Telecommunication Grounding & Bonding

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Presentation Outline

1. Codes & Standard References
2. The Need for Grounding & Bonding
3. Case Review
4. Grounding & Bonding Components
5. Preparations
6. Sample Connections
7. Set Up – IT Room
8. Sizing Up all Conductors
9. Sample Conductor - Grounding System
10. How to Do it – Manner of Installations
11. Testing
12. Poor Soil Conductivity
13. Summary
14. Reading References
15. Codes and Manuals – Where to buy

BICSI

1. Codes and Standard References

- **ANSI J-STD 607-B**
  Commercial Building Grounding (Earthing) and Bonding Requirement for Telecommunications
- **ANSI/NECA/BICSI 607:2011**
  BICSI Standard for Telecommunication Grounding & Bonding, Planning and Installation Methods for Commercial Building
- **ANSI/TIA 607B: 2011**
  Generic Telecommunication Bonding and Grounding (Earthing) for Customer Premises
- **BICSI TDMM 13th Edition:2014**
  BICSI Telecommunication Distribution Method Manual
- **BS 7430:2011**
  British Standard Code of Practice for Protective Earthing of Electrical Installations

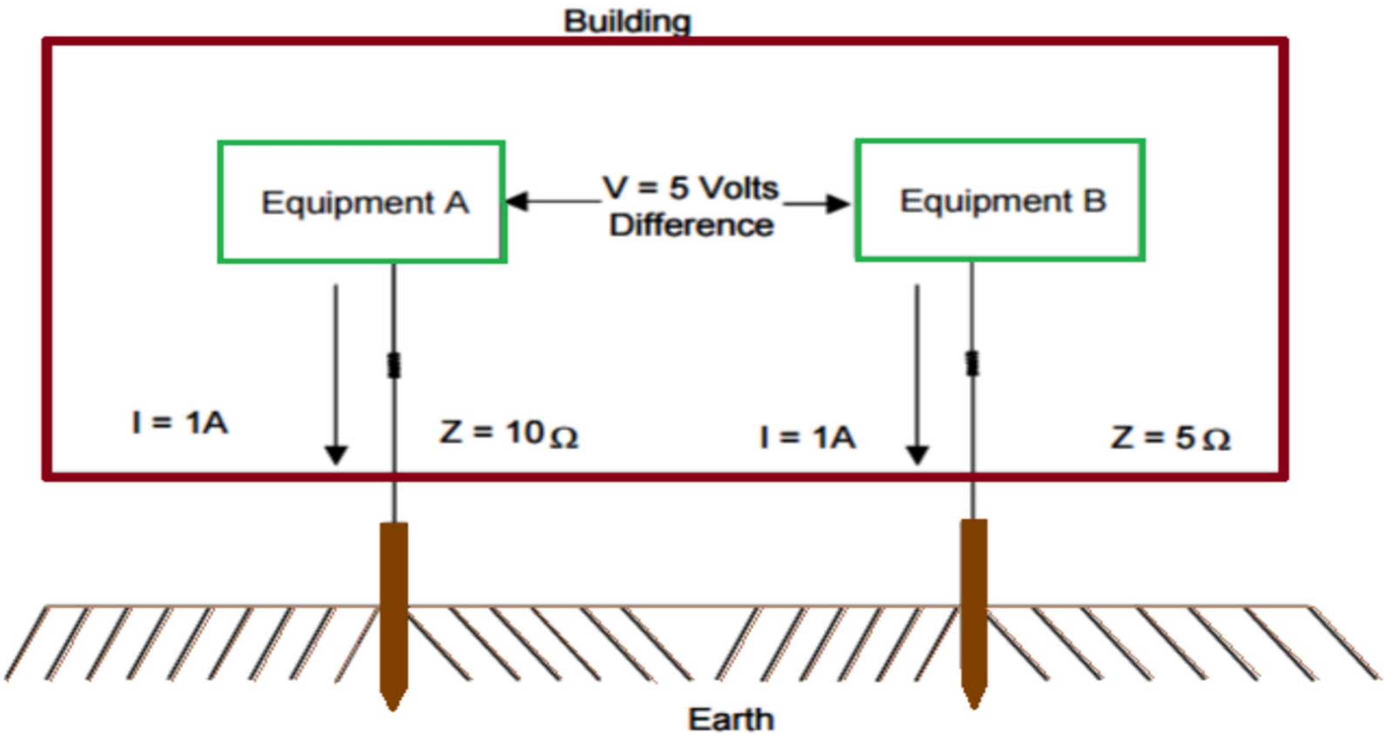
1. Codes and Standard References

- **IEEE 1100:2005**
  Recommended Practice for Power and Grounding Electronic Equipment
- **IEEE 81:2012**
  Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System
- **ISO/IEC 30129:10.2015**
  International Standard Information Technology: Generic for Customer Premises
- **NFPA 70:2017 (NEC)**
  National Electrical Code of USA Article 250 & Article 800
- **Motorola R56:2005**
  Standards and Guidelines for Communication Sites

2. Why The need for Grounding & Bonding

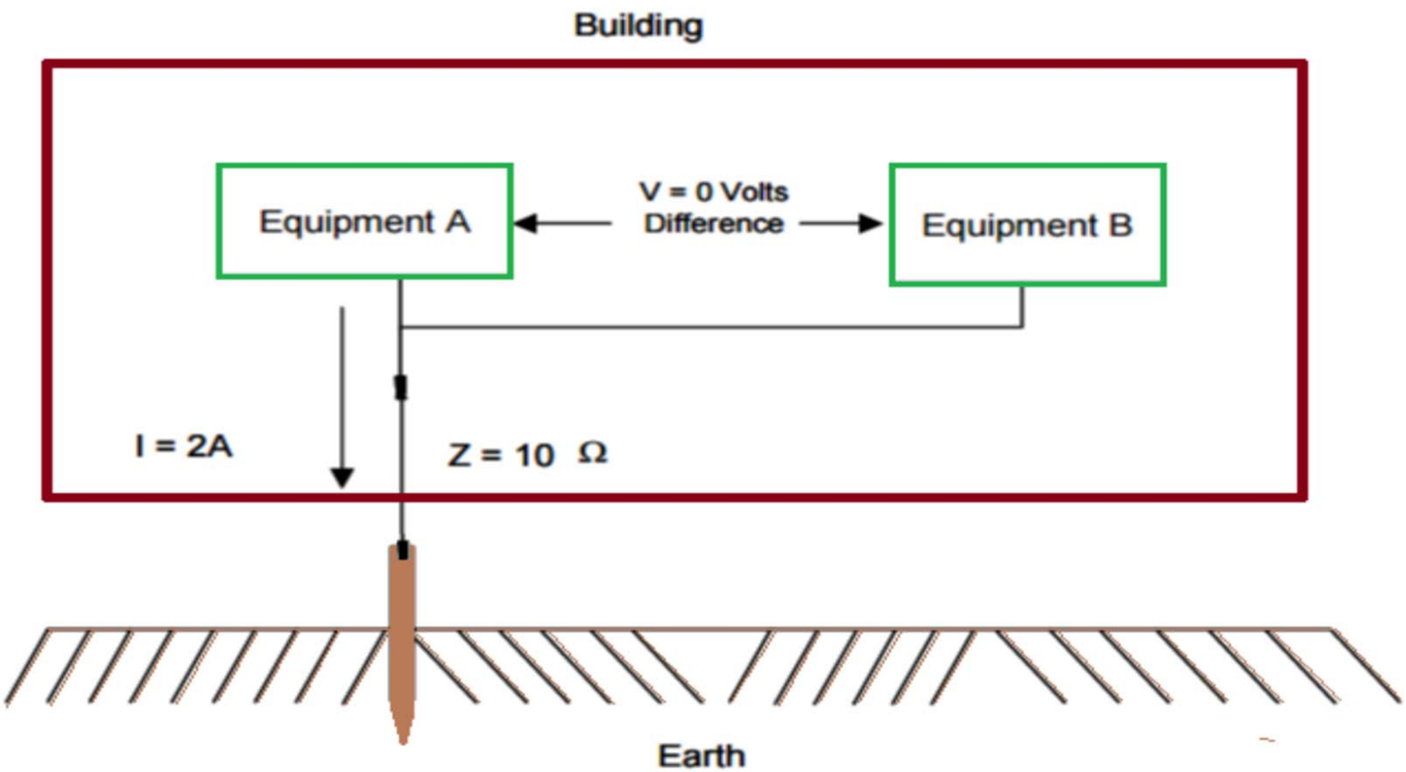
- Equipment Protection
- Satisfy Warranty Requirement
- System Performance
- Service Protection
- Personnel Safety
  (code requirement: PEC/NEC/CSA/BS/IEC)

3. Case Review: Two Ground Reference Points



Effect of Two Earth Reference Points
(voltage difference between two equipment)

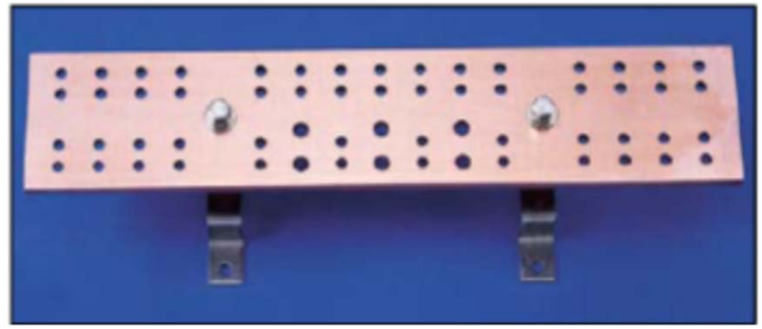
3. Case Review: Single Equipotential Plane



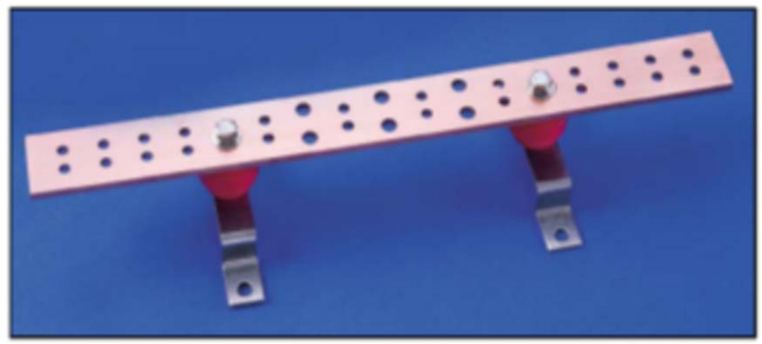
Effect of Single-Point Reference of all Equipment (0 volts Difference)

4. Grounding & Bonding Components

Main Telecommunication Grounding Busbar (TMGB)



Telecommunication Grounding Busbar (TGB)



2-Hole Long Barrel Terminal Lugs & Compression Type Connectors

ANSI/NICA/BICSI 607:2011

4. Grounding & Bonding Components

Main Telecommunication Grounding Busbar (TMGB)

Figure 4 illustrates dimensions typical of a TMGB.

