

Bonding and Grounding Using Codes and Standards

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RCDD, NTS, OSP, TECH, CT

BICSI



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This is a overview of Codes and Standards

The codes we will cover are from the NEC (National Electric Code)

The Standards we will cover are from the TIA 607-C Generic Telecommunications Bonding and Grounding (Earthing) for customer Premises

We will touch on NESC(National Electric Safety Code). Codes for the Public ROW Companies

All this in under 3 hours, Amazing!!



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Craig D Dunton
The Phone Guy

1970 to 1973 New Jersey Bell Telephone

1973 to 1982 Northwestern Bell Telephone

1982 to 1991 Dunton Telephone , an Interconnect in
Owatonna.MN

1989 to 2013 St. Olaf College.(Bethany Lutheran, Carleton,
Gustavus Colleges, the Northfield Hospital, Shattuck-St.
Mary's School)



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-
- 2004 Received authorization to become a CLEC (Competitive Local Exchange Carrier)
 - 2005 Installed a #5 Lucent (Western Electric) ESS Switch (Self maintained)
 - 2006 Cut over St. Olaf, Carleton Colleges and the Northfield Hospital.
 - 2006-2013 Cut over 170 local businesses over our own fiber to the Business (FTTB)
 - \$1.5 million income 2012
 - 2013 Sold the telephone company and sold it for \$800,000.00. and went back to 1989



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60 Minnesota workers killed on the Job in 2011

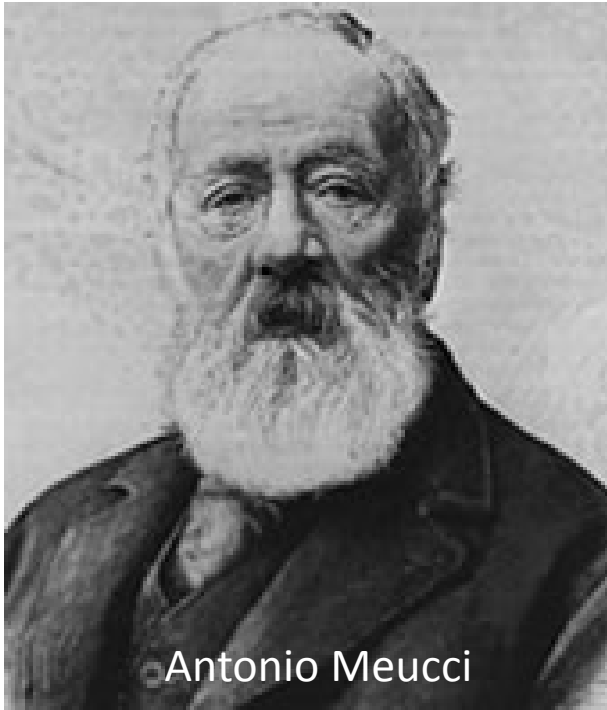


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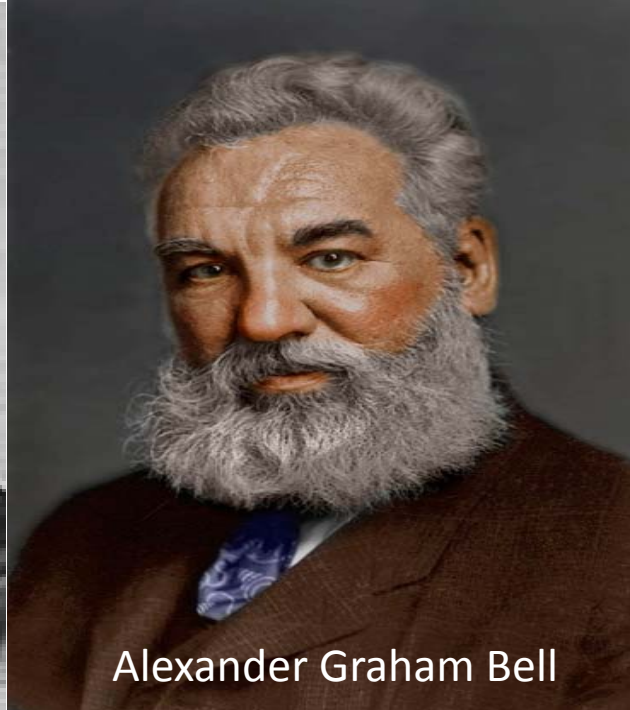
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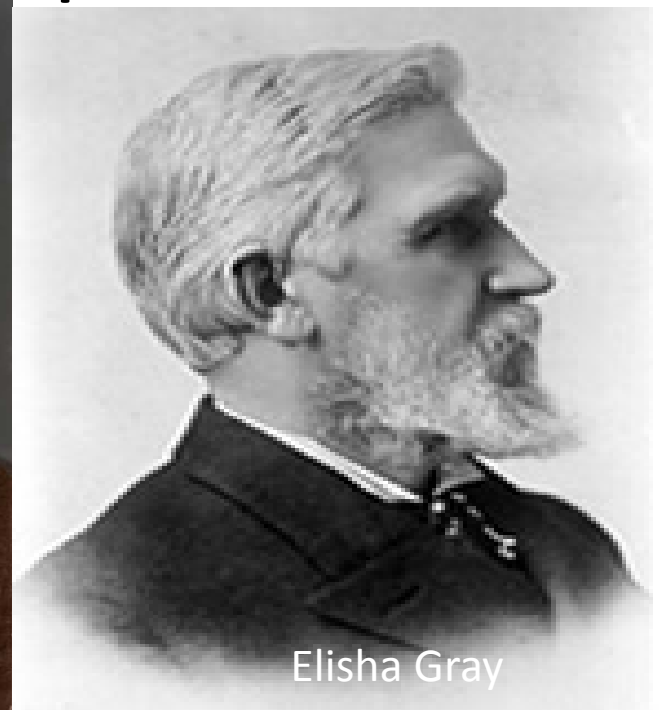
Who invented the Telephone?



Antonio Meucci



Alexander Graham Bell



Elisha Gray

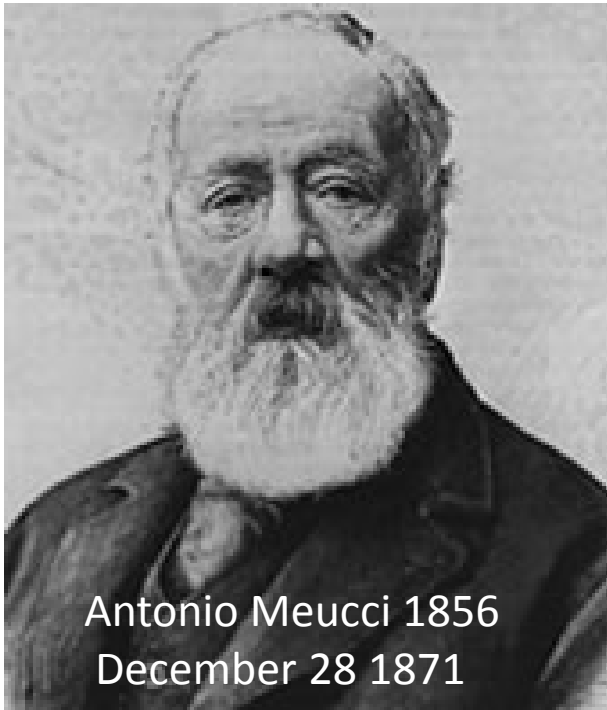


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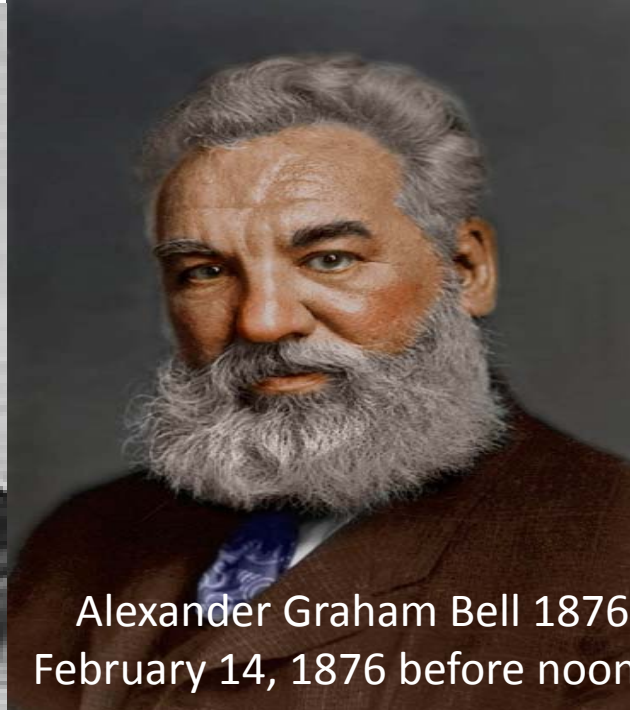
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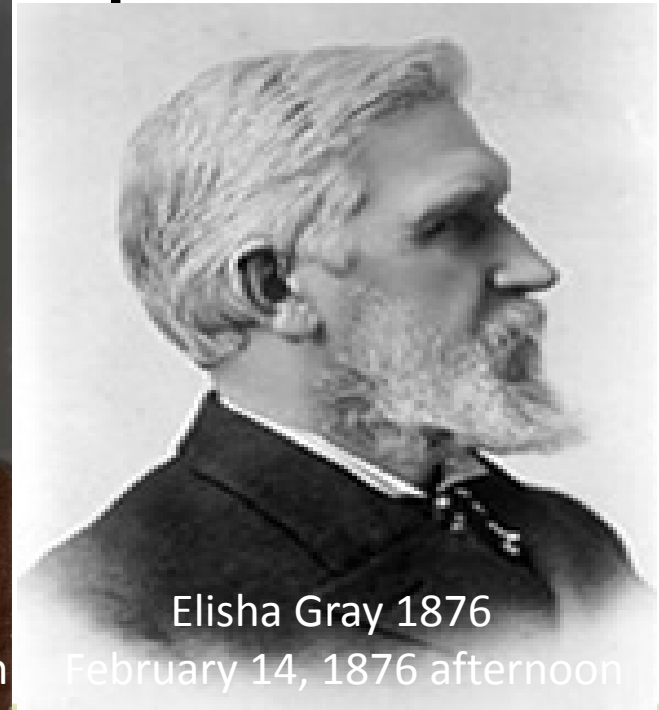
Who invented the Telephone?



Antonio Meucci 1856
December 28 1871



Alexander Graham Bell 1876
February 14, 1876 before noon



Elisha Gray 1876
February 14, 1876 afternoon



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Meucci acknowledged as telephone inventor, June 11, 2002

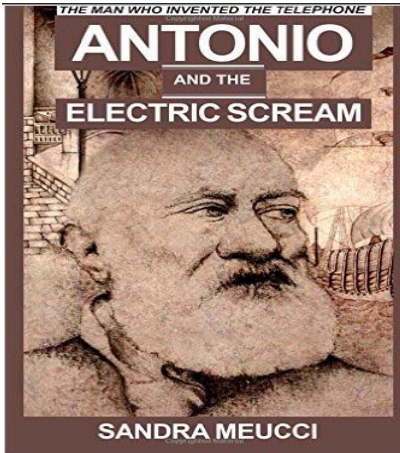
- Historians and Italian-Americans won their battle to persuade Washington to recognize a little-known mechanical genius, Antonio Meucci, as a father of modern communications, 113 years after his death.
- "It is the sense of the House of Representatives that the life and achievements of Antonio Meucci should be recognized, and his work in the invention of the telephone should be acknowledged"
- When Meucci's wife, Ester, became paralyzed he rigged a system to link her bedroom with his neighboring workshop and in 1860 held a public demonstration which was reported in New York's Italian-language press



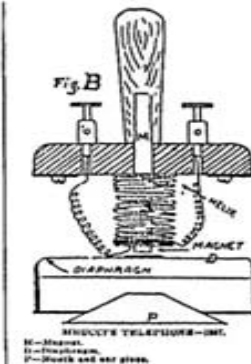
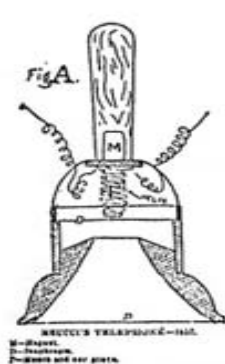
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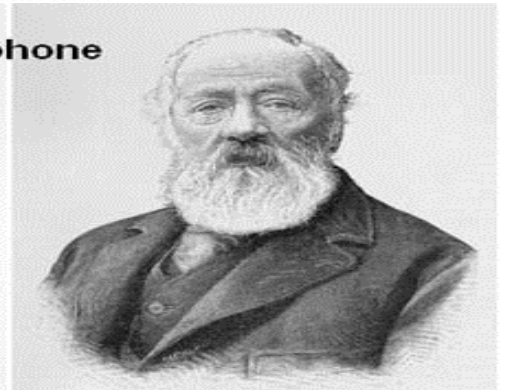
Antonio Meucci 1856



Antonio Meucci True Inventor of the Telephone



Vista del telefono trasmettitore Meucci. (Dallo El. Rev.)



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fascinating



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DANGER

**DO NOT TOUCH
NOT ONLY WILL THIS KILL YOU,
IT WILL HURT THE WHOLE TIME
YOU'RE DYING.**



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The world is too big for us. Too much is going on. Too many crimes, too much violence and excitement. Try as you will, you get behind in the race in spite of yourself. It is an incessant strain to keep pace, and still you lose ground. Science empties its discoveries on you so fast you stagger beneath them in hopeless bewilderment. Everything is high-pressure. Human nature can't endure much more."



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The Atlantic

Editorial in the Atlantic Journal,

June 16, 1833.



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Who is the NFPA? What is the NEC?

- The National Fire Protection Association (NFPA) is a global nonprofit organization, established in 1896, devoted to eliminating death, injury, property and economic loss due to fire, electrical and related hazards.
- NFPA delivers information and knowledge through more than 300 consensus codes and standards of which NFPA 70 the NEC is one.



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June
-July
1950

JUNE-JULY, 1950

FIRE!

don't let your house
burn down through
your own carelessness

By Kenneth Thomas



U.S. National Board of Fire Underwriters.



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Standards vs. Codes

- What is the difference?
- **Codes:**
- Safety
- Must be, Shall be done
- State Law
- Does not have to work
- **Standards:**
- Performance
- How to install
- Does has to work now and in the future
- Interoperable with all standards based equipment



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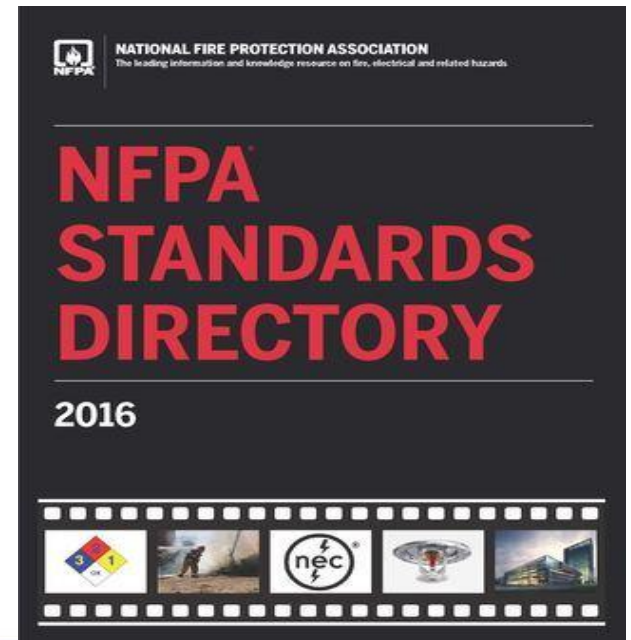
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Who is the NFPA?

- Started with 20 Insurance Companies and Associations.
- Insurance companies love to take money in but don't like to pay out.
- They are not always on your side:
- Eagle Fitness
- Pizza Delivery



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9 Chapters

Chapter 1 General Descriptions

Chapter 2 Wiring and Protection

How to do it

Chapter 3 Wiring Methods and Materials

Chapter 4 Equipment for General Use

Chapter 5 Special Occupancies

Chapter 6 Special Equipment

Equipment to install

Chapter 7 Special Conditions

Chapter 8 Communication Systems

Chapter 9 Tables divided into Articles



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Stands alone

Who decides what goes into the NEC code that we will be talking about?



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A group of Panels

- Each Chapter and most Articles have separate Panels that meet up to 3 times per year, for 3 years.
- Representatives of all disciplines covered by the code
- Power limited is in code panel 16



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A group of Panels

- They evaluate the submissions from YOU!
- They either approve or reject your submission. If they reject it, they must give a statement saying why.
- See the material enclosed for the examples.
- The process to revise the 2020 NEC will be announced by NFPA in the second quarter of 2017.
- Representatives of all disciplines covered by the code- see page 20 of the 2017 NEC for membership classifications



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- **NEC Code 90.1(A) Practical Safeguarding.**
- The purpose of this *Code* is the practical safeguarding of persons and property from hazards arising from the use of electricity.



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Not a Manual! Wait, What?

- **90.1 (A) Practical Safeguarding.** This *Code* is **not** intended as a design specification or an instruction manual for untrained persons.



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-
- **90.1 (B) Adequacy.** This *Code* contains provisions that are considered necessary for safety.
 - *It does not say it has to work!*
 - *It has to be safe!!*



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- **Special Permission.** The authority having jurisdiction for enforcing this *Code* may grant exception for the installation of conductors and equipment.
- *We are still responsible for what and how we install conductors and equipment.*



DO YOU HAVE PERMISSION?



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-
- **90.3 Code Arrangement.**
 - Chapter 8 covers communications systems and is not subject to the requirements of Chapters 1 through 7 except where the requirements are specifically referenced in Chapter 8.
 - However, in the 2017 NEC there are 134 references back to other chapters and references.



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-
- Fifty go back to Article 250 Grounding and we are Bonders not Grounders. Except in two instances.
 - 1) No electricity
 - 2) In one- and two-family dwellings where it is not practicable to achieve an overall maximum primary protector bonding conductor or grounding electrode conductor length of 6.0 m (20 ft), a separate communications ground rod meeting the minimum dimensional criteria shall be driven, The bonding conductor or grounding electrode conductor shall not be required to exceed 6 AWG.



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I thought we had to ground equipment!

- We are bonders not grounders! But if the two situations apply then **250.52** it is:
- **Metal Underground Water Pipe.**
- **Metal In-ground Support Structure(s).**
- **Concrete-Encased Electrode.**
- **Ground Ring.**
- **Rod and Pipe Electrodes.**
- **Other Listed Electrodes.**
- **Plate Electrodes.**
- **Other Local Metal Underground Systems or Structures.**



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- **State Law, Wait, What?**

- **90.4 Enforcement.** This **Code** is intended to be suitable for mandatory application by governmental bodies that exercise legal jurisdiction over electrical installations, including signaling and communications systems, and for use by insurance inspectors



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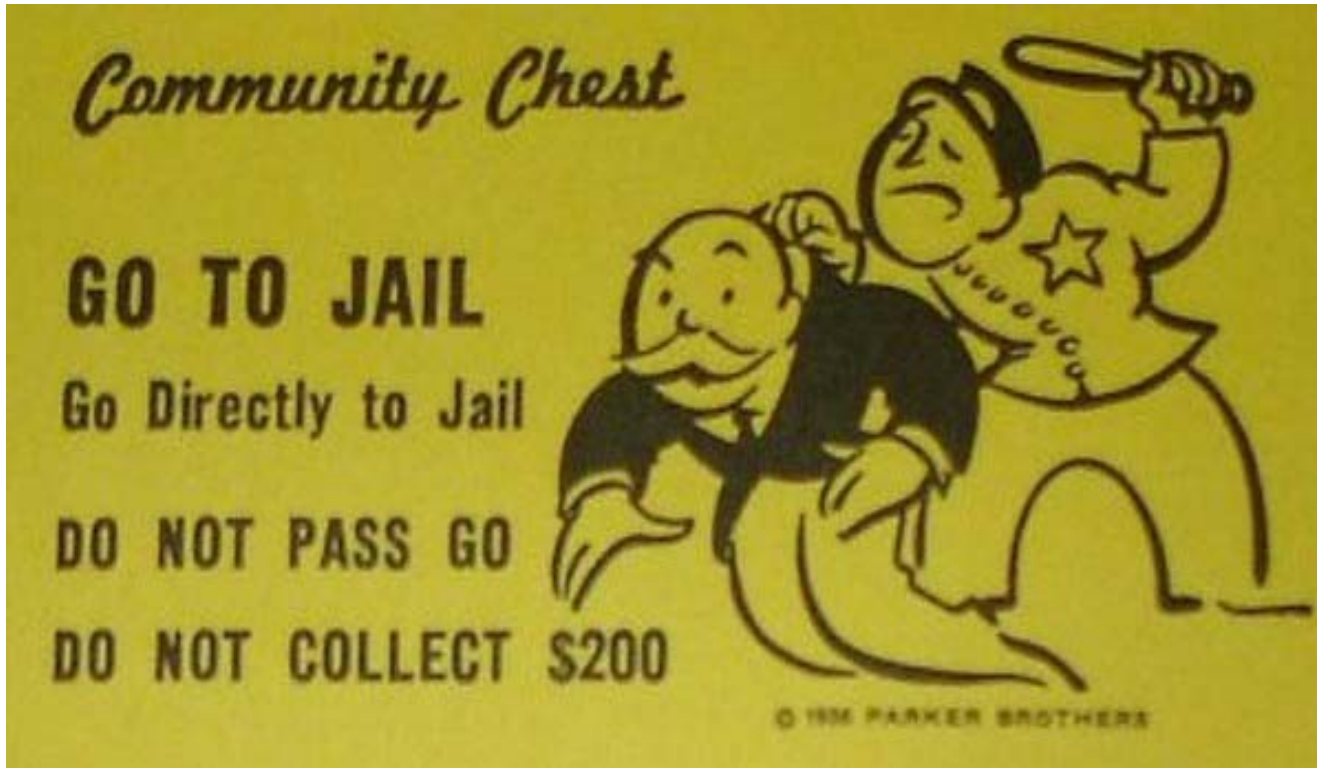
If you
don't
follow the
NEC you
are
violating
State law



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-
- The NEC takes on real significance when it is adopted into **law** by states and local jurisdictions.



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-
- The timing for code adoption varies by locale and may be amended by state and local jurisdictions. The result is that different electrical codes are being enforced in different parts of the U.S at the same time.



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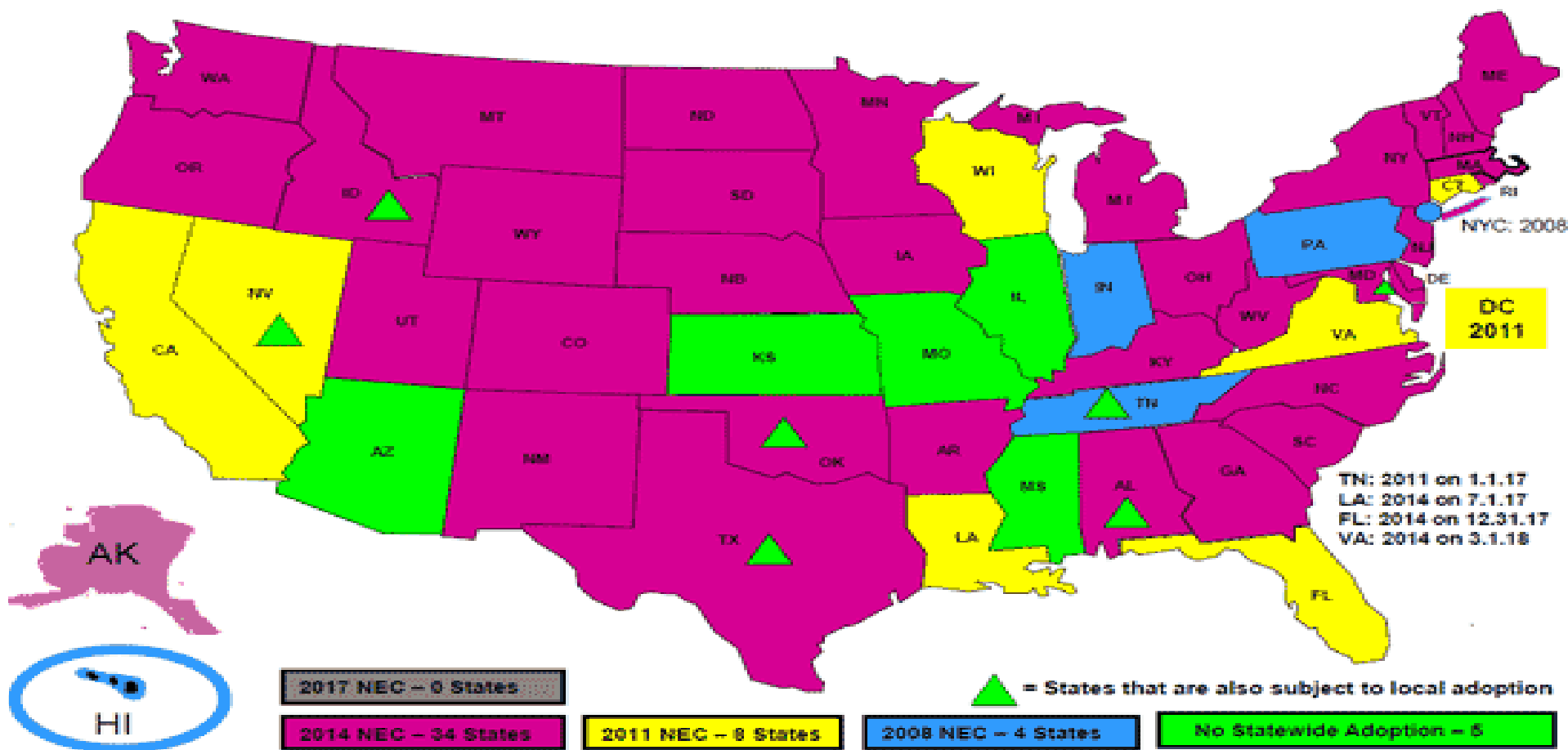
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The timing for code adoption varies by locale and may be amended by state and local jurisdictions. The result is that different electrical codes are being enforced in different parts of the U.S at the same time.

NEC Adoption by State

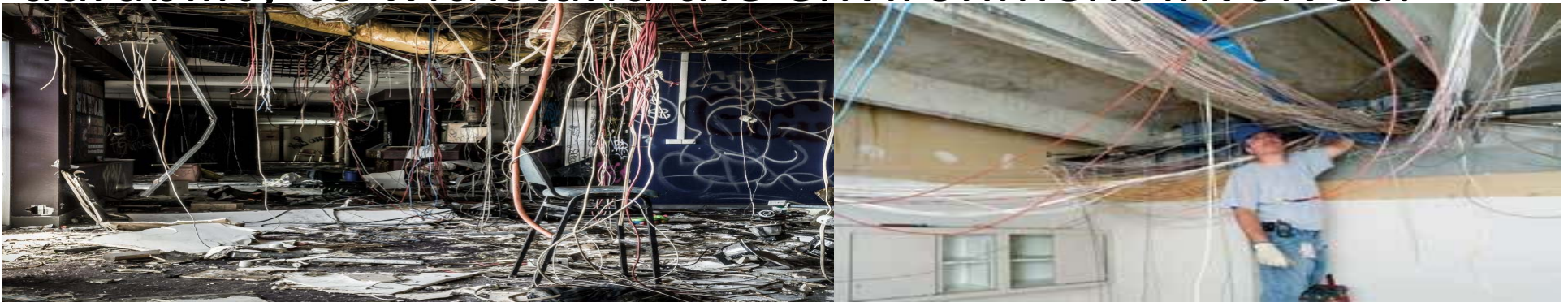
Revised – September 2016



Note: Earlier editions of the NEC may be enforced in states with no statewide adoption or that are subject to local adoption.

800.25 Abandoned Cables.

The accessible portion of abandoned communications cables shall be removed. Where cables are identified for future use with a tag, the tag shall be of sufficient durability to withstand the environment involved.



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800.26 Spread of Fire or Products of Combustion.

Installations of communications cables, communications raceways, cable routing assemblies in hollow spaces, vertical shafts, and ventilation or air-handling ducts shall be made so that the possible spread of fire or products of combustion will not be substantially increased.



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Caulk Non Mechanical putty



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800.26 Spread of Fire or Products of Combustion.

Openings around penetrations of communications cables, communications raceways, and cable routing assemblies through fire-resistant-rated walls, partitions, floors, or ceilings shall be firestopped using approved methods to *maintain the fire resistance rating*.



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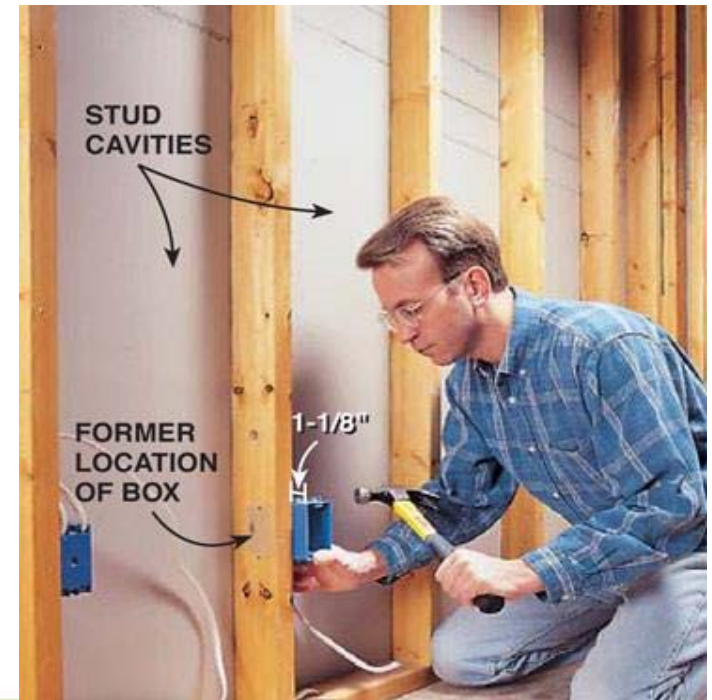
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800.26 Informational Note:


Building codes also contain restrictions on membrane penetrations on opposite sides of a fire resistance-rated wall assembly. An example is the 600 mm (24 in.) minimum horizontal separation that usually applies between boxes installed on opposite sides of the wall.



