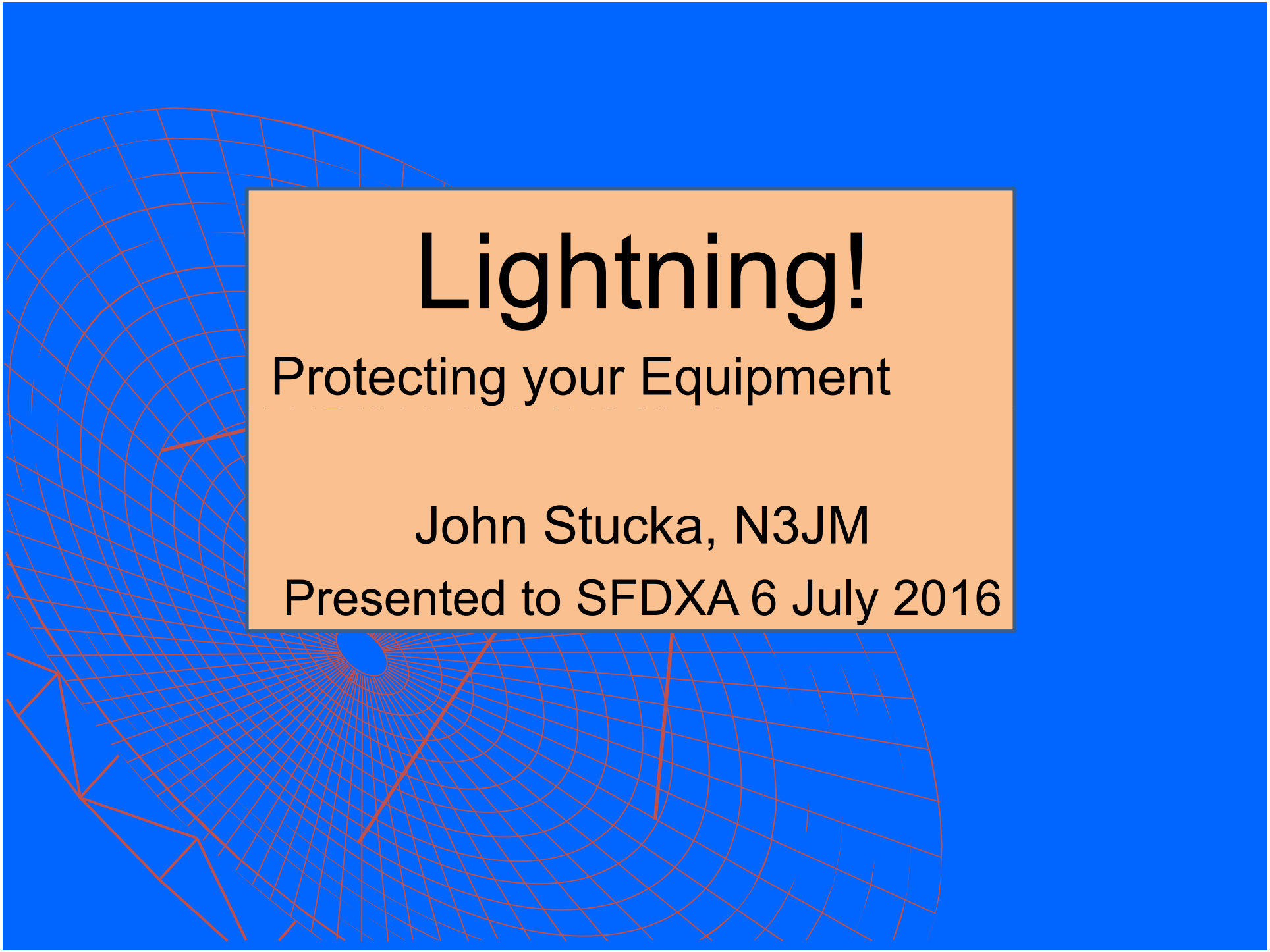

Lightning!
Protecting your Equipment
John Stucka, N3JM
Presented to SFDXA 6 July 2016


ANT 3
ANT 2
ANT 1
CONTROL

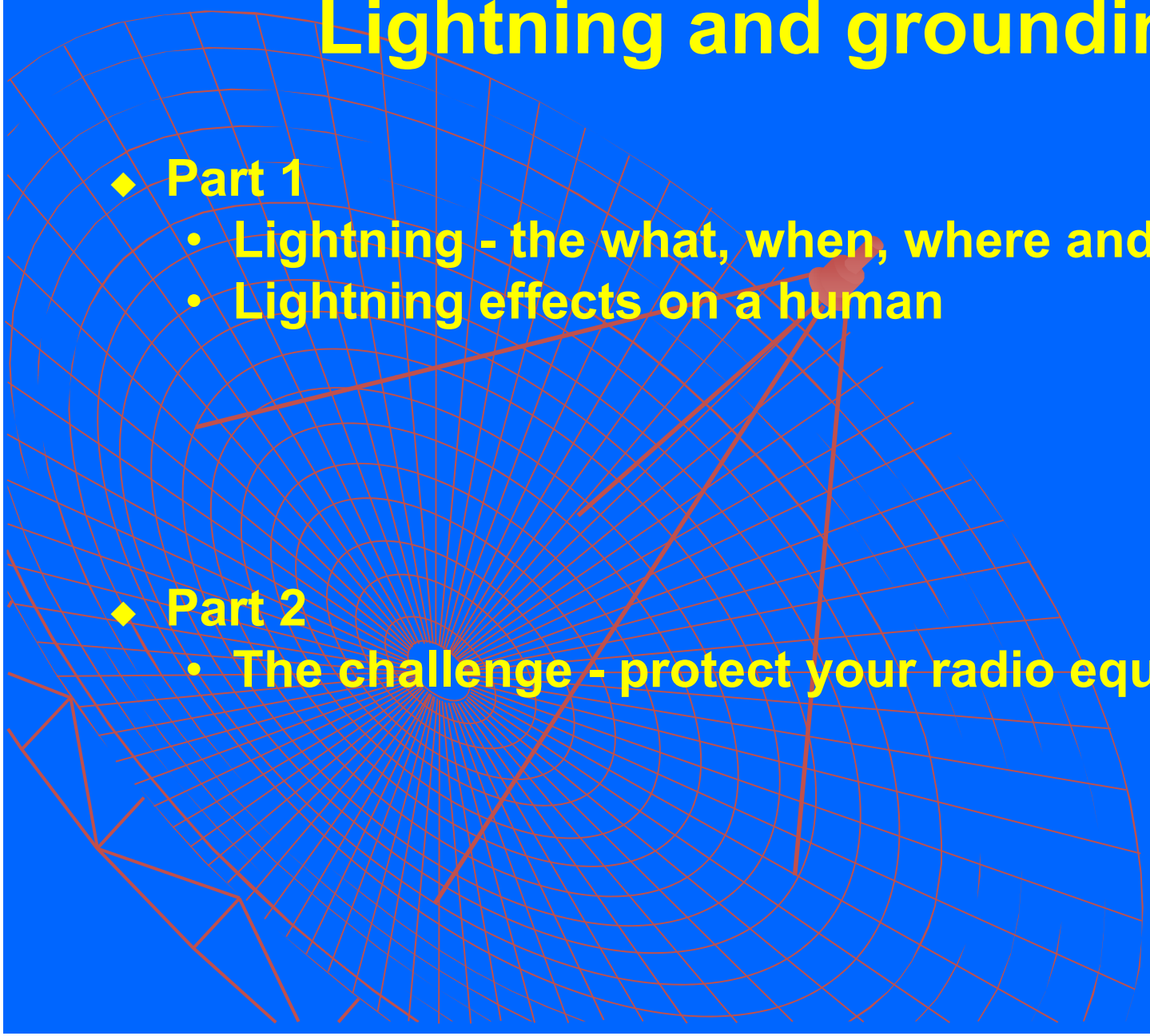

023-1023

Disclosure

Have no relevant financial relationships or conflicts of interest with commercial interests related directly or indirectly to this educational activity.

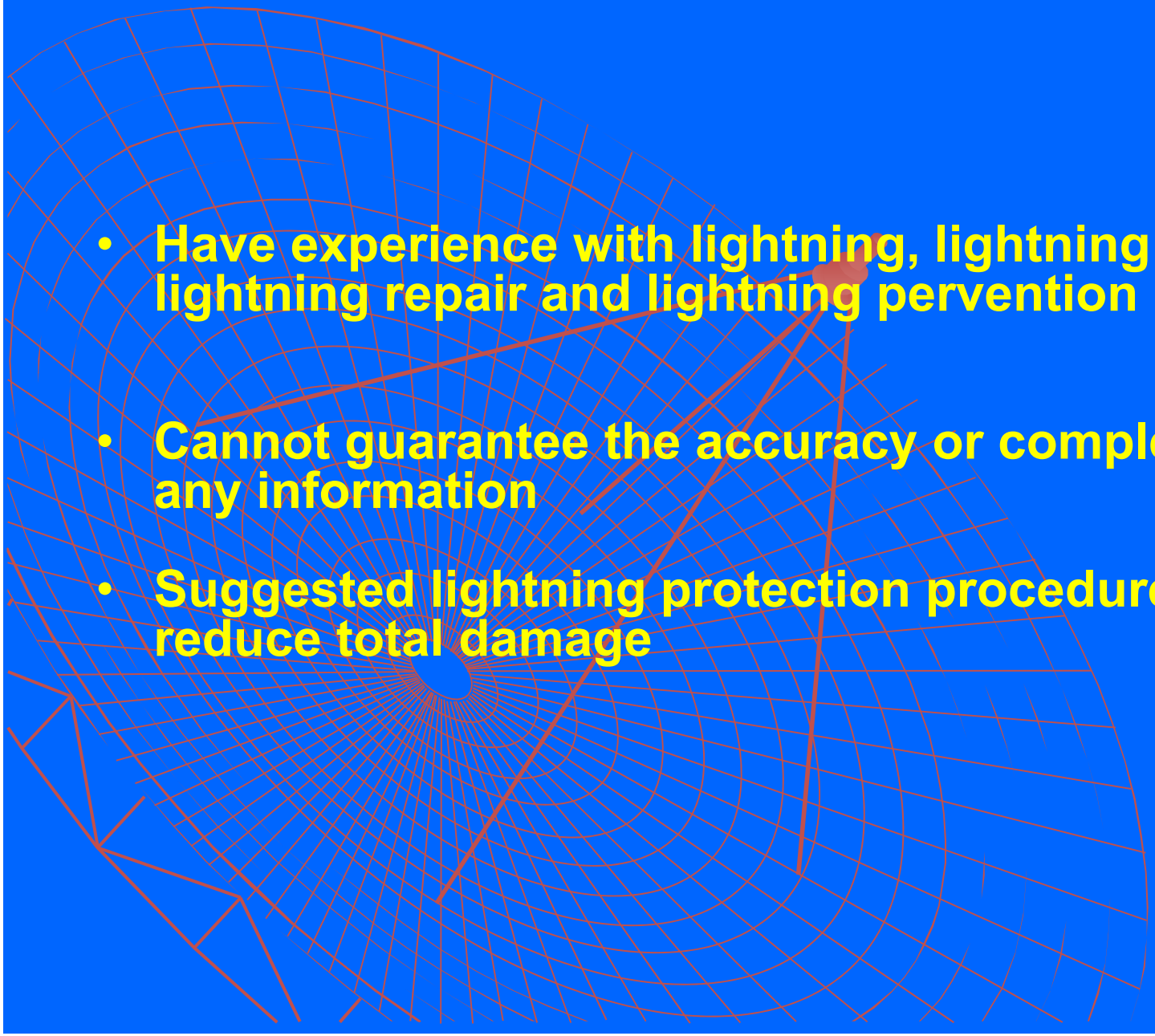

Do not bend
circuit board
U1
U4
U5
J4
SP1
BATTERY IS REPLACED
INCORRECT TYPE.
OF USED BATTERIES ACCORDING
INSTRUCTIONS

Lightning and grounding

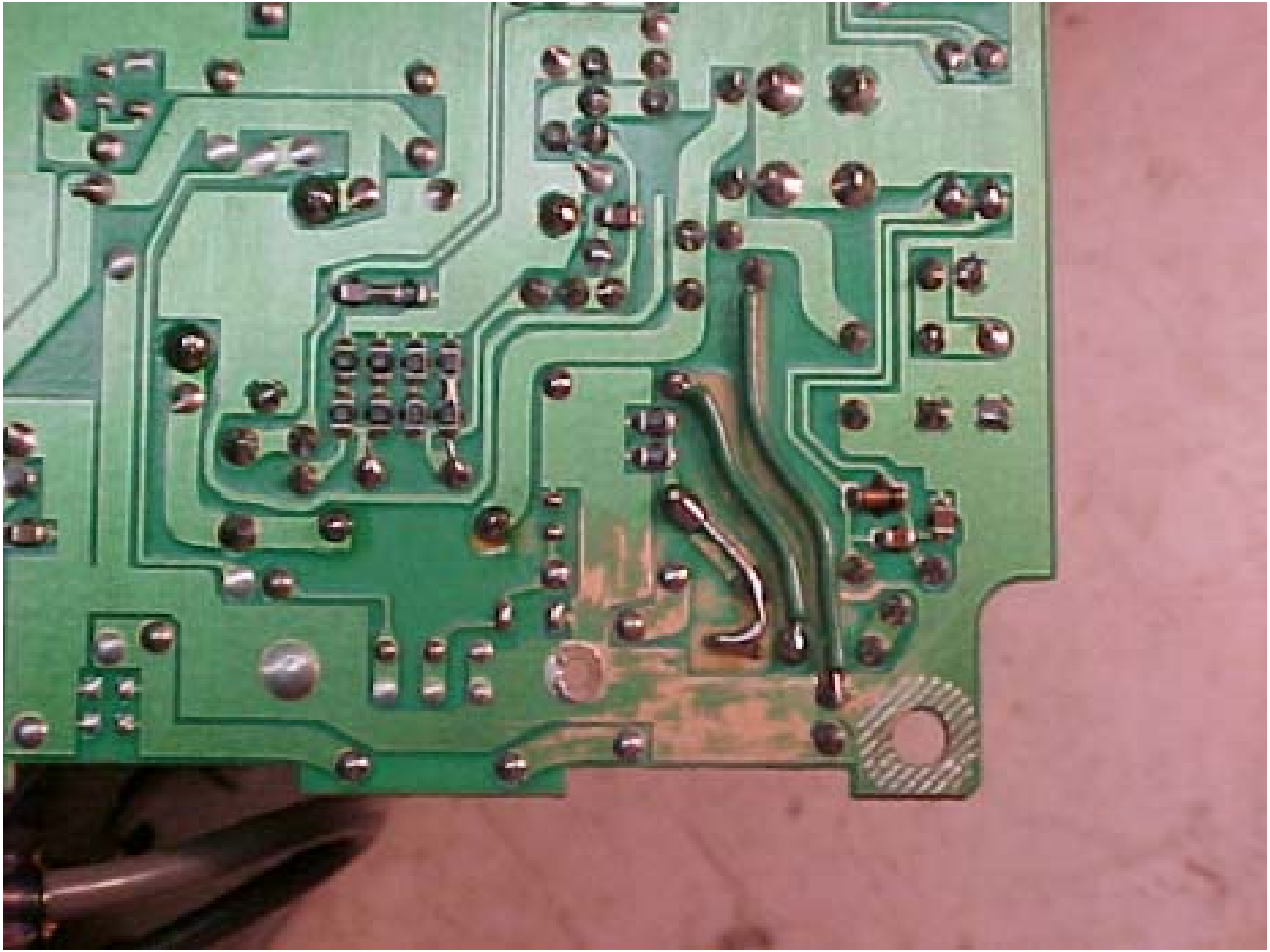


- Part 1
  - Lightning - the what, when, where and how
  - Lightning effects on a human
- Part 2
  - The challenge - protect your radio equipment

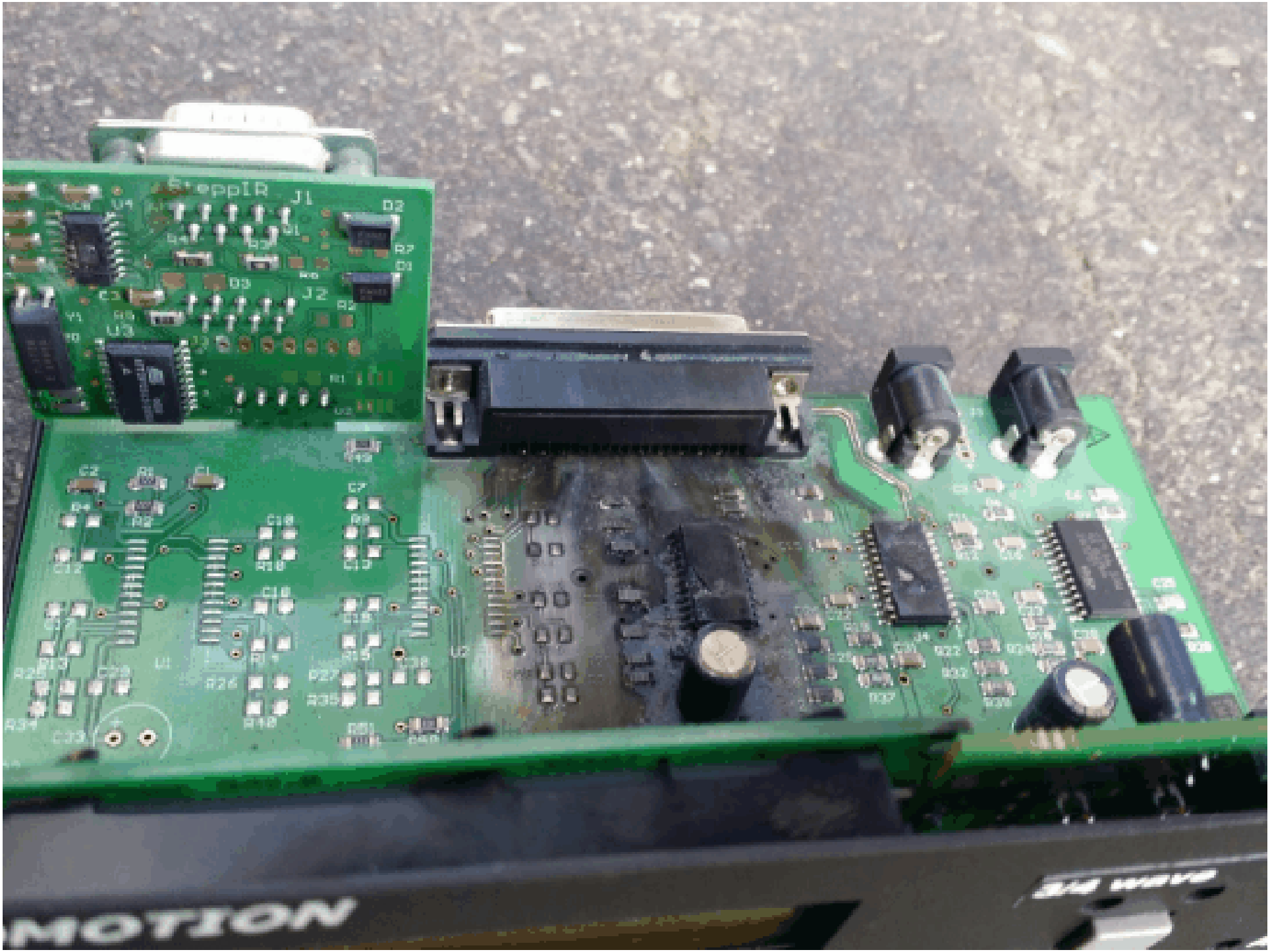
Disclaimer

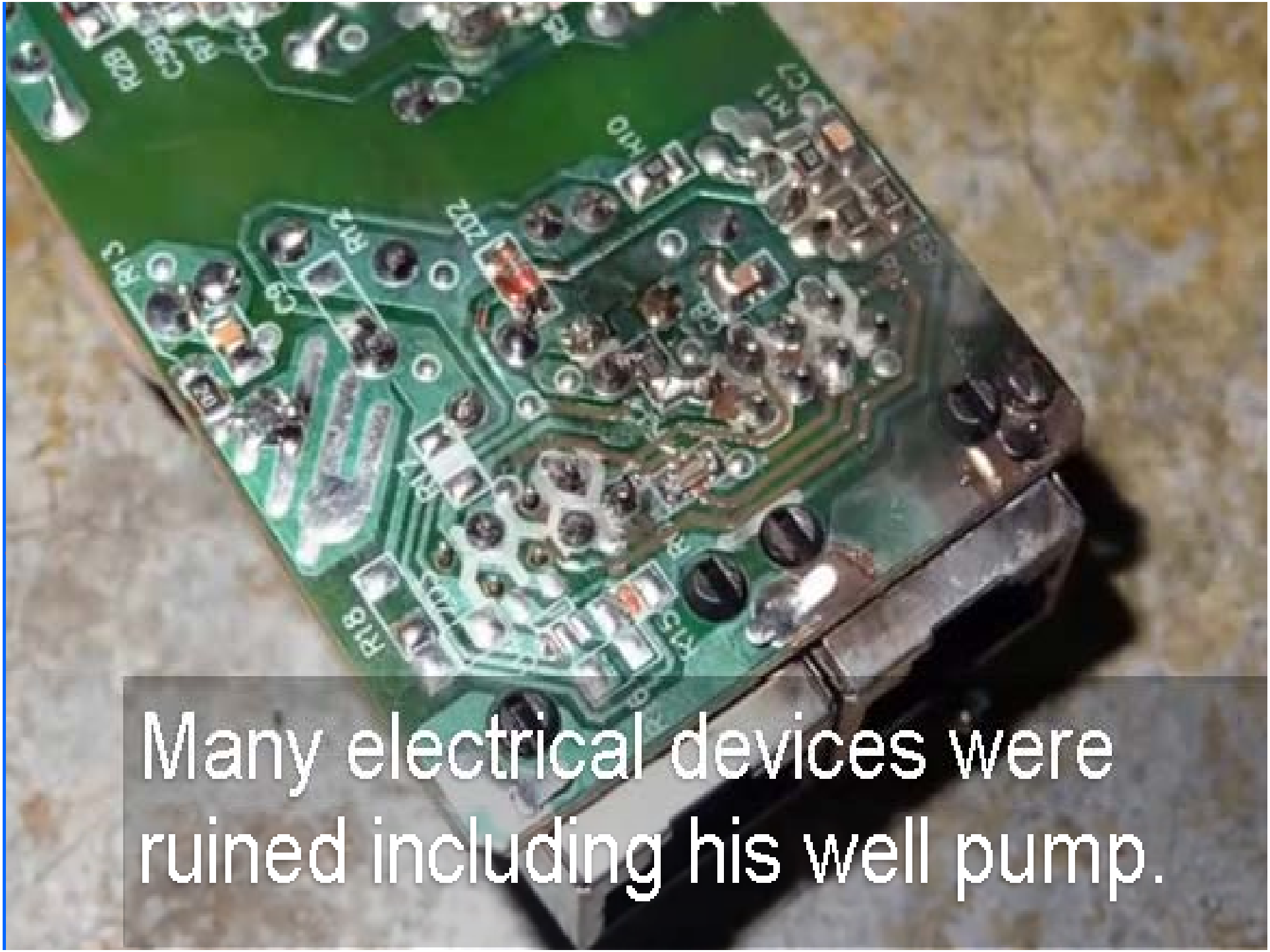


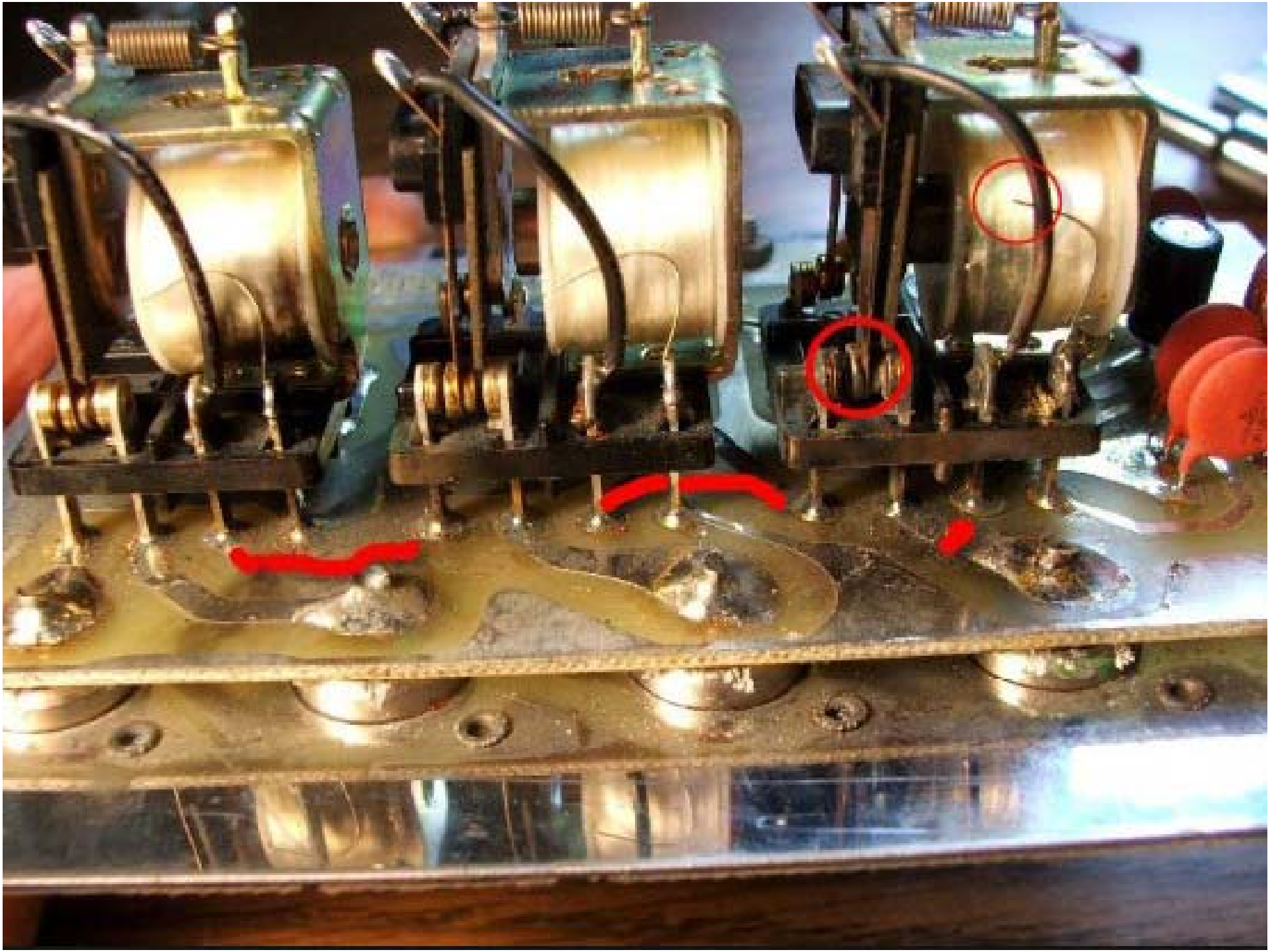
- Have experience with lightning, lightning damage, lightning repair and lightning pervention
- Cannot guarantee the accuracy or completeness of any information
- Suggested lightning protection procedures may reduce total damage



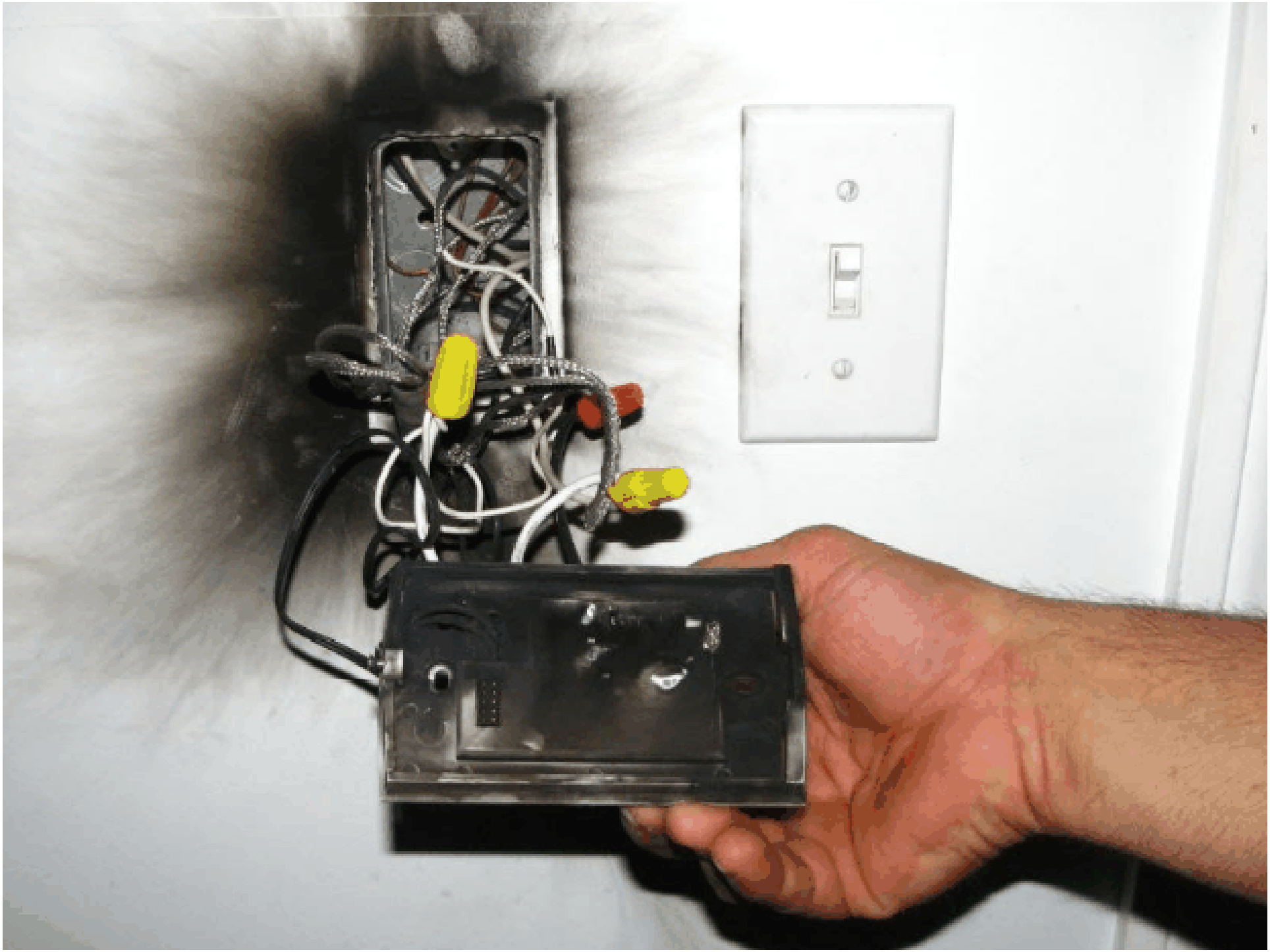
nichicon
F 2.2μF D(K)
400W.V D.C


StreppIR
J1
J2
D1
D2
D3
R7
MOTION


Many electrical devices were ruined including his well pump.




Hole in radio room cement floor.




Ham Radio Antenna Mast.

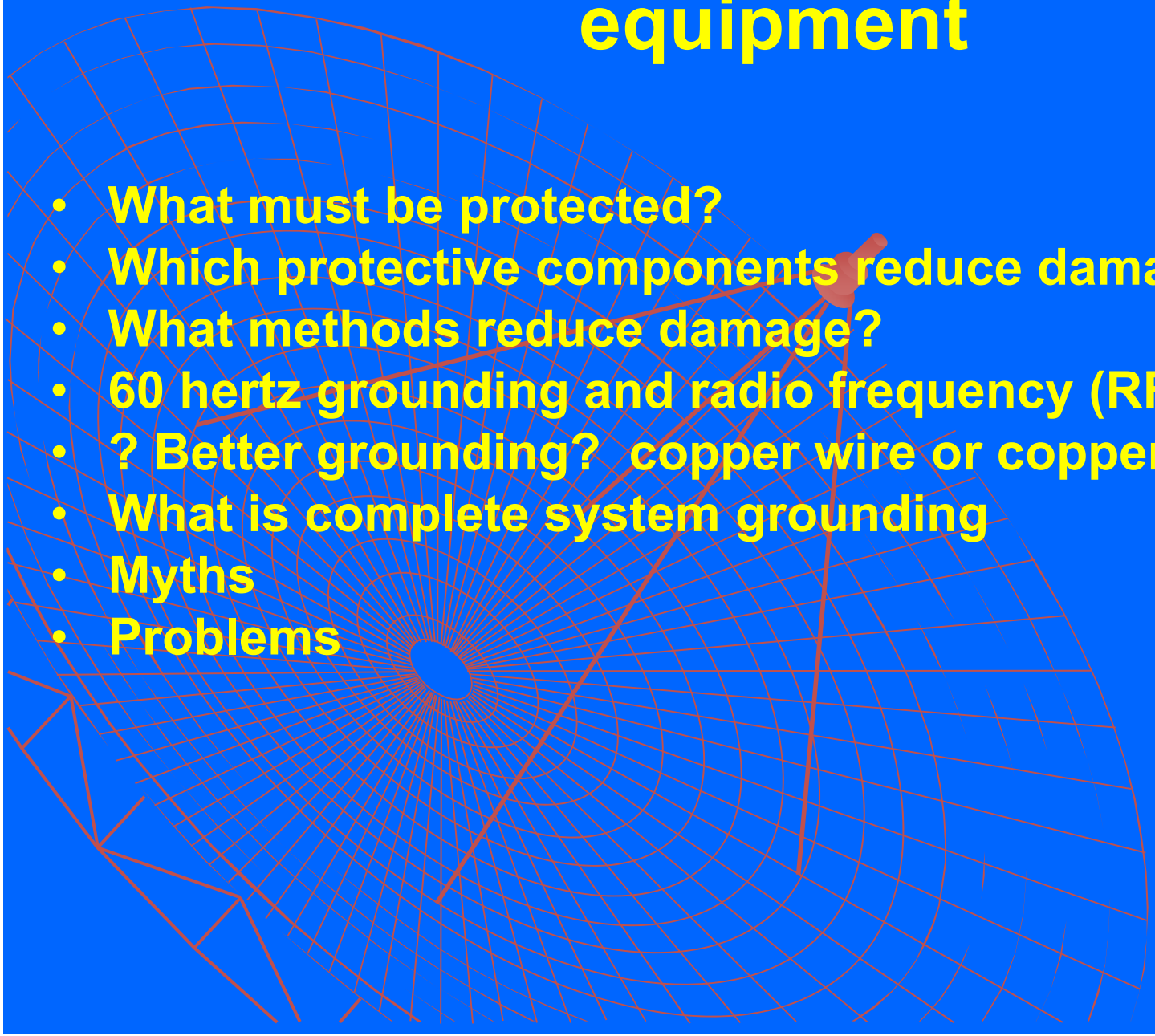

Melted guy wire.


JETSTREAM
Lightning Arresto
JTLAI
1.5-200 MHz
8 kW PEP
50 Ohm


Hook on pulley opened up.


This is what's left of his antenna wire known as ladder line.

The Challenge – protect your radio equipment



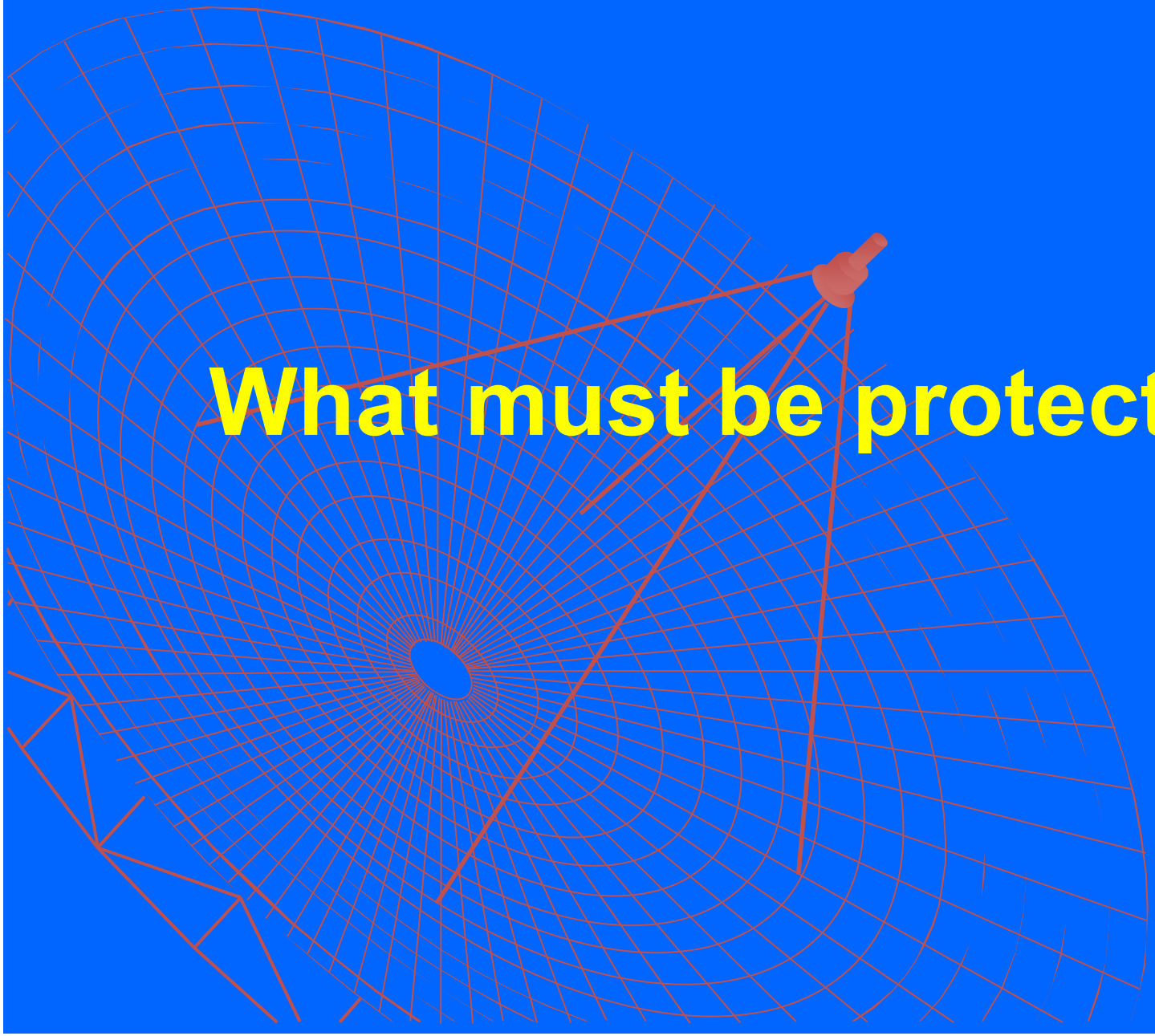
- What must be protected?
- Which protective components reduce damage?
- What methods reduce damage?
- 60 hertz grounding and radio frequency (RF) grounding
- ? Better grounding? copper wire or copper strap
- What is complete system grounding
- Myths
- Problems

References 1 of 2

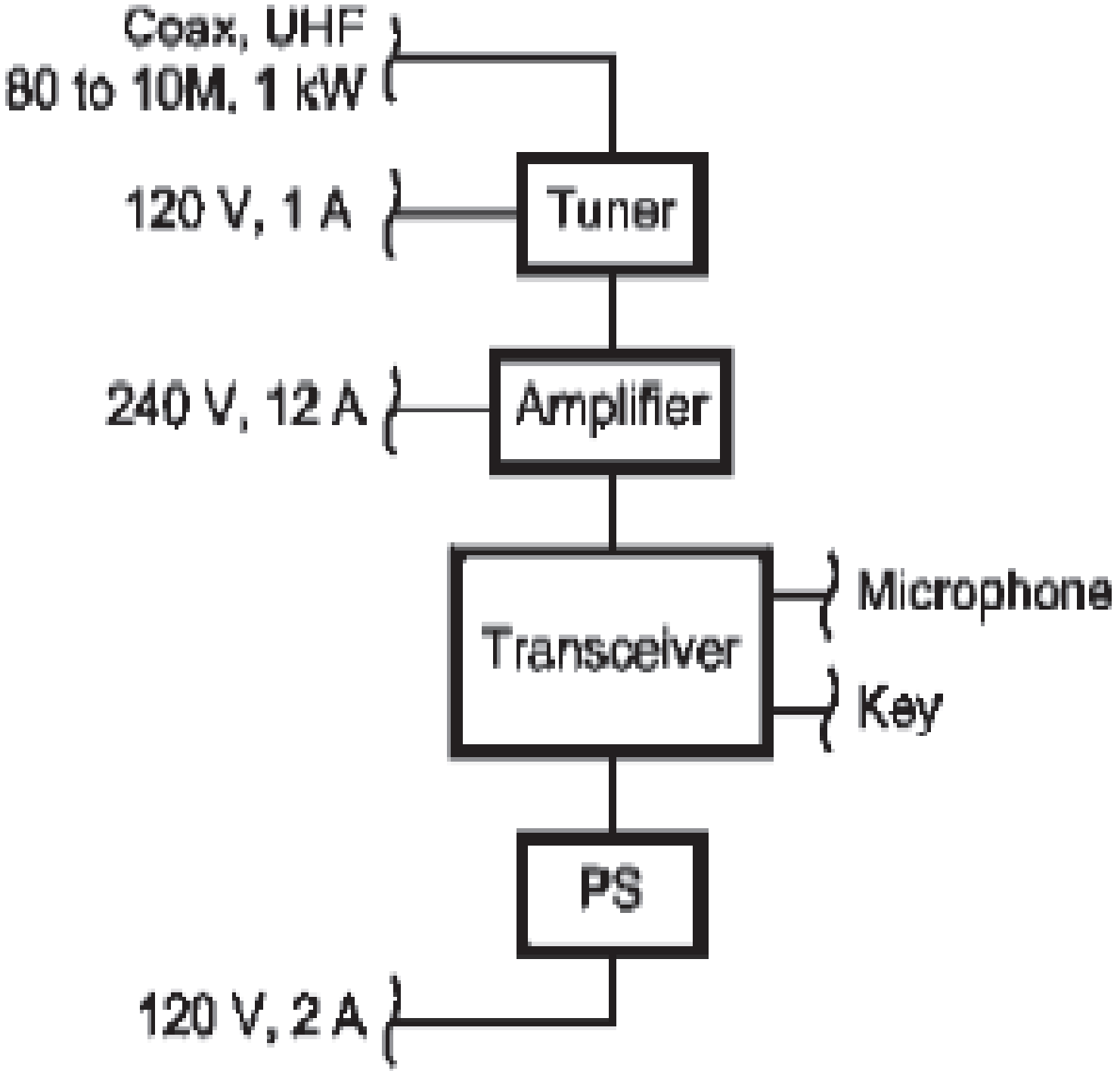
- Alliance for Telecommunications Industry Solutions (ATIS)
- American National Standards Institute (ANSI)
- American Radio Relay League (ARRL)
- American Society of Mechanical Engineers (ASME)
- Australian Standards (AS)
- British Standards Institution (BS)
- Cooper, MA
- Federal Aviation Agency (FAA)
- Federal Communication Commission (FCC)
- http://en.blitzortung.org/live_lightning_maps.php?map=32
- Institute of Electrical and Electronics Engineers (IEEE)
- International Association of Electrical Inspectors (IAEI)
- International Electrotechnical Commission (IEC)
- Lightning, Uman, MA, 1982

References 2 of 2

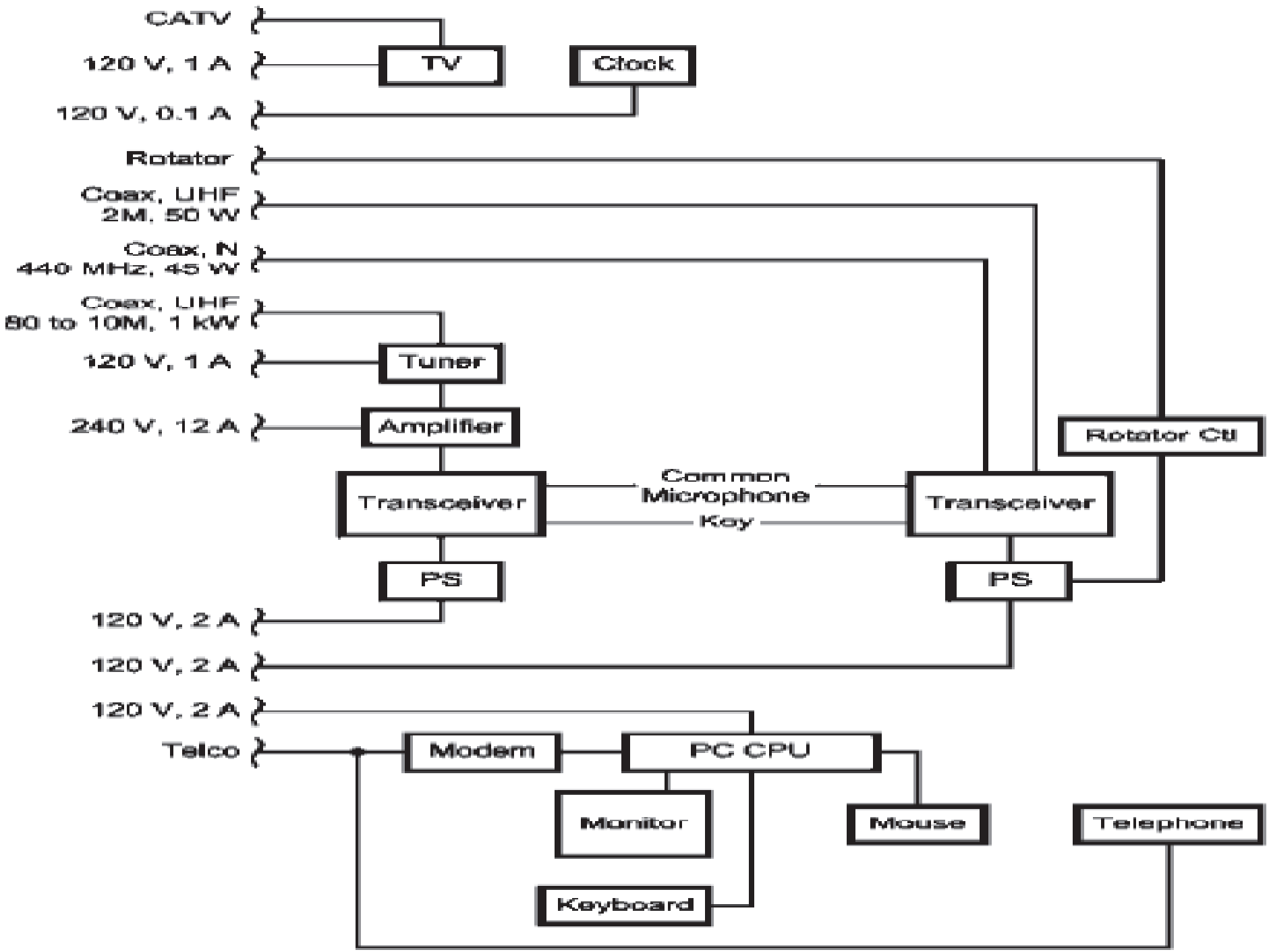
- Lightning Injury Research Program (LIRP)
- Motorola Corporation
- National Electrical Manufacturers Association (NEMA)
- National Fire Protection Association (NFPA)
- National Oceanic and Atmospheric Administration (NOAA)
- PolyPhaser Corporation
- Smith Power Corporation
- Telecommunications Industry Association (TIA)
- The "Grounds" for Lightning and EMP Protection, Block, RR, 1987
- Underwriters Laboratories (UL)
- United States Department of Defense (DoD)
- United States Federal Aviation Administration (FAA)
- United States National Weather Service (NWS)



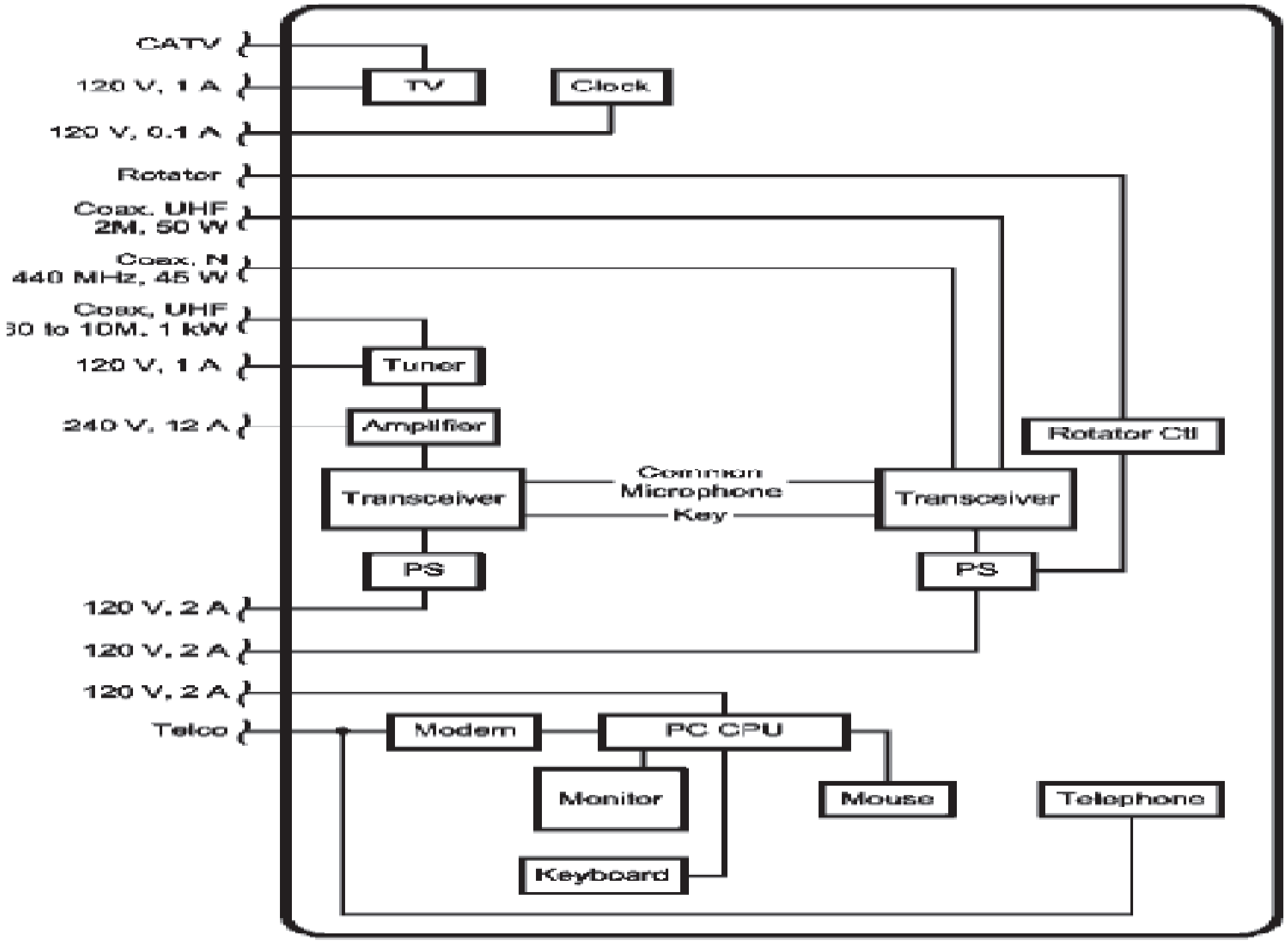
What must be protected?