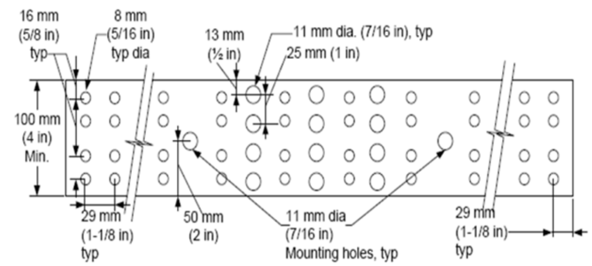


Figure 4 – Typical TMGB

Telecommunication Grounding Busbar (TGB)

ANSI/TIA-607-B

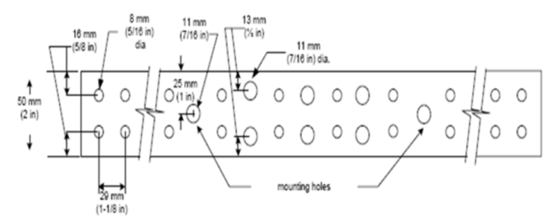
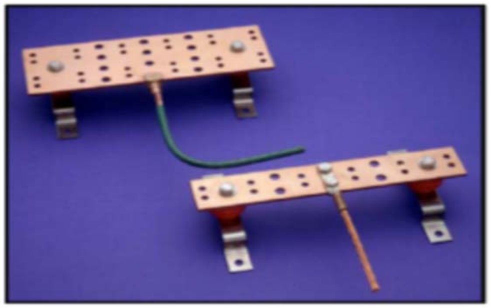
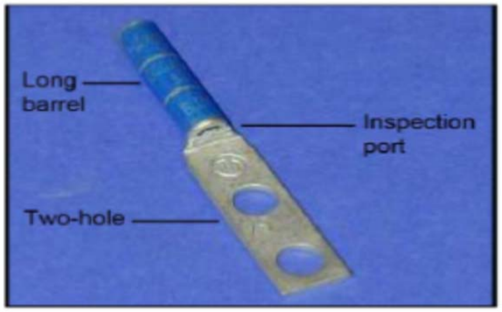


Figure 5 – Typical TGB

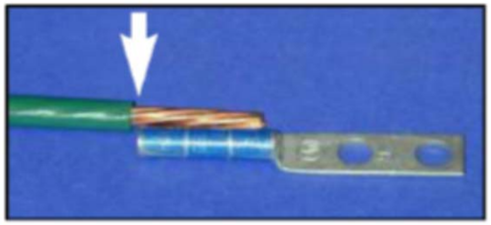
4. Grounding & Bonding Components



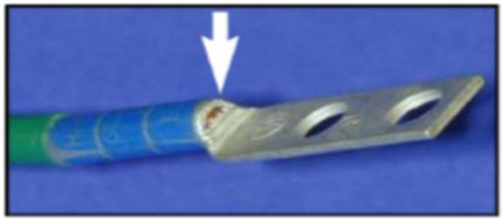
Exothermic connection & a 2-hole lug connection to a busbar



2-Hole Terminal Lug



Trimmed Insulation from a conductor



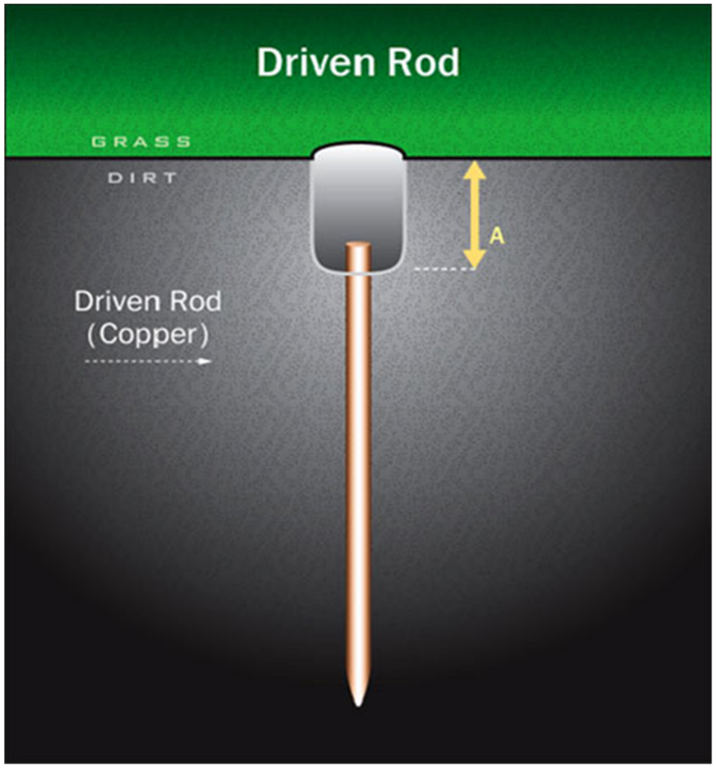
Conductor seen Through the inspection port (window)

4. Grounding & Bonding Components

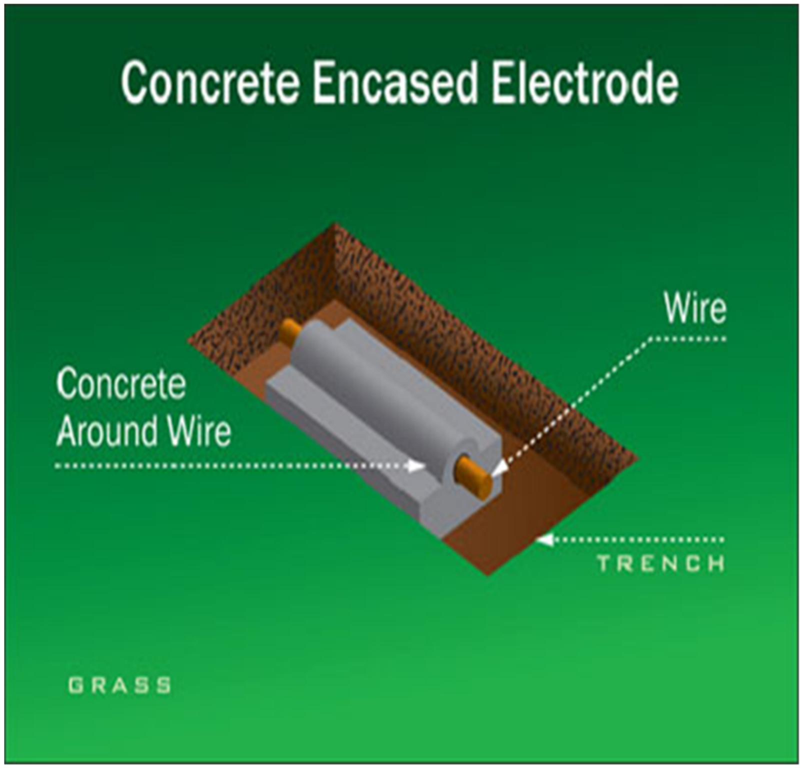
Check What is correct and what is wrong with this Copper Busbar

ANSI/NECA/BICSI 607:2011

4. Grounding Rods Plates & Pipes

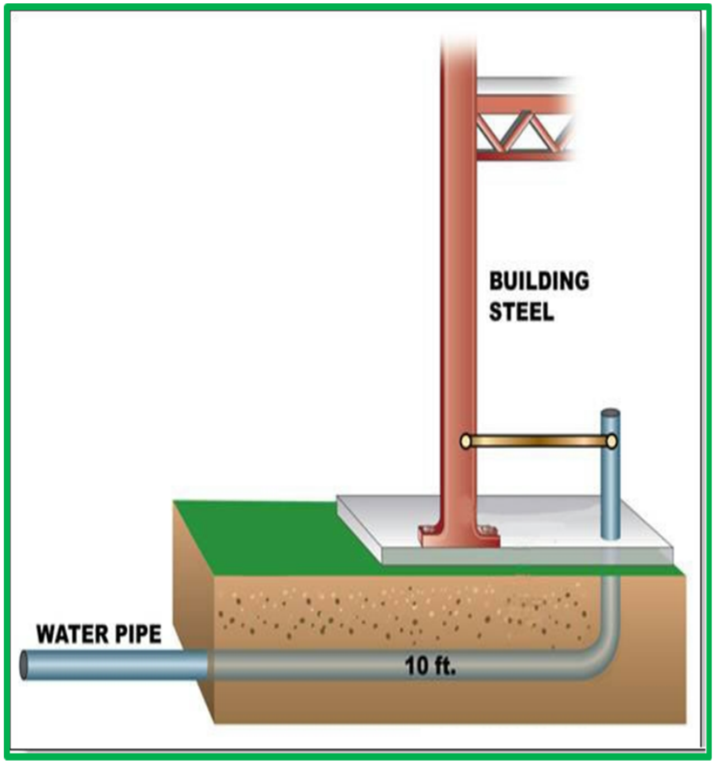


Copper Ground Rod

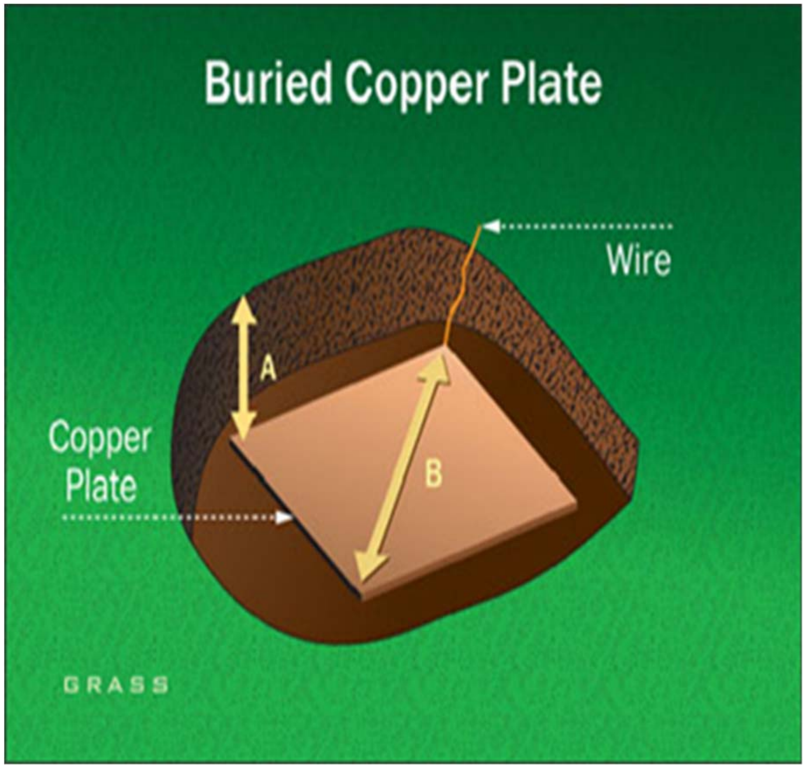


Ufer Grounding Method

4. Grounding Rods Plates & Pipes

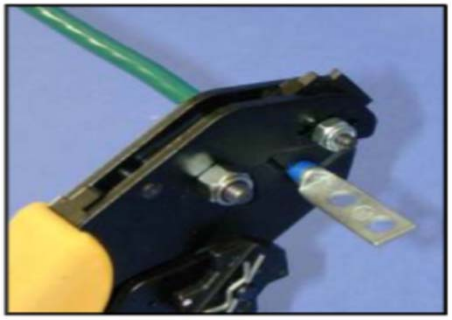


Building Frame & Water Pipe Bonding



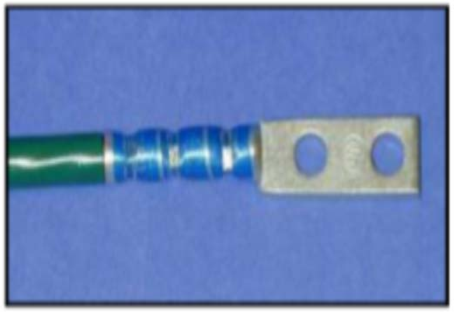
Copper Plate Grounding

5. Preparations: Crimping & Exothermic Welding

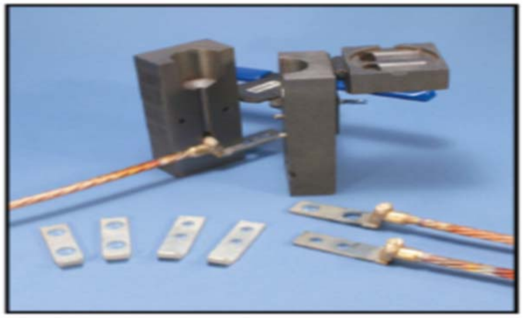


Crimping a conductor in the barrel of the lug

Mold being locked and disk inserted



Finished Barrel with 3-crimps

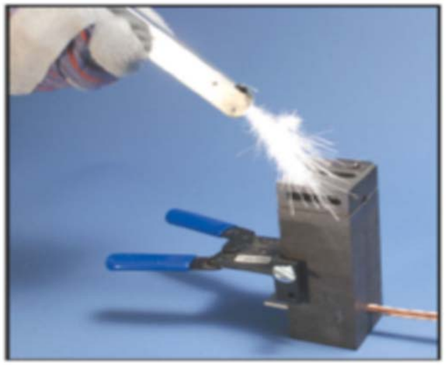


Example of a mold for an exothermic weld

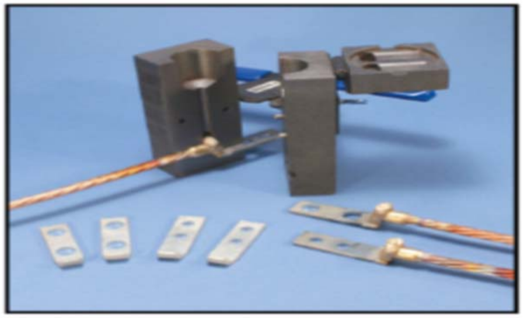
5. Preparations: Exothermic Welding & Busbar

