSAP operator-type equipment positions in which personnel are required to access a computer terminal keyboard while continually wearing a headset.

Measures are presented that are intended to help to control ESD in the network operator-type environment. To help minimize the effects of lightning, surges from commercial ac power lines, and power switching operations, measures are provided for equipotential bonding and grounding at the communication Cable Entrance Facility (CEF) and the Power Entrance Facility (PEF), as well as for equipotential bonding, grounding and, where necessary, electrical protection at the network operator-type equipment position(s).

[1] Although the measures outlined in this standard are specifically intended for new installations, some of the techniques presented may also be useful at existing installations.

2 Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this American National Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

The following documents or portions thereof are referenced within this standard and shall be considered part of the requirements of this document.

2.1 Normative References

[Ref 1] ANSI C2®, *National electrical safety code®.*[2]

[Ref 2] ANSI C62.61®, *Gas tube surge arresters on wire line telephone circuits.*[3]

[Ref 3] ATIS-0600313, *Electrical protection for telecommunications central offices and similar type facilities.*[44]

[Ref 4] ATIS-0600318, *Electrical protection applied to telecommunications network plant at entrances to customer structures or buildings.*[4]

[Ref 5] ESD S4.1®, *Protection of electrostatic discharge susceptible items – Worksurfaces – Resistive characterization.*[5]

[Ref 6] ESD S6.1®, *Protection of electrostatic discharge susceptible items – Grounding – Recommended practice.*[5]

[Ref 7] IEEE C62.41.2, *Recommended practice on characterization of surges in low-voltage (1000V and less) ac power circuits.*[2]

[Ref 8] IEEE C62.42™, *Guide for the application of gas tube and air gap arrester low-voltage (equal to or less than 1000 Vrms or 1200 Vdc) surge-protective devices.*[2]

[Ref 9] IEEE Standards Dictionary Online.[2]

[Ref 10] NFPA 70®, *National electrical code®.*[6]

[Ref 11] UL 497A®ANSI/UL 497A, *Secondary protectors for communication circuits.*[7]

[Ref 12] IEC/UL 60950-1® Second Edition, CAN/CSA-C22.2 NO. 60950-1-07® (R2012): *Information Technology Equipment - Safety - Part 1: General Requirements.*[7]

[Ref 13] ESD-S11.11®, *Standard for Protection of Electrostatic Discharge Susceptible Items – Surface Resistance Measurement of Static Dissipative Planar Materials.*[5]

[Ref 14] ESD-S7.1®, *Standard for Protection of Electrostatic Discharge Susceptible Items – Floor Materials – Resistive Characterization of Materials.*[5]

[Ref 15] MPR 1990:8®, *Test Methods for VDU – Visual Ergonomics and Emission Characteristics.*[8]

[Ref 16] UL 1449, *Standard for Safety – Transient Voltage Surge Suppressors.*[7]

[Ref 17] NENA© E9-1-1, *PSAP Equipment Standards.*[9]

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[2] This document is available from the Institute of Electrical and Electronics Engineers (IEEE). < http://standards.ieee.org/ >

[3] This document is available from the National Electrical Manufacturers' Association. < http://www.nema.org/ >

[4] This document is available from the Alliance for Telecommunications Industry Solutions (ATIS), 1200 G Street N.W., Suite 500, Washington, DC 20005 < https://www.atis.org/>.

[5] Available from the ESD Association. < http://www.esda.org/standards.html >

[6] This document is available from the National Fire Protection Association (NFPA®). < http://www.nfpa.org/ >

[7] This document is available from Underwriters Laboratories, Inc. (via comm2000). < http://www.comm-2000.com/ >

[8] Published by the Swedish National Board for Measurement and Testing. Available from SWEDAC, Box 878, S-50115, Boras, Sweden.

[9] This document is available from the National Emergency Number Association (NENA). < https://www.nena.org >

[Ref 18] Motorola© R56, *Standards and Guidelines for Communication Sites.*[10]

2.2 Informative References

[Ref 100] IEEE 1100™, *IEEE Recommended practice for Powering and grounding sensitive electronic equipment.*[2]

[Ref 101] ESD-ADV1.0®, *ESD Association Advisory – Glossary of Terms.*[5]

[Ref 102] ATIS-0600333, *Grounding and Bonding of Telecommunications Equipment.*[4]

[Ref 103] ANSI-J-STD-607-A®*, Joint Standard Commercial Building Grounding (Earthing) And Bonding Requirements For Telecommunications.*[11]

[Ref 104] TIA942®, *Telecommunications Infrastructure Standard for Data Centers.*[12]

[Ref 105] IEEE C62.36®, *IEEE standard test methods for surge protectors used in low-voltage data, communications, and signaling circuits.*[2]

[Ref 106] IEEE PC62.50®*, Standard for Performance Criteria and Test Methods of Plug-in Multiport (Multiservice) Surge-Protective Devices for Equipment Connected to 120/240 V Single Phase Power Service and Communications Lines.*[2]

[Ref 107] IEEE PC62.51®, *Draft Guide for Performance Criteria and Test Methods of Hardwire Multiport (Multiservice) Surge-Protective Devices for Equipment Connected to 120/240 V Single Phase Power Service and Communications Lines.*[2]

3 Definitions, Acronyms, & Abbreviations

3.1 Definitions

Unless otherwise defined in this clause, the definitions of all terms used in this standard conform to IEEE 100.

Antistatic: The property of a material that inhibits triboelectric charging. The term antistatic should not be used to refer to static dissipative materials. A material's antistatic characteristic does not necessarily correlate with its resistivity or resistance.

Cable Entrance Facility (CEF): A space in a building where cables enter from the outside plant communication network. Cable metallic members are usually grounded here.

Electrostatic Charge (Static Electricity): Electric charge at rest.

Electrostatic Discharge (ESD): The rapid, spontaneous transfer of electrostatic charge induced by a high electrostatic field. Usually the charge flows through a spark (static discharge) between two bodies at different electrostatic potentials as they approach one another.

Electrostatic Field: The electric field produced by an electrostatic charge.

Electrostatic Potential: The electrical potential produced by an electrostatic charge.

Electrostatic Shield: A barrier or enclosure that attenuates an electrostatic field.

ESD protected area: A designated environment provided with materials and equipment to limit electrostatic potentials.

