Electrical Protection of Workstations and Operator-Type Positions – Engineering Application

Contents

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1. General

1.1 Purpose

This practice provides objectives for establishing electrical protection requirements for:

- VDT workstation positions.
- Buildings that house VDT workstation positions.

1.2 Filing Instructions and Supersedures

File this practice in numerical order in your GTE Telephone Operations practices set.

This practice supersedes and cancels:

- All policies, procedures, general instructions, letters, and memoranda which address this subject.
- Any document which provides information contrary to the information contained in this practice.

1.3 Responsibility

This practice was published by the GTE Telephone Operations Administrative Services Department. For more information about this practice, contact the GTE Telephone Operations Headquarters Protection Engineering Support Staff.

1.4 Disclaimer

This practice was prepared solely for the use of GTE Telephone Operations. It must be used only by its employees, customers, and end users when installing, operating, maintaining, and repairing GTE Telephone Operations' equipment, facilities, and services. Any other use of this practice is forbidden. The information contained in this practice may not be applicable in all circumstances and is subject to change without notice. By using this practice the user agrees that GTE Telephone Operations will have no liability (to the extent permitted by applicable law) for any consequential, incidental, special, or punitive damages that may result.

2. Overview

2.1 Introduction

The objective of this practice is to provide measures and techniques to:

- Limit and control Electrostatic Discharge (ESD)-related problems.
- Provide electrical protection to minimize potential differences at the VDT workstation position and to reduce the possibility of shocks to personnel.

2.2 Definitions

The following chart defines the acronyms and terms used in this practice.

Acronym or Term	Definition
AC	Alternating Current
AWG	American Wire Gauge
Bonding	me permanent joining of metallic parts to form an electrically-conducive path that will ensure that there is electrical continuity and the capacity to safely conduct any current likely to be imposed.
Cable Entrance Facility(CEF)	A space in a non-CO building where cables enter from the OSP network. Primary protectors can be located here, and cable metallic members are grounded here.
Cluster	Workstations arranged or grouped closely together.
CO	Central Off ice
Common Bonding	The interconnection of separate ground electrodes required at locations where common grounding has not been or cannot be used.
Common Grounding	The use of the same ground electrode by all services (e.g., power, telephone, cable TV, etc.)
CVGB	Cable Vault Ground Bar
EGC	Equipment Grounding Conductor
Electrostatic Charge	Electric charge at rest. (See Static Electricity.)
Electrostatic Field	The electric field produced by an electrostatic charge.
Electrostatic Potential	The electric potential produced by an electrostatic charge.

(continued)

2.2 Definitions, continued

Acronym or Term	Definition
Electrostatic Shield	A barrier or enclosure that attenuates an electrostatic field.
ESD	Electrostatic Discharge; the rapid, spontaneous transfer of electrostatic charge flows through a spark between two bodies at different electrostatic potentials as they approach each other.
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 • Providing shielding from electrostatic discharges or electrostatic fields.
Ground Ring	A buried grounding electrode, in the form of a conductor in direct contact with the earth, encircling the structure being grounded.
Metallic Member	A non-communications metallic cable component such as a: • Shield. • Vapor barrier. • Strength member.
MGB	Master Ground Bar
NEC	National Electrical Code
NRTL	Nationally Recognized Testing Laboratory
OSP	Outside Plant
Point of Entrance	The point in a building at which the OSP cable emerges from: • An external wall. • A concrete floor slab. • A grounded, rigid, metal conduit. • A grounded, intermediate, metal conduit.

(continued)

2.2 Definitions, continued

Acronym or Term	Definition
Position Bonding Terminal (PBT)	A point such as a metallic terminal, bus, or plate to which all bonding connections are supposed to be made at the VDT workstation or operator-type position.
Power Entrance Facility (PEF)	A space in a building where power cables enter from the commercial AC power serving the building. me Power Entrance Facility: • Contains the AC service equipment. • Might also contain secondary AC surge protective devices.
Primary Protector	A protective device placed on telecommunications conductors in accordance with GTE Telephone Operations Practice 887-l 00-075.
Principal Ground Point	A point within a non-CO structure that provides a means to join conductors requiring an earth reference to earth electrodes. This point might be a: • Separate ground bar located in the structure near the entrance of the earth electrode conductor(s). OR • Point on an earth electrode. **NOTE: In a CO building, it is called MGB.**
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 cords. • Terminal equipment. NOTE: **Secondary protectors are listed per UL 497A.**
Spark	An electrical discharge of very short duration, normally between two conductors separated by a gas (such as air).

(continued)

2.2 Definitions, continued

Acronym or Term	Definition
Surge Protective Device (SPD)	A device designed for repeated limiting of transient voltage surges on AC power circuits. SPDs are intended for indoor use connection on the load side of the main disconnect and with circuits of less than 600 volts.
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.
Static Electricity	The stationary electrical charge produced and accumulated or stored on the surface of materials due to: • Triboelectric action. • Particle impingement. • Electromagnetic field inducement.
T&P	Transmission and Protection
TOPS	Traffic Operator Position System
Triboelectric Action	A charge generation by: • Friction such as air flow. OR • Adhesive forces during separation.
TVSS	See SPD
UL	Underwriters Laboratories
VDT	Video Display Terminal
VDT Workstation Positions	VDT workstations (arranged in either individual positions or clusters of several positions) that contain the following equipment: • Headset. • Headset interface equipment. • VDT. • VDT workstation/position furniture. **NOTE: This type of equipment might have other names depending on the vendor or supplier.**

2.3 References

The following chart provides sources of supplementary information relating to this practice. The documents could be required for performing certain tasks.