Pouring Weld metal power into a mold

Removing Oxidation from the grounding Busbar



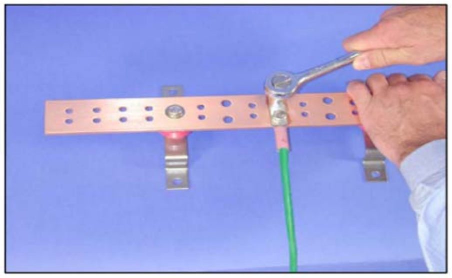
Igniting the Accelerant



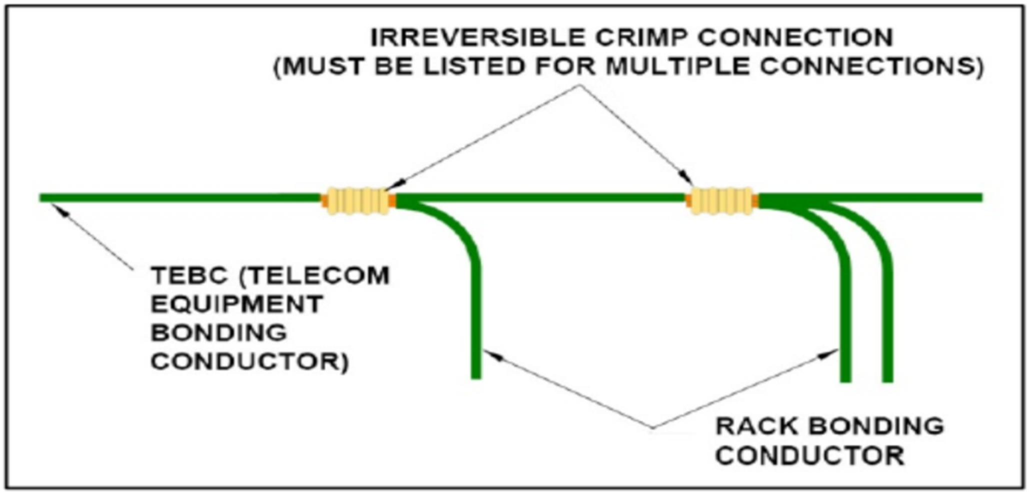
Applying an Antioxidant to the clean area of the grounding Busbar

ANSI/NECA/BICSI 607:2011

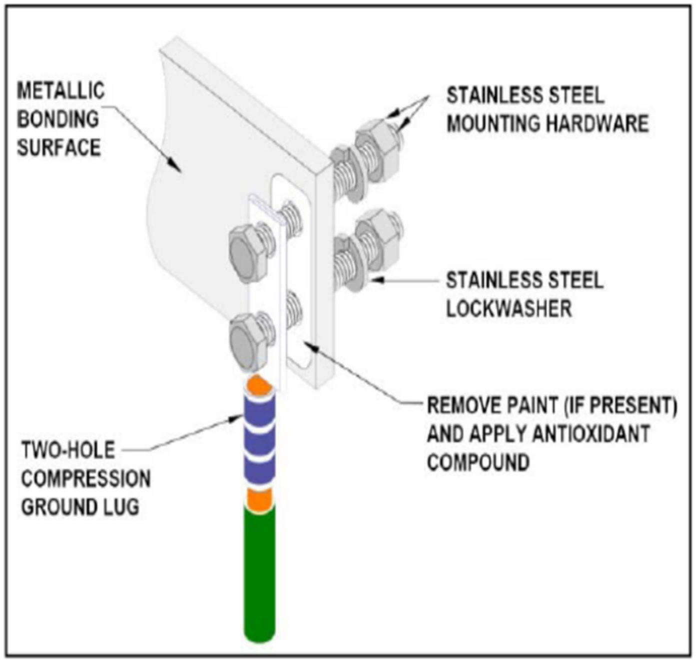
5. Preparations – Busbar Lug Connection



Attaching a Lug to the Grounding Busbar



Example = TEBC to Rack Bonding Conductor Connection



Lug Mounting Configuration

6. Sample – Bonding Connection with Rack Cabinet Door System

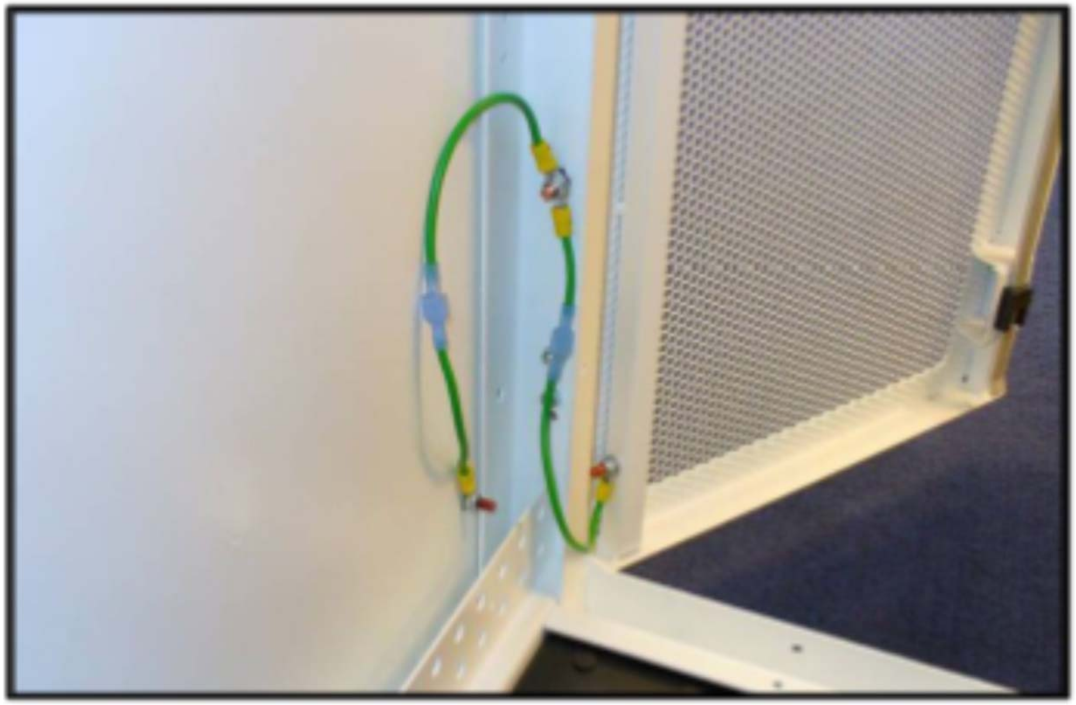


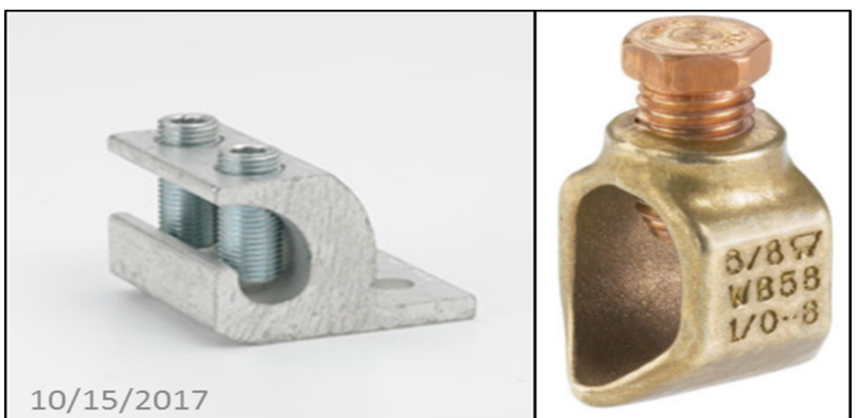
Illustration of a bond connection from a cabinet to the Cabinet door & side Panel

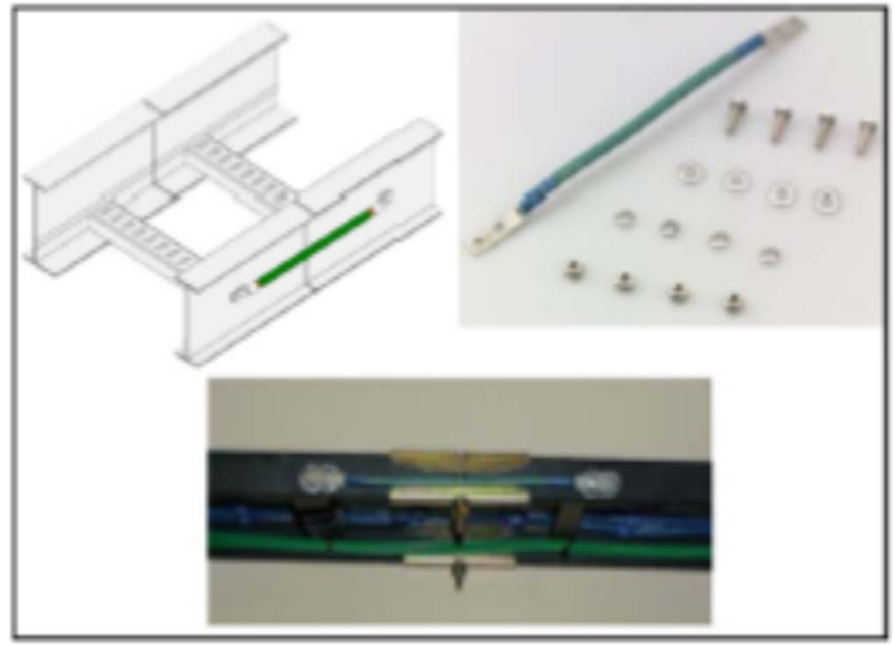
6. Sample – Mechanical & Exothermic Bonding Connection

BAD Example of Grounding using 4-pair UTP CAT5e Cable

6. Sample – Mechanical Bonding on Trays

Example of 2-hole lugs and a ground terminal block & Clips

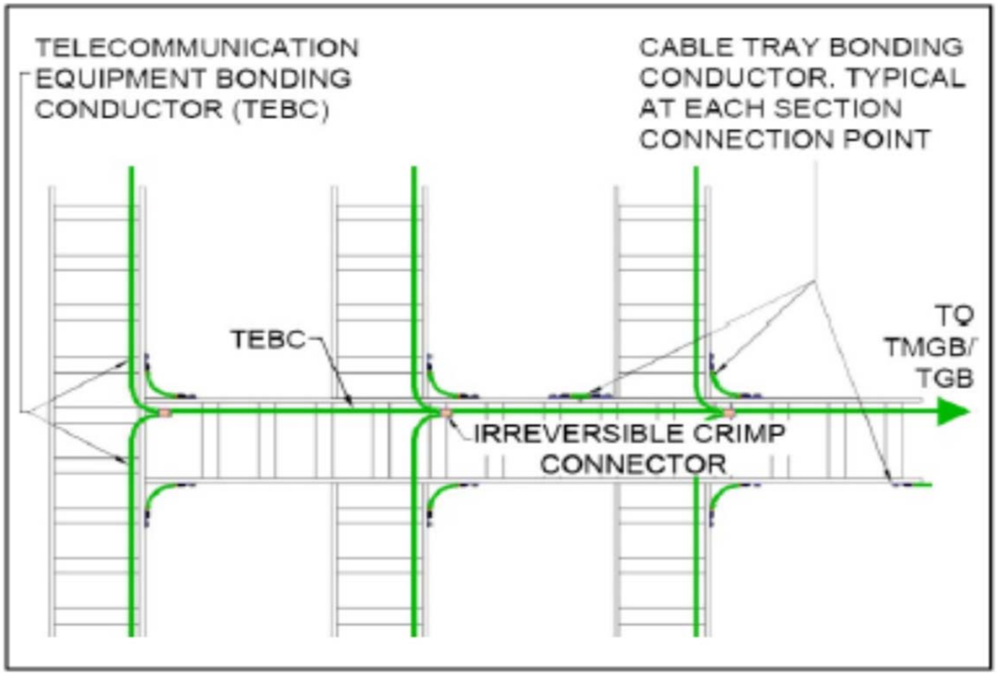




Example of Bonding Jumper and its installation between Cable Tray Segments

ANSI/NICA/BICSI 607:2011

6. Sample – Tray Bonding Routing & Radius



Example of a TEBC routed on a Cable Tray – Bend Radius Shall not be less than 200mm & 90 degrees minimum