ESD Protective: Having the capability of dissipating or limiting the generation of electrostatic charge, or of providing shielding from electrostatic discharges or electrostatic fields.

Insulative: Property of a material having a surface resistivity of at least 10^{12} ohms per square.

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[10] This document is available from Motorola Solutions. < https://www.motorolasolutions.com >

[11] This document is available from Global Engineering Documents < http://global.ihs.com>

[12] This document is available from TIA. < https://tiaonline.org/ >

Metallic Member: A non-communications metallic cable component such as a shield, vapor barrier, or strength member.

Position Bonding Terminal (PBT): A point, such as a metallic terminal, bus or plate, to which all bonding connections are intended to be made at the network operator-type equipment position.

Power Entrance Facility (PEF): A space in a building where commercial ac power, standby ac power, or both, enter the building. The PEF contains the ac service equipment and may also contain secondary ac surge protective devices.

Primary Protector: A protective device placed on telecommunications conductors in accordance with NFPA 70® [Ref 10].

Principal Ground Point (PGP): A point within a structure that provides a means to join conductors requiring an earth reference to grounding electrodes. This point may be a separate busbar located in the structure near the entrance of the grounding electrode conductor(s), or it may be a point on a grounding electrode.

> NOTE: In a central office, the preferred term, per ATIS-0600333 is "Building Principal Ground (BPG)". It may also be called "reference point 0" (see ATIS-0600313 [Ref 3]).

Ring Ground: A buried grounding electrode, in the form of a conductor in direct contact with the earth, encircling the structure being grounded. See NFPA 70® [Ref 10], Article 250.52(A)(4).

Secondary Protector: A protector installed in series with the indoor communications wire and cable between the primary protector and the equipment. The secondary protector provides a means to safely limit the current to less than the current-carrying capacity of the indoor communications wire or cable, telephone set line cords, and terminal equipment. Secondary protectors are typically listed per UL 497A® [Ref 11].

Spark: An electrical discharge of very short duration, normally between two conductors separated by a gas (such as air).

Static Dissipative: The property of a material having a surface resistivity of at least 10^5 ohms per square, but not more than 10^{12} ohms per square.

Surface Resistivity: For electric current flowing across a surface, the ratio of DC voltage drop per unit length to the surface current per unit width. Surface resistivity has units of ohms but is usually written in ohms per square to point out that it is, in effect, the resistance between two opposite sides of a square and is independent of the size of the square or its dimensional units.

Surge: A transient wave of voltage or current. The duration of the surge is not tightly specified, but it is usually less than a few milliseconds.

Surge Protective Device (SPD): An assembly of one or more components intended to limit or divert surges. The device contains at least one nonlinear component. *In the context of this document, SPDs are used with ac power circuits*.

Triboelectric: Relating to the generation of electrostatic charges when two contacting pieces of material are separated or rubbed together.

3.2 Acronyms & Abbreviations

AC	Alternating Current
ACEG	AC Equipment Grounding
ANS	American National Standard
ANSI	American National Standards Institute
ATIS	Alliance for Telecommunication Industry Solutions
AWG	American Wire Gage
BPG	Building Principal Ground
BSS	Building Structural Steel
CEF	Cable Entrance Facility
DC	Direct Current

ESD	Electrostatic Discharge
IEEE	Institute of Electrical and Electronics Engineers
IGZ	Isolated Ground Zone
MGB	Master Ground Bus (bar)
MGE	Building Made Ground Electrode System
MGN	Multi-Grounded Neutral
MSPD	Multi-port (Multi-service) Surge Protective Device
NENA	National Emergency Number Association
NEP	Network Electrical Protection
NFPA®	National Fire Protection Association
NON-IGP	Non-Isolated Ground Plane
NON-IGPB	Non-Isolated Ground Zone Ground Bar
NON-IGZ	Non-Isolated Ground Zone
NON-IGZB	Non-Isolated Ground Zone Bar
PBT	Position Bonding Terminal
PEF	Power Entrance Facility
PGP	Principal Ground Point
PSAP	Public Service Answering Point
rms	Root Mean Square
SPD	Surge Protective Device
SPGS	Single Point Ground System
STEP	Sustainability in Telecom: Energy and Protection Committee
UL	Underwriters Laboratories, Inc.
VDT	Video Display Terminal

4 Measures for Controlling Electrostatic Discharge

Electrostatic charges generated by the triboelectric effect may develop on personnel when they walk on carpeted floors, sit on, or rise from upholstered chairs or brush insulative clothing against furniture. These charges create electrostatic potentials that may exceed 15,000 volts in the absence of measures to control ESD. The intense electric fields generated at the screens of video display terminals can also induce electrostatic potentials on their users. Charge transfer occurs when a person contacts a conductive surface at a different electrostatic potential (usually zero or ground). If the electrostatic potential of the person is sufficiently high and the surface sufficiently conductive, there is a rapid discharge. This discharge is known as ESD.

Historically, the primary ESD concern was related to the reliability of electronic equipment when subjected to discharges from personnel. As a result, most equipment is now designed to withstand relatively high levels of ESD. However, in facilities where ESD is not controlled, there is also an issue of personnel comfort. While generally not considered harmful, electrostatic discharges to personnel can be annoying or even painful. Although electrostatic potentials can be very large, the low capacitance of the human body limits the charge that flows in an ESD event. Discharges to the hand are usually imperceptible below potentials of 3,000 volts; for sensitive areas such as the face, the threshold of perception may be 500 volts or lower.

ESD protective measures are used commonly in locations where integrated circuits and other microelectronic devices are handled. These measures are intended to keep electrostatic potentials to very low levels (less than 10 volts). In general, the measures required to maintain ESD at levels that are comfortable for personnel can be less stringent. The control measures of clause 4 are intended to either reduce the incidence of triboelectric charging (antistatic measures) or to ensure slow charge removal (static dissipation).

There are many strategies for minimizing ESD events. The following clauses list a variety of such measures but are by no means all-inclusive. As a rule, not all of these techniques will be either necessary or desirable to establish an ESD protected area. The appropriate ESD protection strategy should be based on the particular application and the advantages and disadvantages of each ESD protective method.