See...	For information About...
007-005-015	Handling Static-Sensitive Materials
117-200-010	Video Display Terminal (VDT) Workstation Design
605-I 00-201	Cable Bonding and Grounding Entering a Central Off ice
6334X5-200	Kit Cable-Insulating Joint G7340-GC – Electrolytic Capacitor Alpeth Stalpeth and Lead Sheath C
795-805-071	Central Office Grounding Systems Engineering Applications
795-805-072	AC Service Grounding Engineering Applications
887-I 00-075	Engineering Requirements Station Protection
887-903-026	Five-Pin Protector Module Application
903-020-070	Outside Plant Protection General Considerations
916-000-070	Building Facilities General
916-I 00-071	Building Facilities Service Entrance to Buildings
NFPA **70"**	National Electrical Code
UL 497A**	Secondary Protectors for Communication Circuits

* Published by the National Fire Protection Association, Quincy, MA.

** Published by Underwriters Laboratories, Northbrook, IL.

2.4 VDT Workstation

For the purposes of this document, a VDT workstation position is defined as a desk, console, or position where one or more individuals access a computer terminal keyboard while wearing a headset. (Refer to Exhibit 1.)

VDT workstations can be either:

- Unitized.

  OR

- Modular.

The vendor might have included in some VDT workstation equipment:

- Bonding.

  AND/OR

- Protection measures.

VDT workstation positions described in this document include (but are not limited to):

- Operator positions:
  - Long distance.
  - TOPS.
  - Information.
- Maintenance Administration positions.
- Test and Maintenance positions.
- Customer contact and/or attendants' positions.
  - Repair.
  - Test.
  - Dispatch.
- Network Monitoring positions/desks.

2.5 Problem Sources

Electrical disturbances can appear at these VDT workstations or operator-type equipment positions arising from either:

- ESD.

  OR

- Sources internal or external to the building such as:
  - Lightning disturbances.
  - AC power surges.

2.6 Electrical Protection

The electrical protection measures are intended to:

- Help control ESD in the VDT workstation operator-type position environment.
- Help to minimize the effects of lightning, surges from commercial AC power lines, and power switching operations with:
  - Equipment bonding and grounding at the entrance facilities (telephone cable and AC power).
  - Equipotential bonding and grounding at the VDT workstation or operator-type equipment positions.
  - Secondary protection (where necessary).

2.7 Building Types

The VDT workstations described in Section 2.4 can be located in either:

- CO buildings.

  OR

- Regular office (administrative-type) or commercial buildings.

Although this document is primarily intended for GTE Telephone Operations' owned or leased (network) equipment, the same electrical protection principles are applicable to this type of equipment regardless of ownership or location.

2.8 Retrofitting

Some of the protection measures described in this document are intended for new locations (see Sections 5, 7, and 8). Some basic bonding and grounding must be applied, however, to all locations either new or existing (see Sections 4 and 6).

2.9 Inspections

All existing locations housing the VDT workstations or operator-type positions described in Section 2.4 must be inspected to determine:

- Compliance with the requirements of Sections 4 and 6.
- If corrective action is needed. Give priority to those sites that are experiencing problems.

WARNING: It is critical to identify and correct the problems found, since some of the deficiencies might impact personnel safety.

The inspections must be coordinated by the supervisor or department head responsible for the location where the VDT workstations are installed. The T&P Engineer or HQ Protection Staff should be consulted for technical assistance.

2.10 Action Plans

Action plans must be developed from the results of the inspections to determine funding needed to implement the necessary corrective action.

2.11 Responsibilities

The following sections contain a summary of departmental responsibilities.

2.11.1 Supervisor or Department Head

The supervisor or department head in charge of an existing location that houses VDT workstations is responsible for:

- Coordinating the inspection of the site to determine if corrective action is needed.
- Developing an action plan (see Section 2.10).

NOTE: me inspection should be coordinated with Building Services.

The supervisor or department head in charge of an existing location that houses VDT workstations is also responsible for:

- Purchasing of minor items such as static mats and wall-mounted surge arresters.
- Funding corrective action required at existing sites.
- Arranging for technician(s) to provide the PBT and its electrical bonding.

2.11 Responsibilities, continued

2.11.2 Building Services

Buillding Services is responsible for coordinating the participation of a qualified electrician during inspections of existing sites.

On new sites Building Services is responsible for ensuring that the requirements of this practice have been met as far as AC wiring, grounding, and similar electrical protection items. Funding for these items should be included as part of the initial project.

2.11.3 T&P Engineering

T&P Engineering is responsible for providing technical assistance during inspections of existing sites and providing the recommended corrective action. T&P Engineering provides technical support to the work group(s) providing the electrical bonding of the different components.

On new sites T&P Engineering is responsible for reviewing and approving the plans for the site's grounding system and for providing technical assistance.

2.11.4 Standardization Management

Standardization Management is responsible for ensuring that, on a going forward basis, workstation equipment to be considered as GTE Standard meets the electrical protection requirements of this practice.