Coax, UHF
80 to 10M, 1 kW
120 V, 1 A
Tuner
240 V, 12 A
Amplifier
Transceiver
Microphone
Key
PS
120 V, 2 A


Closer Look


CATV
120 V, 1 A
TV
Clock
120 V, 0.1 A
Rotator
Coax, UHF
2M, 50 W
Coax, N
440 MHz, 45 W
Coax, UHF
80 to 10M, 1 kW
120 V, 1 A
Tuner
240 V, 12 A
Amplifier
Rotator Ctl
Transceiver
Common
Microphone
Key
Transceiver
PS
PS
120 V, 2 A
120 V, 2 A
120 V, 2 A
Telco
Modem
PC CPU
Monitor
Mouse
Telephone
Keyboard

Protect all the equipment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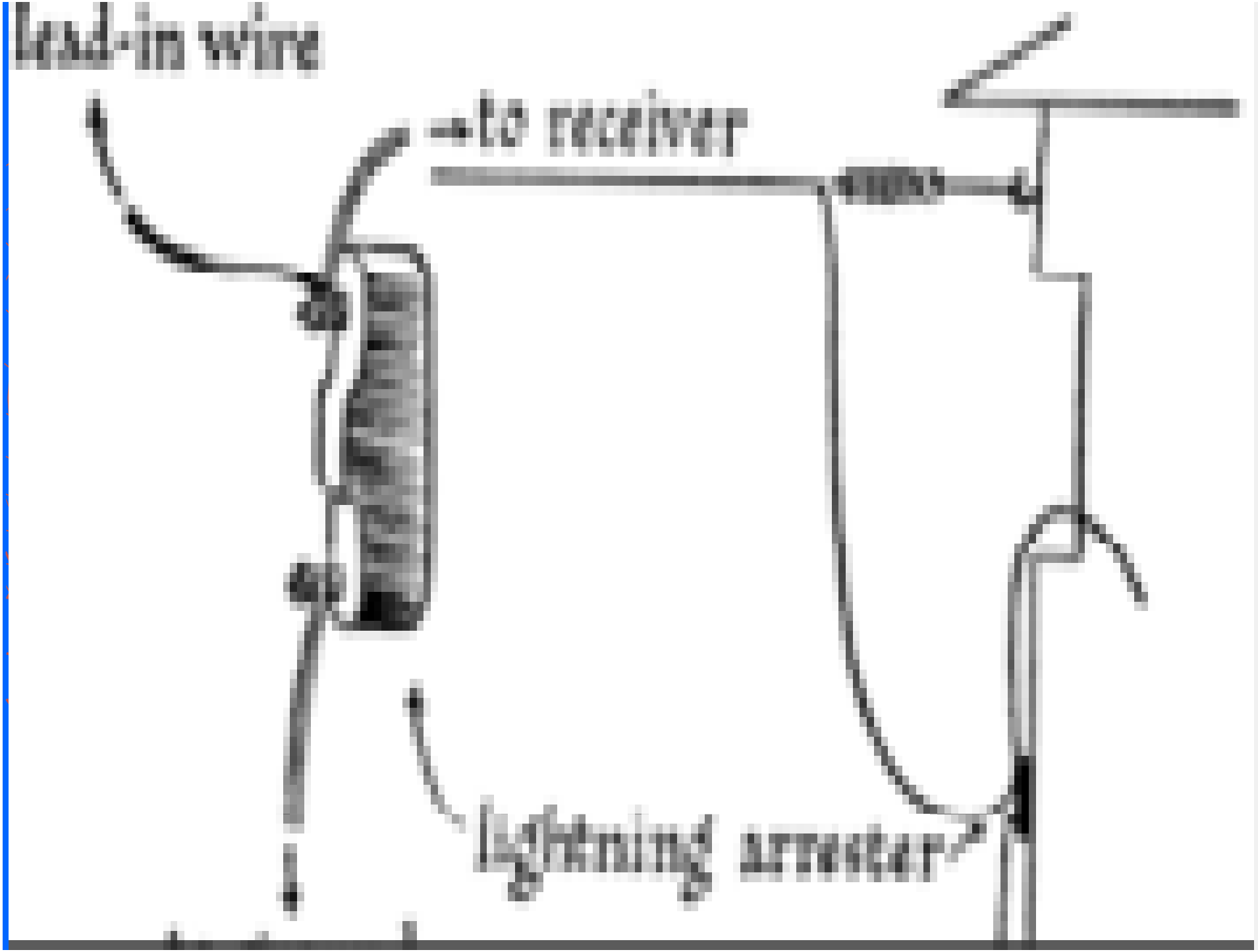
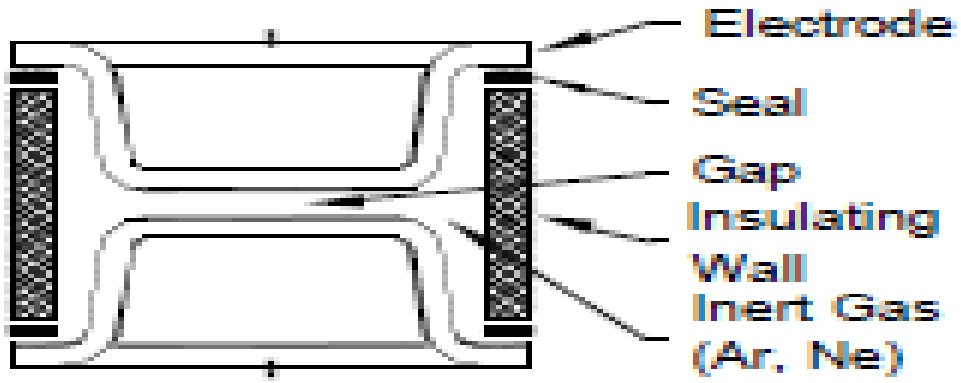
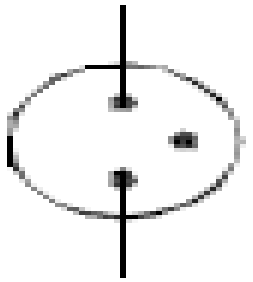
120 V, 1 A
120 V, 0.1 A
Rotator
Coax. UHF
2M, 50 W
Coax. N
440 MHz, 45 W
Coax, UHF
30 to 10M, 1 kW
120 V, 1 A
240 V, 12 A
120 V, 2 A
120 V, 2 A
120 V, 2 A
Telco
TV
Clock
Tuner
Amplifier
Transceiver
PS
Common
Microphone
Key
Transceiver
PS
Rotator Ctl
Modem
PC CPU
Monitor
Keyboard
Mouse
Telephone

Which protective components reduce damage?

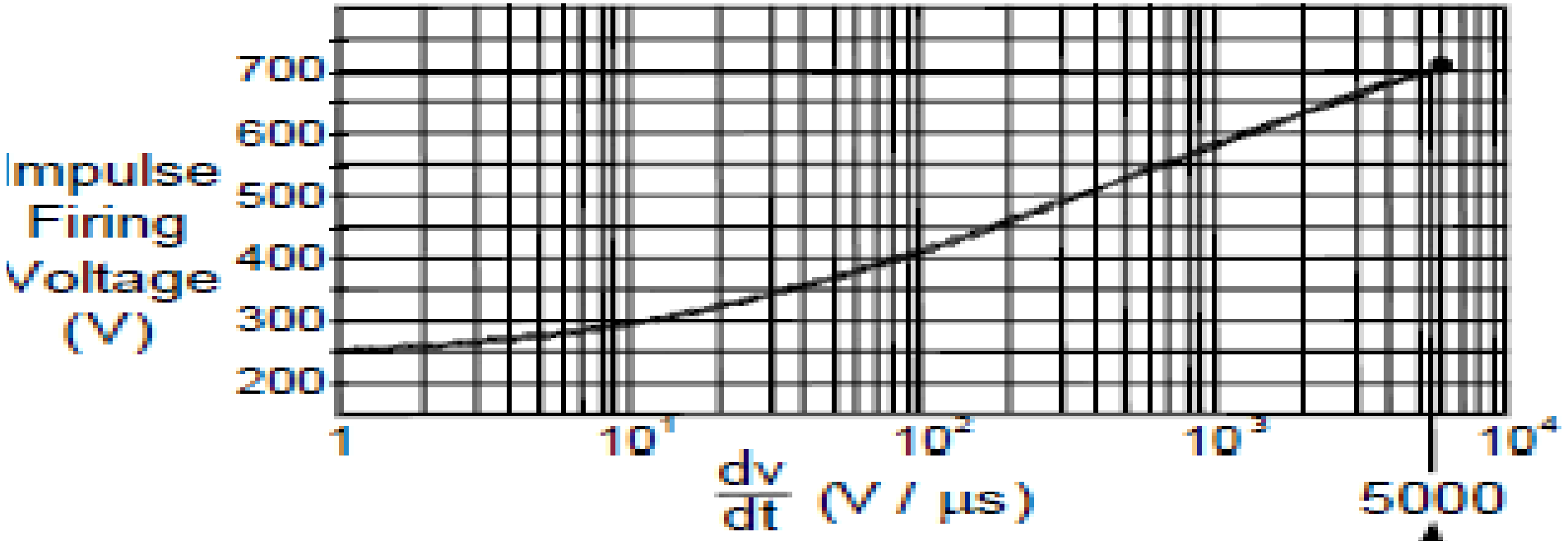

lead-in wire
to receiver
lightning arrester

Cut-away view of gas tube surge arrestor (not to scale)

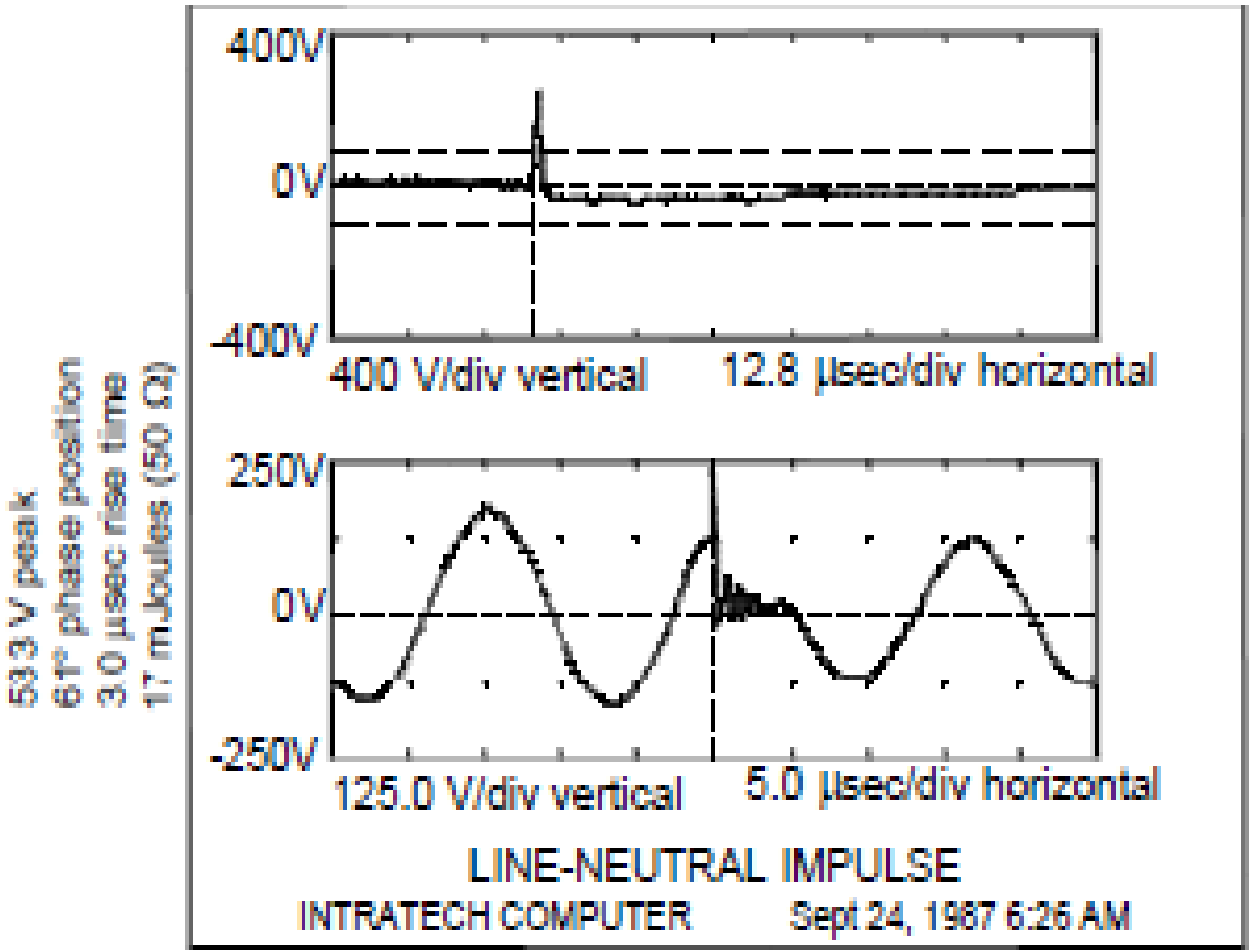




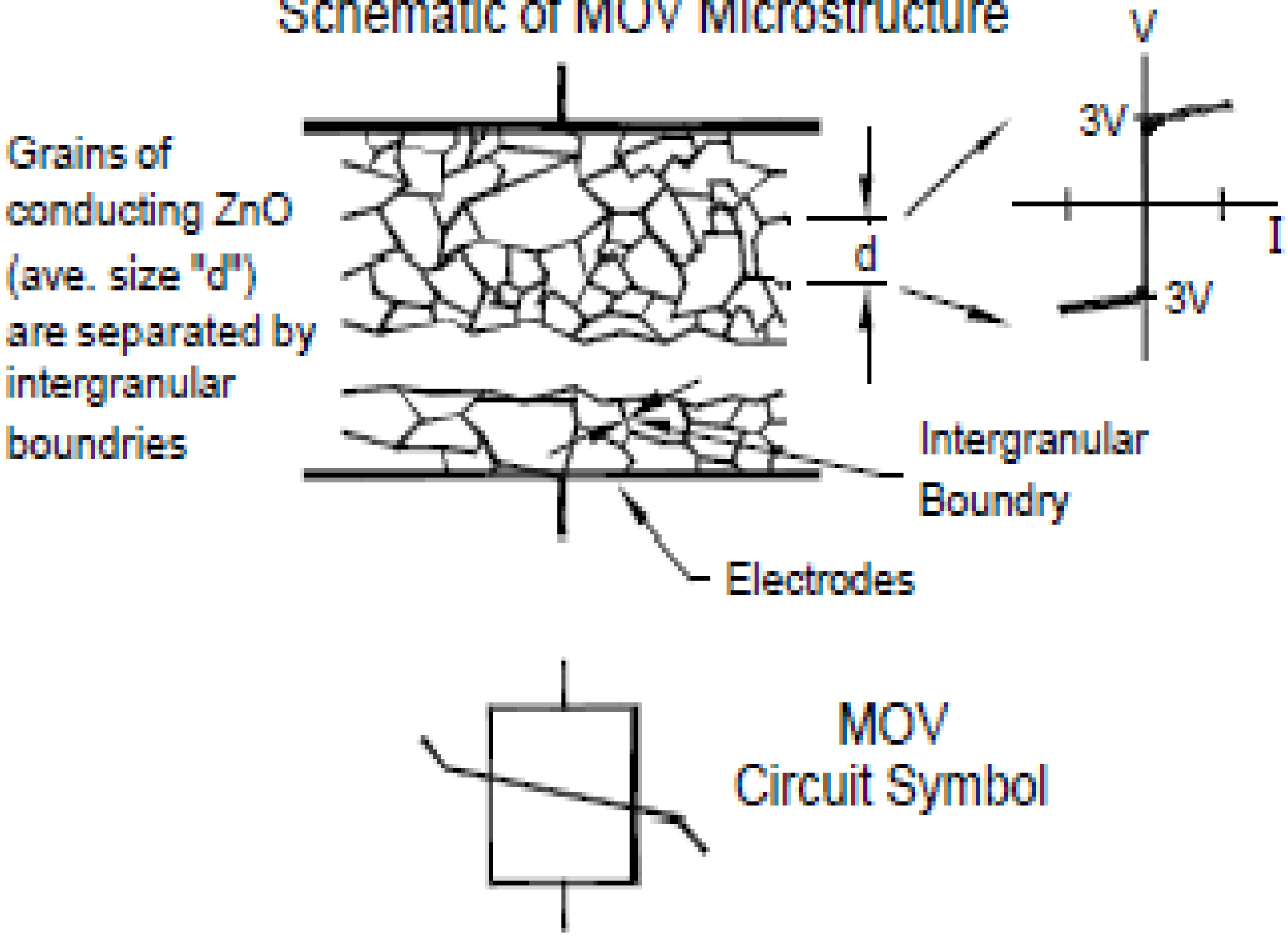
Gas Tube Arrestor Symbol



ANSI C62.41, $\frac{dv}{dt}$ = 5000V / µs
1.2 x 50 µs
Firing Voltage ≈ 700V


400V
0V
-400V
400 V/div vertical
12.8 µsec/div horizontal
250V
0V
-250V
125.0 V/div vertical
5.0 µsec/div horizontal
53.3 V peak
61° phase position
3.0 µsec rise time
17 mJoules (50 Ω)
LINE-NEUTRAL IMPULSE
INTRATECH COMPUTER
Sept 24, 1967 6:26 AM

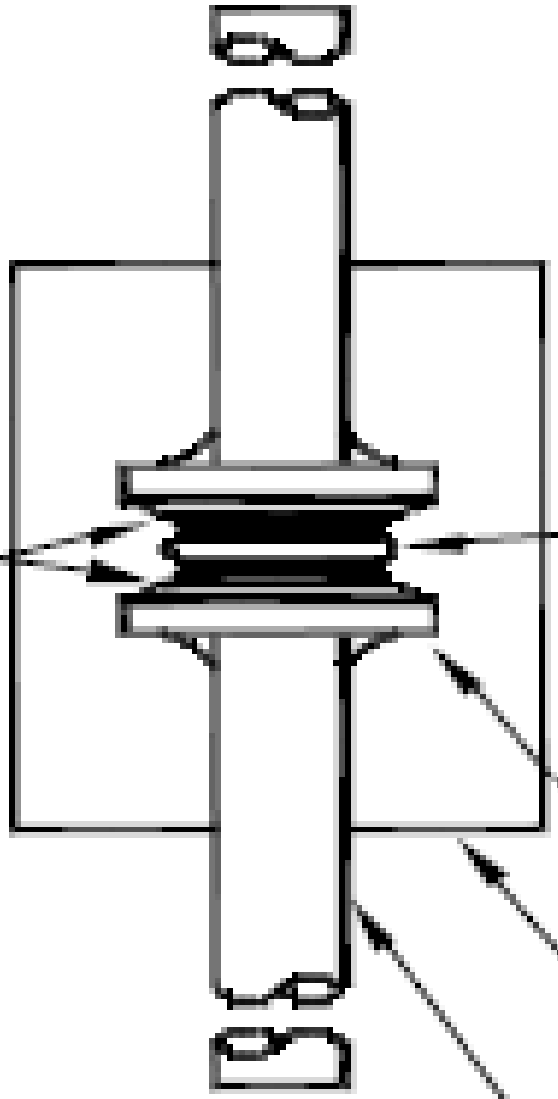
Schematic of MOV Microstructure



MOV
Circuit Symbol

Silicon Avalnche Diode (SAD)

SAD (Cut-Away View)



Sn Pb (Solder)

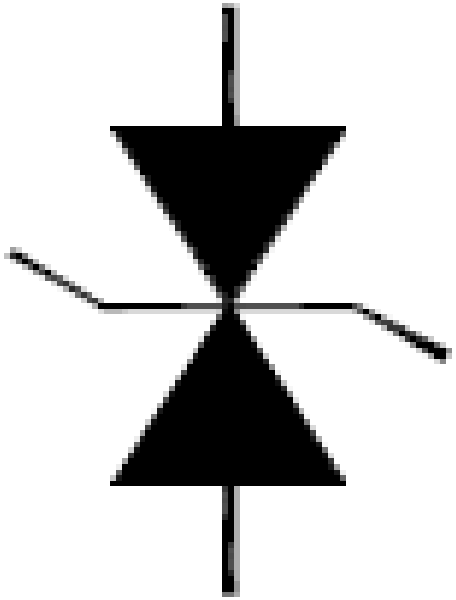
Zener Die (Large Junction Area)

Nailhead Lead

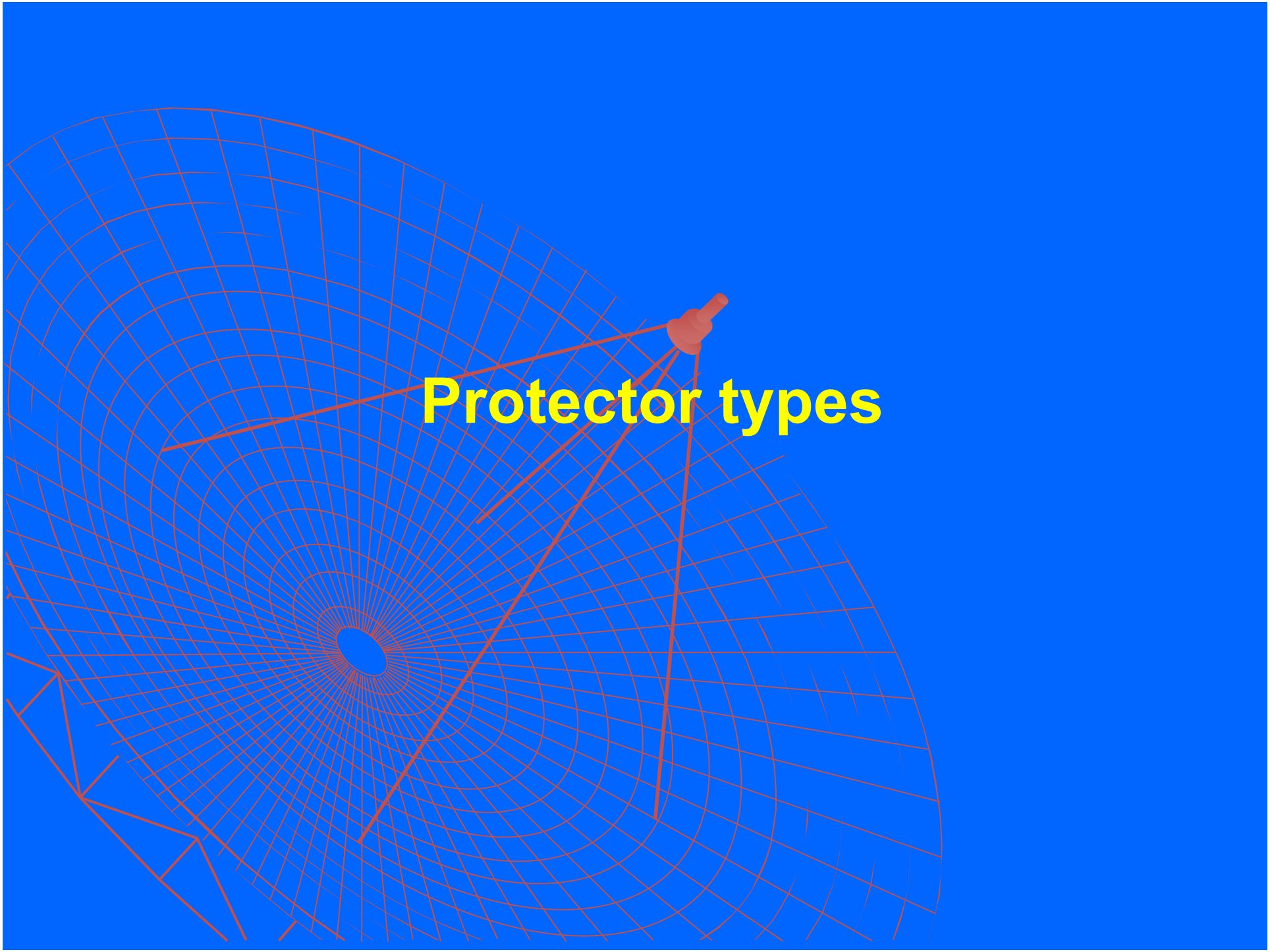
Plastic (Thermoset) Encapsulation

OFHC Copper Lead, Solder Plated

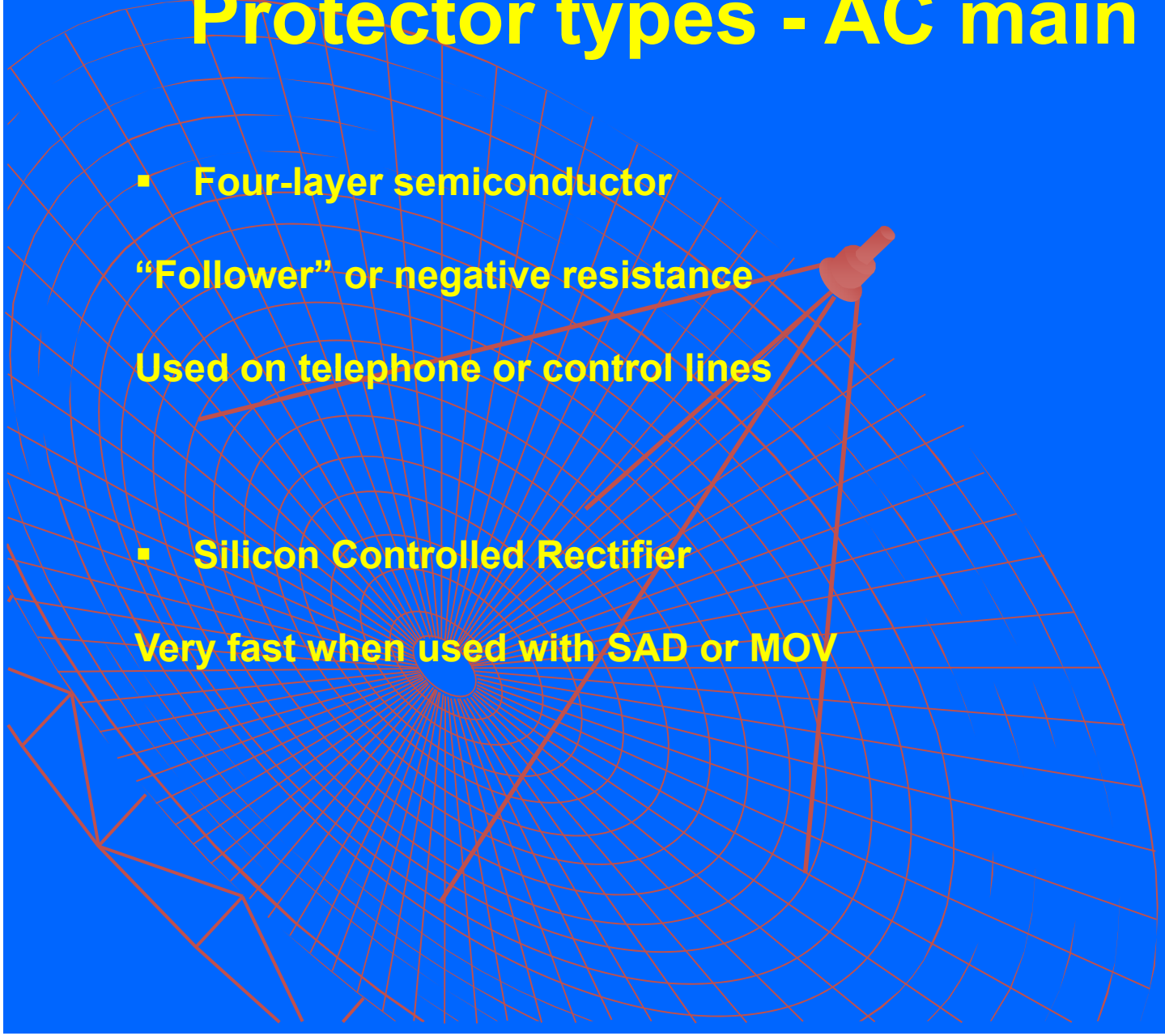
Bipolar SAD Circuit Symbol



What methods reduce damage?


Protector types

Protector types - AC main power



- Four-layer semiconductor

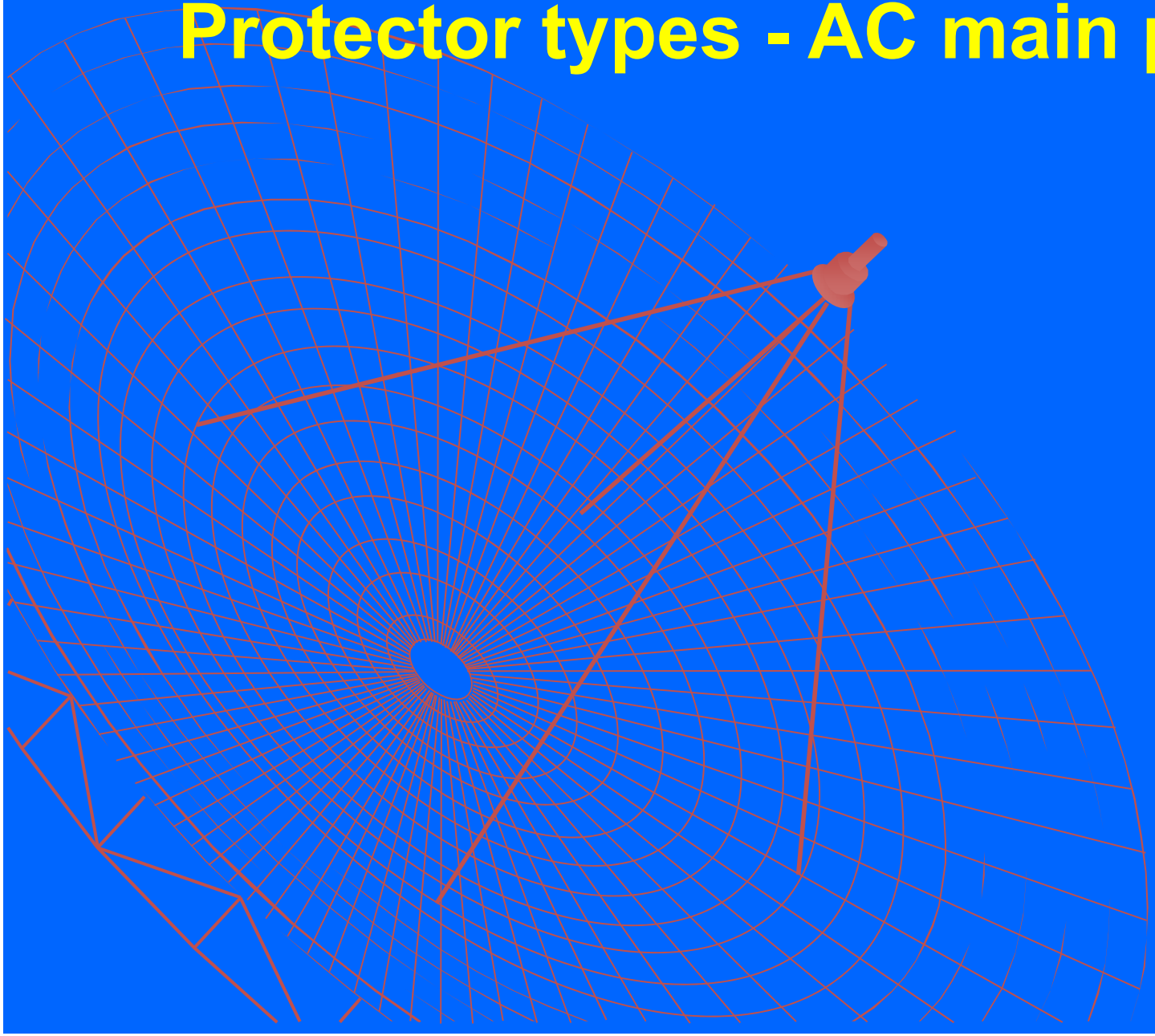
"Follower" or negative resistance

Used on telephone or control lines

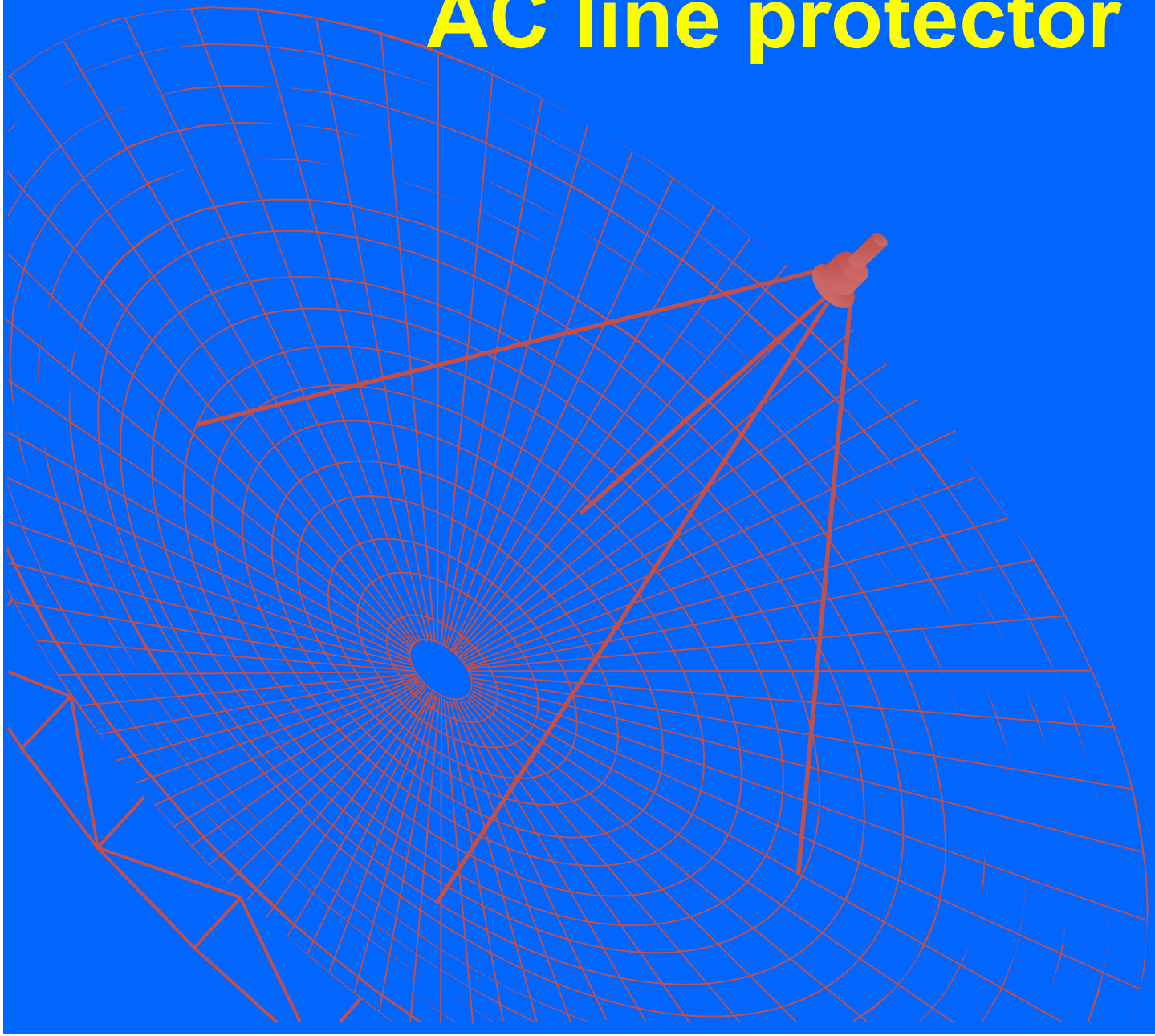
- Silicon Controlled Rectifier

Very fast when used with SAD or MOV

Protector types - AC main power

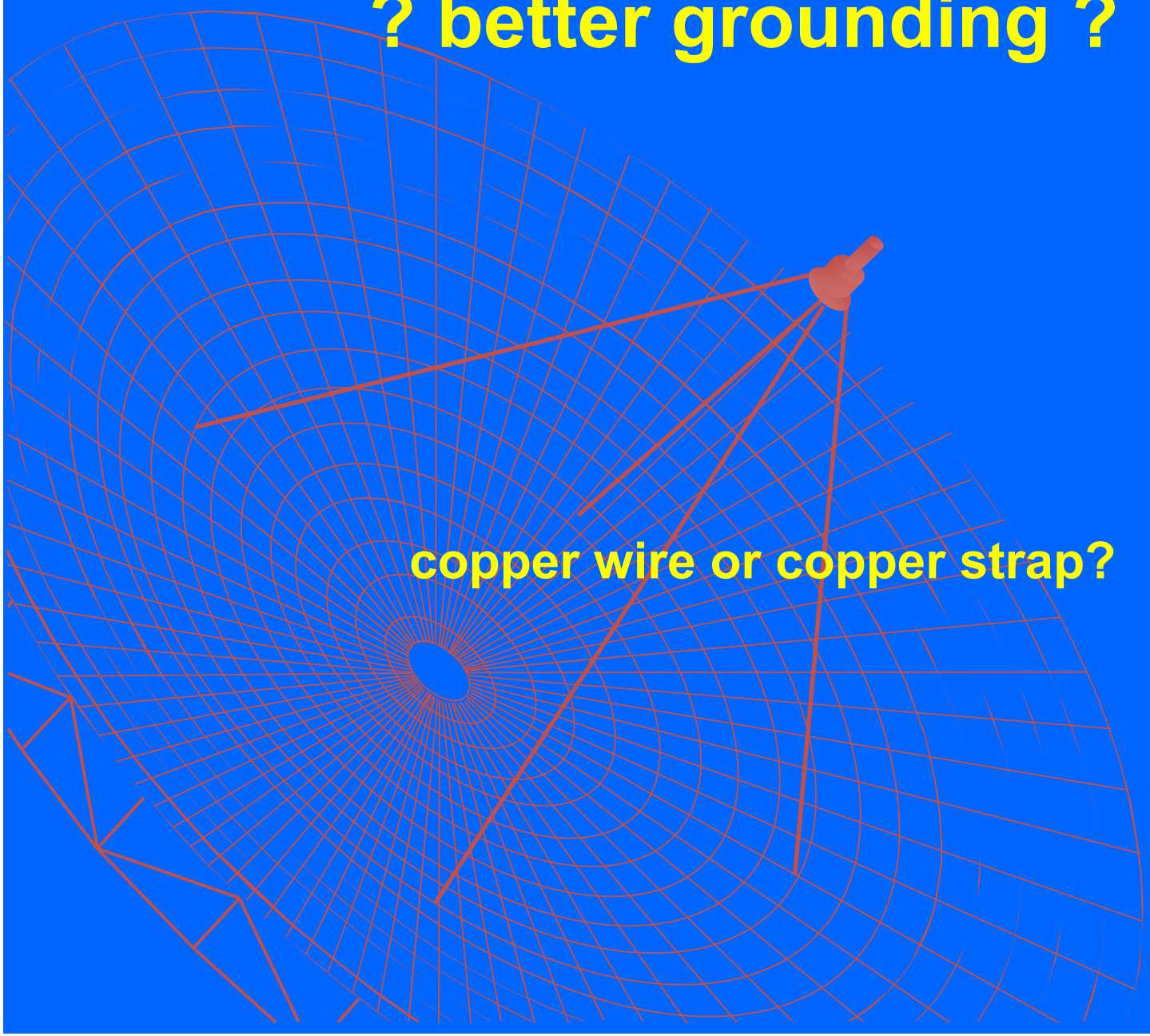


AC line protector

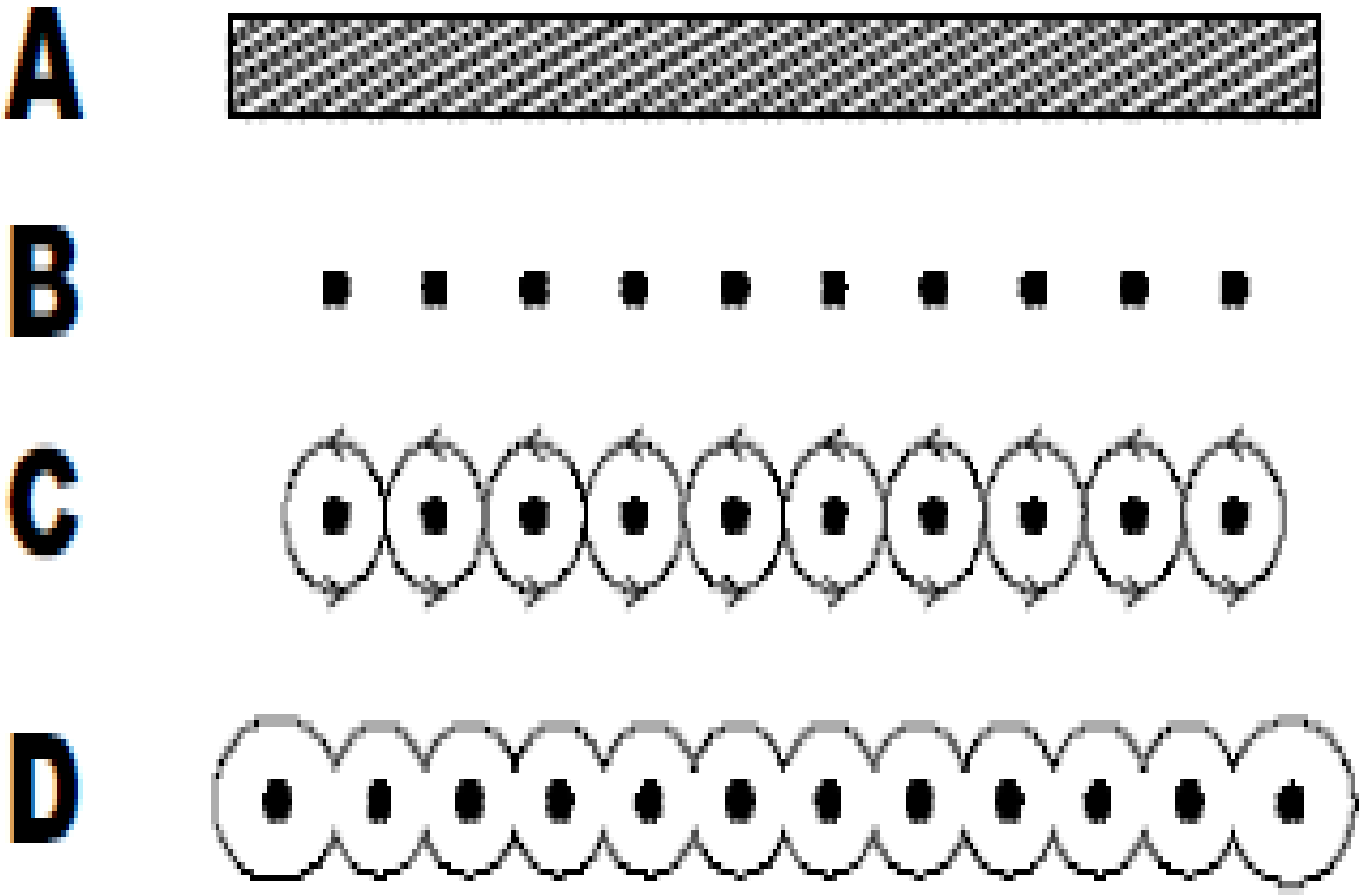


Battery and charger protection

? better grounding ?



copper wire or copper strap?


A
B
C
D

Grounding conductors

Inductance equations for copper conductors

- Round copper wire $L = 2\ell \{ \ln(4\ell/d) - 1 \} \times 10^{-7}$ µH
- Rectangular copper strapping $L = 2\ell \{ \ln[2\ell/(b + c)] + \frac{1}{2} \} \times 10^{-7}$ µH
- Round copper tubing $L = 2\ell \{ \ln(2\ell/r) - \frac{3}{4} \} \times 10^{-7}$ µH

L (µH)
ℓ (length in meters)
d (diameter in meters)
b & c (width and thickness resp. in meters)
r (radius in meters)

Calculated inductances L (μH)

Conductor	Inductance	Cross-sect. Area
• # 10 copper wire:	1.27 μH/m	0.0104 inch^2
• # 6 copper wire:	1.18 μH/m	0.021 inch^2
• 1/2" copper water pipe:	0.91 μH/m	0.307 inch^2
• 2" x 0.011" copper strap:	0.84 μH/m	0.022 inch^2
• 3/4" inch copper water pipe:	0.70 μH/m	0.600 inch^2

Surface area matters at RF frequencies

• Conductor	Circumference	Width
• # 10 copper wire:	0.32 inches	8.12 mm
• # 6 copper wire:	0.51 inches	13.00 mm
• 1/2 " copper water pipe:	1.96 inches	49.80 mm
• 2 " x 0.011 inch copper strap:	4.00 inches	101.60 mm
• 3/4 " copper water pipe:	2.36 inches	59.90 mm

Surge currents on conductors

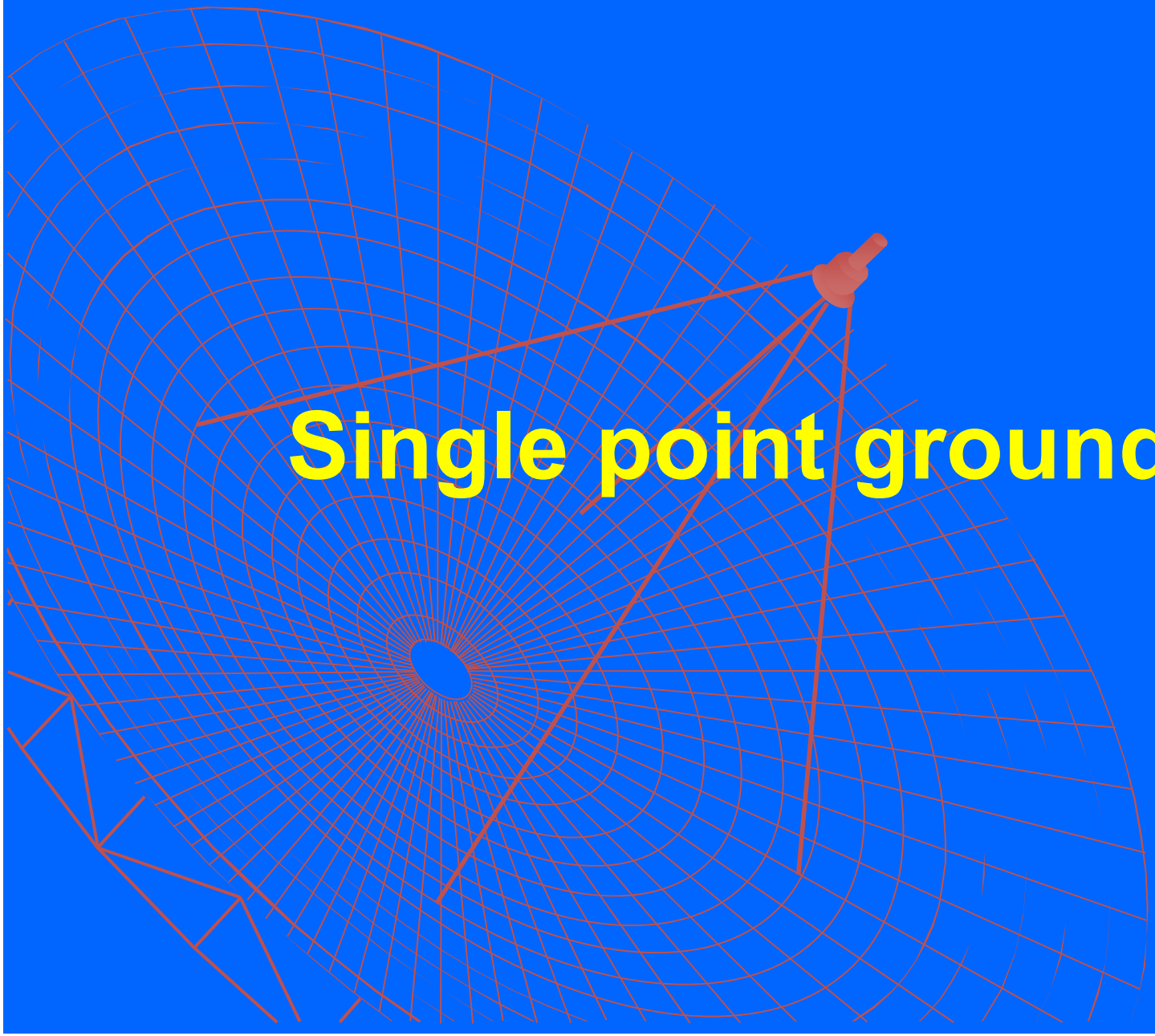
- Ohm's law for inductances
- $V = I X_L = I 2\pi f L = I 2 \pi (1/T) L$

- Suppose you have a 10 meter (32') copper conductor:
- What is the voltage difference between the ends with a surge current of 200 amps with a rise time of 2 μs.

- #6 Copper wire: $\Delta V = 754$ volts
- 2" Copper strap: $\Delta V = 528$ volts

- Ohm's Law for Resistance

- $\Delta V = IR = 2.6$ volts, much smaller than the induced voltage...essentially negligible



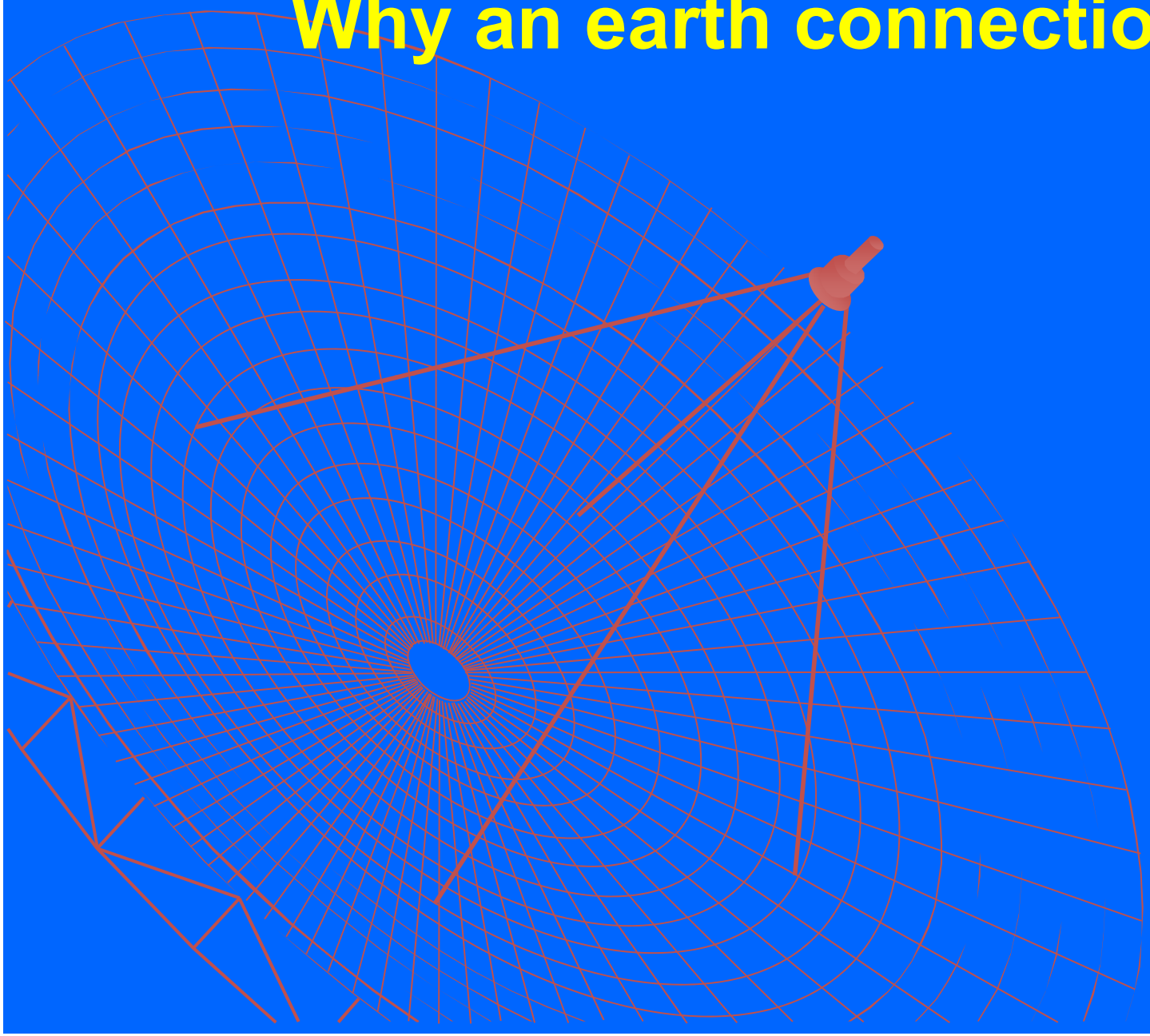
Single point grounding

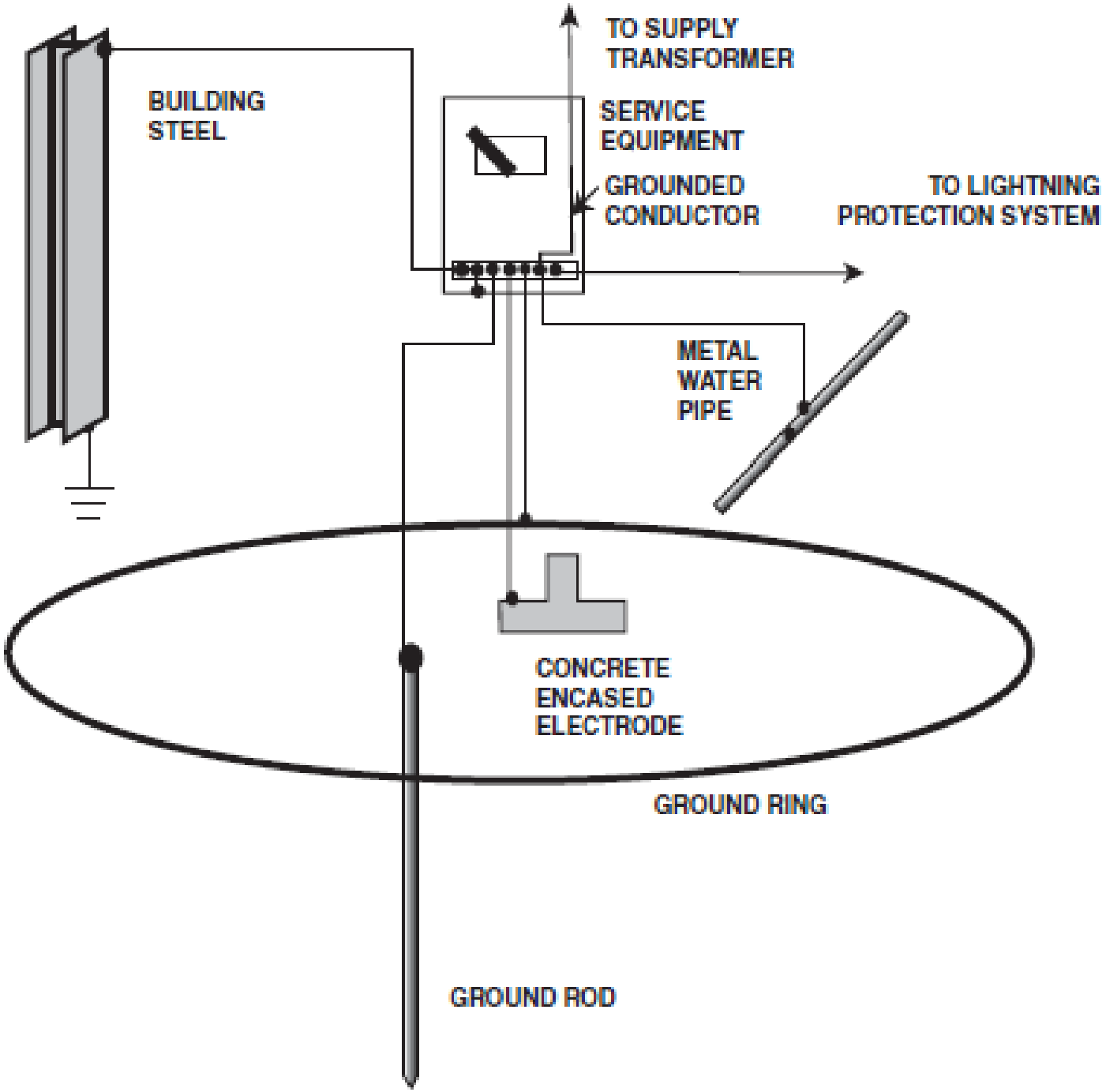
What must be bonded?