4.1 Relative Humidity Control

Control of the relative humidity can be an effective means for ESD mitigation because it aids static dissipation and is associated with lowered triboelectric charging. Many topical antistatic compounds lose their effectiveness if the humidity is too low. Also, contaminants on insulative surfaces become more conductive when humidity increases, a process that often lowers the resistance to ground enough to inhibit ESD. However, because this process depends on (uncontrolled) surface contamination, it should not be relied upon to provide static dissipation.

Rooms containing network operator-type positions should be maintained within the range of 40 to 55 percent relative humidity. Below 40 percent, ESD events are more likely. Above 55 percent, electrolytic corrosion may affect equipment performance. A possible disadvantage of relative humidity control is that improperly designed or maintained humidification systems pose the risk of microbial contamination.

4.2 Flooring

Any carpeting or floor tiles should have a resistance to ground between 10^6 and 10^{10} ohms when measured using the method of ESD-S7.1® [Ref 14]. Existing flooring that does not meet this requirement should be treated with a topical antistatic solution such as an antistatic floor wax. The effectiveness of antistatic solutions is temporary and varies with floor material and relative humidity. Flooring resistance should be monitored every two weeks minimum to verify conformance to the above requirement.

4.3 Chairs

Chairs should be ESD protective and have a resistance to ground of between 10^6 and 10^{10} ohms. Such chairs usually operate in conjunction with ESD protective flooring as described in 4.2.

4.4 Position Desktops (Work Surfaces)

Areas on the desktop of operator positions that may be touched by the operator should have a resistance to ground of between 10^6 and 10^{10} ohms when measured with the method of ESD S4.1 [Ref 5]. This can be accomplished by placing an appropriately sized mat under and around the keyboard. The mat should be grounded in accordance with ESD S6.1 [Ref 6].

4.5 Antistatic Solutions

Topical antistatic coatings should provide a surface resistivity of between 10^5 and 10^{10} ohms per square when measured using the method of ESD-S11.11 [Ref 13]. Such coatings are not permanent and should be remeasured at least every two weeks to verify their performance.

> NOTE: ohms per square is equal to the resistance between two electrodes on opposite sides of a theoretical square. The size of the square is unimportant.

4.6 Video Display Terminals

When a VDT employing a cathode ray tube is switched on or off, the redistribution of charge within the VDT creates powerful external electric fields. An ungrounded operator who is touching the VDT screen, or even located near the VDT, will be polarized by the electric field and can experience an increase in electrostatic potential of more than 7000 volts. This field-induced electrostatic potential can occur without any flow of charge to or from the VDT. When the operator reaches an elevated electrostatic potential, a spark can be drawn to any nearby metallic (or other sufficiently conductive) surface. Two strategies effectively mitigate field-induced ESDs: the use of static dissipative materials and shielding.

Ungrounded operators can reduce field-induced electrostatic potentials on their bodies by touching static dissipative materials at an operator-type equipment position (see 4.2 – 4.5). Because static dissipative materials have surface resistivities in the range of 10^5 to 10^{12} ohms per square (see clause 3.1.19), the large potential difference between the operator and the material is equalized with little or no spark. However, if there is any bare metal in the work area, the possibility remains for an ungrounded operator to experience a startling or painful ESD event.

The second mitigative strategy for VDTs is electrostatic shielding. A conductive shield or enclosure can suppress the fields generated when the VDT switches on or off. Such shields can take the form of a grounded conductive bezel or conductive “anti-glare” screen coating or guard. Hand-held electric field meters can be used to obtain a qualitative estimate of the effectiveness of a shield or screen guard. VDTs may also be constructed to be electrostatically shielded. Electrostatic shielding of VDTs is covered in MPR 1990:8 [Ref 15].

5 Building Entrance Facilities

5.1 Siting the PEF, CEF, & PGP

Locating the PEF and CEF is usually an option only at the design stage of a new or extensively renovated building. The location criteria presented in this clause are intended for such situations. The PEF, CEF, and PGP should be located as close to each other as practicable, but less than 6 meters (20 feet) apart to minimize bonding conductor length. The PGP for the building shall be established near the point where the grounding electrode conductor enters the building. See figure 1.

5.2 Communication Cable Protection

Primary protectors shall be applied to entering telecommunications conductors in accordance with NFPA 70® [Ref 10]. This arrangement is illustrated in figure 1. Metallic members, such as cable shields or strength members, of all entering cables shall either be bonded together and grounded, or interrupted by an insulating joint or equivalent device, per NFPA 70® [Ref 10]. The bonding conductor or ribbon shall, as a minimum, be equivalent to 6 AWG copper, should be as short as practicable, and should be connected to the CEF ground bar, or if there is no CEF ground bar, directly to the PGP.

5.3 Power Entrance Protection

To limit surge voltages that may enter the building on the ac power service conductors, a surge protective device that can withstand the standard surge wave shape characteristics of premises wiring (see IEEE C62.41®), and that is listed by a nationally recognized testing laboratory in accordance with UL 1449® [Ref 16], should be applied on the load side of the power service disconnect.

5.4 Intersystem Bonding

Bonding conductors between the CEF and the PGP, and the PEF and the PGP shall be provided in accordance with NFPA 70® [Ref 10]. This arrangement is illustrated in figure 1.

Where a building contains more than one CEF, PEF, or PGP, an additional bonding conductor should connect to the ground bar at each entrance. This additional bonding conductor should follow the periphery of the building and will form a “ring”. This is illustrated in figure 2. The additional bonding conductor should be a minimum 6 AWG insulated copper conductor.

5.5 Buildings Having a Ring Ground System

Where a ring ground is present at the building containing network operator-type equipment positions, the CEF and PEF ground bars should connect directly to the external buried ring ground conductor via conductors of shortest length. These conductors, which penetrate the building exterior walls, are in addition to the bonding conductors described above. When a ring ground system is used, it shall be bonded to the PGP. Where other grounding electrode configurations are used, the grounding electrode conductor shall be bonded to the PGP.

NOTE: Figure 1 includes additional pictorial information on proper grounding methods.