3. Controlling Electrostatic Discharge (ESD)

3.1 Electrostatic Charges

Electrostatic charges can develop on personnel as they:

- Walk on carpeted floors.
- Sit on, or rise from, upholstered chairs.
- Brush insulative clothing against furniture.

WARNING: These charges, without ESD control measures, can create electrostatic potentials in excess of 15,000 volts .

The intense electrical fields generated at the screens of VDTs can also induce electrostatic potentials on their users.

3.2 ESD

Charge transfer occurs when a person contacts a conductive surface at a different electrostatic potential (zero or ground). If the electrostatic potential of the individual is sufficiently high and the surface is sufficiently conductive, there is a rapid discharge called ESD between the person and the conductive surface (s).

Conditions that generate static electricity of sufficient voltage to cause an ESD hazard generally exist where the environment has low humidity, especially where static-generating materials are present in furnishings, clothing, or equipment.

3.3 Minimizing ESD

There are many strategies for minimizing ESD events. The following sections list several measures, which are not all-inclusive. As a rule, not all of these techniques will be either necessary or desirable to establish an ESD protected area.

The effectiveness of the static control devices depend on connections to a good electrical ground through which static charges can be dissipated.

me appropriate ESD protection strategy should be based on the:

- Particular application.
- Advantages and disadvantages of each ESD protective method.

3.3.1 Relative Humidity Control

Control of the relative humidity can be an effective means for ESD mitigation because it aids static dissipation.

Rooms containing VDT workstations or similar operator-type positions should be maintained within the range of 30% to 55% relative humidity.

Since ESD events are more likely when the relative humidity is below 40%, the use of static mats is recommended at these sites.

3.3.2 Work Surfaces and Desktops

Areas on the desktop of operator positions that might be touched by the operator should have a static dissipative surface. This can be accomplished easily by placing an appropriately sized static mat under and around the keyboard. The mat, to be obtained locally, should be grounded.

3.3.3 Chairs and Floor8

Chairs with static dissipative materials are often used at locations with chronic (persistent) ESD problems. This type of chair is most effective when used in combination with floors that have conductive carpets or conductive tiles.

Due to its higher costs, this option should be used as a last resort.

3.3.4 Bonding

Bonding is the connecting of various conductive elements to keep these elements at the same electrical potential (equipotential plane). Static sparking cannot take place between objects that are at the same potential.

4. Site Protection Requirements-All Sites

4.1 Minimum Requirements

The basic protection requirements detailed in this section:

- Are always required.
- Should be considered as minimum requirements for all existing installations housing the type of VDT workstations described in Section 2.4.

The following chart lists the GTE Telephone Operations practices that describe the minimum requirements.

Minimum Requirements for...	Are Provided in Practice...
Central Off ices	795-805-071
	795-805-072
Administrative Off ices	887-l 00-075
	887-903-026
	903-020-070
	916-000-070
	916-l 00-071

NOTE: CO locations that meet the grounding and protection requirements of GTE Telephone Operations Practices 795-805-071 and 795-805-072 and house the type of VDT workstations described in Section 2.4 should not require additional bonding, grounding, or protection work to meet the requirements of Sections 4.2 through 4.7.

4.2 Entrance Facilities

The entrance facilities (including telephone cable and AC power) for a non-CO building should be bonded together as close to the point of entry as possible.

NOTE: Locating the entrance facilities close to each other helps minimize the length of the bonding conductor.

4.3 Power Service Entrance

The AC power service should be grounded to comply with requirements of the NEC Article 250. The AC service conductors should have surge arresters on the load side of the power service disconnect per GTE Telephone Operations Practice 795-805-072.

4.4 Telephone Cable Entrance

Telephone cables with metallic shields or metallic strength members entering a building or structure should be grounded properly.

Telephone cables with metallic pairs should be adequately protected with GTE standard protectors (and current limiting devices if required). Refer to the practices listed in Section 4.1.

4.5 Conductor Sizing

Size conductors as indicated in the practices listed in Section 4.1. In no case should a bonding or grounding conductor be smaller than #6 AWG insulated copper.

4. Site Protection Requirements-All Sites, continued

4.6 Multiple Entrances

Buildings with multiple entrances (for route diversity) require not only compliance with Sections 4.3 and 4.4 but also require common bonding between the different elements of each entry point. See Exhibit 2.

4.7 Ground Rings

Administrative office-type buildings that have a ground ring should meet the same bonding, grounding, and protection requirements detailed in the preceding sections. The ground ring should be connected to the MGB (or equivalent).

NOTE: **If a ground ring is not present, the grounding electrode must meet the requirements of the National Electrical Code, Section H.**

4.8 Equipment Bonding and Grounding

The grounding and bonding of the equipment (telephone and data) should be in accordance with:

- GTE Telephone Operations Practices 795-805-071 and 795-805-073.
- Manufacturer's requirements for the equipment.

If additional grounding systems are used, they must be connected to the MGB.

5. Site Protection Requirements-New Sites

5.1 Introduction

The following sections describe location criteria that is intended for:

- All new buildings.

  OR

- Extensively renovated buildings.

Some of the requirements described in Section 4 are also included in these sections.

5.2 Entrance Facilities

The entrance facilities (including telephone cable and AC power) for a non-CO type building should be bonded together as close to the point of entry as possible, and within 20 feet (6 m) to minimize the length of the bonding conductors.

The MGB for the non-CO building should be established near the point where the grounding electrode conductor enters the building.