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NEC 800.26
Spread of Fire



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There were fire walls
in the attic, but one
failed, Chief Olson
said



2013 DES MOINES, Wash.



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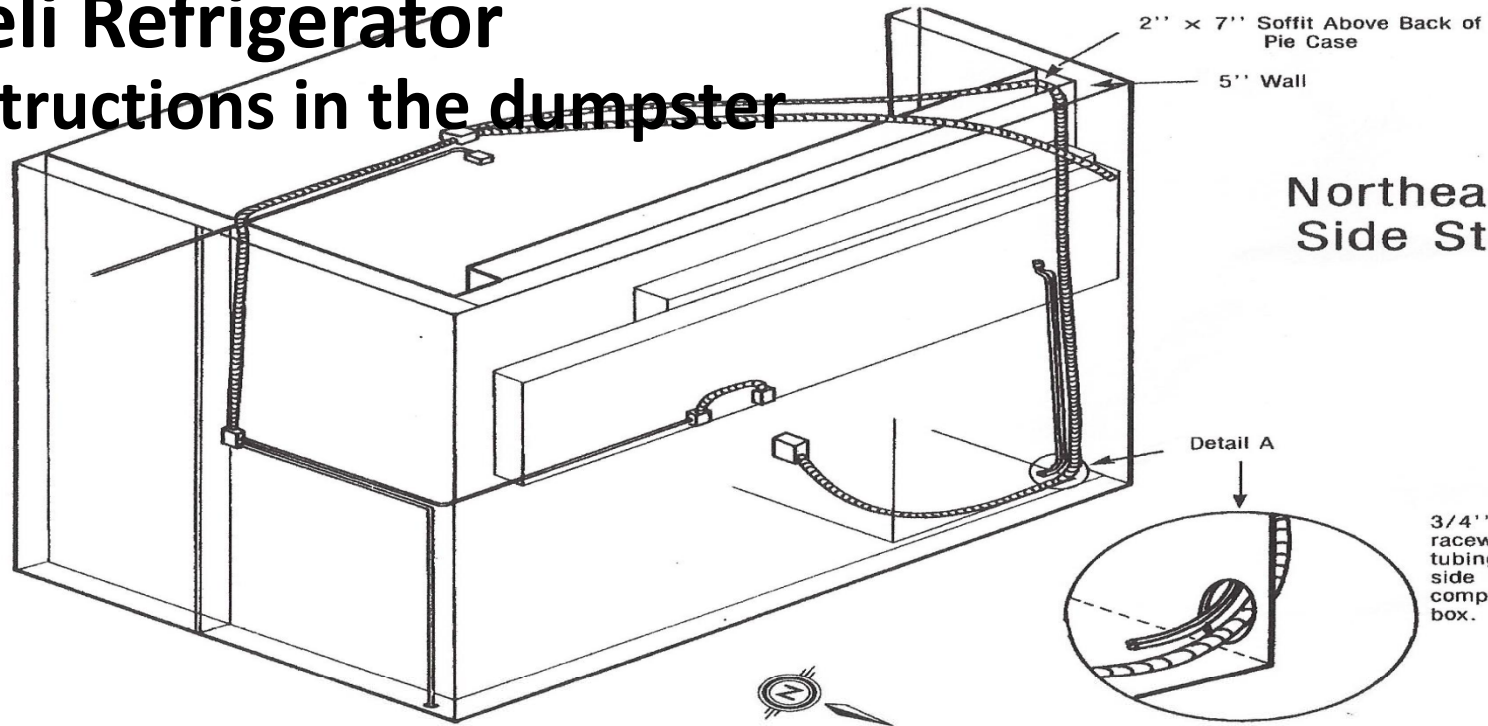


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Deli Refrigerator Instructions in the dumpster



Northeast View
Side Stand #2

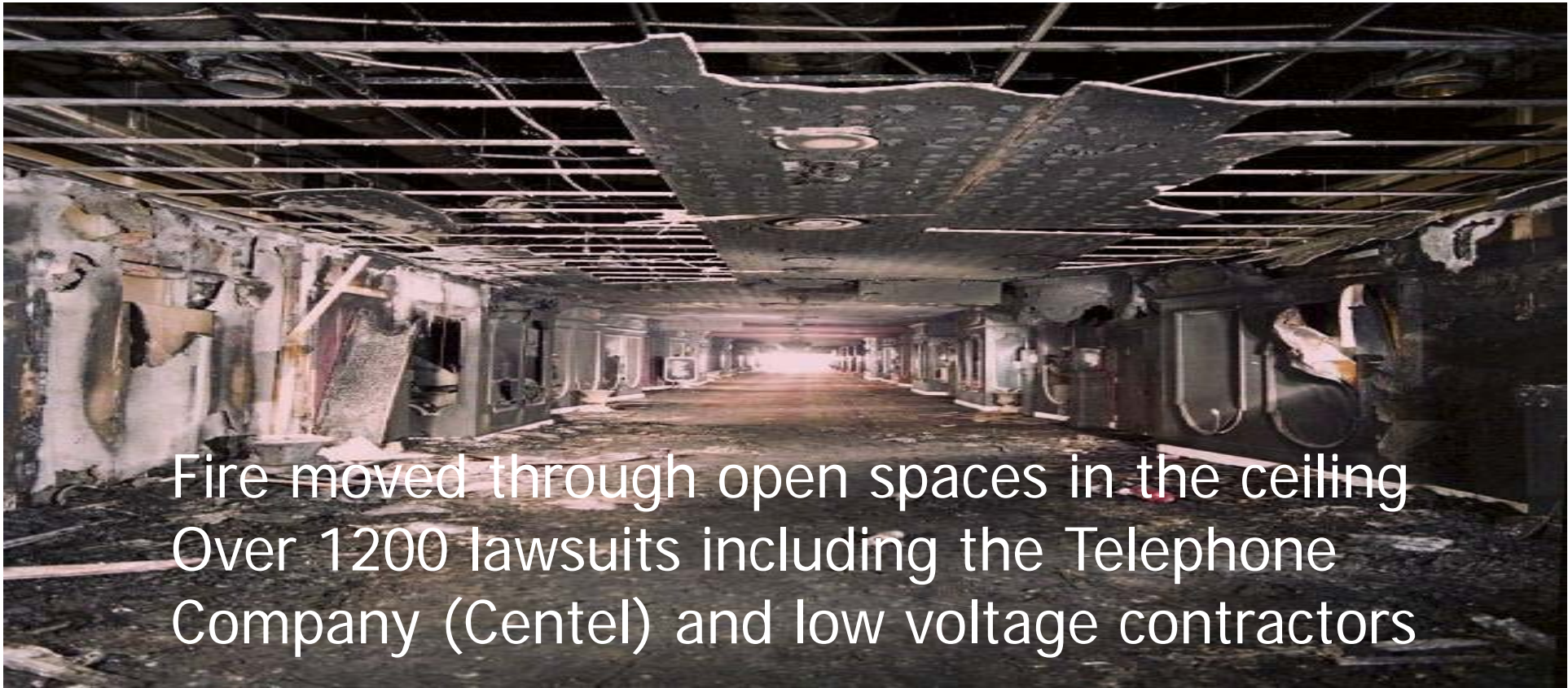
3/4'' flexible aluminum raceway and two copper tubing lines through hole in side of cabinet containing compressor to 4'' junction box.



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Fire moved through open spaces in the ceiling
Over 1200 lawsuits including the Telephone
Company (Centel) and low voltage contractors



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Fire moved at 19 feet per second



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Fire Blows out the door just like the movie Backdraft



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Cause?

- As with all large disasters there were many causes.
- Deli refrigerator installed incorrect (NEC) and not as per the manufactures instructions.
- No plenum cable used.
- All wall penetrations not fire caulked
- Vertical shafts not sealed at each floor
- Ceiling assembly not installed as per manufactures instructions.
- Result- 85 dead and multiple businesses out of businesses. Having to live with that.
- 3 people went to jail. Not following manufacturers instructions
- ***Follow the code and manufacturers instructions!!***



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Summary So far

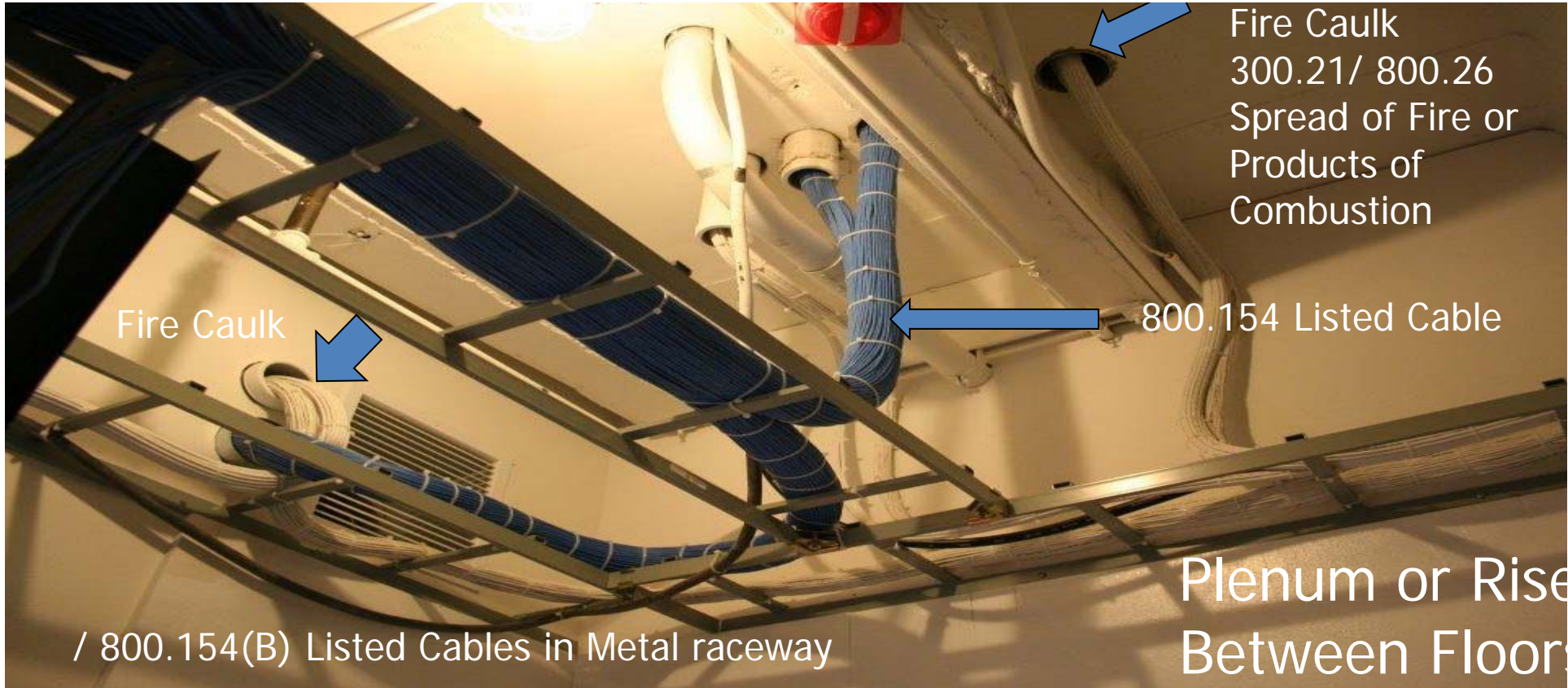
- NFPA started in 1896
- NEC = National Electric Code
- It becomes State Law
- It is not a manual
- We are bonders not grounders
- Chapter 8 Communications stands alone with 135 references back
- We are personally responsible for complying with the NEC.
- Kill someone– go to jail
- MGM Grand hotel 1980
- It is a blame assignment book



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Fire Caulk
300.21/ 800.26
Spread of Fire or
Products of
Combustion

Fire Caulk

800.154 Listed Cable

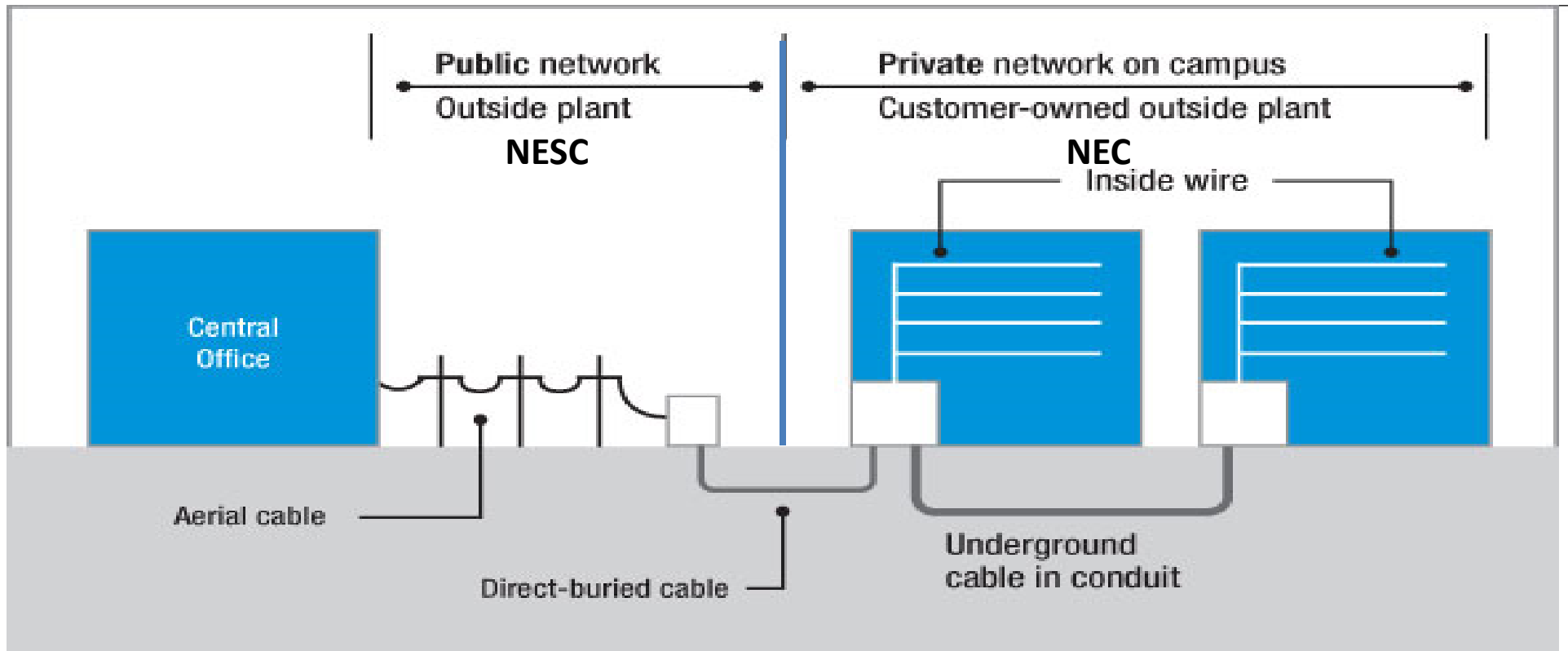
Plenum or Rise
Between Floors

/ 800.154(B) Listed Cables in Metal raceway



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NESC or NEC?



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770.24 Mechanical Execution of Work.

Optical fiber cables shall be installed in a neat and workmanlike manner. Cables installed exposed on the surface of ceilings and sidewalls shall be supported by the building structure in such a manner that the cable will not be damaged by normal building use.

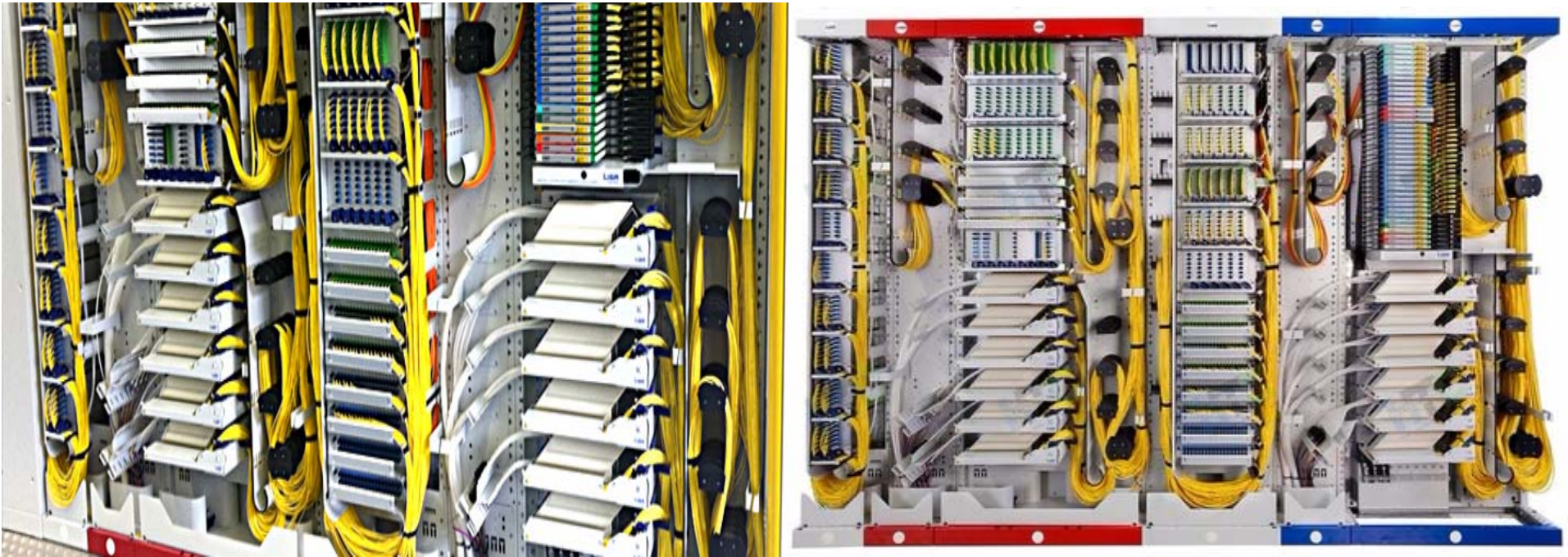


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770.24 Mechanical Execution of Work.



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770.24



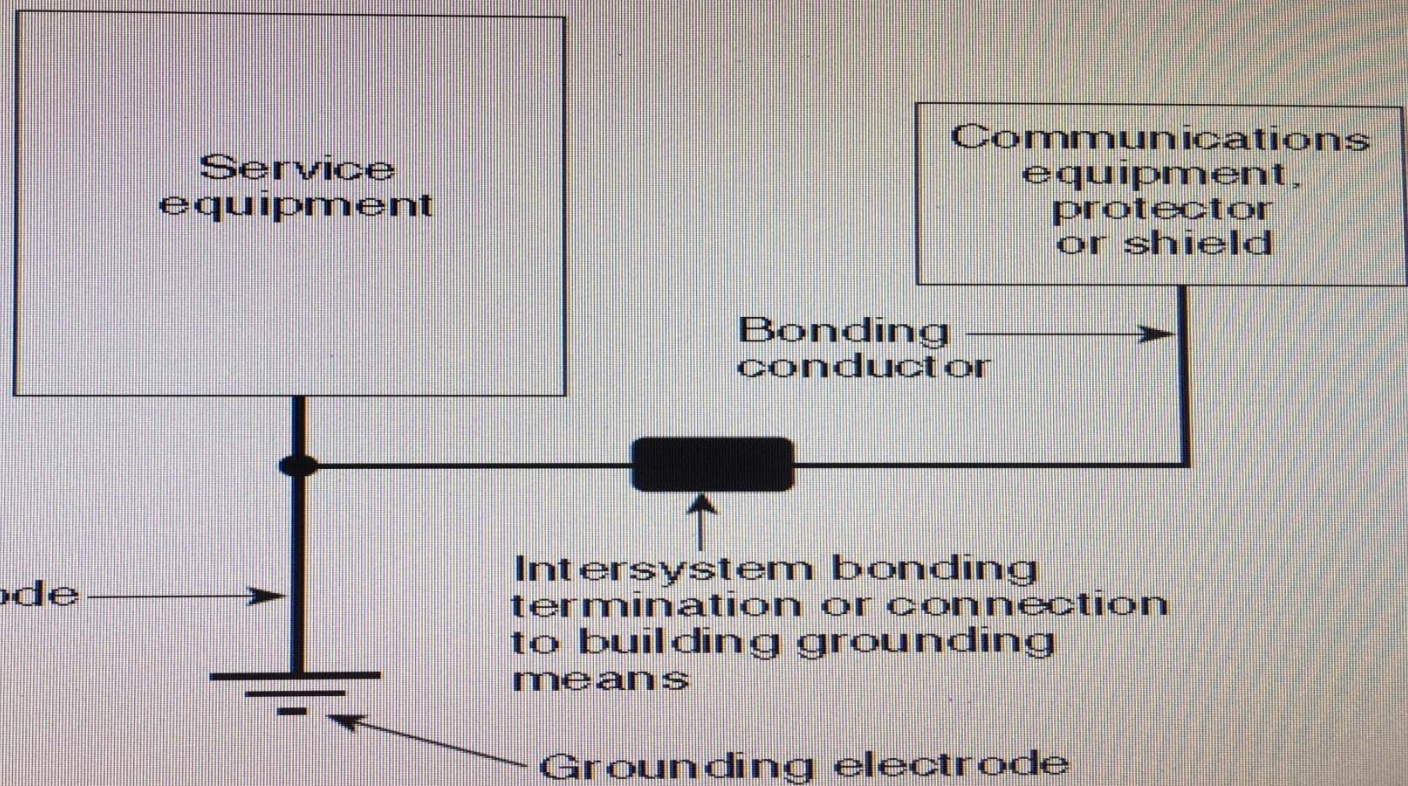
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Figure 800A

Illustration of a Bonding Conductor in a Communications Installation.



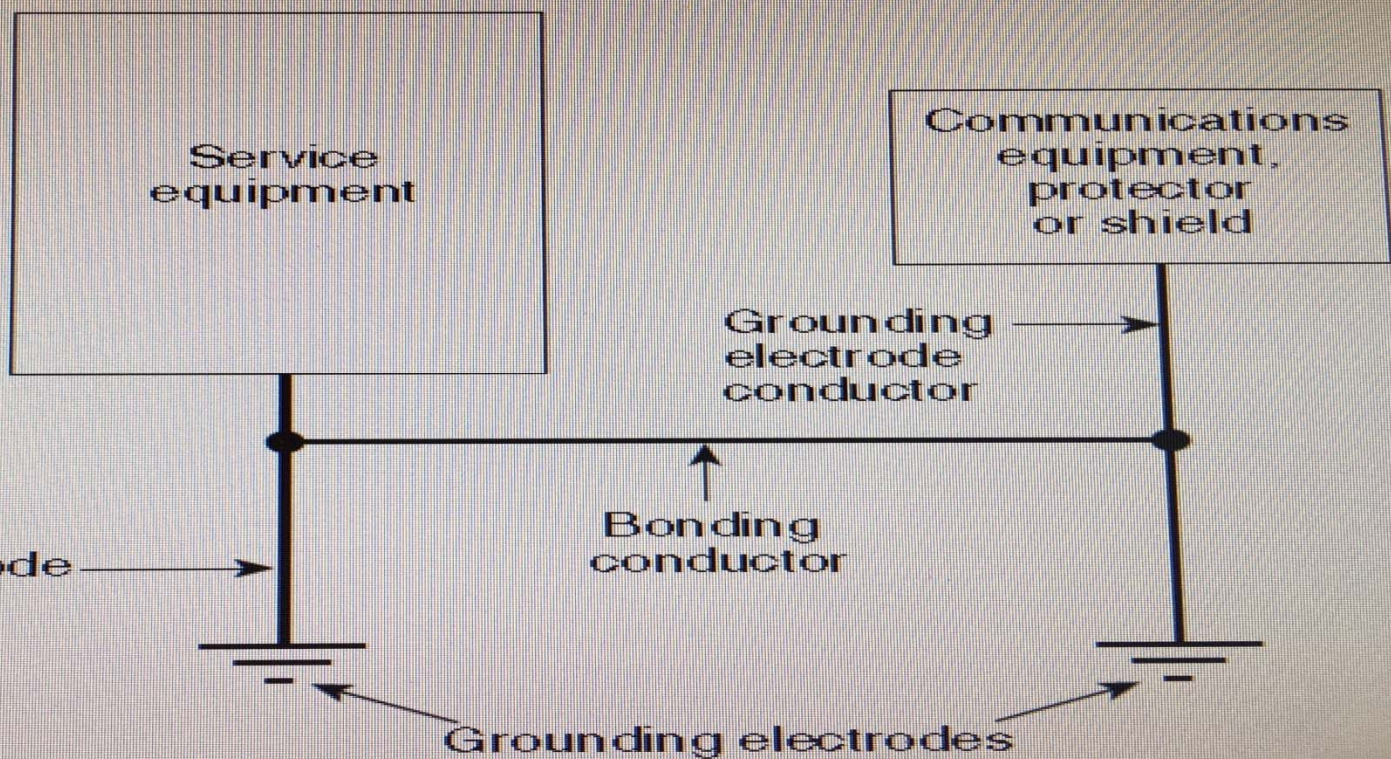
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Figure 800(b)

Illustration of a
Grounding Electrode
Conductor in a
Communications
Installation



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800.2 Definitions.

- **Cable Sheath.** A covering over the conductor assembly that may include one or more metallic members, strength members, or jackets.



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800.2 Definitions.

- **Point of Entrance.** The point within a building at which the communications wire or cable emerges from an external wall or from a concrete floor slab.



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800.24 Mechanical Execution of Work.

Communications circuits and equipment shall be installed in a neat and workmanlike manner. Cables installed exposed on the surface of ceilings and sidewalls shall be supported by the building structure in such a manner that the cable will not be damaged by normal building use.



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800.25 abandoned cable

800.18 Installation of equipment



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800.24 Mechanical Execution of Work.

- Communications circuits and equipment shall be installed in a neat and workmanlike manner. Cables installed exposed on the surface of ceilings and sidewalls shall be supported by the building structure in such a manner that the cable will not be *damaged by normal building use*.



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800.24 Neat
and
workmanlike
. Not to
affect the
building
operation

Nothing
really to
say,
except
your
Fired!

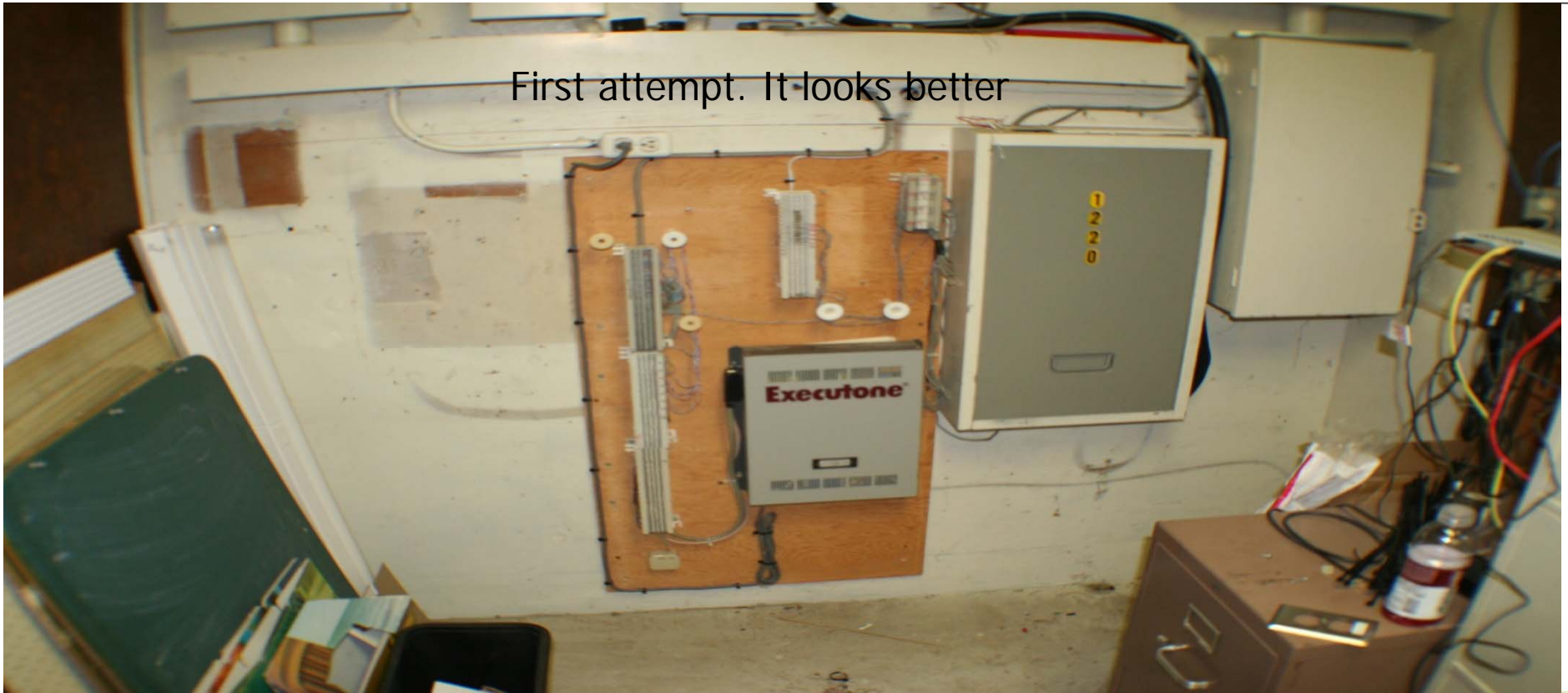


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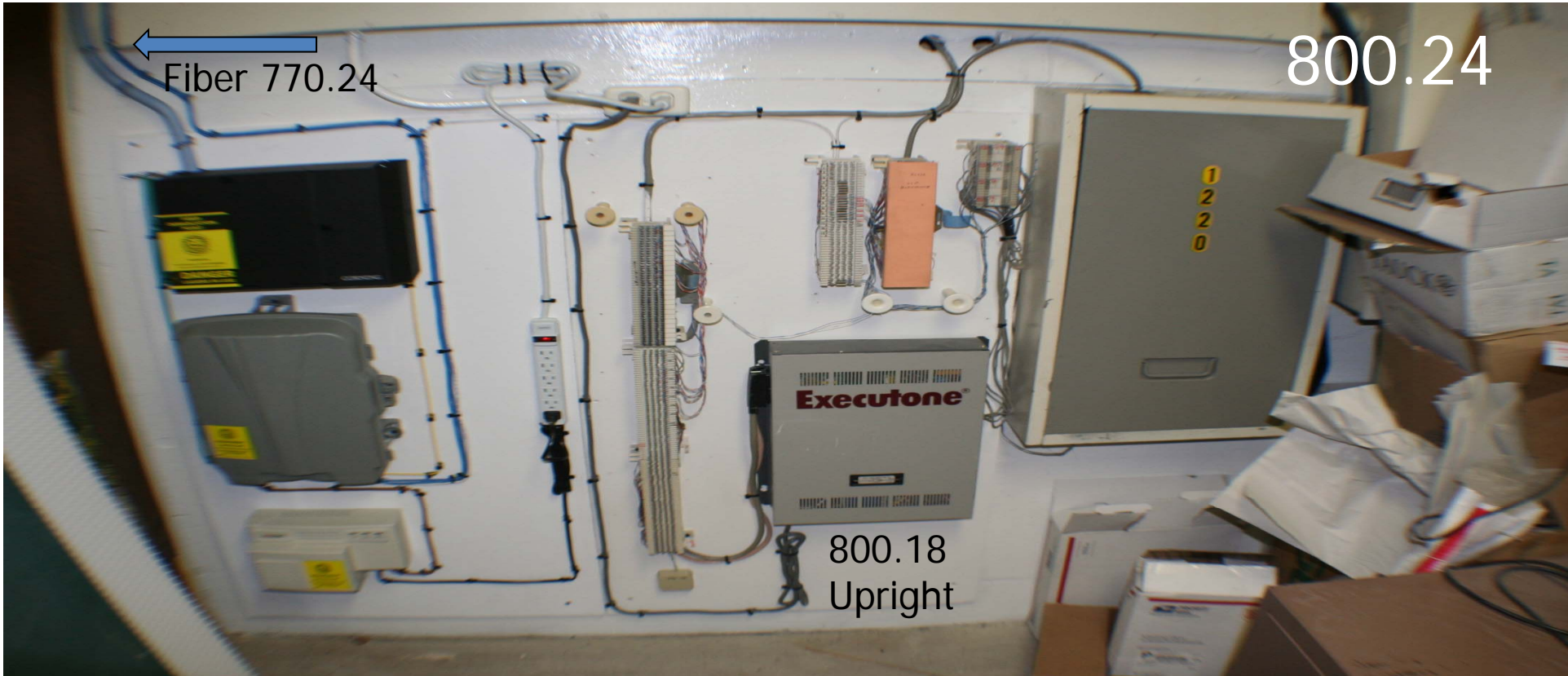
First attempt. It looks better



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← Fiber 770.24

800.24

Executone

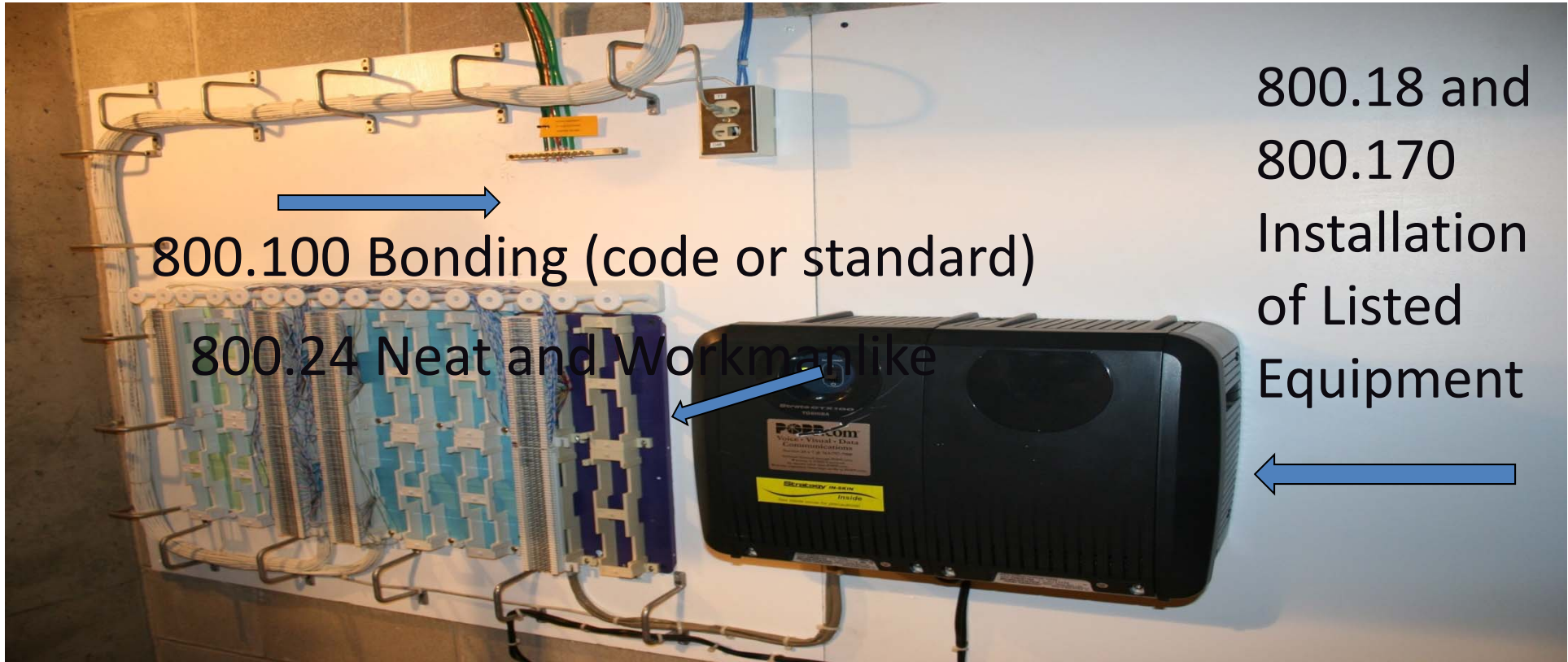
800.18
Upright

1
2
2
0



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800.100 Bonding (code or standard)