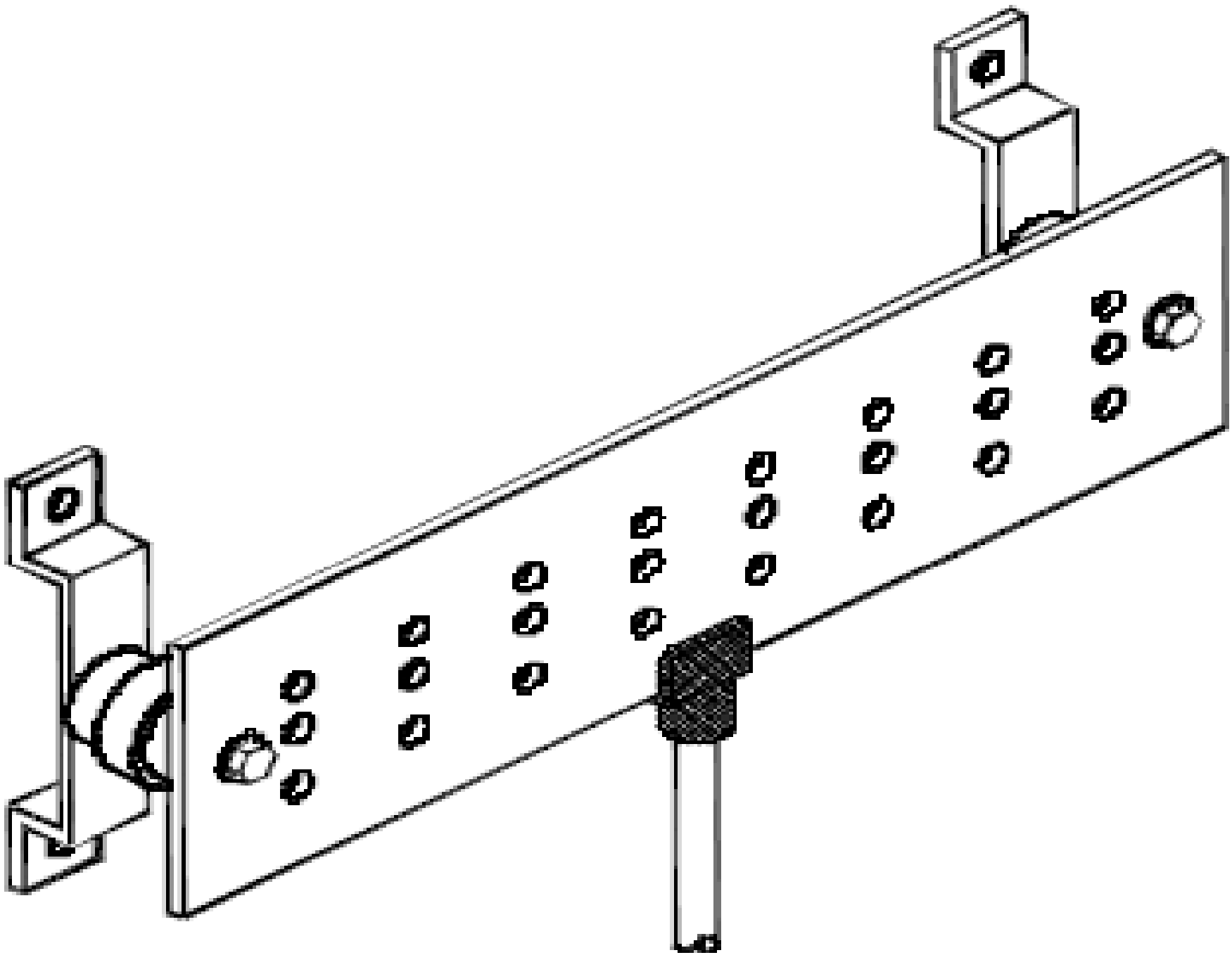
Everything must be bonded together

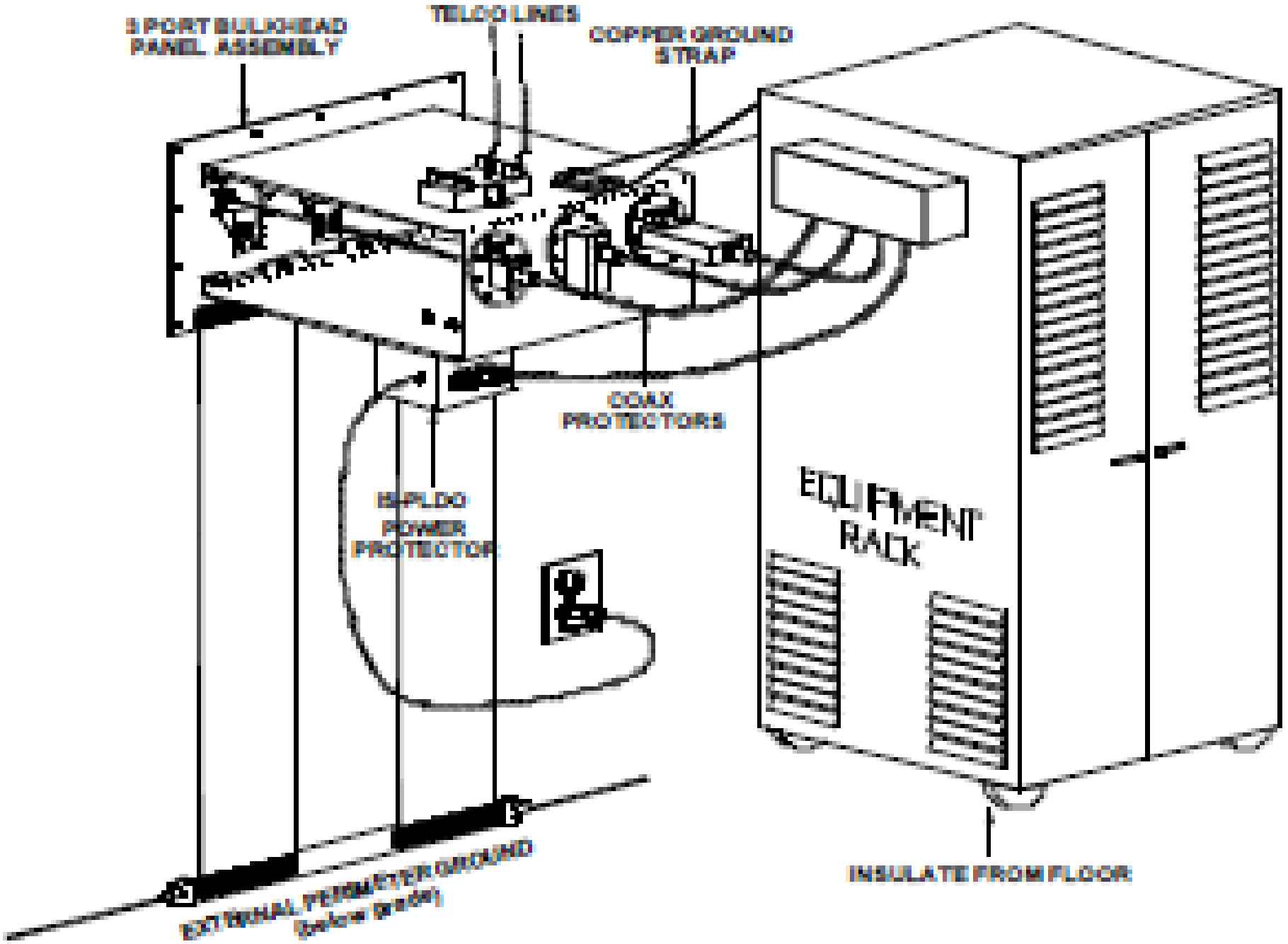
Separate grounds are unsafe and illegal!

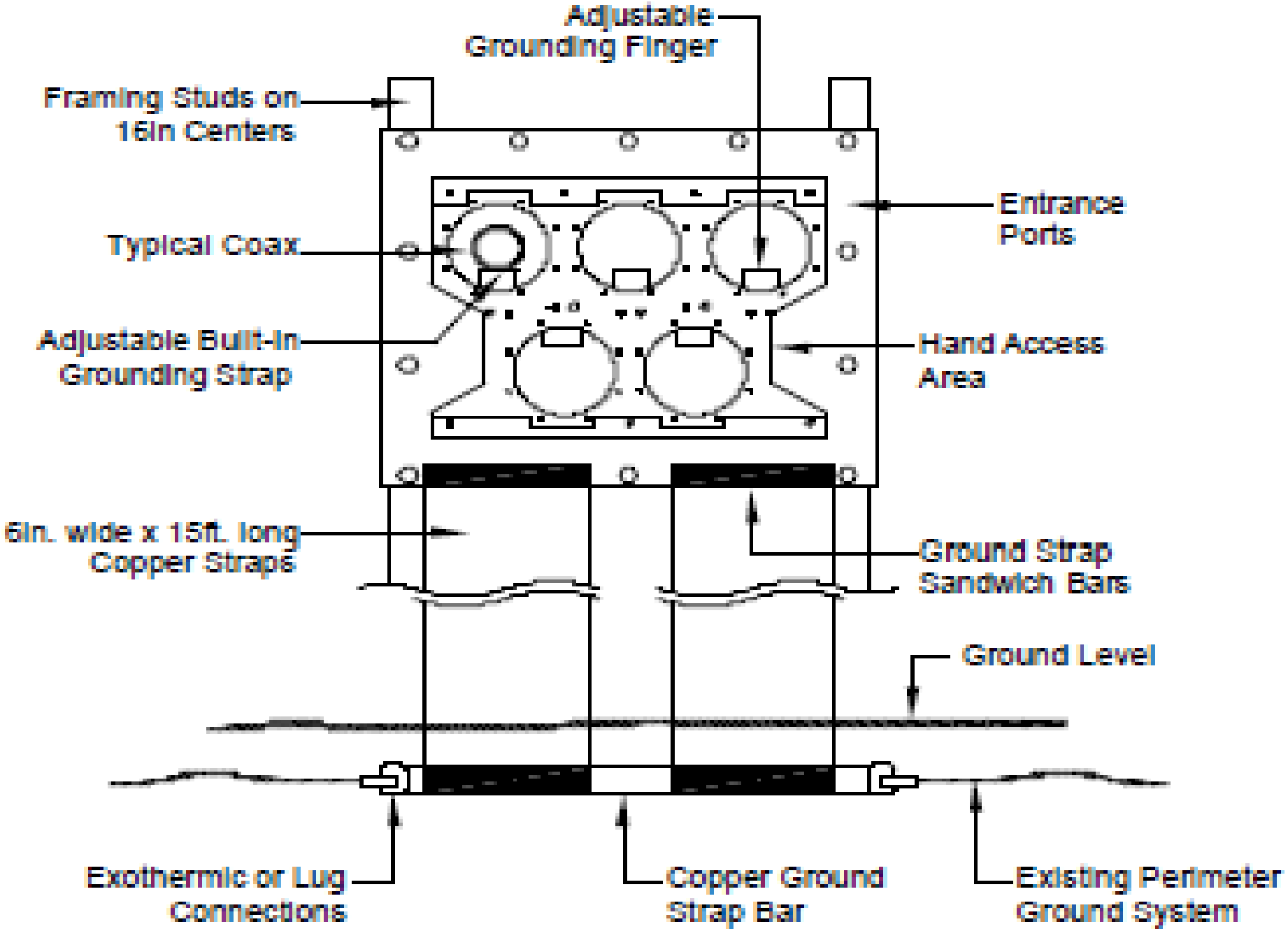
Why an earth connection?



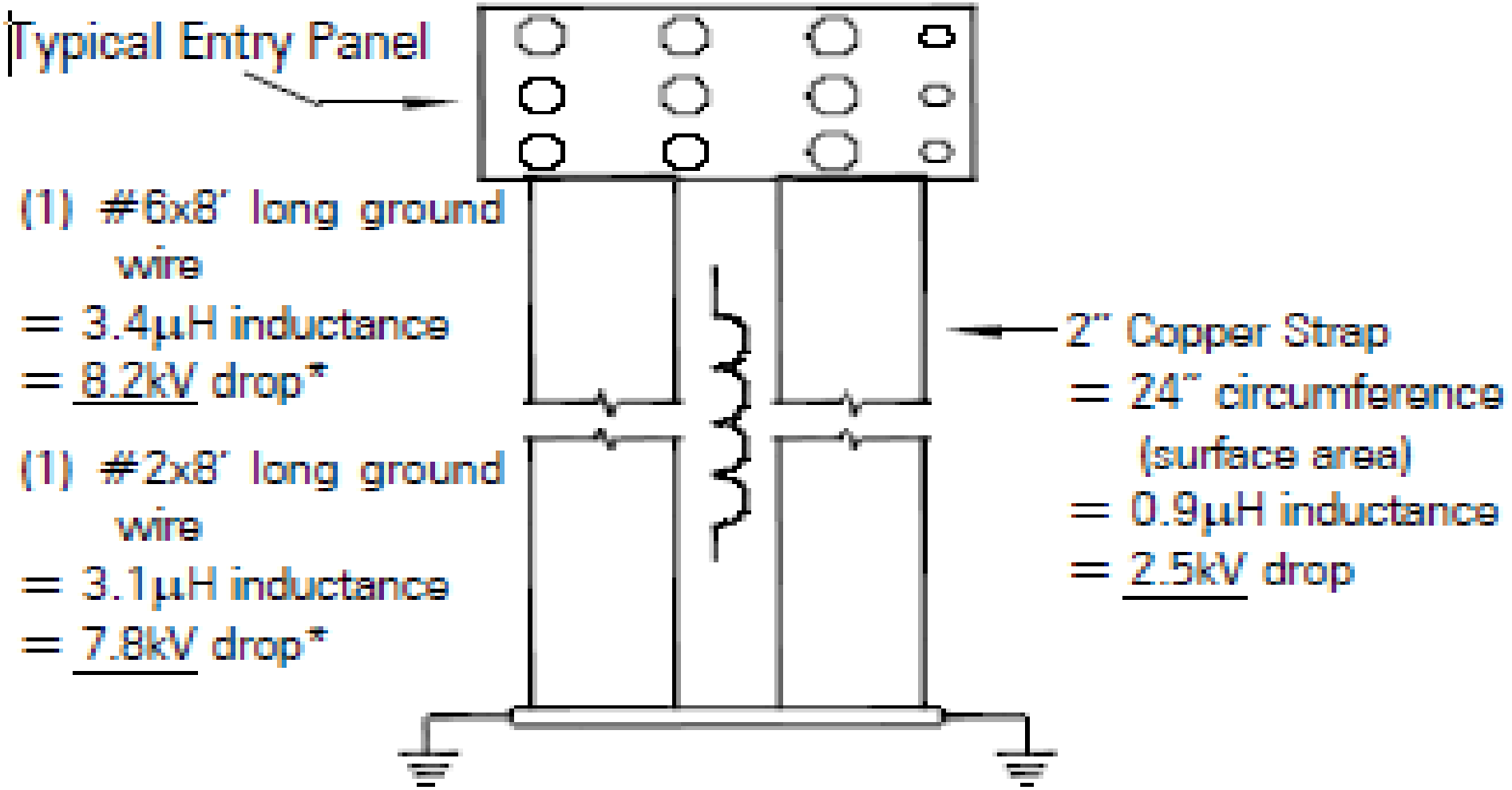

TO SUPPLY
TRANSFORMER
BUILDING
STEEL
SERVICE
EQUIPMENT
GROUNDED
CONDUCTOR
TO LIGHTNING
PROTECTION SYSTEM
METAL
WATER
PIPE
CONCRETE
ENCASED
ELECTRODE
GROUND RING
GROUND ROD




3 PORT BULKHEAD
PANEL ASSEMBLY
TELCO LINES
COPPER GROUND
STRAP
COAX
PROTECTORS
ISPLDO
POWER
PROTECTOR
EQUIPMENT
RACK
INSULATE FROM FLOOR
EXTERNAL PERIMETER GROUND
(below grade)

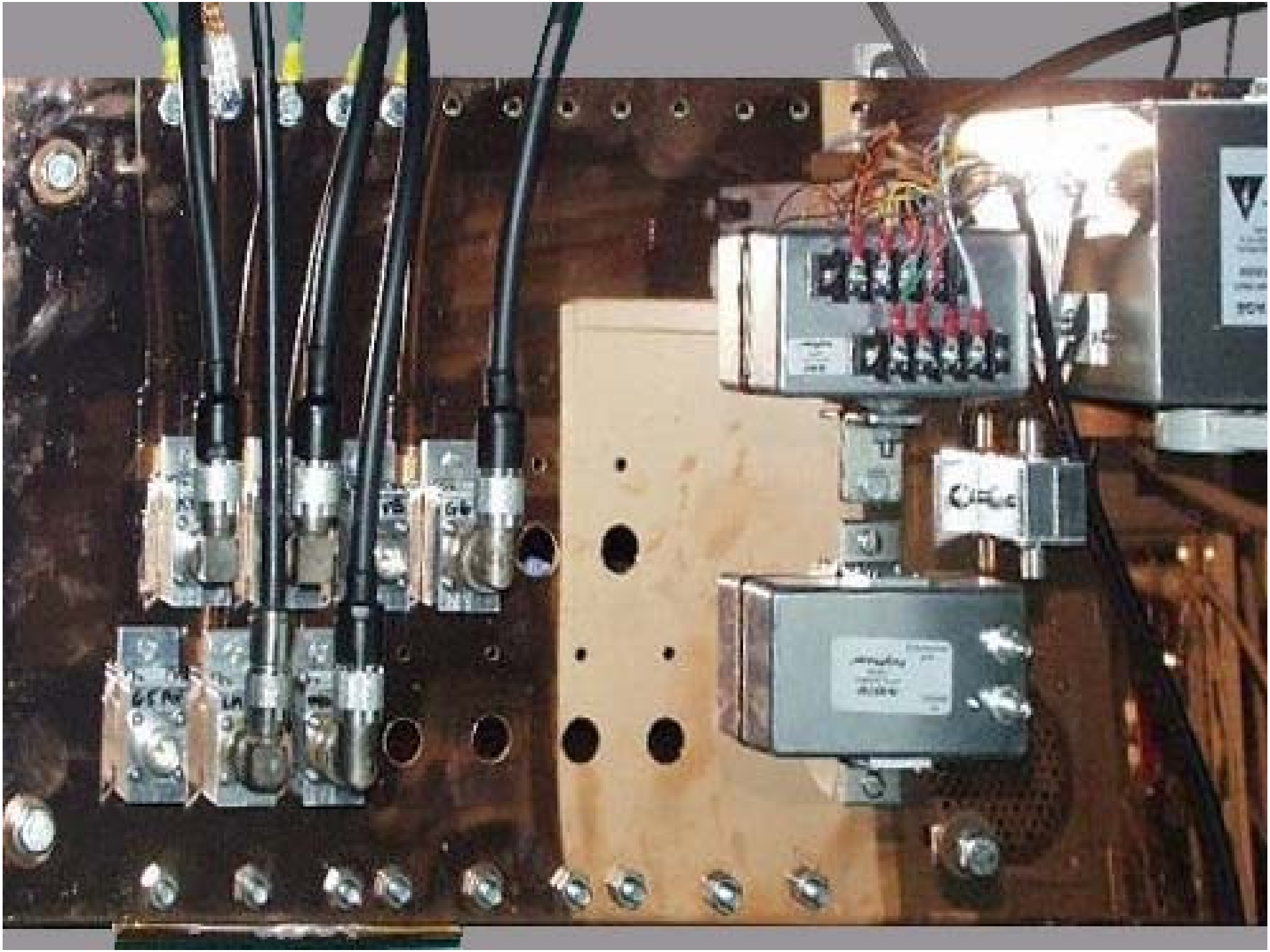

Adjustable
Grounding Finger
Framing Studs on
16In Centers
Entrance
Ports
Typical Coax
Adjustable Built-In
Grounding Strap
Hand Access
Area
6In. wide x 15ft. long
Copper Straps
Ground Strap
Sandwich Bars
Ground Level
Exothermic or Lug
Connections
Copper Ground
Strap Bar
Existing Perimeter
Ground System

(9) 7/8 coax = 24.75" circumference
(3) 1/2 coax = 4.75" circumference
Total Circumference = 29.50"

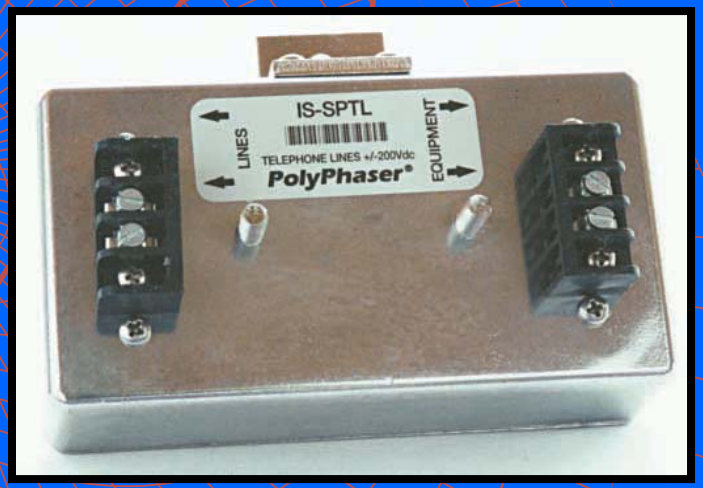


* 20kA/8 µs pulse


Whole house surge protector



Lightning suppressors



Ron Block KB2UYT in *QST*

Coaxial In-Line Arrestor

IS-B50LU-C0 | Broadband dc Blocked Protector

The IS-B50 is a dc blocked 50 Ohm bulkhead mounted protector and should be connected directly to a bulkhead or a master ground bar

Availability: In stock

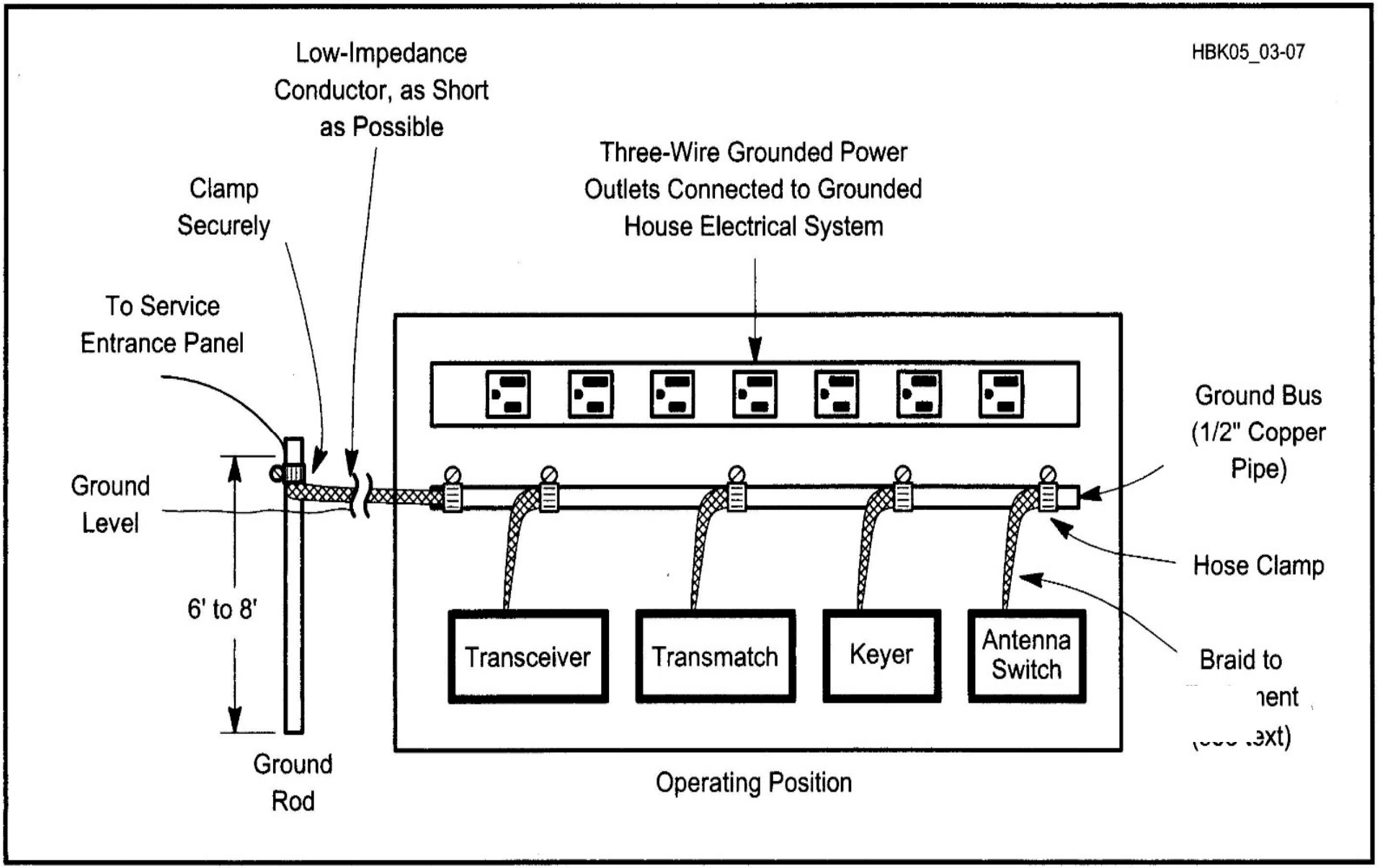
Request Quote

TECHNICAL SPECIFICATIONS

Customer Print

Freq. (MHz):	1.5 - 400	**Protected Side Connector:**	UHF Female
RF Power (Watts):	125 - 2000 Watts	**Surge Side Connector:**	UHF Female
Application:	HF test	**Insertion Loss (dB):**	0.1
Unit Imp. (Ohms):	50 Ω	**Mounting:**	Bulkhead
Throughput Energy (µJ):	≤ 10000.0000 µJ	**Turn On Voltage (Volts):**	+/- 600 V
Throughput Voltage (Volts):	≤ 900 Vpk	**VSWR:**	1.2:1
Weatherized:	No		

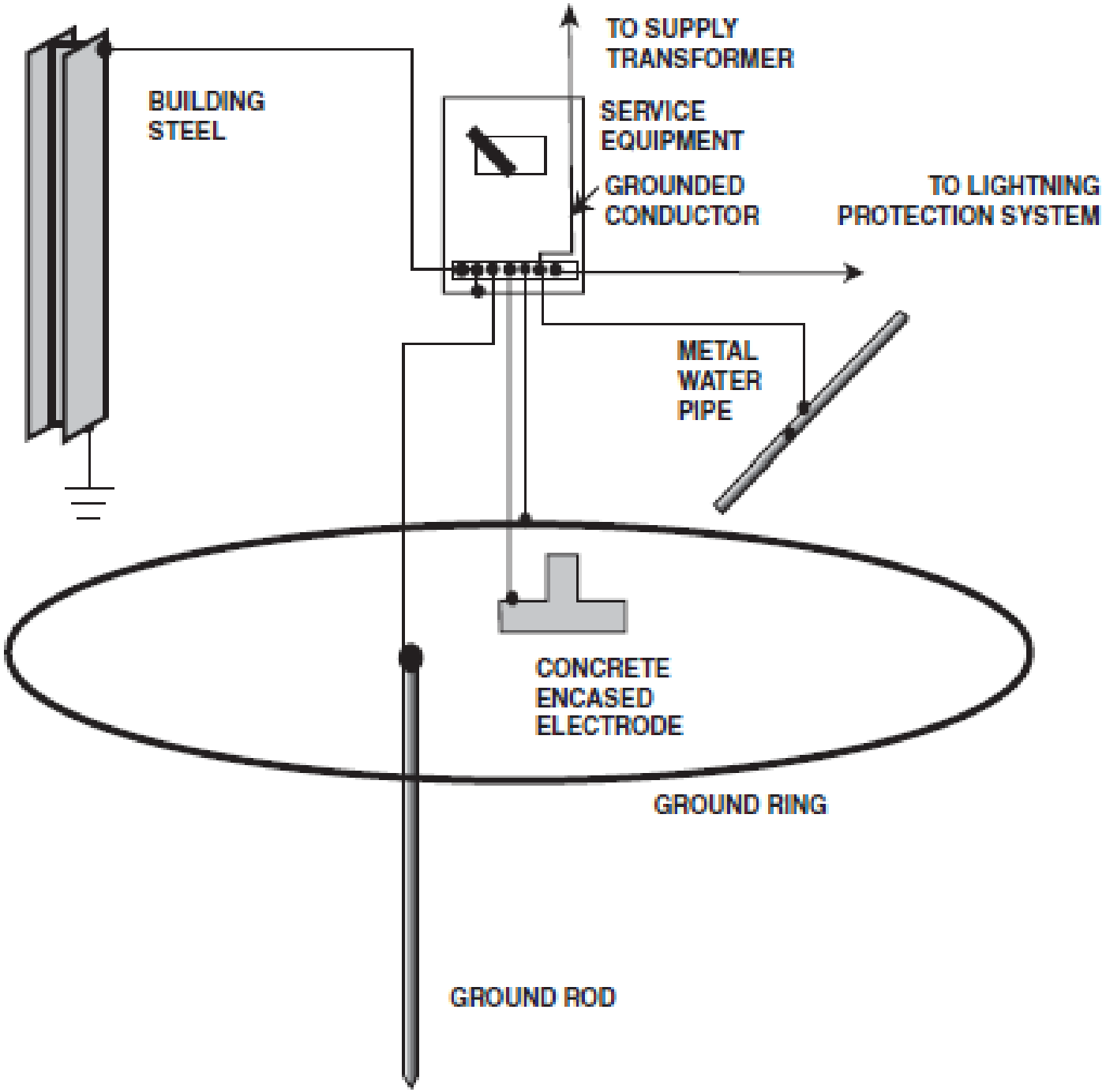
Polyphaser datasheet

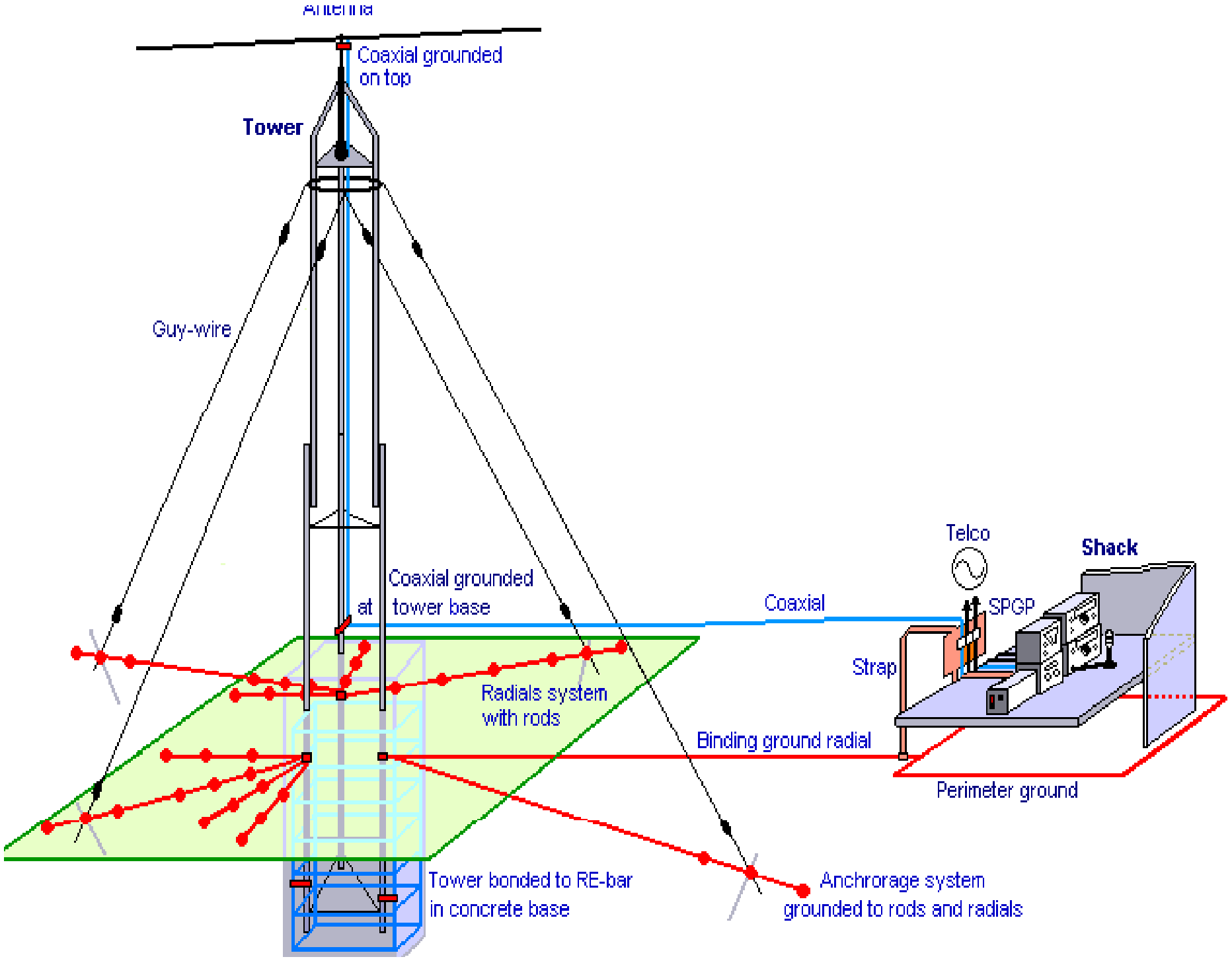


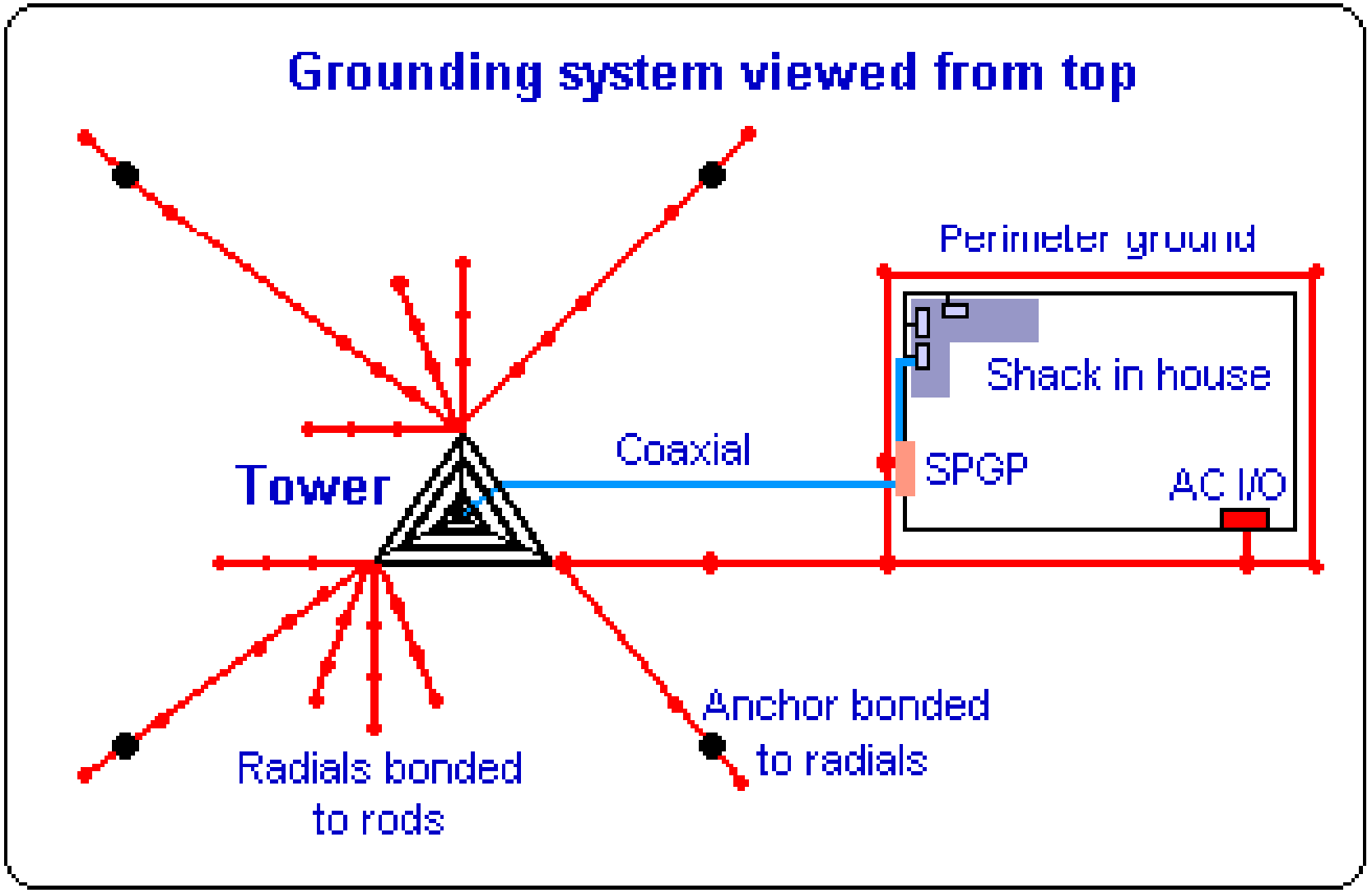
*** Common ground point** *** Fuse or circuit breaker**

*** Safety interlock on high voltage supplies**

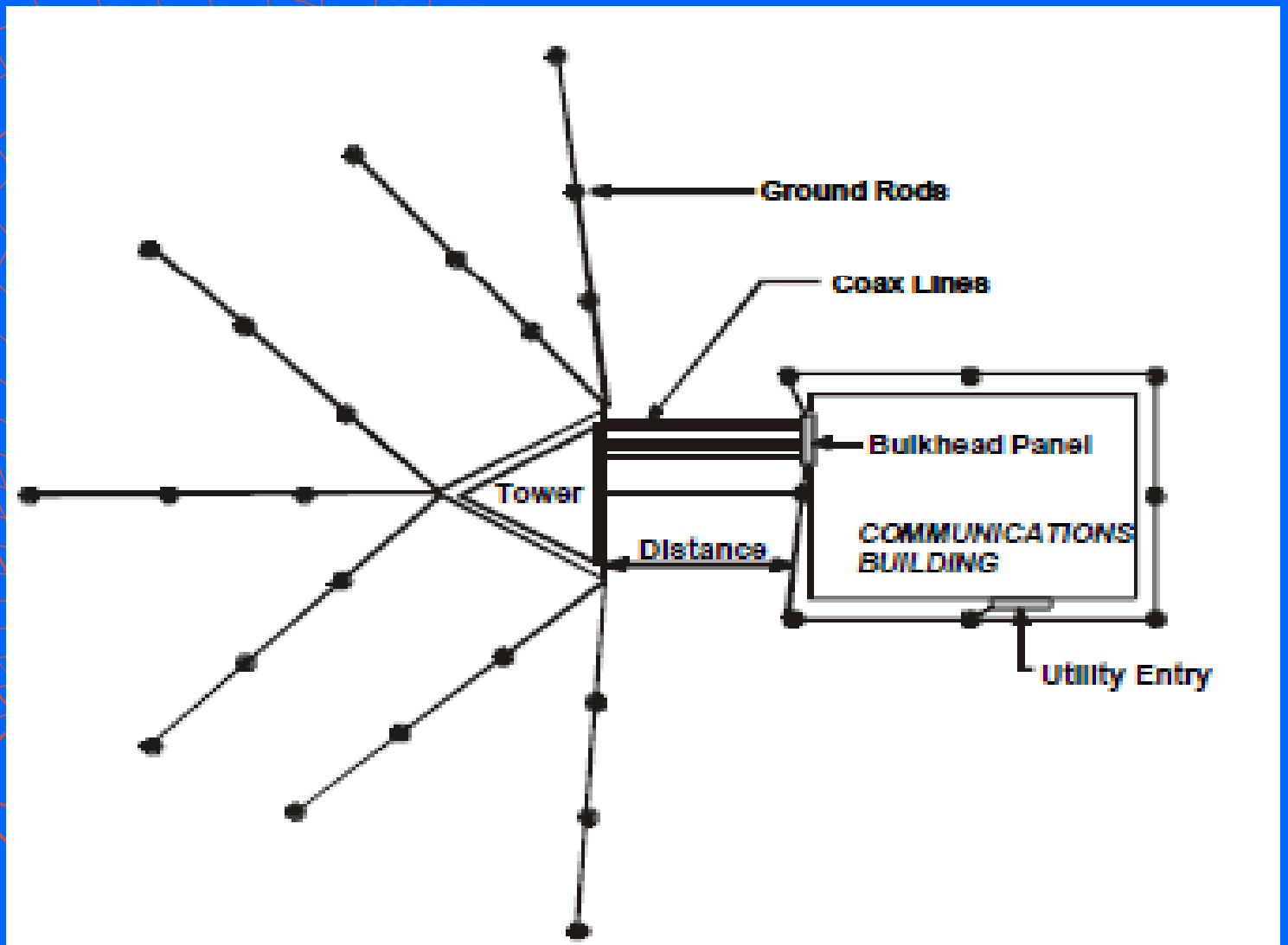
*** Everyone in your house should know how to shut off the power**


TO SUPPLY
TRANSFORMER
BUILDING
STEEL
SERVICE
EQUIPMENT
GROUNDED
CONDUCTOR
TO LIGHTNING
PROTECTION SYSTEM
METAL
WATER
PIPE
CONCRETE
ENCASED
ELECTRODE
GROUND RING
GROUND ROD

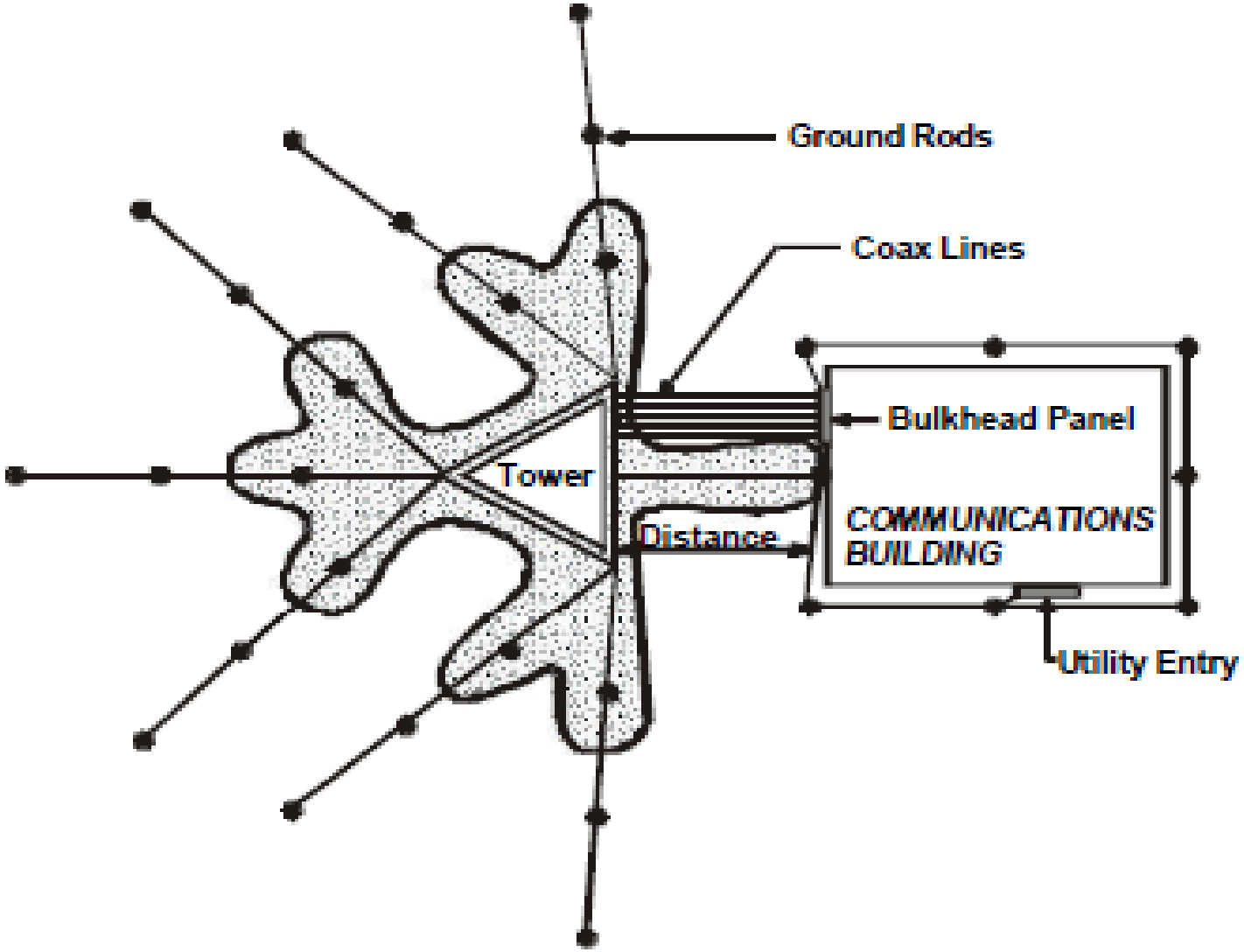

Antenna
Coaxial grounded
on top
Tower
Guy-wire
Coaxial grounded
at tower base
Coaxial
Telco
Shack
SPGP
Strap
Radials system
with rods
Binding ground radial
Perimeter ground
Tower bonded to RE-bar
in concrete base
Anchrorage system
grounded to rods and radials


Grounding system viewed from top
Perimeter ground
Shack in house
Coaxial
Tower
SPGP
AC I/O
Anchor bonded
to radials
Radials bonded
to rods

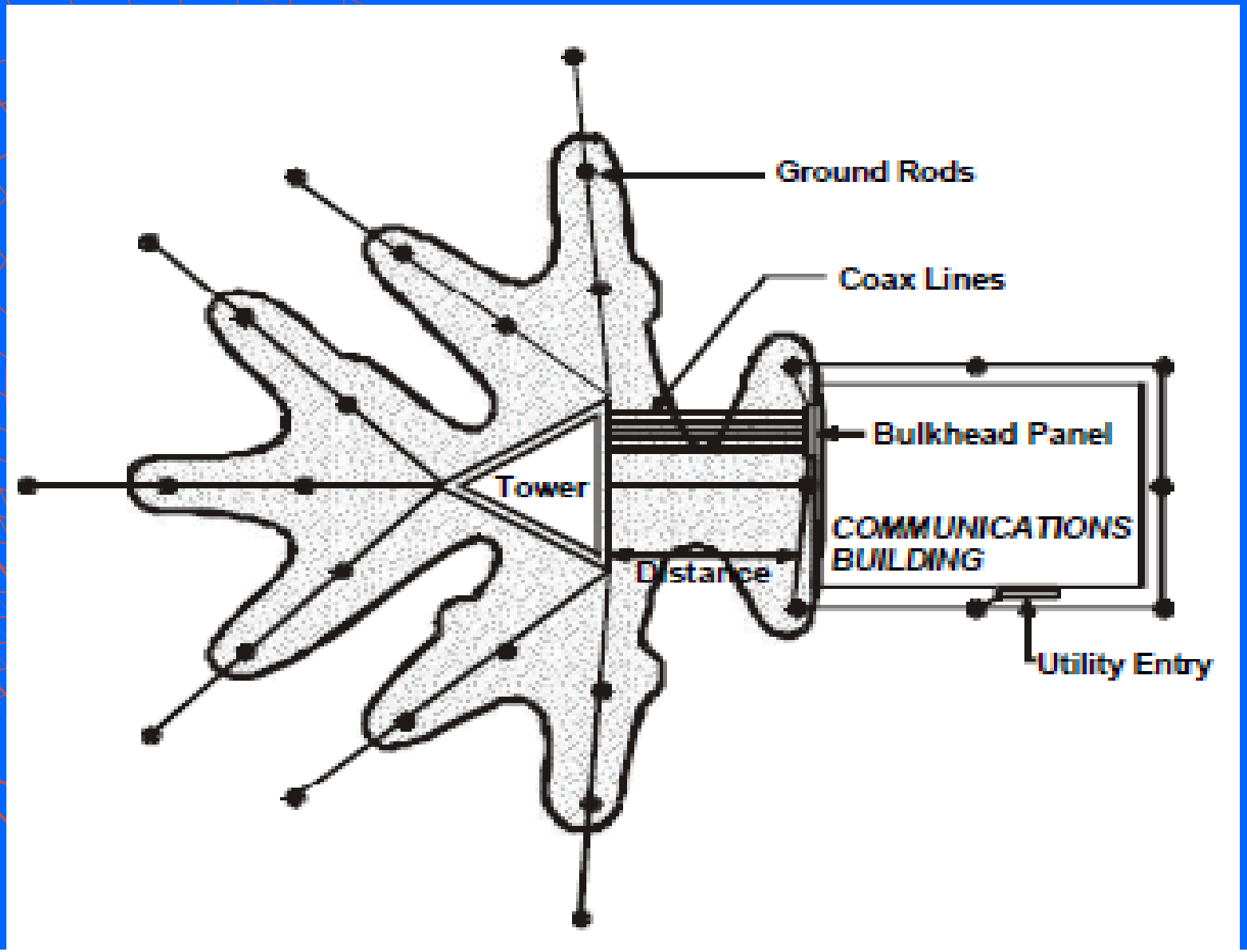
Lightning strike ground saturation before strike @ t = -



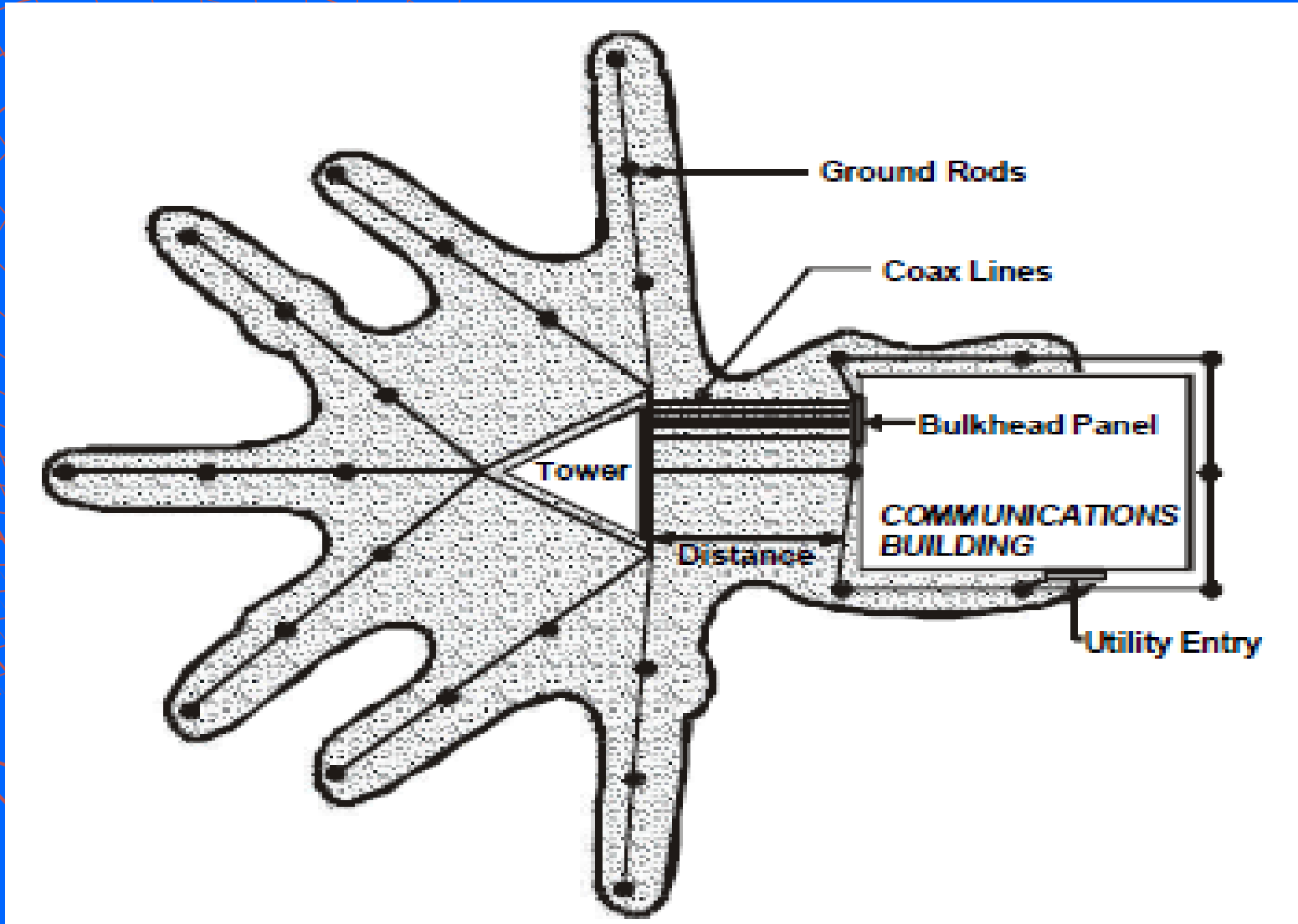
Lightning strike ground saturation immediately after incident @ t = +