NOTE: The location of the MGB in a CO building should follow the guidelines established in the GTE Telephone Operations Practice 795-805-071.

5.3 Power Service Entrance

The AC power service should be grounded to comply with requirements of the NEC Article 250.

To limit surge voltages that might enter the building on the AC power service conductors, a listed surge protective device as described in GTE Telephone Operations Practice 795-805-072 should be installed on the load side of the power service disconnect.

5.4 Telephone Cable Entrance

Telecommunications conductors entering a building or structure must be equipped with primary protectors to meet GTE Telephone Operations' requirements (see Section 4.1).

Metallic members, such as cable shields or strength members, of all entering cables should be either:

- Bonded together and grounded.

  OR

- Interrupted by an insulating joint or equivalent device.

NOTE: Insulation joints are used for cathodic protection. See GTE Telephone Operations Practices 605-l 00-201 and 633-405-200 for installation instructions.

5.5 Conductor Sizing

The bonding conductor must be:

- **#6** AWG insulated copper (minimum).
- As short as practical.
- Connected to the CVGB or if there is no CVGB, directly to the MGB.

5.6 Common Bonding

Bonding conductors between the cable entrance and the MGB and the power entrance and the MGB must be provided in accordance with GTE Telephone Operations Practice 795-805-071.

For non-CO buildings housing the VDT workstations described in this document, an additional power entrance to cable entrance bonding conductor (minimum 6 #AWG insulated copper) should be provided between the power entrance and the cable entrance facilities. This arrangement is shown in Exhibit 3. This additional bonding conductor ensures that there is a low impedance common bond.

5.7 Multiple Entrances

Where a building contains more than one cable entrance or more than one AC Power Entrance Facility, an additional bonding conductor must be added to connect the ground bar at each entrance. This additional bonding conductor should follow the periphery of the building forming a loop (see Exhibit 2). The additional bonding conductor should be a minimum **#6** AWG insulated copper conductor.

5.8 Ground Rings

Where a ground ring is present at the building containing VDT workstation operator-type positions, the cable entrance and the power entrance ground bars should connect directly to the external buried ground ring conductor via conductors with the shortest length. These conductors, which penetrate the building's exterior walls, are in addition to the bonding conductors described in Section 5.7. When a ground ring system is used, it must be bonded to the MGB. Where other grounding electrode configurations are used, the grounding electrode conductor must be bonded to the MGB.

5.9 Equipment Bonding and Grounding

The grounding and bonding of telephone and data equipment in the equipment room or closet must be in agreement with GTE Telephone Operations' and the manufacturer's requirements for the equipment. If additional grounding systems are used, they all must be connected to the MGB.

NOTE: **This should be included in the original work order/project proposal.**

6. Equipment Bonding and Grounding at the VDT Workstation Positions-All Sites

6.1 Bonding at the VDT Workstation

At the VDT workstation or operator-type position, all of the following must be bonded together and connected to the PBT:

- Metallic equipment enclosures.
- Frames.
- Chassis.
- Position furniture (other than chairs).

Bonding will be accomplished using bonding conductors of minimum #6 AWG insulated copper.

When AC power is present at a VDT workstation or operator-type position, a bonding conductor must be used to connect the PBT to the EGC at the power outlet box. Any metallic outlet box, conduit, or armor must be bonded to the EGC as required by the NEC.

NOTE: Common bonding at the position is important, especially when different vendors have supplied the different components located at the VDT workstation.

6.2 Bonding Requirements

All furniture, telephone cable shields, and data cable shields should be bonded together at the position or within the equipment. Where AC power is present at the position, all equipment should be bonded to the EGC within the equipment. Externally-provided DC power, if present, should also be bonded within the equipment.

6.3 Bonding Terminal (PBT)

A PBT should be established, as shown in Exhibit 3, to facilitate bonding. If the VDT workstation positions are arranged in clusters, a single PBT can be shared at each cluster.

All bonding connections at the VDT workstation position or cluster must be routed through the PBT. The PBT should be located so that the bonding conductor length is minimized.

When not provided by the manufacturer, or equipment provider, the PBT should be provided locally. The PBT should be of sufficient size to accommodate all of the bonding leads.

6.4 Conductor Requirements

Bonding conductors must be routed in as straight and direct a manner as possible, and be of minimum length to minimize inductance. Bonding conductors must never be coiled. Unless otherwise stated, all bonding conductors must be #6 AWG copper.

6.5 Bonding to Power

When AC power is present at a VDT workstation position, a bonding conductor should connect the PBT to the EGC at the power outlet box. Any metallic outlet box, conduit, or armor, and the EGC must also be interconnected as required by the NEC.

The grounding conductors of AC branch circuits serving the operator-type equipment positions must not be single point grounded, or isolated in any way. The EGC power grounding conductor must not be isolated from the building bonding network (e.g., isolated ground receptacles [orange outlets] must not be used).

6. Equipment Bonding and Grounding at the VDT Workstation Positions-All Sites, continued

6.6 Cable Bonding

Metallic members of telecommunications cables serving the VDT workstation position or cluster must be bonded to the PBT with a bonding conductor of minimum #6 AWG insulated copper. The metallic member-to-PBT bond will be provided automatically where cable connectors contain a shield-to-chassis connection.