800.24 Neat and Workmanlike

800.18 and
800.170
Installation
of Listed
Equipment

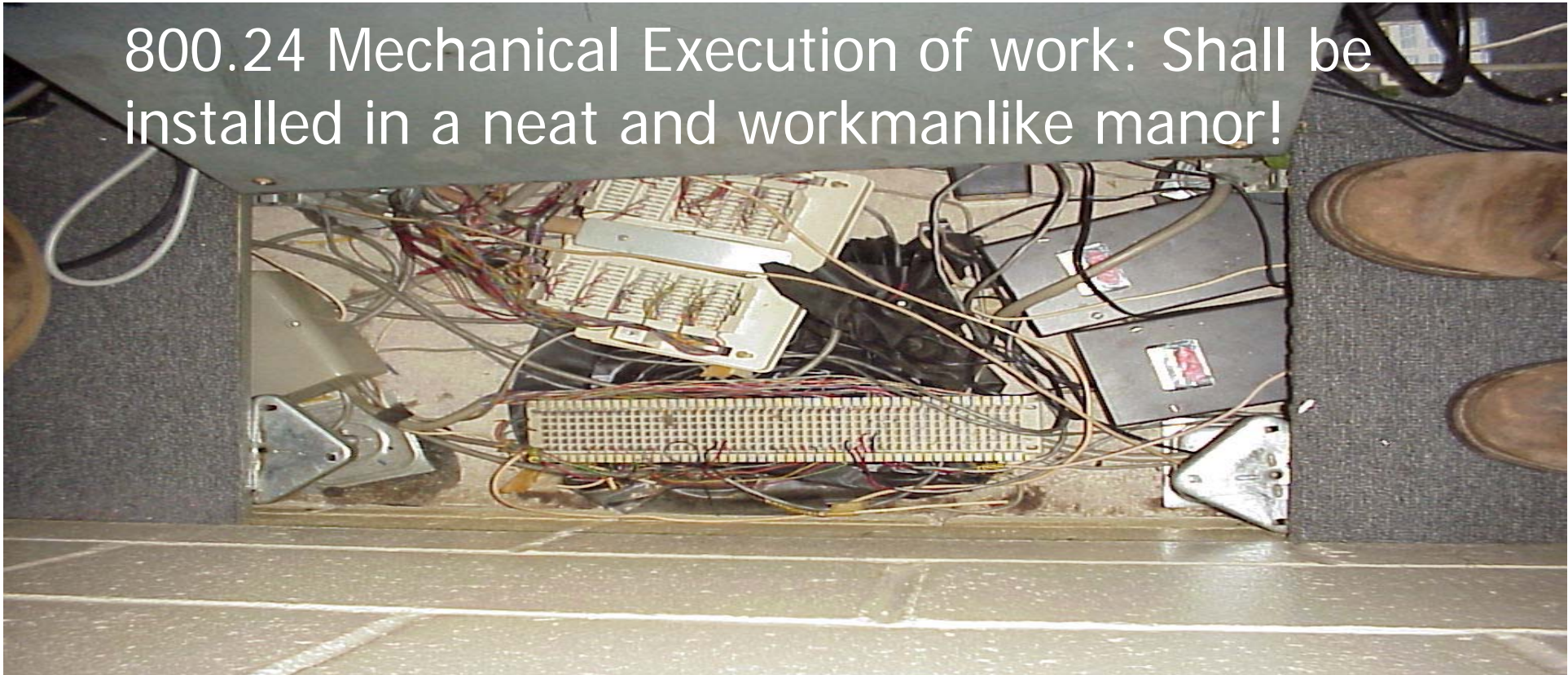


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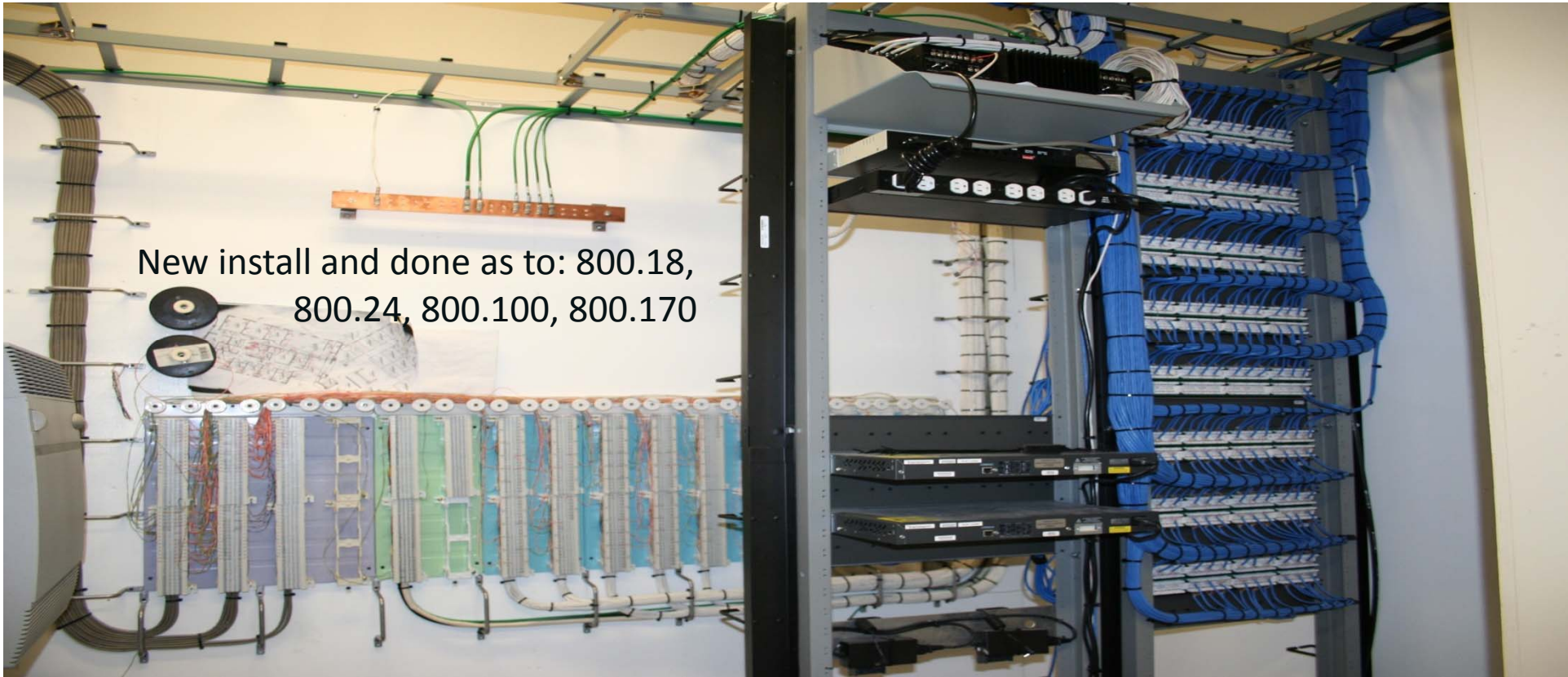
800.24 Mechanical Execution of work: Shall be installed in a neat and workmanlike manor!



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New install and done as to: 800.18,
800.24, 800.100, 800.170



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← **Not to exceed 50' from the Point of Entrance 800.48**

Not a listed Fire Stop

800.26 Firestop 26%





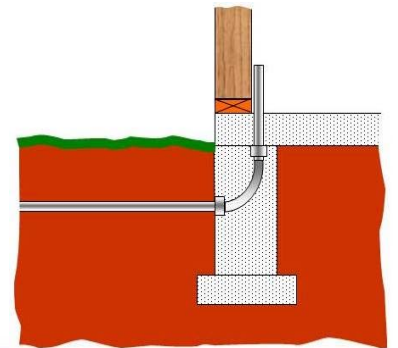
ID TER-568-C-2 CST & POTUSRES TOURE S 938295
BERK-TER LAJMARK-6 23 ALUS CNF 78C CUL
BERK-TER LAJMARK-6 23 ALUS CNF

800.47 Underground Communications Wires and Cables Entering Buildings.

Underground communications wires and cables entering buildings shall comply with 800.47(A) and (B).

The requirements of 310.10(C) shall not apply to communications wires and cables.

Wait, What we don't have to comply?



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310 Wet Locations

(C) Wet Locations. Insulated conductors and cables used in wet locations shall comply with one of the following:

- (1) Be moisture-impervious metal-sheathed
- (2) Be types MTW, RHW, RHW-2, TW, THW, THW-2, THHW, THWN, THWN-2, XHHW, XHHW-2, or ZW
- (3) Be of a type listed for use in wet locations



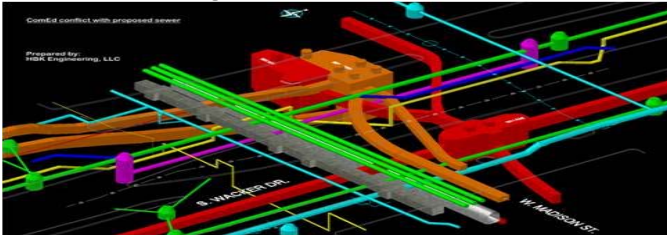
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Underground Block Distribution.

- **(B)** Where the entire street circuit is run underground and the circuit within the block is placed so as to be free from the likelihood of accidental contact with electric light or power circuits of over 300 volts to ground.



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Underground Cable Installation 1910



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Bond all shields all the time



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800.48 Unlisted Cables Entering Buildings

Unlisted outside plant communications cables shall be permitted to be installed in building spaces other than risers, ducts used for environmental air, plenums used for environmental air, and other spaces used for environmental air, where the length of the cable within the building, measured from its point of entrance, does not exceed 15 m (50 ft) and the cable enters the building from the outside and is terminated in an enclosure or on a listed primary protector.



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800.48 Unlisted Cables Entering Buildings

The point of entrance shall be permitted to be extended from the penetration of the external wall or floor slab by continuously enclosing the entrance cables in rigid metal conduit (RMC) or intermediate metal conduit (IMC) to the point of emergence.

800.2 Point of Entrance. The point within a building at which the communications wire or cable emerges from an external wall or from a concrete floor slab.

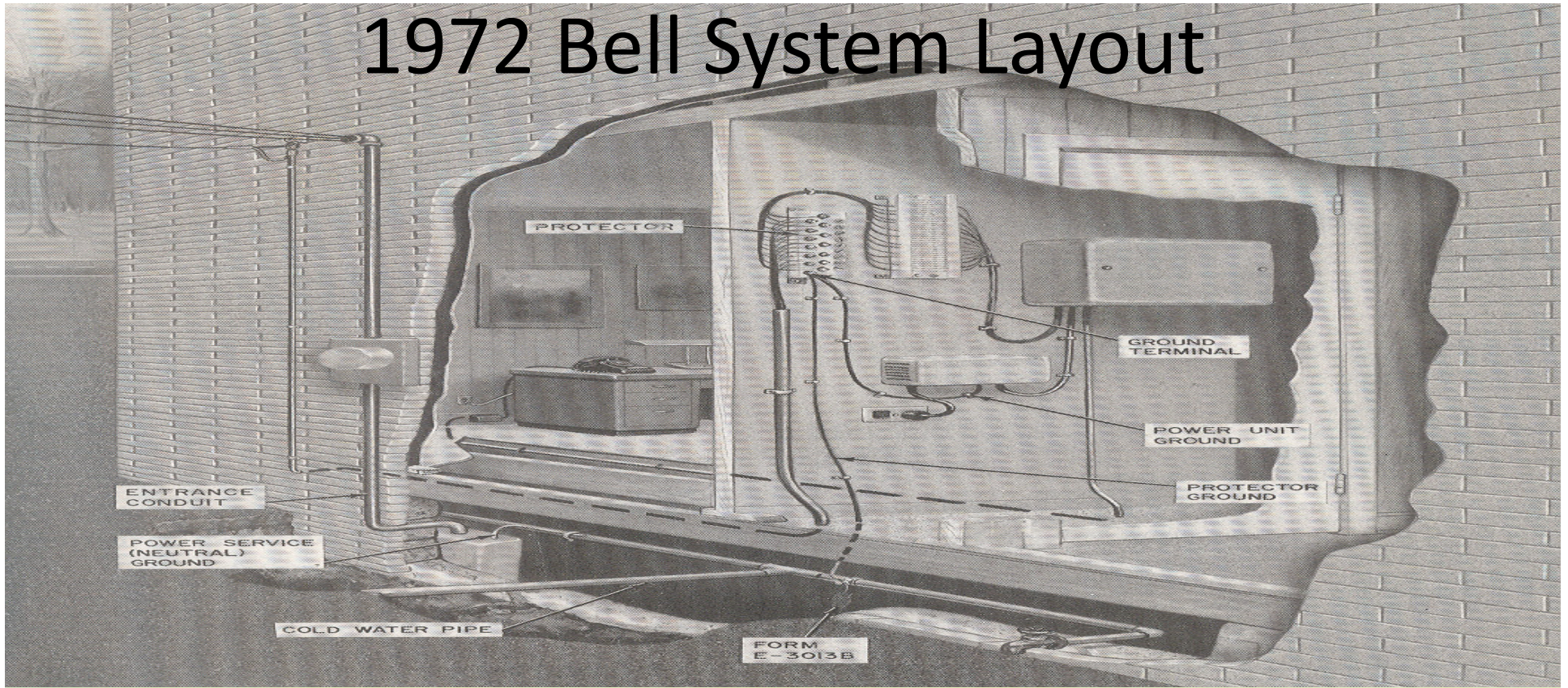


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1972 Bell System Layout



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Informational Note No. 2:

This section limits the length of unlisted outside plant cable to 15 m (50 ft), while 800.90(B) requires that the primary protector be located as close as practicable to the point at which the cable enters the building. Therefore, in installations requiring a primary protector, the outside plant cable may not be permitted to extend 15 m (50 ft) into the building if it is practicable to place the primary protector closer than 15 m (50 ft) to the *point of entrance*.



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800.49 Metallic Entrance Conduit Grounding. Metallic conduit containing communications entrance wire or cable shall be connected by a bonding conductor or grounding electrode conductor to a grounding electrode in accordance with 800.100(B).



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800.100 Cable and Primary Protector Bonding and Grounding.

- The primary protector and the metallic member(s) of the cable sheath shall be bonded or grounded as specified in 800.100(A) through 800.100(D).



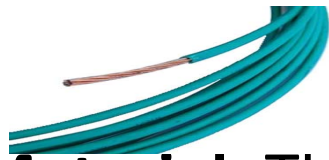
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800.100 Cable and Primary Protector Bonding and Grounding.

- **(1) Insulation.** The bonding conductor or grounding electrode conductor shall be listed and shall be permitted to be insulated, covered, or bare.



- **(2) Material.** The bonding conductor or grounding electrode conductor shall be copper or other corrosion-resistant conductive material, stranded or solid.



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800.100 Cable and Primary Protector Bonding and Grounding.

- **(3) Size.** The bonding conductor or grounding electrode conductor shall not be smaller than 14 AWG. It shall have a current-carrying capacity not less than the grounded metallic sheath member(s) and protected conductor(s) of the communications cable. The bonding conductor or grounding electrode conductor shall not be required to exceed 6 AWG.



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800.100 Cable and Primary Protector Bonding and Grounding.

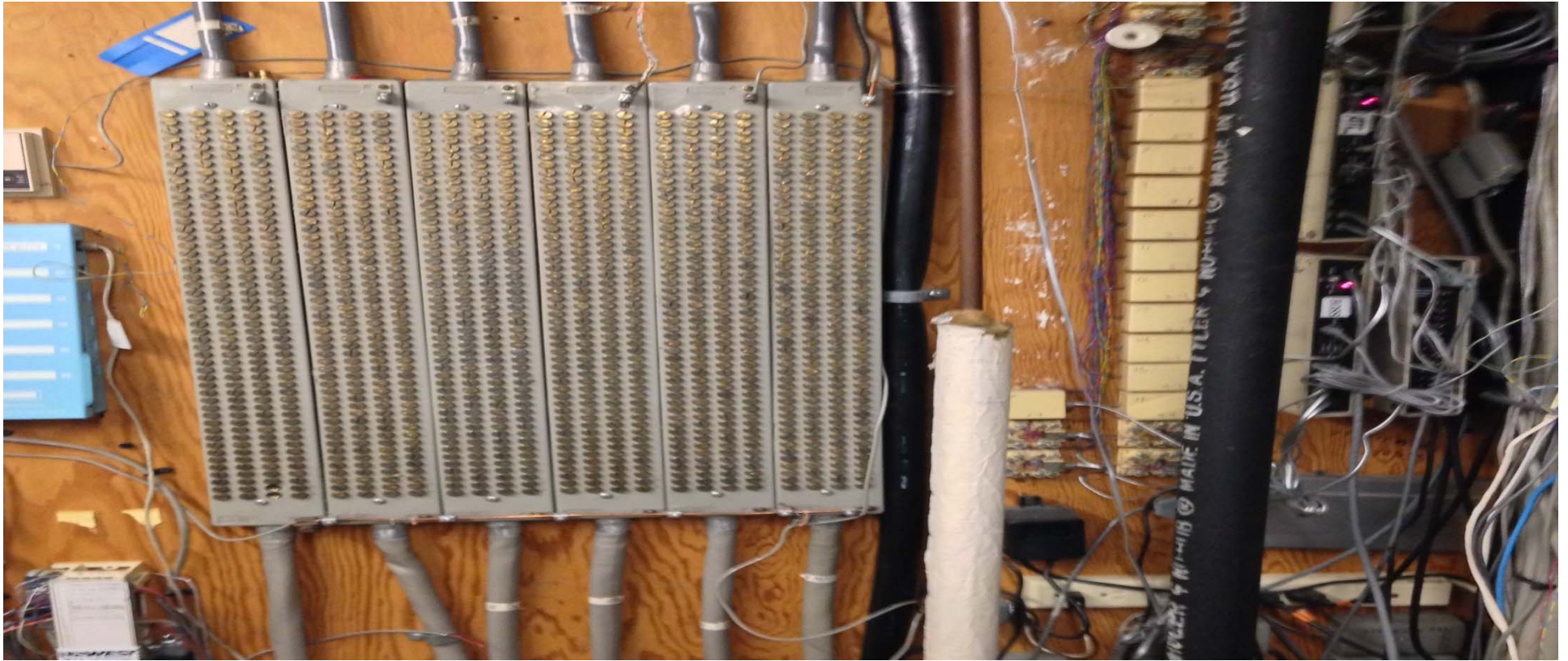
- **(4) Length.** The primary protector bonding conductor or grounding electrode conductor shall be as short as practicable. In one- and two-family dwellings, the primary protector bonding conductor or grounding electrode conductor shall be as short as practicable, not to exceed 6.0 m (20 ft) in length.



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800.100 Cable and Primary Protector Bonding and Grounding.

Exception: In one- and two-family dwellings where it is not practicable to achieve an overall maximum primary protector bonding conductor or grounding electrode conductor length of 6.0 m (20 ft), a separate communications ground rod meeting the minimum dimensional criteria of 800.100(B)(3)(2) shall be driven, the primary protector shall be connected to the communications ground rod in accordance with 800.100(C), and the communications ground rod shall be connected to the power grounding electrode system in accordance with 800.100(D).



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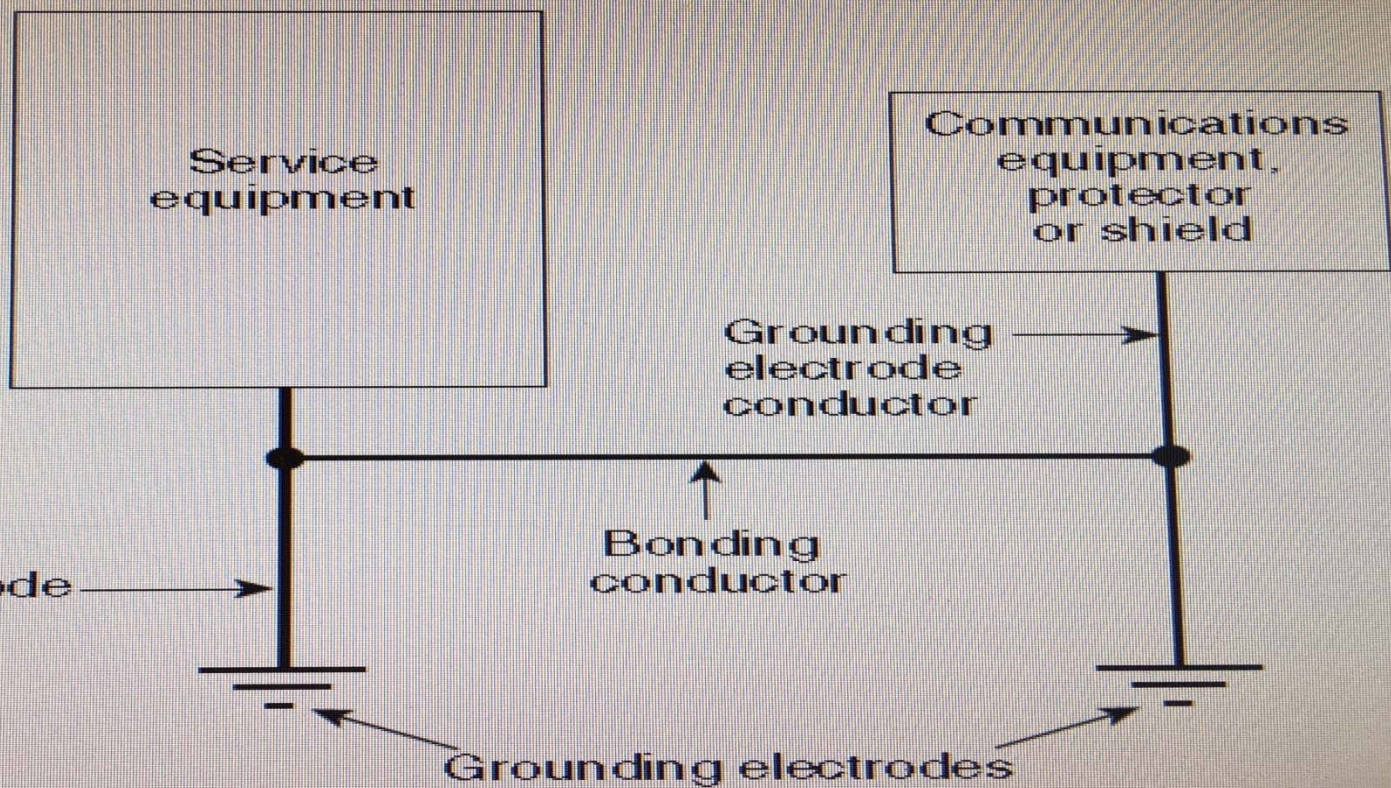
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Figure 800(b)

Illustration of a Grounding Electrode Conductor in a Communications Installation.

Power service grounding electrode conductor



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800.100 Cable and Primary Protector Bonding and Grounding.

800.100(B)(3)(2) If the building or structure served has no intersystem bonding termination or has no grounding means, as described in 800.100(B)(2) or (B)(3)(1), to any one of the individual grounding electrodes described in 250.52(A)(7) and (A)(8) or to a ground rod or pipe not less than 1.5 m (5 ft) in length and 12.7 mm (1/2 in.) in diameter, driven, where practicable, into permanently damp earth and separated from lightning protection system conductors as covered in 800.53 and at least 1.8 m (6 ft) from electrodes of other systems. Steam, hot water pipes, or lightning protection system conductors shall not be employed as electrodes for protectors and grounded metallic members.

YIKES! No electricity or more than 20 feet in a one or two family dwelling



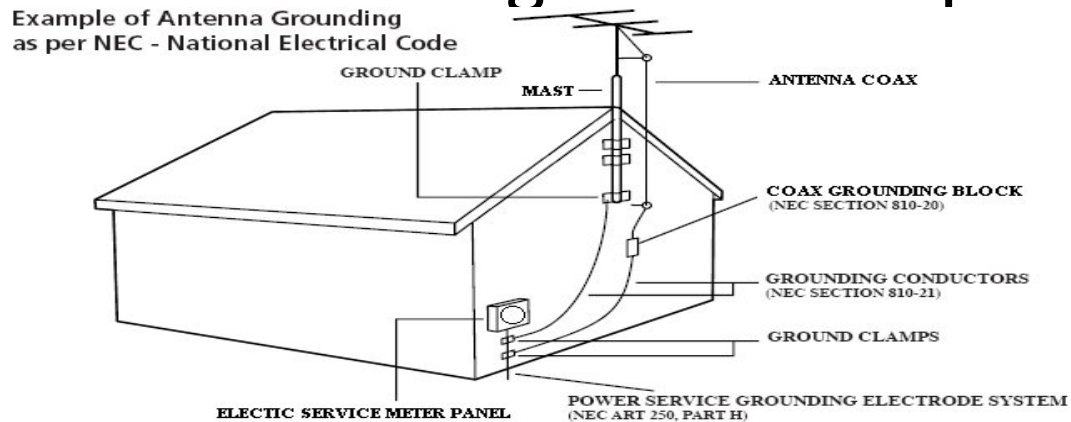
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800.100 Cable and Primary Protector Bonding and Grounding.

- **(5) Run in Straight Line.** The bonding conductor or grounding electrode conductor shall be run in as straight a line as practicable.



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800.100 Cable and Primary Protector Bonding and Grounding.

- **(6) Physical Protection.** Bonding conductors and grounding electrode conductors shall be protected where exposed to physical damage. Where the bonding conductor or grounding electrode conductor is installed in a metal raceway, both ends of the raceway shall be bonded to the contained conductor or to the same terminal or electrode to which the bonding conductor or grounding electrode conductor is connected.



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800.100 Cable and Primary Protector Bonding and Grounding.

- **(B) Electrode.** The bonding conductor or grounding electrode conductor shall be connected in accordance with 800.100(B)(1), 800.100(B)(2), or 800.100(B)(3).
- **(B)(1) In Buildings or Structures with an Intersystem Bonding**

Termination. If the building or structure served has an intersystem bonding termination as required by 250.94, the bonding conductor shall be connected to the intersystem bonding termination.



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800.100 Cable and Primary Protector Bonding and Grounding.

- **250.94 Bonding for Communication Systems.** Communications system bonding terminations shall be connected in accordance with (A) or (B).
- **(A) The Intersystem Bonding Termination Device.** An intersystem bonding termination (IBT) for connecting intersystem bonding conductors shall be provided external to enclosures at the service equipment or metering equipment enclosure and at the disconnecting means for any additional buildings or structures.



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800.100 Cable and Primary Protector Bonding and Grounding.

- If an **IBT** (Intersystem Bonding Termination) is used, it shall comply with the following:
 - (1) Be accessible for connection and inspection.
 - (2) Consist of a set of terminals with the capacity for connection of not less than three intersystem bonding conductors.
 - (3) Not interfere with opening the enclosure for a service, building or structure disconnecting means, or metering equipment.



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800.100 Cable and Primary Protector Bonding and Grounding.

- (4) At the service equipment, be securely mounted and electrically connected to an enclosure for the service equipment, to the meter enclosure, or to an exposed nonflexible metallic service raceway, or be mounted a one of these enclosures and be connected to the enclosure or to the grounding electrode conductor with a minimum 6 AWG copper conductor.
- (5) At the disconnecting means for a building or structure, be securely mounted and electrically connected to the metallic enclosure for the building or structure disconnecting means, or be mounted at the disconnecting means and be connected to the metallic enclosure or to the grounding electrode conductor with a minimum 6 AWG copper conductor.



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- **(2) In Buildings or Structures with Grounding Means.** If an intersystem bonding termination is established, 250.94(A) shall apply. If the building or structure served has no intersystem bonding termination, the bonding conductor or grounding electrode conductor shall be connected to the nearest accessible location on one of the following:



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- (1) The building or structure grounding electrode system as covered in 250.50
 - (2) The grounded interior metal water piping system, within 1.5 m (5 ft) from its point of entrance to the building, as covered in 250.52
 - (3) The power service accessible means external to enclosures using the options identified in 250.94(A), Exception
 - (4) The nonflexible metallic power service raceway
 - (5) The service equipment enclosure
 - (6) The grounding electrode conductor or the grounding electrode conductor metal enclosure of the power service
 - (7) The grounding electrode conductor or the grounding electrode of a building or structure disconnecting means that is grounded to an electrode as covered in 250.32



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800.110 Raceways and Cable Routing Assemblies for Communications

Wires and Cables.

- **(B) Raceway Fill for Communications Wires and Cables.** The raceway fill requirements of Chapters 3 and 9 **shall not apply** to communications wires and cables.
- What about firestop?
- Sleeves 26% to 30% fill ratio.
- What about 40%?
- What about 800.110?

Please,
help me!



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800.113 Installation of Communications Wires, Cables and Raceways, and Cable Routing Assemblies.

(A) Listing. Communications wires, communications cables, communications raceways, and cable routing assemblies installed in buildings shall be listed.



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800.170 Equipment. Communications equipment shall be listed as being suitable for electrical connection to a communications network.

(A) Primary Protectors. The primary protector shall consist of an arrester connected between each line conductor and ground in an appropriate mounting. Primary protector terminals shall be marked to indicate line and ground as applicable.

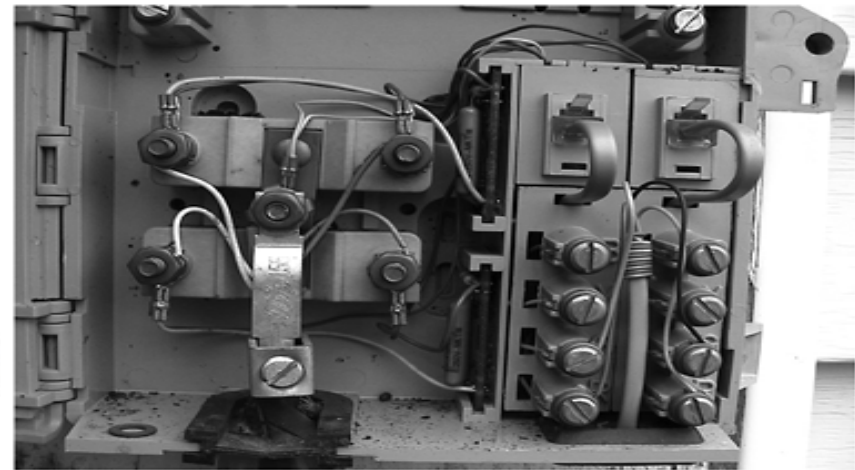


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(A) Primary Protectors.



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(B) Secondary Protectors. The secondary protector shall be listed as suitable to provide means to safely limit currents to less than the current-carrying capacity of listed indoor communications wire and cable, listed telephone set line cords, and listed communications terminal equipment having ports for external wire line communications circuits.



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(B) Secondary Protectors.



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800.180 Grounding Devices. Where bonding or grounding is required, devices used to connect a shield, a sheath, or non-current-carrying metallic members of a cable to a bonding conductor or grounding electrode conductor shall be listed or be part of listed equipment.



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Radio and Television Equipment

810.1 Scope. This article covers antenna systems for radio and television receiving equipment, amateur and citizen band radio transmitting and receiving equipment, and certain features of transmitter safety.



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810.6 Antenna Lead-In Protectors.

Where an antenna lead-in surge protector is installed, it shall be listed as being suitable for limiting surges on the cable that connects the antenna to the receiver/transmitter electronics and shall be connected between the conductors and the grounded shield or other ground connection. The antenna lead-in protector shall be grounded using a bonding conductor or grounding electrode conductor installed in accordance with 810.21(F).



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810.6 Antenna Lead-In Protectors



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(F) Electrode. The bonding conductor or grounding electrode conductor shall be connected as required in 810.21(F)(1) through 810.21(F)(3).

- (1) In Buildings or Structures with an Intersystem Bonding Termination.
- (2) In Buildings or Structures with Grounding Means.
- (3) In Buildings or Structures Without an Intersystem Bonding Termination or Grounding Means.



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ARTICLE 810 — RADIO AND TELEVISION EQUIPMENT

810.7 Grounding Devices. Where bonding or grounding is required, devices used to connect a shield, a sheath, non-current-carrying metallic members of a cable, or metal parts of equipment or antennas to a bonding conductor or grounding electrode conductor shall be listed or be part of listed equipment.



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**It is not a listed ground
or bonding clamp.**



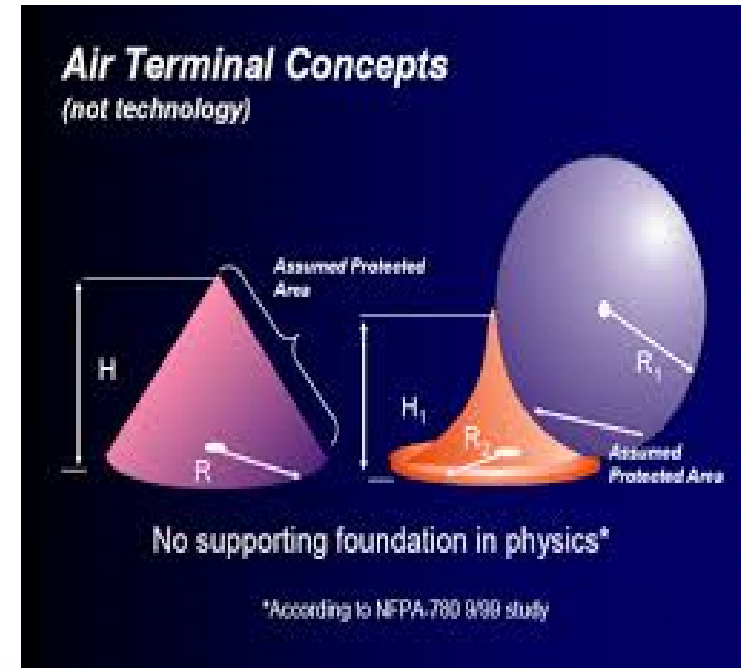
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810.15 Grounding.