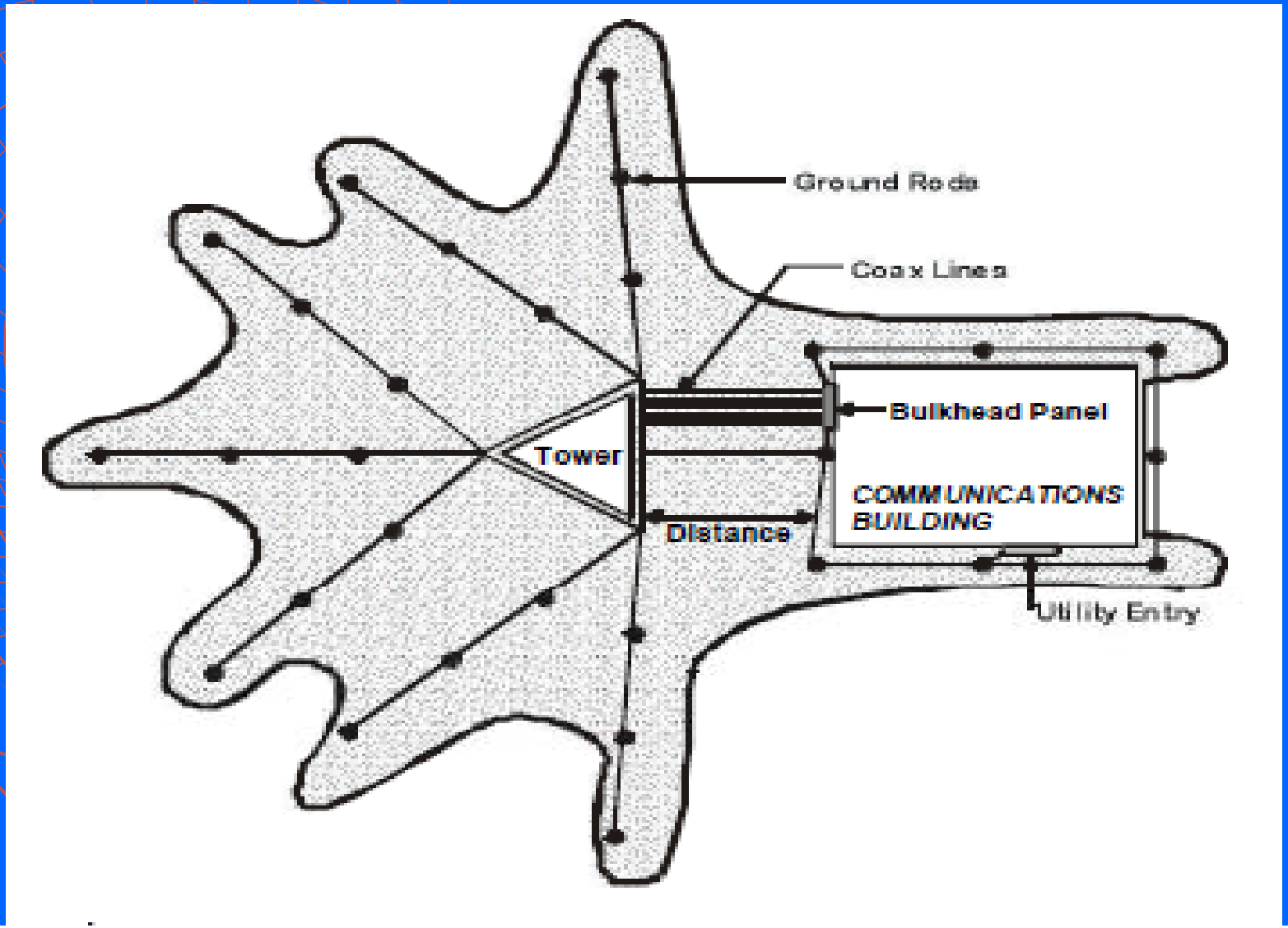
Lightning strike ground saturation immediately after incident @ t = 2+



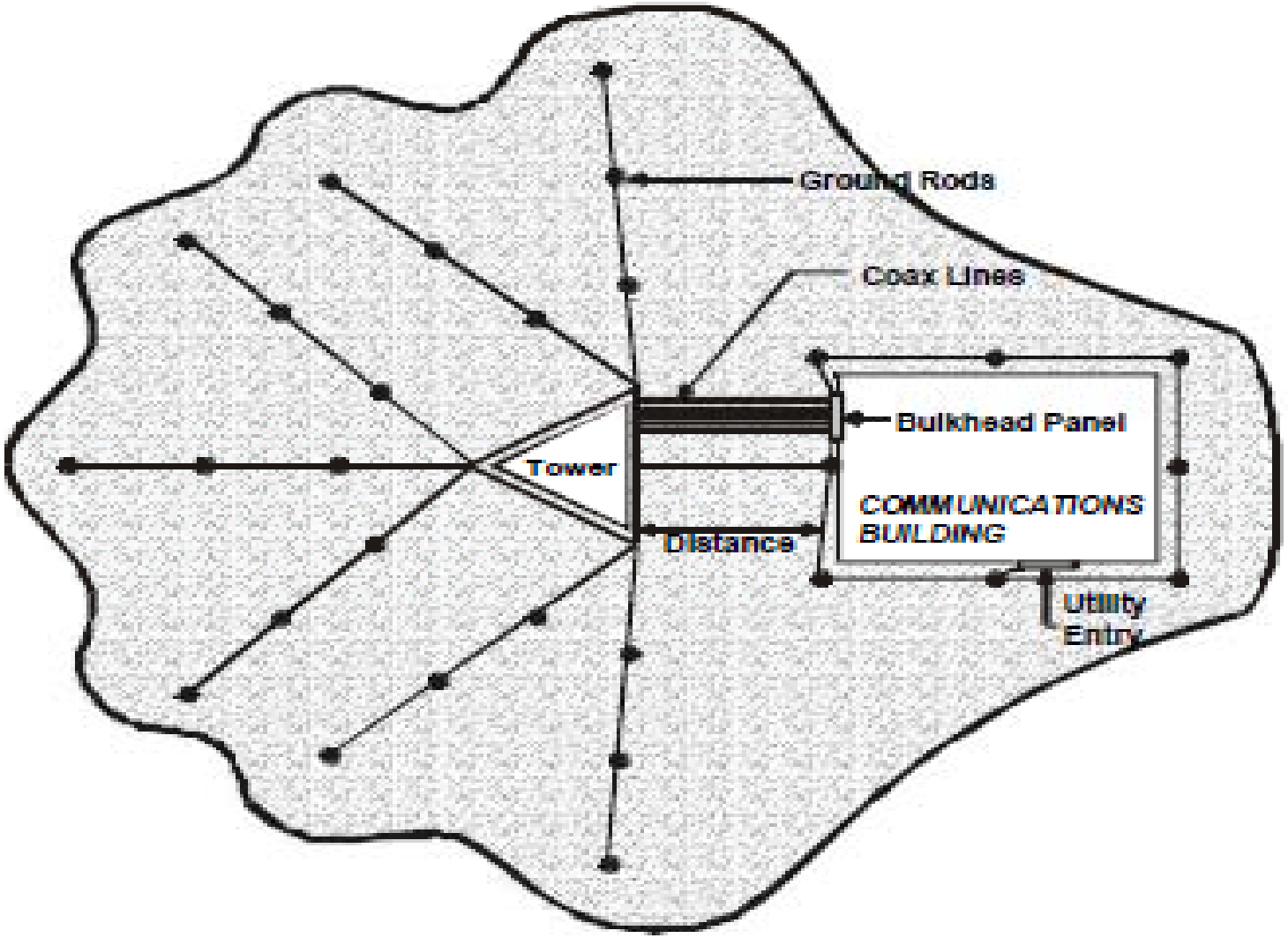
Lightning strike ground saturation immediately after incident @ t = 3+



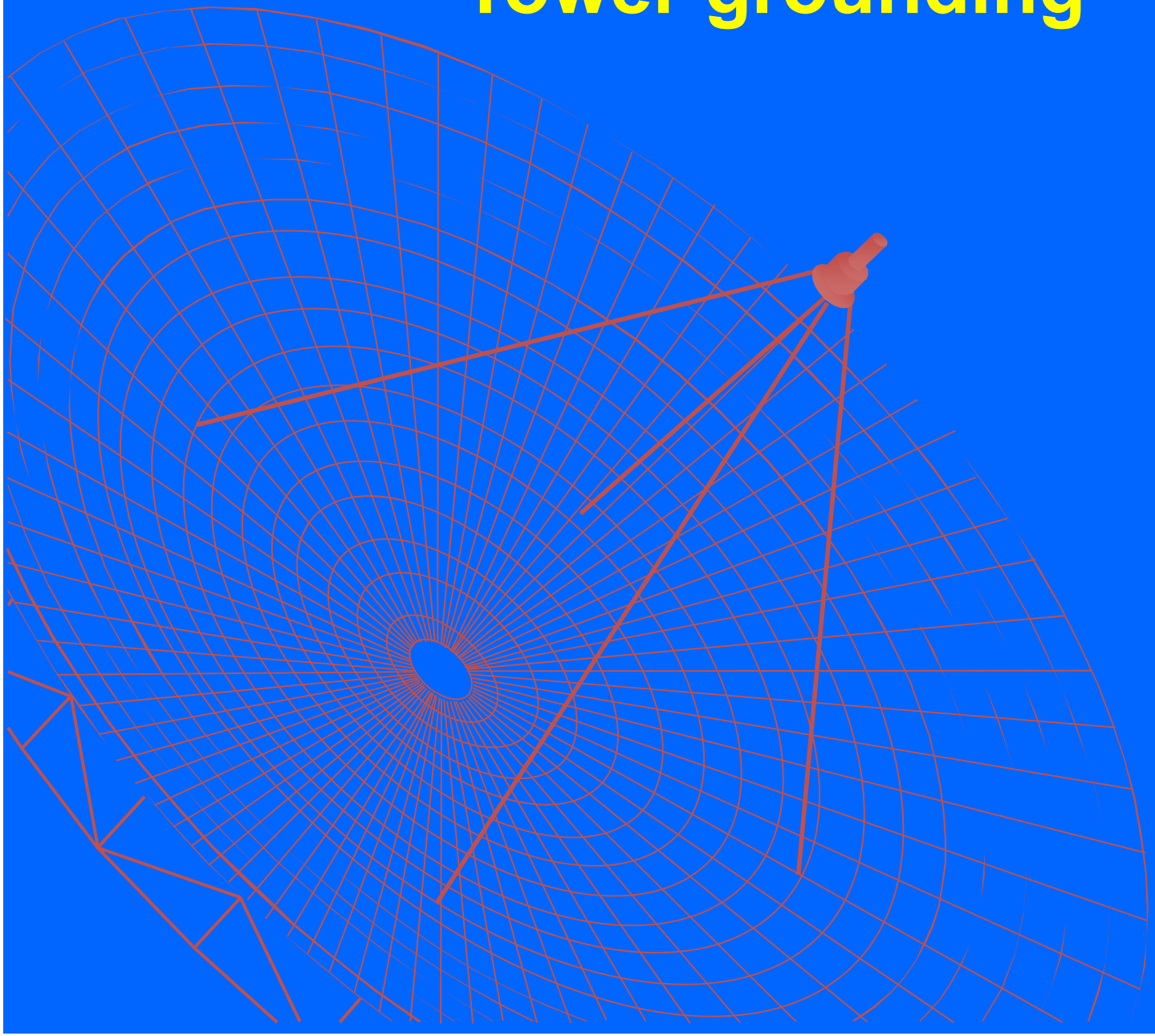
Lightning strike ground saturation immediately after incident @ t = 4+

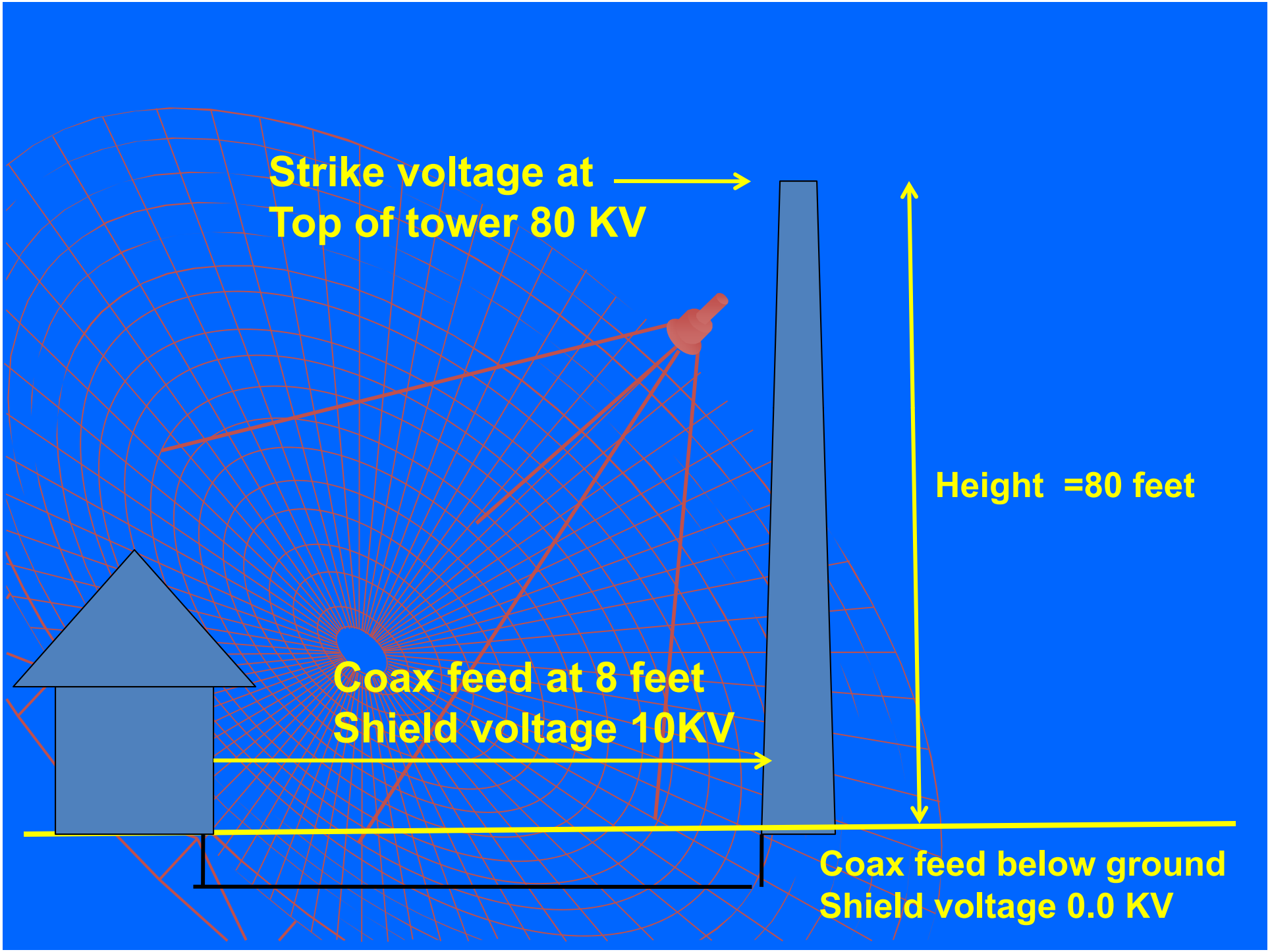


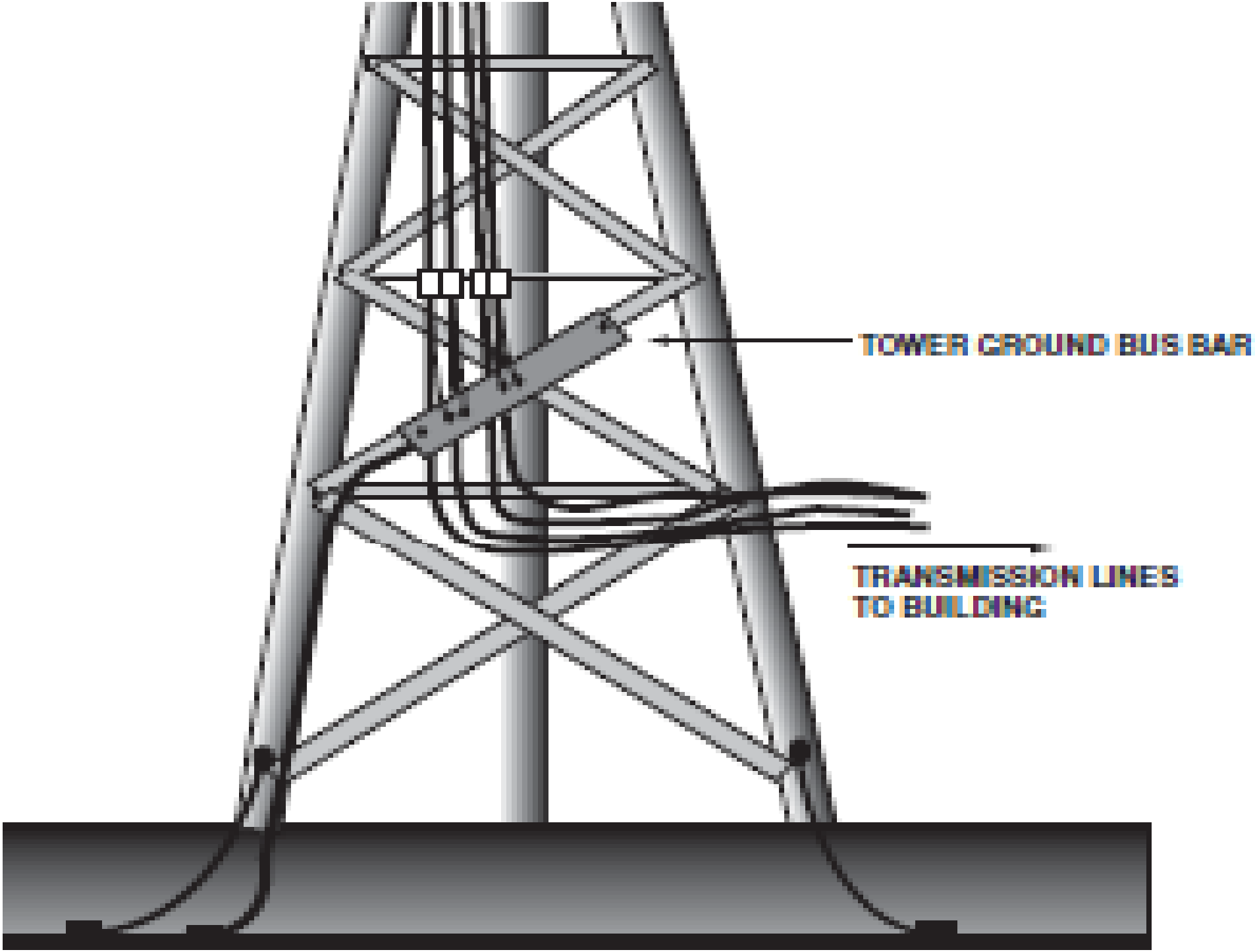
Lightning strike ground saturation immediately after incident @ t = 5+



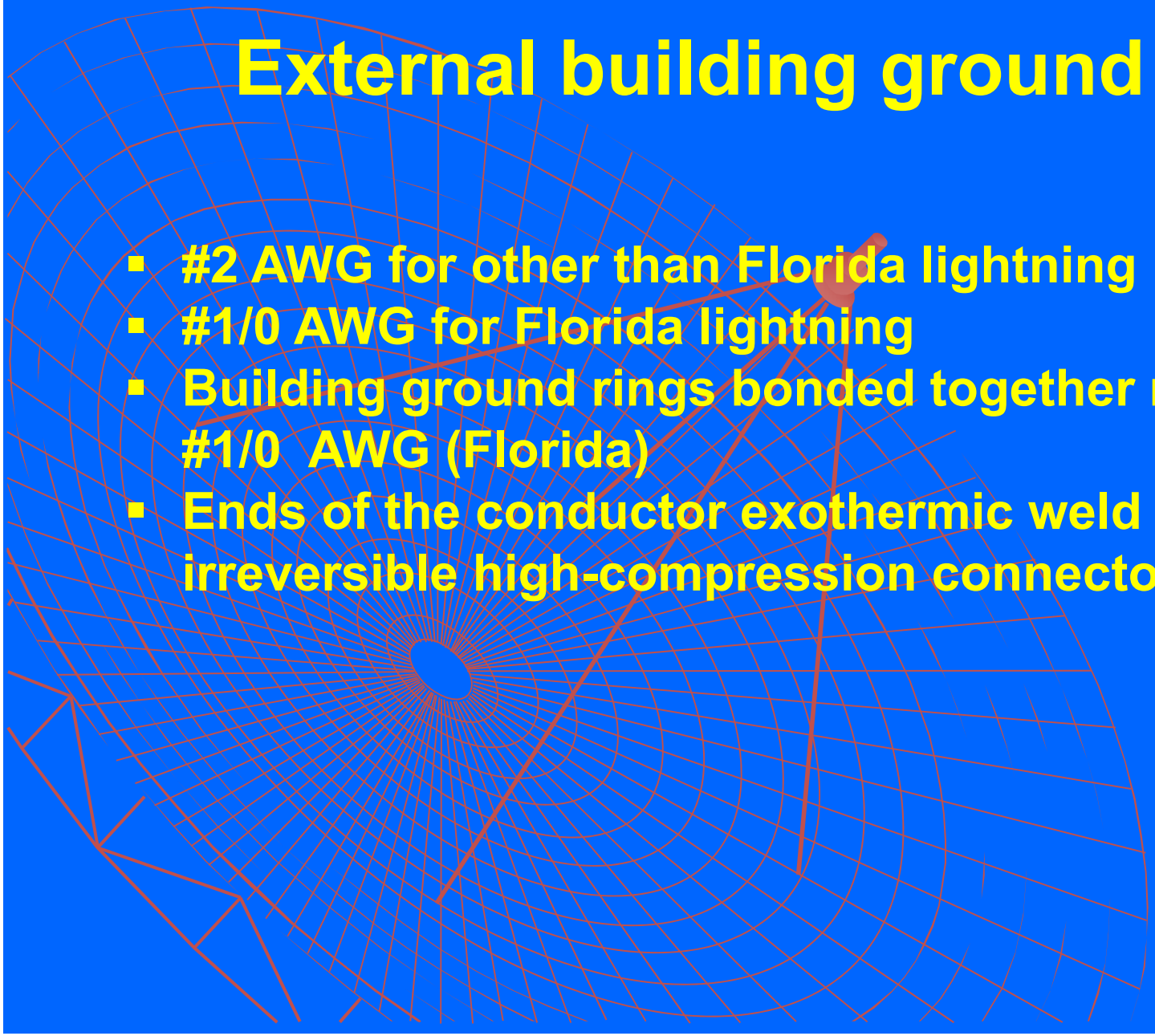
Tower grounding




Strike voltage at
Top of tower 80 KV
Height =80 feet
Coax feed at 8 feet
Shield voltage 10KV
Coax feed below ground
Shield voltage 0.0 KV


TOWER GROUND BUS BAR
TRANSMISSION LINES
TO BUILDING

External building ground ring

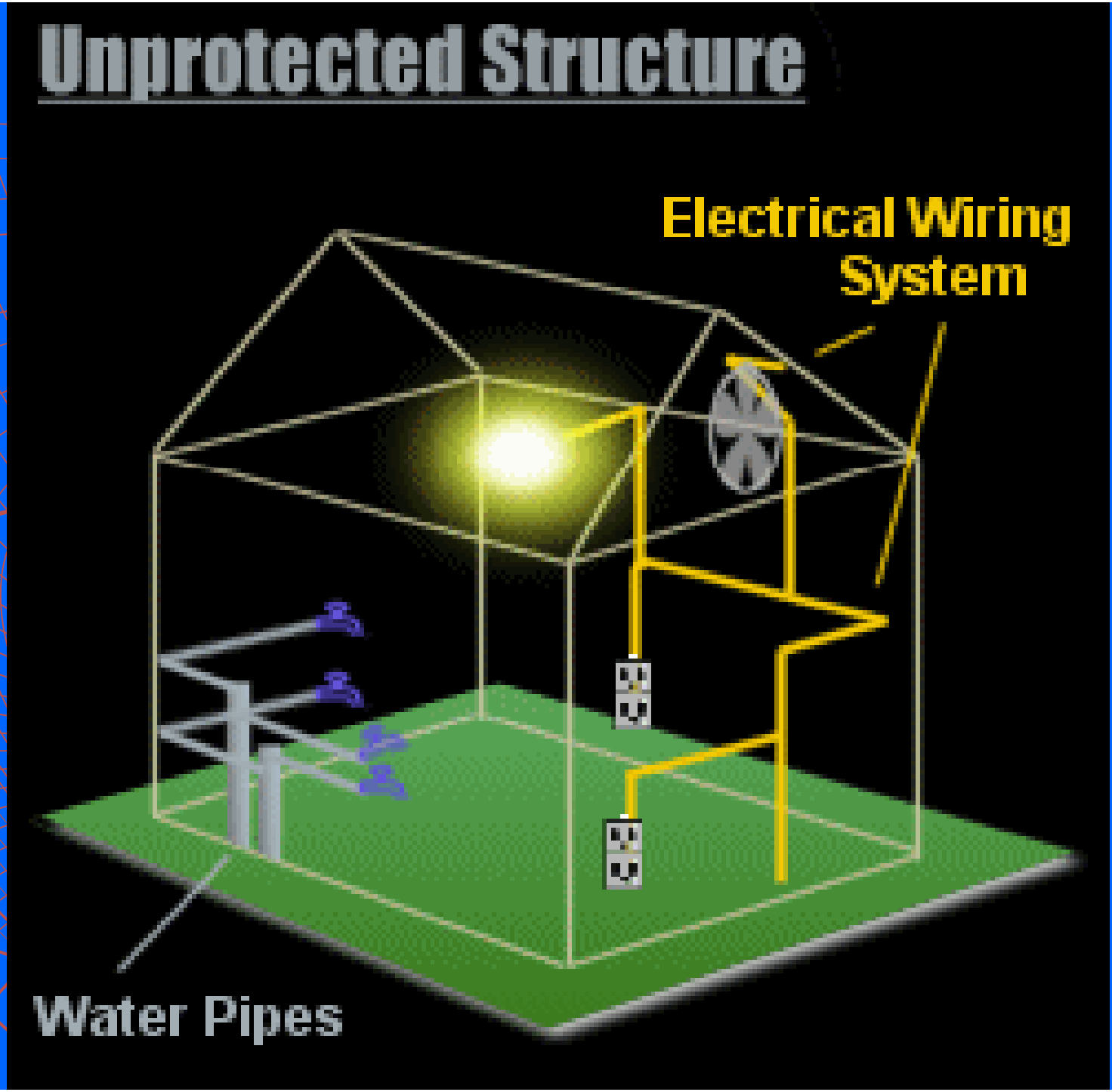


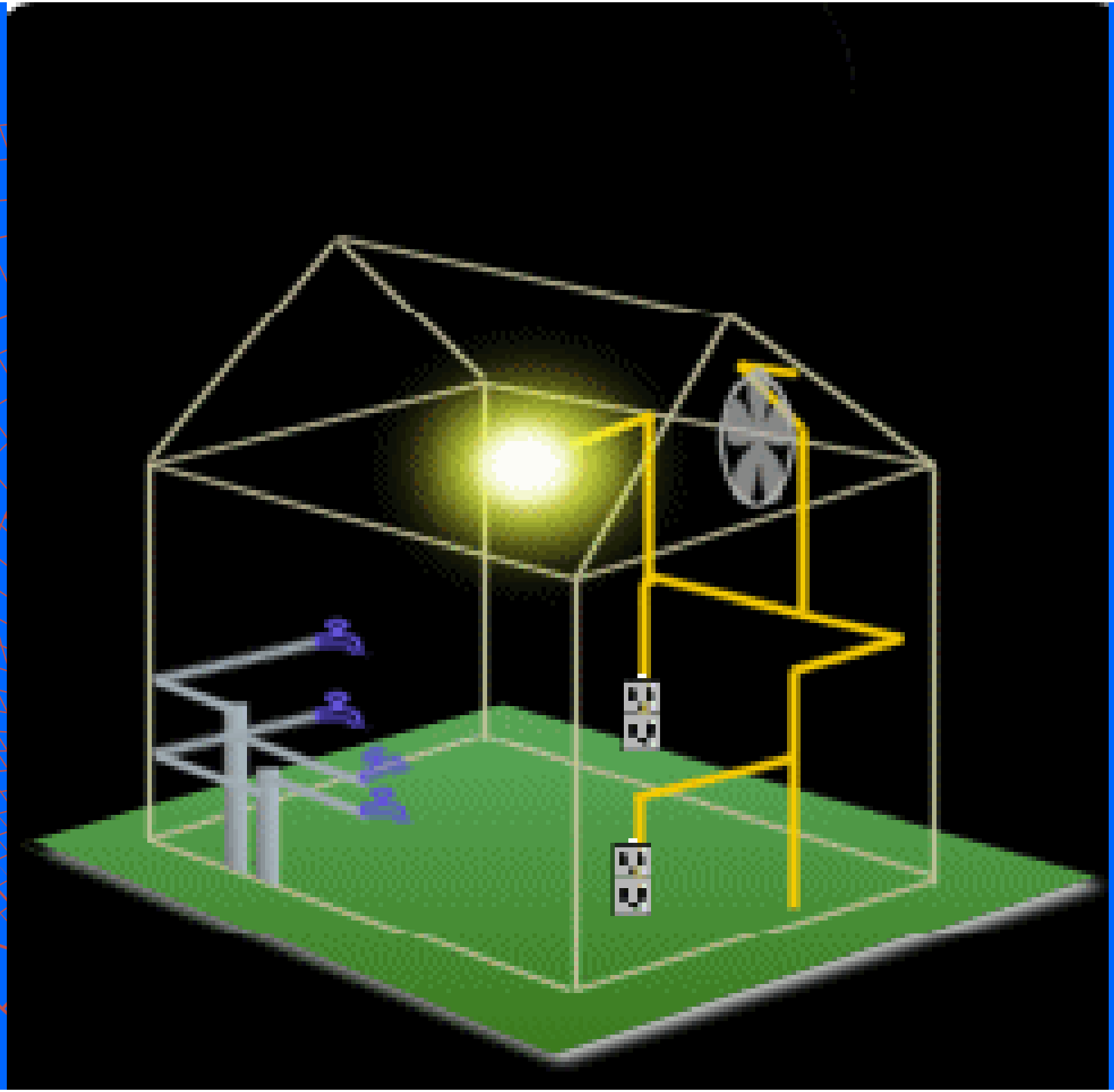
- #2 AWG for other than Florida lightning
- #1/0 AWG for Florida lightning
- Building ground rings bonded together minimum #1/0 AWG (Florida)
- Ends of the conductor exothermic weld or listed irreversible high-compression connector

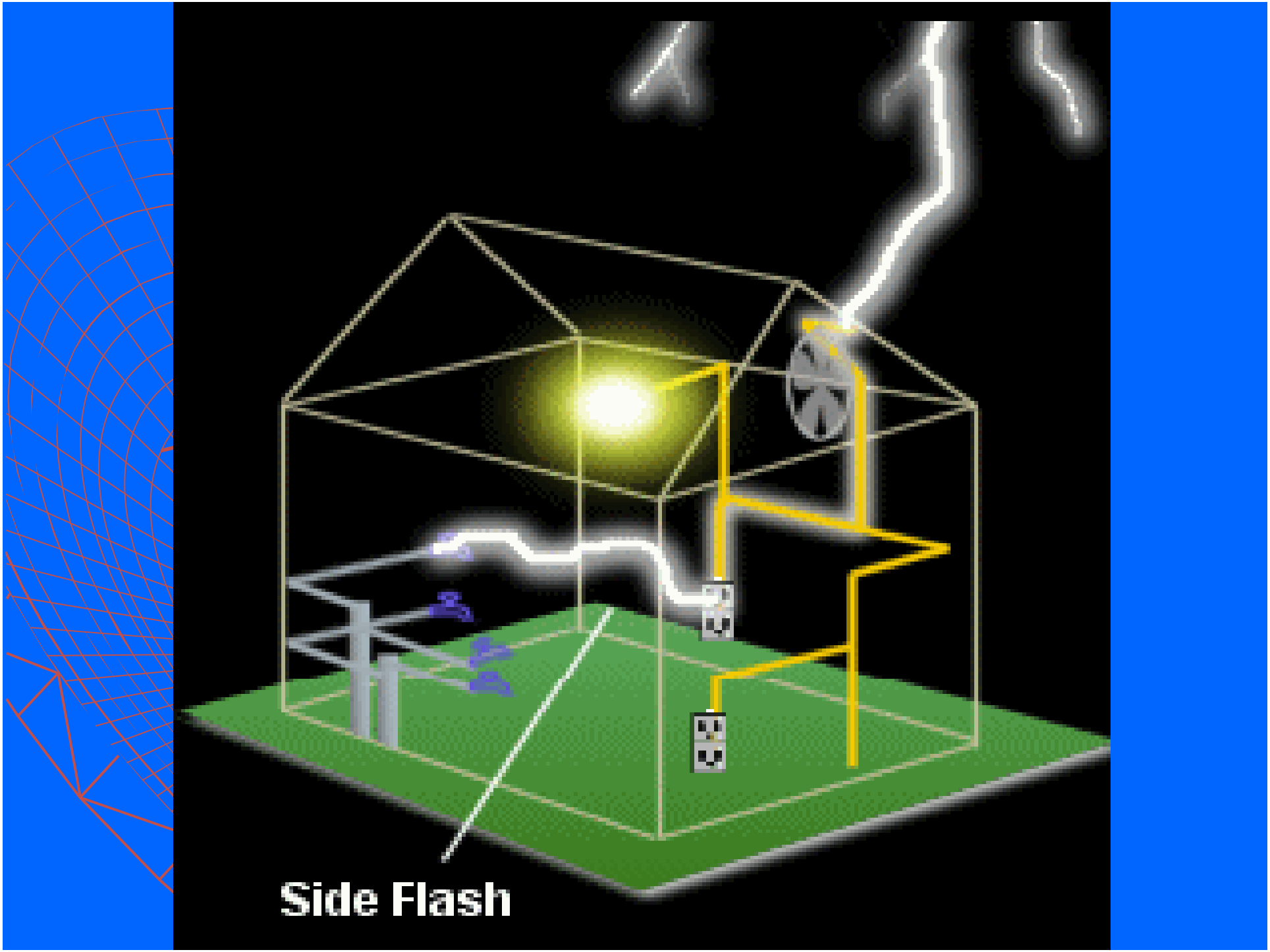
Feed Lines and Grounding

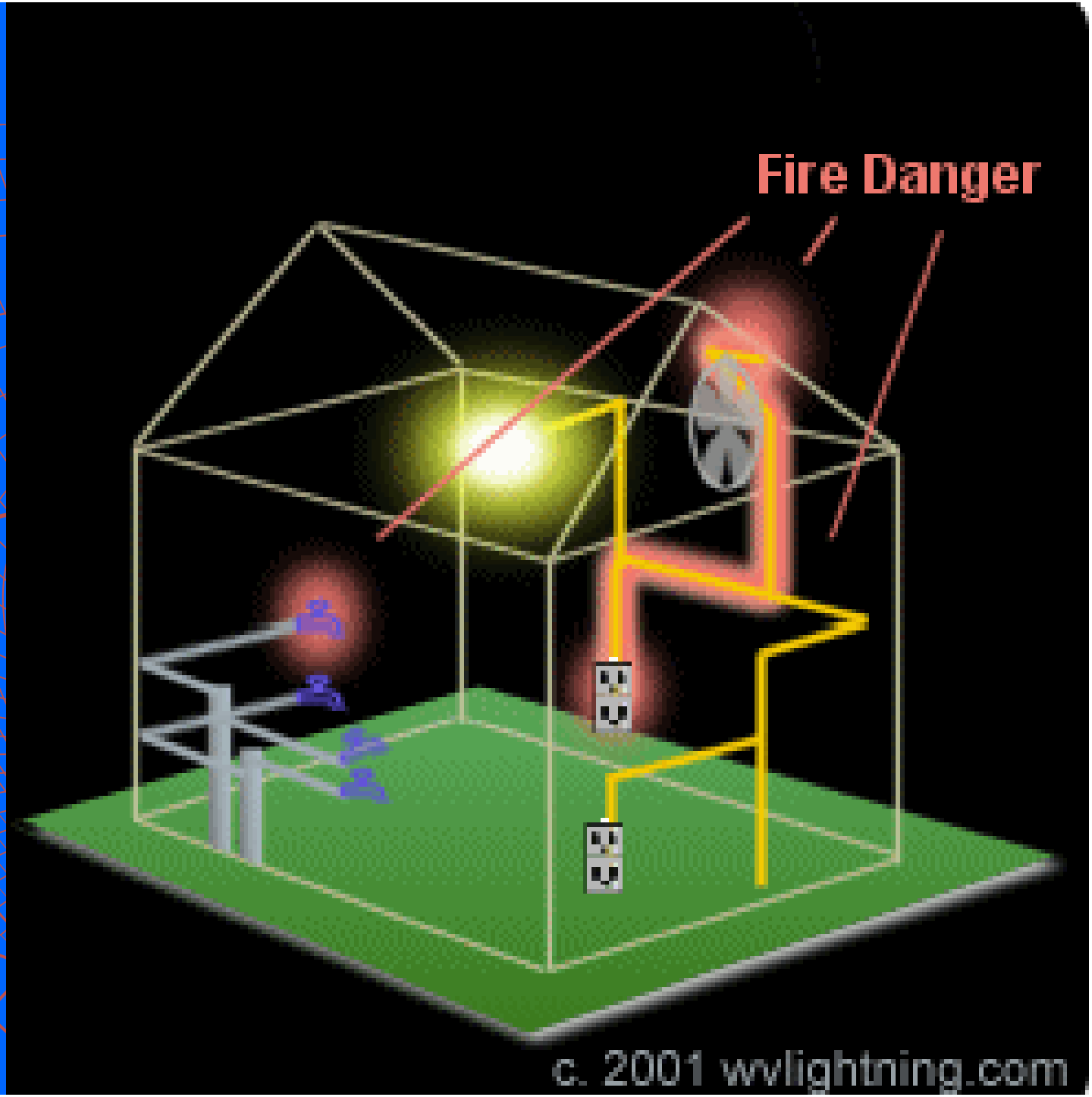
- Coax lines -- in underground conduit rather than going overhead.
- In-line surge protectors on coax and shunt protectors on rotator cable at the base of the tower.
- Ground rods at each tower leg and additional rods spaced at twice their length and all tied together
- Perimeter ground and the AC service ground at entrance panel (service ground).
- Single Point Ground at entry point to shack tied to perimeter ground.
- Feed lines: Ground coax shields at base of tower