7. Equipment Bonding and Grounding at the VDT Workstation Positions-New Sites

7.1 Equipment Requirements

Equipotential bonding at VDT workstation operator-type positions must be integrated (built in) into the position equipment to the greatest extent possible. This will largely reduce the need to place bonding conductors on a per-installation basis.

7.2 Bonding at the VDT Workstation

At the VDT workstation or operator-type position, all of the following must be bonded together and connected to the PBT:

- Metallic equipment enclosures.
- Frames.
- Chassis.
- Position furniture (other than chairs).

Bonding conductors should be #6 AWG copper (minimum) not to exceed 10 feet (3 m) in length.

When AC power is present at a VDT workstation or operator-type position, a bonding conductor not exceeding 3 feet (0.9 m) in length must be used to connect the PBT to the EGC at the power outlet box. Any metallic outlet box, conduit, or armor must be bonded to the EGC as required by the NEC.

NOTE: Common bonding at the position is important, especially when different vendors have supplied the different components located at the VDT workstation.

7.3 Bonding Requirements

All furniture, telephone cable shields, and data cable shields should be bonded together at the position or within the equipment. Where AC power is present at the position, all equipment should be bonded to the EGC within the equipment. Externally provided DC power, if present, should also be bonded within the equipment.

7.4 Bonding Terminal

A PBT should be established by the equipment installer, as shown in Exhibit 3, to facilitate bonding. If the VDT workstation positions are arranged in clusters, a single PBT can be shared at each cluster, provided that the bonding conductor length restrictions of **Sections 7.6** through 7.8 are met.

All bonding connections at the VDT workstation position or cluster must be routed through the PBT. The PBT should be located so that bonding conductor length is minimized.

7. Equipment Bonding and Grounding at the VDT Workstation Positions-New Sites, continued

7.5 Conductor Requirements

Bonding conductors must be routed in as straight and direct a manner as possible, and be of minimum length to minimize inductance. Bonding conductors must never be coiled. Acceptable maximum lengths are given in the following sections for each bonding conductor application. Unless otherwise stated, all bonding conductors must be #6 AWG copper.

7.6 Bonding to Power

When AC power is present at a VDT workstation position, a bonding conductor not exceeding 3 feet (0.9 m) in length should connect the PBT to the EGC at the power outlet box. Any metallic outlet box, conduit, or armor, and the EGC must also be interconnected as required by the NEC.

The grounding conductors of AC branch circuits serving the operator-type equipment positions must not be single point grounded, or isolated in any way. The EGC power grounding conductor must not be isolated from the building bonding network (e.g., isolated ground receptacles [orange outlets] must not be used).

7.7 Cable Bonding

Metallic members of telecommunications cables serving the VDT workstation position or cluster must be bonded to the PBT with a bonding conductor of minimum #6 AWG insulated copper, not exceeding 6 feet (1.8 m) in length. The metallic member-to-PBT bond will be provided automatically where cable connectors contain a shield-to-chassis connection.

7.0 Other Bonding

Nearby (within 6 feet [1.8m]) metallic objects such as building steel, raised floors, and ventilation ducts should be bonded to the PBT.

7.9 Multicluster Arrangements

For multicluster arrangements, it is more practical to establish a interposition bonding grid connecting the PBTs of the individual clusters.

NOTE: The **interposition bonding grid is of value when an operator approaches a position in a neighboring cluster while still connected to her or her own position.**

The interposition bonding grid (see Exhibit 4) is a network of bonding conductors that interconnects all PBTs and serves to equalize potentials (creating an equipotential plane) between the equipment positions in the different clusters.

7.9.1 Placement and Interconnection of the Bondina 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 equipment positions.

Alternate 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.

7. Equipment Bonding and Grounding at the VDT Workstation Positions- New Sites, continued

7.9 Multicluster Arrangements, continued

7.9.2 **Typical Bonding Grid Configuration**

A typical grid configuration is shown in Exhibit 4. Connections at the junction points of the conductors of the grid (referred to as grid **nodes) must 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 5 feet (1.5m) or less are acceptable. The PBT and its grid node should be interconnected by a #6 AWG stranded copper bonding conductor of the shortest length possible.

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.

7.9.3 **Bonding Grid and in-floor Raceways**

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 1 ft (0.3m) 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.

7.9.4 **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 the equipment positions and any 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 bar of equipment rooms serving the equipment positions.
- Water fountain(s).
- Raised-floor support structures in at least four places, preferably at the comers of the position area.

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

8. Voltage Limiting at VDT Workstation Positions

8.1 Protection at the VDT Workstation

To help to minimize voltage differences, voltage limiting devices should be present on:

- All communication (telephone and data).
- AC power conductors at every VDT workstation position or cluster.

8.1 Protection at the VDT Workstation, continued

8.1.1 Communications Conductors

To limit voltage differences between communications conductors and the conductive surfaces at the VDT workstation position, the position equipment should contain a deliberate voltage-limiting capability, either:

- Inherently in the position equipment electronics.

  OR

- A separate SPD.

When the voltage-limiting is internal to the equipment, it must be provided between each communications conductor and the equipment's reference to the PBT.

For VDT workstation positions that do not contain an internal voltage-limiting capability, a secondary protector must be provided between the PBT and each of the communications conductors where they appear at the position (see Exhibit 3).

8.1.2 AC Power Conductors

Voltage limiting should be present on AC power conductors at every VDT workstation position or cluster to help to minimize voltages between:

- Phase and neutral conductors.
- Equipment ground (EGC).