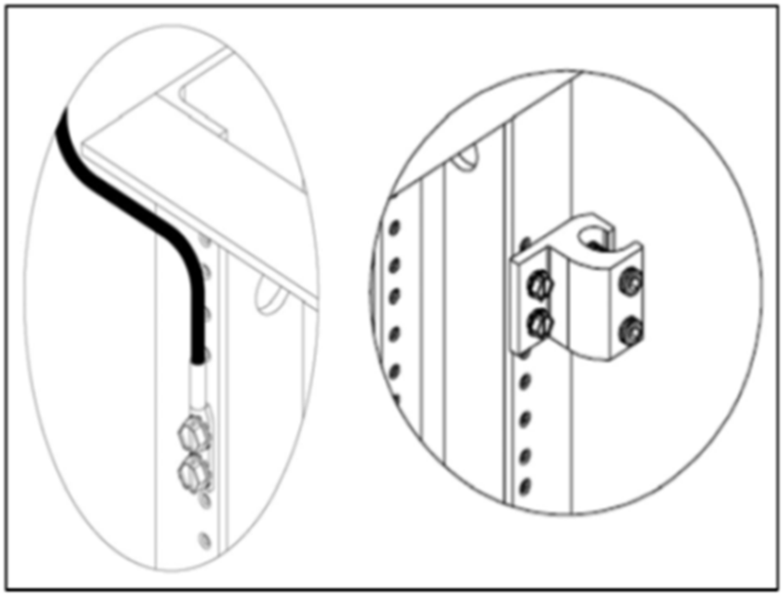
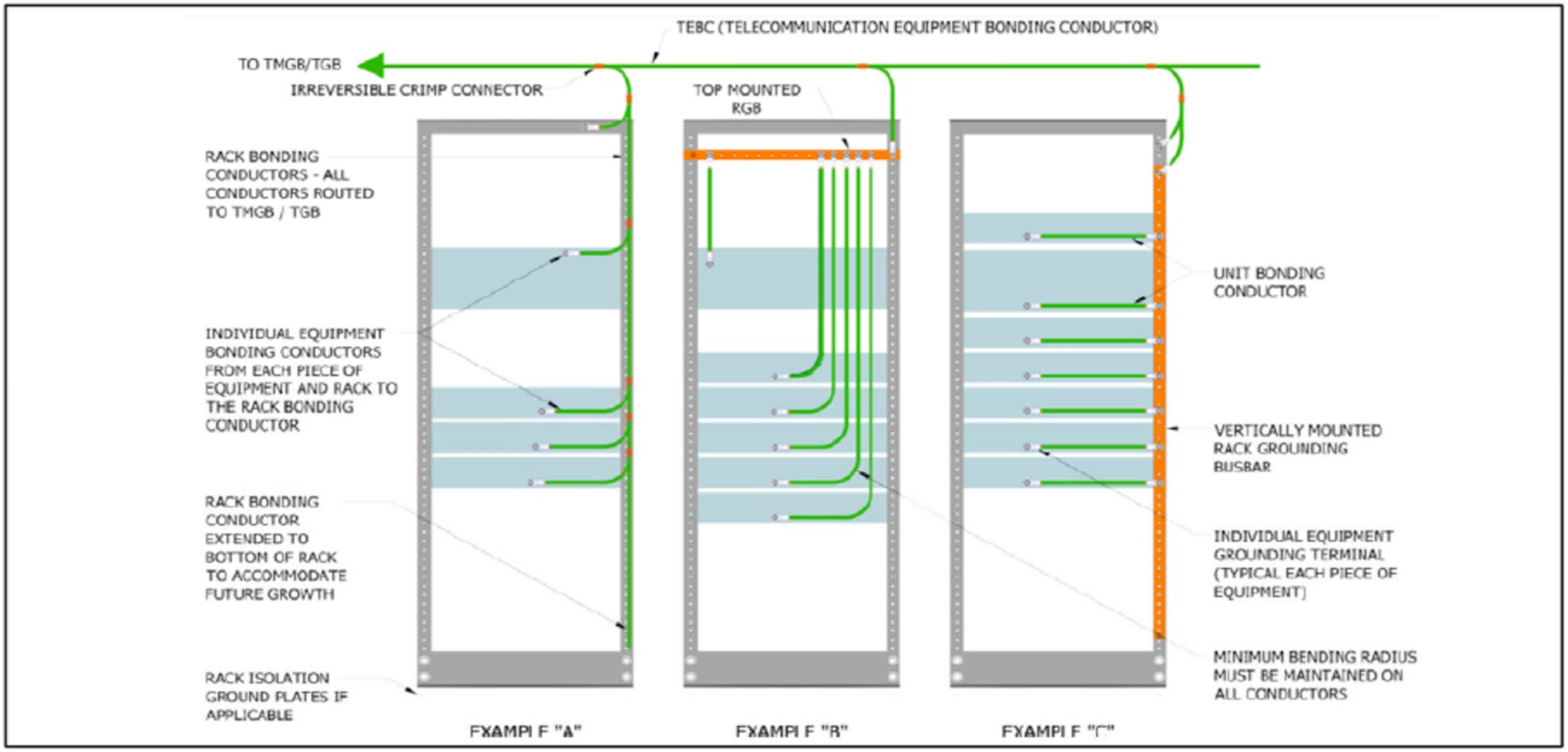


Illustration of a connection point to a Rack from a TECB

ANSI/NICA/BICSI 607:2011

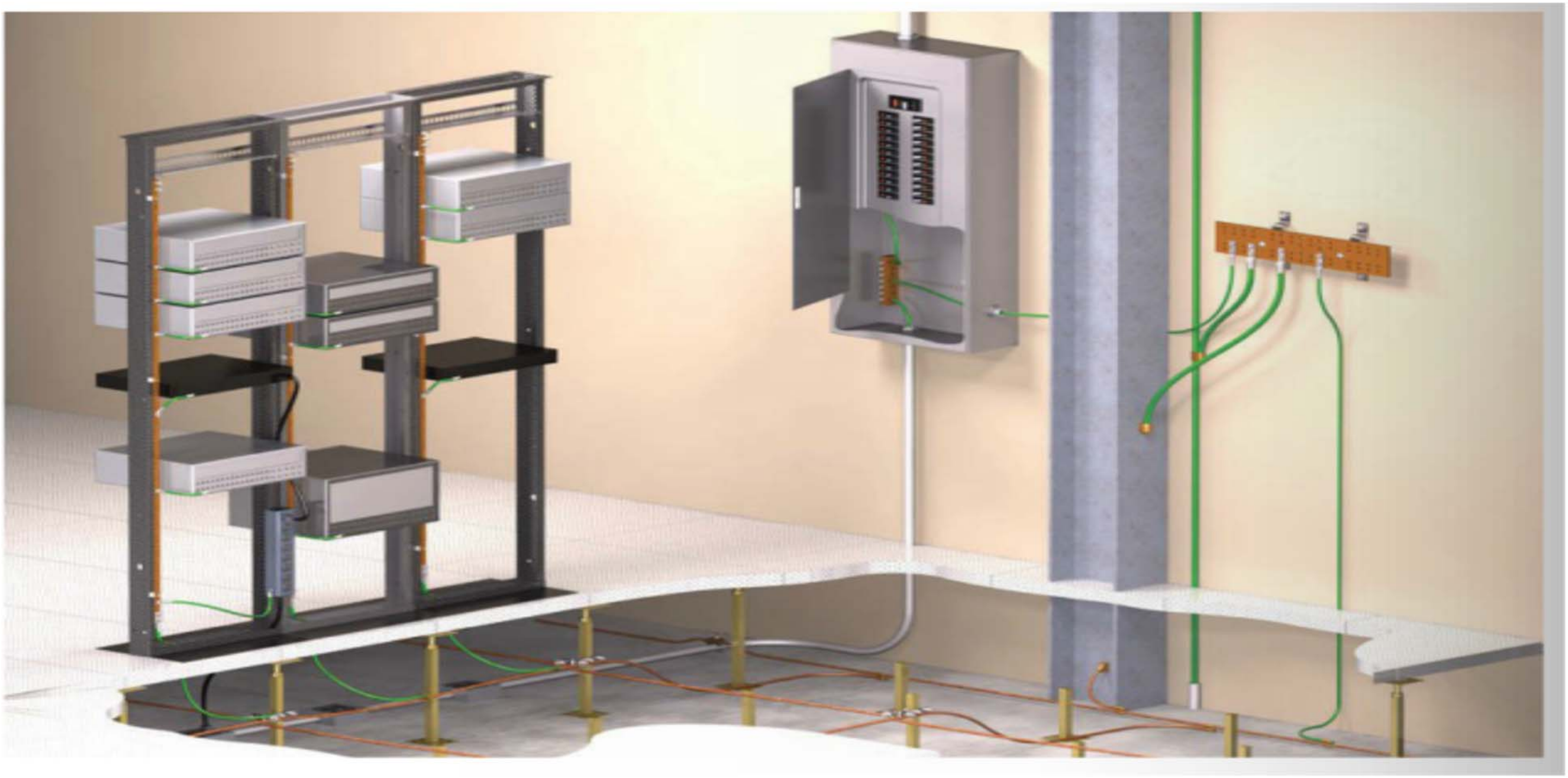
6. Sample – Rack Bonding Configuration



Three Methods to Bond Equipment & Racks to Ground

ANSI/NICA/BICSI 607:2011

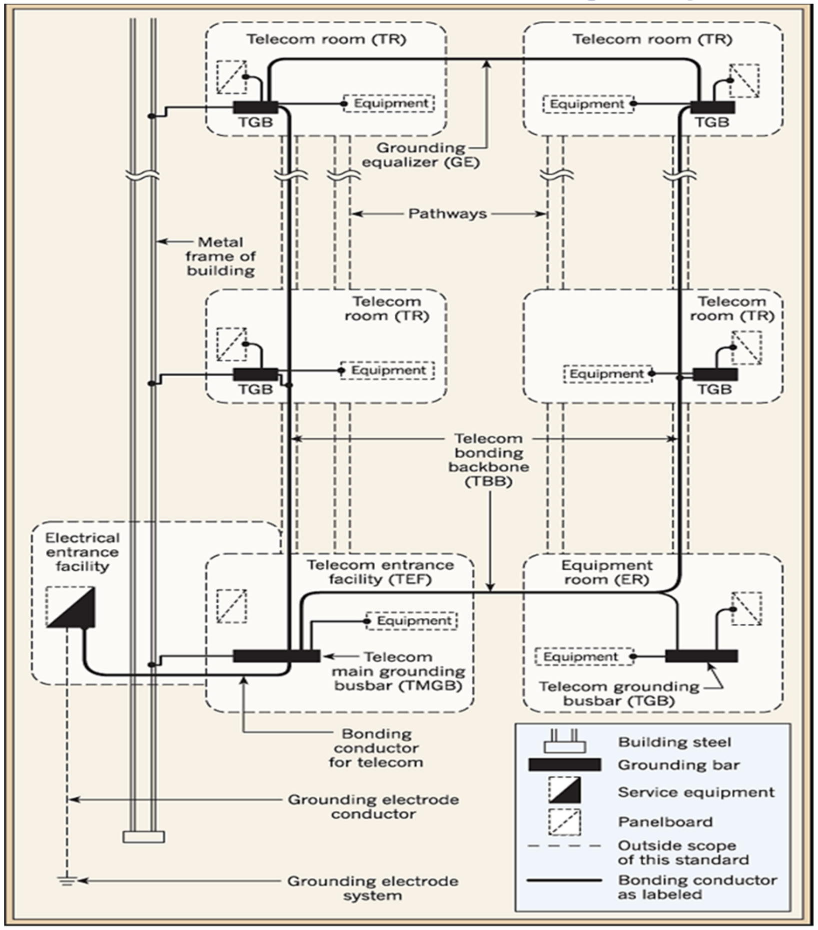
6. Sample – Rack Bonding Configuration



TMGB = Should be closest possible to the Electrical Panels – Bond Everything Metallic

ANSI/NICA/BICSI 607:2011

7. Set UP – Components of Grounding & Bonding System ISO/IEC Referenced



Note that on the ISO/IEC 30129 (released Oct 2015) Standard for Information Technology : Telecommunications Bonding Networks for Buildings and other structures – GEs (Also known as Bonding Equalizer) must be made every other 3 floors and the top floor.