Unprotected Structure

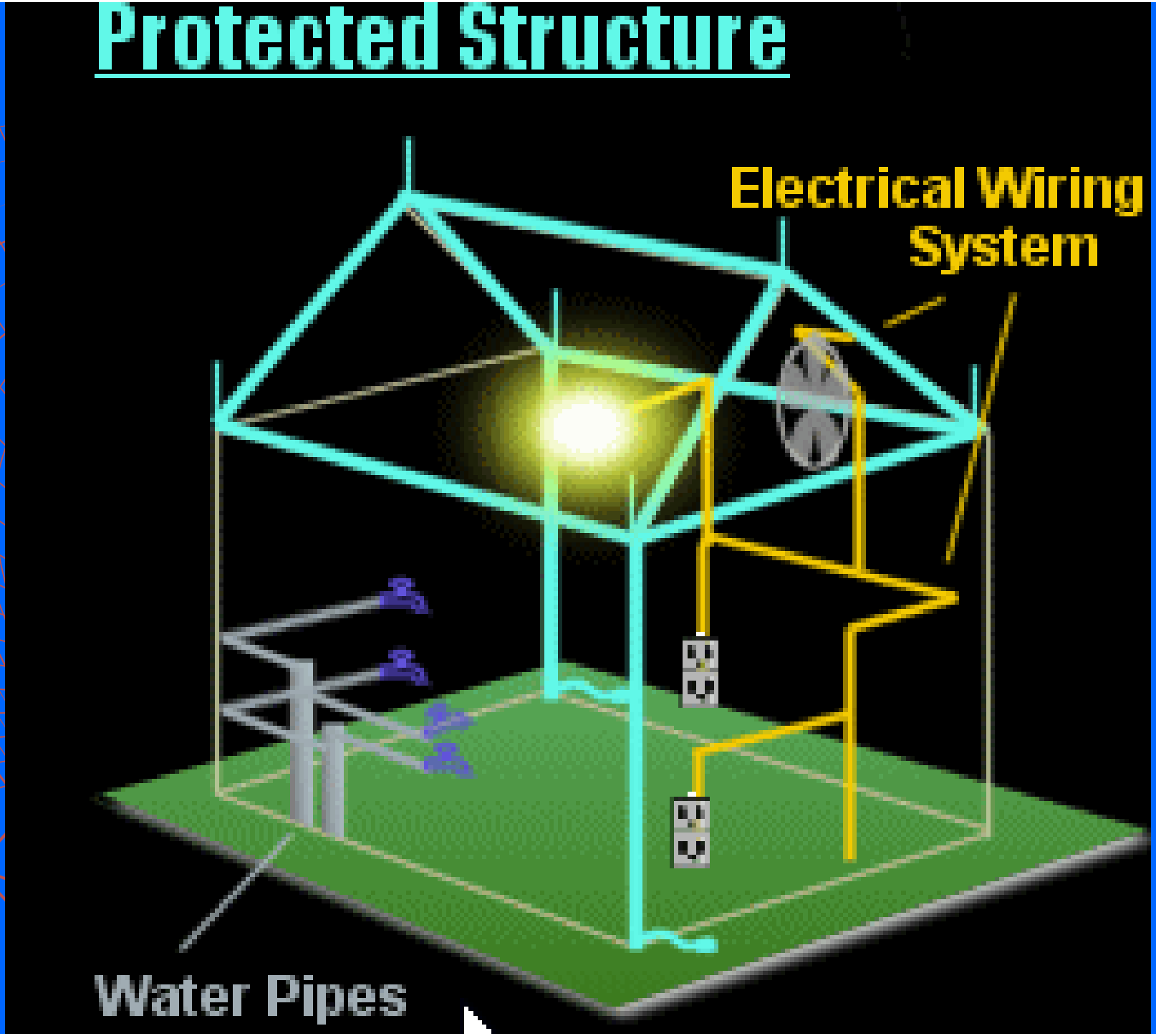


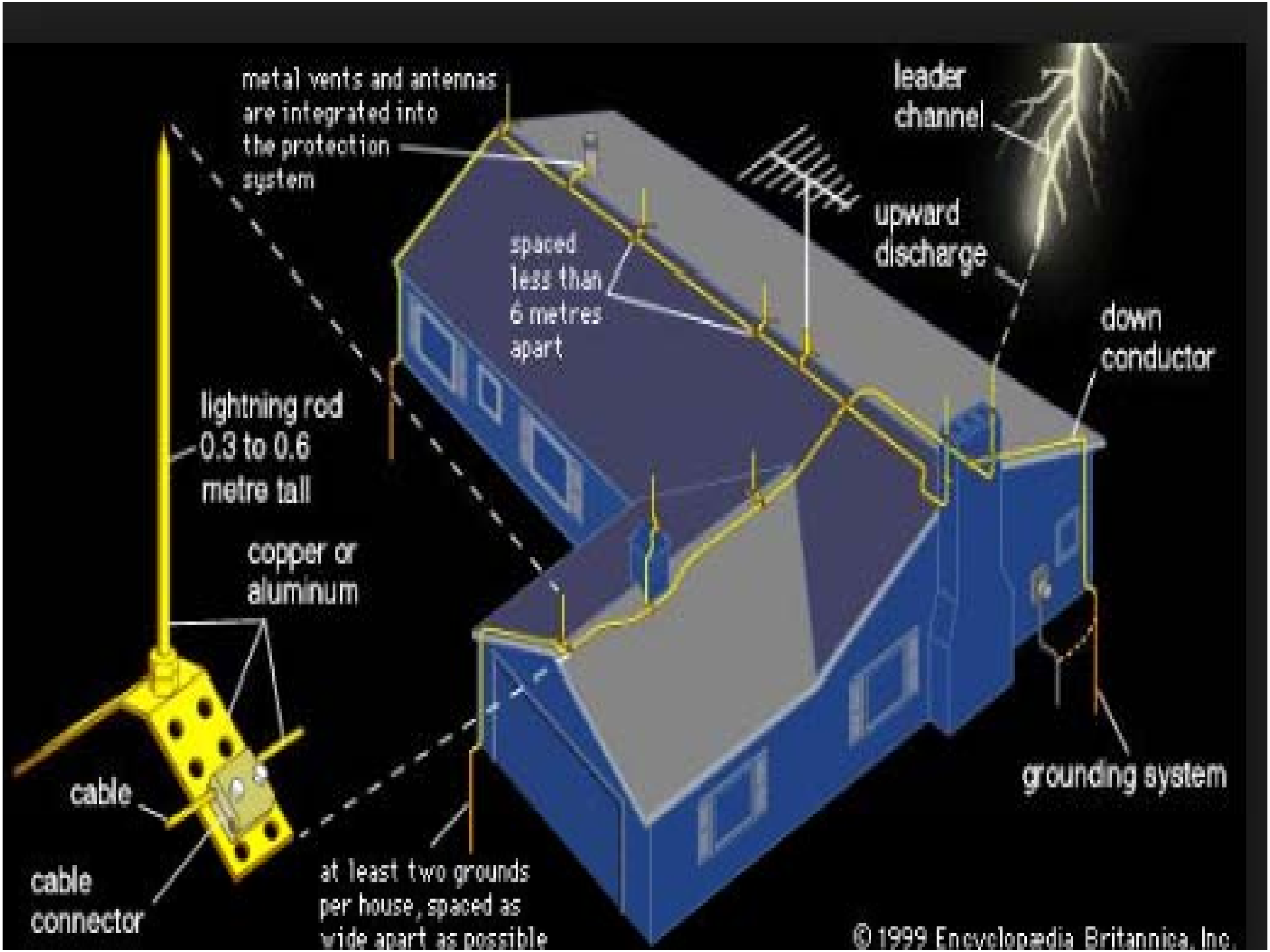



Side Flash


Fire Danger
c. 2001 wvlightning.com

Protected Structure




metal vents and antennas are integrated into the protection system
leader channel
upward discharge
spaced less than 6 metres apart
down conductor
lightning rod 0.3 to 0.6 metre tall
copper or aluminum
cable
cable connector
at least two grounds per house, spaced as wide apart as possible
grounding system
© 1999 Encyclopaedia Britannica, Inc.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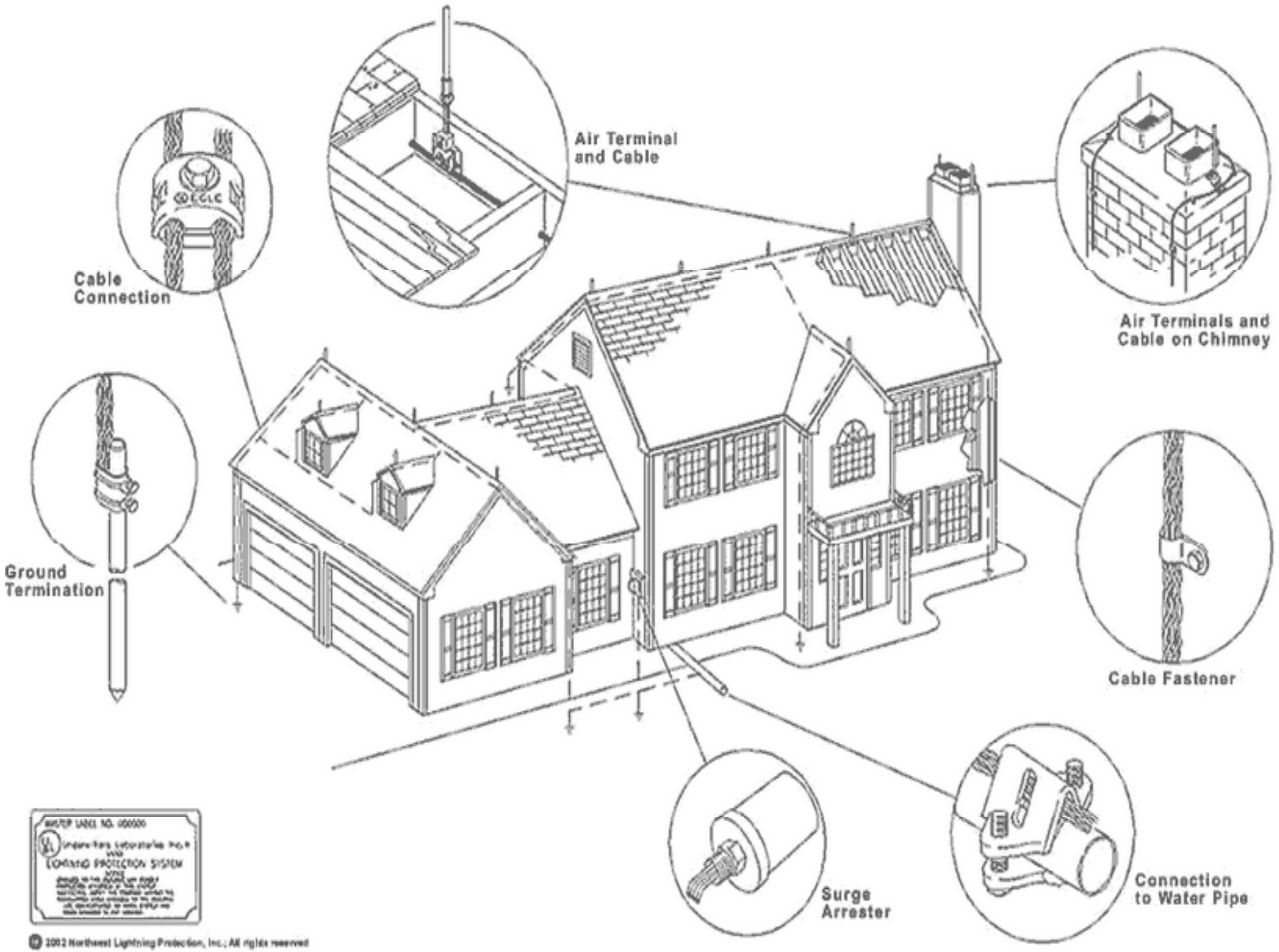
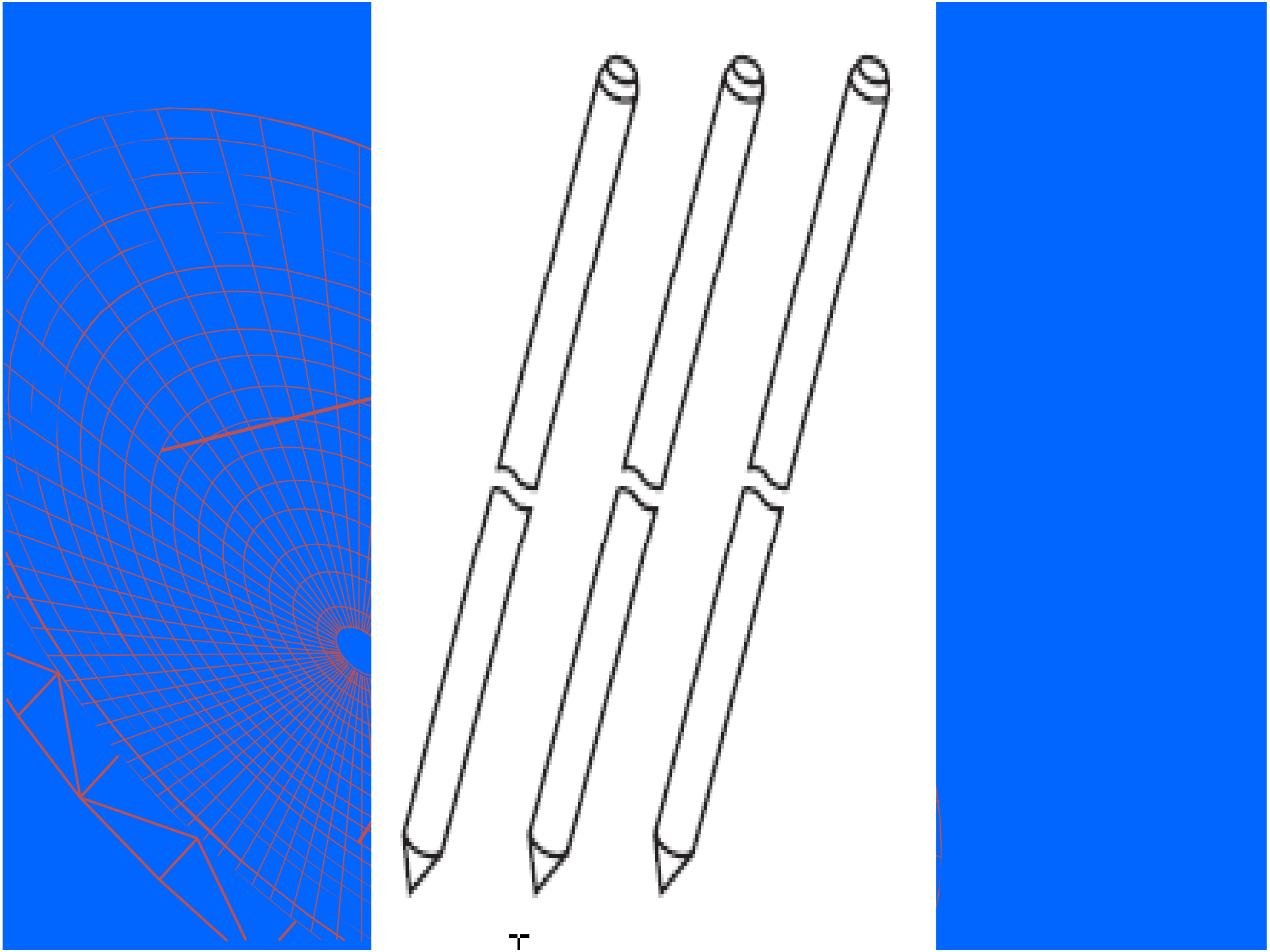
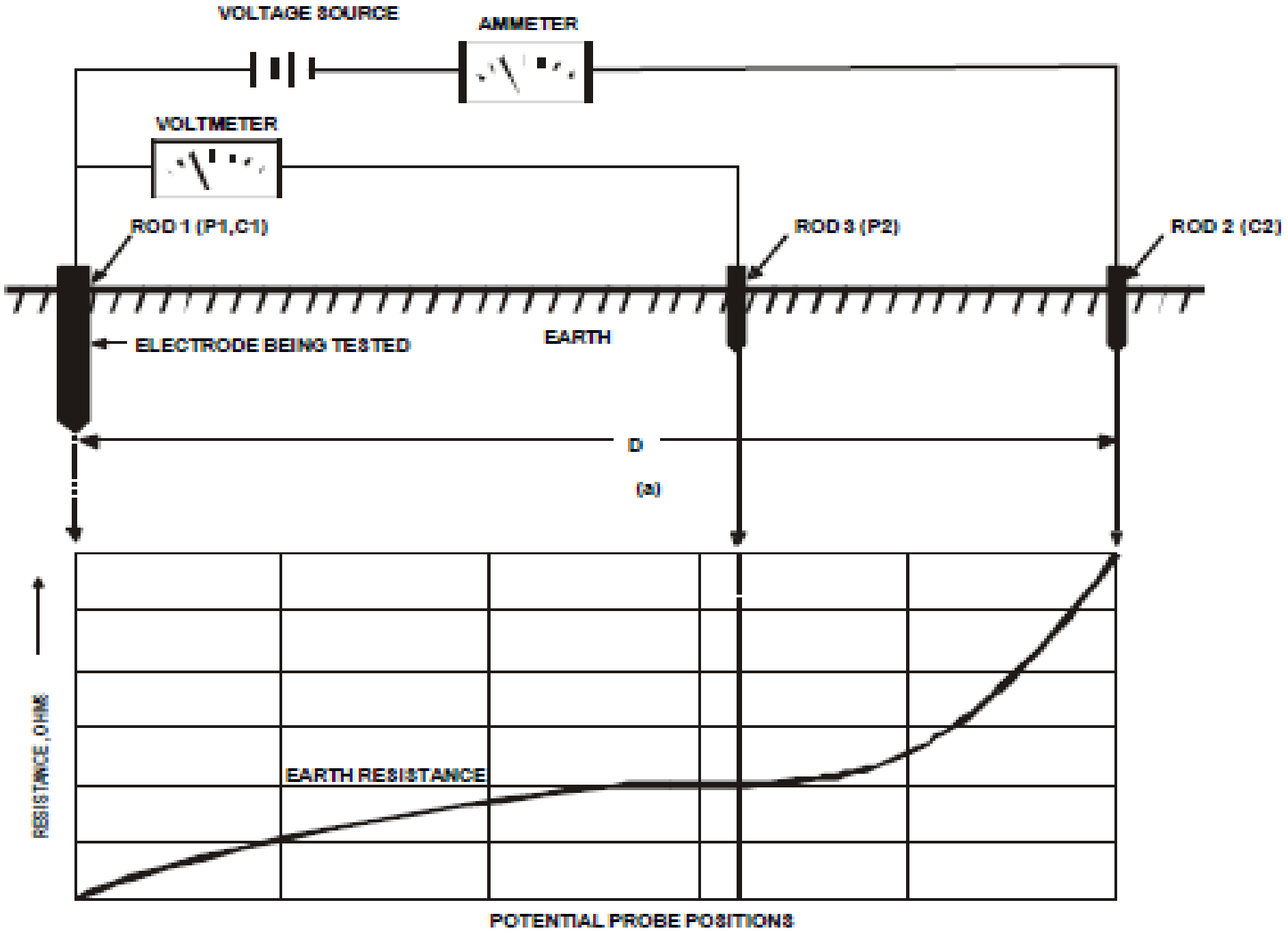
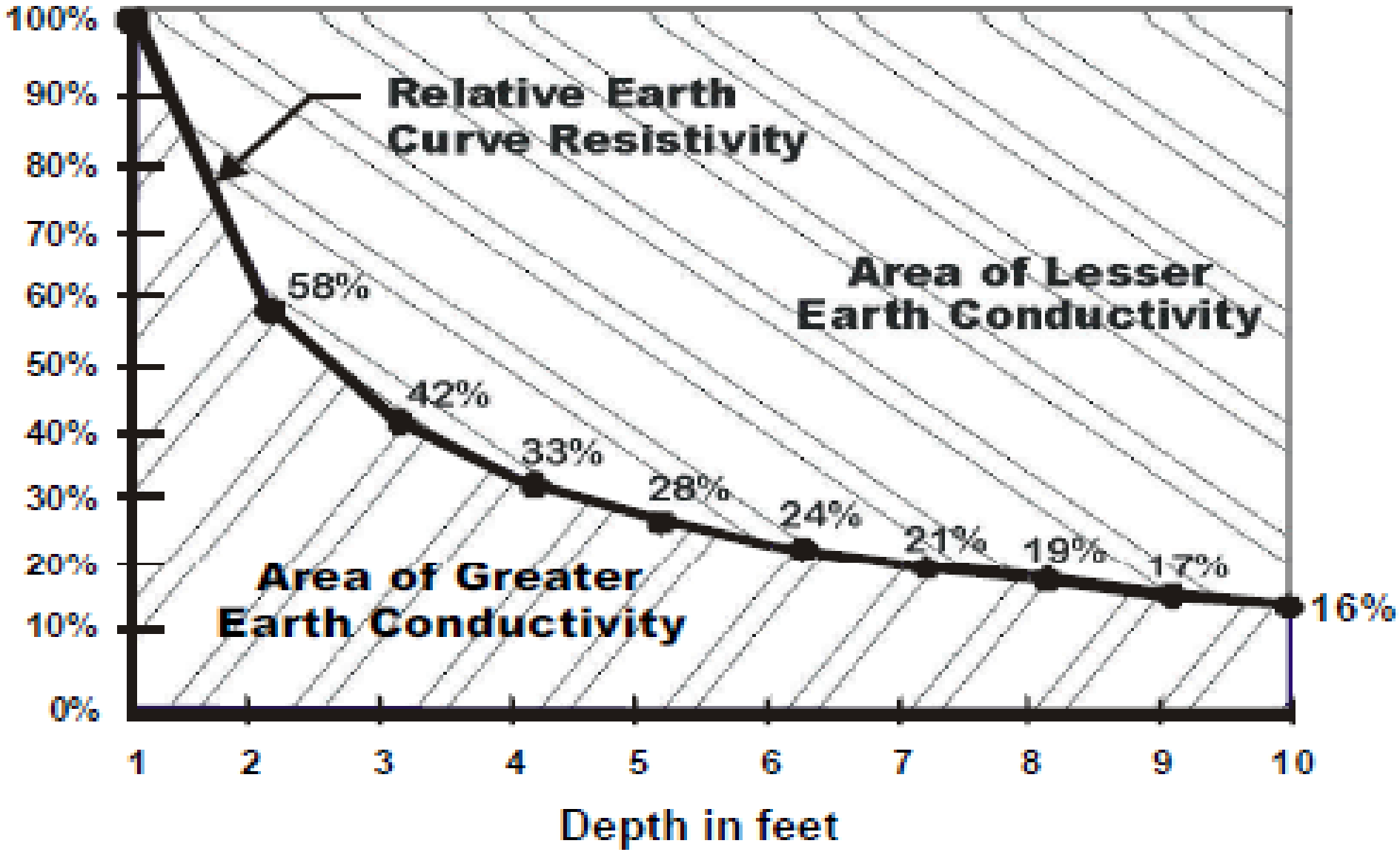


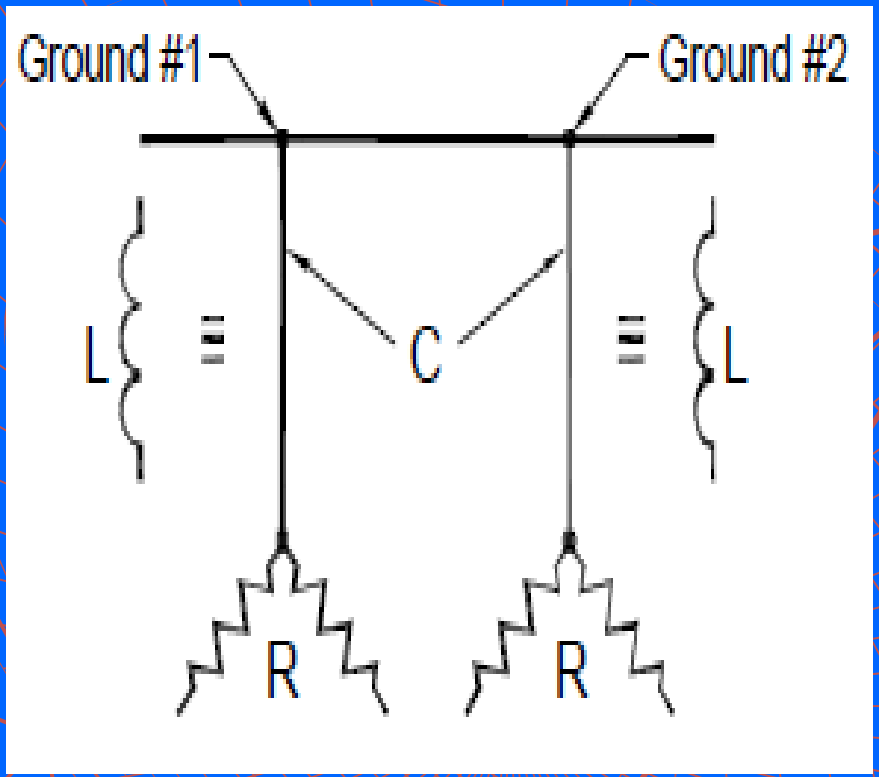


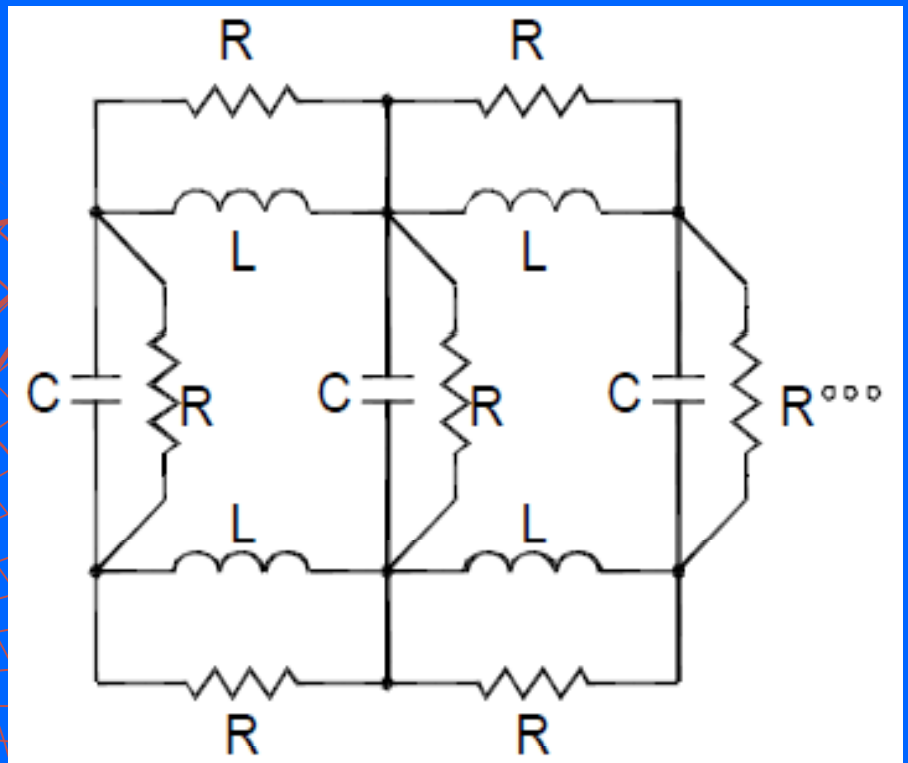

VOLTAGE SOURCE
AMMETER
VOLTMETER
ROD 1 (P1,C1)
ROD 3 (P2)
ROD 2 (C2)
ELECTRODE BEING TESTED
EARTH
D
(a)
RESISTANCE , OHMS
EARTH RESISTANCE
POTENTIAL PROBE POSITIONS

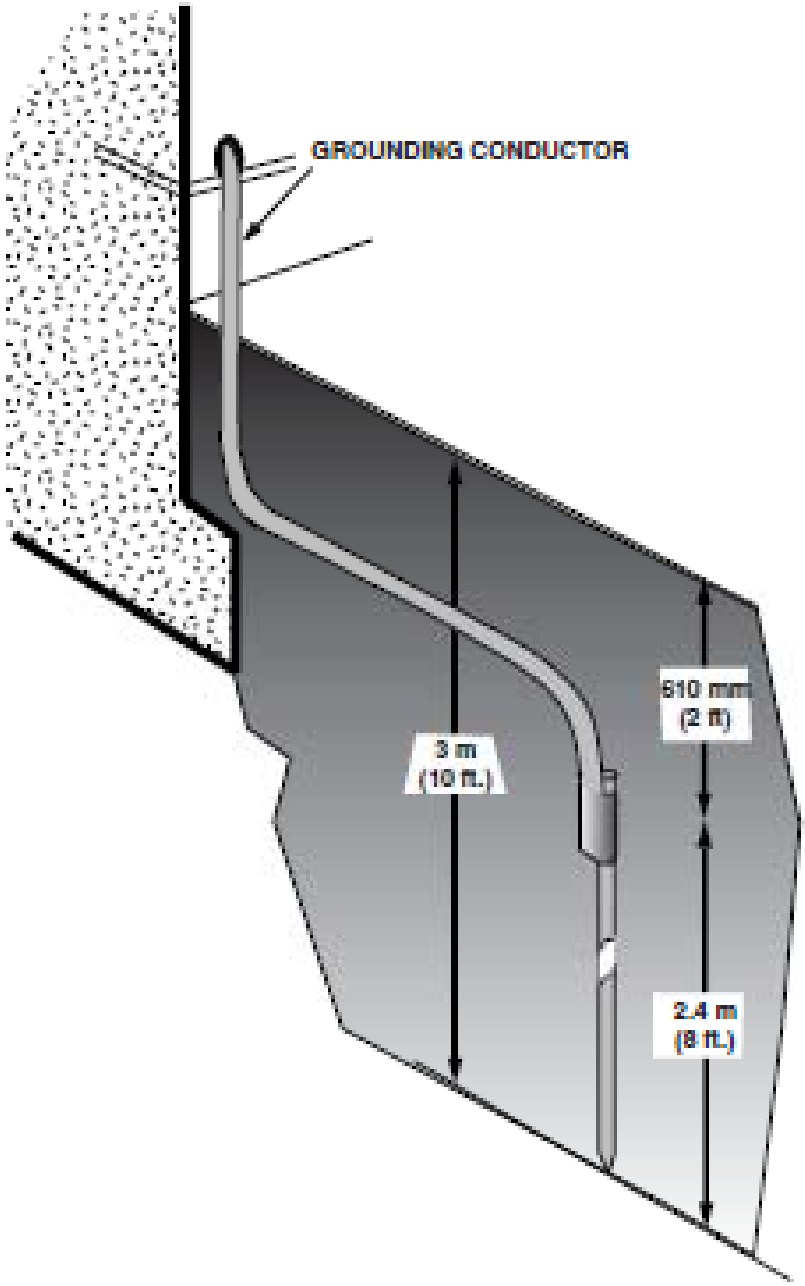
Ground system measuring



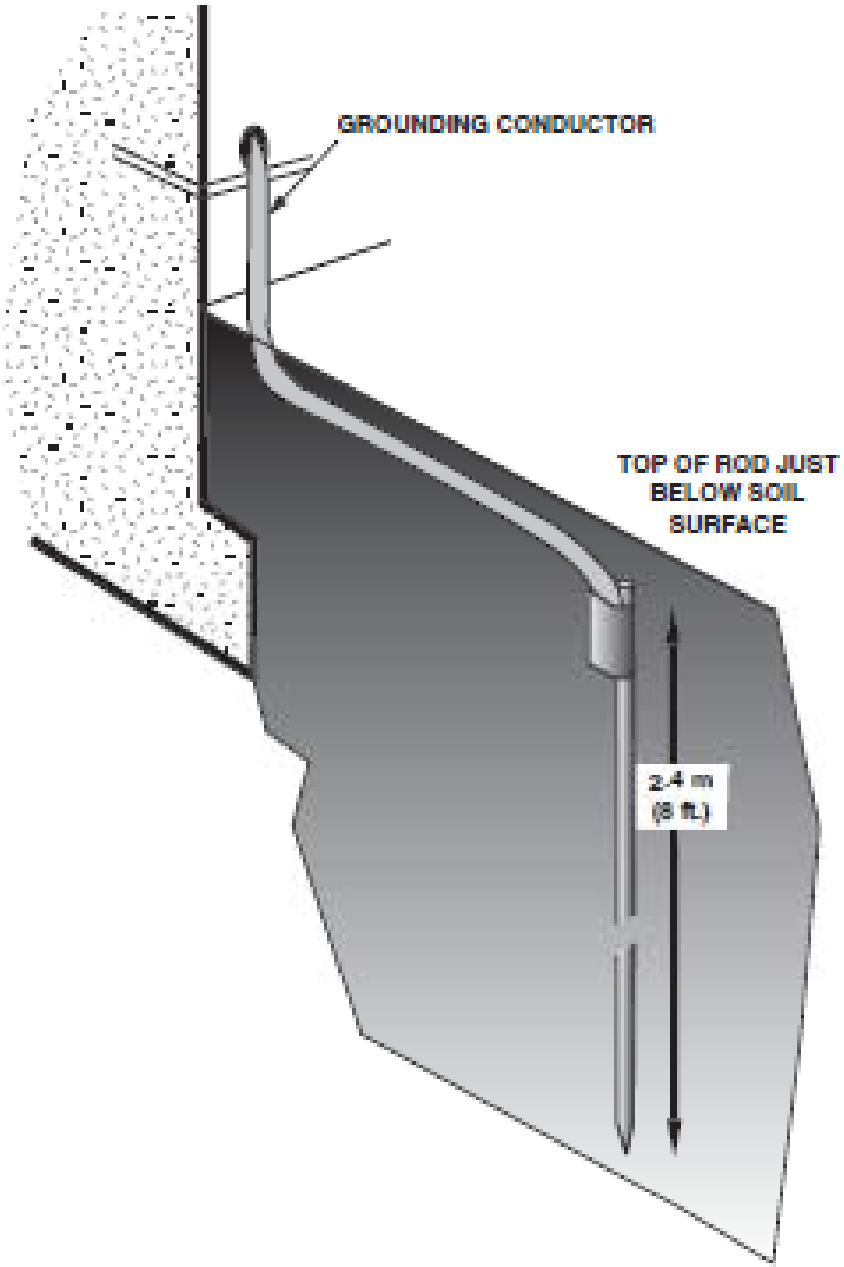
Ground stakes



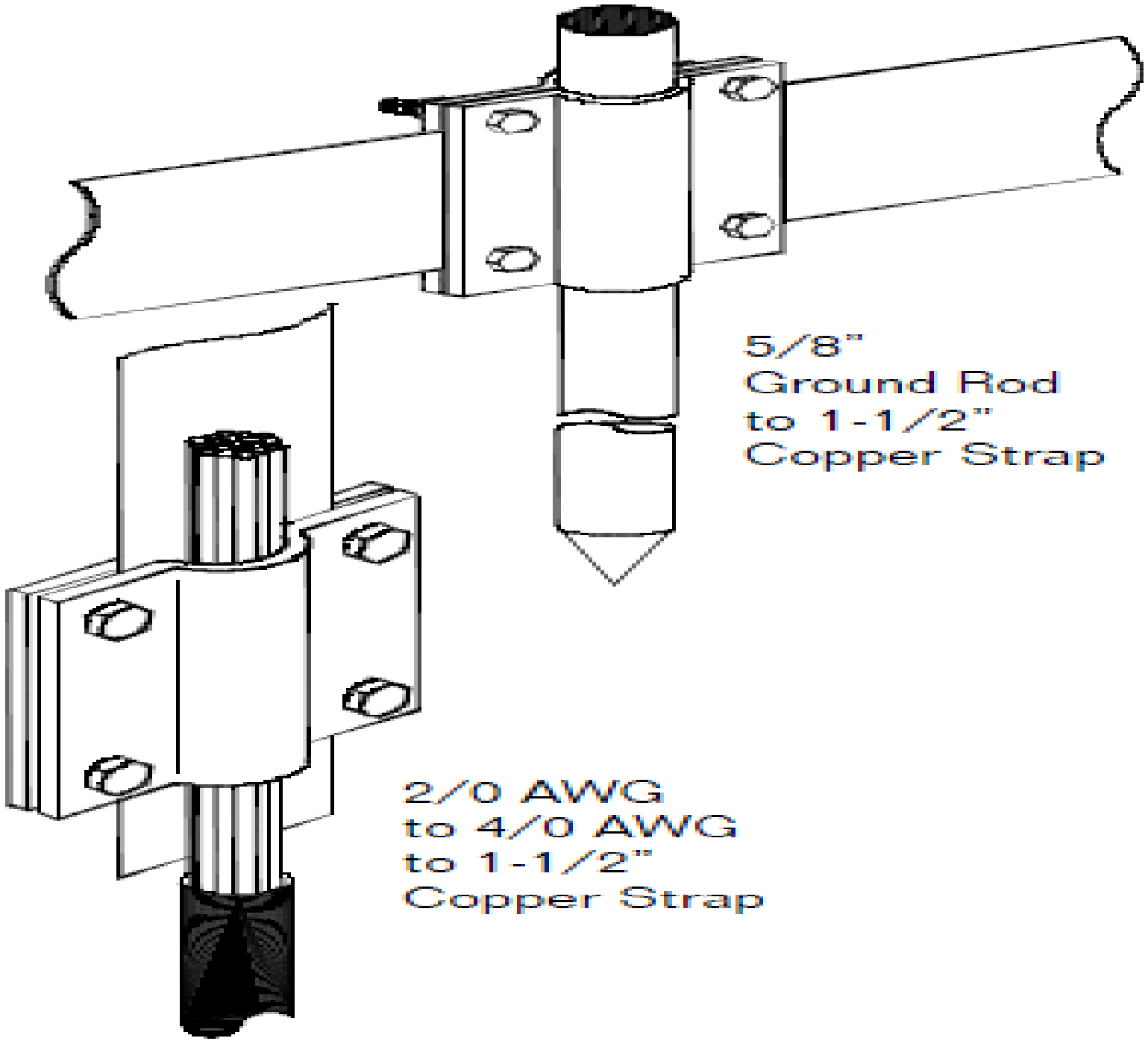


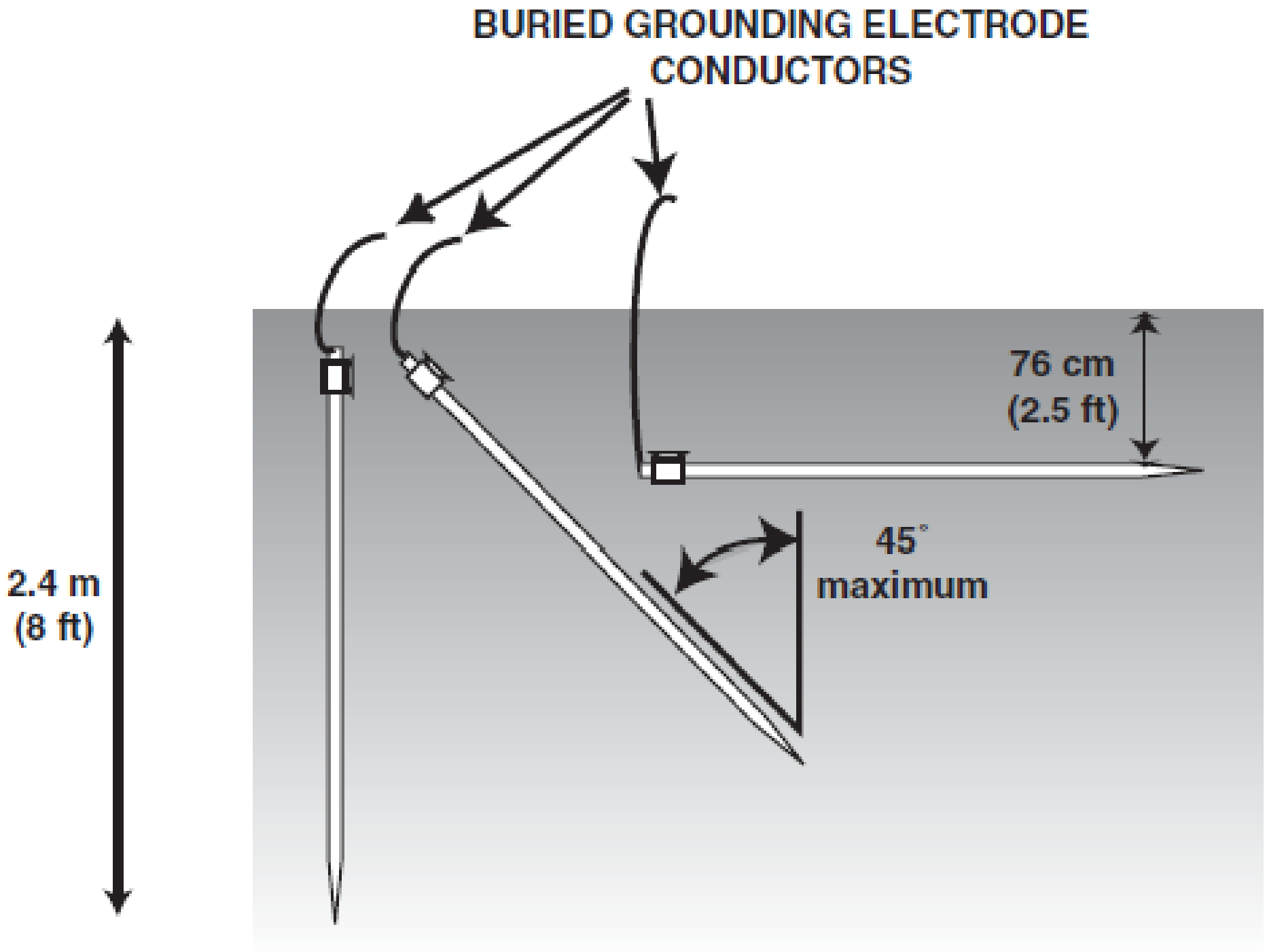


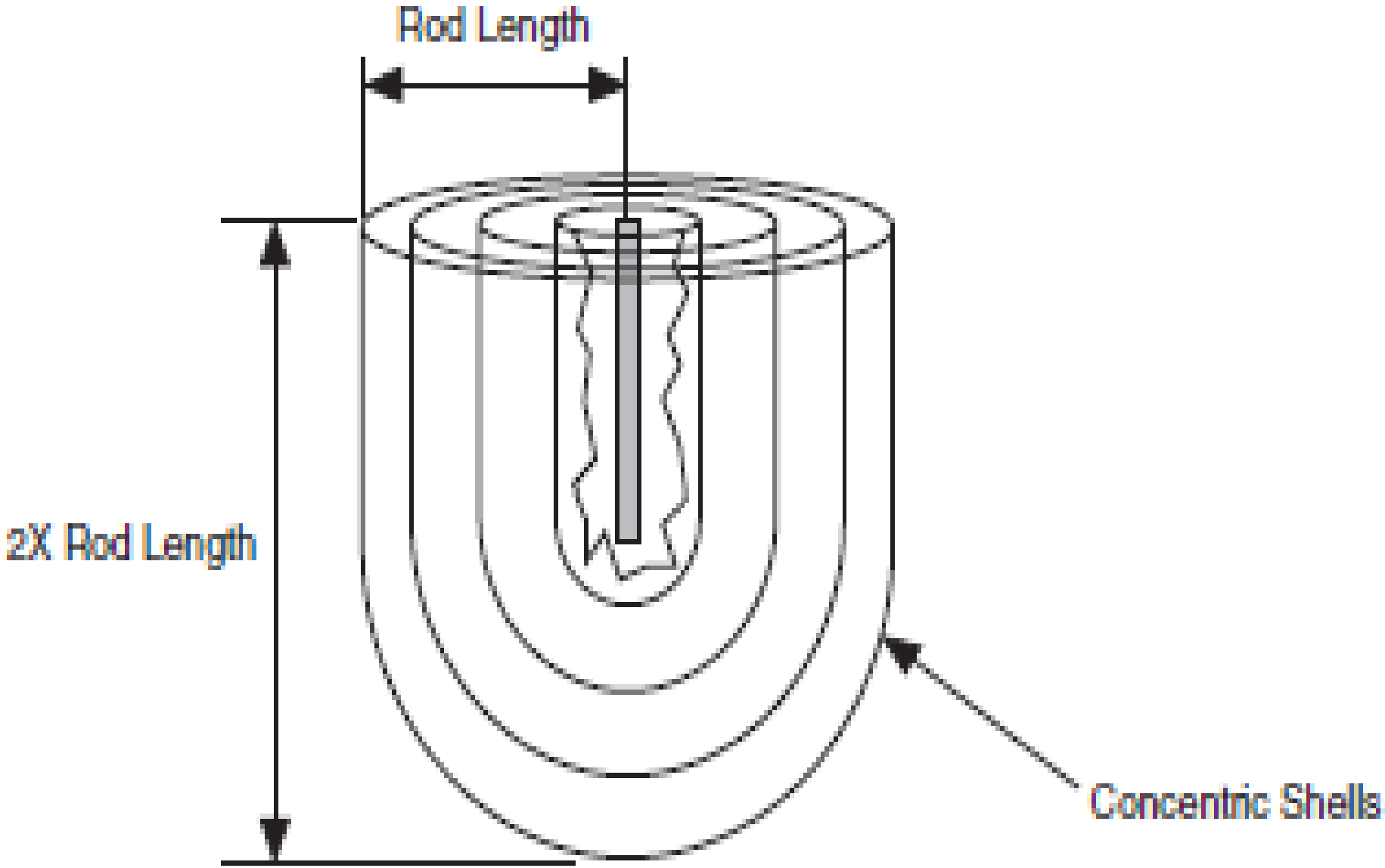
RECOMMENDED DEPTH



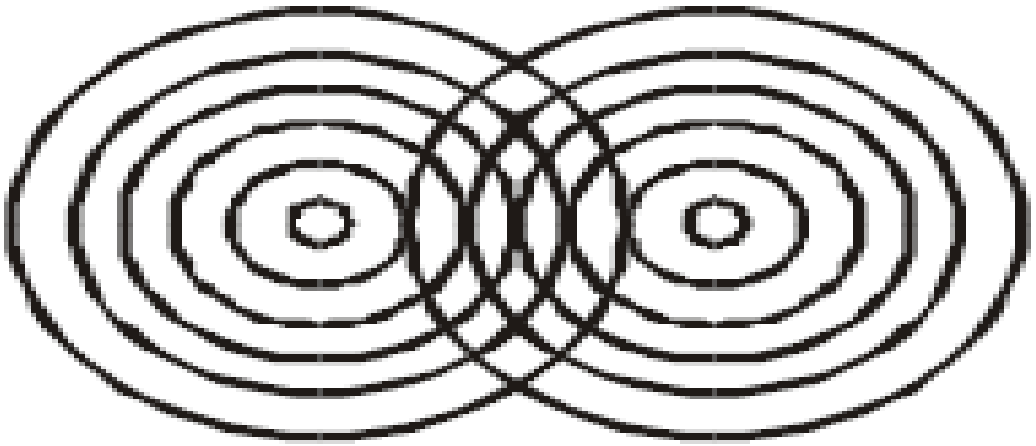
MINIMUM DEPTH


5/8"
Ground Rod
to 1-1/2"
Copper Strap
2/0 AWG
to 4/0 AWG
to 1-1/2"
Copper Strap

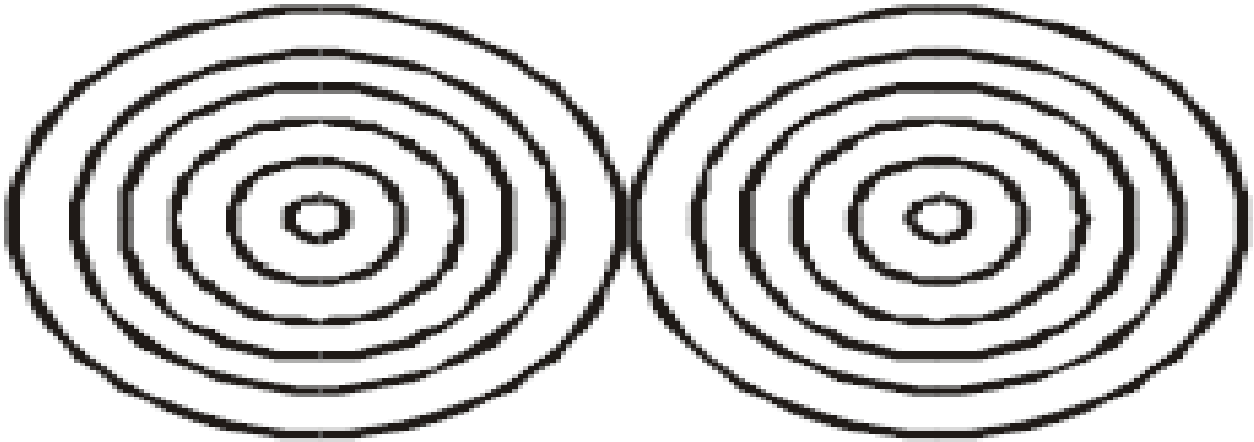

BURIED GROUNDING ELECTRODE CONDUCTORS
76 cm (2.5 ft)
45˚ maximum
2.4 m (8 ft)

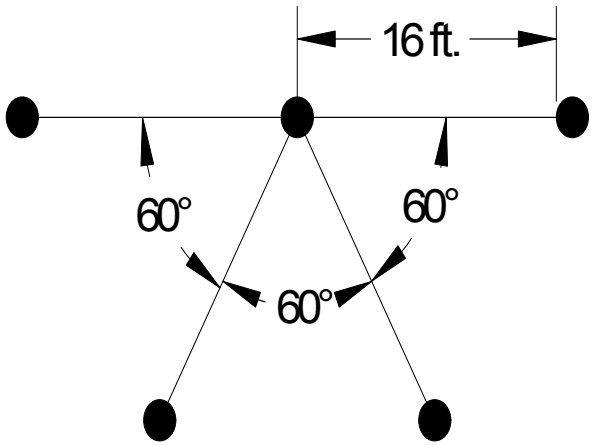

Rod Length
2X Rod Length
Concentric Shells

Incorrect Spacing

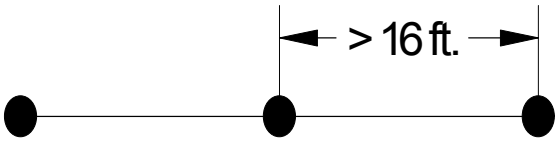


Correct Spacing

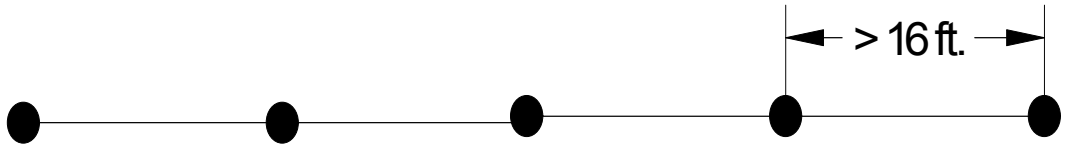




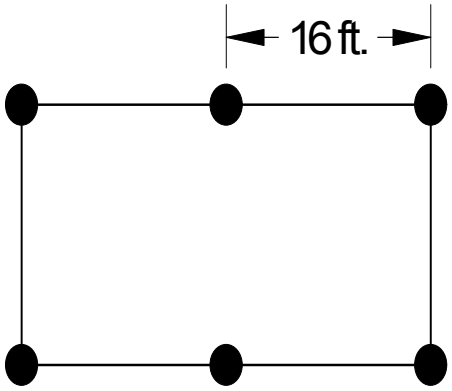
Star Grounding Pattern
~ 5 ohms



Horizontal Array Pattern
~ 10 ohms

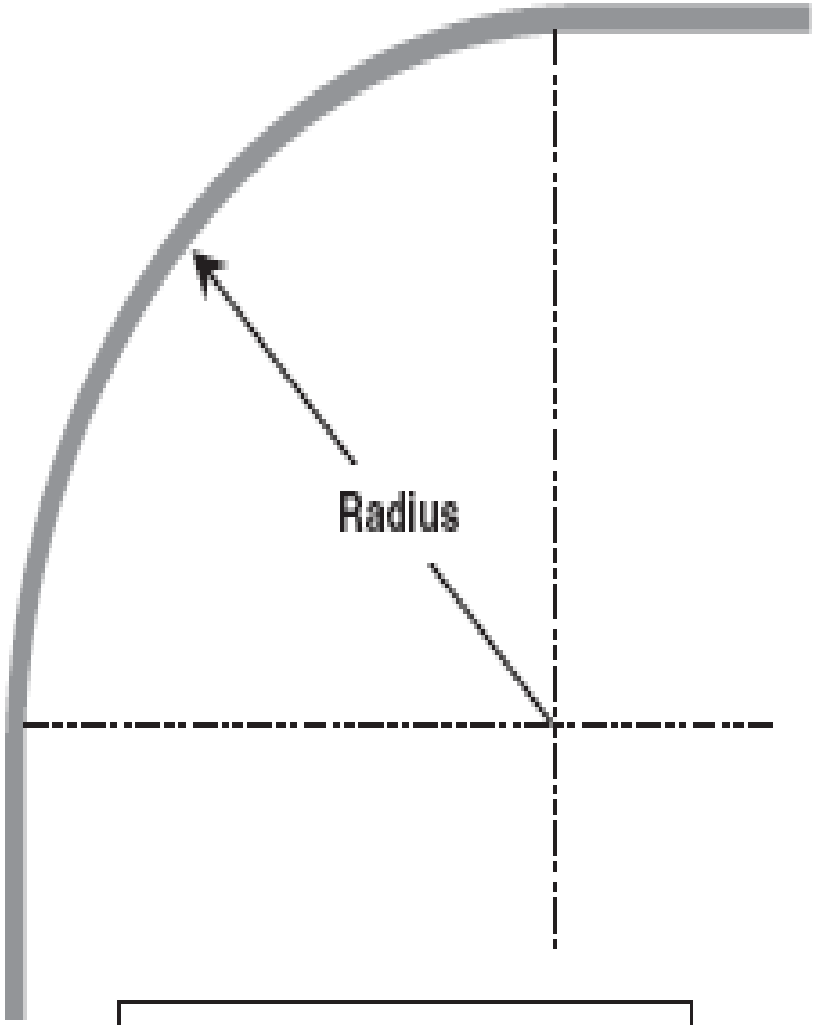


Horizontal Array Pattern
~ 5 ohms

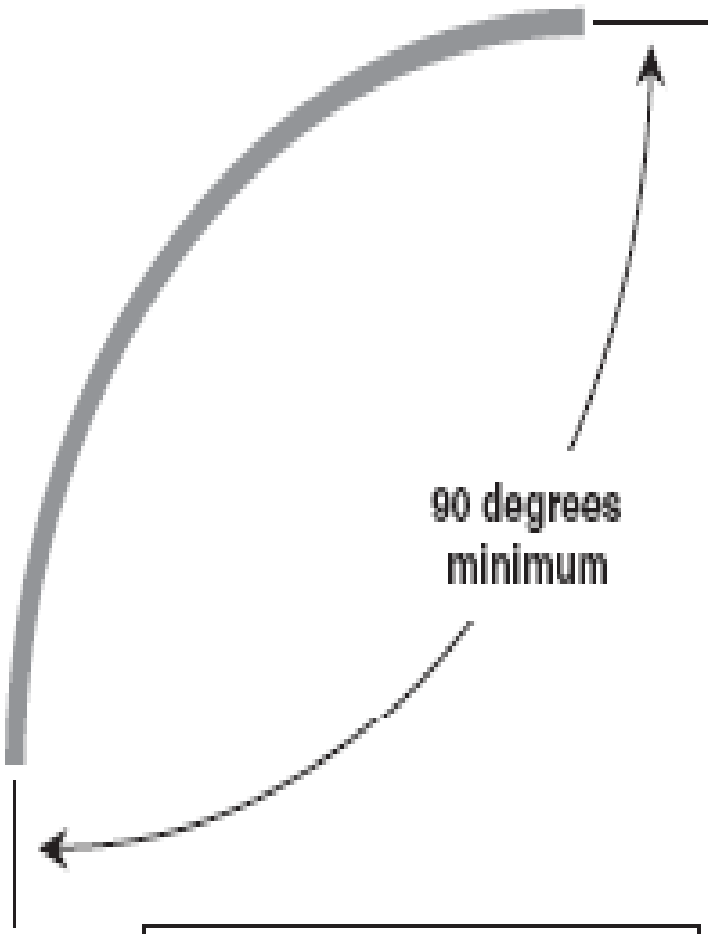


Perimeter Grounding Pattern

Single Ground Rod
~ 25 ohm per NEC

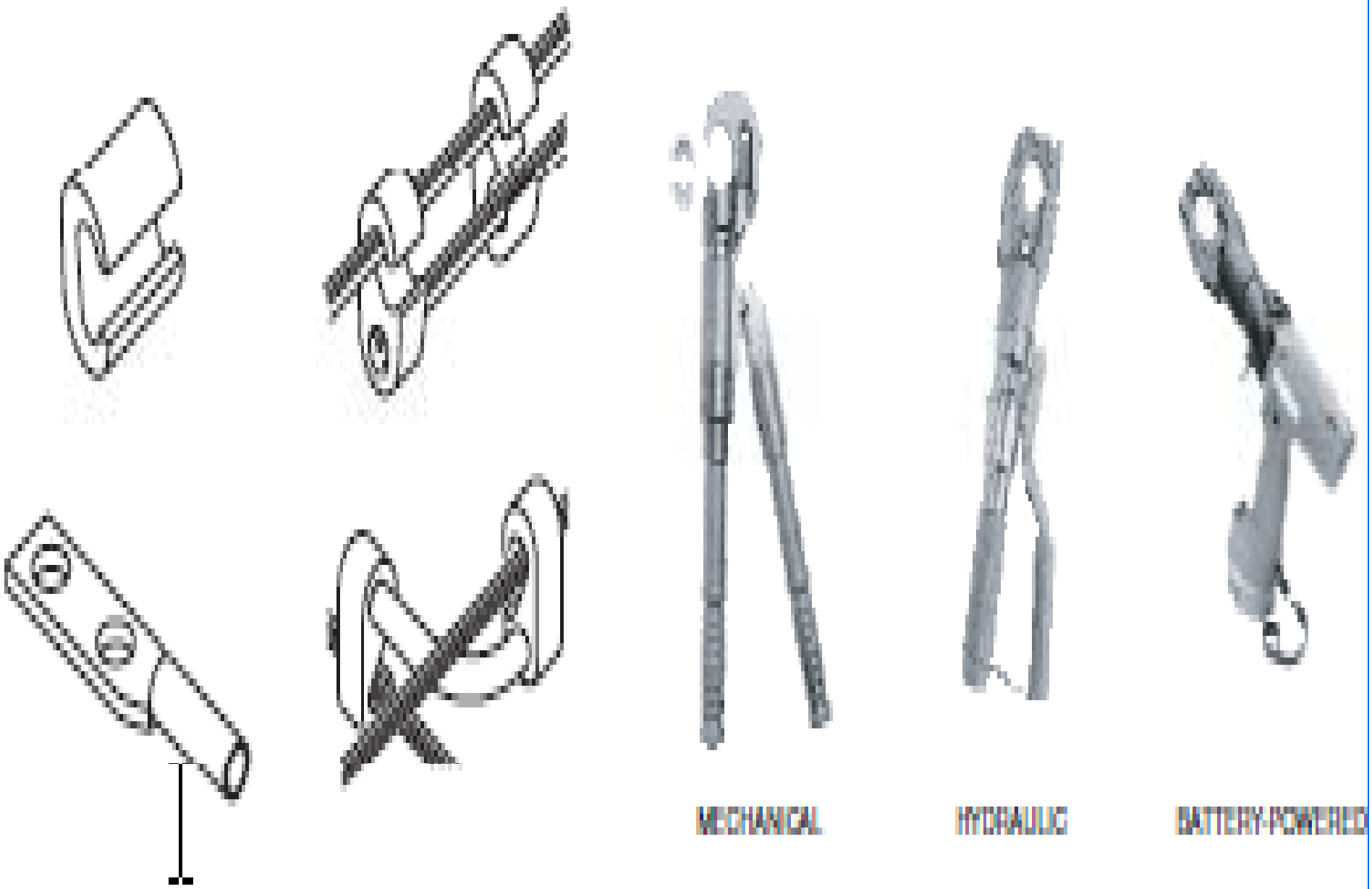


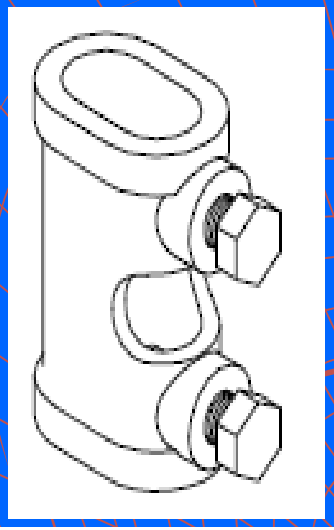
The radius of any bend shall not be less than 203 mm (8 in.)

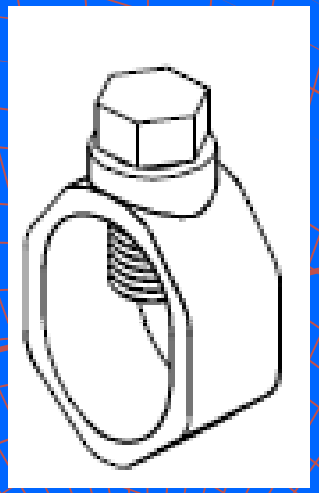


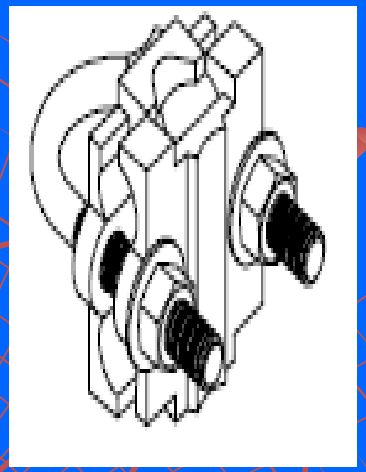
The angle of any bend shall not be less than 90 degrees.