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 SPD device.

When the voltage-limiting is internal to the equipment, it should be provided between each combination of phase, neutral, and EGC conductors. For VDT workstation positions that do not contain an internal voltage-limiting capability for the AC power input, an external SPD should be provided between each combination of phase, neutral, and EGC conductors where they appear at the position (see Exhibit 3). The grounding terminal for the external SPD must be connected to the PBT with a minimum #6 AWG insulated copper conductor not exceeding 3 feet (0.9 m) in length.

8.2 Protector Grounding

The grounding terminal for the secondary protector must be connected to the PBT with a minimum #6 AWG insulated copper conductor not exceeding 3 feet (0.9 m) in length.

8.3 Secondary Protector Specifications

Secondary protectors for use at a VDT workstation equipment position must be listed for the purpose by a NRTL for conformance to NEC 800-32.

The limiting voltage should:

- Not exceed 200 volts.
- Be sufficiently low to coordinate with equipment dielectric at the VDT workstation position.
- Not interfere with normal signaling and function.
- Not adversely affect the service on the telecommunications or data conductors being protected.

8.4 SPD Grounding

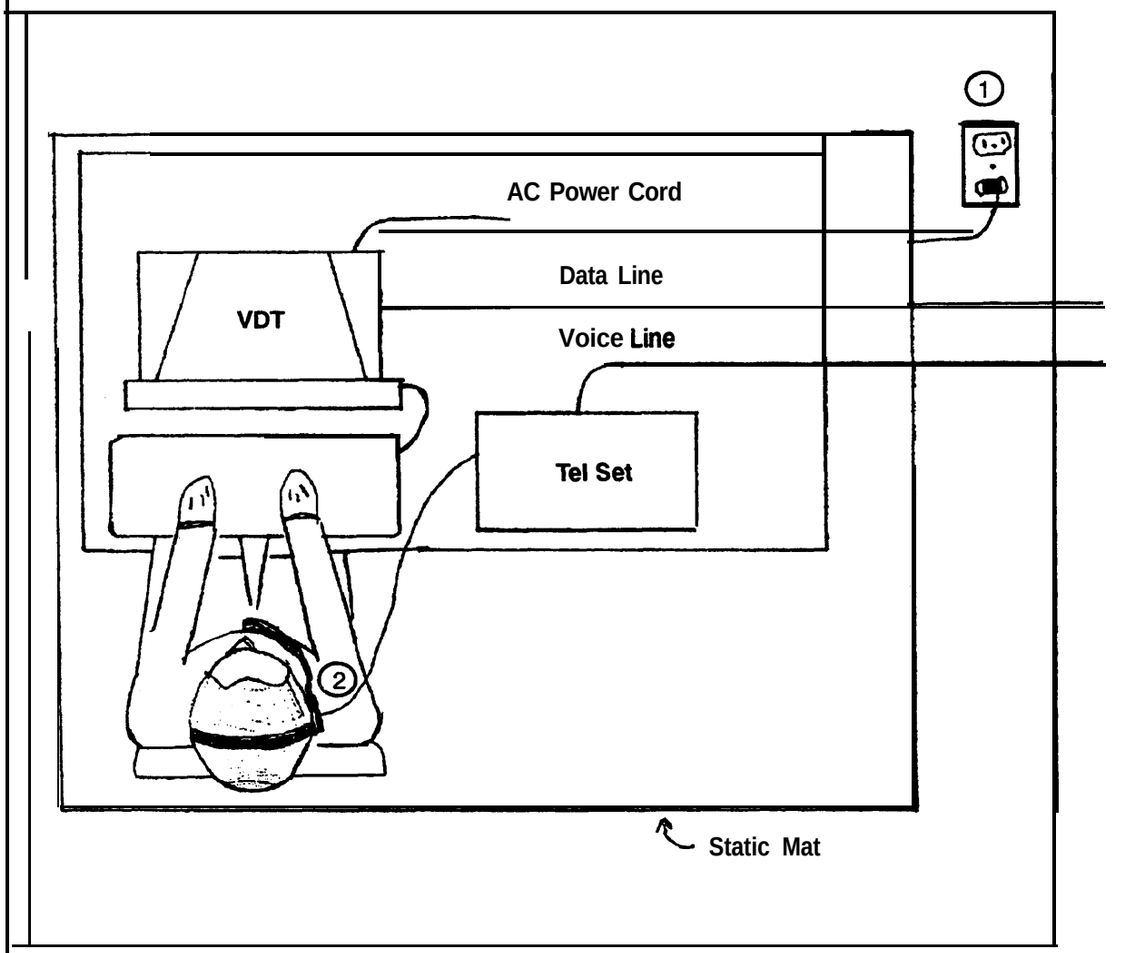
If the SPD has an external grounding terminal, the grounding terminal must be connected to the PBT.

8.5 Typical SPD Specifications

External SPD applied at a VDT workstation position should be listed for the purpose by a NRTL.

The limiting voltage should:

- Be sufficiently low to coordinate with equipment dielectric at the VDT workstation position.
- Not interfere with normal signaling and function.
- Not adversely affect the service on the equipment conductors being protected.
- Coordinate with upstream SPD devices used in the facility.