Masts and metal structures supporting antennas shall be grounded in accordance with 810.21, unless the antenna and its related supporting mast or structure are within a zone of protection defined by a 46 m (150 ft) radius rolling sphere.



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810.20(3)(H)

- **(H) Size.** The bonding conductor or grounding electrode conductor shall not be smaller than 10 AWG copper, 8 AWG aluminum, or 17 AWG copper-clad steel or bronze.



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810.21 Bonding Conductors and Grounding Electrode

- **(E) Run in Straight Line.** The bonding conductor or grounding electrode conductor for an antenna mast or antenna discharge unit shall be run in as straight a line as practicable.
- **3(G) Inside or Outside Building.** The bonding conductor or grounding electrode conductor shall be permitted to be run either inside or outside the building.



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810.21(3)(J) Bonding of Electrodes

A bonding jumper not smaller than 6 AWG copper or equivalent shall be connected between the radio and television equipment grounding electrode and the power grounding electrode system at the building or structure served where separate electrodes are used.



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820.48 Unlisted Cables Entering Buildings.

Unlisted outside plant coaxial cables shall be permitted to be installed in building spaces other than risers, ducts used for environmental air, plenums used for environmental air, and other spaces used for environmental air, where the length of the cable within the building, measured from its ***point of entrance***, does not exceed 15 m (***50 ft***) and the cable enters the building from the outside and is terminated at a grounding block.



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820.48 Unlisted Cable Entering Buildings

- The point of entrance shall be permitted to be extended from the penetration of the external wall or floor slab by continuously enclosing the entrance cables in rigid metal conduit (RMC) or intermediate metal conduit (IMC) to the point of emergence.

820.2 Definitions:

- **Point of Entrance.** The point within a building at which the coaxial cable emerges from an external wall or from a concrete floor slab.



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820.49 Metallic Entrance Conduit Grounding.

- Metallic conduit containing entrance coaxial cable shall be connected by a bonding conductor or grounding electrode conductor to a grounding electrode in accordance with 820.100(B).
- **(B) Electrode.** The bonding conductor or grounding electrode conductor shall be connected in accordance with 820.100(B)(1), 820.100(B)(2) , or 820.100(B)(3).



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820.100 Cable Bonding and Grounding.

- **820.100(B)(1):** In Buildings or Structures with an Intersystem Bonding Termination.
- **820.100(B)(2):** In Buildings or Structures with Grounding Means.
- **820.100(B)(3):** In Buildings or Structures Without an Intersystem Bonding Termination or Grounding Means.



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ARTICLE 830 — NETWORK-POWERED BROADBAND
COMMUNICATIONS SYSTEMS

- **830.2 Definitions. Point of Entrance.** The point within a building at which the network-powered broadband communications cable emerges from an external wall, from a concrete floor slab, from rigid metal conduit (RMC), or from intermediate metal conduit (IMC).



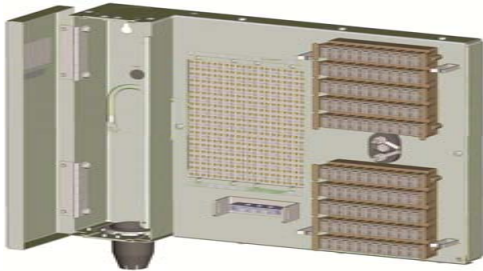
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830.47 Underground Network-Powered Broadband Communications

- **Cables Entering Buildings.** Underground network powered broadband communications cables entering buildings shall comply with 830.47(A) through 830.47(D).



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830.47 Underground Network-Powered Broadband Communications Cables Entering Buildings.

- **(A) Underground Systems with Electric Light and Power, Class 1, or Non-Power-Limited Fire Alarm Circuit Conductors.** Class 1 circuits shall be in a section permanently separated from such conductors by means of a suitable barrier.
- **(B) Direct-Buried Cables and Raceways.** Direct-buried network-powered broadband communications cables shall be separated by at least 300 mm (12 in.)
- **(C) Mechanical Protection.** Direct-buried cable, conduit, or other raceways shall be installed to meet the minimum cover requirements of Table 830.47(C).
- **(D) Pools.** Cables located under the pool or within the area extending 1.5 m (5 ft)



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830.49 Metallic Entrance Conduit Grounding.

- Metallic conduit containing network-powered broadband communications entrance cable shall be connected by a bonding conductor or grounding electrode conductor to a grounding electrode in accordance with 830.100(B).
- **830.100(B)(1):** In Buildings or Structures with an Intersystem Bonding Termination.
- **830.100(B)(2):** In Buildings or Structures with Grounding Means.
- **830.100(B)(3):** In Buildings or Structures Without an Intersystem Bonding Termination or Grounding Means.



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- **830.93 Grounding or Interruption of Metallic Members of Network-Powered Broadband Communications Cables.**
 - Network-powered communications cables entering buildings or attaching to buildings shall comply with **830.93(A) or (B).**
 - **(A) Entering Buildings.** In installations where the network powered communications cable enters the building, the shield shall be grounded in accordance with 830.100, and metallic members of the cable not used for communications or powering shall be grounded in accordance with 830.100 or interrupted by an insulating joint or equivalent device. The grounding or interruption shall be as close as practicable to the point of entrance.



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- **830.93 Grounding or Interruption of Metallic Members of Network-Powered Broadband Communications Cables.(B) Terminating Outside of the Building.**
 - **(B)** In installations where the network-powered communications cable is terminated outside of the building, the shield shall be grounded in accordance with 830.100, and metallic members of the cable not used for communications or powering shall be grounded in accordance with 830.100 or interrupted by an insulating joint or equivalent device. The grounding or interruption shall be as close as practicable to the point of attachment of the NIU.

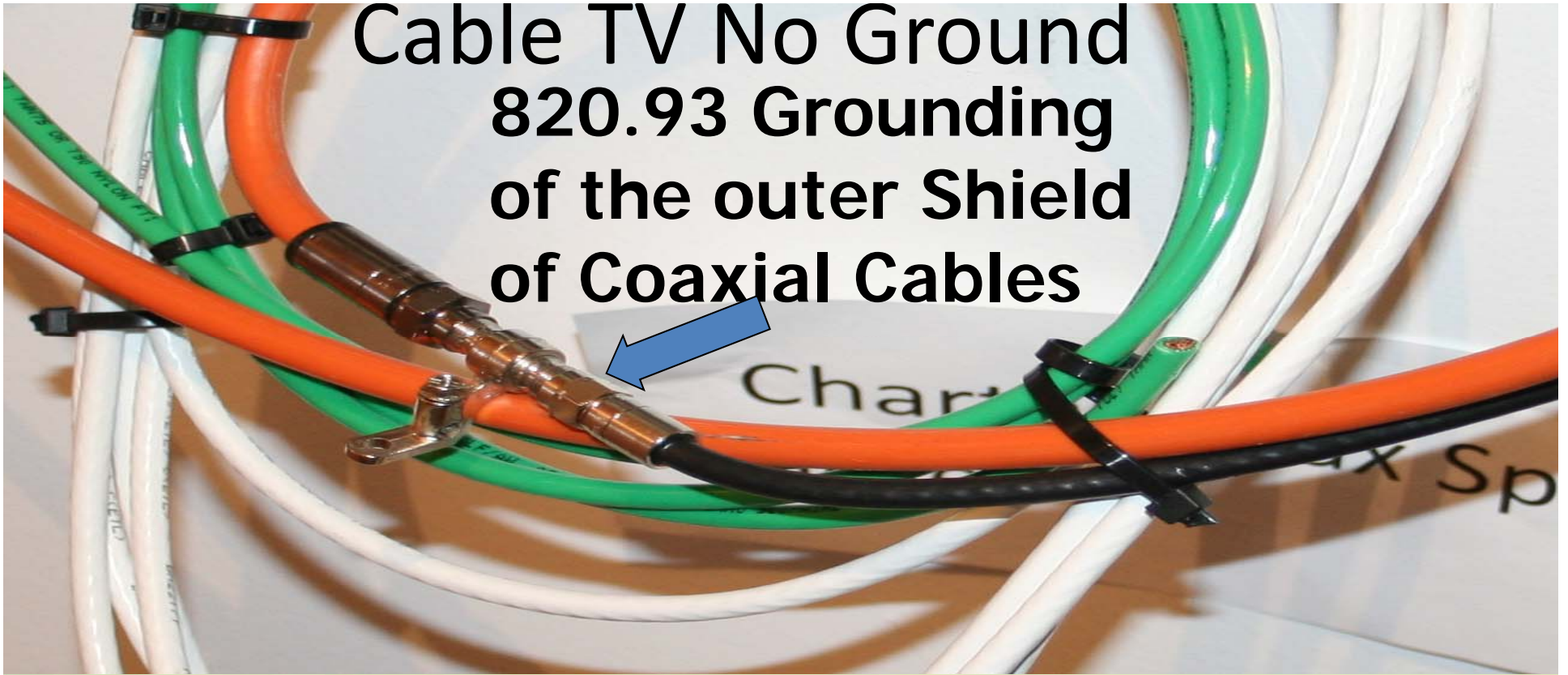


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Cable TV No Ground 820.93 Grounding of the outer Shield of Coaxial Cables



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820.93

820.24 Mechanical execution of work



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- **830.100 Cable, Network Interface Unit, and Primary Protector Bonding and Grounding.** Network interface units containing protectors, NIUs with metallic enclosures, primary protectors, and the metallic members of the network-powered broadband communications cable that are intended to be bonded or grounded shall be connected as specifi



830.100 Cable, Network Interface Unit, and Primary Protector: Bonding and Grounding.

- **830.100(B)(1):** In Buildings or Structures with an Intersystem Bonding Termination.
- **830.100(B)(2):** In Buildings or Structures with Grounding Means.
- **830.100(B)(3):** In Buildings or Structures Without an Intersystem Bonding Termination or Grounding Means.



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830.100 Cable, Network Interface Unit, and Primary Protector: Bonding and Grounding.

- **(A) Bonding Conductor or Grounding Electrode Conductor.**
- **(1) Insulation.** The bonding conductor or grounding electrode conductor shall be listed and shall be permitted to be insulated, covered, or bare.
- **(2) Material.** The bonding conductor or grounding electrode conductor shall be copper or other corrosion-resistant conductive material, stranded or solid.



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830.100 Cable, Network Interface Unit, and Primary Protector: Bonding and Grounding.

(3) Size. The bonding conductor or grounding electrode conductor shall not be smaller than 14 AWG and shall have a current-carrying capacity not less than that of the grounded metallic member(s) and protected conductor(s) of the network-powered broadband communications cable. The bonding conductor or grounding electrode conductor shall not be required to exceed 6 AWG.



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830.100 Cable, Network Interface Unit, and Primary Protector: Bonding and Grounding.

- **(4) Length.** The bonding conductor or grounding electrode conductor shall be as short as practicable. In one- and two family dwellings, the bonding conductor or grounding electrode conductor shall be as short as practicable, not to exceed 6.0 m (20 ft) in length.
- Remember: *Exception: In one- and two-family dwellings where it is not practicable to achieve an overall maximum bonding conductor or grounding electrode conductor length of 6.0 m (20 ft),*



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830.100 Cable, Network Interface Unit, and

Primary Protector: Bonding and Grounding.

- **(5) Run in Straight Line.** The bonding conductor or grounding electrode conductor shall be run in as straight a line as practicable.
- **(6) Physical Protection.** Bonding conductors and grounding electrode conductors shall be protected where exposed to physical damage.
- ***** *Where the bonding conductor or grounding electrode conductor is installed in a metal raceway, both ends of the raceway shall be bonded to the contained conductor or to the same terminal or electrode to which the bonding conductor or grounding electrode conductor is connected.*



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830.100 Cable, Network Interface Unit, and

Primary Protector: Bonding and Grounding.

- **(B) Electrode.** The bonding conductor or grounding electrode conductor shall be connected in accordance with 830.100(B)(1), 830.100(B)(2), or 830.100(B)(3).
- **(D) Bonding of Electrodes.** A bonding jumper not smaller than 6 AWG copper or equivalent shall be connected between the network-powered broadband communications system grounding electrode and the power grounding electrode system at the building or structure served where separate electrodes are used.



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840.101 Premises Circuits *Not Leaving the Building.*

(A) Coaxial Cable Shield Grounding. The shield of coaxial cable shall be grounded by one of the following: (1) Any of the methods described in 820.100 or 820.106

- (2) A fixed connection to an equipment grounding conductor as described in 250.118
- (3) Connection to the network terminal grounding terminal provided that the terminal is connected to ground by one of the methods described in 820.100 or 820.106, or to an equipment grounding conductor through a listed grounding device that will retain the ground connection if the network terminal is unplugged



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840.101 Premises Circuits *Not Leaving the Building.*

- **(C) Network Terminal Grounding.** The network terminal shall not be required to be grounded unless required by its listing.
- If the coaxial cable shield is separately grounded as described in 840.101(A)(1) or 840.101(A)(2), the use of a cord and plug for the connection to the network terminal grounding connection shall be permitted.



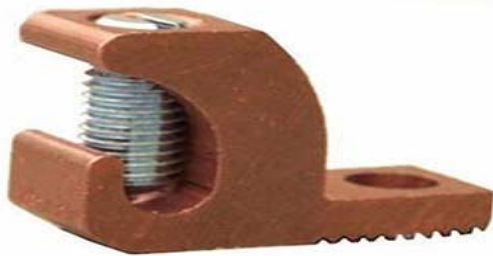
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840.180 Grounding Devices.

- Where bonding or grounding is required, devices used to connect a shield, a sheath, or non-current-carrying metallic members of a cable to a bonding conductor, or grounding electrode conductor, shall be **listed** or be part of **listed**



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NEC Summary

- Follow the NEC, its not just a good idea it is the LAW!
- We are Bonders not grounders
- Article 800 is 17 pages and stands alone
- It is safety driven not performance driven.
- It does not have to work.
- Everything metal has to be bonded together so we do not become a conductor and to keep the potential between the electric ground and the low voltage the same.
- Don't kill anyone!!



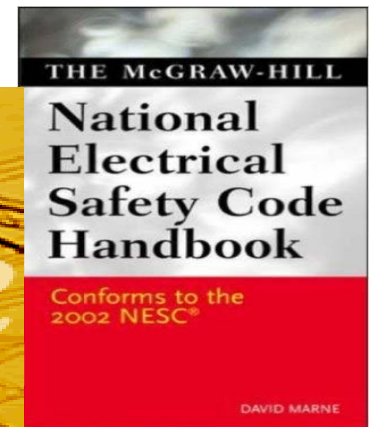
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NESC (National Electric Safety Code)

- **010 Purpose:** The NESC is used for the “practical safeguarding of persons during the installation, operation, and maintenance of electrical supply and communication facilities, under specified conditions.”



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NESC (National Electric Safety Code)

- The persons the **code** is referring to are both public and utility workers (employees and contractors).



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NESC (National Electric Safety Code)

- The utility facilities the **Code** is referring to are electric supply stations (covered in part 1), overhead supply and communication lines (covered in Part 2), and underground supply and communication lines (covered in Part 3).



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NESC Part 2 overhead communication lines

- **Rule 215 C** Anchor guys and spans guys must be effectively grounded and bonded together
- **Rule 220 D** Communication conductors marked or numbered to indicate ownership
- **Rule 235H** Communications messengers should be spaced not less than 12" apart.



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NESC (National Electric Safety Code)

12",24",36" Depth for Load Rule 323A

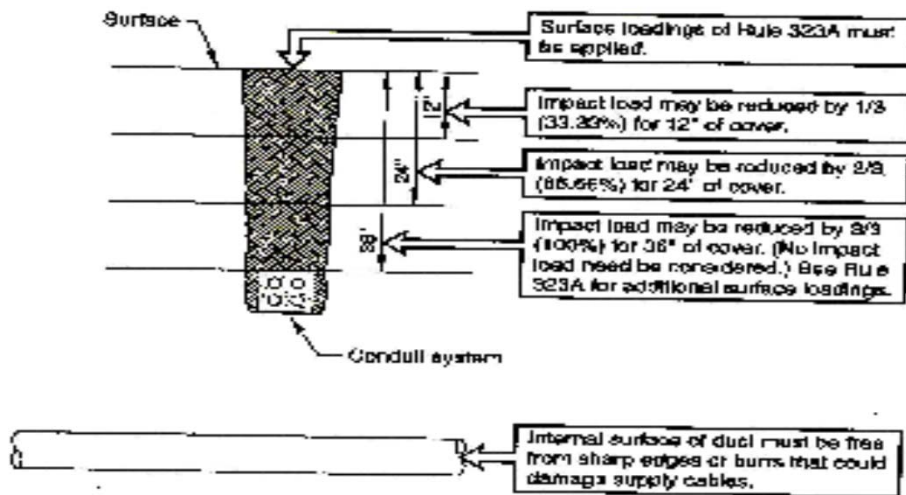


Fig. 323-1. General requirements for ducts and joints (Rule 323A).

12" Radial Separation Rule 320B5

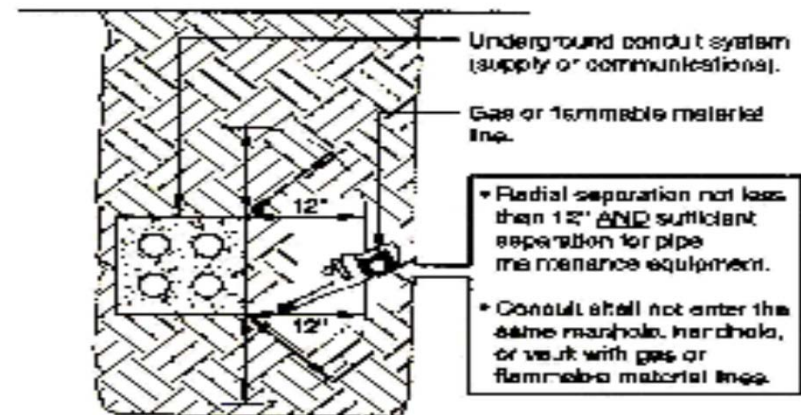


Fig. 320-10. Separation from gas or other line (see appropriate Damnable material) (Rule 320B5).



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NESC Part 3 underground communication lines

- **Rule 331** All cable shields must be bonded together to keep different cables at the same potential.
- **Rule 353** direct buries cable or radial separation or 12" or more from other utilities.
- **Rule 352-D1** and **Rule 12C** No specific depth is provided for communications cable in the ROW for Public Utilities.



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NESC (National Electric Safety Code) Summary

- NESC applies to the OSP in the public ROW
- All metal parts to be bonded together
- 12” radial distance Rule 320B5
- No depth requirement for underground cable.
- Practical safeguarding of persons and utilities
- All metal shields must be bonded together
- All utilities must be marked



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Standards

- What are they?
- Do we have to follow them?
- Who makes them up?
- What does it cover?



International
Organization for
Standardization



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Standards

- What are they?
- A standard is a document that provides requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose.



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Standards

- Do we have to follow them? No but-----
- They address especially the needs for interconnection and interoperability. This is particularly important for open markets, where users, who are increasingly mobile, can 'mix and match' equipment and services, and where suppliers can benefit from economies of scale.
- Standards are equally important for ensuring safety, reliability and environmental care.



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Standards:

- A) Performance standards: 295' Horizontal cable run, bend radius of a bonding conductor is 8 times the diameter, bend radius of 4 pair is 4 time the radius, 16½' maximum patch or equipment cords unless using a MUTOA.
- B) Installation standards/ BICSI Best Practices: Plywood is 8" AFF, AC plywood on a minimum of two walls, A side out, two 4 pairs to each locations

Will it work or is it a design?



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Standards

- **OH, I guess we should follow them if we want stuff to work now and in the future!**
- 568.0 Generic Buildings
- 568.1 Commercial Building standard
- 568.2 Balanced Twisted Pair Components
- 568.3 Optical Fiber Components
- 569 Pathways and Spaces
- *607-C Bonding and Grounding*



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Permitted by the code? Will it work? Cat 6 (4) 90 degree bends.

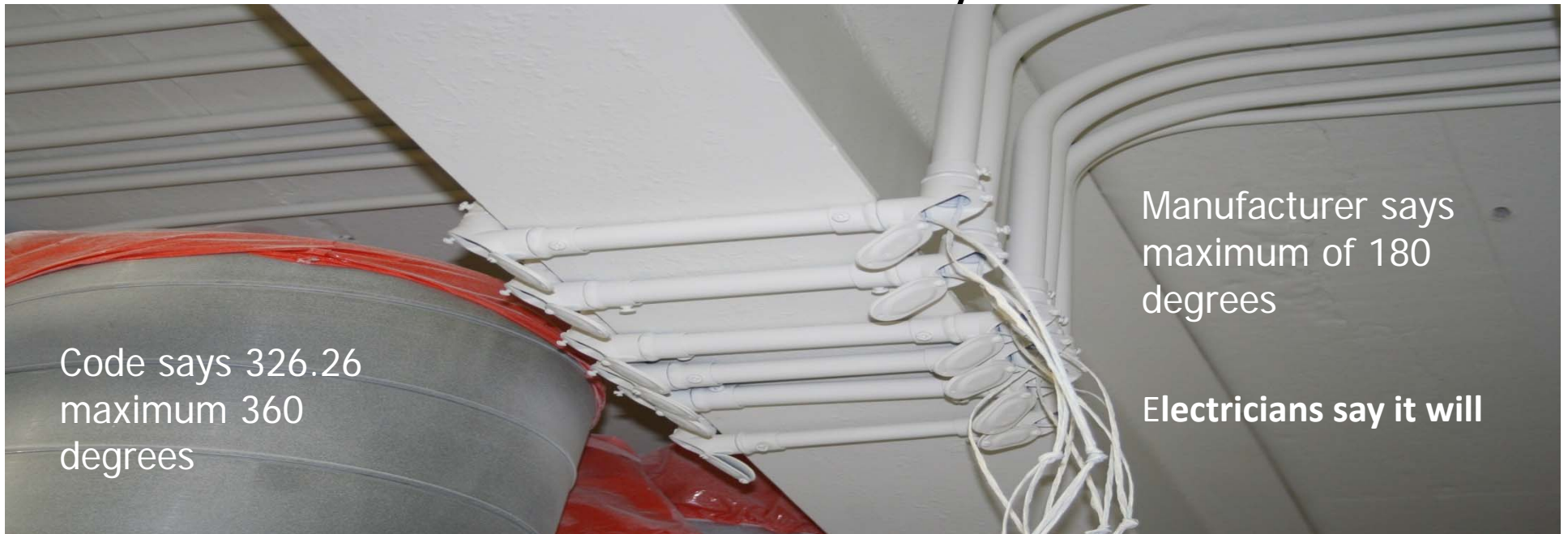


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Yes permitted by the code but it will not work with CAT6 Cable. Why?



Code says 326.26
maximum 360
degrees

Manufacturer says
maximum of 180
degrees

Electricians say it will



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The quandary

- The electricians quote the CODE
- You must know the CODE and the STANDARDS!
- But where to find them?
- Which ones to hold tough on?
- How would you negotiate with the electrician or the construction manager?
- How would you stand up for the customer?



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TIA 607-C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

- **Purpose:** The purpose of this Standard is to enable and encourage the planning, design, and installation of generic telecommunications bonding and grounding systems within premises with or without prior knowledge of the telecommunications systems that will subsequently be installed.



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TIA 607-C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

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



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TIA 607-C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

- Three types of bonding systems
- 1) AC grounding (earthing) electrode system (also known as the earthing system)
- 2) Equipment grounding system (also known as the equipment bonding system)
- 3) Telecommunications bonding infrastructure



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AC grounding (earthing) electrode system (also known as the earthing system)

- The AC grounding electrode system is the direct connection to the earth.
- The grounding electrode conductor (ground wire)
- The grounding electrode (ground rod).
- Although the ICT installer and RCDD should be concerned and observe the route and condition this is the responsibility of the electrician



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Equipment grounding system (also known as the equipment bonding system)

- The third prong is part of the Equipment grounding system.
- If there is a fault in the equipment the third prong sends the current to the earth grounding system
- The third prong is also a grounding reference for the computer CPUs in all of our electronic equipment.
- This is why it is paramount that the electric and the telecommunications bonding systems are tied together.



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Telecommunications bonding infrastructure

- Not designed to be a current carrying system but can carry a current if the third prong fails.
- Bonds all the metal objects and telecommunication equipment together.
- Bonds to the electric bonding and grounding system.
- Keeps the ground potential between the electric and telecommunications bonding the same.
- Especially important and during lightning storms.
- Most important to transport low static to earth ground through AC grounding system. Therefore large conductors.



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607-C Bonding and Grounding Standards
Lightning strikes are a common source of hazardous foreign potentials.



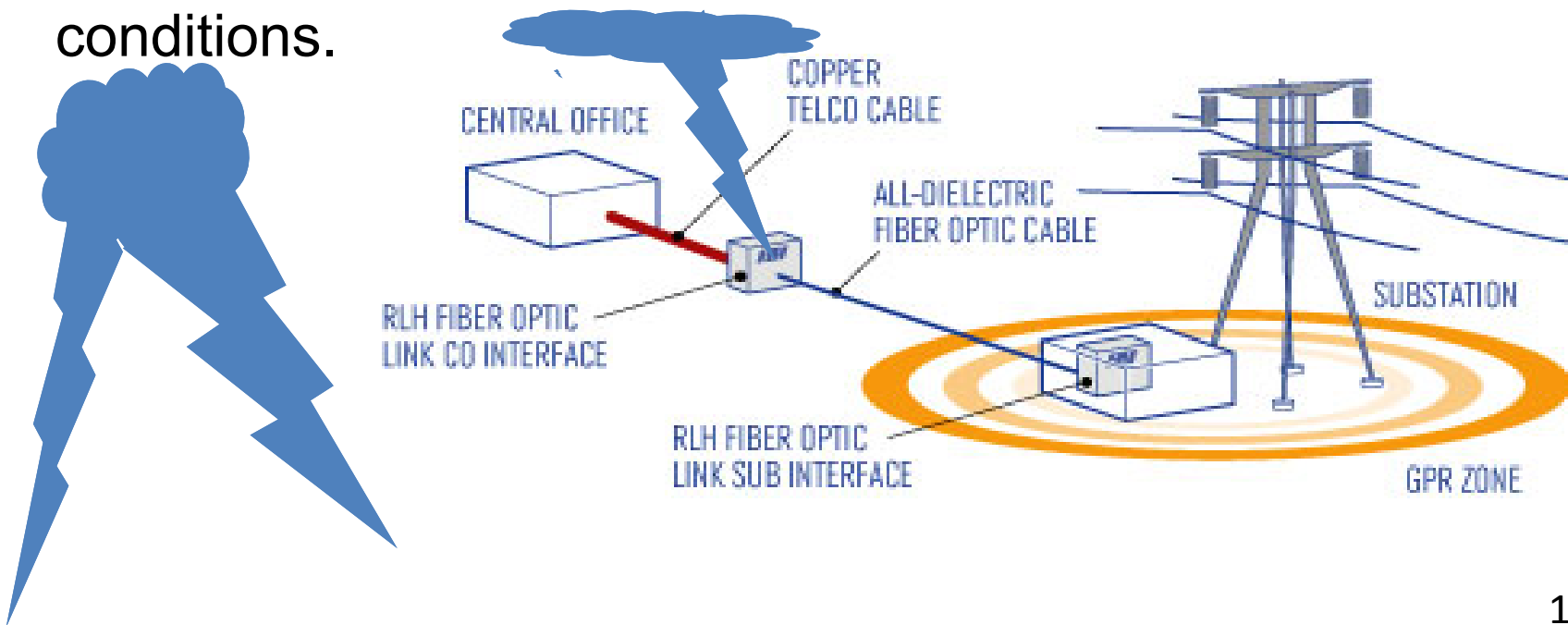
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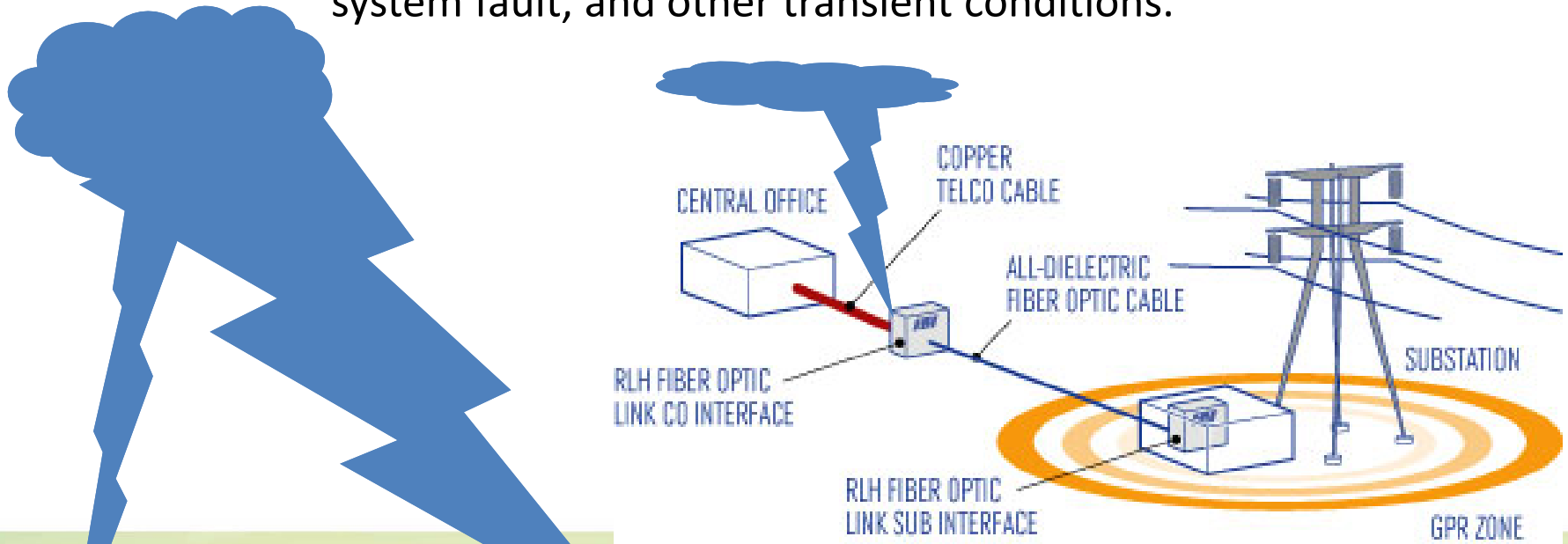
Ground Potential Rise

GPR can be caused by a variety of factors, including lightning, electrical system fault, and other transient conditions.