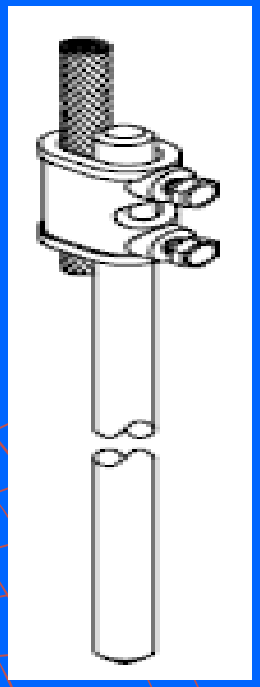
Examples from HARGER Lightning Protection Grounding Equipment Catalog

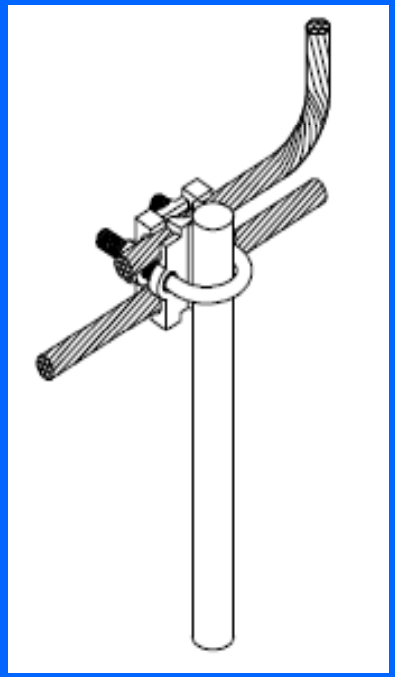

MECHANICAL
HYDRAULIC
BATTERY-POWERED

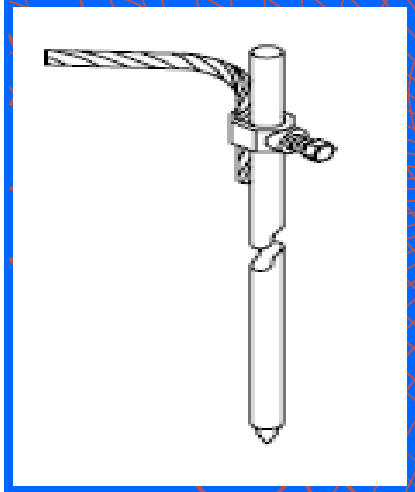




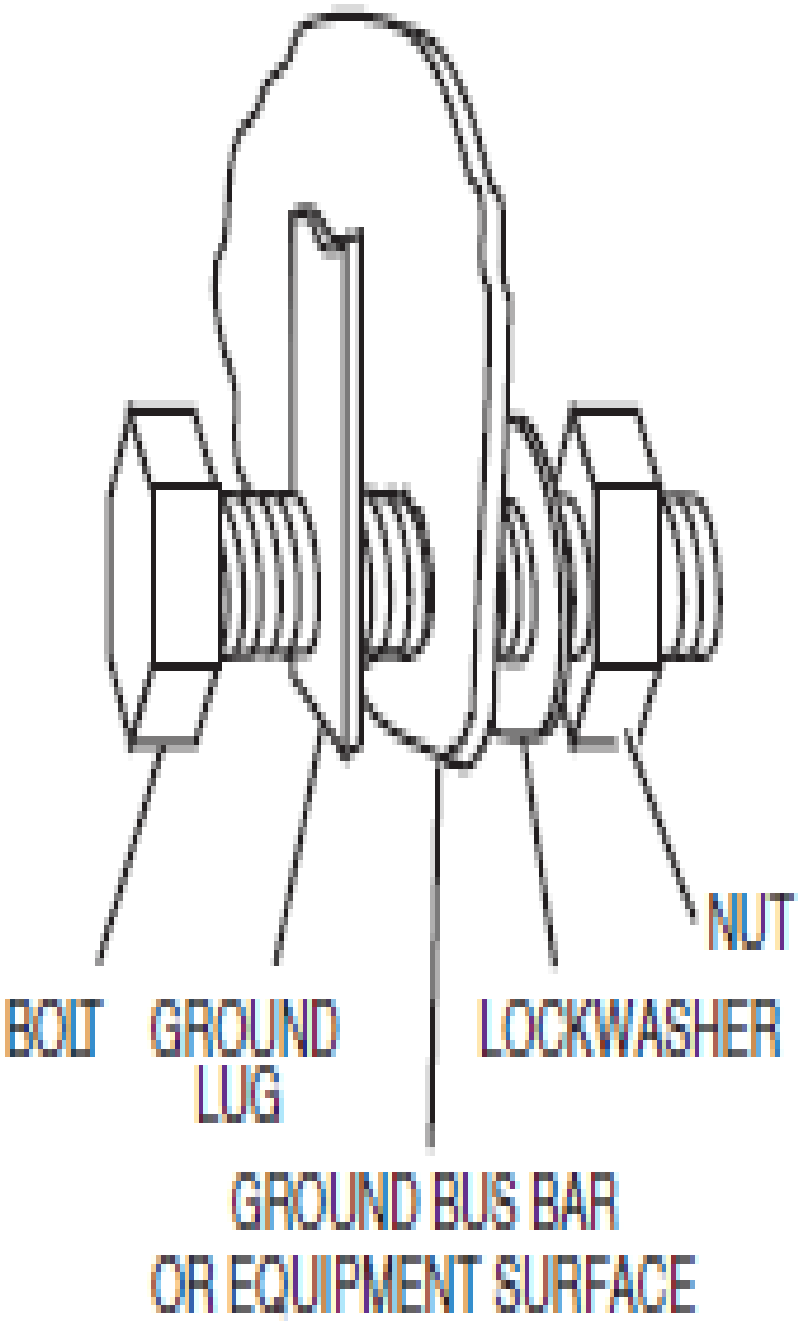


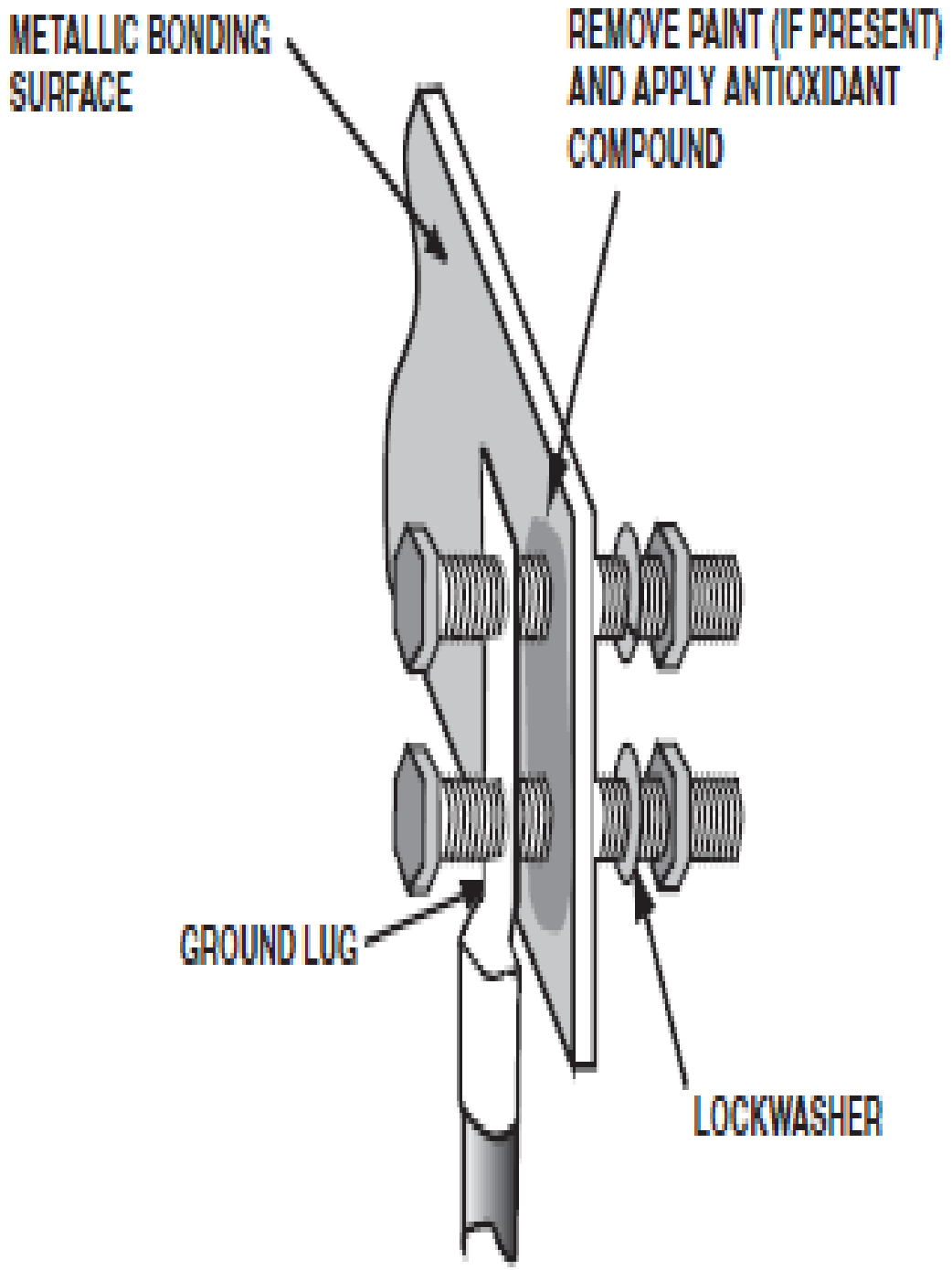




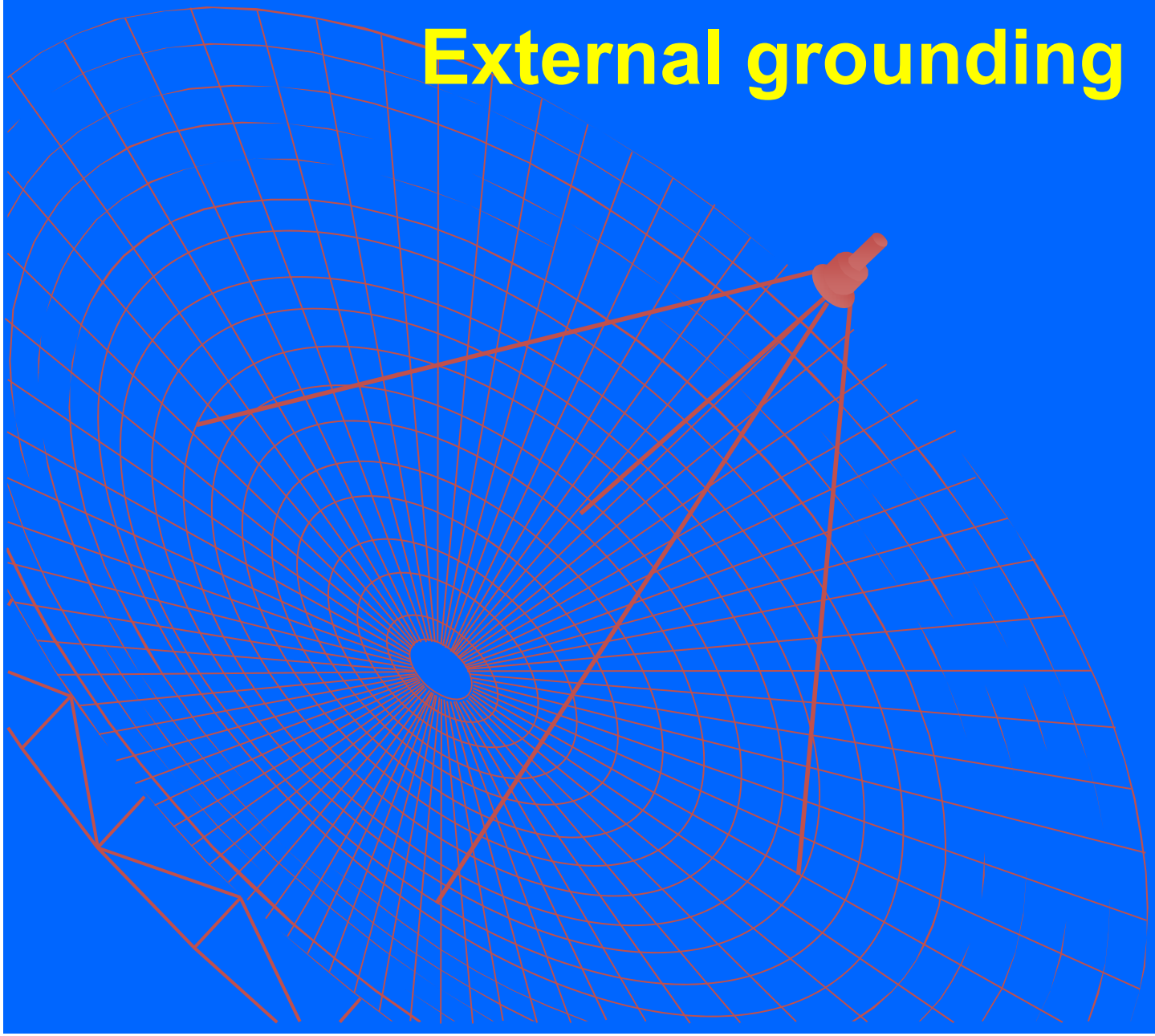


Examples from HARGER Lightning Protection Grounding Equipment Catalog

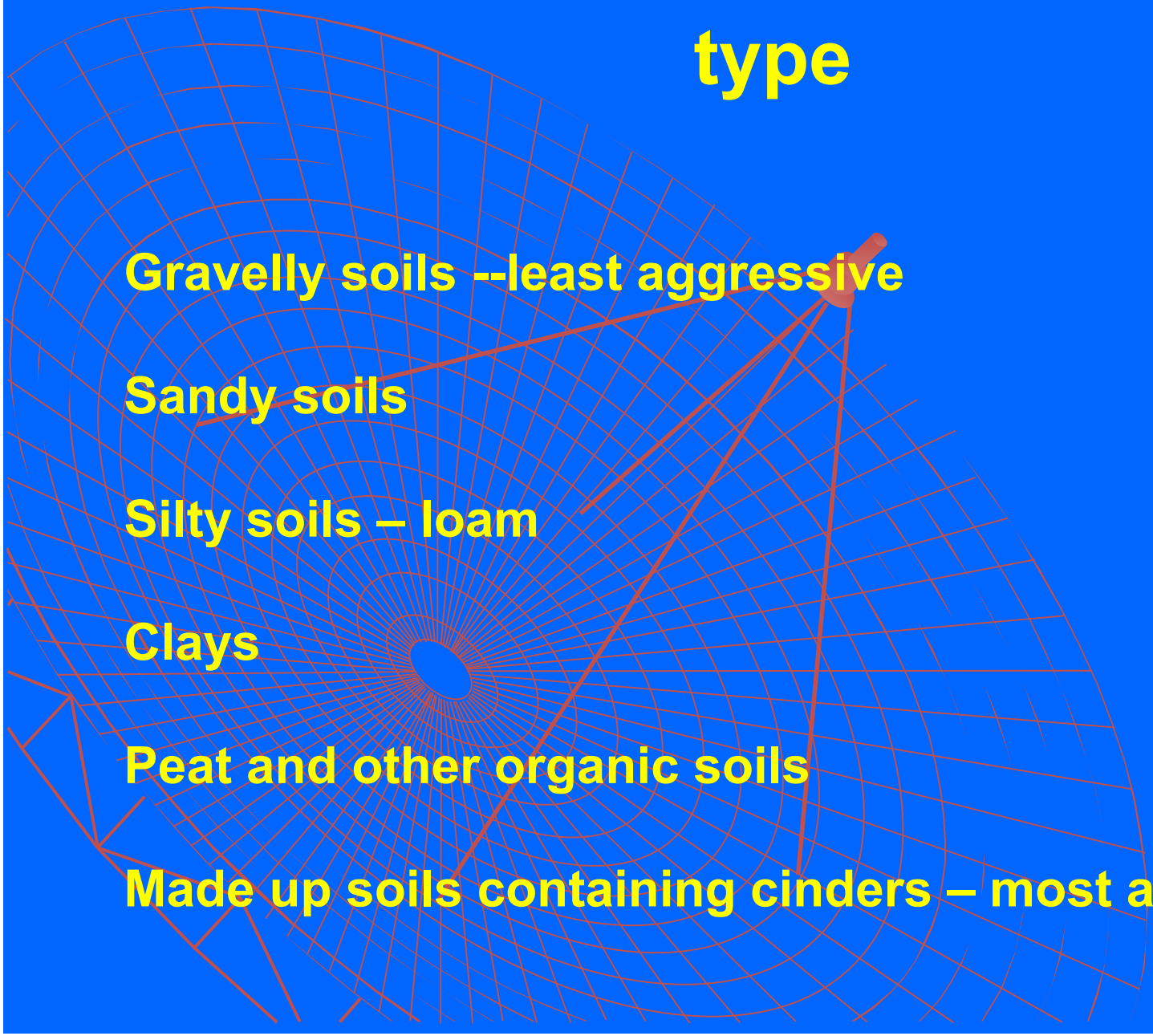

BOLT
GROUND LUG
LOCKWASHER
NUT
GROUND BUS BAR OR EQUIPMENT SURFACE


METALLIC BONDING SURFACE
REMOVE PAINT (IF PRESENT) AND APPLY ANTIOXIDANT COMPOUND
GROUND LUG
LOCKWASHER

External grounding



Reduce metal corrosion in soil type



Gravelly soils --least aggressive

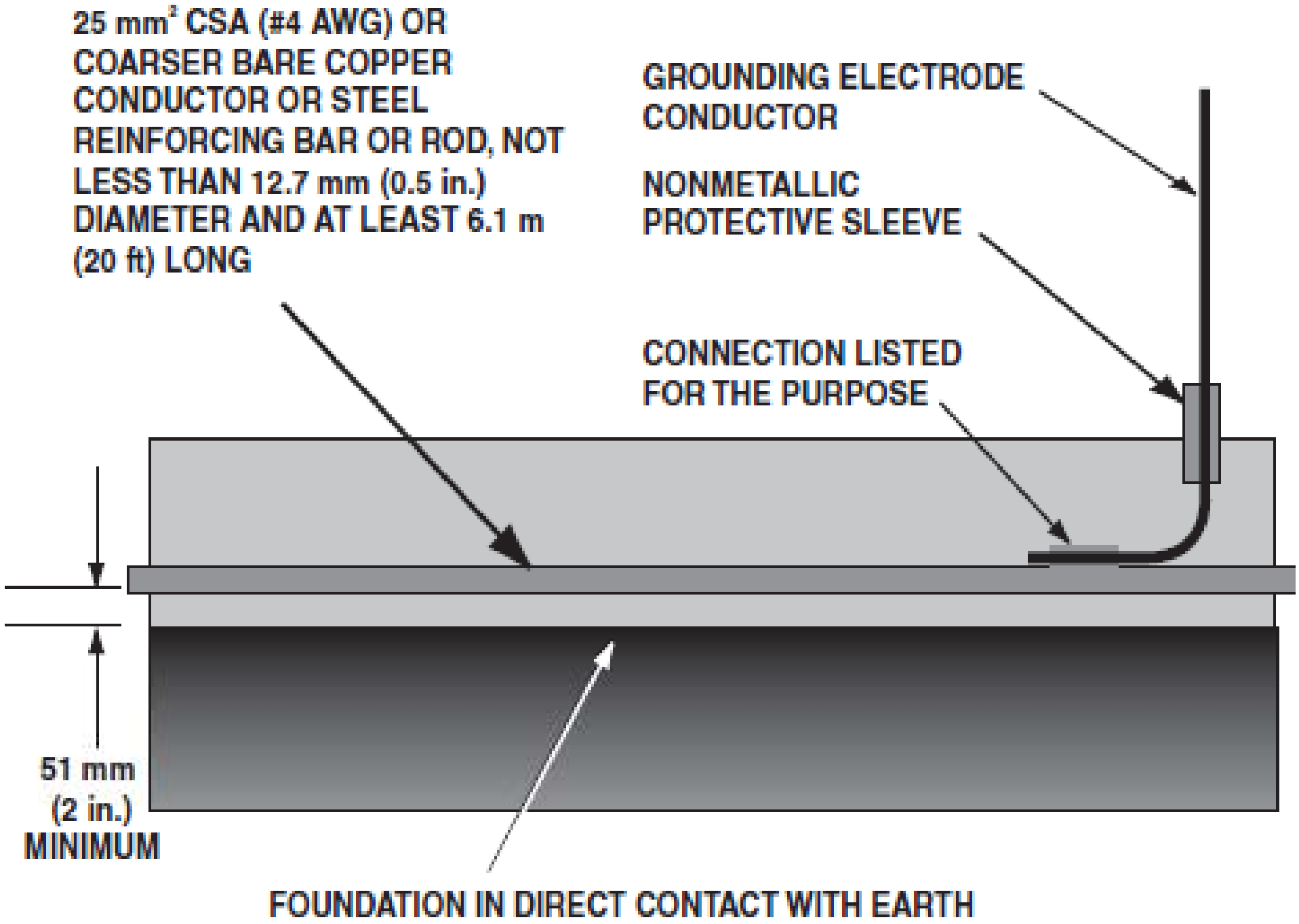
Sandy soils

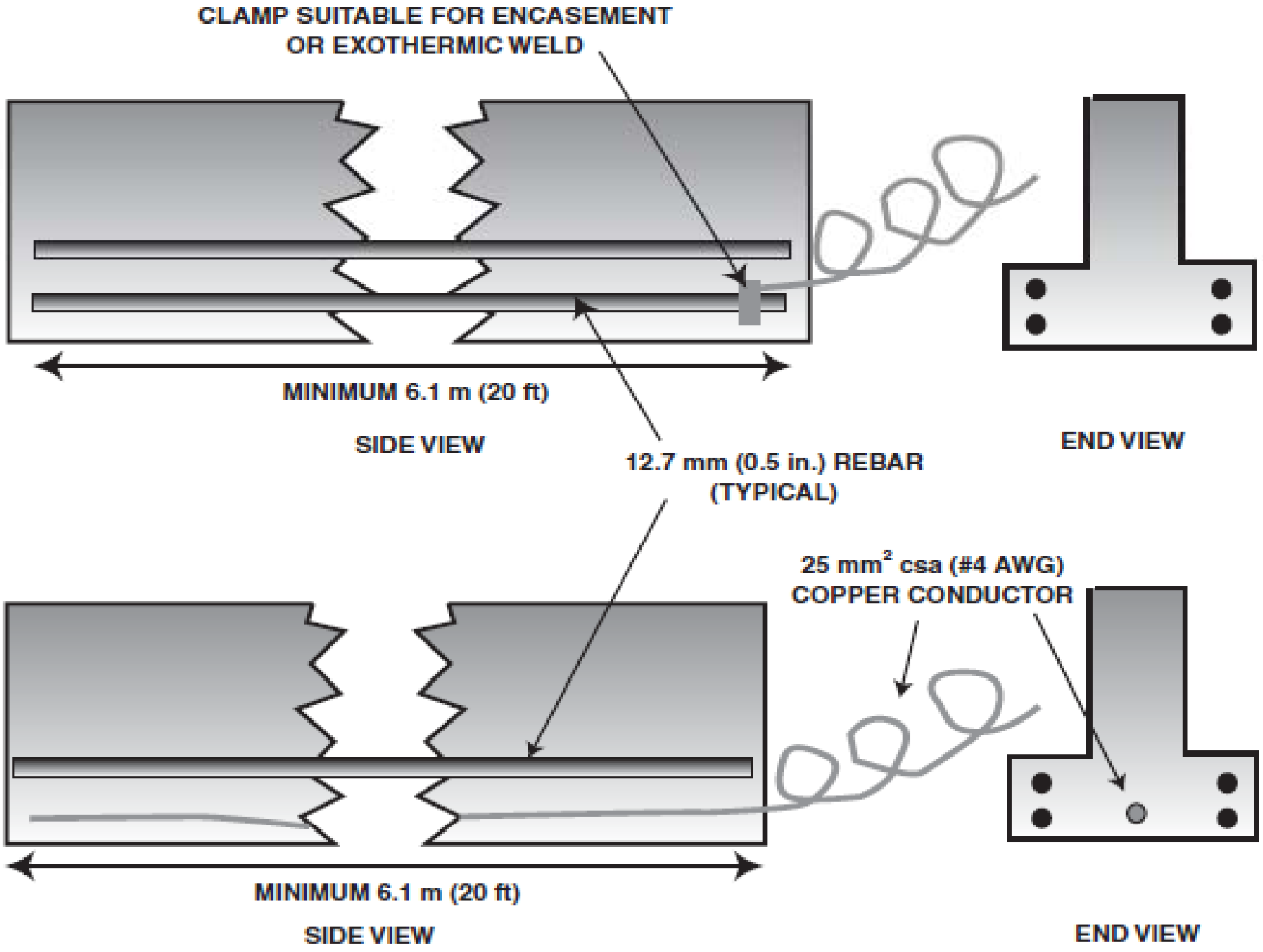
Silty soils – loam

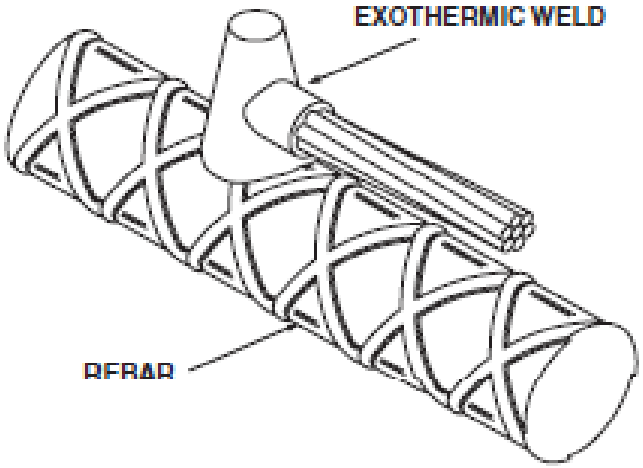
Clays

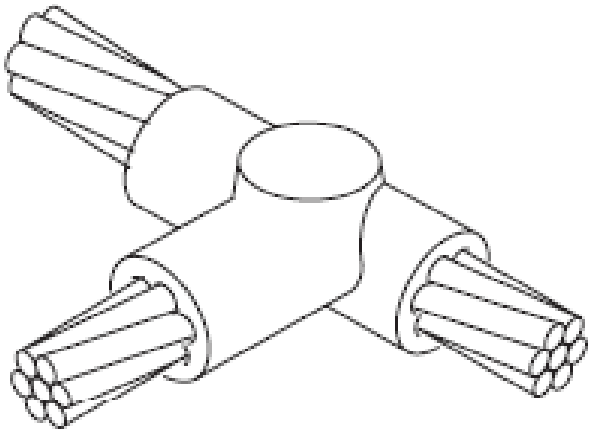
Peat and other organic soils

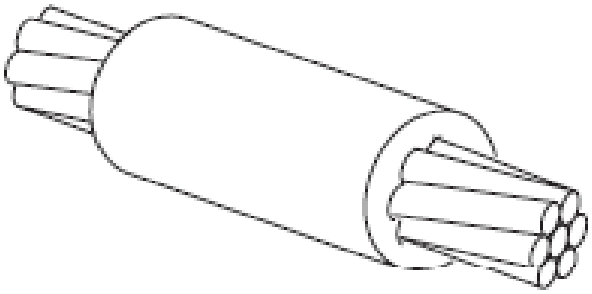
Made up soils containing cinders – most aggressive

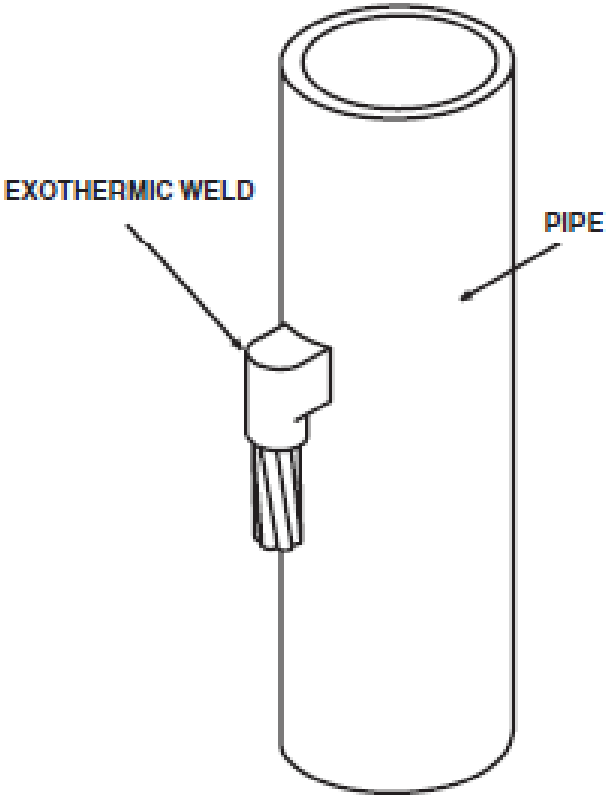

25 mm² CSA (#4 AWG) OR COARSER BARE COPPER CONDUCTOR OR STEEL REINFORCING BAR OR ROD, NOT LESS THAN 12.7 mm (0.5 in.) DIAMETER AND AT LEAST 6.1 m (20 ft) LONG
GROUNDING ELECTRODE CONDUCTOR
NONMETALLIC PROTECTIVE SLEEVE
CONNECTION LISTED FOR THE PURPOSE
51 mm (2 in.) MINIMUM
FOUNDATION IN DIRECT CONTACT WITH EARTH

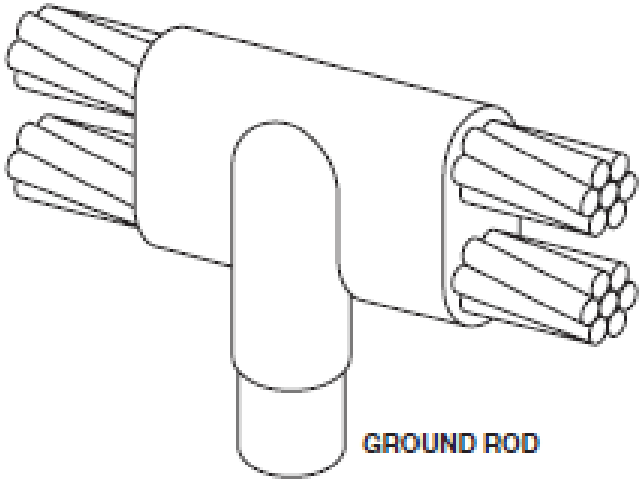

CLAMP SUITABLE FOR ENCASEMENT
OR EXOTHERMIC WELD
MINIMUM 6.1 m (20 ft)
SIDE VIEW
END VIEW
12.7 mm (0.5 in.) REBAR
(TYPICAL)
25 mm² csa (#4 AWG)
COPPER CONDUCTOR
MINIMUM 6.1 m (20 ft)
SIDE VIEW
END VIEW

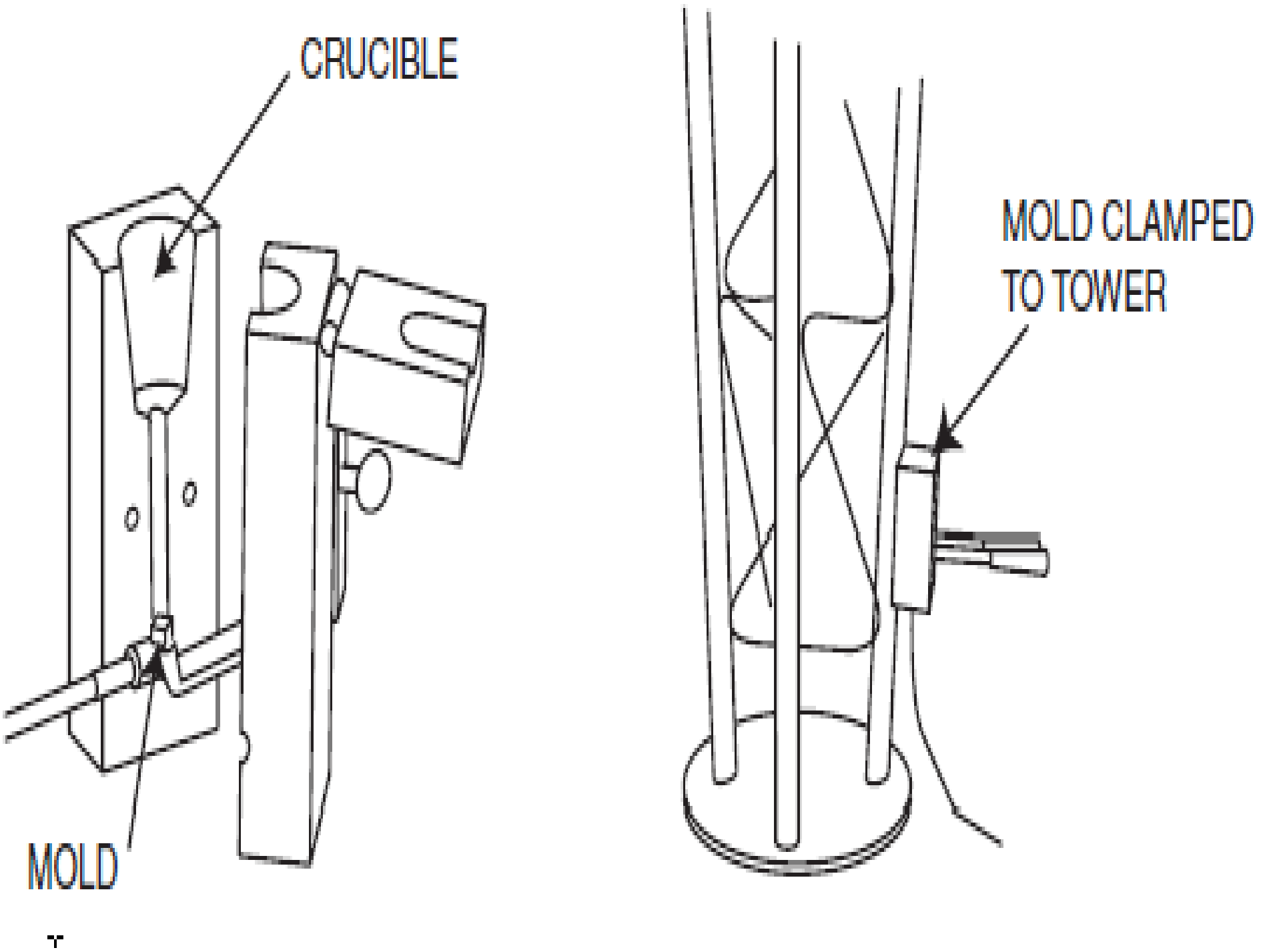

EXOTHERMIC WELD
REBAR

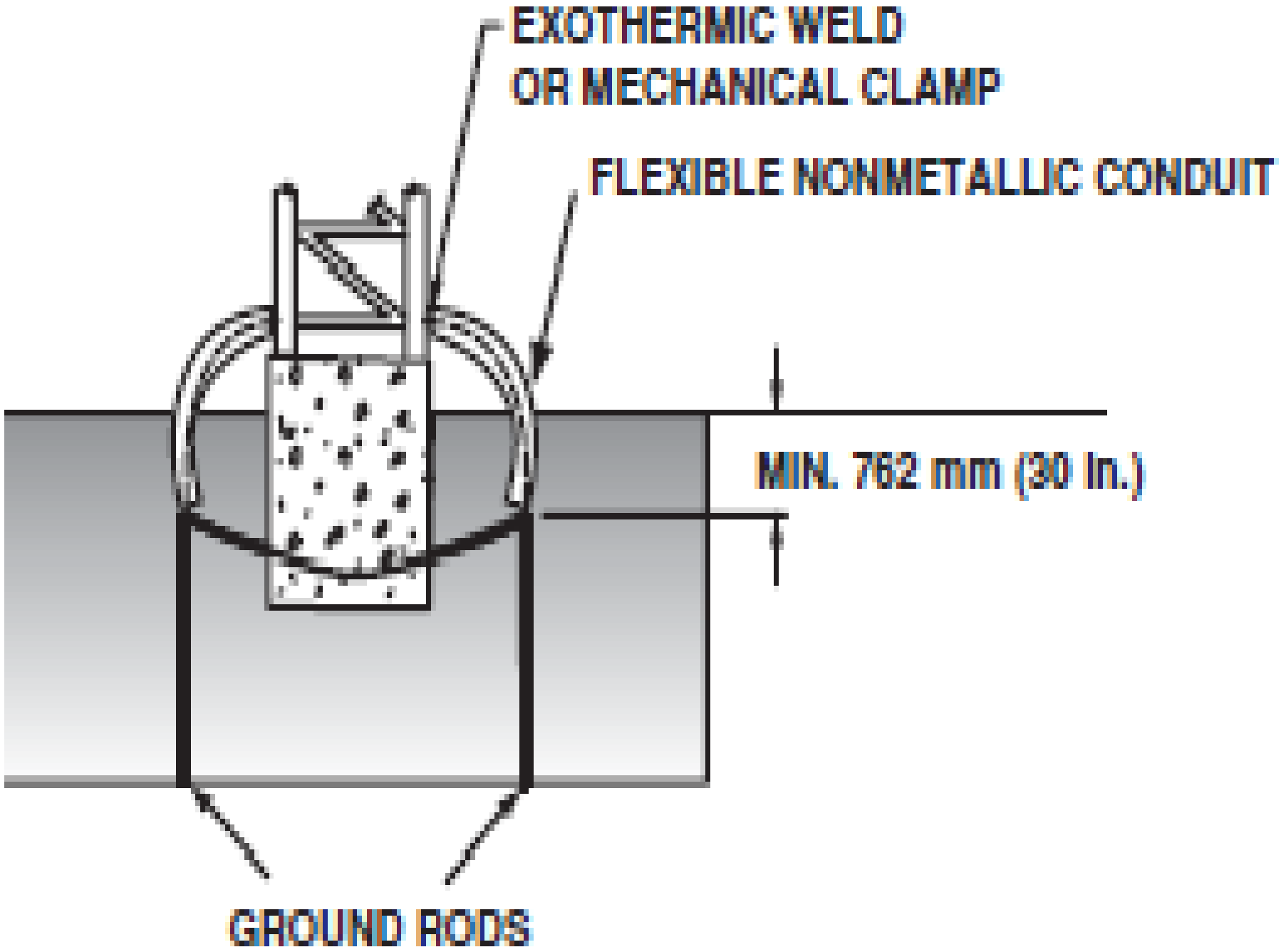


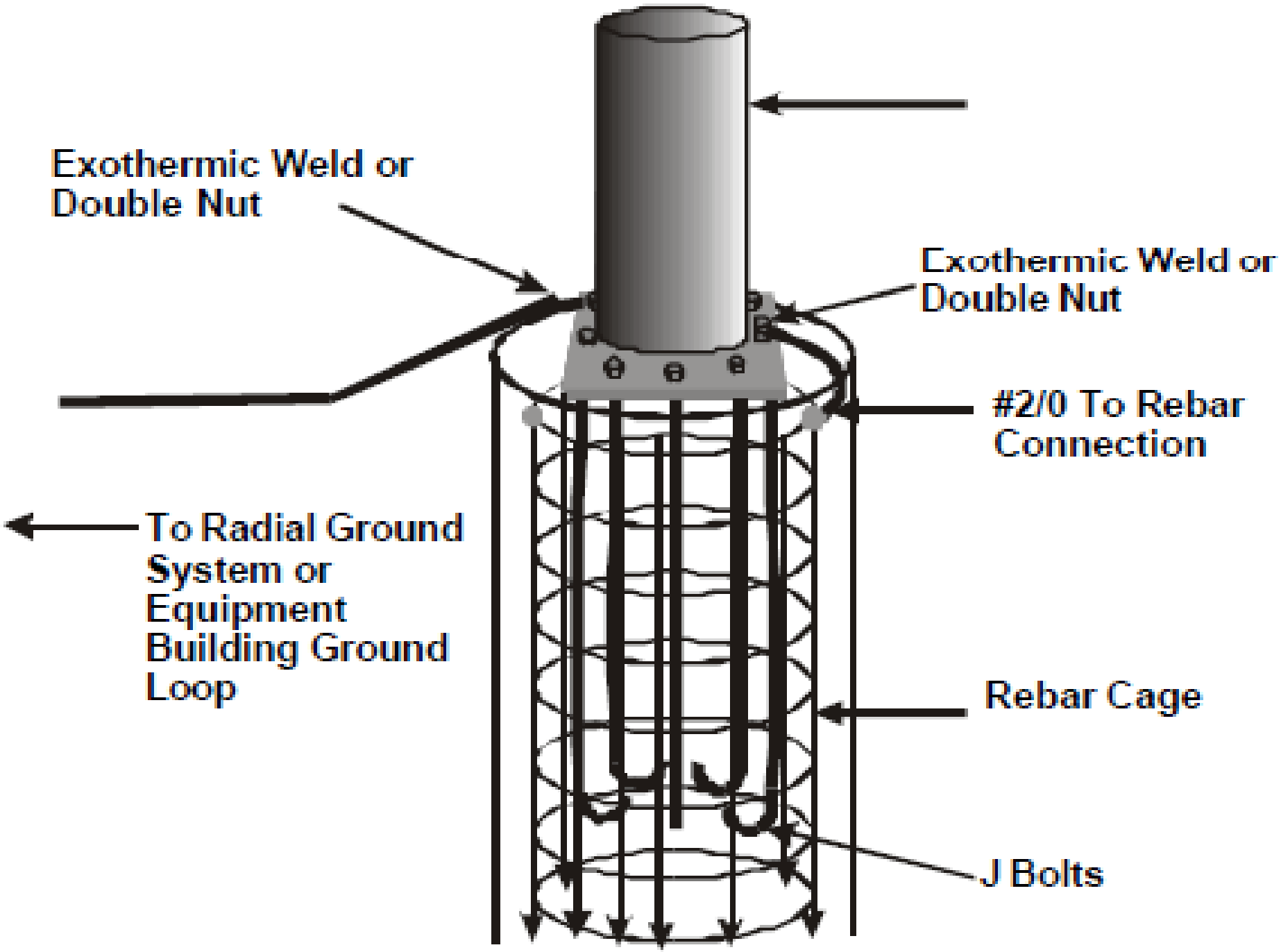


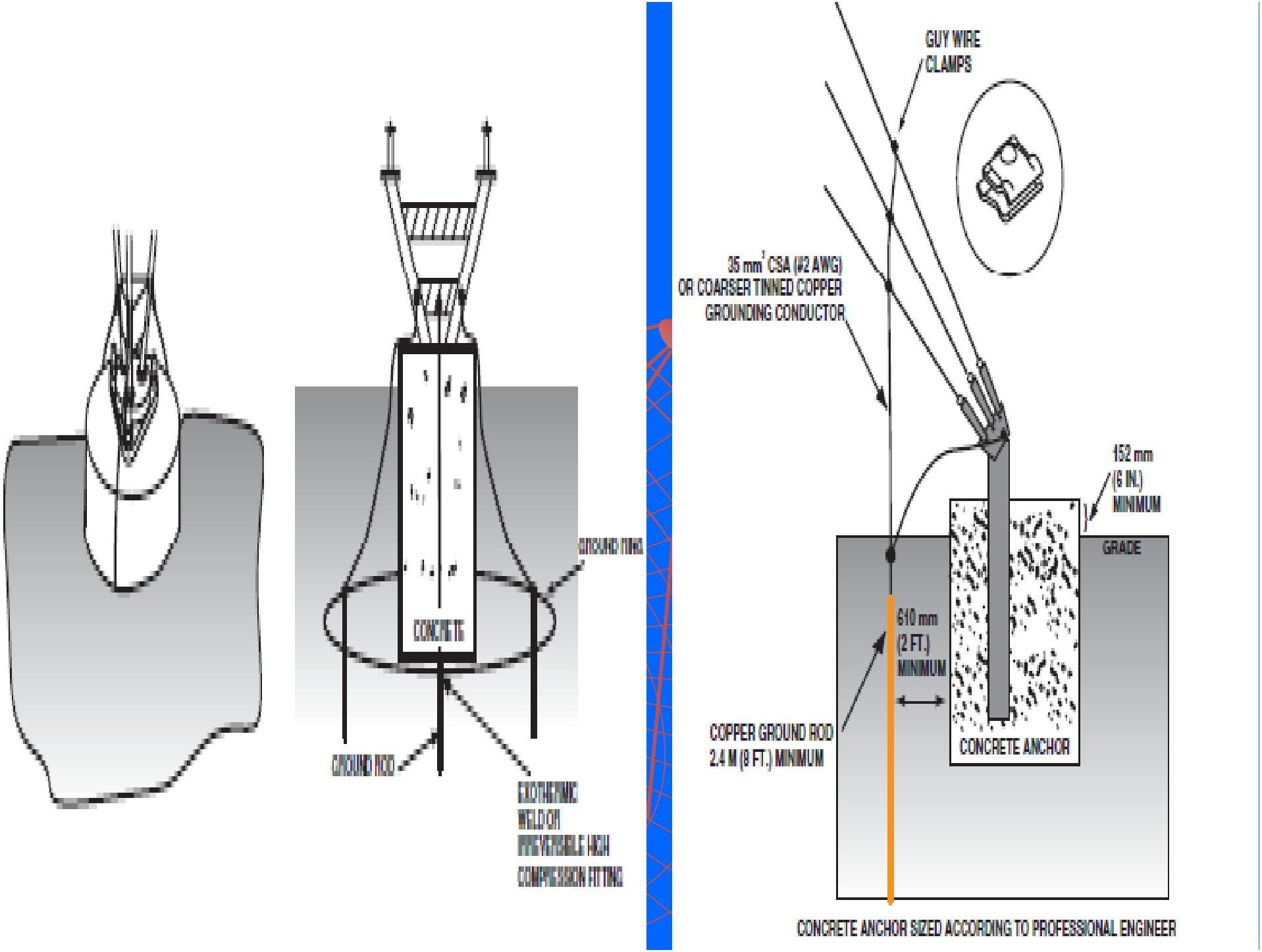

EXOTHERMIC WELD
PIPE

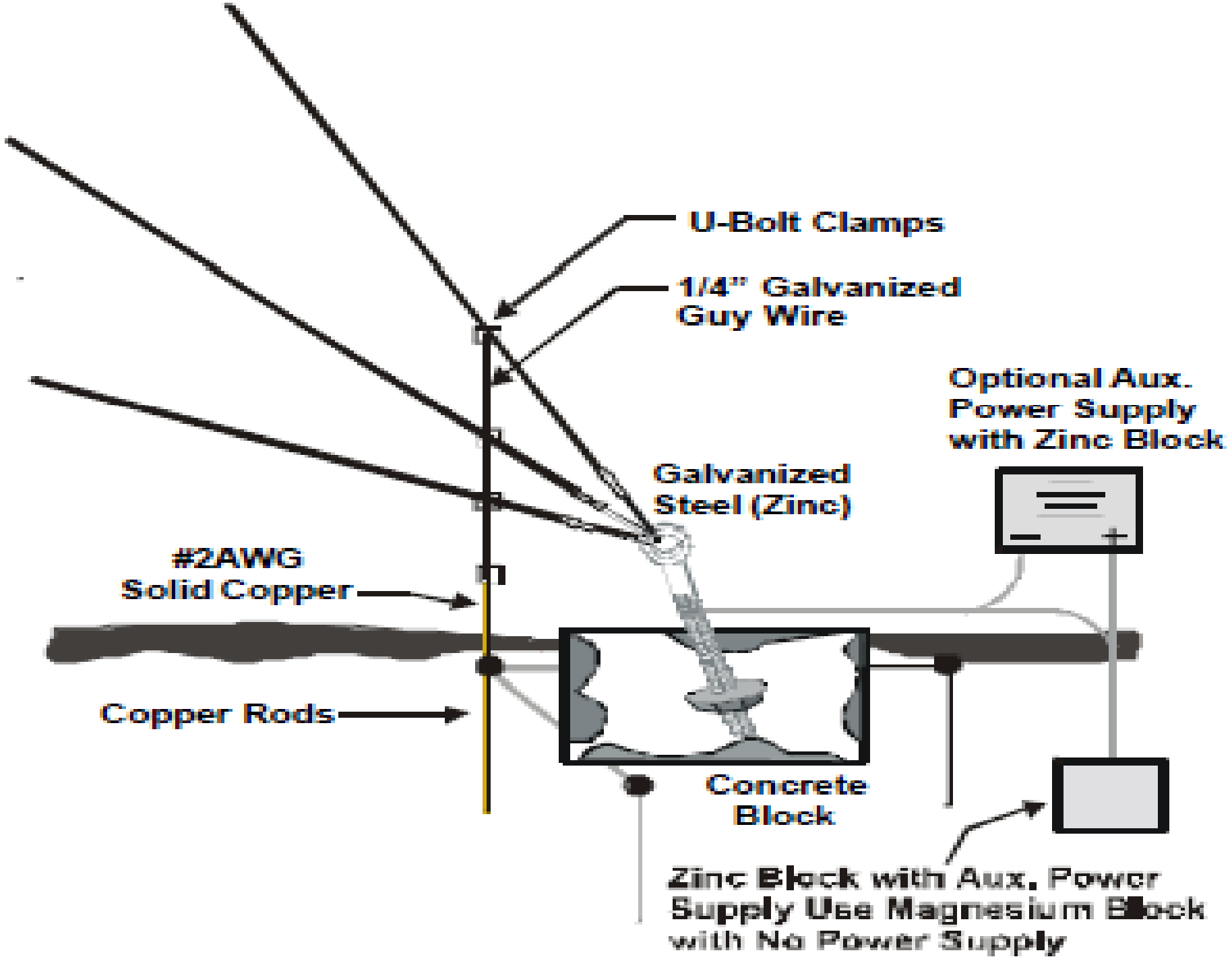

GROUND ROD

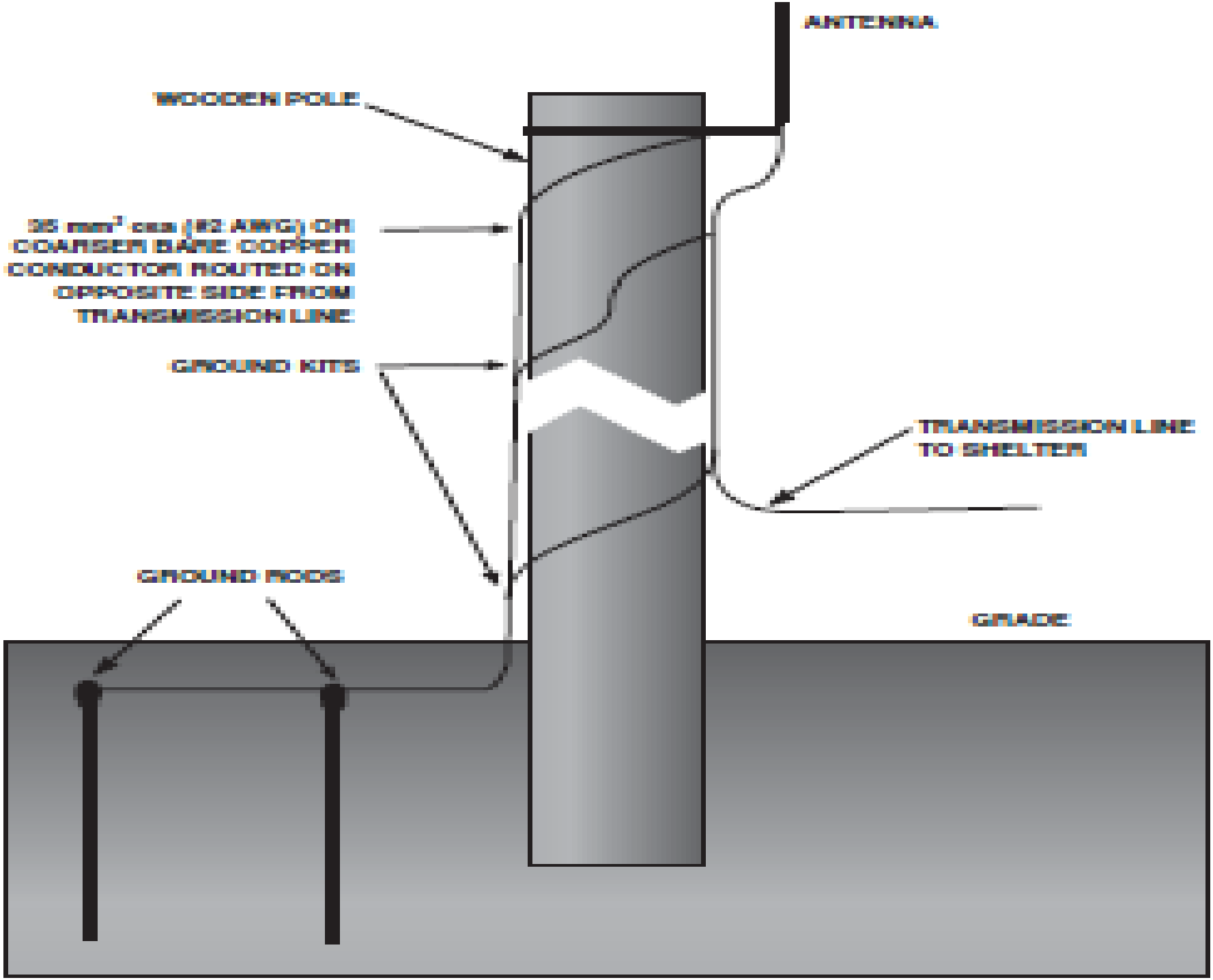

CRUCIBLE
MOLD
MOLD CLAMPED
TO TOWER

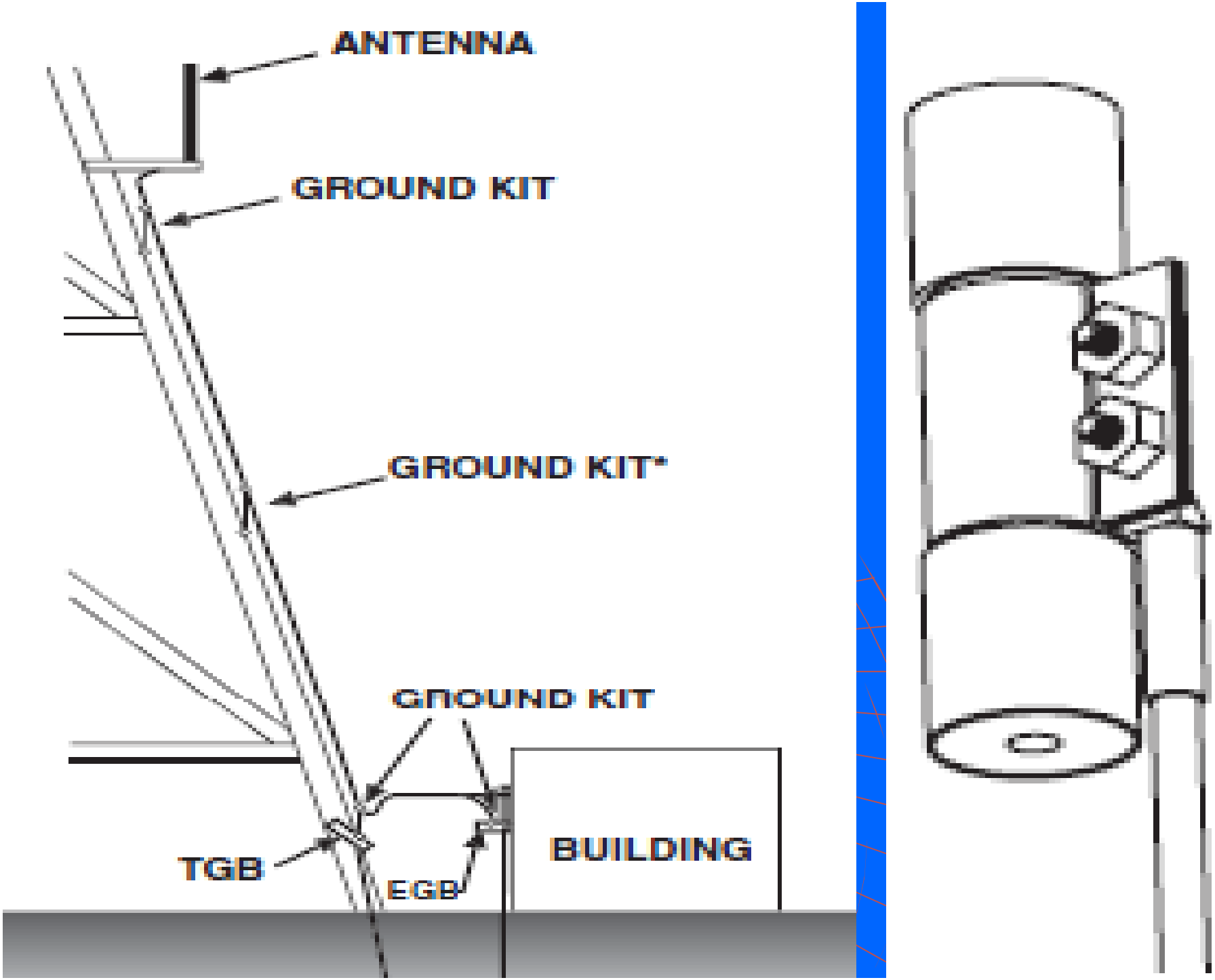

EXOTHERMIC WELD
OR MECHANICAL CLAMP
FLEXIBLE NONMETALLIC CONDUIT
MIN. 762 mm (30 In.)
GROUND RODS

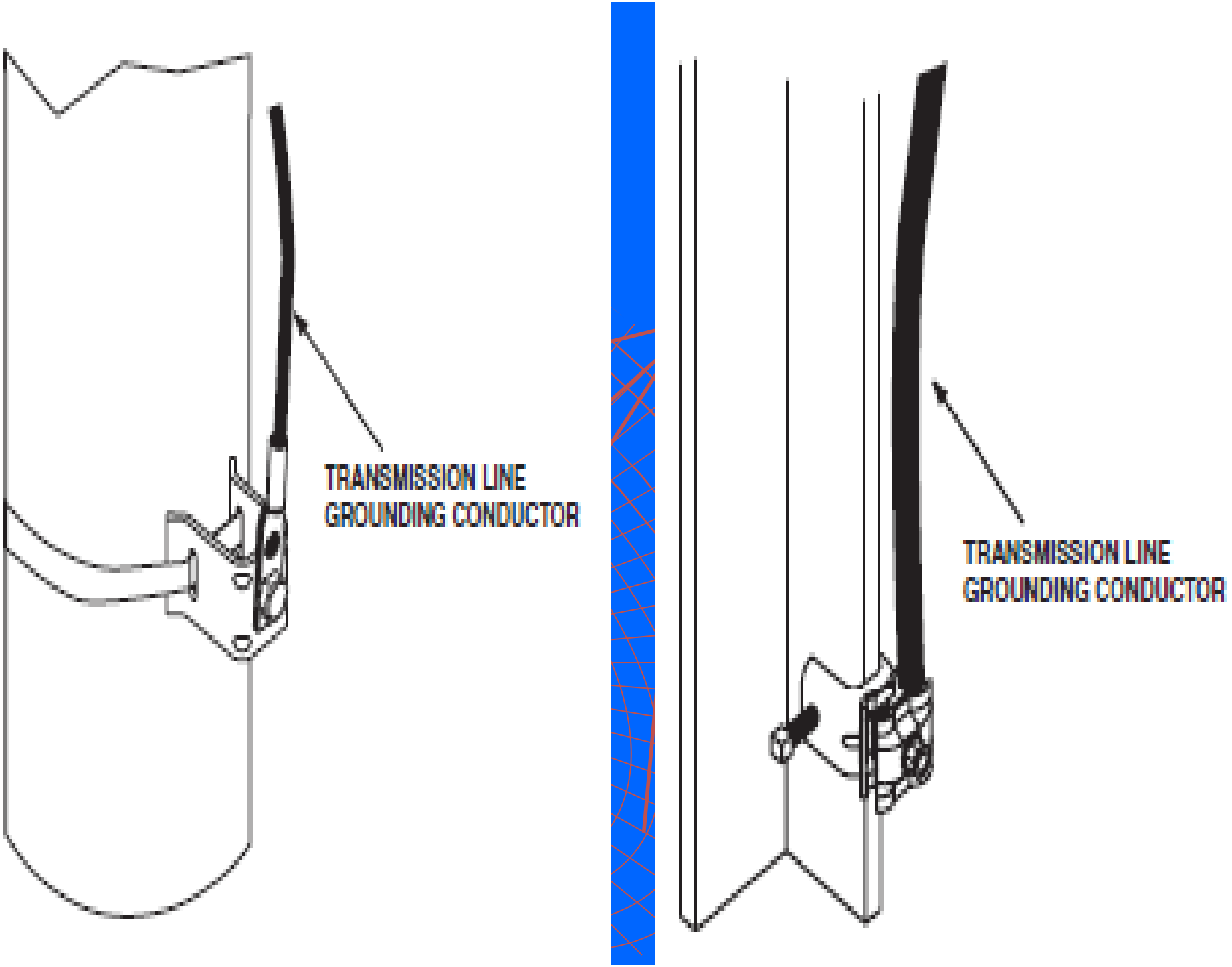

Exothermic Weld or
Double Nut
Exothermic Weld or
Double Nut
#2/0 To Rebar
Connection
To Radial Ground
System or
Equipment
Building Ground
Loop
Rebar Cage
J Bolts