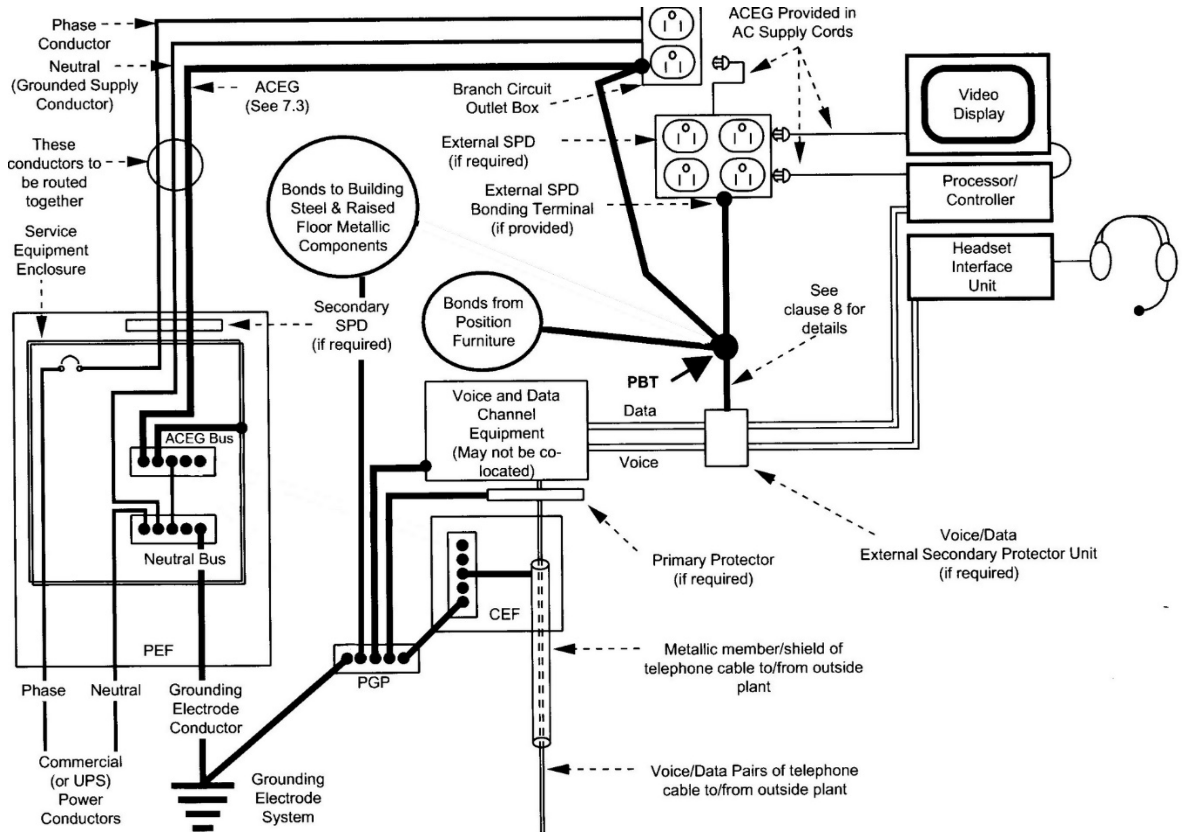

Figure 5.1 – Example of entrance facility bonding, PBT, external secondary protector and external SPD at ac-powered network operator-type equipment positions

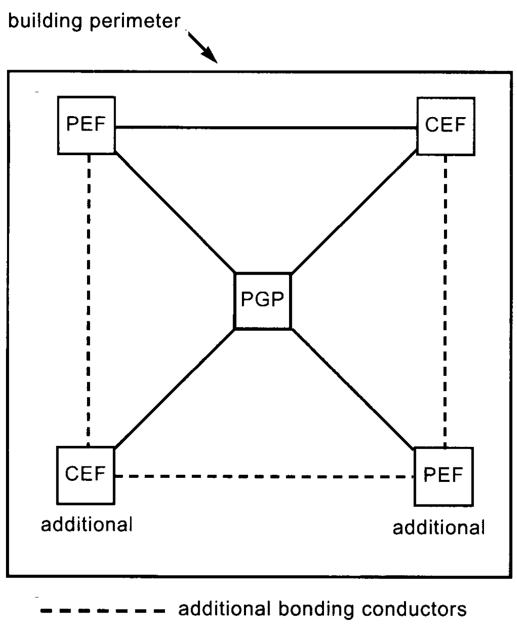

Figure 5.2: Example of bonding in a building with additional entrance facilities

5.6 Public Safety Answering Point (PSAP) Locations

5.6.1 Single Point Ground System

The single point ground system (SPGS) is a grounding methodology that provides a single ground reference point which creates an equal electrical potential for all metallic structures (and equipment) within a given area. Single point ground system components consist of ground electrodes, grounding electrode conductors, grounded conductors, grounding conductors and grounding bus bars.

Grounding conductors are designed to create a path of least resistance/impedance. This allows any current produced from a fault to flow or return to Earth (ground) along a designed path.

Connections to the SPGS will reduce voltage potential differences between metallic components and equipment. This should reduce personnel safety hazards, protect the equipment and reduce noise currents that may affect the operation of voltage-sensitive equipment. This includes equipment such as communication switching equipment and any computer controlled equipment.

The SPGS has one main connection point. The single ground reference point is usually designated as the master ground bus (bar) (MGB).

Different standards may specify other titles for this single ground reference point. Carrying out the SPGS methodology is simple yet very complex. The designated grounding conductors are connected throughout the building safety protection system within designated areas to the single ground reference point at the MGB.

Grounding conductors and their grounded components must be isolated from any unintended contact with other grounding conductors and grounded components except at the single ground reference point. Any unintended points of contact among different grounding conductors and components create ground loops within the SPGS and are violations of the SPGS.

The Single Point Ground System (SPGS) master ground bus bar (MGB) is divided into (P-A-N-I) sections, which designates where specific grounding conductors are terminated. Each conductor connection attached to the MGB should be tagged or stenciled to identify its point of origin.

These sections are as follows:

5.6.2 (P) – Surge Producers

Grounding conductors are expected to reduce surge current. Different sources of surge energy include local lightning strikes, local commercial power surges, electrostatic discharges (ESD) from within the building, or any combination directed into the building on commercial AC service entrance conductors, communication cable shields/conductors, coaxial cables or radio antenna wave guides.

Examples of producer grounding conductors include:

- Radio Equipment and Frames
- Communication Cable Entrance Shields
- Communication Cable Primary Protectors
- Transformer Frame Inside Building
- External radio wave guide/ coaxial shields

5.6.3 (A) – Surge Absorbers

“Absorber” conductors are designed to provide a low impedance path for lightning or power fault surge currents to ground. Surge sources are usually lightning, AC power faults or electrostatic discharge (ESD).