Ground Potential Rise

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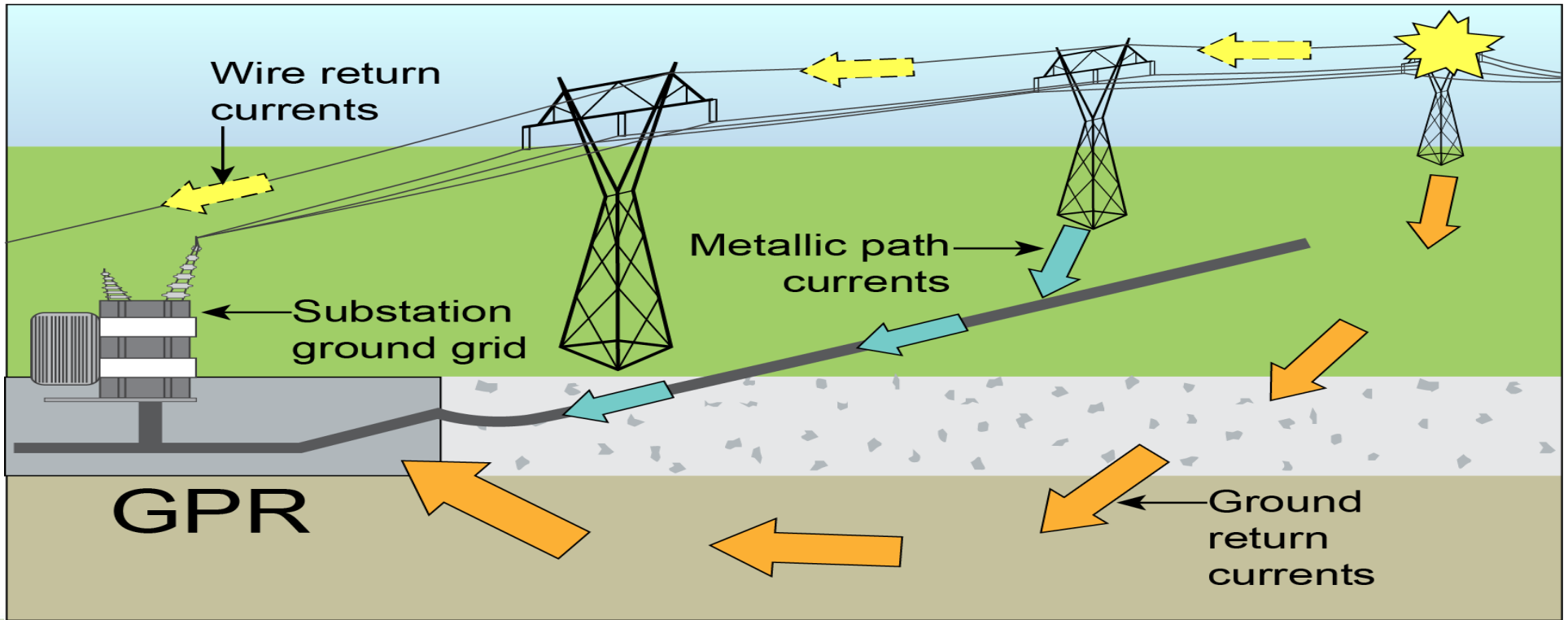


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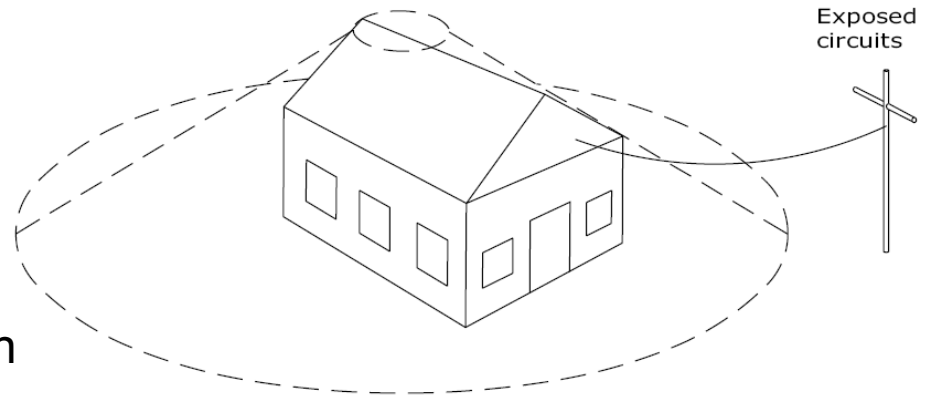
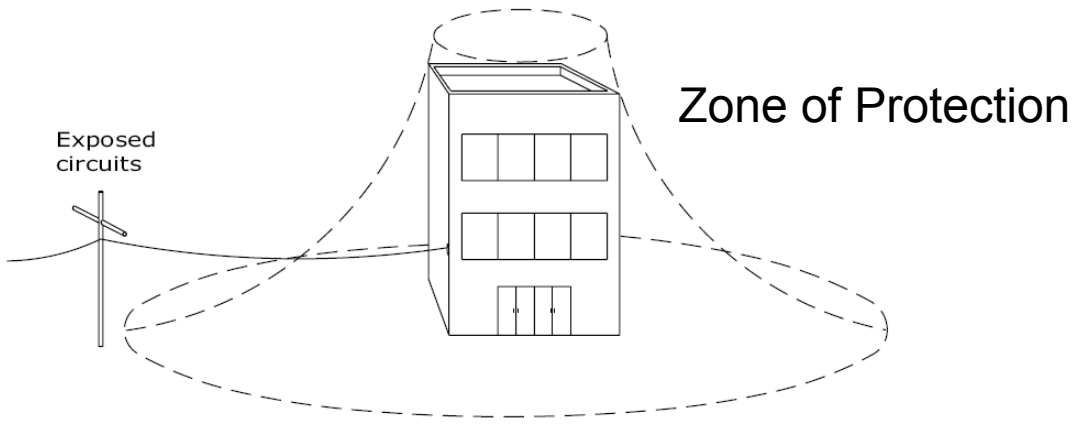
Fault currents flow back to their ground source(s)



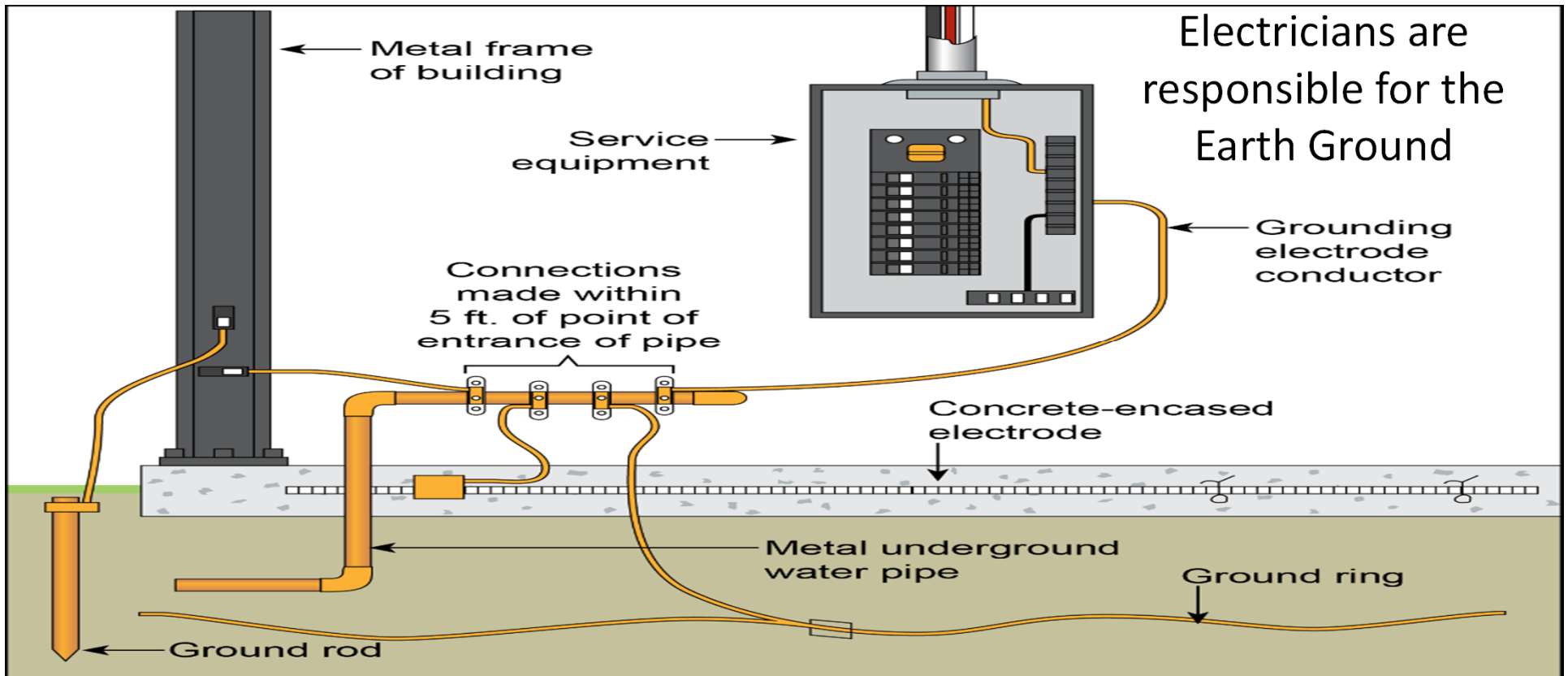
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800.90 Inter-building Telecommunications Exposure

- Telecommunication copper pairs have lightning exposure (need Protectors) except:
- Circuits in large metropolitan areas
- Interbuilding telecommunications cable runs < 42.7 m (140 ft)
- In areas with an average of < 5 thunderstorm days/year
- In areas with earth resistivity of < 100 ohms



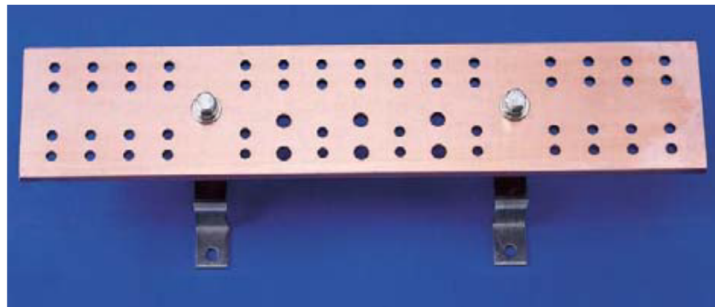
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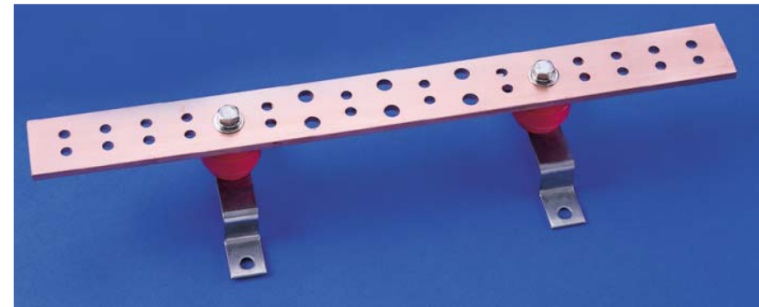
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Busbar Names

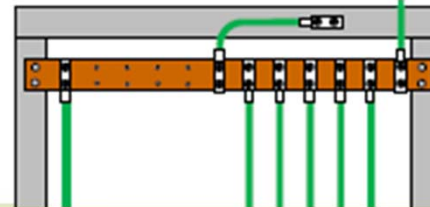
Primary bonding busbar (PBB)
607-C 5.2.2



Secondary bonding busbar (SBB)
607-C 5.2.5



Rack bonding busbar (RBB)
607-C 6.2.3



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Bonding Conductor Names

TBC Telecommunications bonding conductor

TBB Telecommunications bonding backbone

BBC Backbone bonding conductor

CBC Coupled bonding conductor

TEBC Telecommunications equipment bonding conductor

UBC Unit bonding conductor

RBC Rack bonding conductor

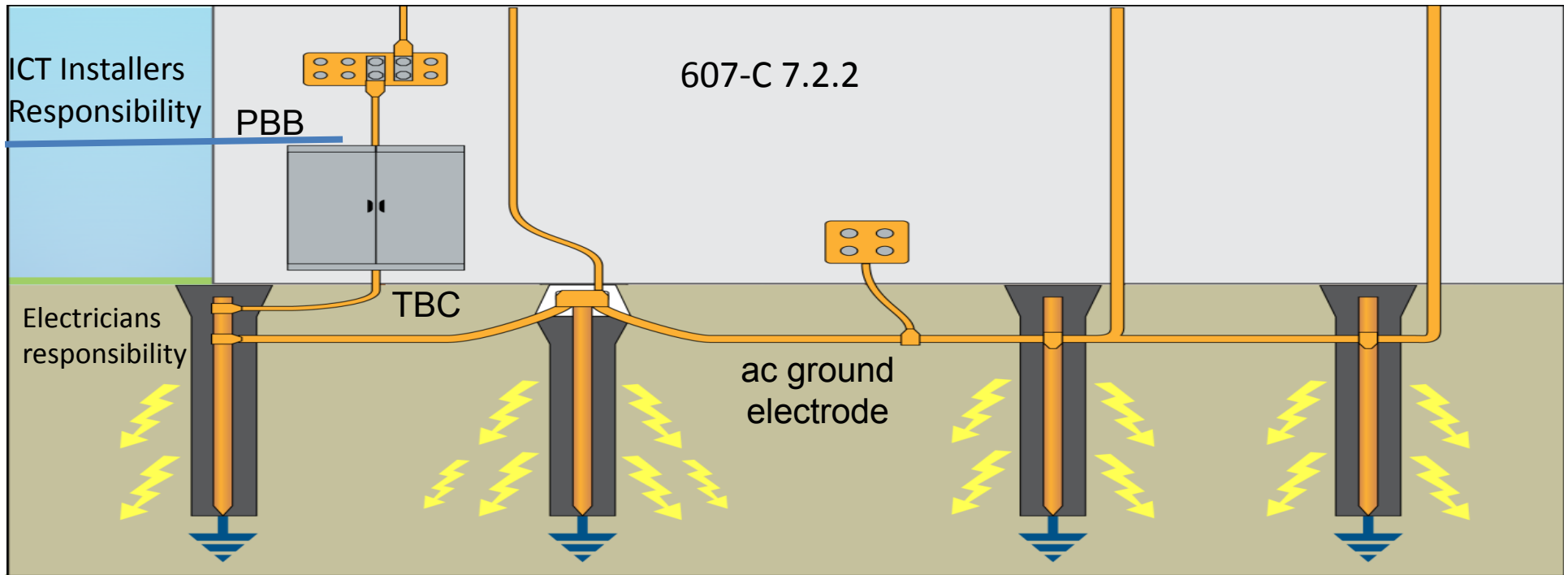


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Bonding to the ac Grounding Electrode System



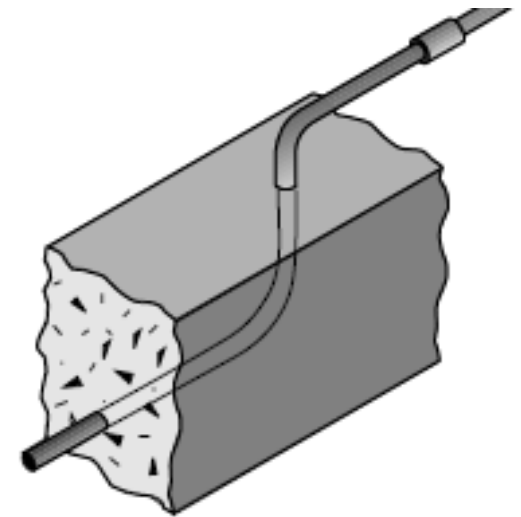
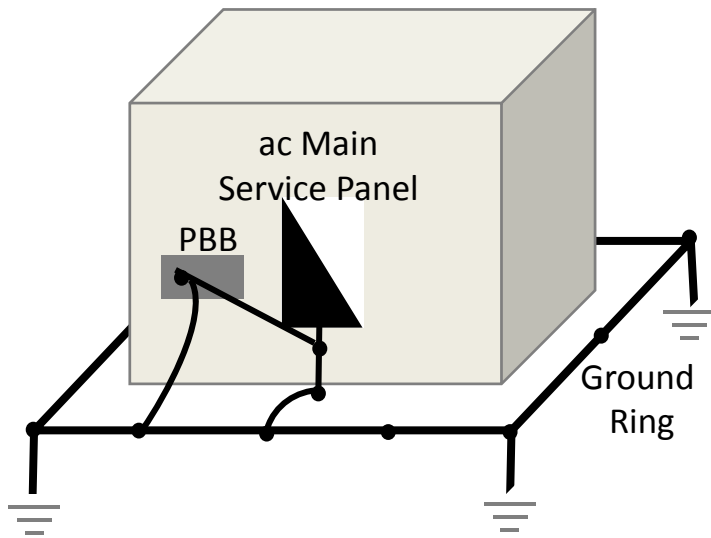
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Methods to Ground Electrodes

Ufer Ground, Named after Herbert Ufer, 1942, 20 feet in concrete



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Telecommunications Entrance Facility

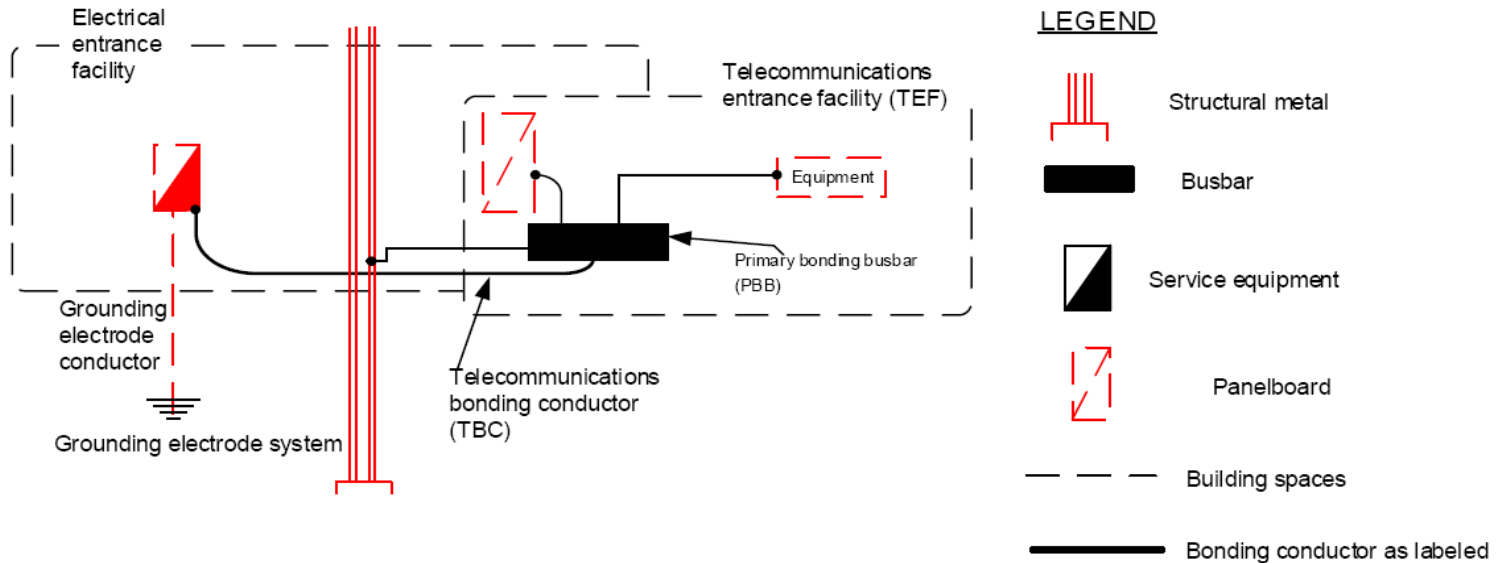


Figure 5 – Illustrative example of a smaller building



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Primary Bonding Busbar (PBB)

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



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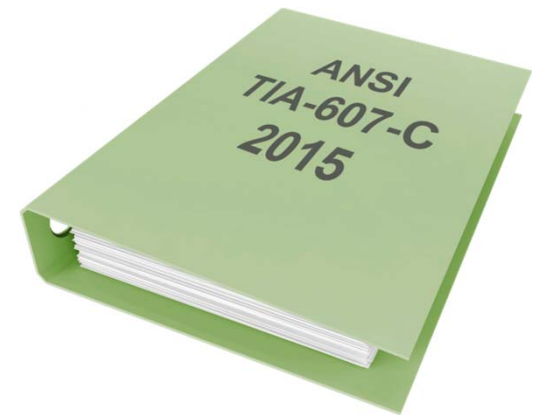
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Placement of the Primary Bonding Busbar (PBB)

- **TIA-607-C 2015 Section 7.2.1**

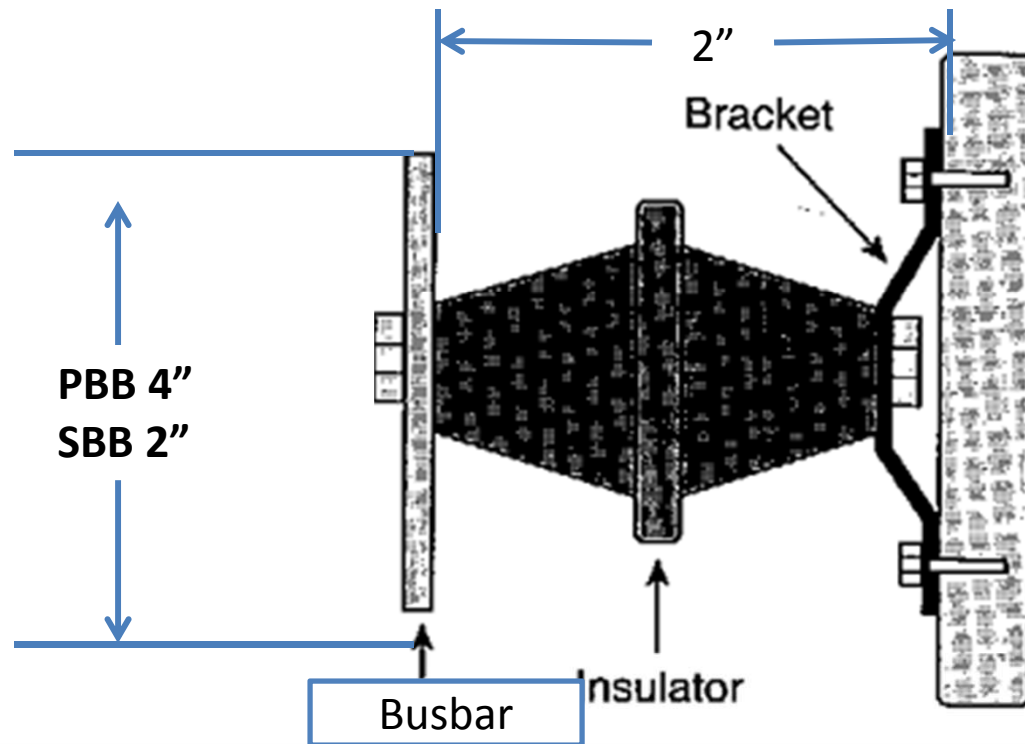
The length of the PBB is not specified within this Standard. It is desirable that the busbar be electrotin-plated for reduced contact resistance. The busbar shall be cleaned and an antioxidant should be applied prior to fastening connectors to the busbar.



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TIA 607-C 6.2.1



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TIA 7.2.2 Bonds to the PBB

607-C 7.2.1

- The PBB should serve telecommunications equipment that is located within the same room or space. The PBB serves as the central bonding busbar for the telecommunications bonding infrastructure. It also serves as the bonding busbar for equipment located in the telecommunications entrance room or space.
- the PBB shall be insulated from its support using an insulator that is listed for the purpose by a nationally recognized testing laboratory (NRTL). A minimum of 50 mm (2 in) separation from the wall is recommended to allow access to the rear of the busbar.



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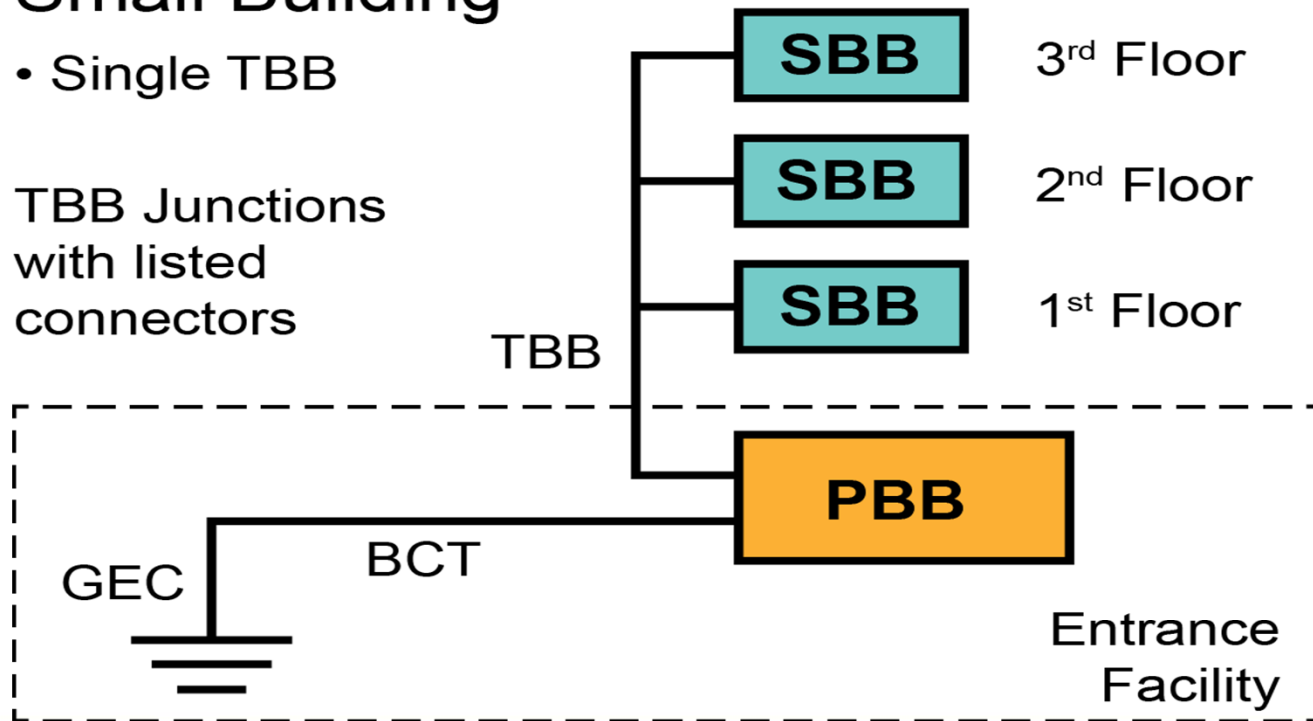
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Small Building

- Single TBB

TBB Junctions
with listed
connectors

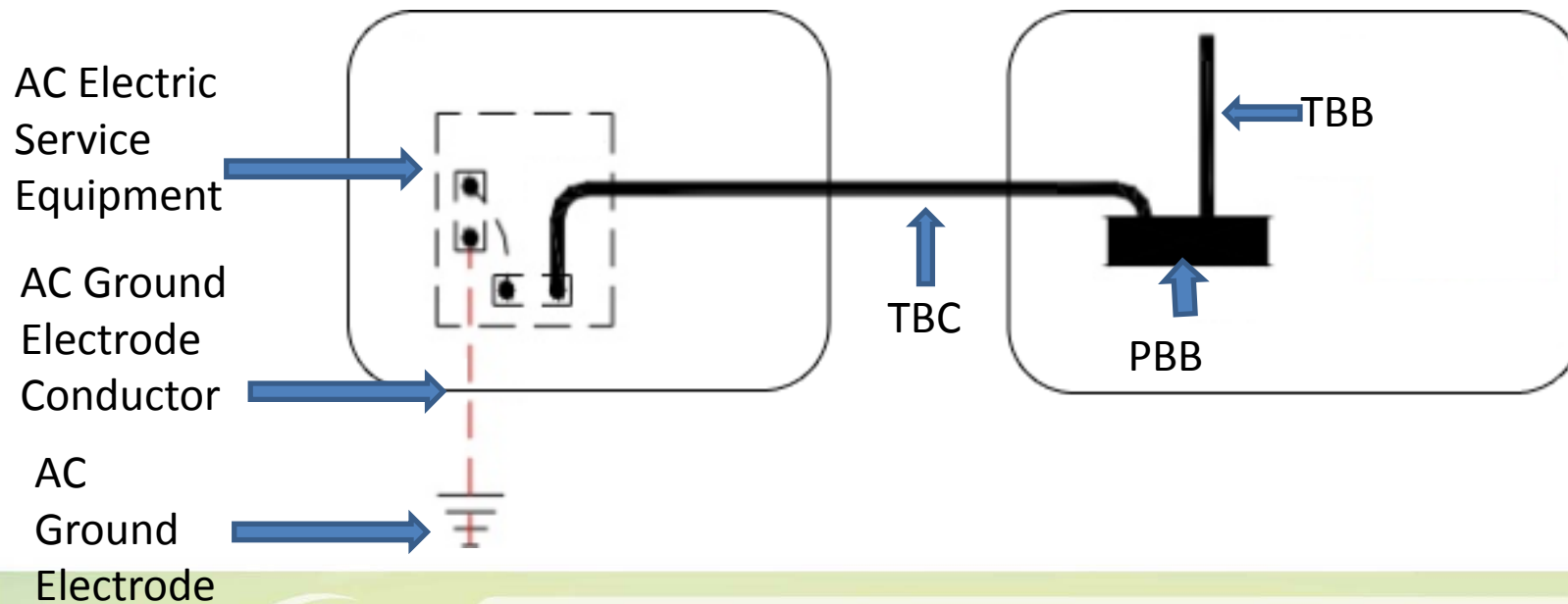


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Telecommunications Bonding Backbone



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Additional Bonding Connections

PBB serves to bond the following:

Primary and secondary surge
protectors

Cable trays

Ladder racks

Equipment racks

Branch circuit panelboards

Power conditioning equipment

Cable shields

Battery racks

Entrance conduits

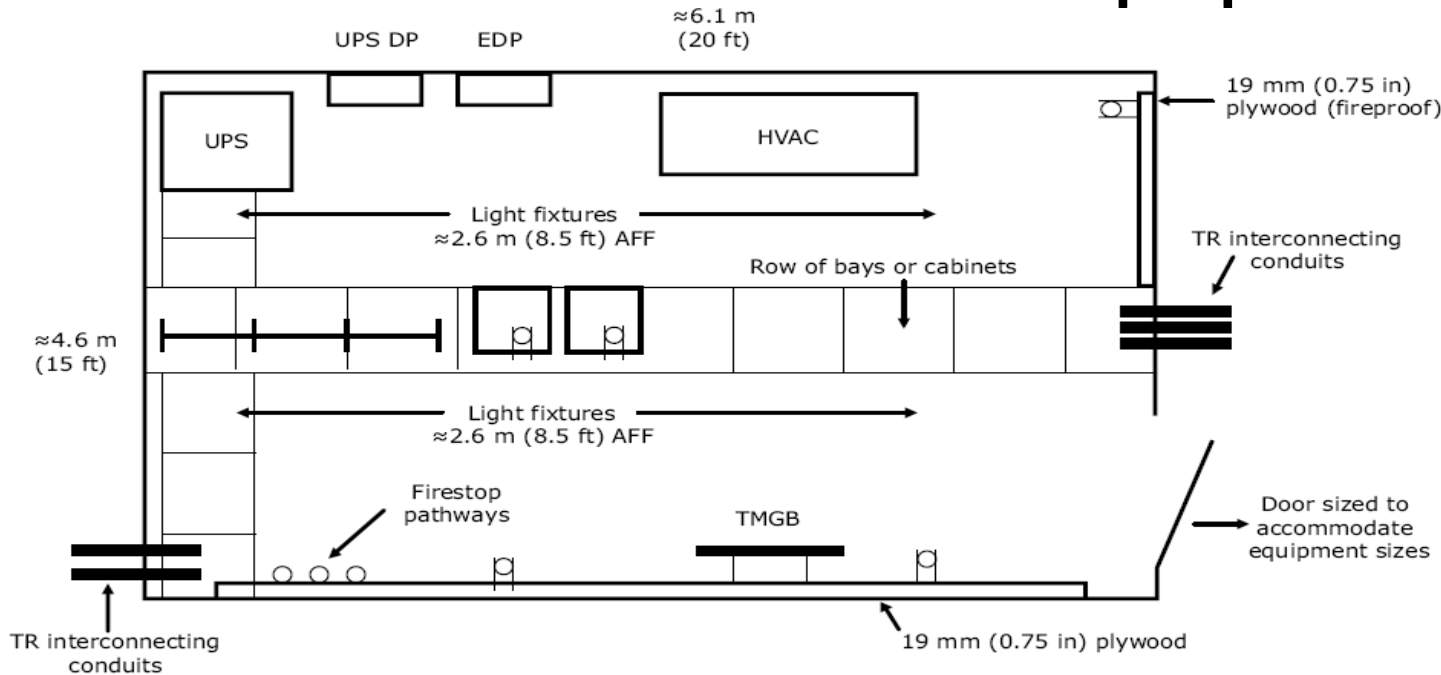


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Telecommunications Equipment Room



- Min 2 walls $\frac{3}{4}$ " Plywood
- AC A facing out
- Painted 2 coats fire retardant paint**
- Outlet every 6'
- Fire Extinguisher
- (ER)-Min 4+1 4" Sleeves

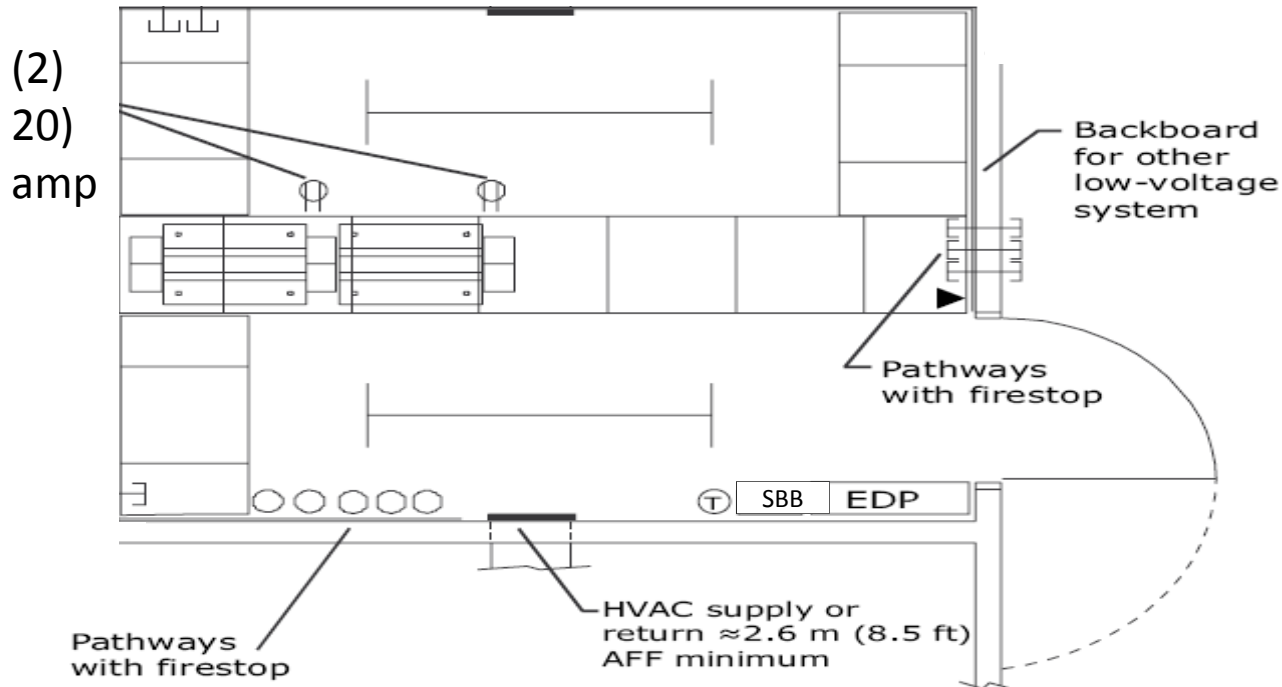


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Telecommunications Room (TR)



- Min 2 walls $\frac{3}{4}$ " Plywood
- -AC A facing out
- -Painted 2 coats fire retardant paint**
- -Outlet every 6'
- -Fire Extinguisher
- -Min 4+1 4" Sleeves



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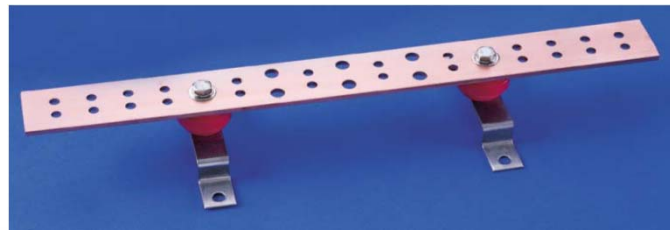
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Secondary Bonding Busbar (SBB)

TIA-607-C 2015 Section 6.2.2

The SBB must meet which requirements?