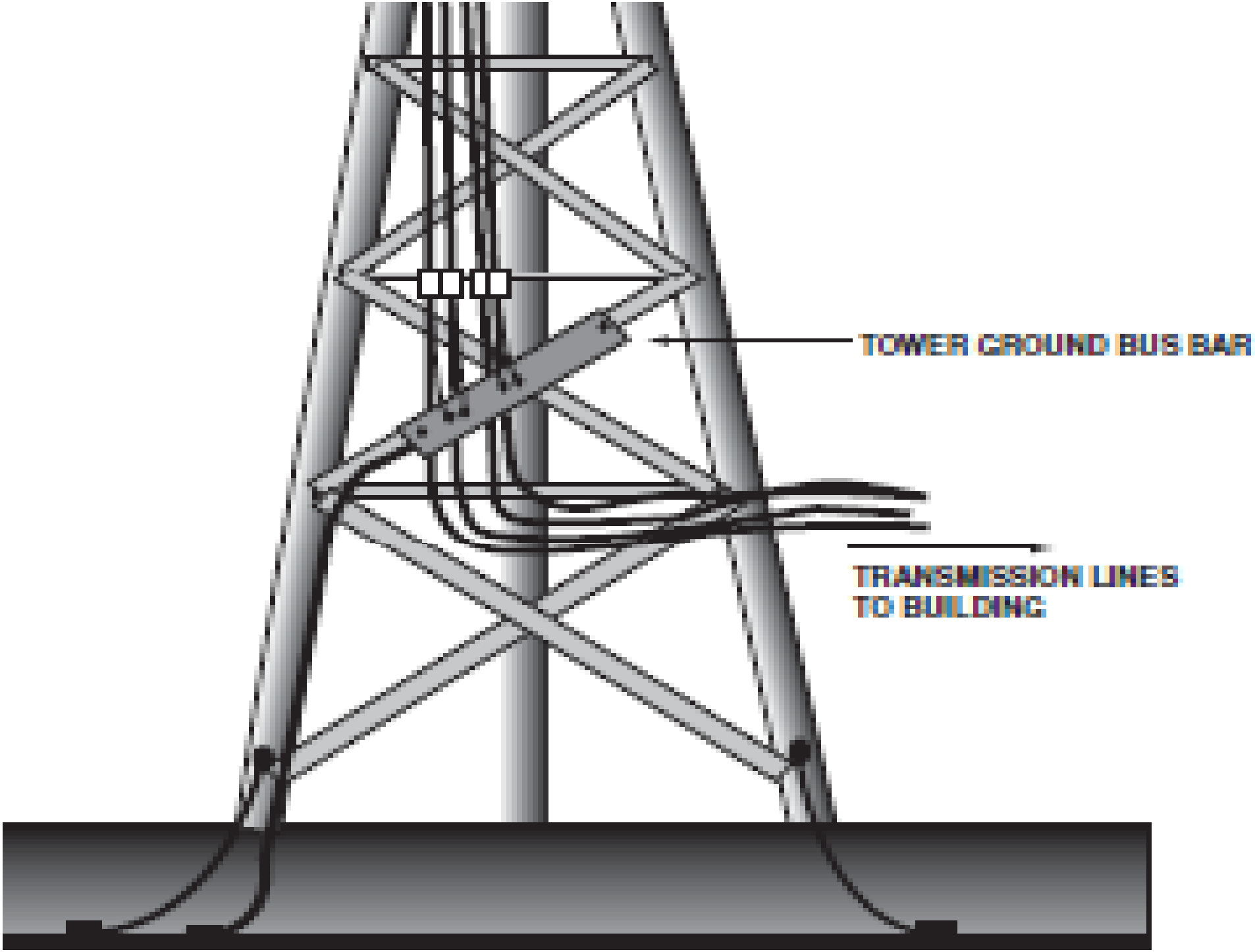

GUY WIRE
CLAMPS
35 mm² CSA (#2 AWG)
OR COARSER TINNED COPPER
GROUNDING CONDUCTOR
152 mm
(6 IN.)
MINIMUM
GRADE
610 mm
(2 FT.)
MINIMUM
COPPER GROUND ROD
2.4 M (8 FT.) MINIMUM
CONCRETE ANCHOR
CONCRETE ANCHOR SIZED ACCORDING TO PROFESSIONAL ENGINEER
GROUND RING
CONCRETE
GROUND ROD
EXOTHERMIC
WELD OR
IRREVERSIBLE HIGH
COMPRESSION FITTING

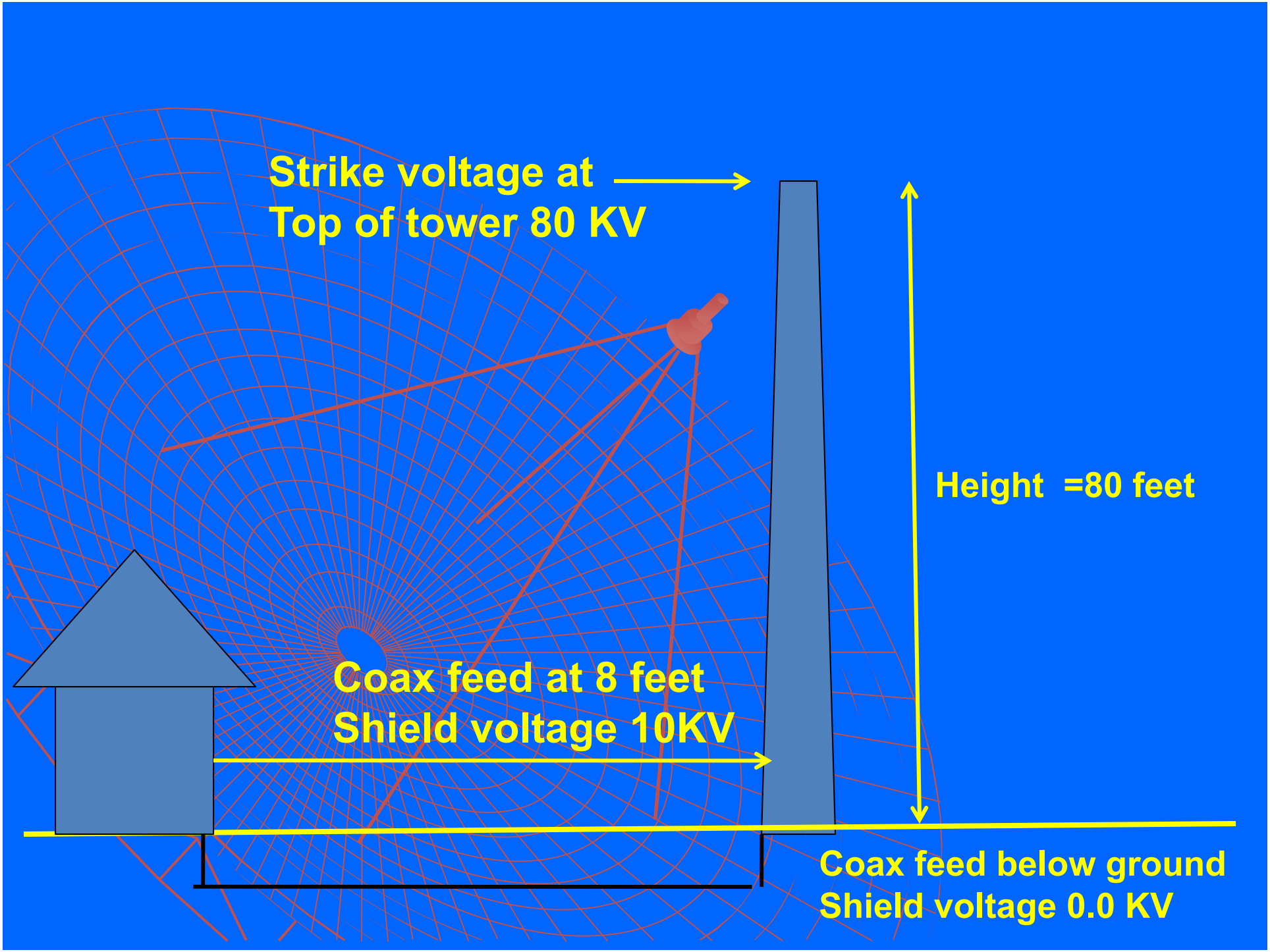

U-Bolt Clamps
1/4" Galvanized
Guy Wire
Optional Aux.
Power Supply
with Zinc Block
Galvanized
Steel (Zinc)
#2AWG
Solid Copper
Copper Rods
Concrete
Block
Zinc Block with Aux. Power
Supply Use Magnesium Block
with No Power Supply

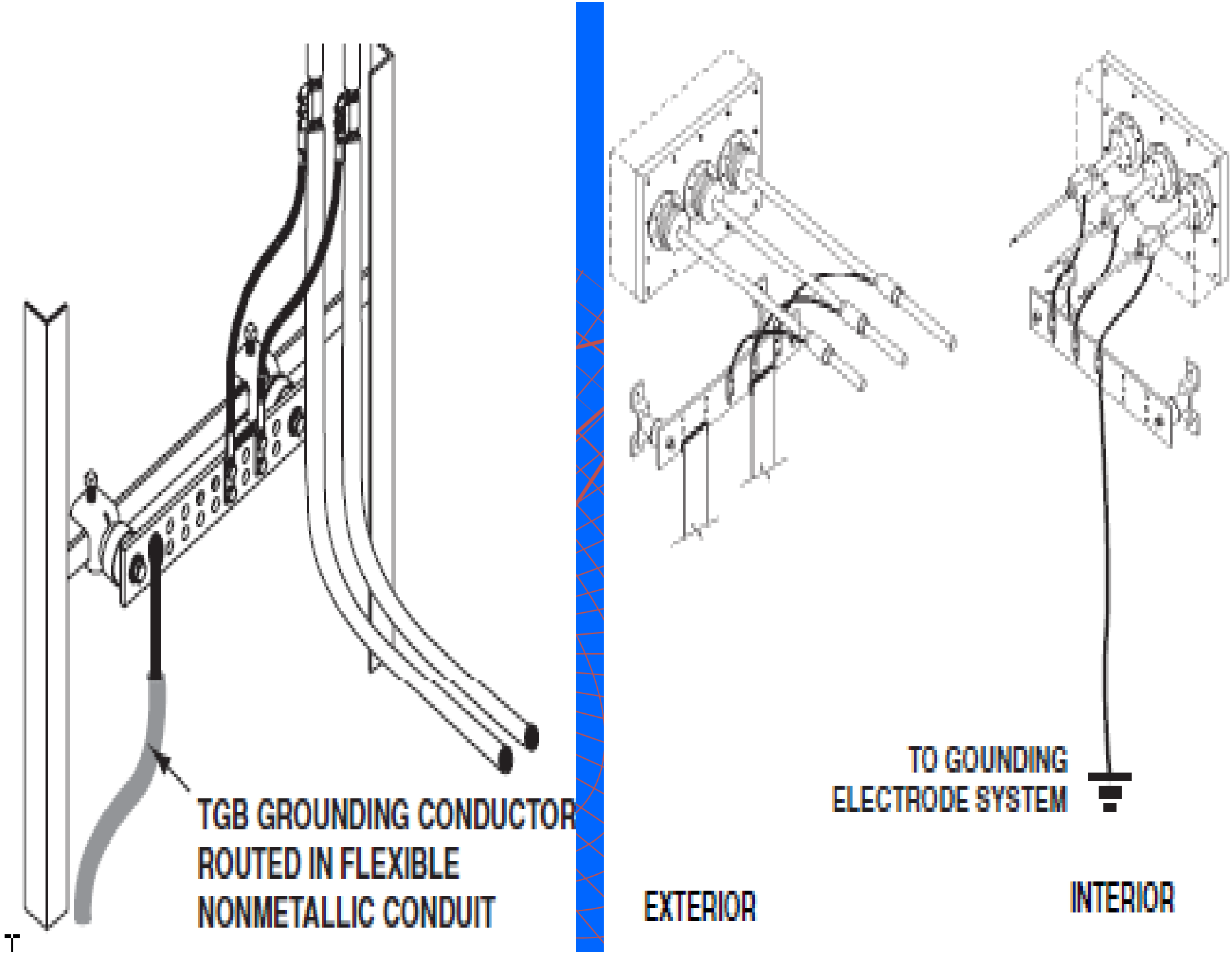

ANTENNA
WOODEN POLE
35 mm² cca (#2 AWG) OR COARSER BARE COPPER CONDUCTOR ROUTED ON OPPOSITE SIDE FROM TRANSMISSION LINE
GROUND KITS
TRANSMISSION LINE TO SHELTER
GROUND RODS
GRADE

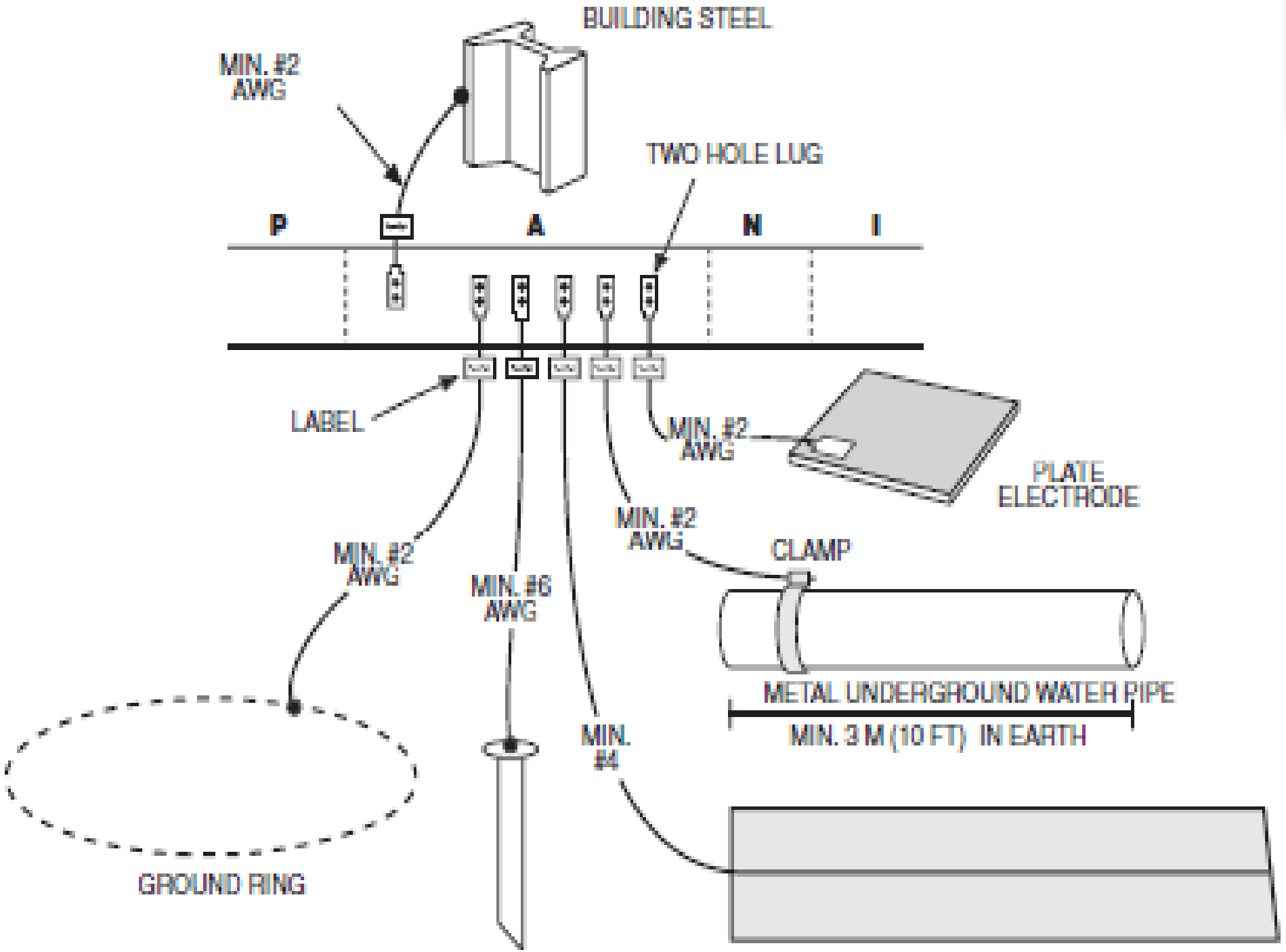

ANTENNA
GROUND KIT
GROUND KIT*
GROUND KIT
TGB
EGB
BUILDING


TRANSMISSION LINE
GROUNDING CONDUCTOR
TRANSMISSION LINE
GROUNDING CONDUCTOR

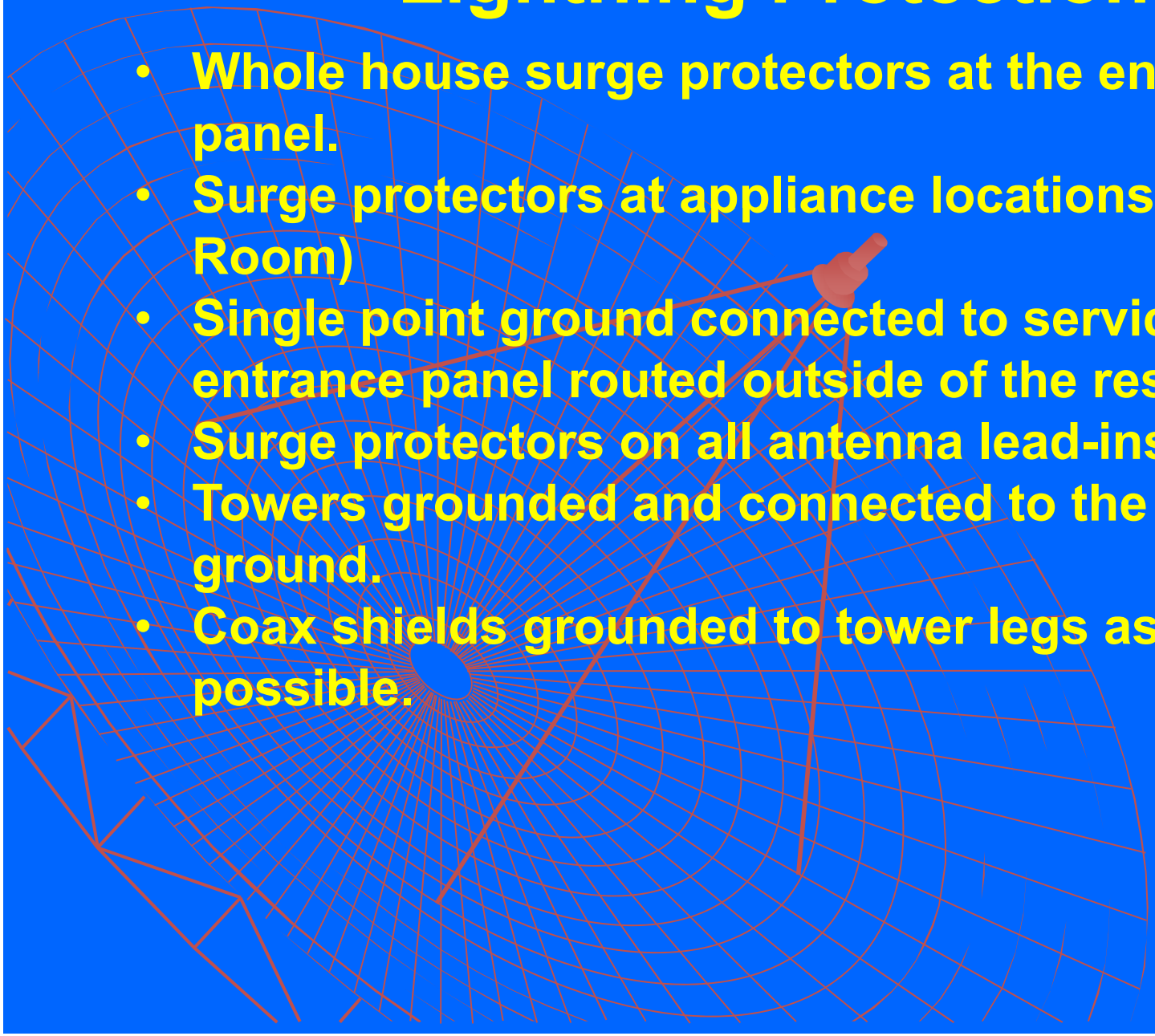

TOWER GROUND BUS BAR
TRANSMISSION LINES
TO BUILDING


Strike voltage at
Top of tower 80 KV
Height =80 feet
Coax feed at 8 feet
Shield voltage 10KV
Coax feed below ground
Shield voltage 0.0 KV


TGB GROUNDING CONDUCTOR
ROUTED IN FLEXIBLE
NONMETALLIC CONDUIT
EXTERIOR
TO GOUNDING
ELECTRODE SYSTEM
INTERIOR


BUILDING STEEL
MIN. #2 AWG
TWO HOLE LUG
P
A
N
I
LABEL
MIN. #2 AWG
PLATE ELECTRODE
MIN. #2 AWG
CLAMP
MIN. #2 AWG
MIN. #6 AWG
METAL UNDERGROUND WATER PIPE
MIN. 3 M (10 FT) IN EARTH
MIN. #4
GROUND RING

Lightning Protection

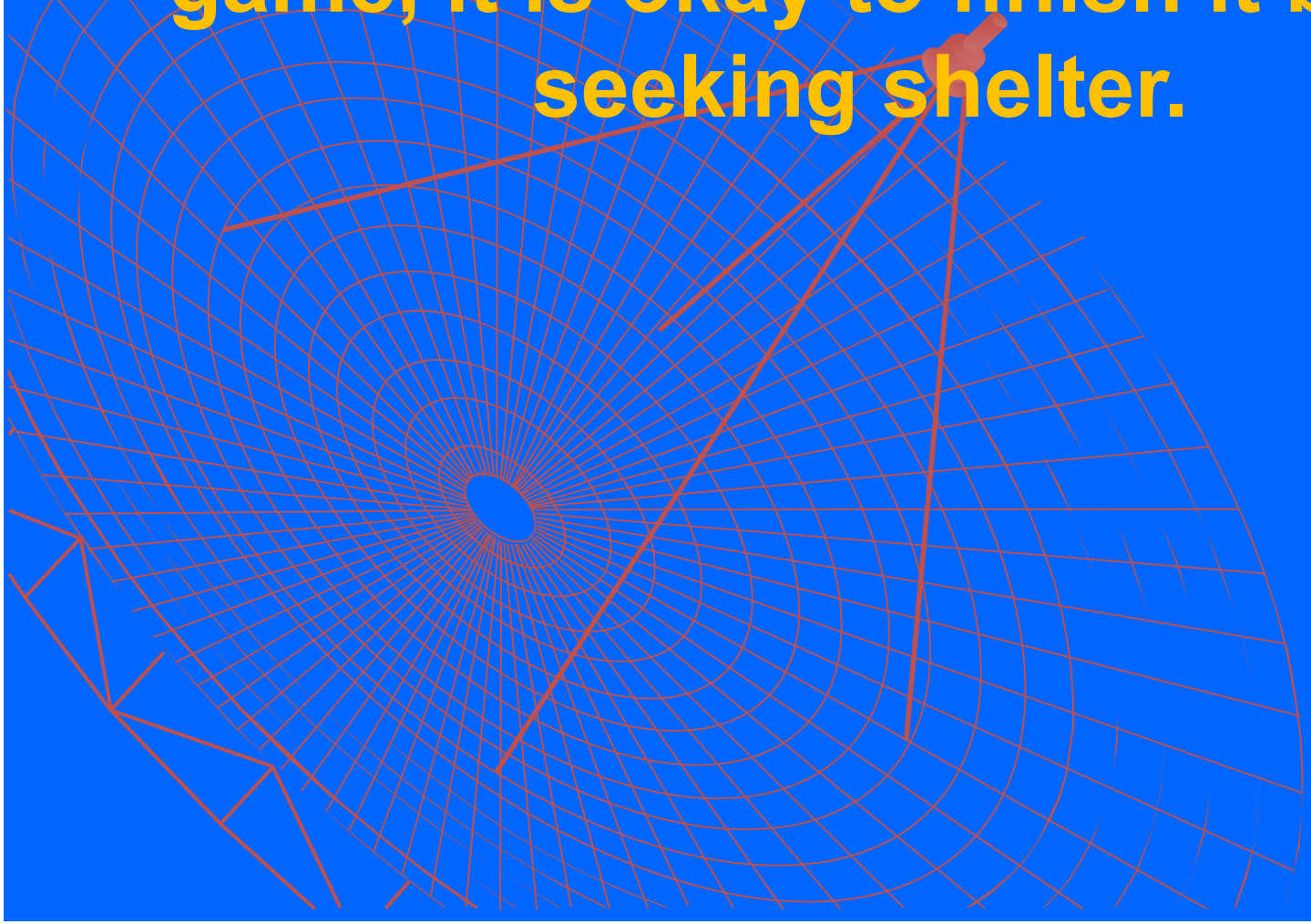


- Whole house surge protectors at the entrance panel.
- Surge protectors at appliance locations (Radio Room)
- Single point ground connected to service ground at entrance panel routed outside of the residence.
- Surge protectors on all antenna lead-ins.
- Towers grounded and connected to the single point ground.
- Coax shields grounded to tower legs as low as possible.

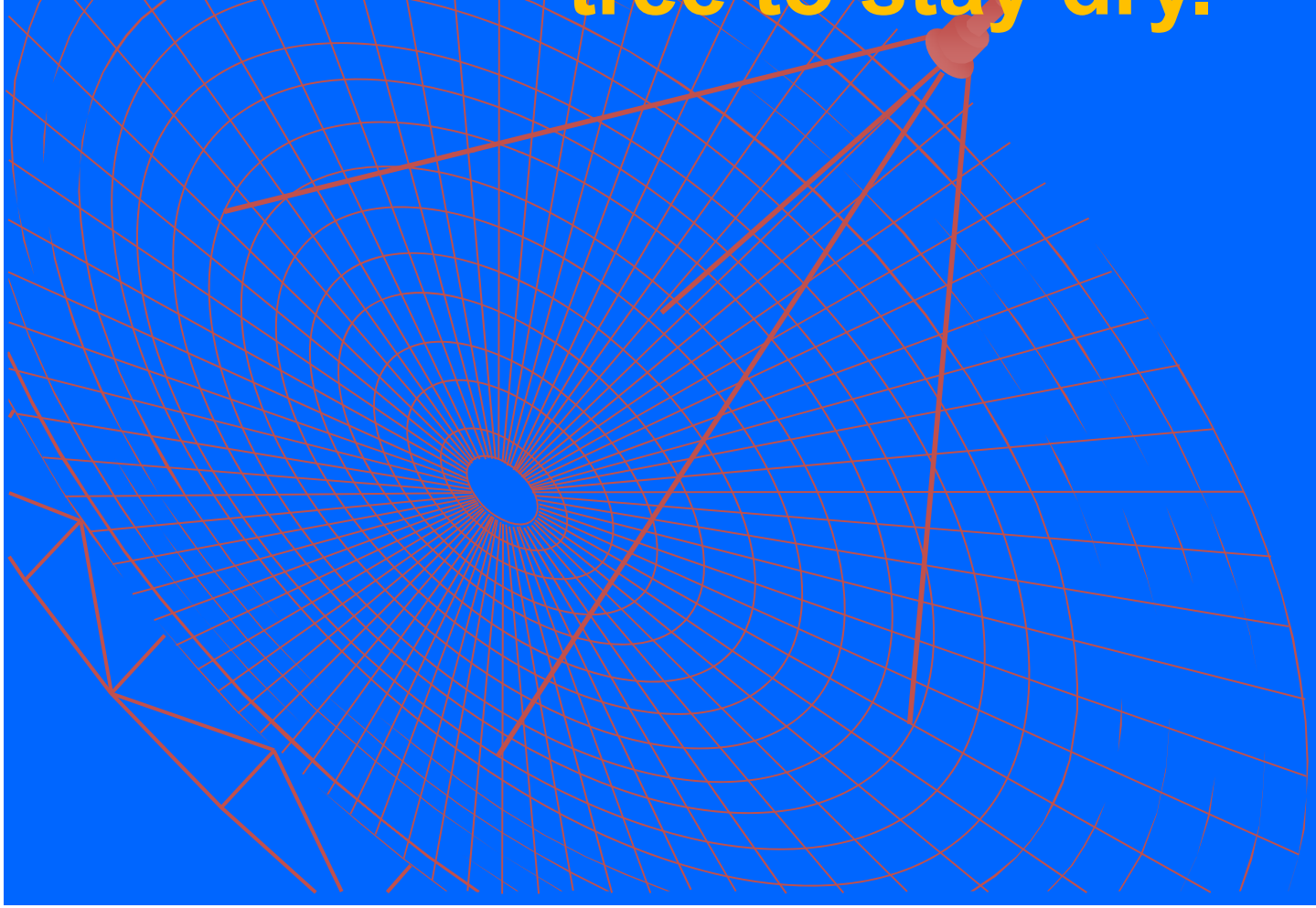

Myths

Myth: If it's not raining or there aren't clouds overhead, you're safe from lightning.

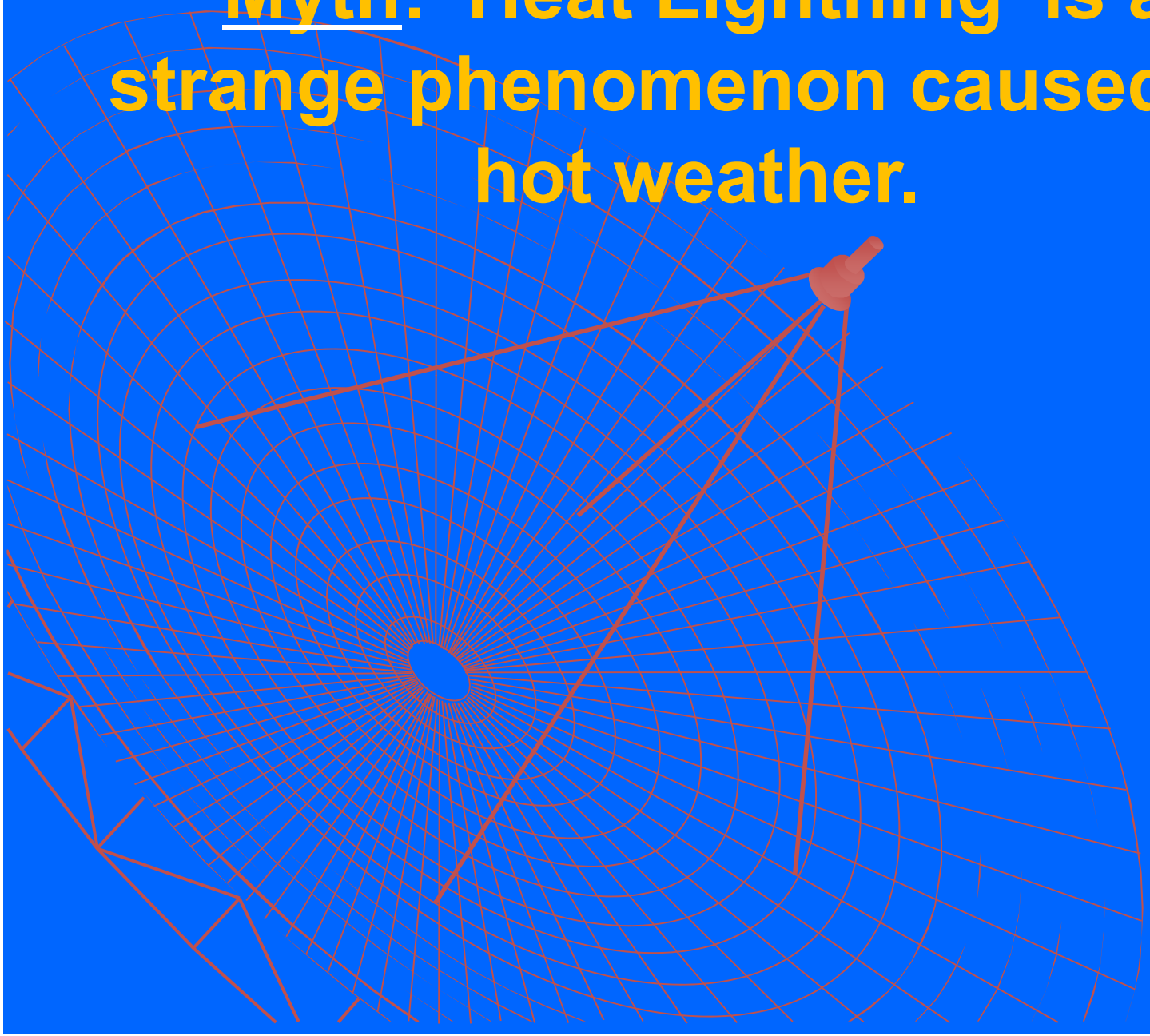
Myth: If thunderstorms threaten while you are outside playing a game, it is okay to finish it before seeking shelter.



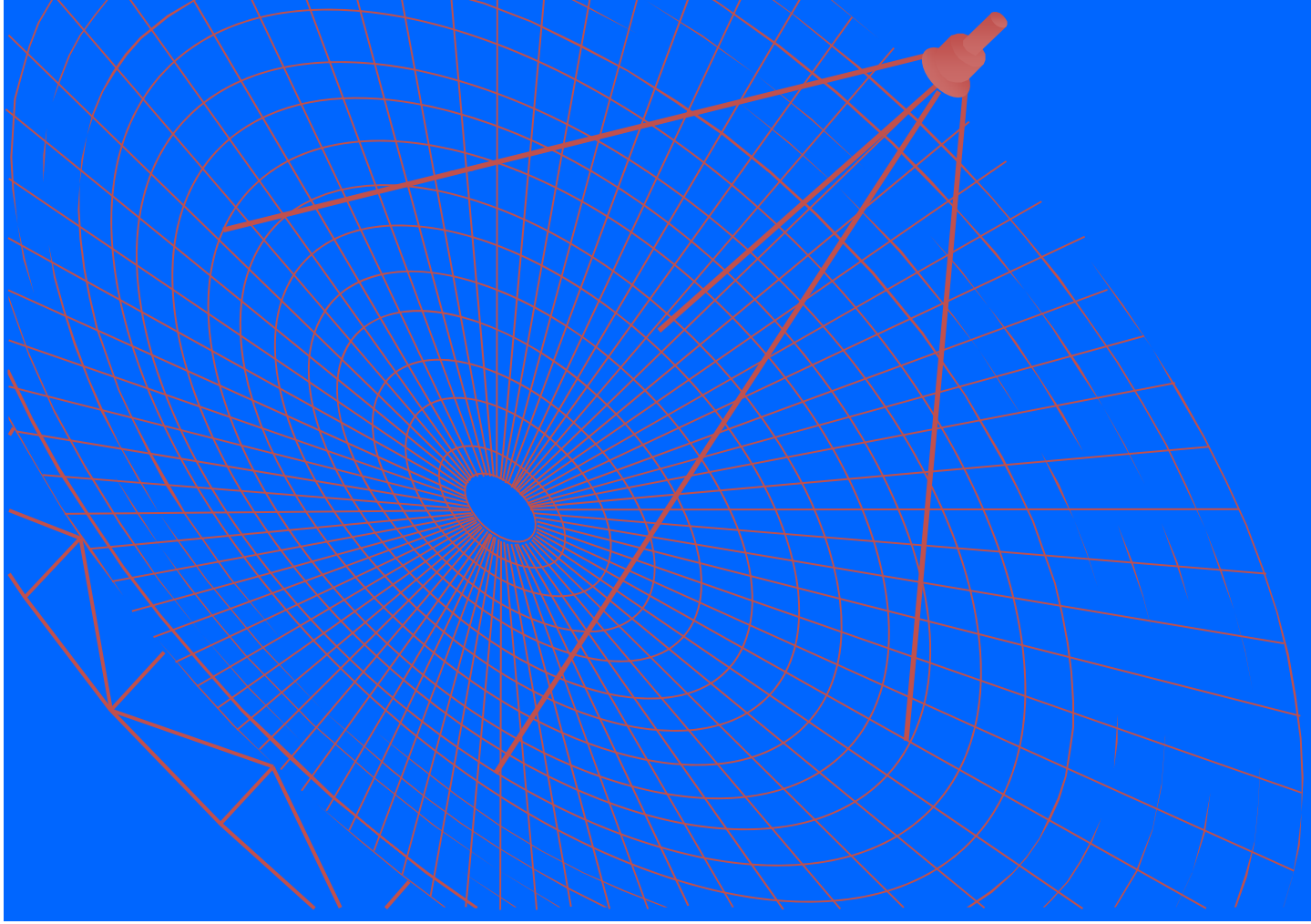
Myth: If outside in a thunderstorm, you should seek shelter under a tree to stay dry.



Myth: 'Heat Lightning' is a strange phenomenon caused by hot weather.



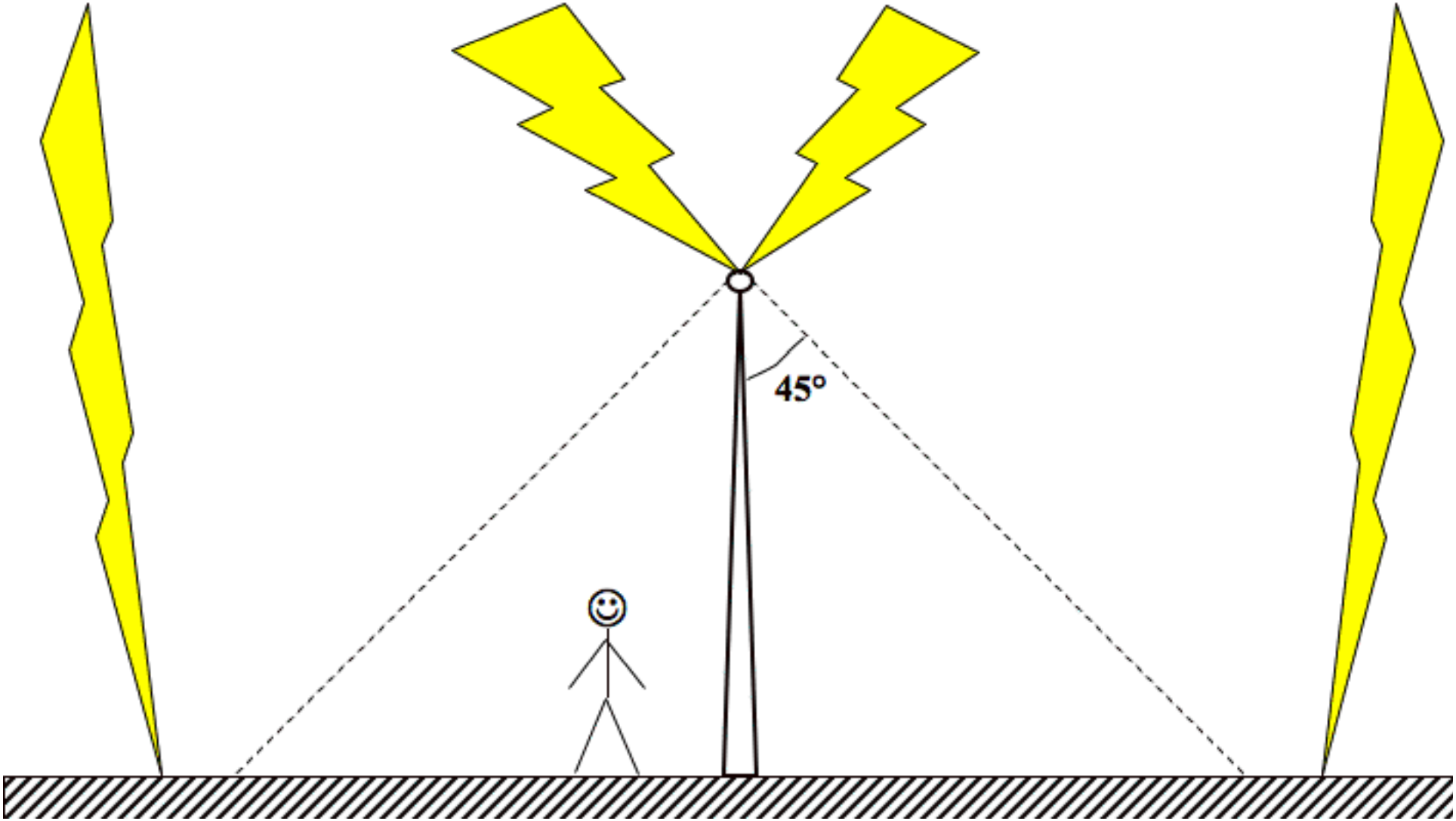
Myth: Lightning never strikes the same place twice.



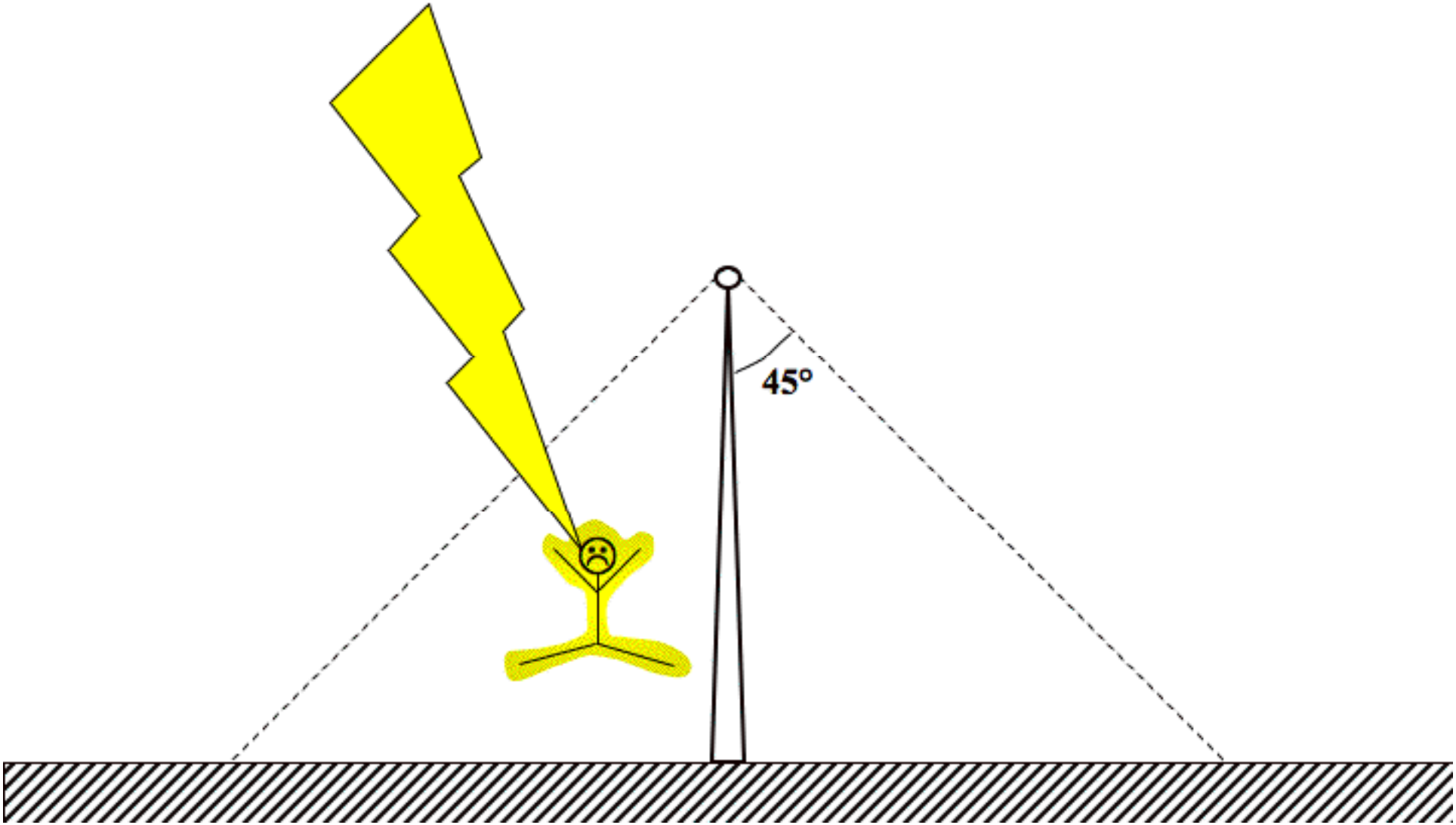
Myth: The automobile's rubber tires you from lightning by insulating you from the ground.

MYTH: Cone Of Protection

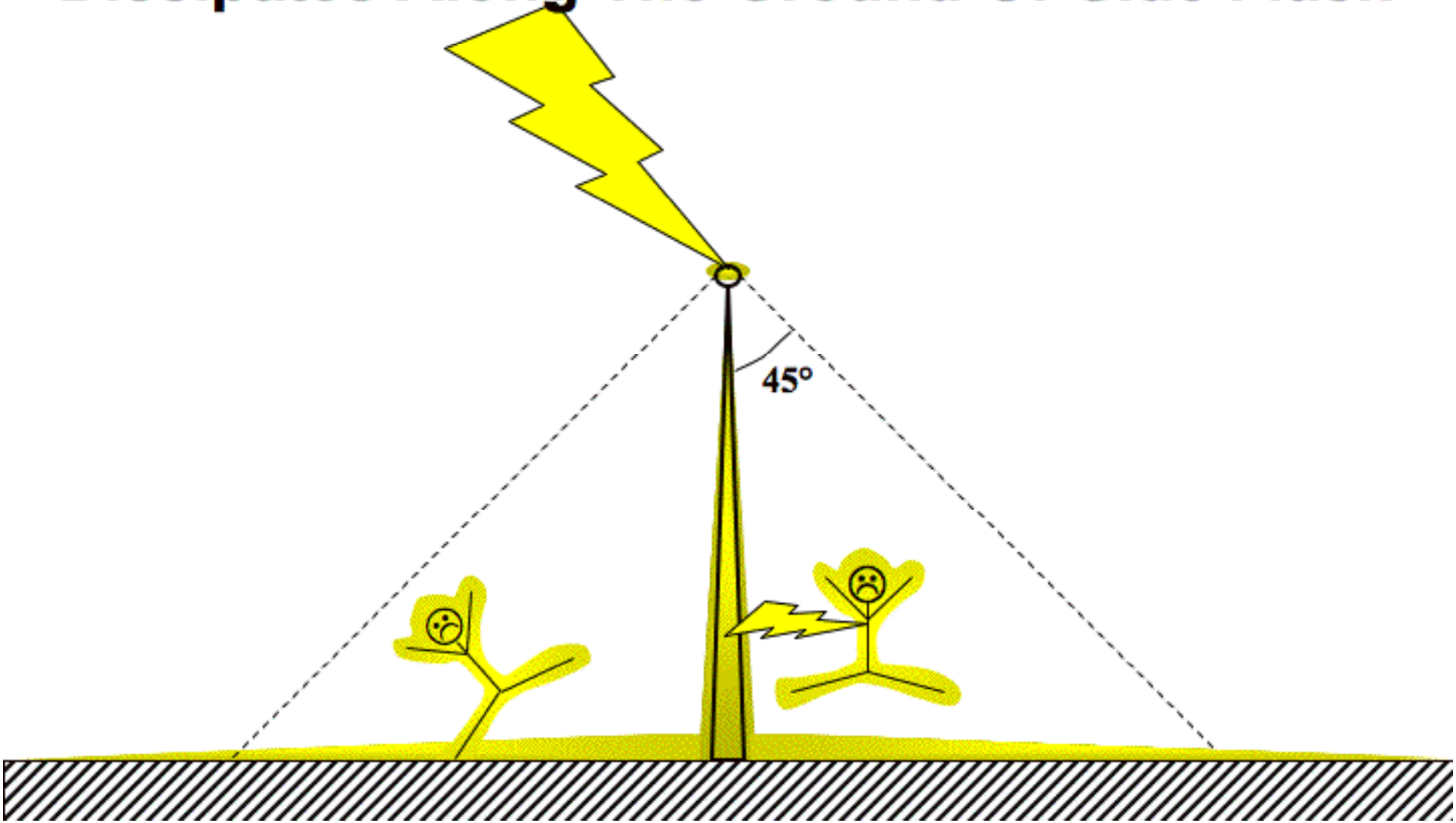
- Lightning won't strike within a cone within 45° of a tall isolated object, since it will attract lightning that close



REALITY: Lightning Can Easily Strike Inside The So-Called "Cone Of Protection"



REALITY (continued): Even If Lightning Strikes The Object, You're Still In Danger As It Dissipates Along The Ground Or Side Flash

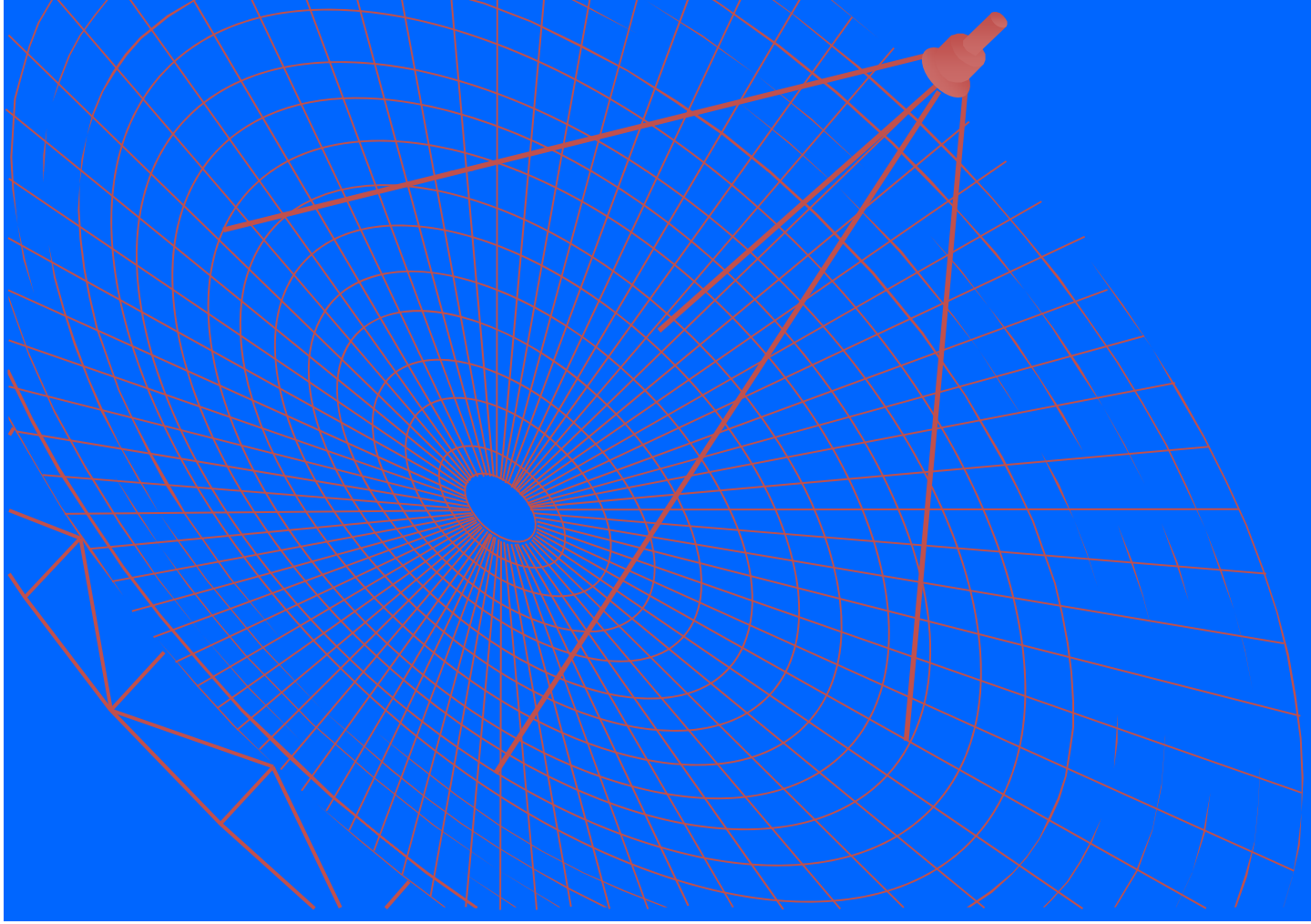


Myth: Average homeowners lightning insurance claim is over $10,000.