Examples of “Absorber” conductors include:

- AC power entrance multi-grounded neutral (MGN)
- Building made ground electrode system (MGE)
- Building structural steel (BSS)

- Grounded Metallic Conduit System
- Grounded Metallic Water Pipe
- Well Casing

5.6.4 (N) – Non-Isolated Ground Plane (NON-IGP) Equipment Grounds

Some grounding systems design the Non-Isolated Ground Zone Bar (NON-IGZB) to serve as a common collection point of grounding conductors serving the Non-Isolated Ground Zone (NON-IGZ).

This non-isolated ground zone ground bar (Non-IGZB) becomes a "window" to the MGB. The non-isolated ground zone ground bar (NON-IGPB) MUST have a properly routed and sized grounding conductor bonded directly to the MGB and connected in the N portion of the MGB PANI configuration.

Non-isolated ground zone (NON-IGZ) grounding conductors are designed to return all fault current to earth. In most NON-IGZ areas, some amount of fault current flow is expected, although not desirable.

The NON-IGZ section of the MGB is also the ground reference point for the DC power bus. This connection between the DC power bus and the MGB is not to be current carrying and is provided for potential reference.

Examples of Non-Isolated Ground Plane (NON-IGP) components include:

- Battery Racks
- Electronic Equipment Mounting Frame(s)
- (-) Reference in a DC Power Plant with Negative Ground
- (+) Reference in a DC Power Plant with Positive Ground
- Electronic Equipment Card Storage Cabinets
- Transmission Frames

5.6.5 (I) – Isolated Ground Zone (IGZ) Equipment Grounds

> **NOTE:** IGZ generally does not apply to a PSAP.

The intent of an isolated ground zone (IGZ) is to isolate all voltage-sensitive equipment inside the IGZ from any voltage event occurring outside the IGZ. This will prevent any event outside the IGZ from causing any form of service outage to the voltage sensitive equipment inside the IGZ. Most buildings use an IGZ for isolating voltage-sensitive equipment, such as a digital switch, from the rest of the equipment within the building.

5.7 Radio Tower Grounding

Many PSAP centers incorporate a radio dispatch system into the operator terminal equipment. Special care must be taken for grounding the radio equipment before it interconnects to the PSAP terminal equipment located at the operator/ dispatcher position. Chapter 5 of Motorola R56® *Standards and Guidelines for Communication Sites* [Ref 18] provides guidance for Internal grounding, Chapter 4 for external (tower and equipment) grounding and chapter 7 for the application of surge protective devices for most radio installations. For a more complete guide to E911 equipment installation, see NENA E9-1-1©, *PSAP Equipment Standards* [Ref 17].