- a) be a busbar provided with holes for use with correctly matched listed lugs and hardware;
- b) be made of copper, or copper alloys having a minimum of 95% conductivity when annealed
- as specified by the IACS;
- c) have minimum dimensions of 6.35 mm (0.25 in) thick x 50 mm (2 in) wide and variable in
- length; and,
- d) be listed.



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Secondary Bonding Busbar (SBB) 607-C 7.3.1

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

The bonding conductor between a TBB and an SBB shall be continuous and routed in the shortest practical straight-line path. The SBB shall be insulated from its support using an insulator that is listed for the purpose by a NRTL.

A minimum of 50mm (2 in) separation from the wall is recommended to allow access to the rear of the busbar.

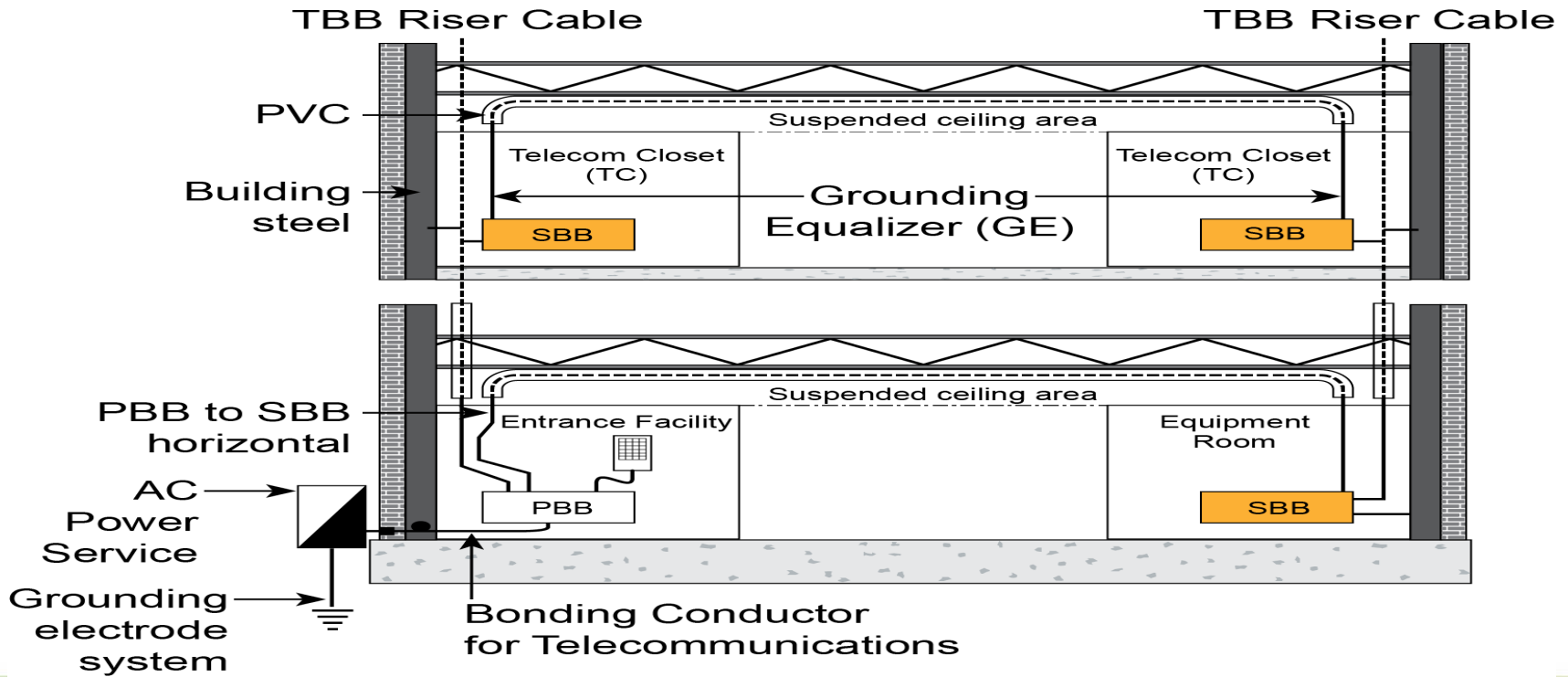


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7.3.2 Bonds to the SBB



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7.5.4 Telecommunications bonding backbone (TBB)

- The type of building construction, building size, general telecommunications requirements, and the configuration of the telecommunications pathways and spaces should be considered when designing the TBB. Specifically, the design of a TBB shall:
 - a) be connected to the PBB;
 - b) be consistent with the design of the telecommunications backbone cabling system (e.g., follow the backbone pathways);
 - c) permit multiple TBBs as necessary (e.g., multiple distributors per floor; see figure 2);
 - d) be continuous from the PBB to the furthest SBB to which it is connected (i.e., not be daisy-chained from busbar to busbar); and,
 - e) minimize, to the extent practical, the lengths of the TBB(s).

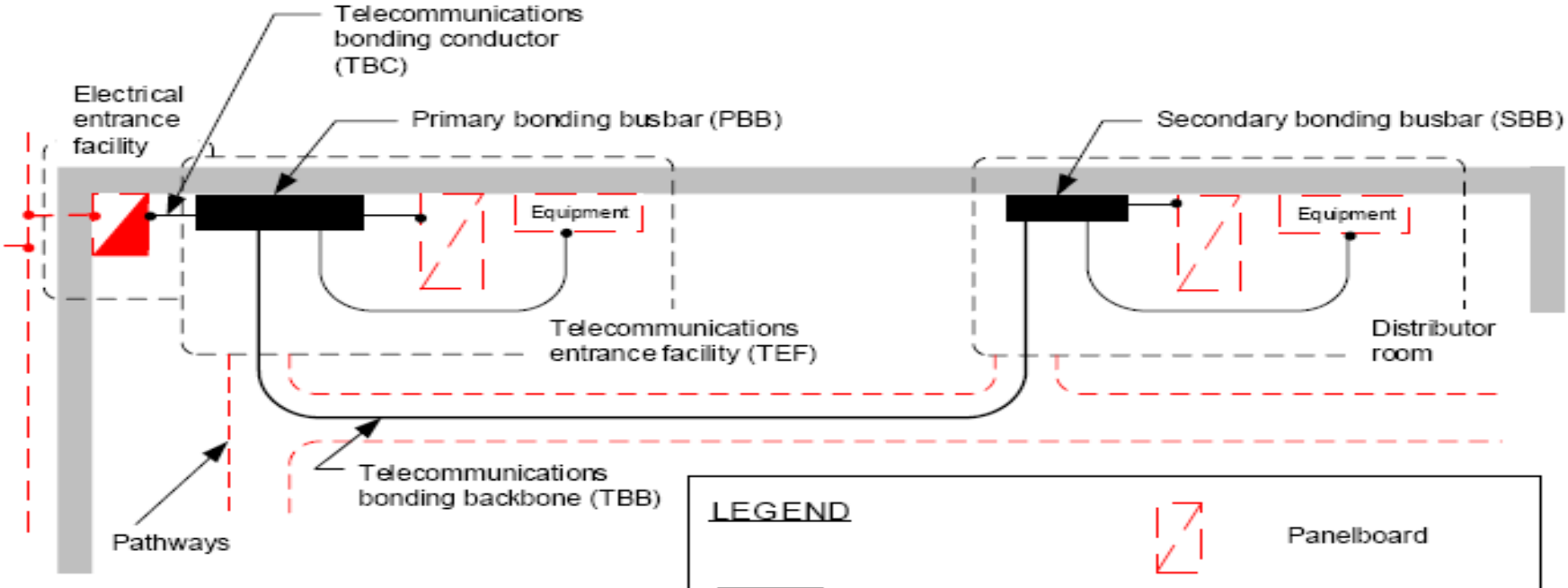


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Telecommunications Bonding Backbone (TBB)



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7.5.4 Telecommunications bonding backbone (TBB)

- Placement of the TBB

Design of the TBB must:

- Be connected to the PBB
- Follow the Backbone pathway
- Permit multiple TBBs as necessary
- Be continuous from the PBB to the furthest SBB
- Use the minimum length as is practical



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7.5.4 Telecommunications bonding backbone (TBB)

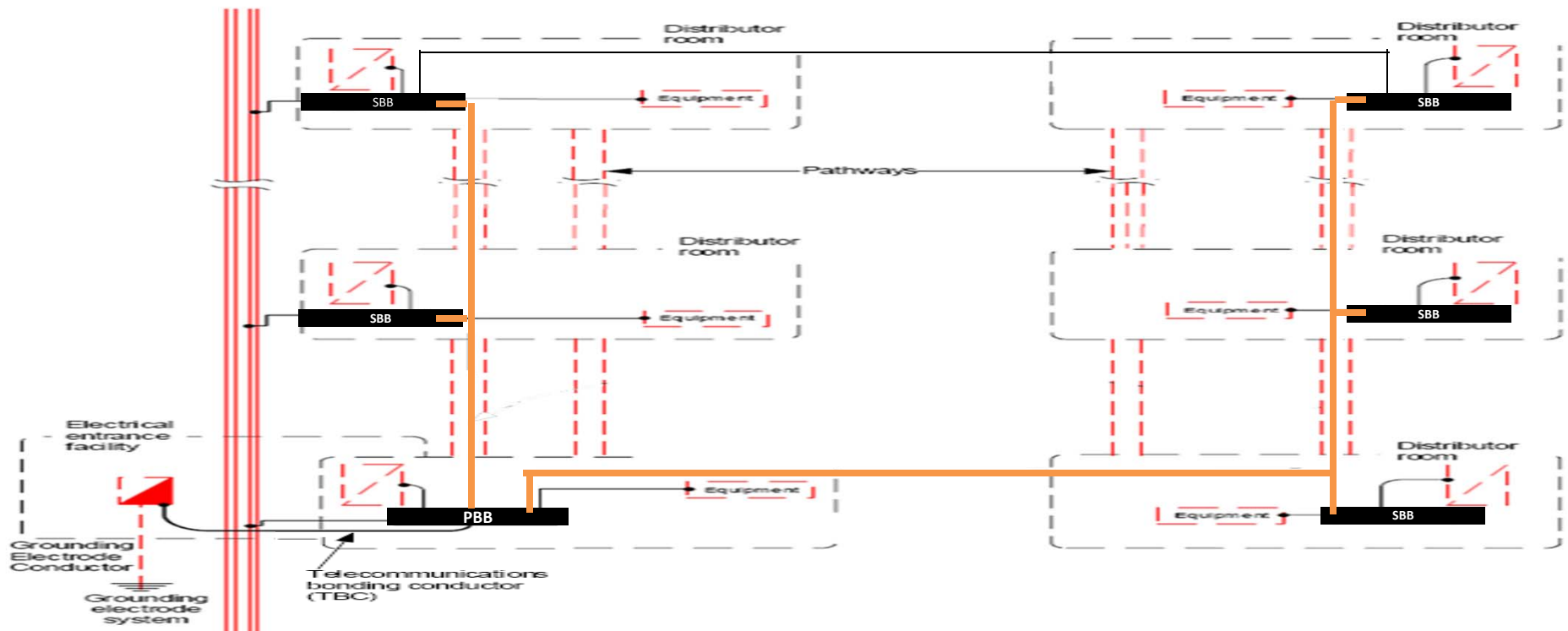
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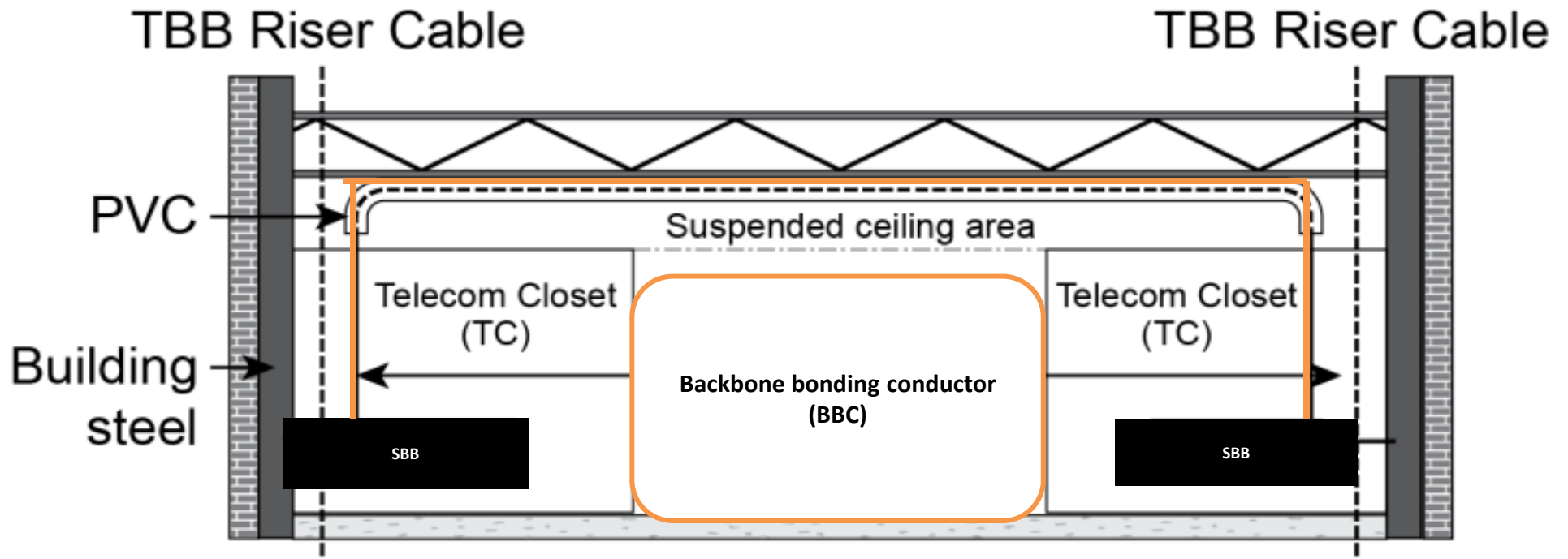


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Backbone Bonding Conductor (BBC)

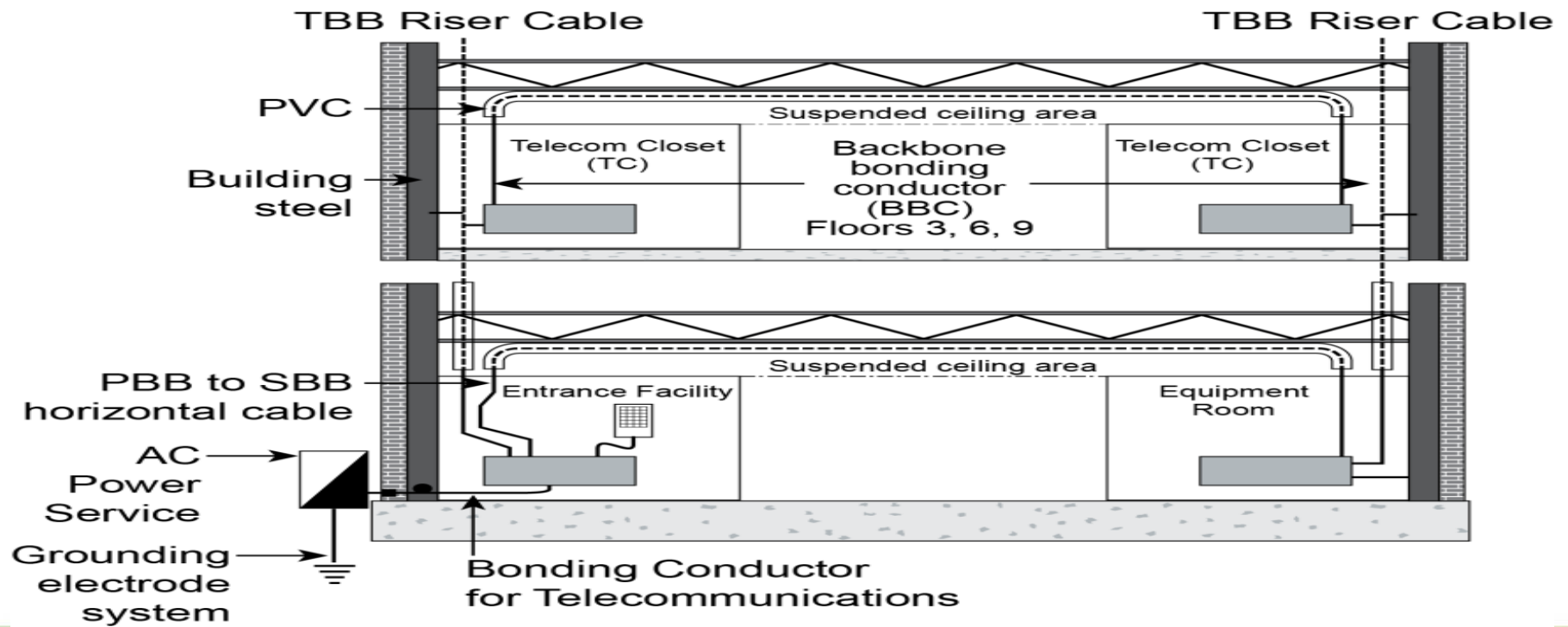


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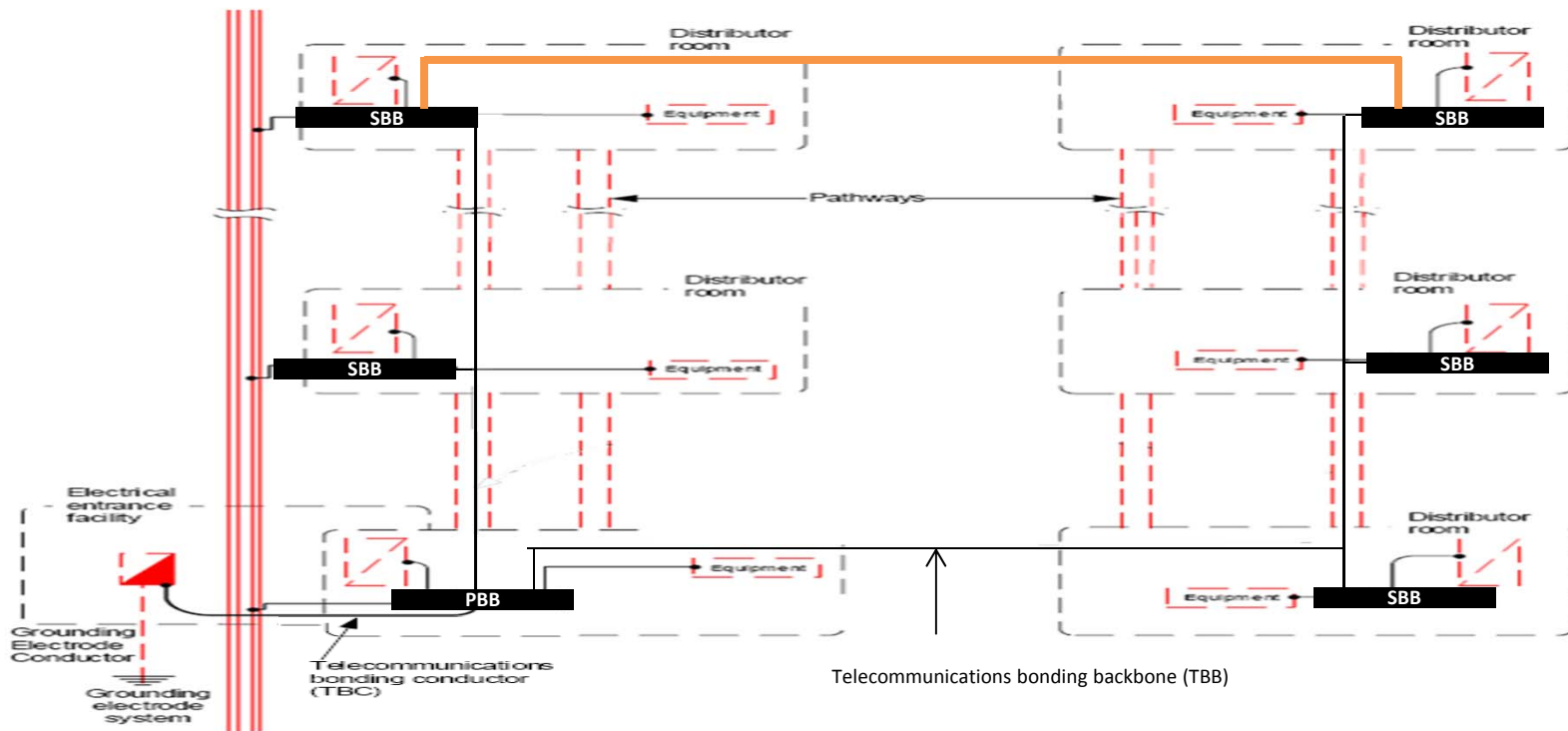
Placement of the BBC (Backbone Bonding Conductor)(GE)



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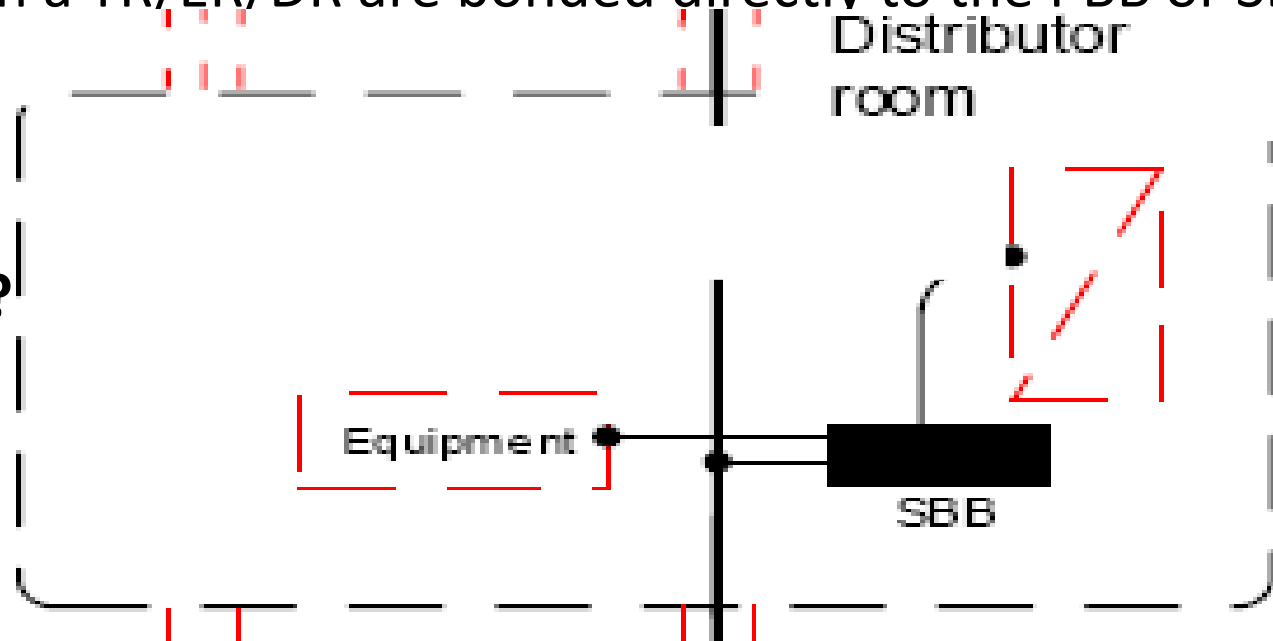
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Electrical panels in a TR/ER/DR are bonded directly to the PBB or SBB

- 607-C 7.5.1

Distributor Room?



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Electrical panels in a TR/ER/DR are bonded directly to the PBB or SBB

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



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PBB or SBB

7.5.2 Bend radius and included angle

- Bends of bonding conductors terminating at the PBB or SBB shall have a minimum inside bend radius of 200 mm (8 in).
- A minimum bend radius of 10 times the bonding conductor diameter is recommended. In all cases, a minimum included angle of 90° shall be used.



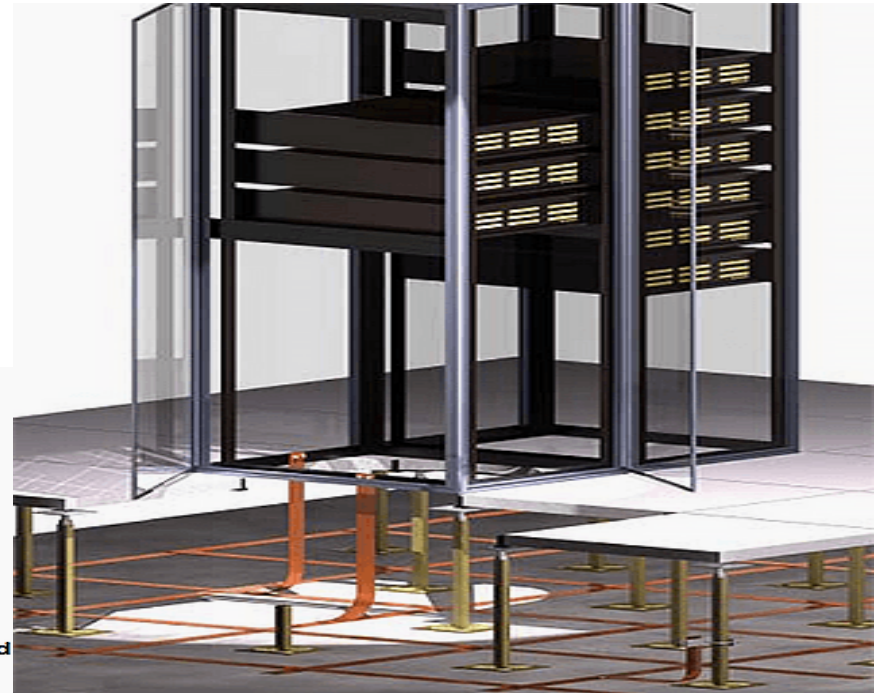
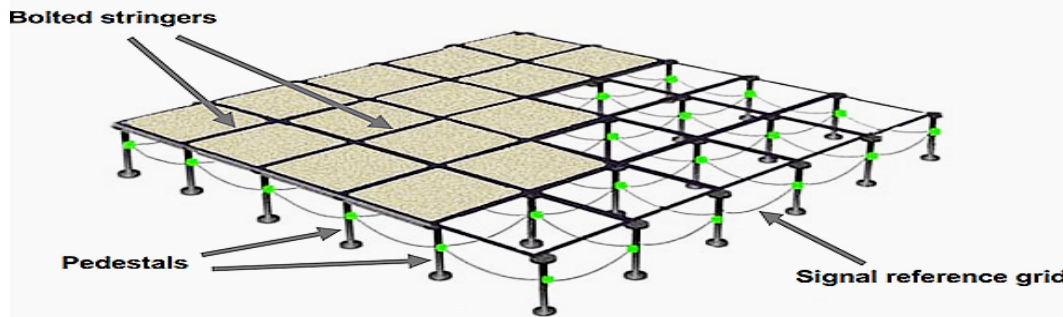
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7.8 Supplementary bonding networks

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



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7.8 Supplementary bonding networks

The supplementary bonding network is in addition to the infrastructure bonding network specified in clause 6. The supplementary bonding network provides for a greater degree of equipotential bonding to that provided by the required bonding conductors. Supplementary bonding networks are always bonded to the CBN within the building.



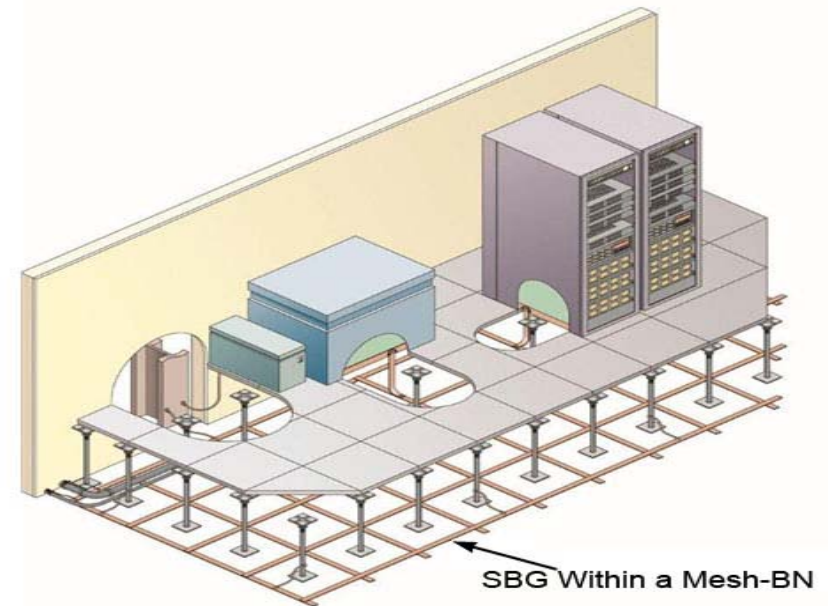
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Signal Reference Grid (SRG)

Equipotential bonding may help mitigate issues caused by steady-state and transient voltages and currents generated by lightning, power systems, power circuit ground faults and EMI



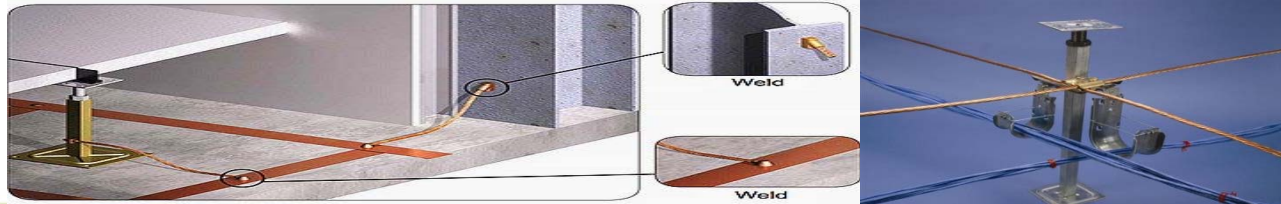
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SRG Installation Requirements

- Meet local codes
- Bond in two places and installed according to the manufacturers instructions
- Bond equipment to the SRG using low impedance risers
- Raised access floors must be bolted stringer type
- Every sixth raised floor pedestal must be exothermic welded

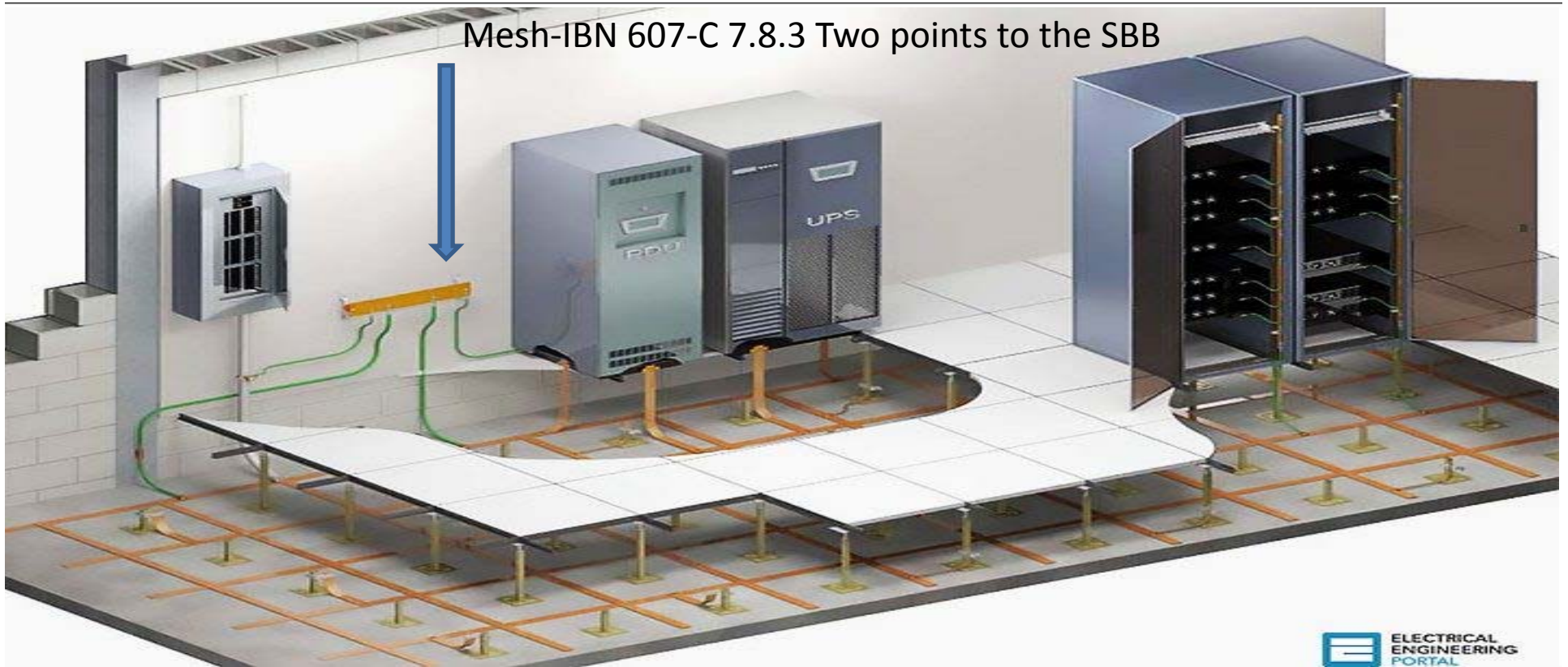


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Mesh-IBN 607-C 7.8.3 Two points to the SBB



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If your GEC is 4 AWG [5.2 mm (0.2 in)], and your bonding conductor has to travel 90 m (300 ft), the bonding conductor size would be calculated as follows:

- If you take the length, 90 m (300 ft) of travel and divide by
 - 30 m (100 ft) = 3.
- So you have to increase the size of the conductor by 3 AWG [5.8 mm (0.23 in)].
 - Move three places down the Conductor Size table.