NOTES:

1.120 VAC Branch Circuit with EGC (Green Wire) bonded to grounding system at service entrance.

2. Minimum 5 kV flashover.

Exhibit 1 – Typical Workstation Position

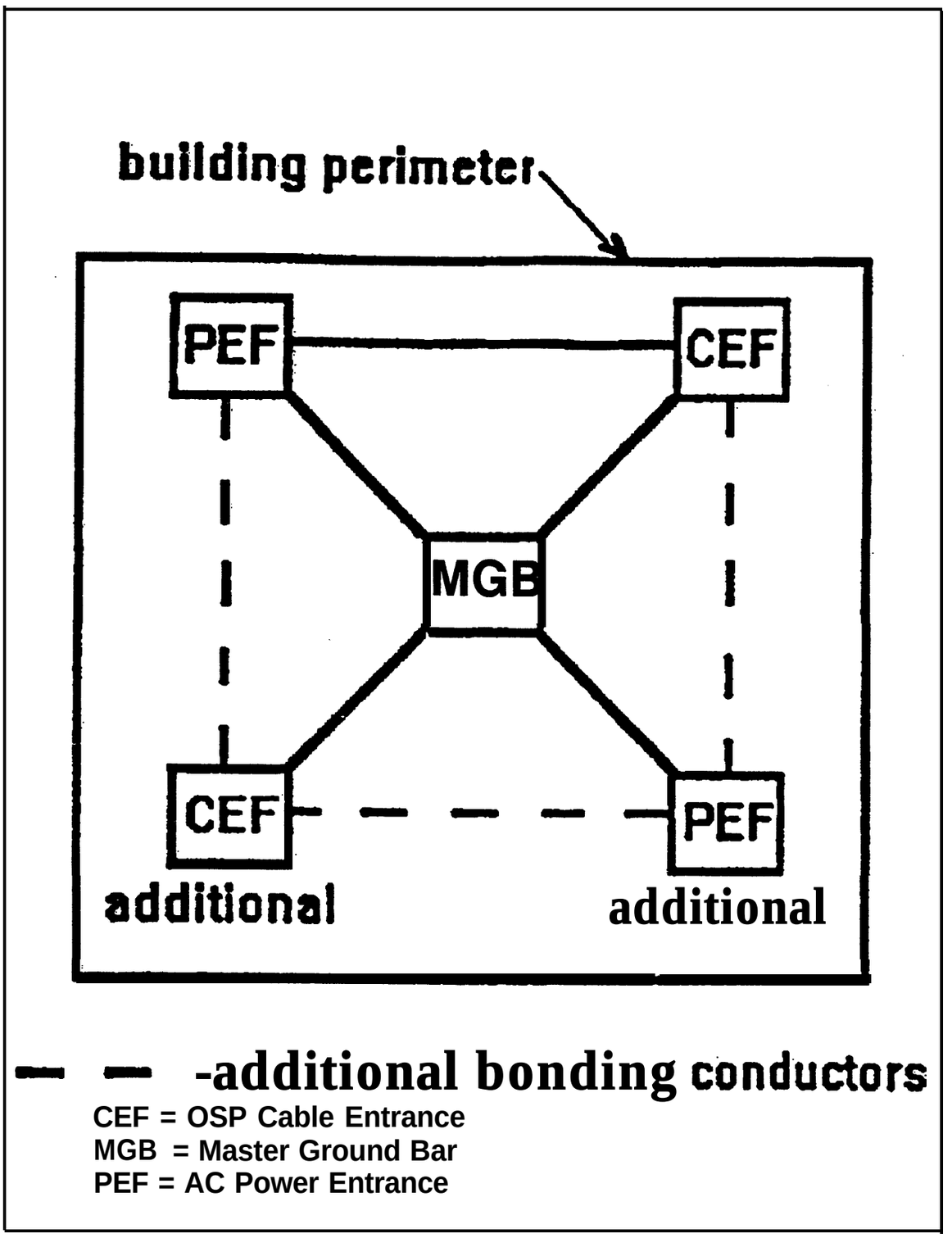


Exhibit 2 - Example of Typical Bonding in a Building with Additional (Multiple) Entrance Facilities