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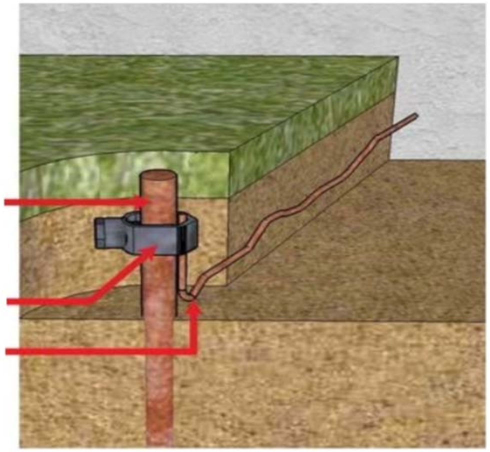
8. Sizing Up all Conductors – Main Bonding Conductors & Bonding Jumpers

Maximum TMGBB (PBB) to TGBB (SBB) Length (L) meters (feet)	Conductor cross-sectional area (minimum)	
	Nominal Int'l Conductor (mm2)	Nominal AWG Conductor
L ≤ 4m (13ft)	16	6
4 < L ≤ 6m (14 – 20ft)	25	4
6 < L ≤ 8m (21 – 26ft)	35	3
8 < L ≤ 10m (27 – 33ft)	35	2
10 < L ≤ 13m (34 – 41ft)	50	1
13 < L ≤ 16m (42 – 52ft)	60	1/0
16 < L ≤ 20m (53 – 66ft)	70	2/0
20 < L ≤ 26m (67 – 84ft)	95	3/0
26 < L ≤ 32m (85 – 105ft)	120	4/0
32 < L ≤ 38m (106 – 125ft)	150	250 kcmil
38 < L ≤ 46m (126 – 150ft)	150	300 kcmil
46 < L ≤ 53m (151 – 175ft)	185	350 kcmil
53 < L ≤ 76m (176 – 250ft)	250	500 kcmil
76 < L ≤ 91m (251 – 300ft)	300	600 kcmil
Greater than 91m (301ft)	400	750kcmil
For lengths in excess of those shown above, the conductor cross-sectional area should be calculated as 3.3mm2/m or 2kcmil/ft.		

TIA 607-B &
ISO/IEC 30129

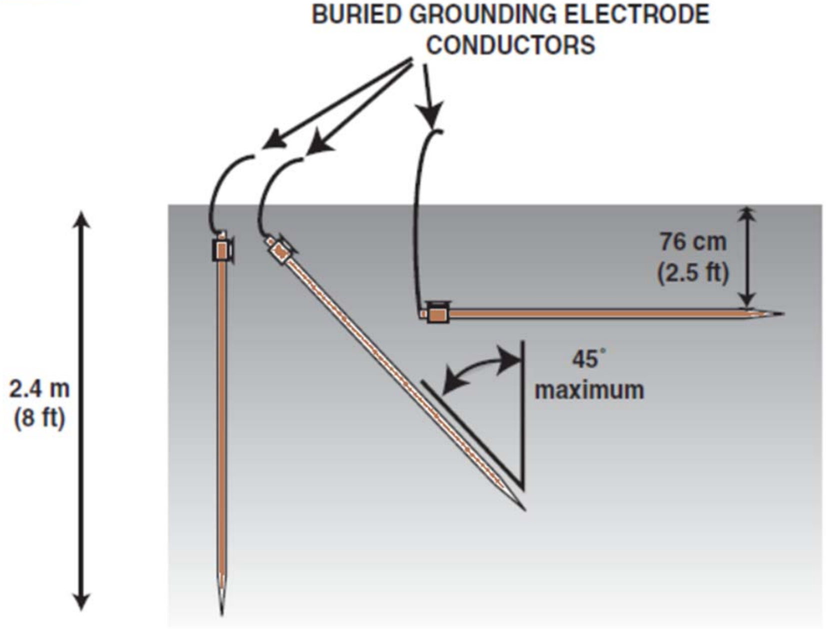
9. Sample Conductor – Main Grounding Electrode Conductor

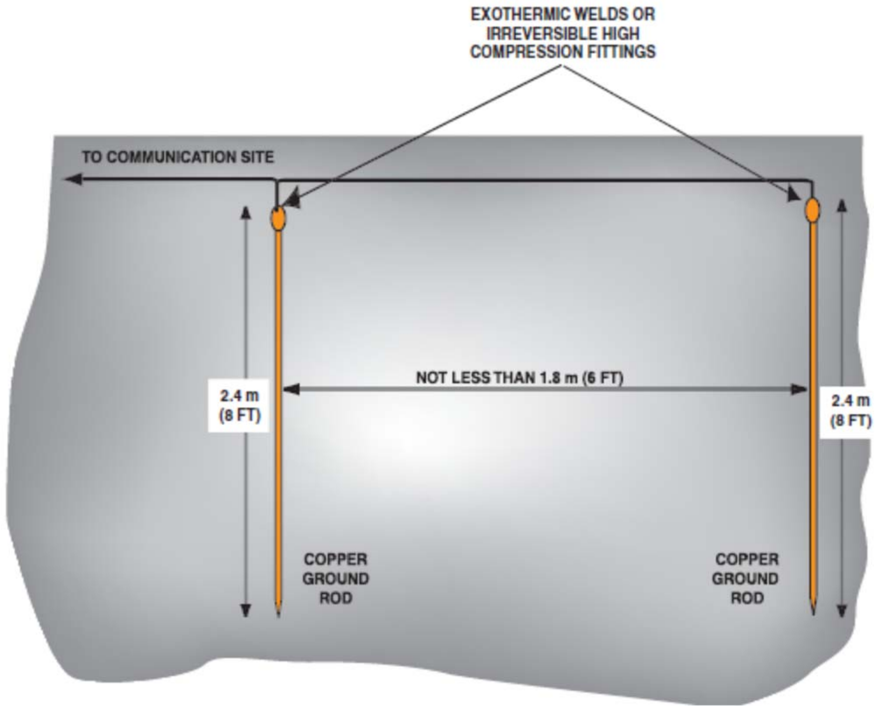
Grounding System Using Thermo-weld with Code Compliant Conductor Sizing



Grounding System Using Mechanical Connector with None Compliant Conductor Sizing

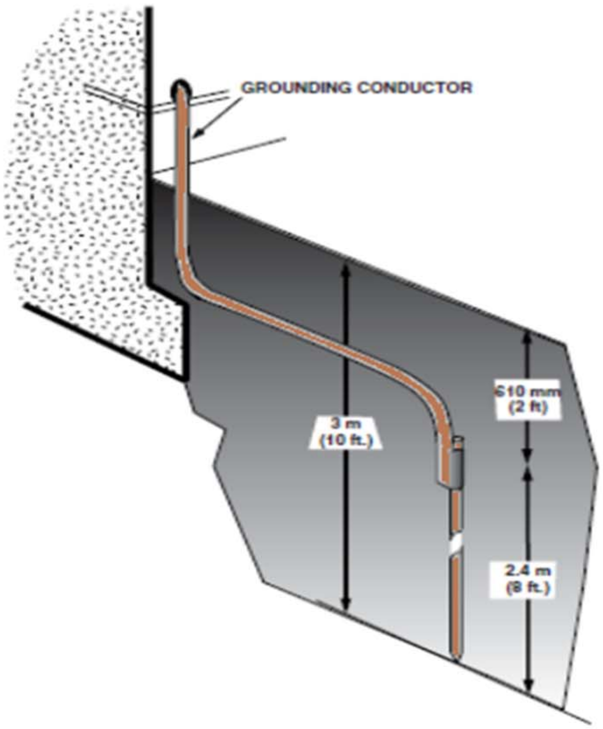
10. How to do It: – Main Grounding Electrode Optional Positions



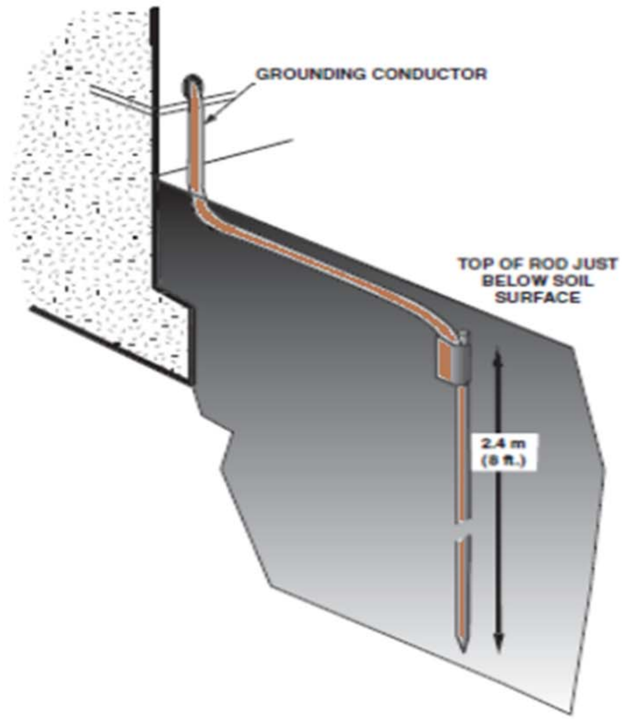


NPFA 70 = equal to the length of the Rod – minimum, with recommended spacing of <u>twice the length</u> of the Rod

10. How to do It: – Main Grounding Electrode Depth



RECOMMENDED DEPTH



MINIMUM DEPTH

11. Testing – What numbers to look at??

Typical Ground Resistance Requirements – Which one to Follow!

Type "A" Sites: (One Rod or Two Rods Grounding Systems)

- **NFPA 70:2017 (NEC) = One Rod - 25 Ohms or use two rods or more**
- **PEC 2009 = One Rod - 25 Ohms or use two rods or more**

11. Testing – What numbers to look at??

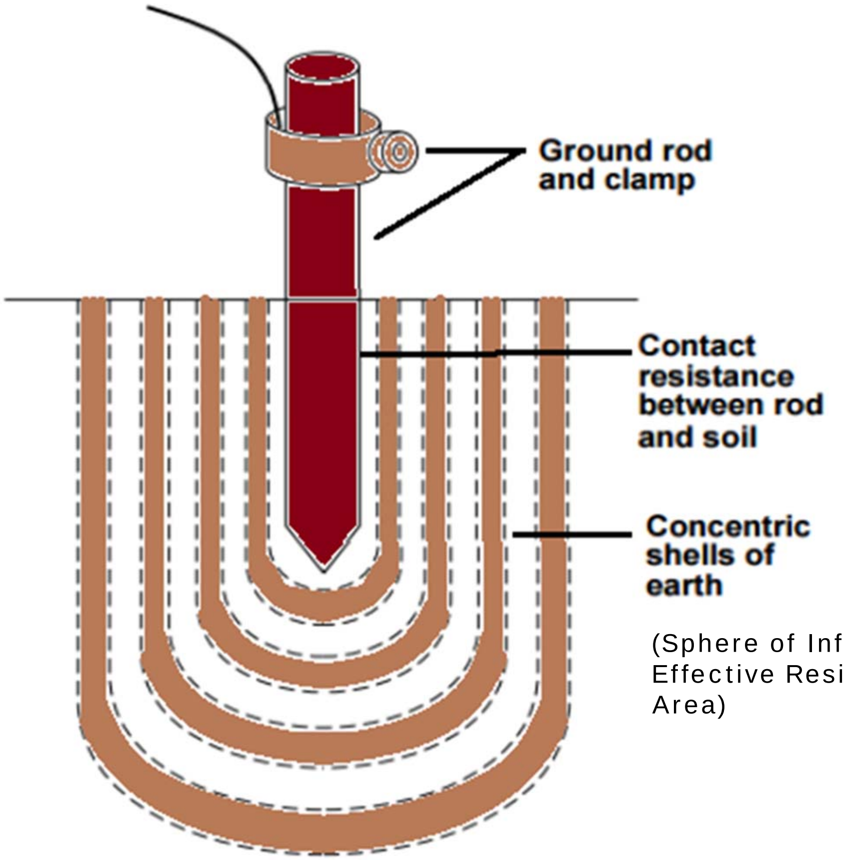
Typical Ground Resistance Requirements – Which one to Follow!