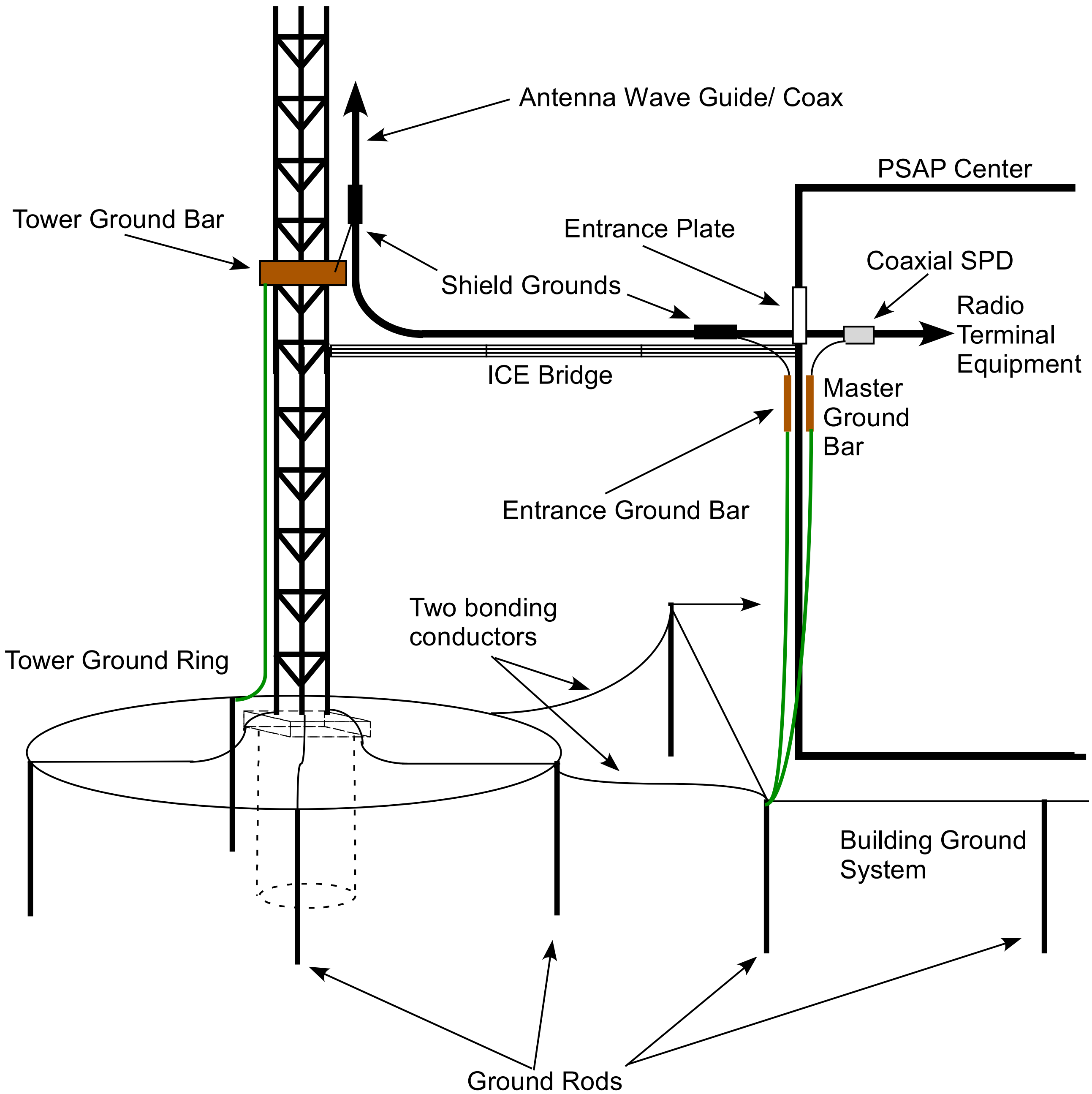

Figure 5.3 – Example of tower and wave guide grounding on building exterior

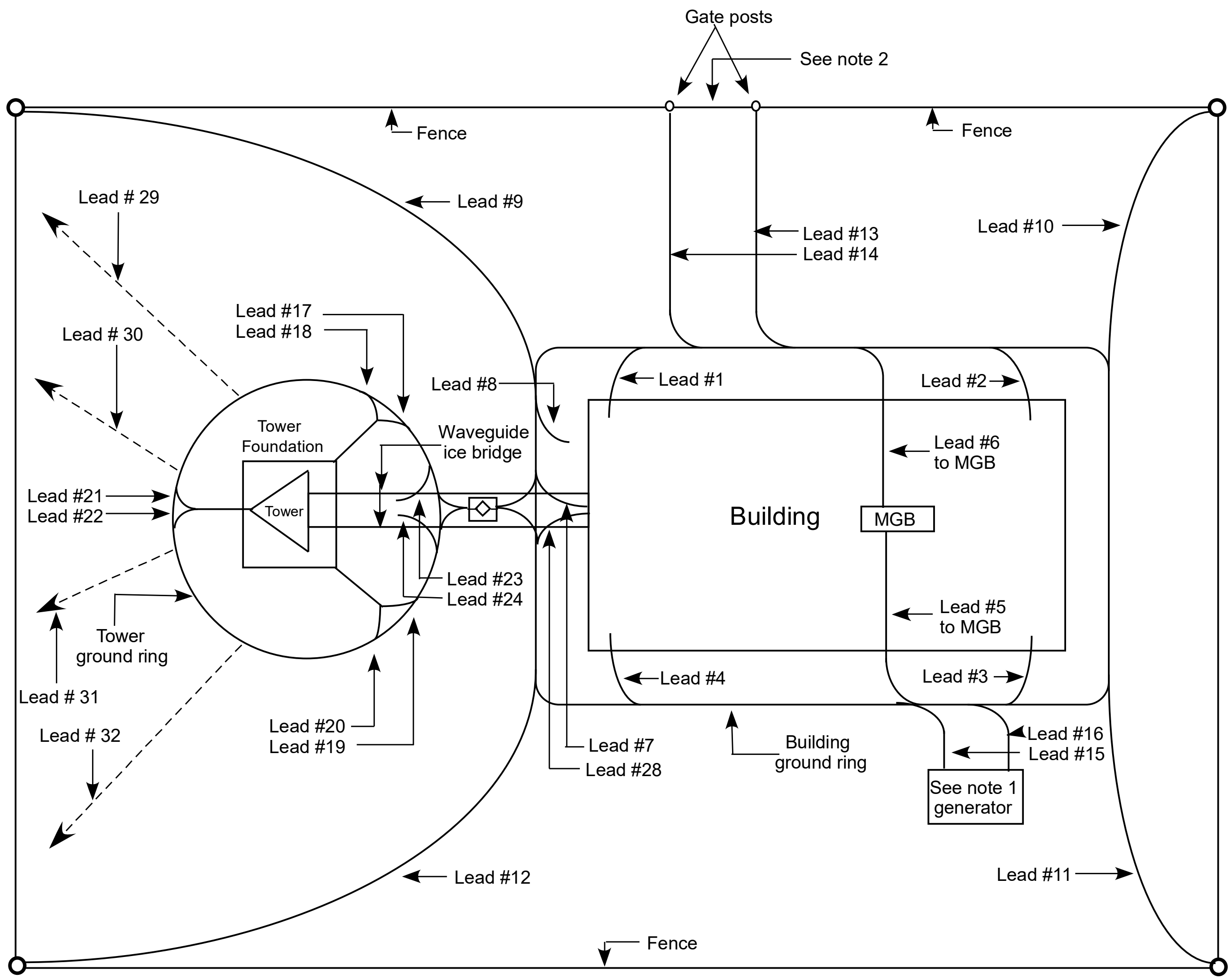

Figure 5.4 – Supplemental radio tower site grounding

Ground lead identification:

1-4	From building ground ring to building halo ground.
5-6	From building ground ring to Master Ground Bar (MGB).
7	From building ground ring to exterior feedline building entrance ground bar.
8	From building ground ring to exterior AC service ground.
9-12	From building ground ring to corner fence post.
13-14	From building ground ring to gate post.
15-16	From building ground ring to generator frame.
17-22	From tower ground ring to tower leg.
23	From tower ground ring to metallic support member.
24	From tower ground ring to tower feedline ground bar.
25-27	From tower ground ring to tower guys and ground rods.
28	From tower ground ring to metallic support member.
29-32	In high lightning prone areas or areas with high soil resistivity, additional radial grounds may be added for a low impedance path for lightning energy away from the site building.

NOTE 1: If the generator is more than 6 feet from the building foundation, install one ground rod and bond to chassis.

NOTE 2: To ensure no difference of potential, bond gate posts.

For additional information on tower and building grounding, see chapter 10 of ATIS-0600313 [Ref 3].

6 Equipment Room Bonding

The grounding and bonding of communication and data equipment shall comply with NFPA 70® [Ref 10] and the manufacturer's requirements for the equipment. If additional grounding systems are employed, they shall be connected to the PGP.

7 Equipotential Bonding at Network Operator-type Equipment Positions

Equipotential bonding at network operator-type equipment positions should be integrated into the position equipment to the greatest extent possible. This will largely reduce the need to place bonding conductors on a per-installation basis. All furniture, telecommunications cable shields, data cable shields, and the ACEG should be bonded together at the position (PBT) or within the equipment.

7.1 Position Bonding Terminal (PBT)

A PBT shall be installed as illustrated in figure 1 to facilitate bonding. If network operator-type equipment positions are arranged in clusters, a single PBT may be shared at each cluster, provided that the bonding conductor length restrictions of 7.3 through 7.5 can be met.