The bonding conductor would be 1 AWG [7.3 mm (0.29 in)].



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Magic scotch
tape
Experiment!
Static
Electricity we
are trying to
send to ground



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Bonding Methods

Unnecessary connections or splices in bonding conductors should be avoided.

Approved bonding methods:

Listed lugs

Listed pressure connectors

Listed clamps

Exothermic weld



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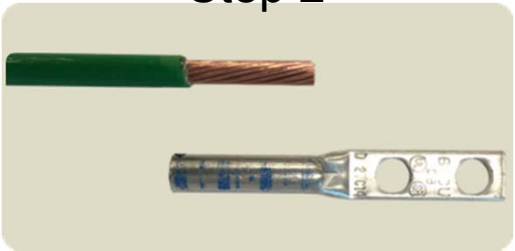
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Bonding Connection Using Irreversible Crimps

Step 1



Step 2



Step 3



Step 4



Step 5



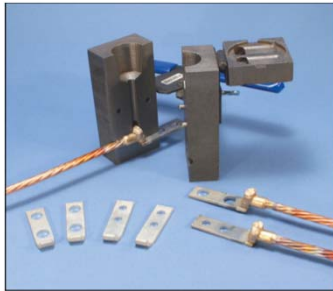
Step 6



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Bonding Connection Using Exothermic Welding

Step 1



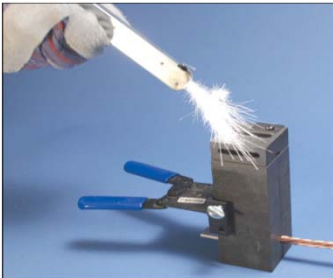
Step 2



Step 3



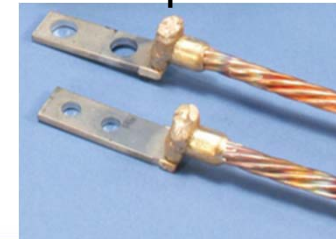
Step 4



Step 5



Step 6



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He used Exothermic Welding in an occupied building!



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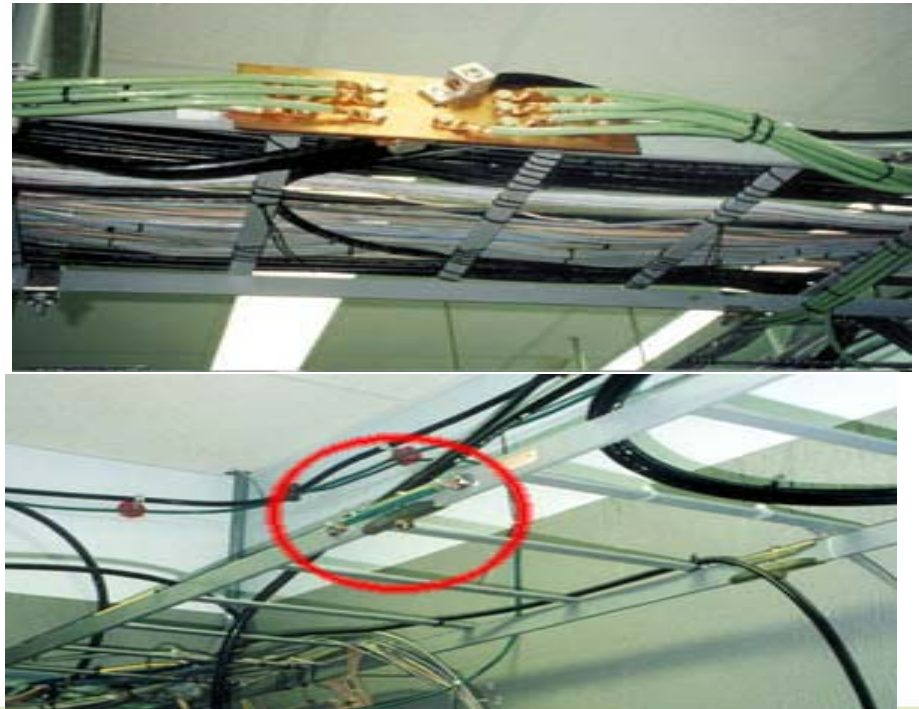
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Inspecting Bonding Connections

Visual inspection can usually reveal problems, such as:

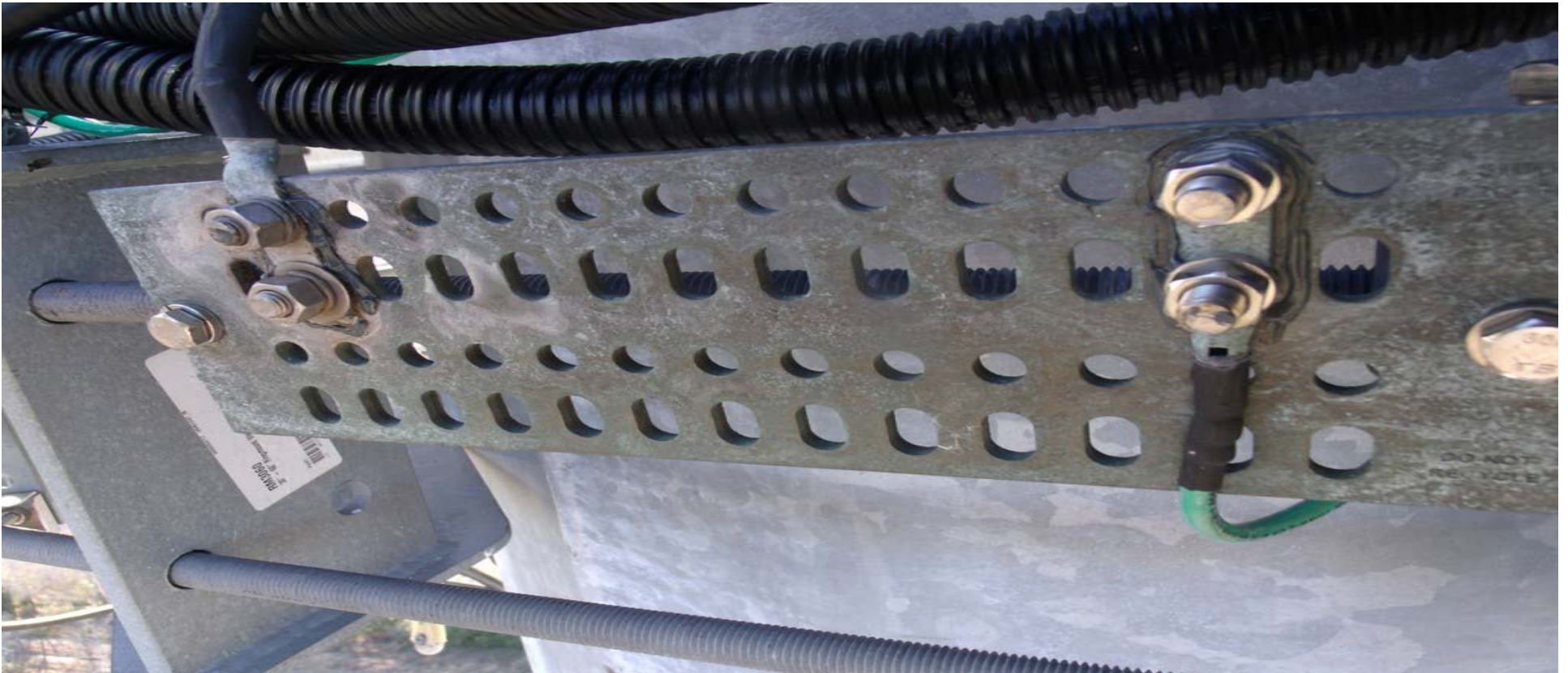
- Loose connections
- Corrosion
- Physical damage
- System modifications



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Testing Bonding Connections

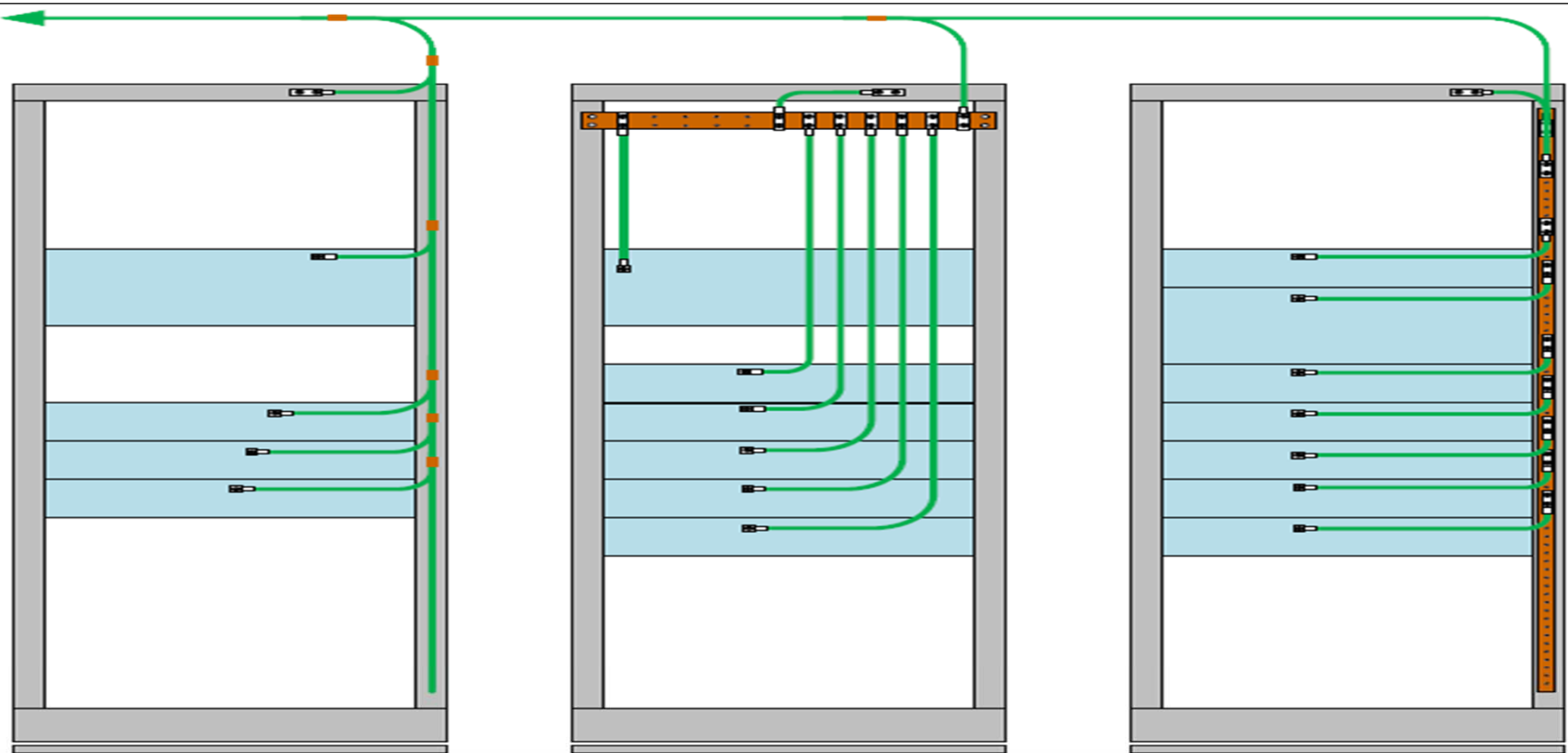
Two-point bonding
measurements
Recommended bonding
resistance between two
points is no more than
0.1 ohms (100 milliohms)



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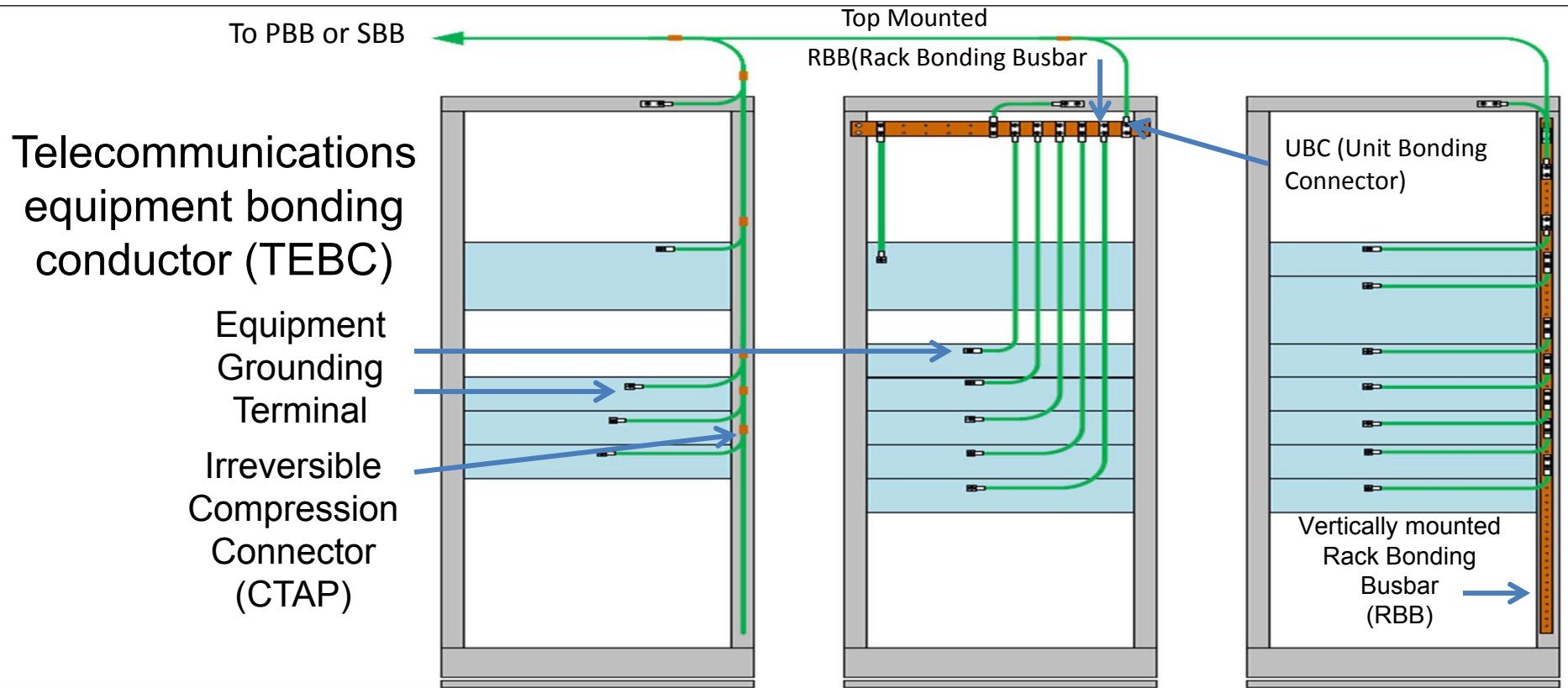
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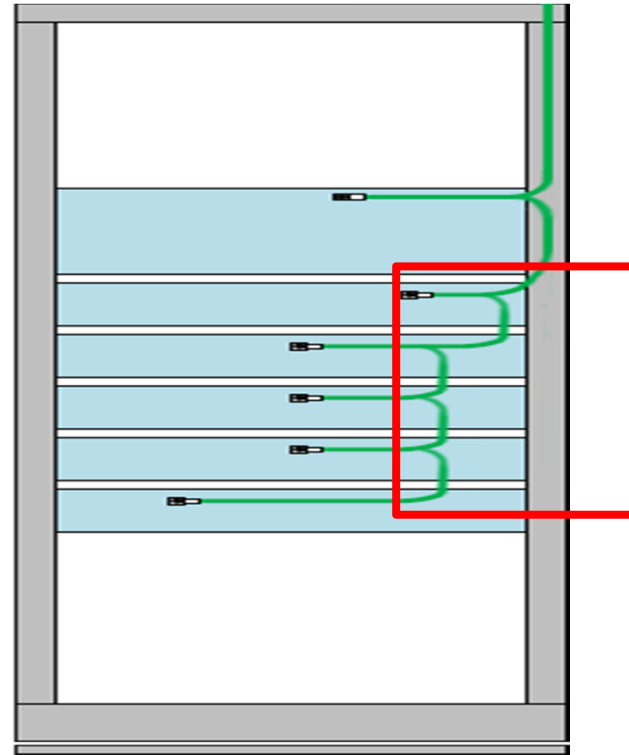


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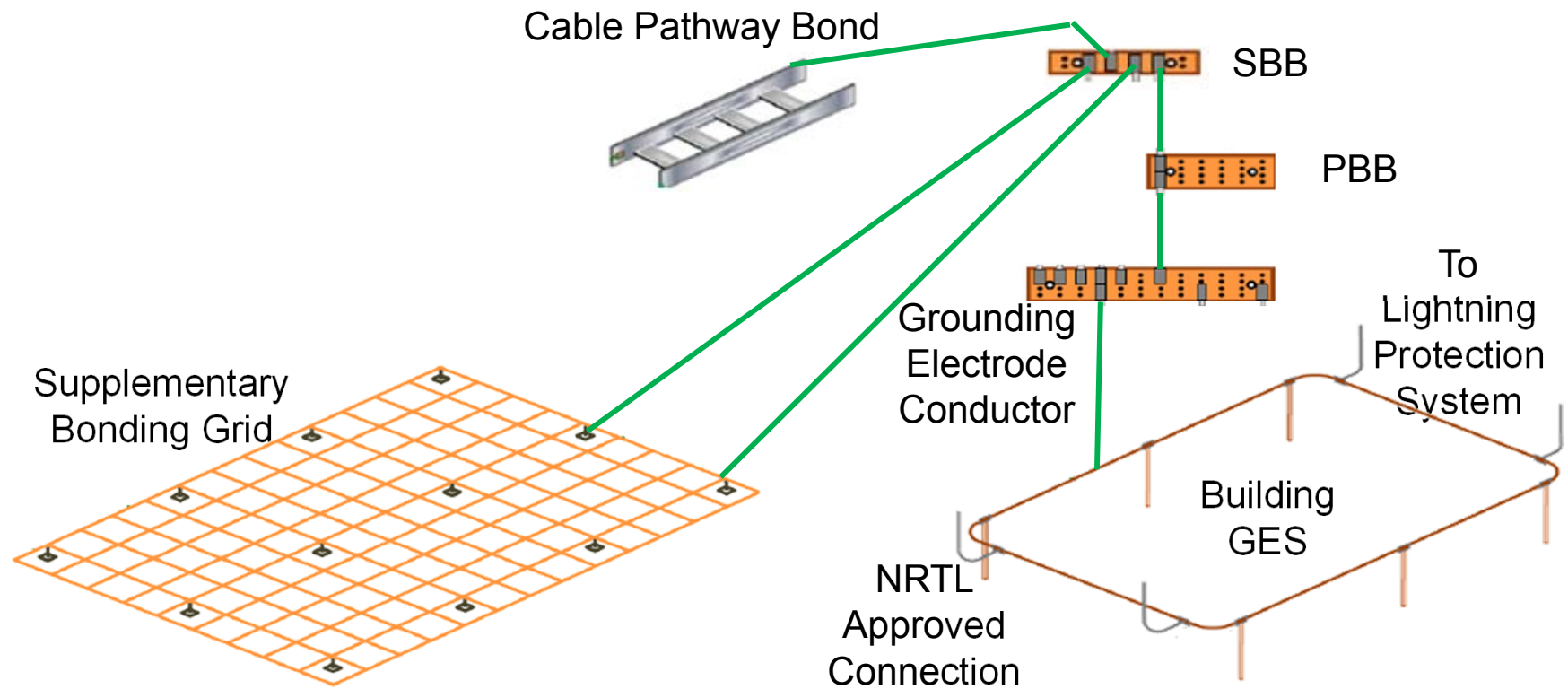
What is wrong?



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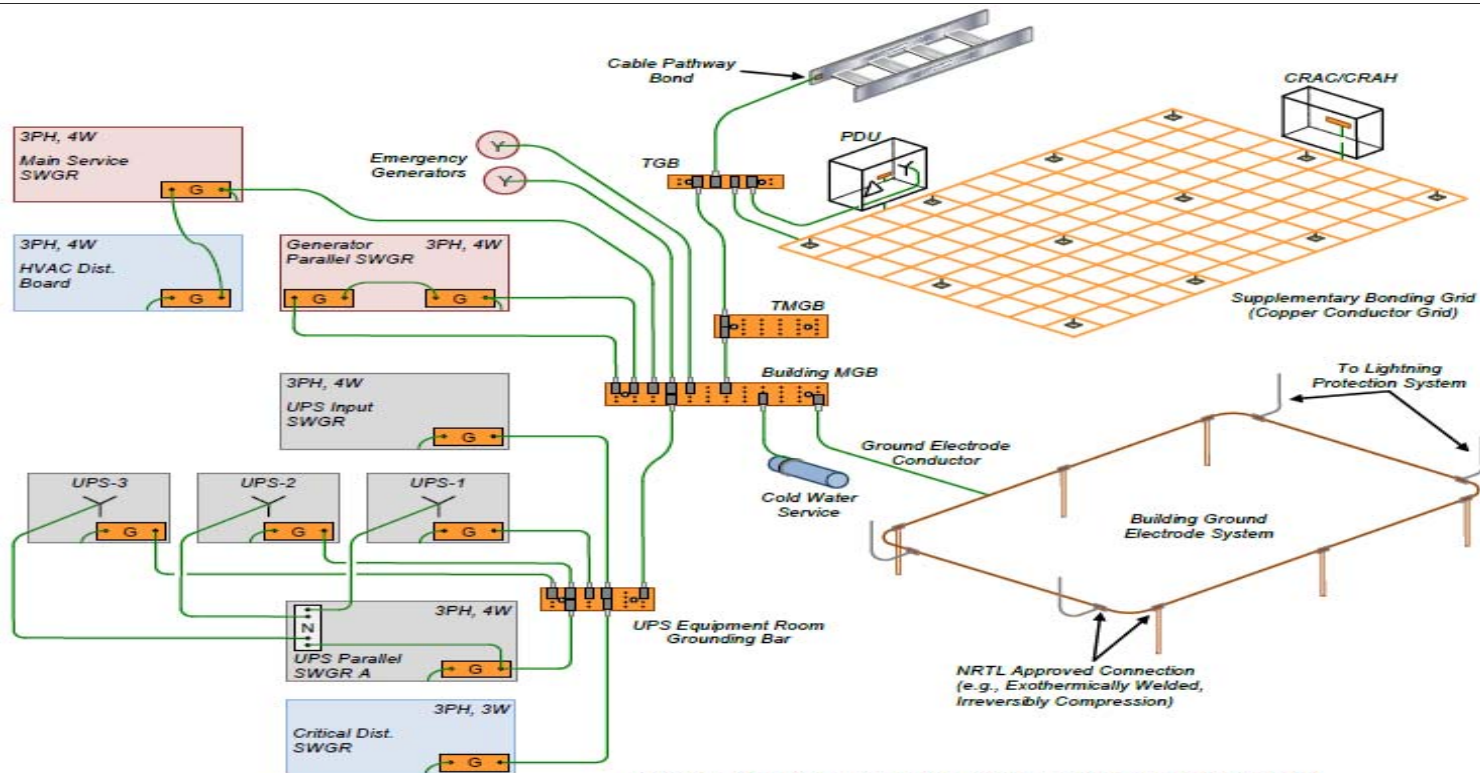
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Note 1: Not all items shown are present in every data center.
 Note 2: Actual wiring should take into account local rules and conditions.



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General Bonding Recommendations

- Bond all metal objects
- Ensure equipotential grounding
- No dedicated ground for data center equipment
- Bonding infrastructure for electrical power system and for telecommunications
- Supplementary bonding of data center
- Decoupling of data circuits between data centers and different floors

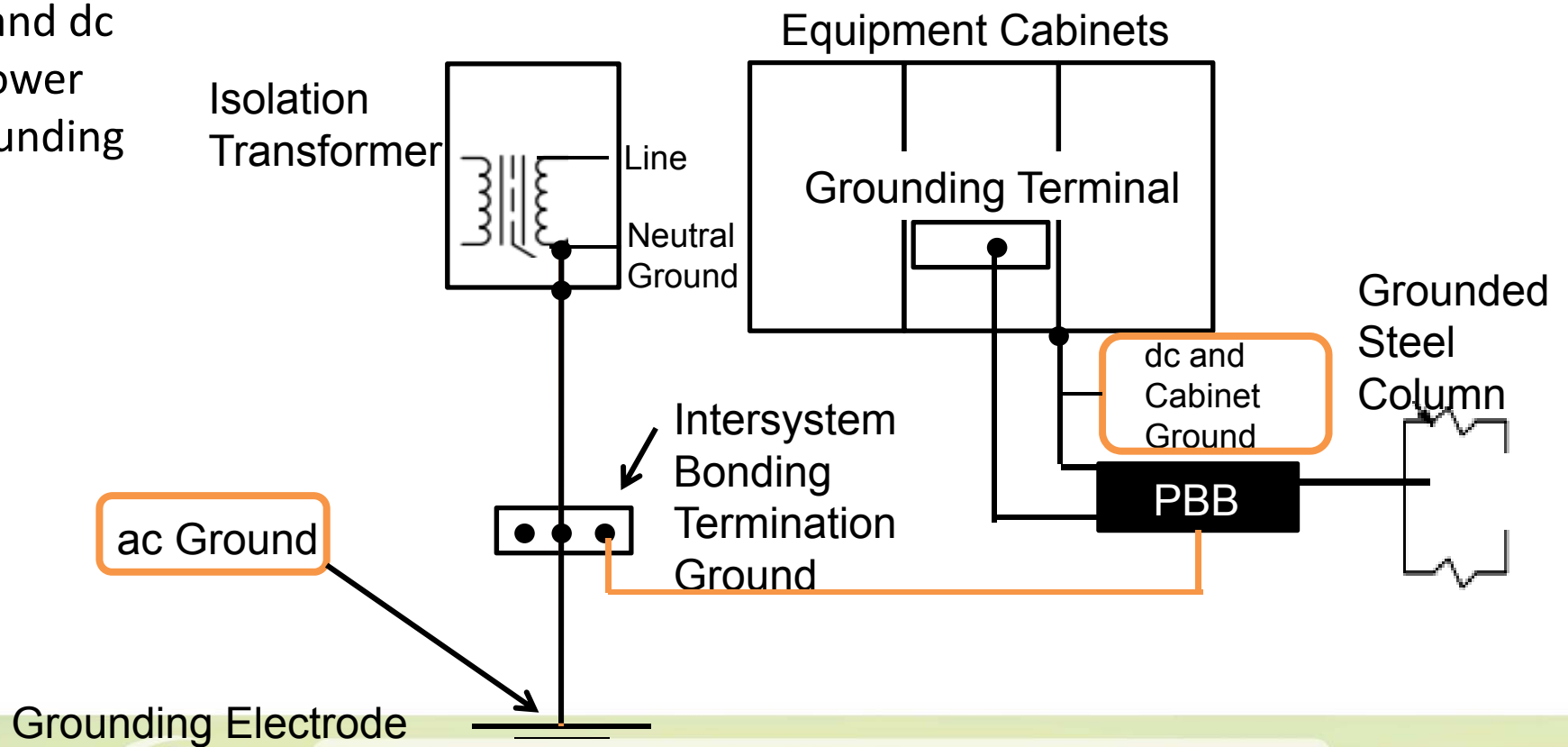


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ac and dc
Power
Grounding

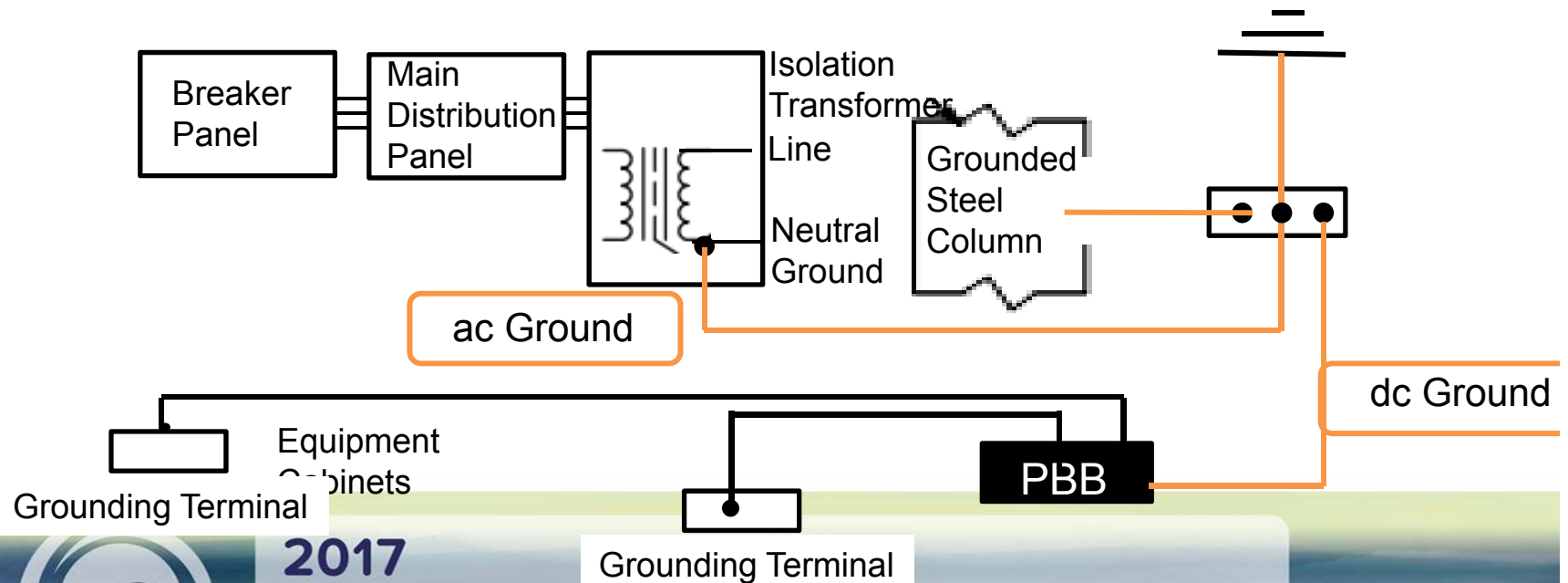


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ac and dc Power Grounding



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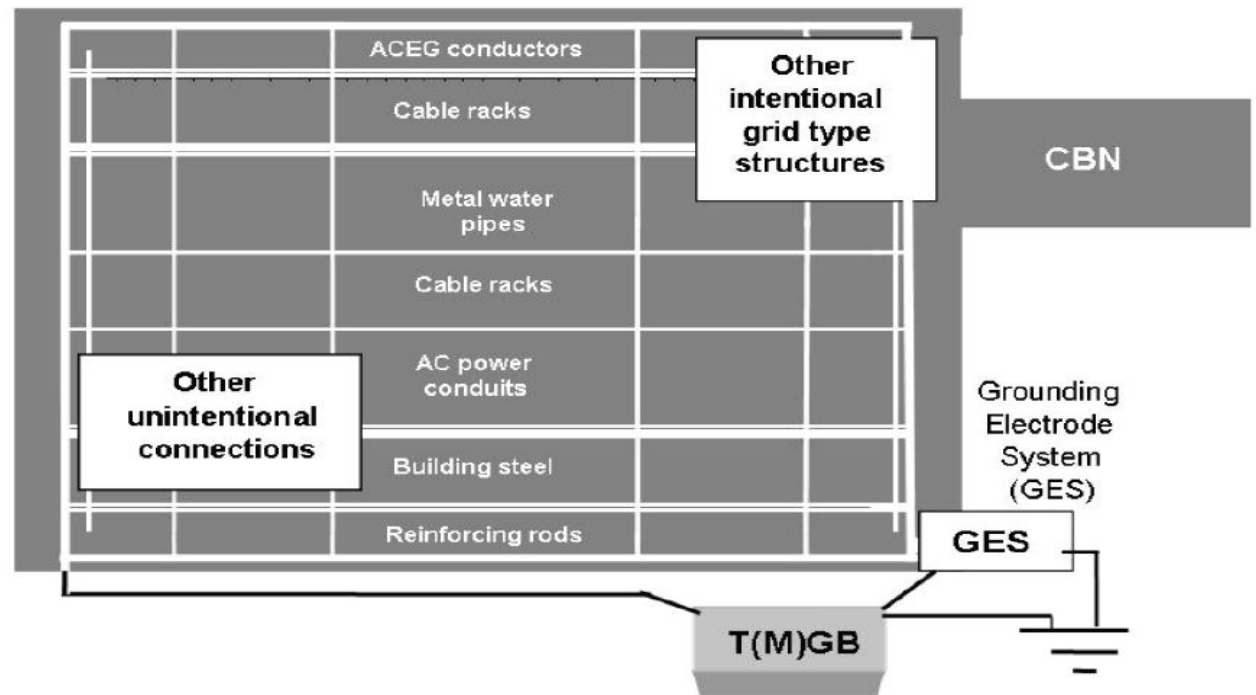
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Common Bonding Network (CBN)

607-C 7.8.3

Mesh topology connects to grounding electrode system



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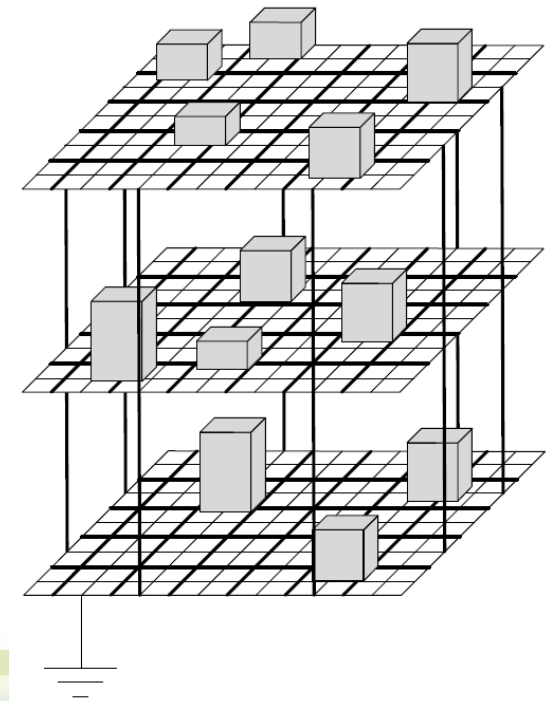
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Mesh-Bonding Network (BN)

607-C 7.8.3

- Include SRG
- Integral part of CBN(common bonding network)
- Must not be insulated or isolated from building electrical system ground
- Everything metal bonded together
- Safety and low impedance path to equipotential electric earth ground.