Type "B" Sites: (Two or more Rods Grounding Systems in ring/radial or special set up)

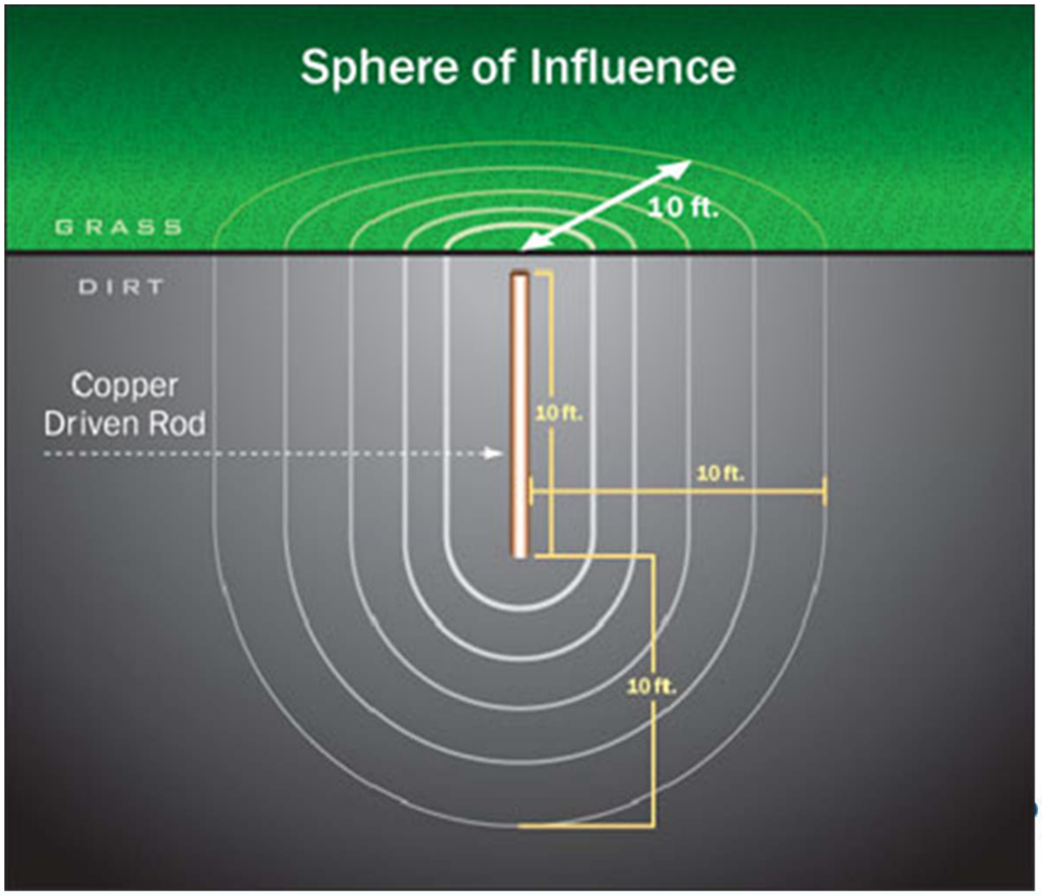
- **IEEE Standard 1100** = 1 Ohm (125Vac L-G) USA
  = 0.8 Ohm (277Vac L-G) USA
  = 0.8 Ohm (347Vac L-G) Canada
- **Motorola Standard R56** = 10 Ohms (Design Goal – 5 Ohms Recommended)
- **Telecommunications Cos** = 3 to 5 Ohms, Regional TELCOs Less than 10 Ohms
- **GE & Other Medical Systems** = 2 Ohms
- **ANSI/BICSI 002:2014** = 5 Ohms Maximum, but recommends
  3 Ohms for Class F2 & F3 DC, and
  1 Ohm for Class F4 Data Centers Design

- **DEWA - Dubai** = 1 Ohm (Section 5.2.4 – 1997Ed)
- **TEWR - Abu Dhabi** = 10 Ohms (Section 6.2.1a – 2014ed)

11. Testing – Components of Resistance in an Earth Electrode



(Sphere of Influence - Effective Resistance Area)



11. Testing – Option 1 = Fall of Potential Method

Reference: IEEE 81:2012 = Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System

How to Space the Current Probe from Electrode to be Tested?..... How Far!

On a Single Electrode

- **Minimum Distance = 5 Times the Length of the Rod**
- **Ideal? = 10 Times the Length of the Rod**

@ 10FT Rod, Current Probe = 100Feet Away

Note: In numerous test on soil with uniform soil resistivity it has been found that ground's resistance is at around 62% (some documents says at 61.8%) away from the rod under test!! Hence Fall of Potential Method is also known as 62% Method of Ground Resistance Testing.

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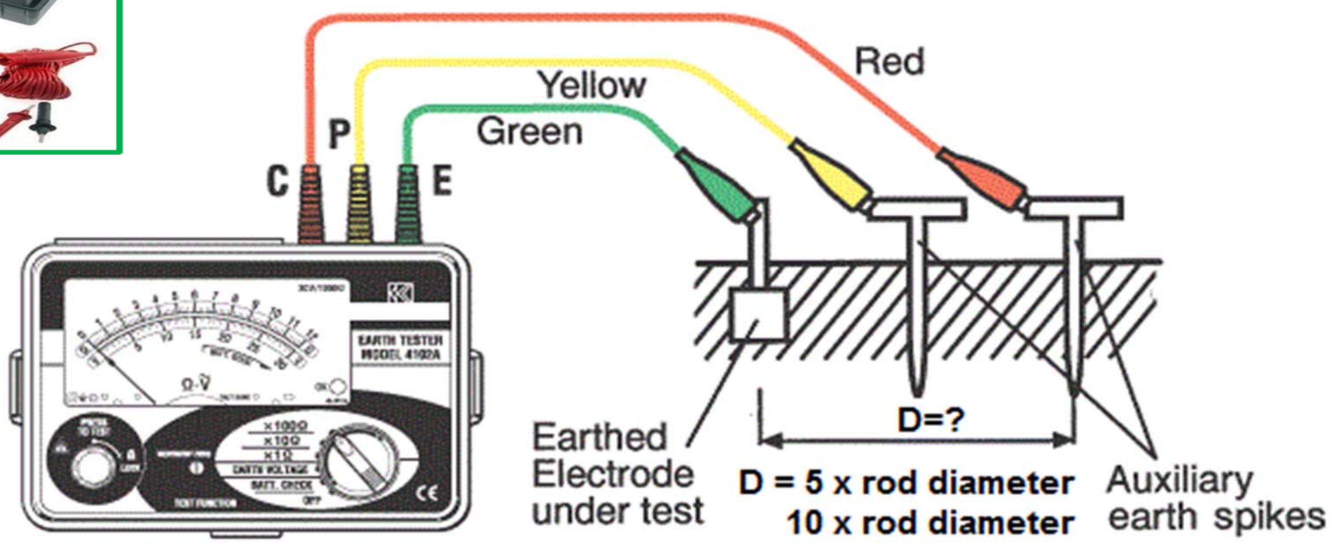
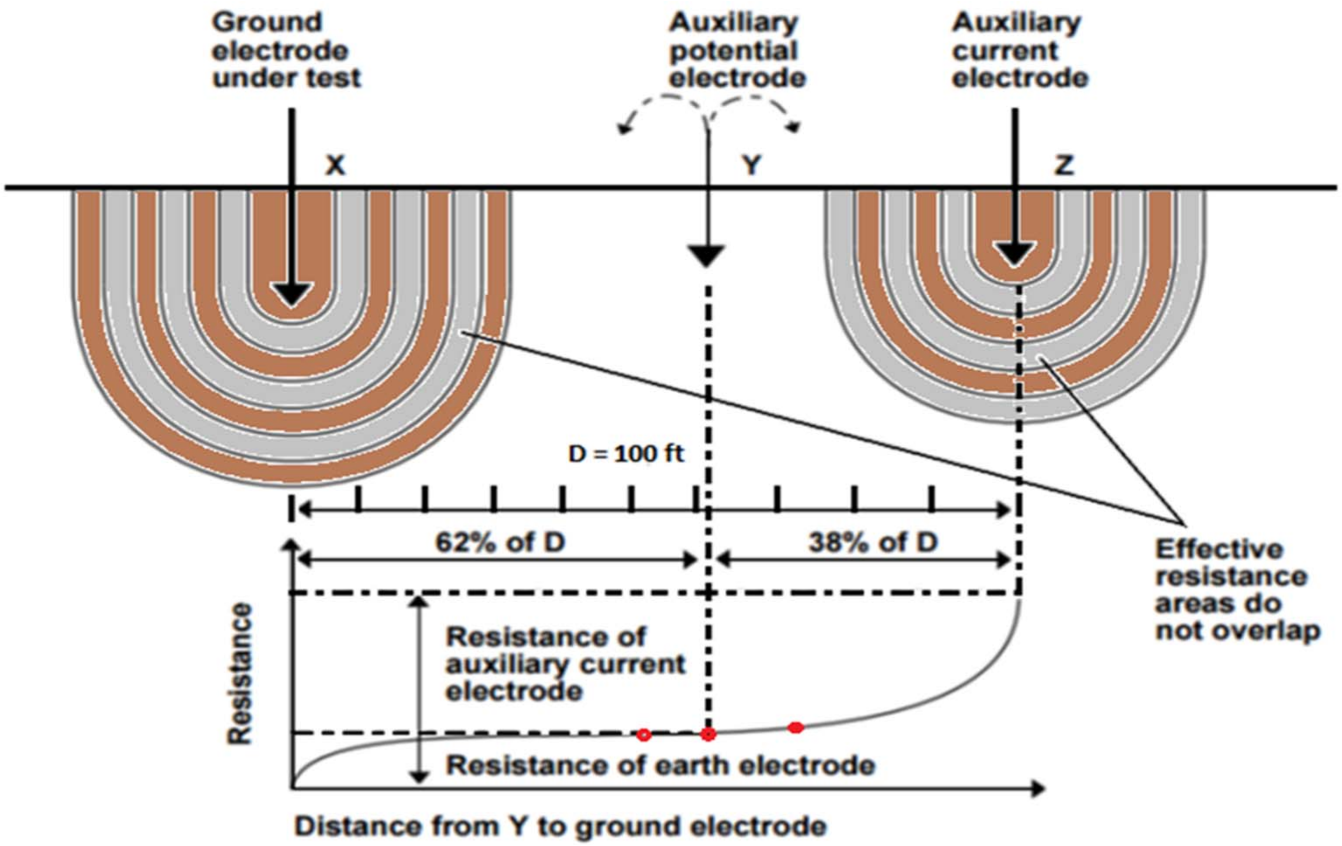
11. Testing – Option 1 = Fall of Potential Method

Test Instrument:
Earth/Ground Tester

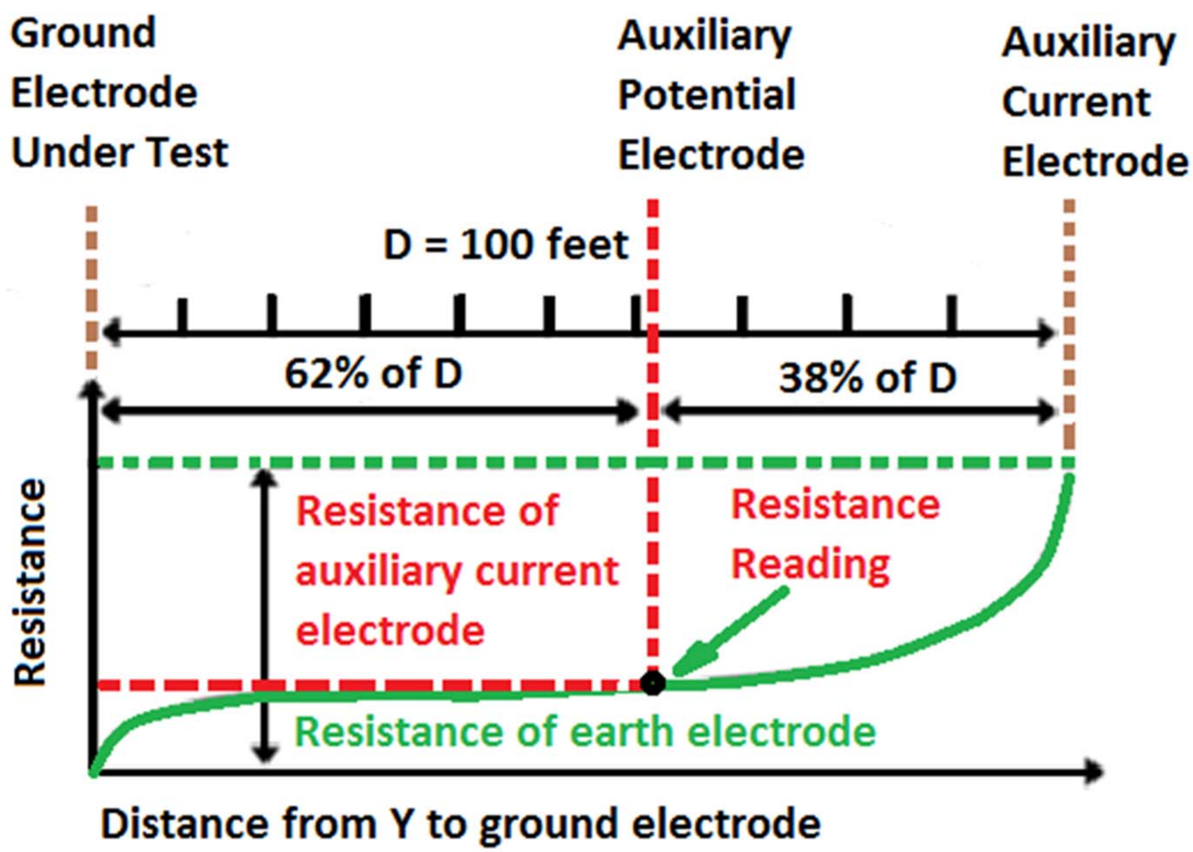


Note: NFPA 70, PEC & IEEE 81 requires Ground Rod minimum size of ¾"diameter x 10ft long (19mm x 3000mm)