All bonding connections at the network operator-type equipment position or cluster shall be terminated on the PBT. The PBT shall be located so that bonding conductor length is as short and straight as practicable.

7.2 Bonding Conductors

In order to keep their inductance low, all bonding conductors shall be kept as short as practicable and shall be routed in as straight and direct a manner as possible. Bonding conductors shall never be coiled. Acceptable maximum lengths are given in the following clauses for each bonding conductor application. Unless otherwise stated, all bonding conductors shall be minimum 10 AWG copper.

7.3 Bonding to Power at the Operator-type Equipment Position

When ac power is present at a network operator-type equipment position, a bonding conductor not exceeding 1 meter (3 feet) in length shall connect the PBT to the ACEG at the power outlet box. The conduit or raceway serving the outlet box shall not be relied upon as the sole ACEG at the position (i.e., a separate, insulated equipment grounding conductor shall be run with the branch circuit supply conductors). Any metallic outlet box, conduit or armor, and the ACEG shall also be interconnected as required by NFPA 70® [Ref 10].

The equipment grounding conductors (ACEG) of ac branch circuits serving the network operator-type equipment positions shall not be electrically isolated from the building grounding and bonding network in any way. Because of the bond from the PBT to the ACEG at the outlet box, isolated ground receptacles ("orange" outlets) shall not be used.

7.4 Bonding of Furniture and Equipment at the Operator-type Equipment Position

At the network operator-type equipment position, all metallic equipment enclosures, frames, and chassis, as well as the position furniture (other than chairs) shall be bonded together and to the PBT. Bonding shall be accomplished using conductors not exceeding 3 meters (10 feet) in length.

7.5 Bonding of Telecommunications Cable Metallic Members

Metallic members of telecommunications cables serving the network operator-type equipment position or cluster shall be bonded to the PBT. If it is not possible to bond the metallic member directly to the PBT, a metallic member-to-PBT bonding conductor not exceeding 2 meters (6 feet) in length shall be used to bond the cable metallic member to the PBT. Note that the metallic member-to-PBT bond will be provided automatically where cable connectors contain a shield-to-chassis connection.

7.6 Bonding of Nearby Metallic Objects

Nearby metallic objects such as building steel, raised floors, and ventilation ducts should be bonded to the PBT.

7.7 Interposition Bonding

Consideration should be given to establishing an interposition bonding grid for multi-cluster network operator-type equipment positions. The bonding grid is a network of bonding conductors that interconnects all PBTs into a grid and equalizes potentials between network operator-type equipment position clusters. It is likely to be of value if an operator approaches a position in a neighboring cluster while still connected to his or her own position.

7.7.1 Placement & Interconnection of the Bonding Grid

The bonding grid should be placed in the same space that is used for running power and communications cables to the positions. This will most likely be the space below a raised floor that supports the positions. Alternative locations are the space immediately below the structural floor supporting the positions, or the space above a suspended ceiling.

The bonding-grid conductor(s) should be 6 AWG stranded copper. A possible grid configuration is illustrated in figure 3. Connections at the junction points of the conductors of the grid (“grid nodes”) shall be made using irreversible connections listed for the purpose. A grid node should be positioned vertically below each PBT (or above each PBT in the case of a ceiling-placed grid). Horizontal offsets of 1.50 meters (5 feet) or less are acceptable. The PBT and its grid node should be interconnected by a 6 AWG stranded copper bonding conductor of shortest length.

If the cell shape of the grid is other than square, or if the grid has irregularly shaped extensions, each grid node should connect to all of its nearest neighbors except those that would result in an included angle between bonding conductors of less than 55 degrees.

When an in-floor metallic electrical raceway is present, the raceway typically forms a de facto grid and should be used in lieu of a separately designed bonding grid. Each PBT should be located no more than 0.30 meter (1 foot) from the floor and should be bonded to a vertical raceway extension. When a raceway serves as the bonding grid, no attempt should be made to place bonding grid conductors within the raceway.

7.7.2 Bonding the Grid to Other Equipment in the Room

The bonding grid is intended to equalize potentials between clusters. It is also desirable to equalize potentials between network operator-type equipment positions and other equipment within the room. The following items, if present in the room, should be bonded, by the shortest path, to the nearest bonding-grid conductor:

- AC panel(s) serving ac outlets in the room;
- The ground bus bar of equipment rooms serving the network operator-type equipment positions;
- Water fountain(s);
- Raised-floor support structures in at least four places, preferably at the corners of the position area.

Where practical, ground bus bars, metallic plumbing, metallic ventilation ducts, and other metallic objects should also be bonded to the nearest grid conductor.