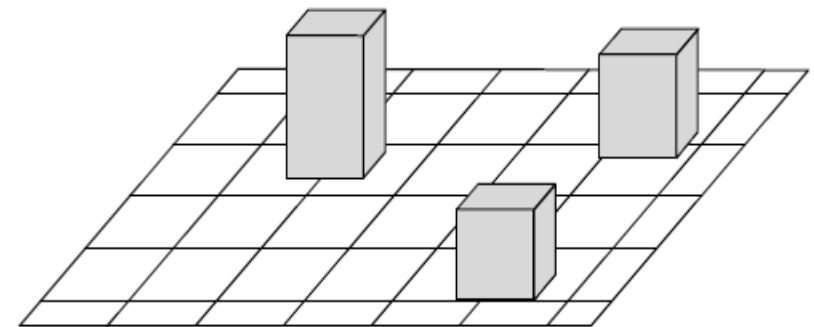
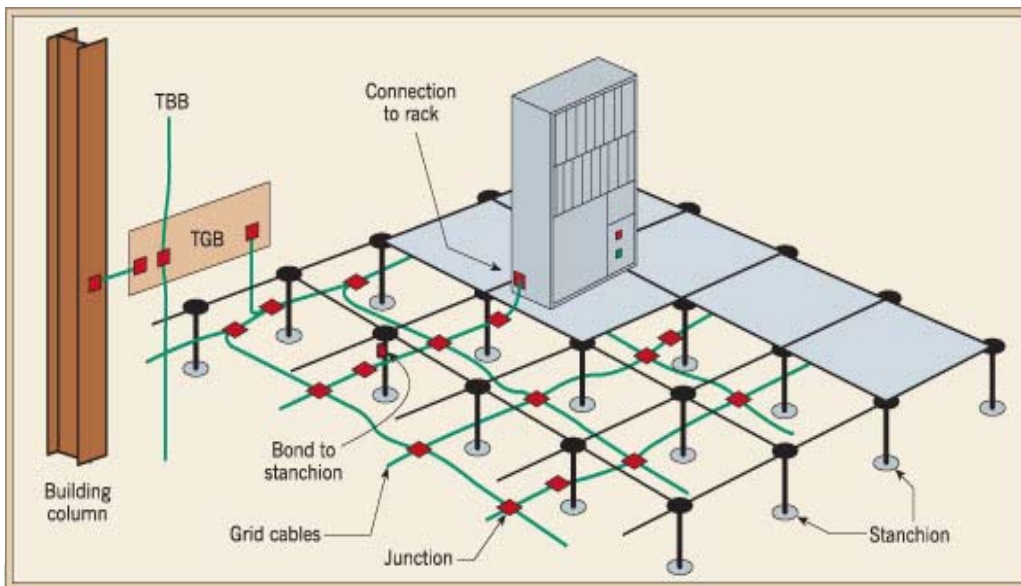
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- Must be insulated or isolated from CBN
Use listed ground clamps

Mesh-Isolated Bonding Network (IBN)



To PBB or SBB



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listed: Used for what it was listed for.

607-C 3 Definitions

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

607-C 6.1 General This clause specifies components of the telecommunications bonding infrastructure. Where the word “listed” is used as a requirement for a component, the component shall be listed to the applicable standard(s) through a nationally recognized testing laboratory (NRTL). (Such as UL or ETL)



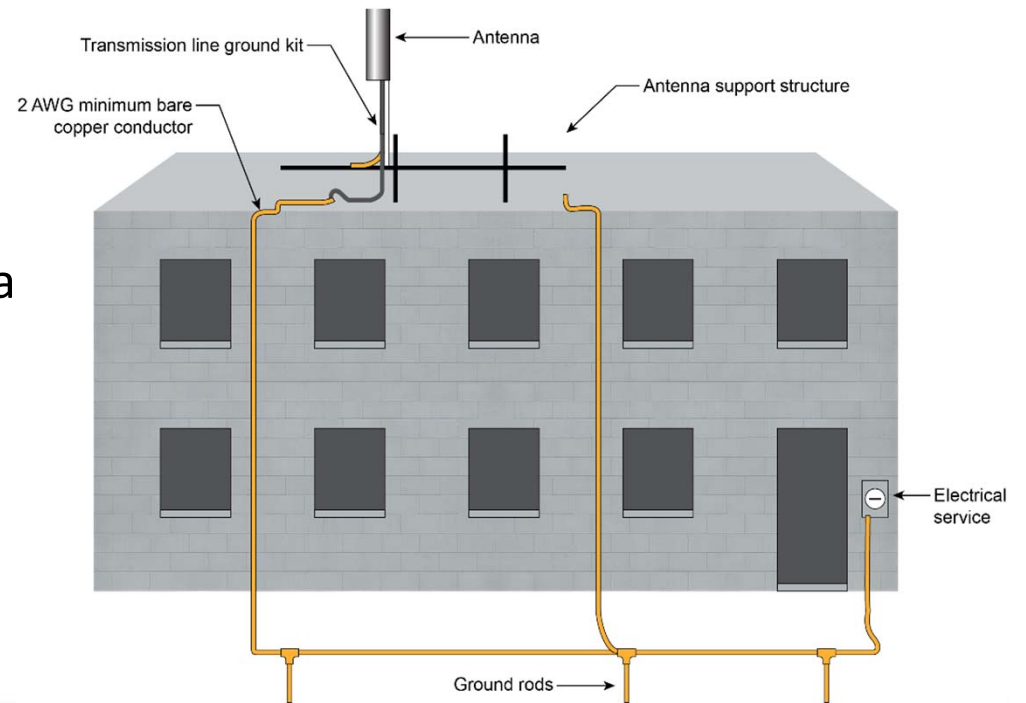
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607-C C.2.6 Rooftop Sites grounding System

- Use regular lightning **protection** conductors and hardware
- Place a wire ring around the antenna support or tower
- Connect:
 - Tower base footings
 - Antenna metal members
 - Antenna support structure
 - Ring



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Down Conductors

- At least two down conductors
- Connected to:
 - Buried ground ring
 - 2 or more rods
- Additional down conductors for each 30 m (100 ft)
- Roof conductors should be supported every 0.9 m (3 ft)

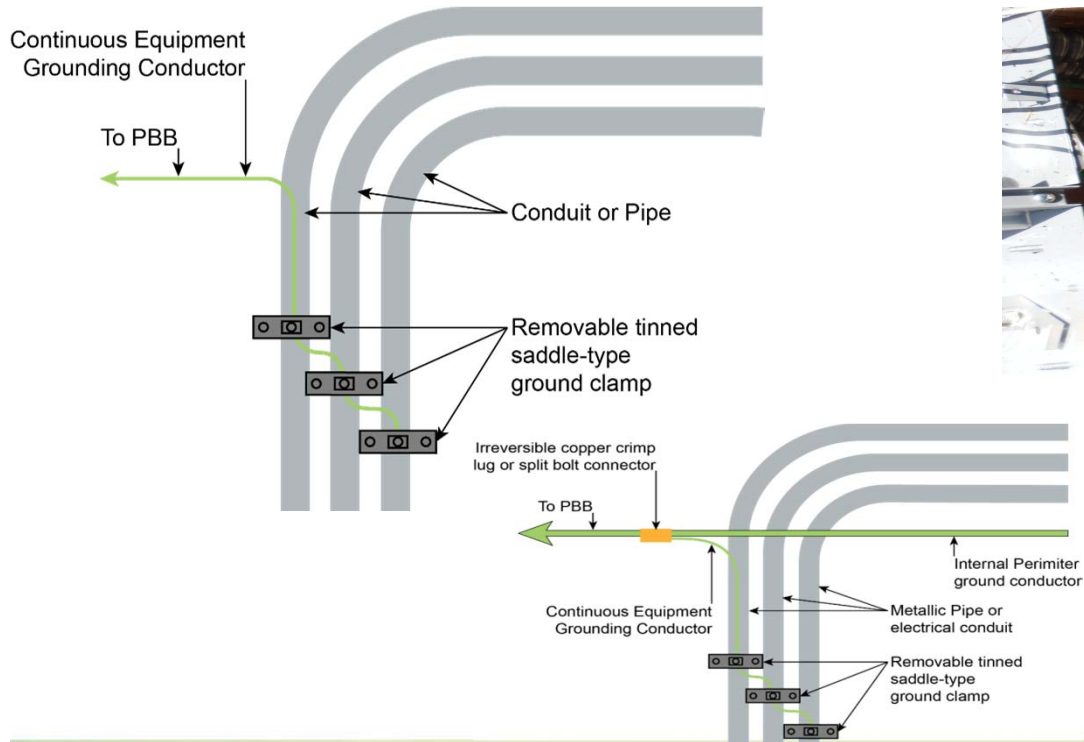


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Metallic Conduit Bonding to Ground

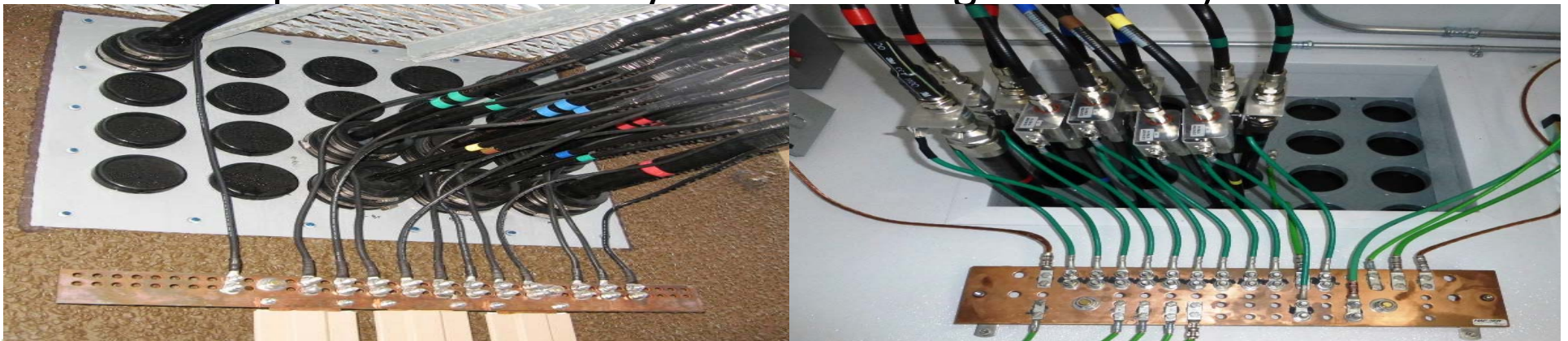


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- **External bonding busbar C.2.2 (E)(NEC 820.93)**
- The purpose of the external bonding busbar is to provide convenient termination points for the sheath (shield) of antenna transmission lines and other telecommunications cables prior to their entry into a building or shelter.)



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820.93 Grounding of the Outer Conductive Shield of Coaxial Cables.

- **(A) Entering Buildings.** In installations where the coaxial cable enters the building, the outer conductive shield shall be grounded in accordance with 820.100. The grounding shall be as close as practicable to the point of entrance.



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607-C C.2.2(C) Tower bonding busbar

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



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Tower Bonding Busbar

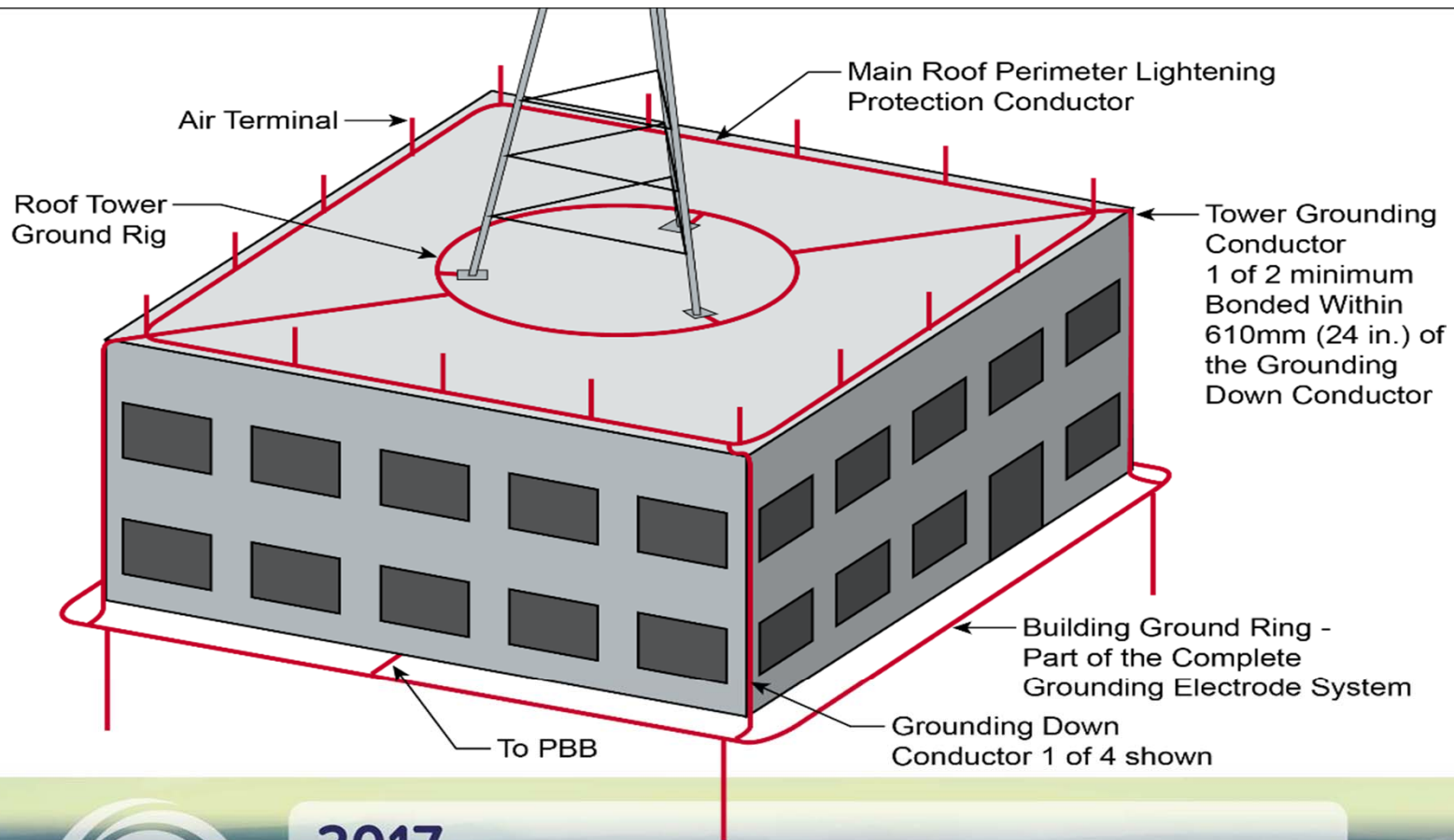
- Installed below the transmission line ground kits
- Connected to the tower grounding electrode system
- Directly bonded to the tower
- Installed at the top and bottom of the tower
- Installed every 15 m (50 ft) if tower height > 60 m (200 ft)
 - Bonded to the tower and the transmission line cable shields



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Global Positioning System (GPS)

- Never be mounted at the highest point on the tower
- Transmission line shall be installed and grounded similar to that in RF transmission lines
- SPD shall be installed within 610 mm (2 ft) of the cable entry port
- Optimized to compensate for the delay caused by:
 - SPD
 - Variations in the length of transmission line

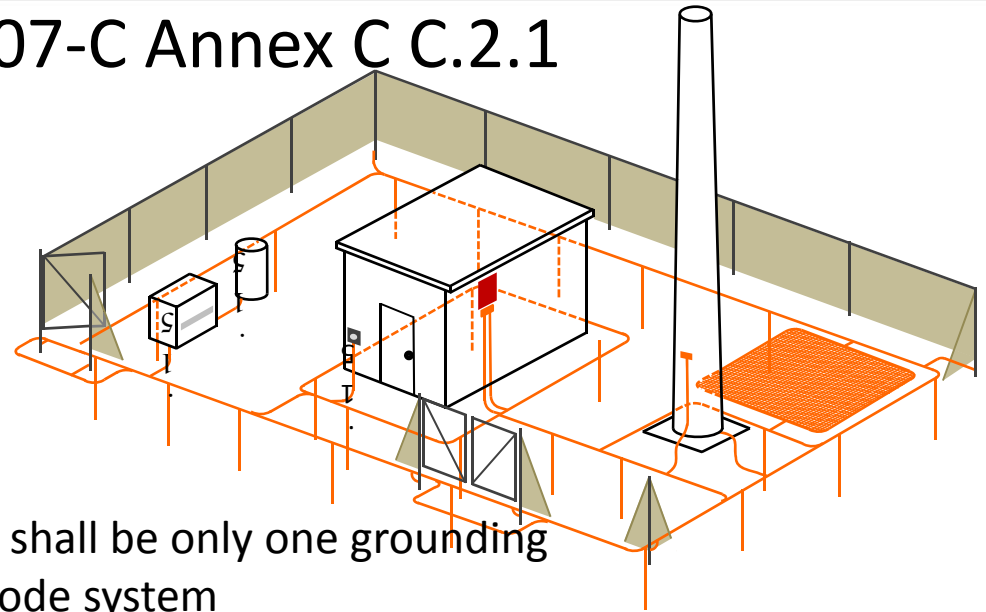


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Communication Towers 607-C Annex C C.2.1



- There shall be only one grounding electrode system
- All grounding media in or on a structure shall be interconnected
- Intersystem bonding termination



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Inspection of Installations

- Was the job designed right?
- Knowing if it is right!
- Was the job installed correctly and per the design?
- What if it is not per the design or the design is not right?
- Does it follow the codes (The law, Jail Time) or the standards (performance, does it work)
- How often?



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Visual Inspection

- A visual inspection of all the installed connections and equipment should be made on a yearly basis or as your company policy dictates.



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Visual Inspection

- Qualitative observation of physical characteristics:
 - Cleanliness
 - Physical integrity
 - Evidence of overheating
- Conducted by a trained personnel,
- Oh NO! I have to know something about Codes and Standards



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Visual Inspection: DC Power

- Logical flow of power
- Inverter's proximity to ac loads
- Clearances for battery racks and cabinets
- Separation of power cables from other cables
- Use of two-hole lugs
- Working space and equipment space



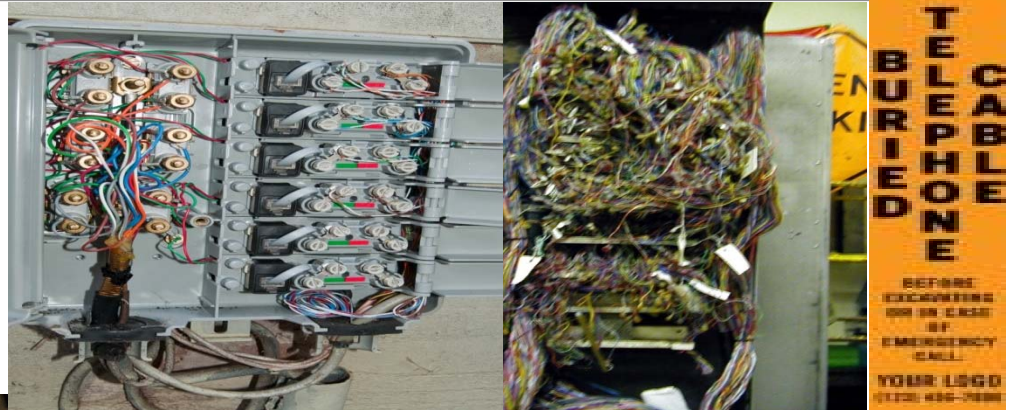
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Visual Inspection: Cable Entrances

- Underground or
- buried entrances



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Aerial entrances



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Visual Inspection: Primary Bonding Busbars

607-C 7.2.1

- Its placement should provide for the shortest and straightest practical routing of the telecommunications bonding conductor (TBC) and the primary protector grounding conductor
- The PBB shall be as close as practical to the panelboard (electrical power panel) and shall be installed to maintain clearances required by applicable electrical codes.



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7.3.3 Connections to the SBB

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



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Visual Inspection: Primary Bonding

- Busbars 607-C 7.2.1:
- Separation between conductors and cables
- Bonding to PBB and Connections to PBB. The vertical location of the PBB should be determined by considering whether the bonding conductors are routed in an access floor or overhead cable support.



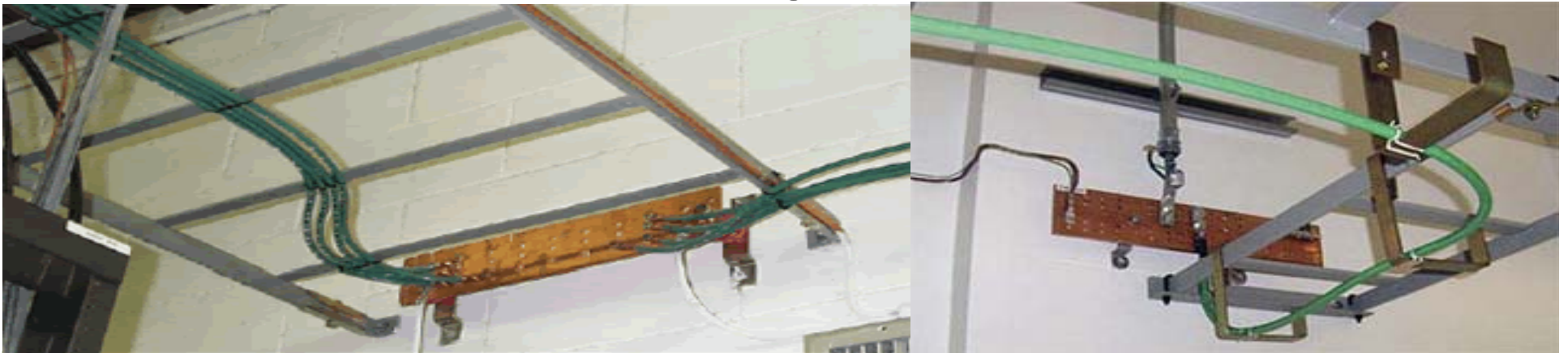
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Visual Inspection: Secondary Bonding Busbars

- Connections to SBB
- Separation from the wall
- Proximity to the panelboard
- Bonding to SBB



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Visual Inspection: Rack Bonding Busbar

- Connections to RBB Separation from the rack
- Bonding to RBB



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Visual Inspection: Telecommunications Room

- Connections used
- Incidental contacts
- Conductors
- Workmanship
- Cleanliness
- Prohibited materials
- Compliance with construction documents
- Horizontal cross-connect
- Adequate spacing
- Bonding and grounding



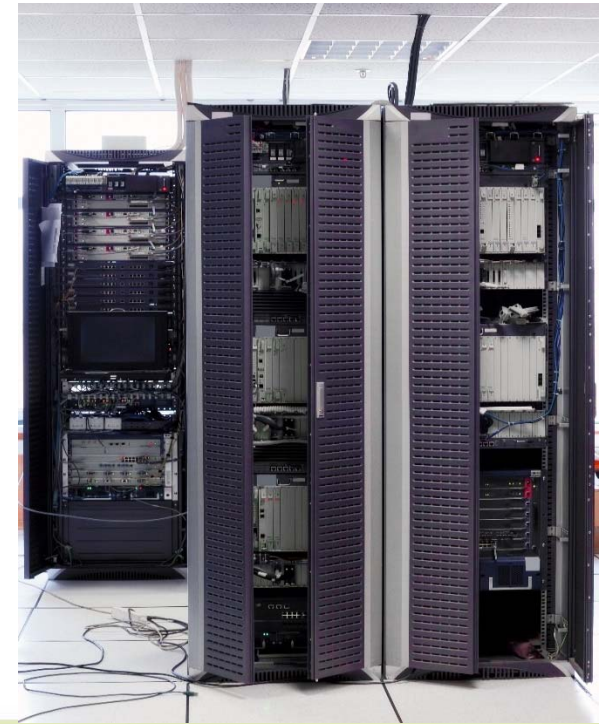
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Visual Inspection: Data Center Rooms

- Sufficient slab-to-slab height
- Adequate lightning
- Exit signage
- Location of the UPS system
- IT equipment's position
- Length of links
- Accessibility of conductors
- Bonding and grounding strategy
- Unattended trash
- Labelling, and visual indicators
- Cracks or holes



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Visual Inspection: Bonding in Backbone Distribution Systems

- Metallic raceways or conduits
- Connections between bonding conductor and grounding electrode
- Bonding and grounding electrode conductor
- Bonding of metallic member of backbone cable



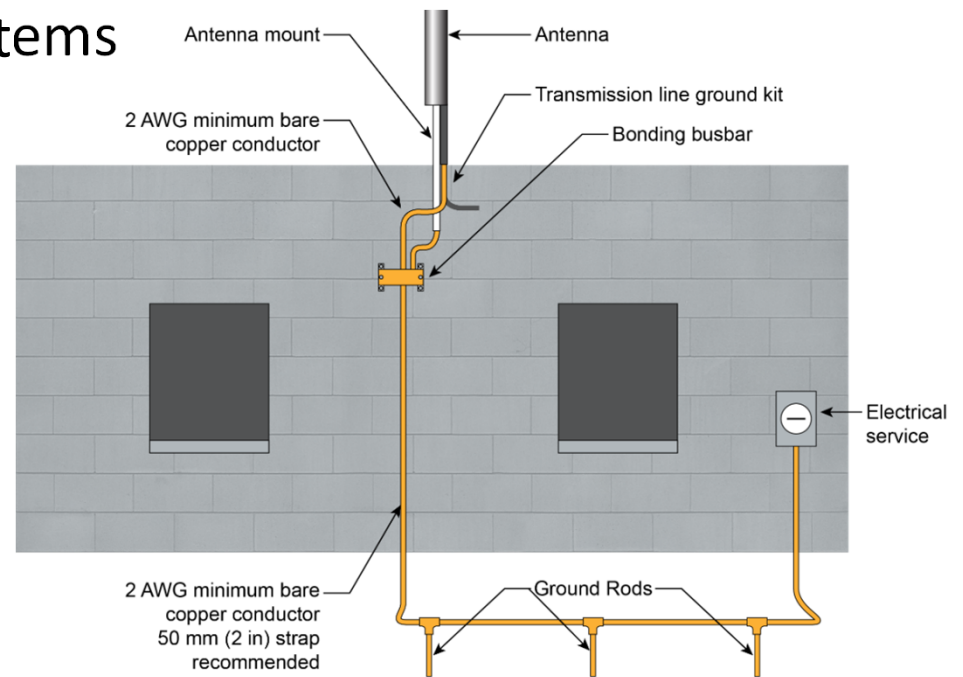
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Visual Inspection: Antenna Systems

Down conductors
Coaxial cable
shield bonding
Conduit bonding
Coaxial cable
protection



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



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Visual Inspection: Lightning/Surge Protectors

- Lightning rods
- Loose or damaged cable connections
- Connectors and fittings
- Surge protection devices physical condition and connections
- Surge protector grounding conductor length
- Adequate space for surge protection devices
- Location of surge protectors for each equipment and cables
- Bonding of surge lightning and surge protection devices



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Visual Inspection: External Metallic Components

- Effectively grounding
- Accidental contact
- Exposure to lightning
- Bonding and grounding of cables and cable shields
- Conduit stubs
- Span for aerial entrances
- Clearance and separation from electrical power lines and traffic
- Conduit termination
- Mast extension
- Surface-mounted cabinets
- Maintenance hole



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Backbone Bonding Distribution Systems

- Communications cables entering a building
- Communications cables terminating on the outside
- Intersystem bonding termination
- No intersystem bonding termination
- No intersystem bonding termination or grounding means



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Horizontal Distribution Systems

- Configuration
- Layout and capacity
- Flexibility to accommodate expansion
- Maintenance and relocation
- Accommodates types of telecommunications cabling
- Proximity to sources of EMI
- Grounding and bonding



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Type and Use of Equipment

- PBB to the service equipment (power) ground
- TBB to the PBB and to telecommunications room
- PBB/SBB to equipment racks/cabinets
- Welded and bolted cabinet/equipment rack
- PBB to the ac grounding (earthing) electrode system
- Telecommunications bonding connections to:
 - Primary and secondary surge protectors
 - Cable trays, ladder racks, and equipment racks
 - Branch circuit panelboards
 - Power conditioning equipment
 - Cable shields
 - Battery racks and entrance conduits



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Documenting the Results of the Test

- A good documentation process goes hand in hand with a good inspection program



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Sign and Date Report and Site readiness

- Commissioning report will:
- Be delivered to the site manager or facility manager
- Have the complete documentation of the results of all tests
- Have a certification document

- Site is ready for service:
- Once all inspections have been completed
- Passed all tests



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BG102: Best Practices for Telecommunications Bonding and Grounding class

- BG102 is an intensive 3-day course that provides learners with skill building activities for designing best practice solutions for bonding and grounding commercial buildings and campuses as outlined in TIA-607-C).
- [Tampa, FL](#)
April 11-13, 2017
- [Atlanta, GA](#)
March 21-23, 2017
- [Columbus, OH](#)
May 23-25, 2017
- [Tampa, FL](#)
April 25-27, 2017



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BG102: Best Practices for Telecommunications Bonding and Grounding class

- Determine the types of bonding and grounding systems required for a campus
- Design the bonding and grounding components for the facility (building/campus), given an infrastructure type
- Design the bonding and grounding for the telecommunications structure in a building or facility
- Design the bonding infrastructure for a data center in a building or facility
- Design the bonding infrastructure for the DAS in a building or facility
- Identify the steps for testing the bonding and grounding connections



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Summary

- Two types of standards
- Bonding equalizes
- We do bond every metal part together
- We want a low impedance path to equal the electric earth ground. (Scotch tape example)
- We not want to be the conductor
- Who really invented the telephone
- We wants things to work
- We don't want to kill anyone and go to jail!



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-
- Thank You for spending the time this afternoon.
 - Any questions???
 - If you have any questions later please let me know
 - Craig D Dunton
 - cdunton@bicsi.org
 - 813-295-9817



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