11. Testing – Option 1 = Fall of Potential Method



11. Testing – Option 1 = Fall of Potential Method



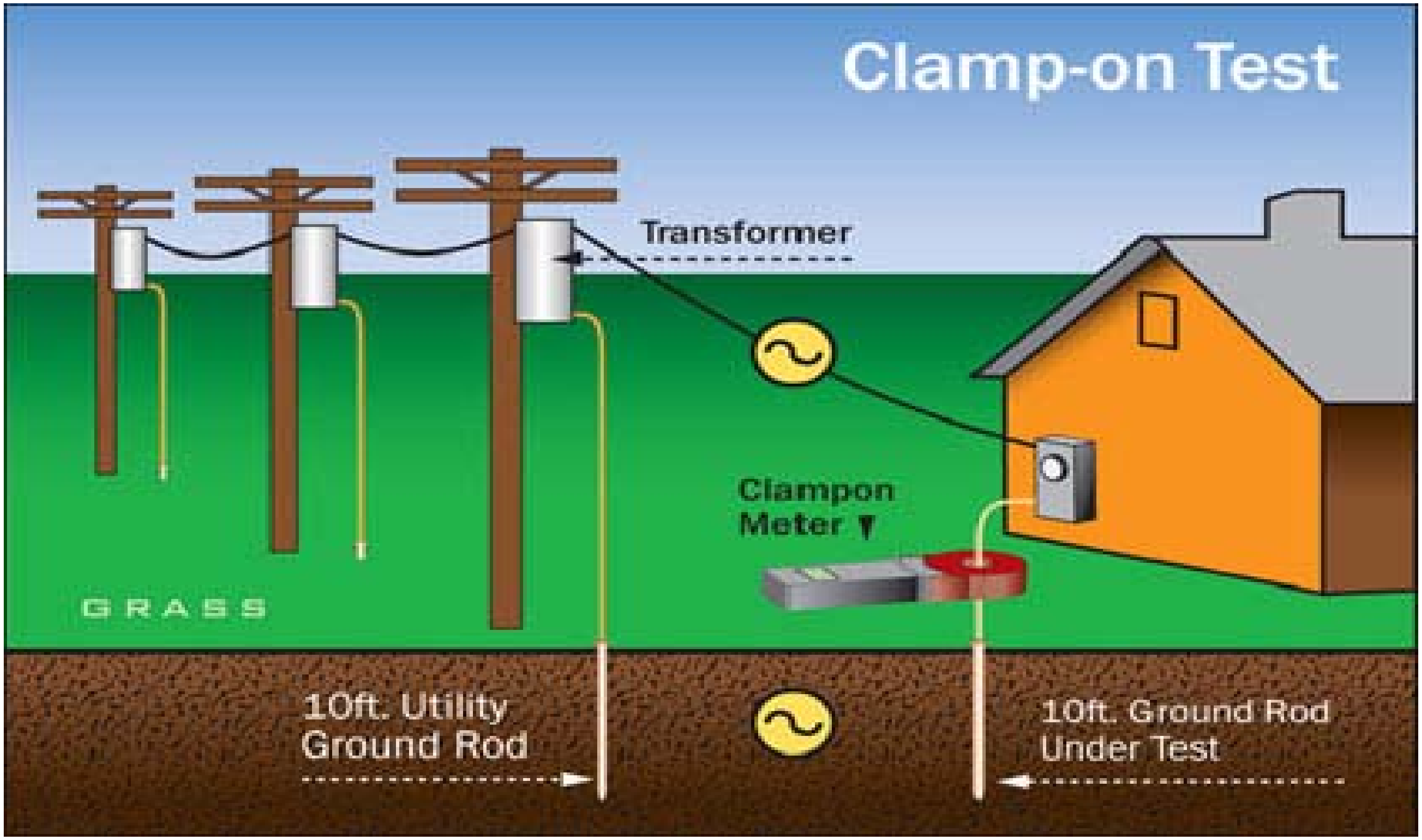
11. Testing – Option 2 = Clamp-on Testing Method

Clamp-on Ground Resistance Meter

* Does Not Require Disconnecting Equipment
* Measures Current on the Ground to get Ground Resistance,
* Referenced with Pole Butt Proper and consistent resistance, and
* Very Convenient, Quick & Easy

However, it will most likely read Ground Loops instead of Ground Resistance!!

11. Testing – Option 2 = Clamp-on Testing Method



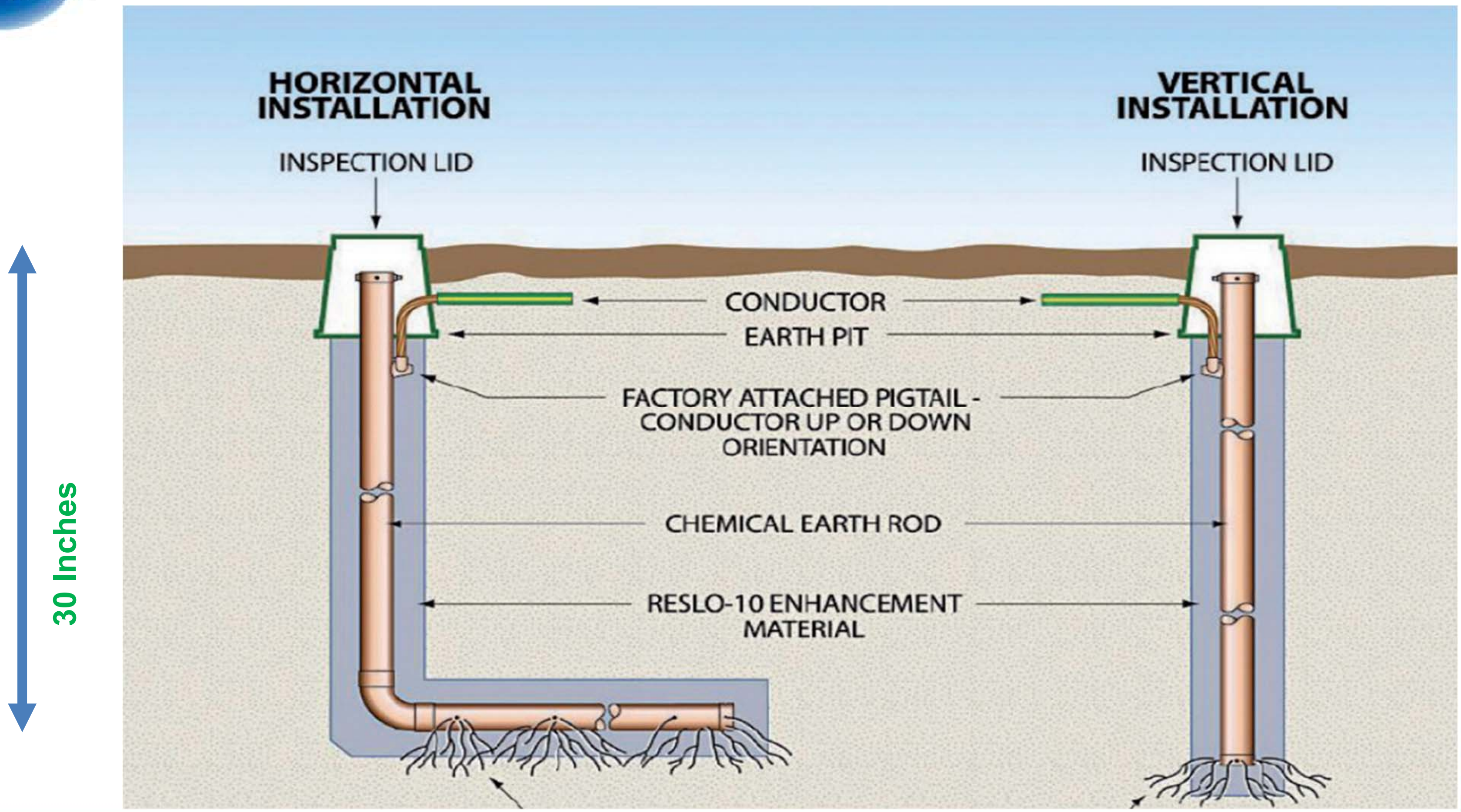
12. Area with Poor Soil Conductivity

Option 1: Electrolytic Grounding Rod Systems

- **Commercially available electrolytic ground rods should be considered.** (MIL-HDBK-419A Volume I, and UL 467-2013)

- **These are in straight or L-shaped versions. Generally constructed of 54 mm (2.125 in.) dia. hollow copper pipe and filled with a mixture of non-hazardous natural earth salts.**

12. Area with Poor Soil Conductivity



12. Area with Poor Soil Conductivity

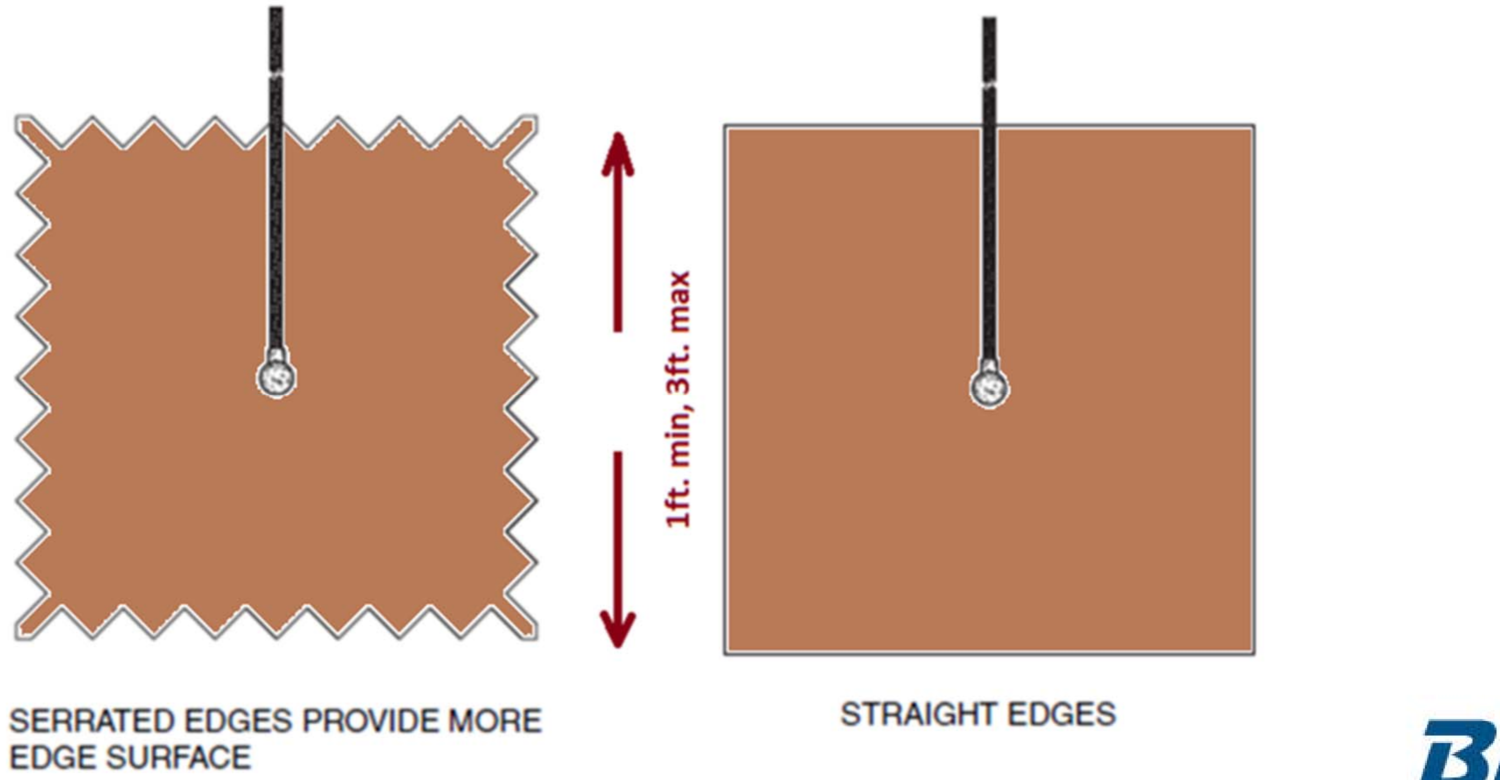
Option 2: Copper Plates Grounding Systems

Requirements and use of ground plate electrodes are as follows:

- **It shall be buried not less than 762 mm (30 in.) below the surface of the earth (NFPA 70-2017).**
- **Where practical, a ground plate shall be embedded below permanent moisture level (BS 7430:1998, & NFPA 70-2017).**
- **Ground plates should be installed vertically to allow for minimum excavation and better contact with the soil when backfilling (BS 7430:1998 and IEEE STD 142-1991)**