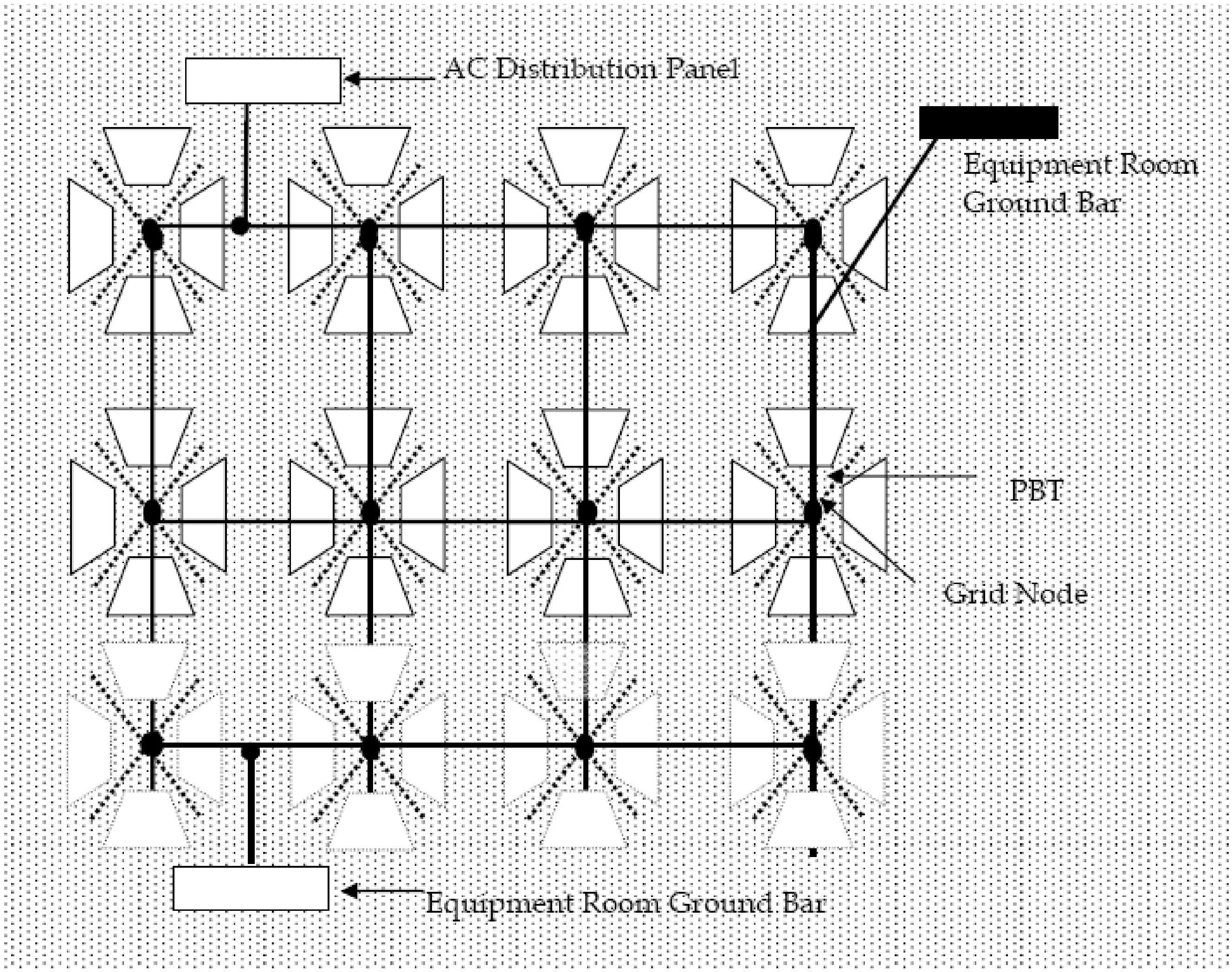

Figure 7.1 – Example of bonding grid and interconnection to other equipment

8 Voltage Limiting of Communications Conductors at Network Operator-type Equipment Positions

Voltage limiting should be present on communications conductors (communication and data) at every network operator-type equipment position or cluster to help to minimize voltages between communications conductors and conductive surfaces. The position equipment should contain a deliberate voltage-limiting capability, either inherent in the position equipment electronics or a separate protective device. When the voltage-limiting is internal to the equipment, it shall be provided between each communications conductor and the equipment's ground reference (for example, the ACEG conductor in the equipment power cord) to the PBT. For network operator-type equipment positions that do not contain an internal voltage-limiting capability, a secondary protector shall be provided between the PBT and each of the communications conductors where they appear at the position. An example of this is shown in figure 1. The grounding terminal for the secondary protector shall be connected to the PBT with a minimum 10 AWG insulated copper conductor not exceeding 1 meter (3 feet) in length.

8.1 Generic Criteria for Secondary Protectors

Secondary protectors applied at a network operator-type equipment position shall be listed for the purpose by a nationally recognized testing laboratory. One way to determine applicable requirements for a listed secondary protector is to refer to UL 497A® [Ref 11]. The nominal limiting voltage shall not exceed 200 volts, shall be sufficiently low to coordinate with equipment dielectric at the network operator-type equipment position, and shall not interfere with normal signaling and function.

9 Voltage Limiting of ac Power Conductors at Network Operator-type Equipment Positions

Voltage limiting should be present on ac power conductors at every network operator-type equipment position or cluster to help to minimize voltages between phase and neutral conductors and the ACEG. The position equipment should contain a deliberate voltage limiting capability for the ac power input, either inherent in the position equipment electronics or as a separate external Surge Protective Device (SPD). When the voltage limiting is internal to the equipment, it should be provided between each combination of phase and neutral conductors and the ACEG. For network operator-type equipment positions that do not contain an internal voltage-limiting capability for the ac power input, an external SPD should be provided between phase and neutral conductors and the ACEG where these conductors appear at the position. An example of this is shown in figure 1. Where the external SPD is equipped with an external grounding terminal, the external grounding terminal shall be connected to the PBT with a minimum 10 AWG insulated copper conductor run as short and straight as practicable and not exceeding 1 meter (3 feet) in length. Refer to clause on Surge Reference Equalizers in IEEE Standard 1100 for additional information.

9.1 Generic Criteria for Surge Protective Devices (SPD)

External SPDs applied at a network operator-type equipment position shall be listed for the purpose by a nationally recognized testing laboratory, at a minimum, in accordance with UL 1449® [Ref 16]. The limiting voltage shall be in accordance with the applicable location category as defined in IEEE C62.41®. The SPD shall coordinate with upstream surge protective devices. The limiting voltage shall not interfere with normal powering functions, including uninterruptable power supplies or other power conditioning units.

10 Multi-port (Multi-service) Surge Protective Device

Multi-port (Multi-service) Surge Protective Device (MSPD) can provide external SPDs for communications and power circuits as well as the functionality of PBT as discussed in Sections 8 and 9 and shown in Figure 1 in a common enclosure. The MSPD shall be listed.

All communication and power cables serving the protected equipment are routed via the MSPD, which provides a common terminal for equipotential bonding (i.e., PBT) within its enclosure. Therefore, the MSPD will minimize the grounding conductors that connect the grounding terminal of SPDs to PBT and can be as long as 1 m in length (see Sections 8 and 9). Cables from the one or more telecommunication circuits enter the MSPD at ports designated input, while protected equipment is connected to ports designated as equipment or output. The conductor separation requirements of NFPA 70® shall be observed.

The functionalities of MSPD will help minimize the effects of a surge that may appear at one of the input ports of the MSPD, does not result in an excessive coupled surge on the output ports of the MSPD.

Clause 8.14 of IEEE C62.36® [Ref 105] provides a multi-port coupling test to verify that MSPD minimizes the coupled surge. In addition, IEEE standard, C62.50® [Ref 106] provides performance criteria and test methods for plug-in and hard-wire MSPDs. Draft guide PC62.51 [Ref 107], considers the ramifications of deploying multiservice surge protective devices (MSPDs) as specified in C62.50® [Ref 106].