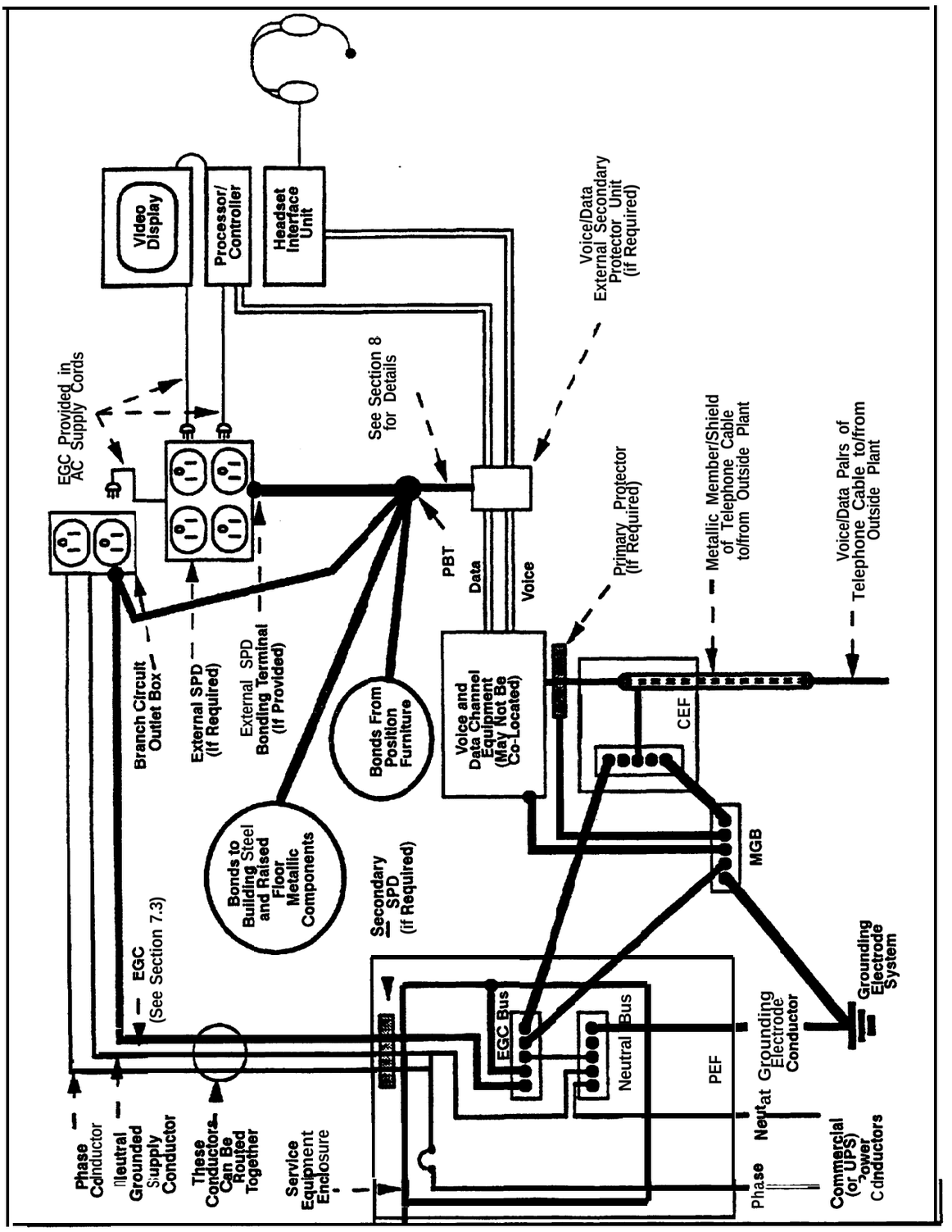


Exhibit 3 – Example of Entrance Facility Bonding, PBT, External Secondary Protector and External SPD at AC Powered Network Operator-Type Equipment Positions

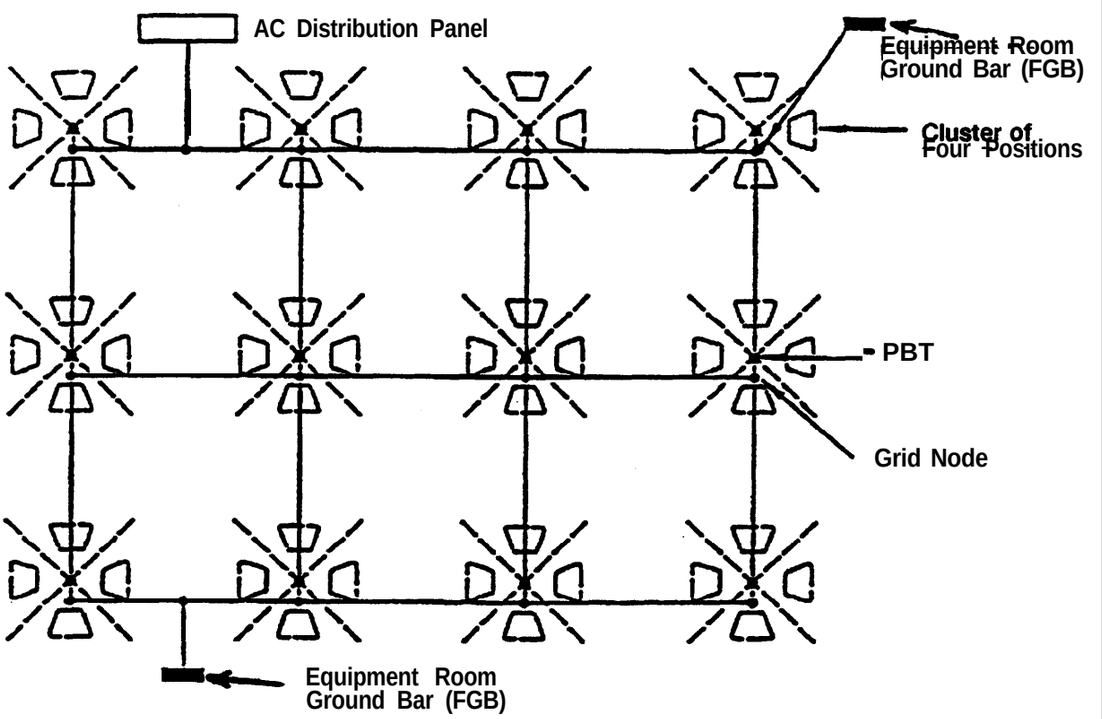


Exhibit 4 - Example of Bonding Grid and Interconnection to Other Equipment