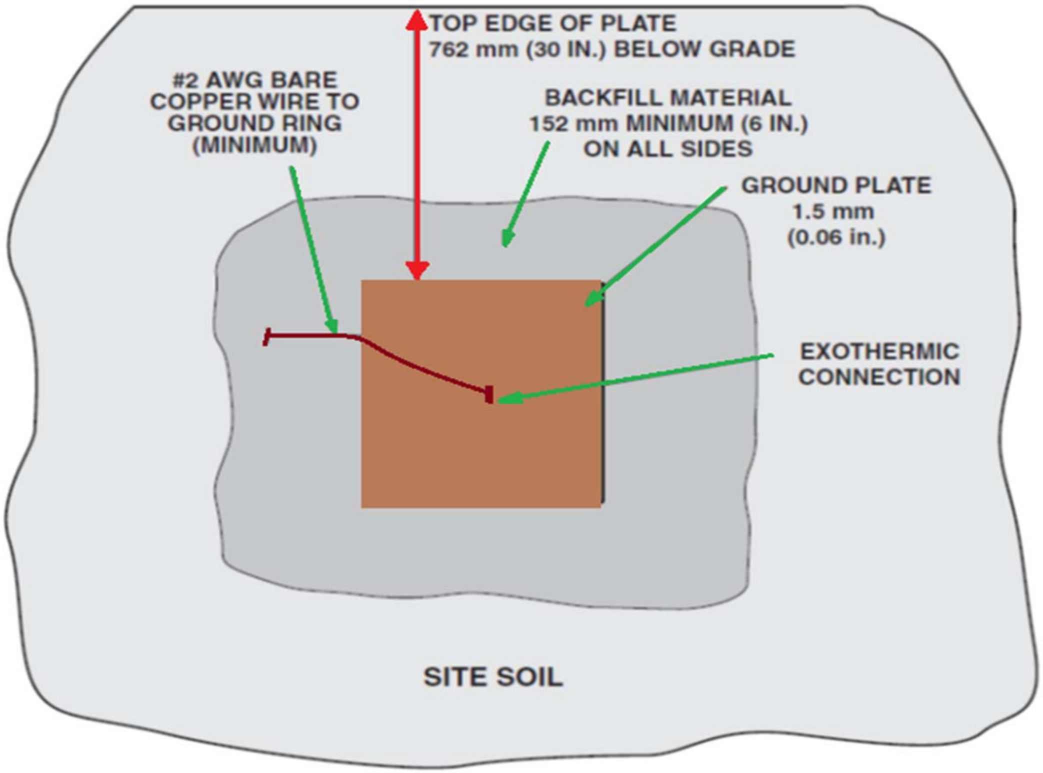
12. Area with Poor Soil Conductivity

Option 2: Copper Plates Grounding Systems



12. Area with Poor Soil Conductivity

Option 2: Copper Plates Grounding Systems



12. Area with Poor Soil Conductivity

Option 2: Copper Plates Grounding Systems

Ground Plate
Installed in
Horizontal layout

12. Area with Poor Soil Conductivity

Option 3: Ufer Grounding Systems – Concrete Encasement

- Though concrete-encased electrodes (also known as Ufer electrodes, or foundation earth electrodes - named after Herbert G. Ufer,), they should be used in new construction as a method of supplementing the grounding electrode system (IEC 62305-3).

- It enhance the effectiveness of the grounding electrode system in two ways:
  * the concrete absorbs and retains moisture from the surrounding soil, and

  * the concrete provides a much larger surface area in direct contact with the surrounding soil. (This is especially helpful at sites with limited area for installing a grounding electrode system).

- See IEEE STD 142-1991 section 4.2.3, and the International Association of Electrical Inspectors publication, Soares Book on Grounding and Bonding, 9th Edition, for added information.

12. Area with Poor Soil Conductivity

Option 3: Ufer Grounding Systems – Concrete Encasement

Requirements for a concrete encased electrode, if used, are listed as follows (IEC 62305-3, NFPA 70-2017, and NFPA 780-2017):

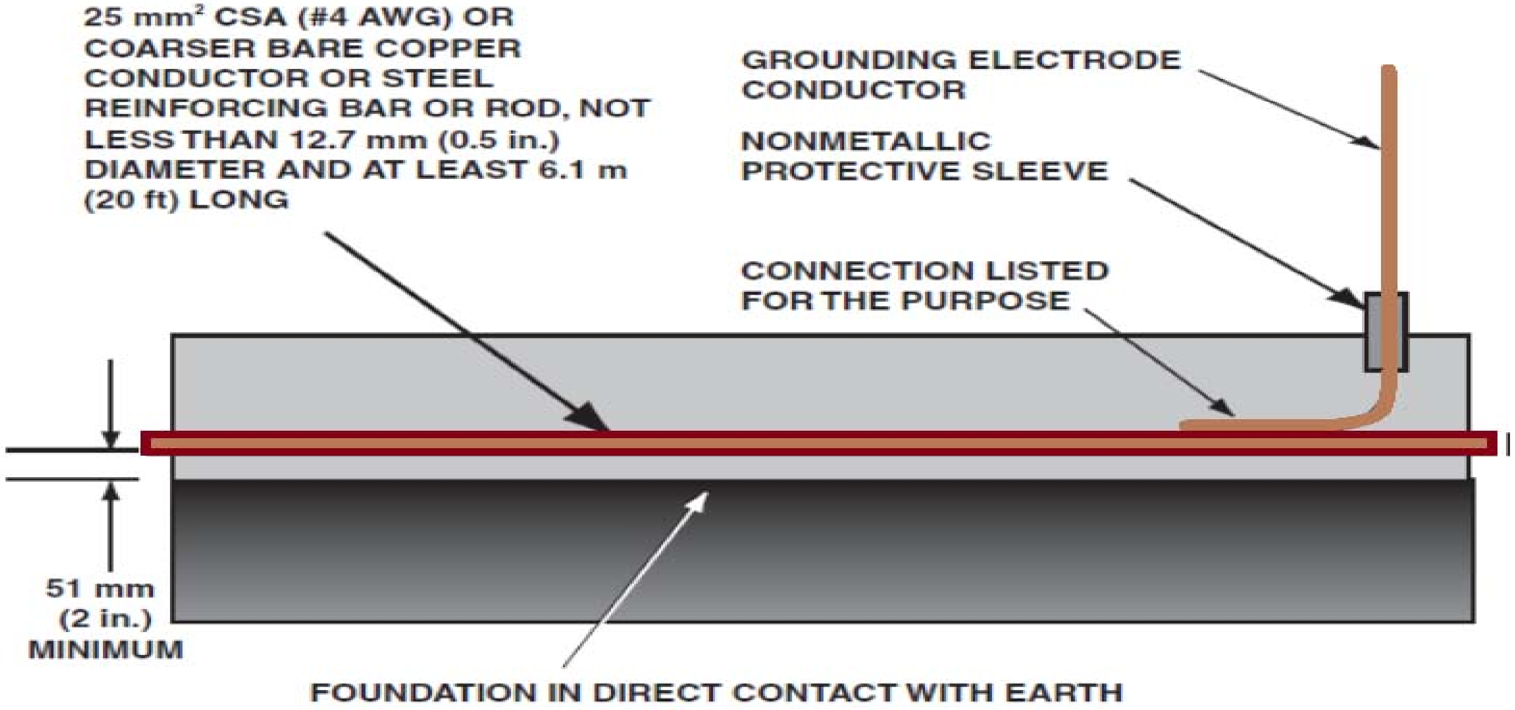
- **Concrete-encased electrodes shall be encased by at least 51 mm (2 in.) of concrete, located within and near the bottom of a concrete foundation or footing that is in direct contact with the earth (or ground).**

- **It shall be at least 6.1 m (20 ft.) of bare copper conductor not smaller than 25 mm2 (#4 AWG) or at least 6.1 m (20 ft.) of one or more bare or zinc galvanized or other conductive coated steel reinforcing bars, or rods at least 12.7 mm (0.5 in.) in diameter.**

- **And, shall be bonded to any other grounding electrode system at the site as per NFPA 70-2017.**

12. Area with Poor Soil Conductivity

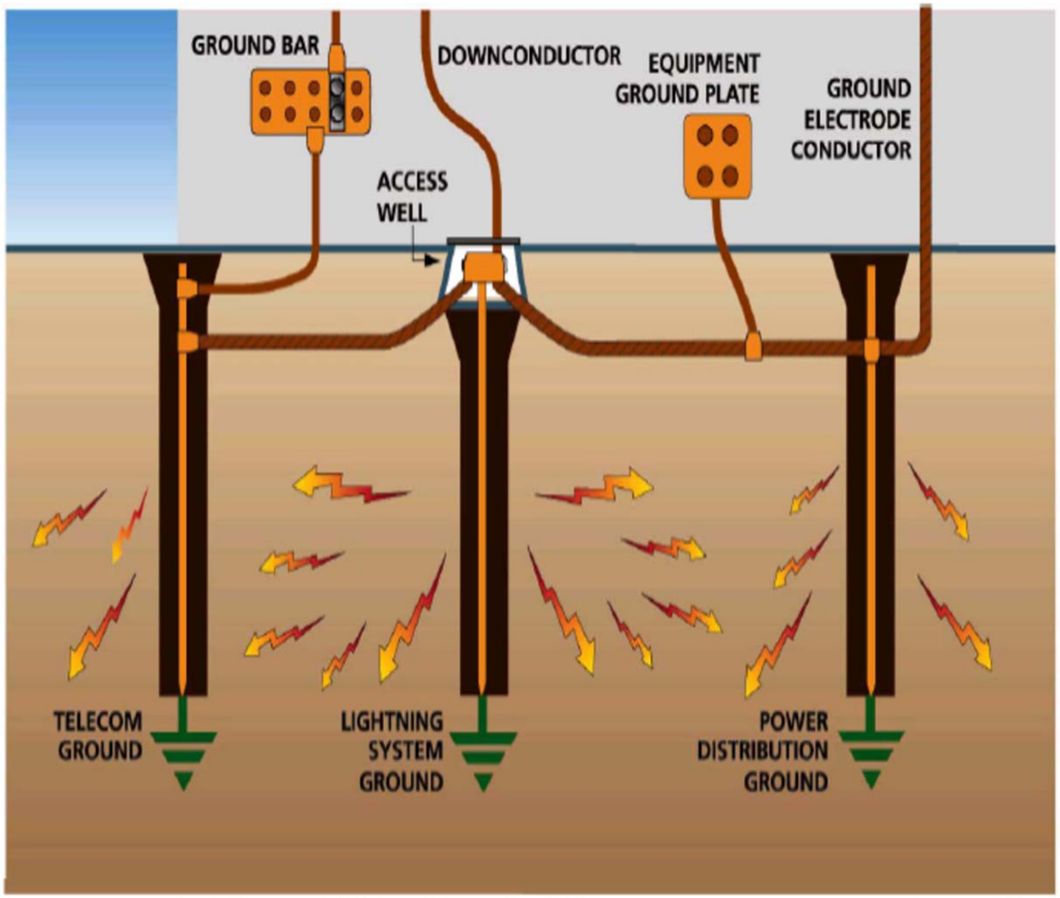
Option 3: Ufer Grounding Systems – Concrete Encasement



13. Summary = Bond it Together

NFPA 70:2017
Art 800 Communication Circuits
Section: 800.100(D)

Bonding of Electrodes. A bonding jumper not smaller than **6AWG (14mm2)** copper or equivalent shall be connected between the communications grounding electrode and power grounding electrode system at the building or structure served where separate electrodes are used.



14. Further Reading References in Areas with Poor Conductivity Soil Conditions

BS 7430:2011 (Code of Practice for Protective Earthing of Electrical Installations)

ISO/IEC 62305-3 (Protection of Structure Against Lightning)

IEEE 142:2007 (Green Book – Grounding of Industrial & Commercial Power Systems)

Motorola R56 (Standards & Guidelines for Communication Sites)

MIL-HDBK-419A (Military Handbook Grounding, Bonding & Shielding for Electronic Equipment & Facilities)

MIL-UFC-3-580-01:2016 (Military Unified Facility Command Telecommunications Interior Infrastructure Planning & Design)

MIL-I3A Standard 2016 (Military Technical Criteria for the Installation Information Infrastructure & Architecture)

UL – 469:2013 (Grounding & Bonding Equipment)

BICSI

15. Where to Buy Codes & Manuals

www.bicsi.org

www.iso.org

www.global.ihs.com

www.tiaonline.org

Telecommunication Grounding & Bonding

Thanks a Lot
Q & A

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