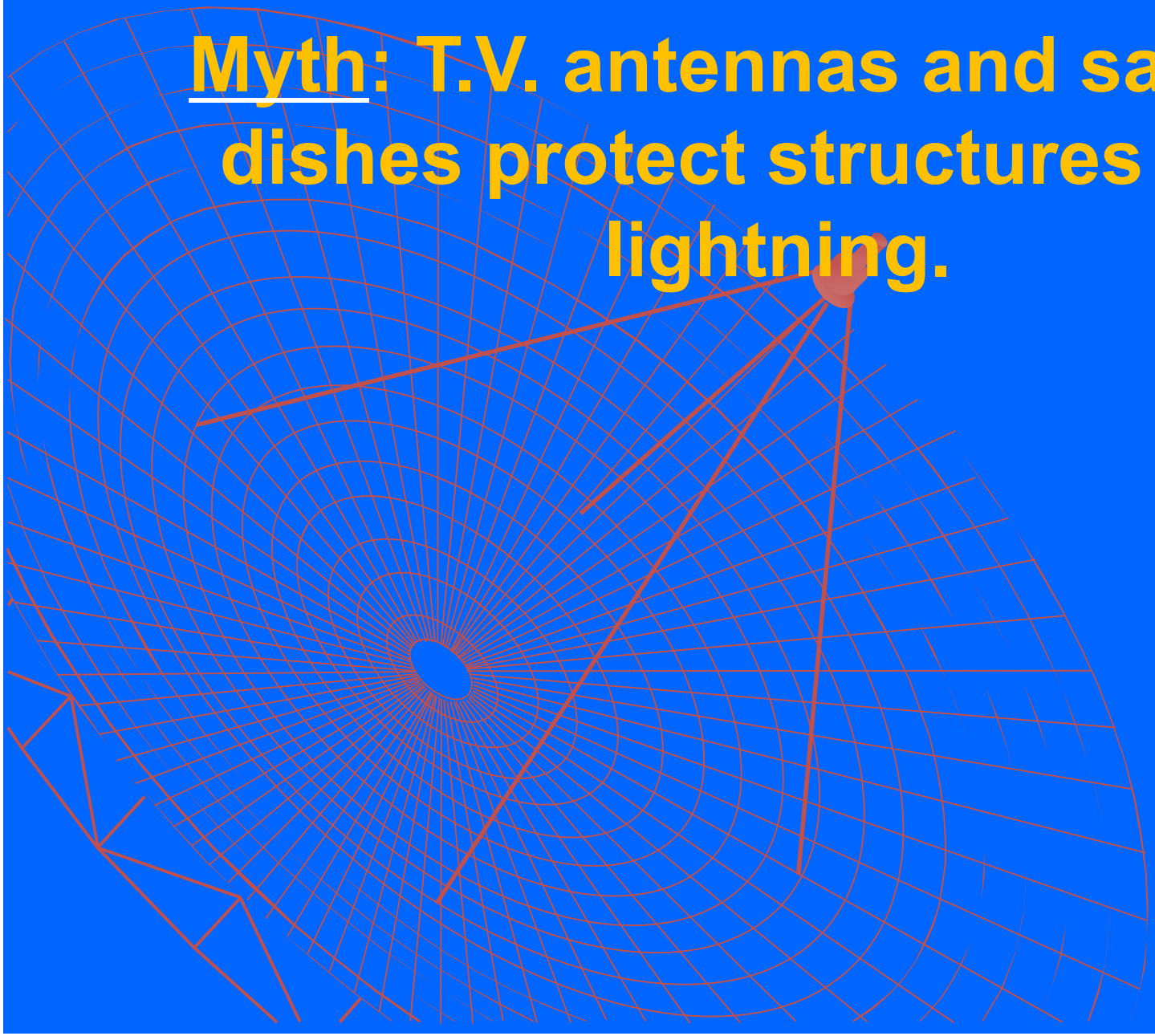
Year	Number of Claims	Value of Claims ($ millions)	Average Cost Per Claim
2004	278,000	$735.5	$2,646
2005	265,700	819.6	3,084
2006	256,000	882.2	3,446
2007	177,100	942.4	5,321
2008	246,200	1,065.5	4,329
2009	185,789	798.1	4,296
2010	213,278	1,033.5	4,846
2011	186,307	952.5	5,112
2012	151,000	969.0	6,400
2013	114,740	673.5	5,869
% change, 2004-2013	-58.7%	-8.4%	121.8%
% change, 2012-2013	-24.0%	-30.5%	-8.3%

Source: Insurance Information Institute, State Farm®.

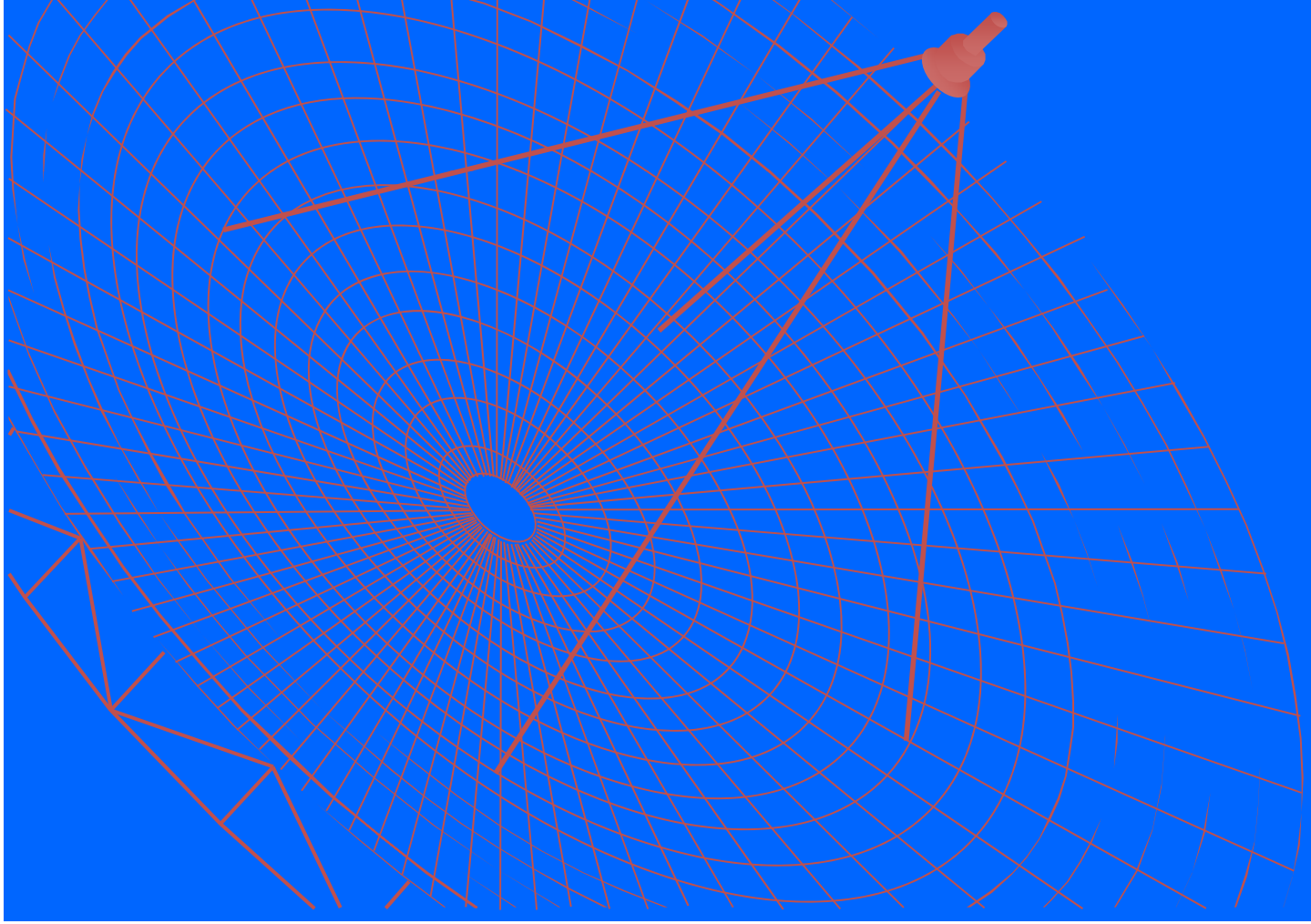
Myth: All modern buildings are "grounded" and don't need lightning protection, right?



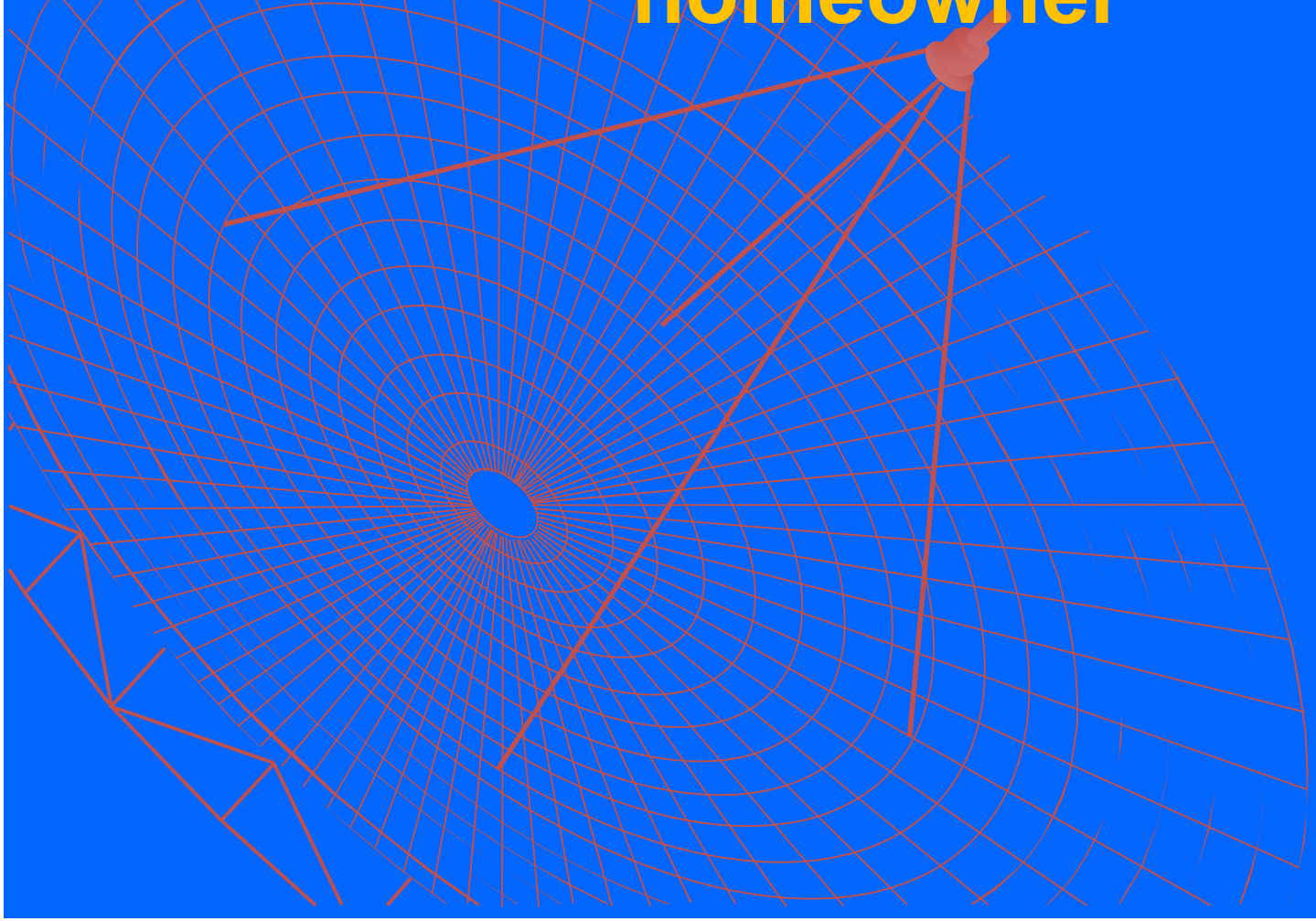
Myth: T.V. antennas and satellite dishes protect structures from lightning.



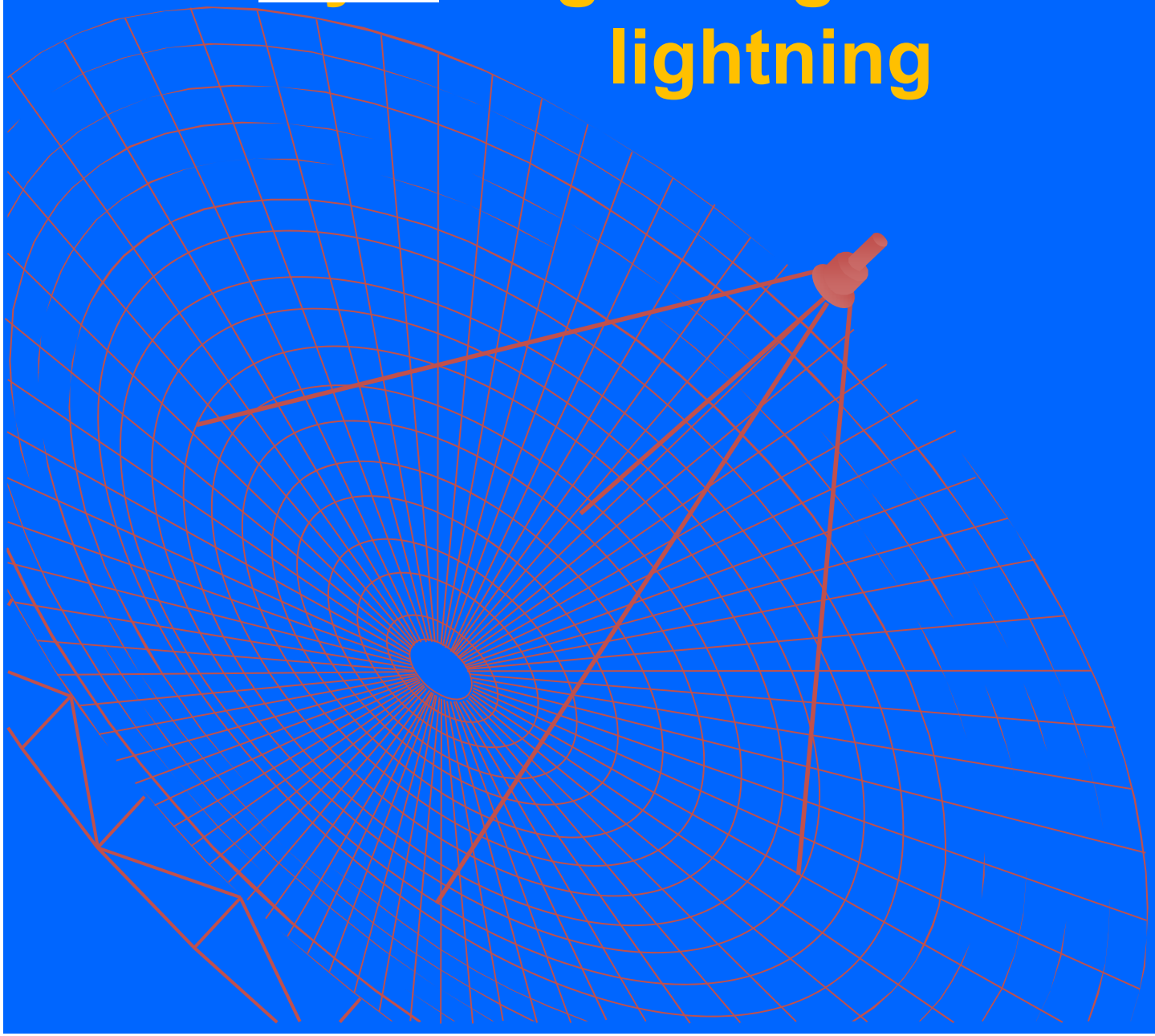
Myth: Surge arresters and suppressors will protect my home against lightning.



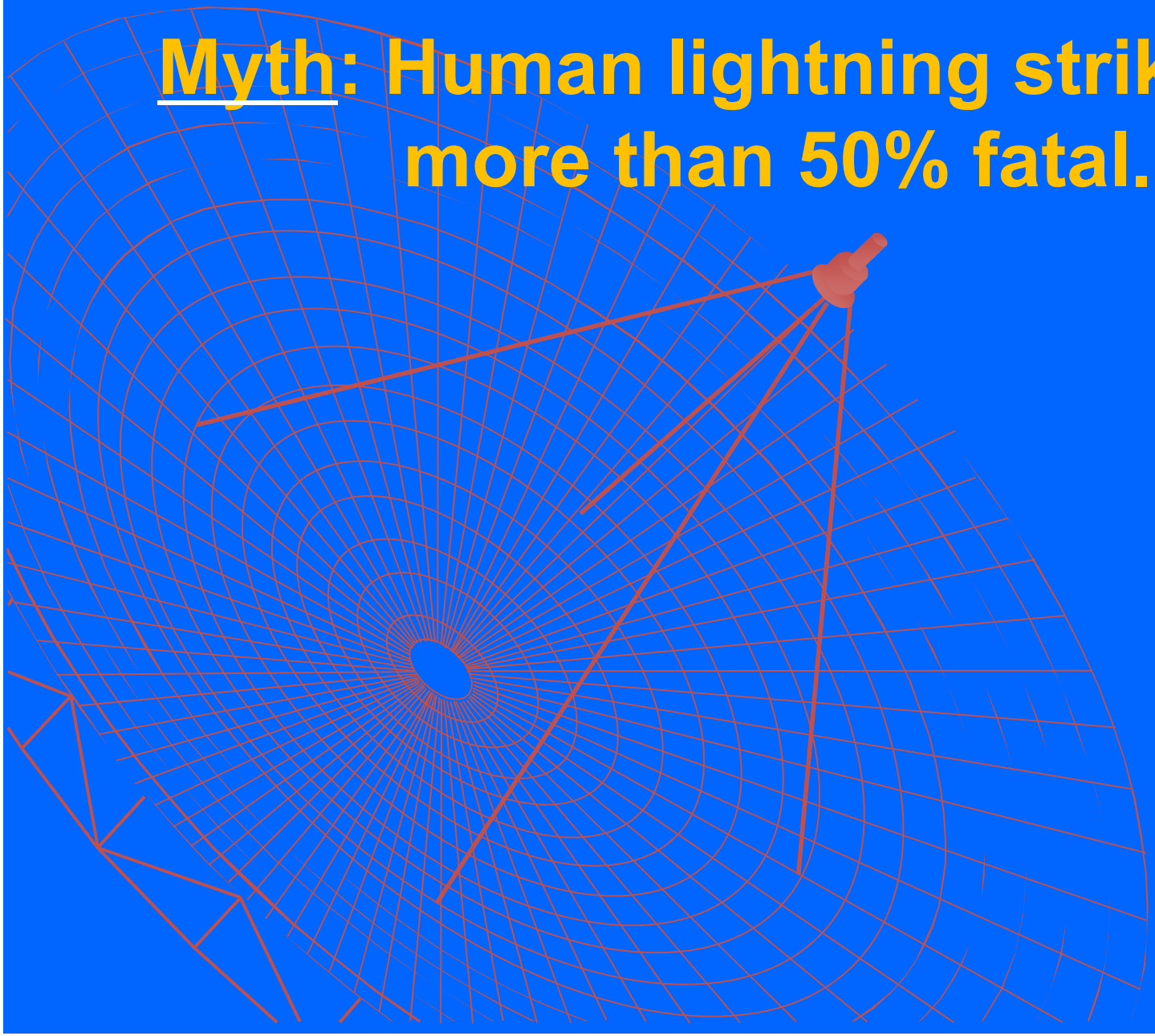
Myth: Lightning protection is way too expensive for the average homeowner



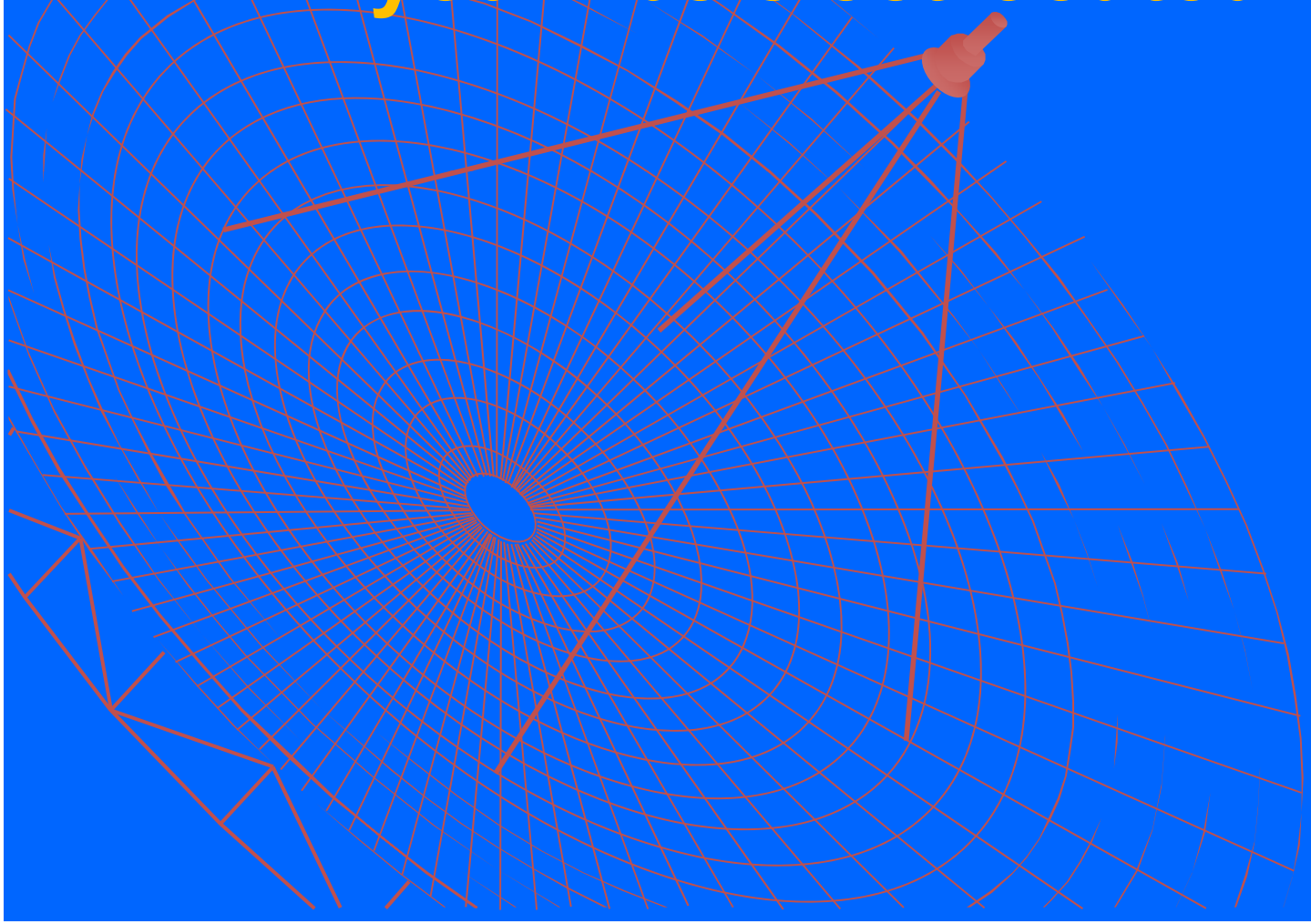
Myth: Lightning rods attract lightning



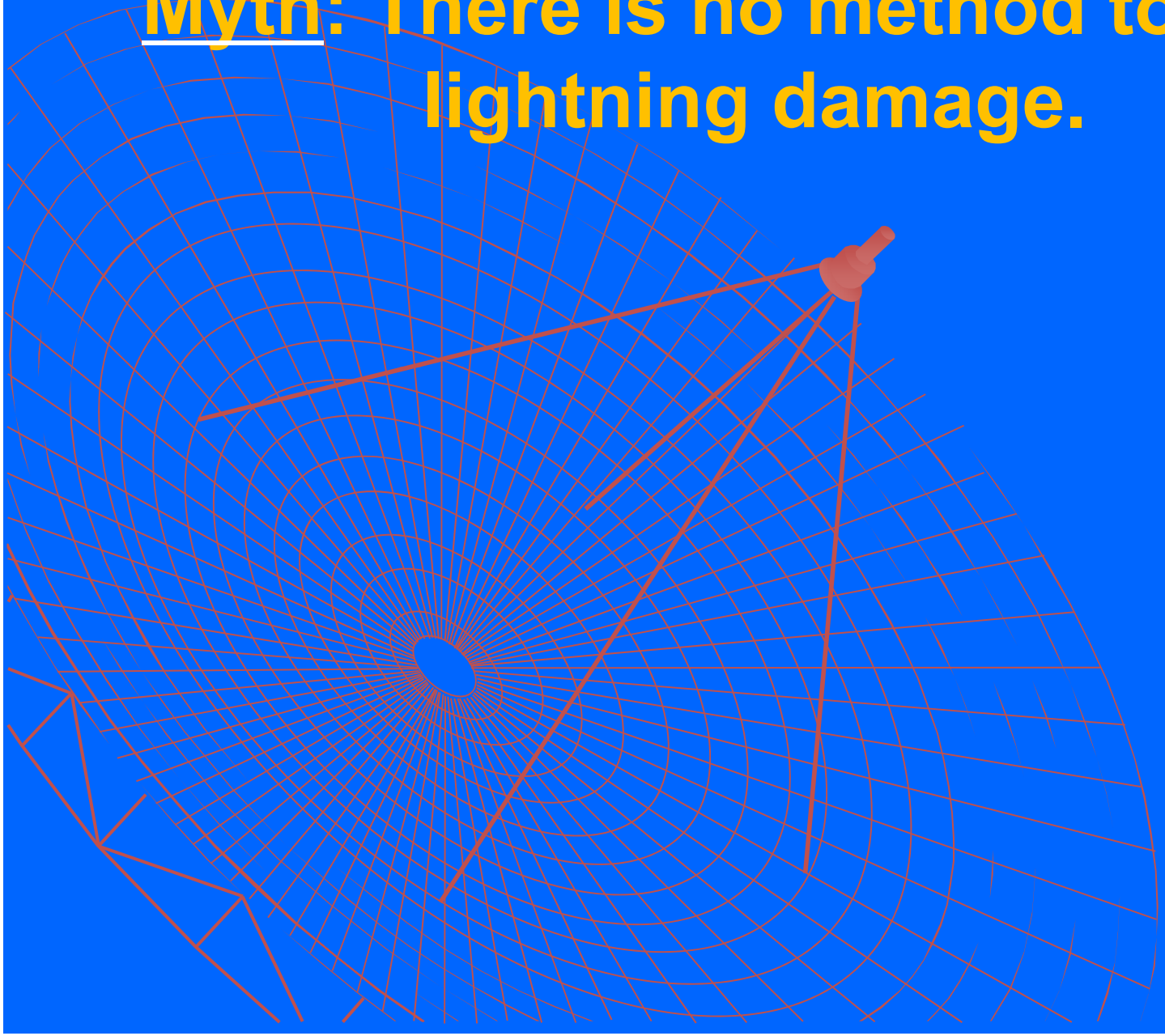
Myth: Human lightning strikes are more than 50% fatal.



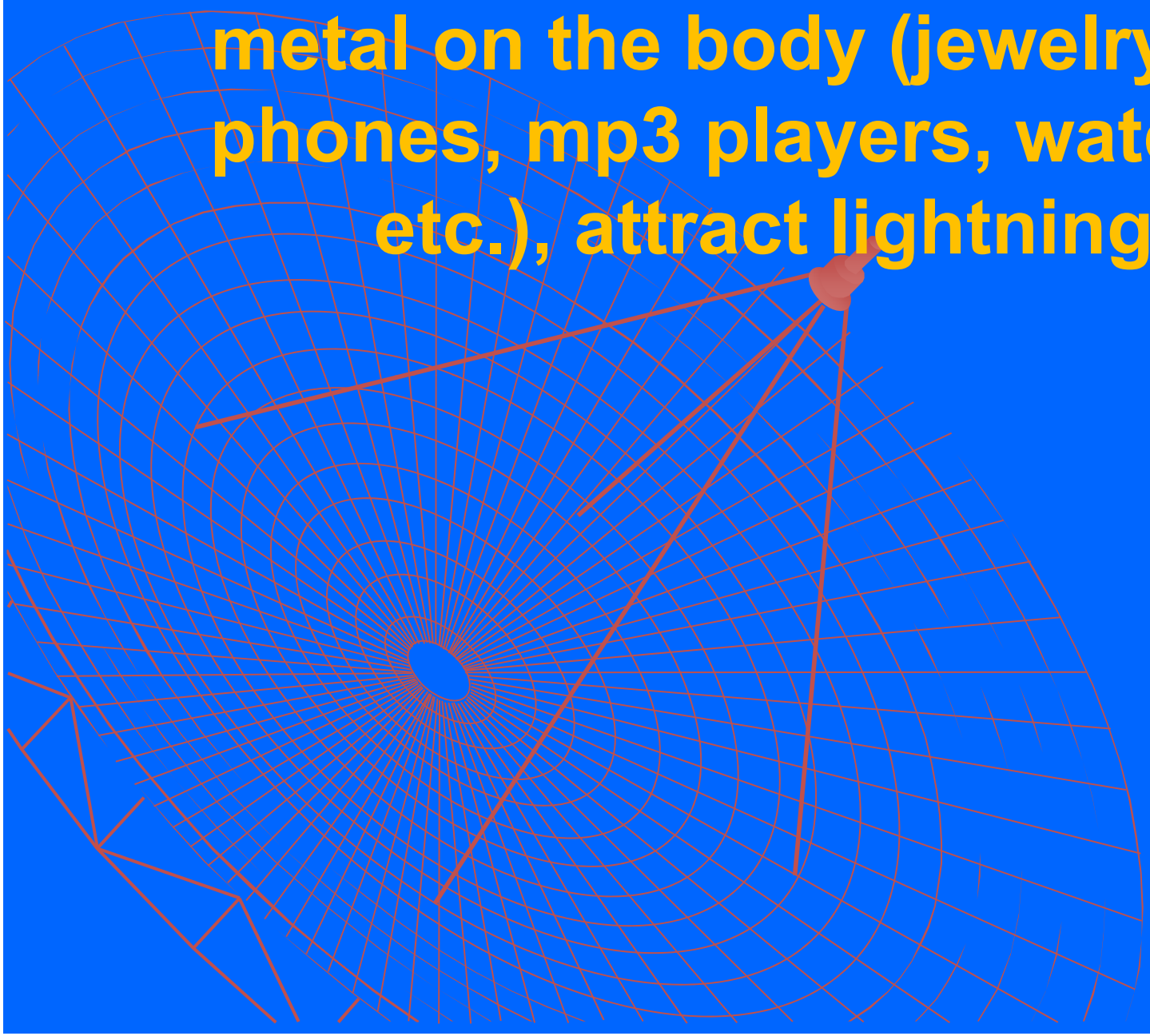
Myth: A lightning victim is electrified. If you touch them, you'll be electrocuted.



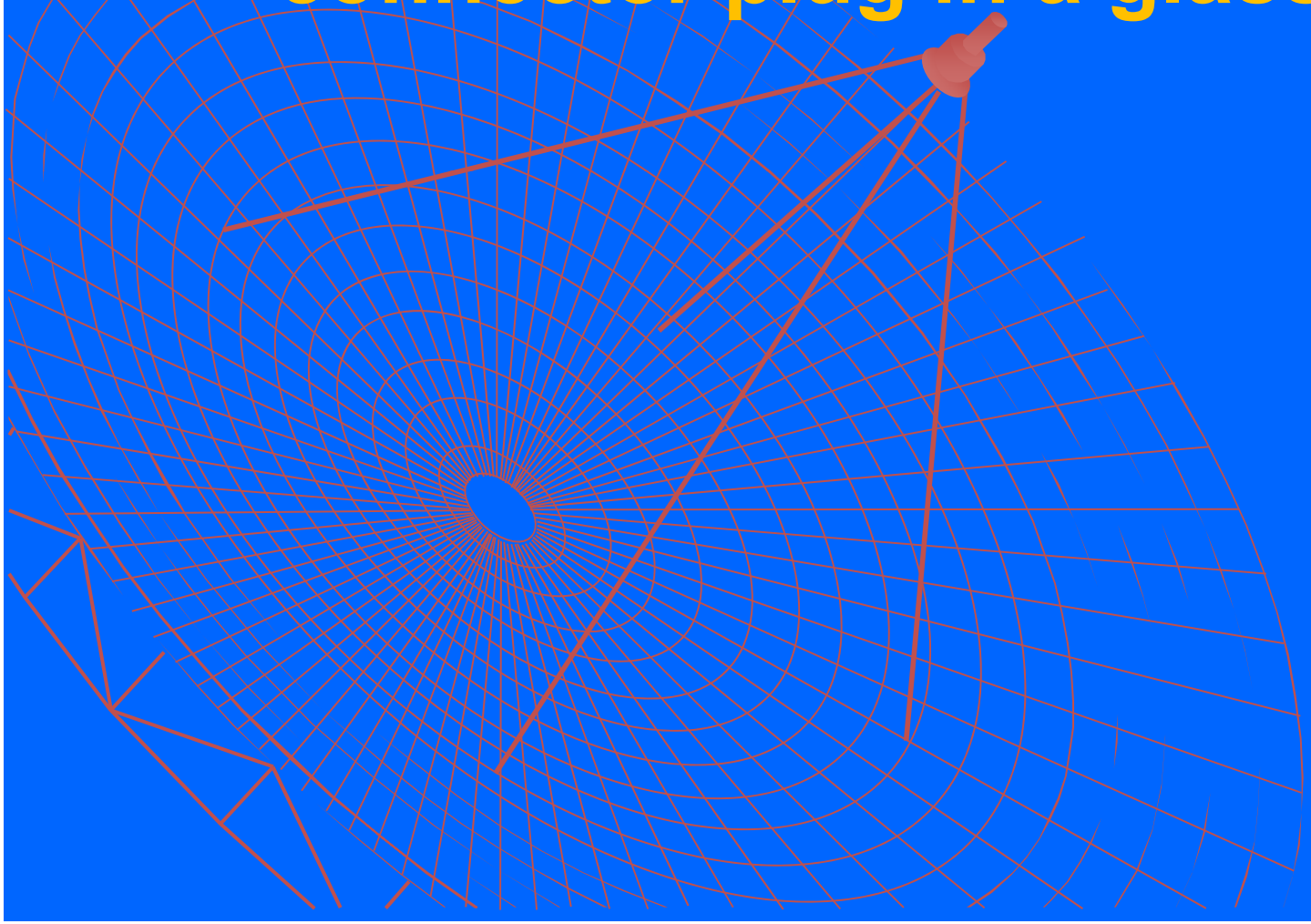
Myth: There is no method to stop lightning damage.



Myth: Structures with metal, or metal on the body (jewelry, cell phones, mp3 players, watches, etc.), attract lightning.



Myth: To stop lightning strike in your home, put the antenna coax connector plug in a glass cup.



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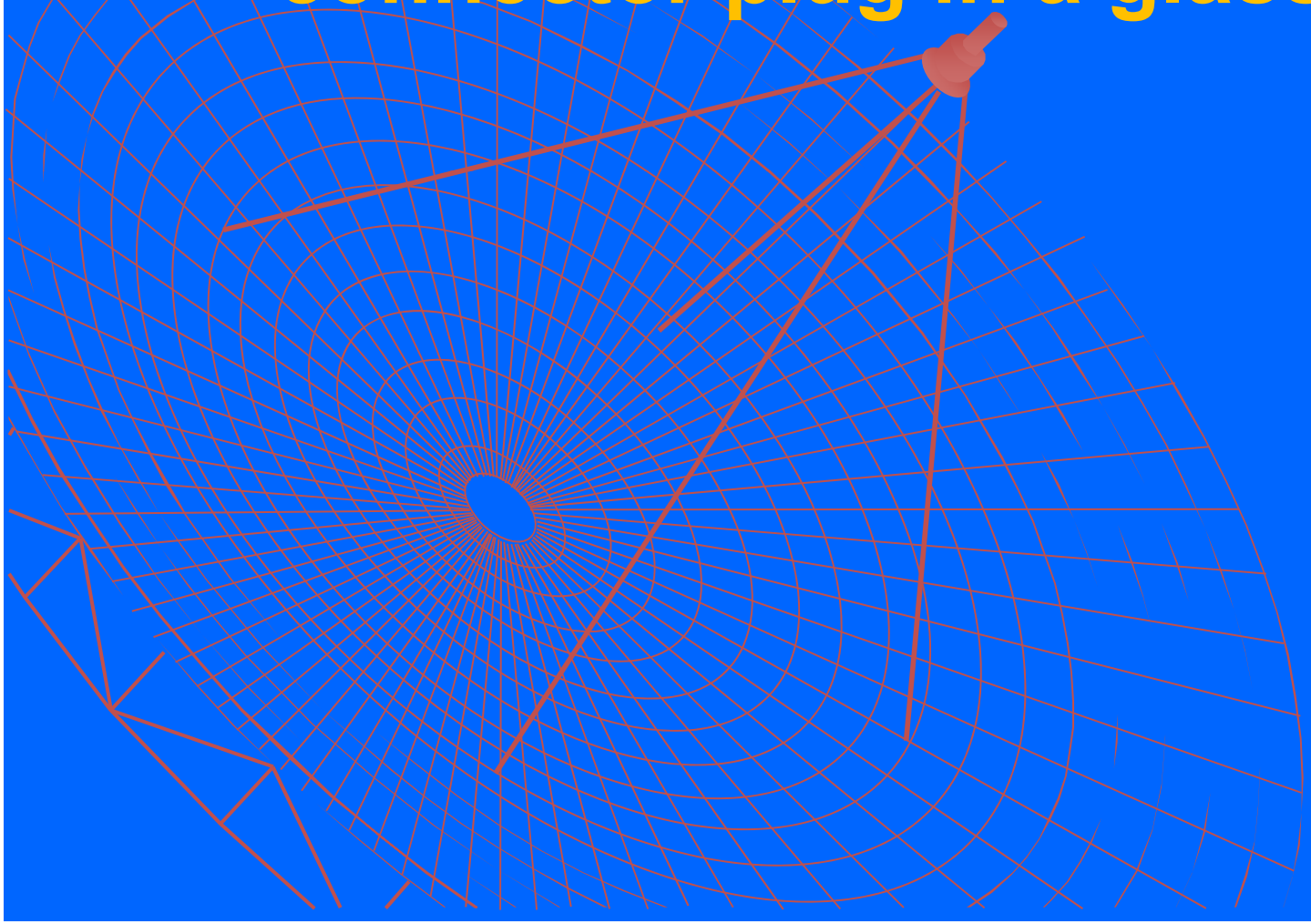
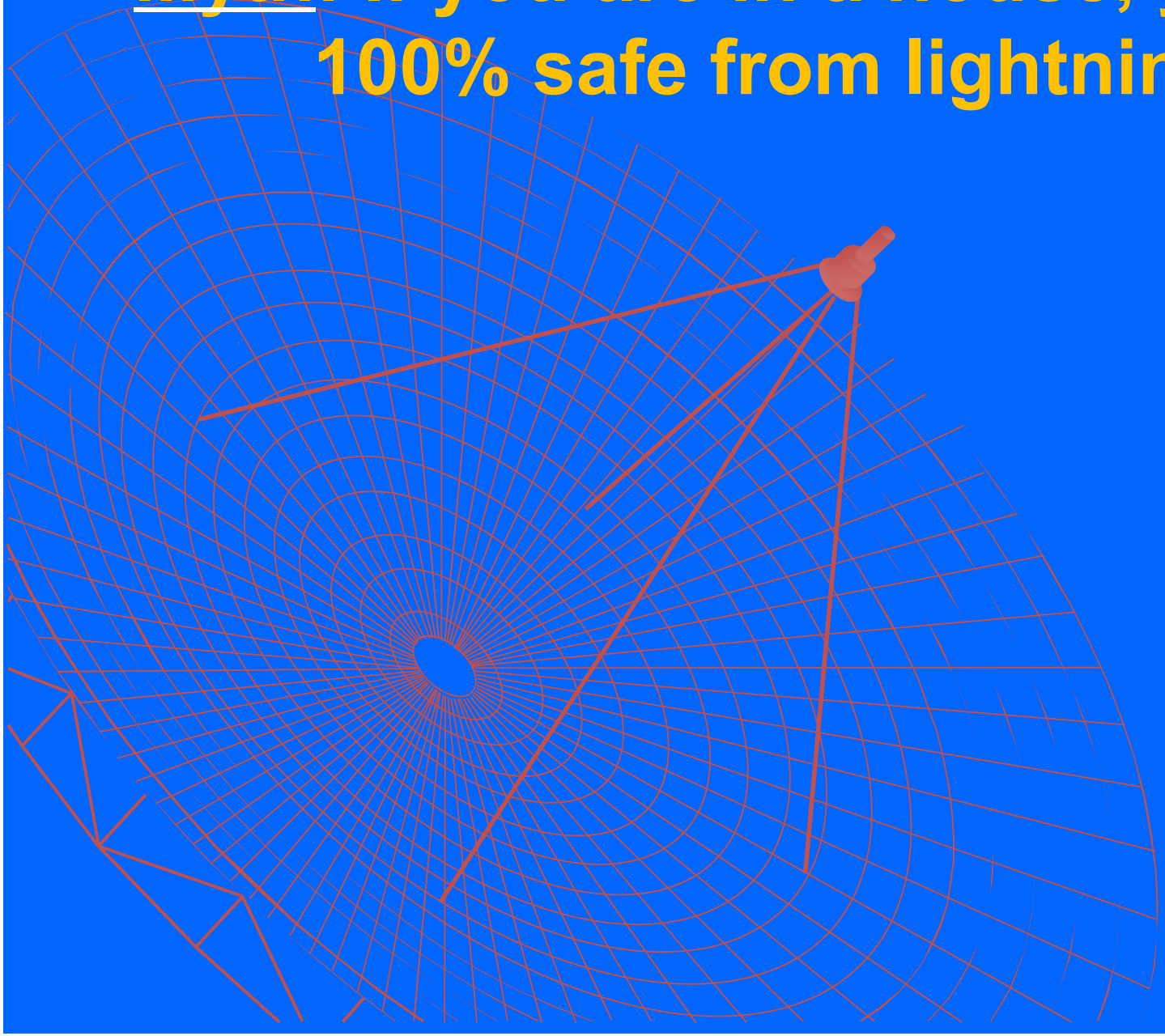


Myth: If you are in a house, you are 100% safe from lightning.



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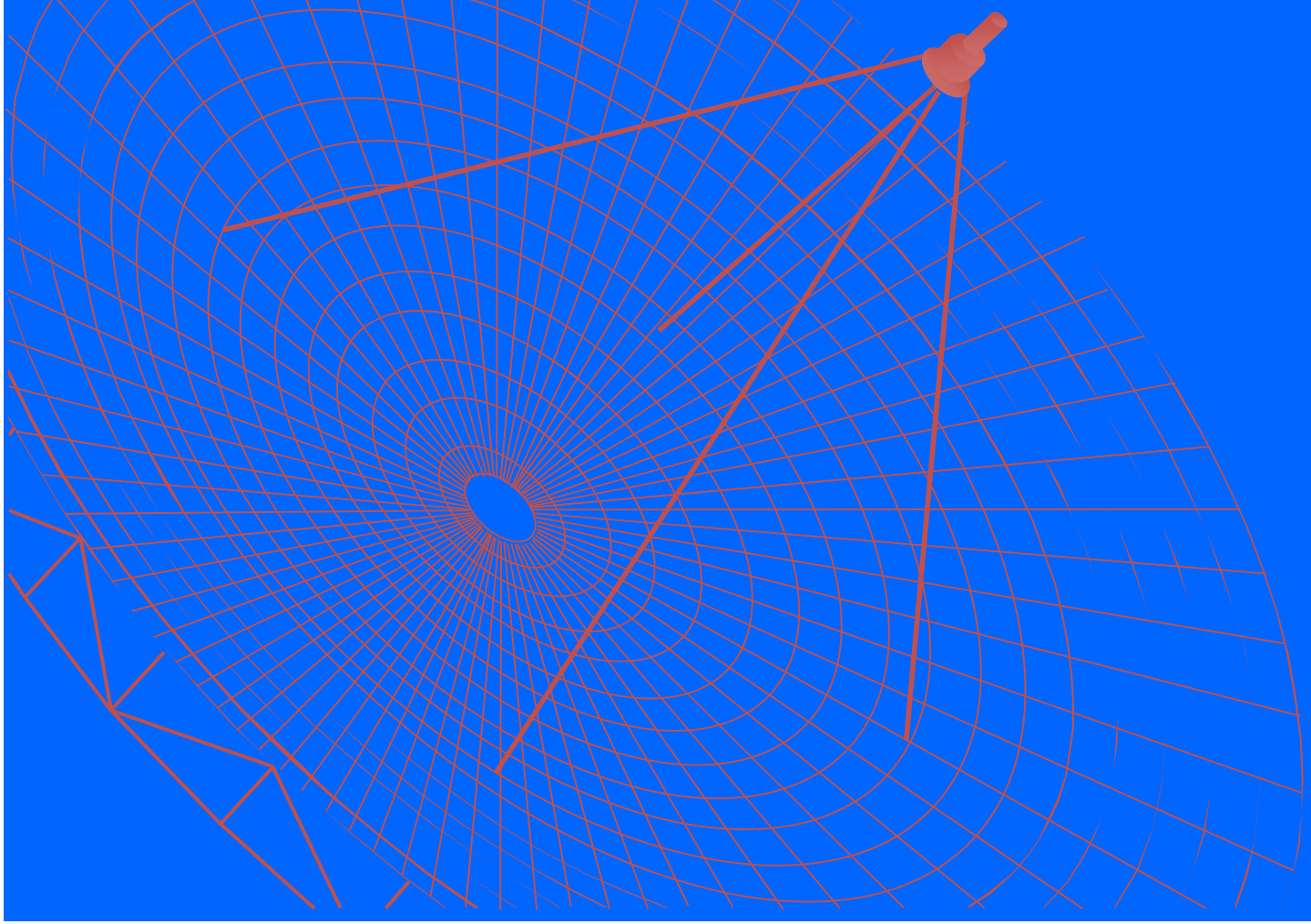

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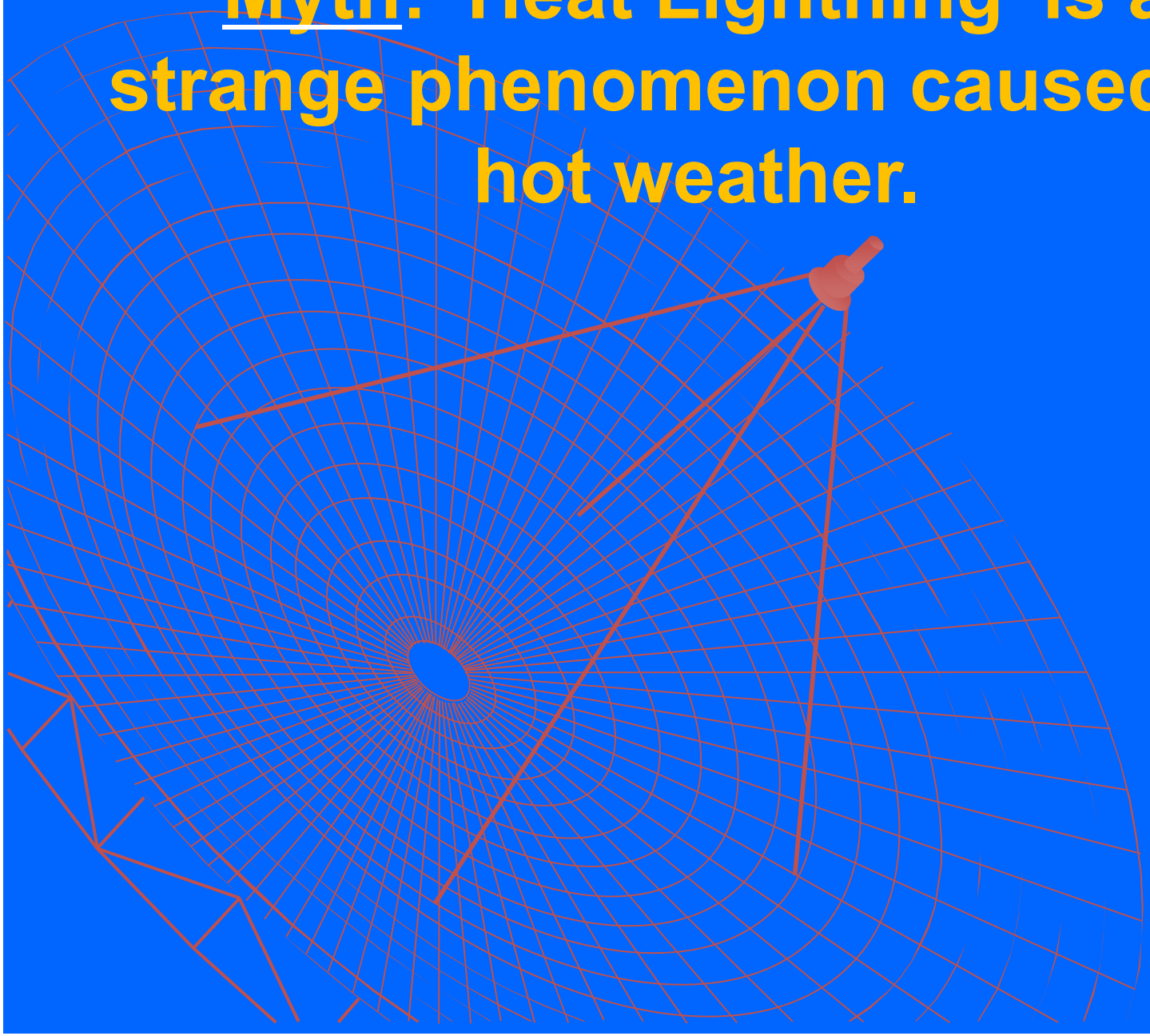

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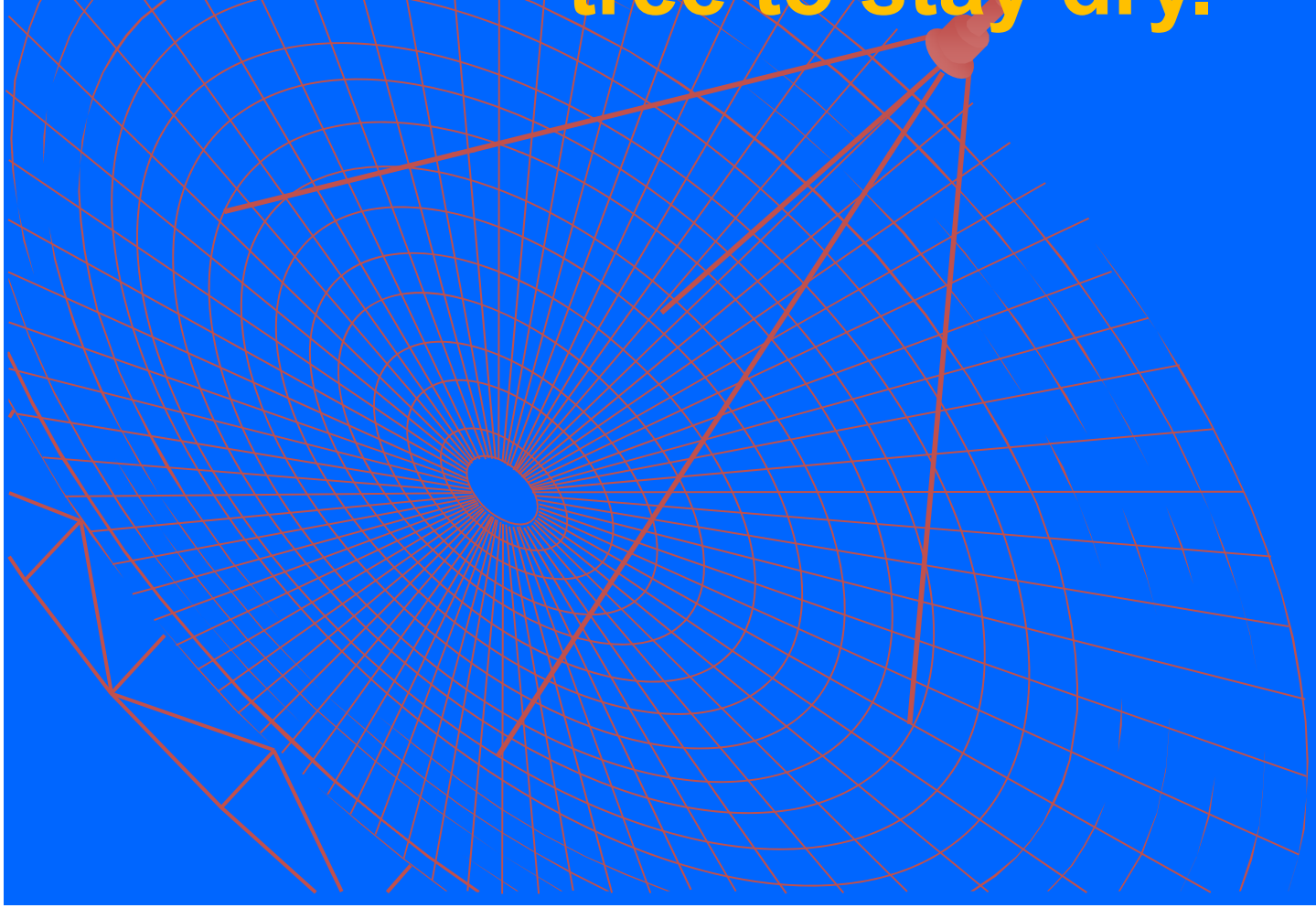

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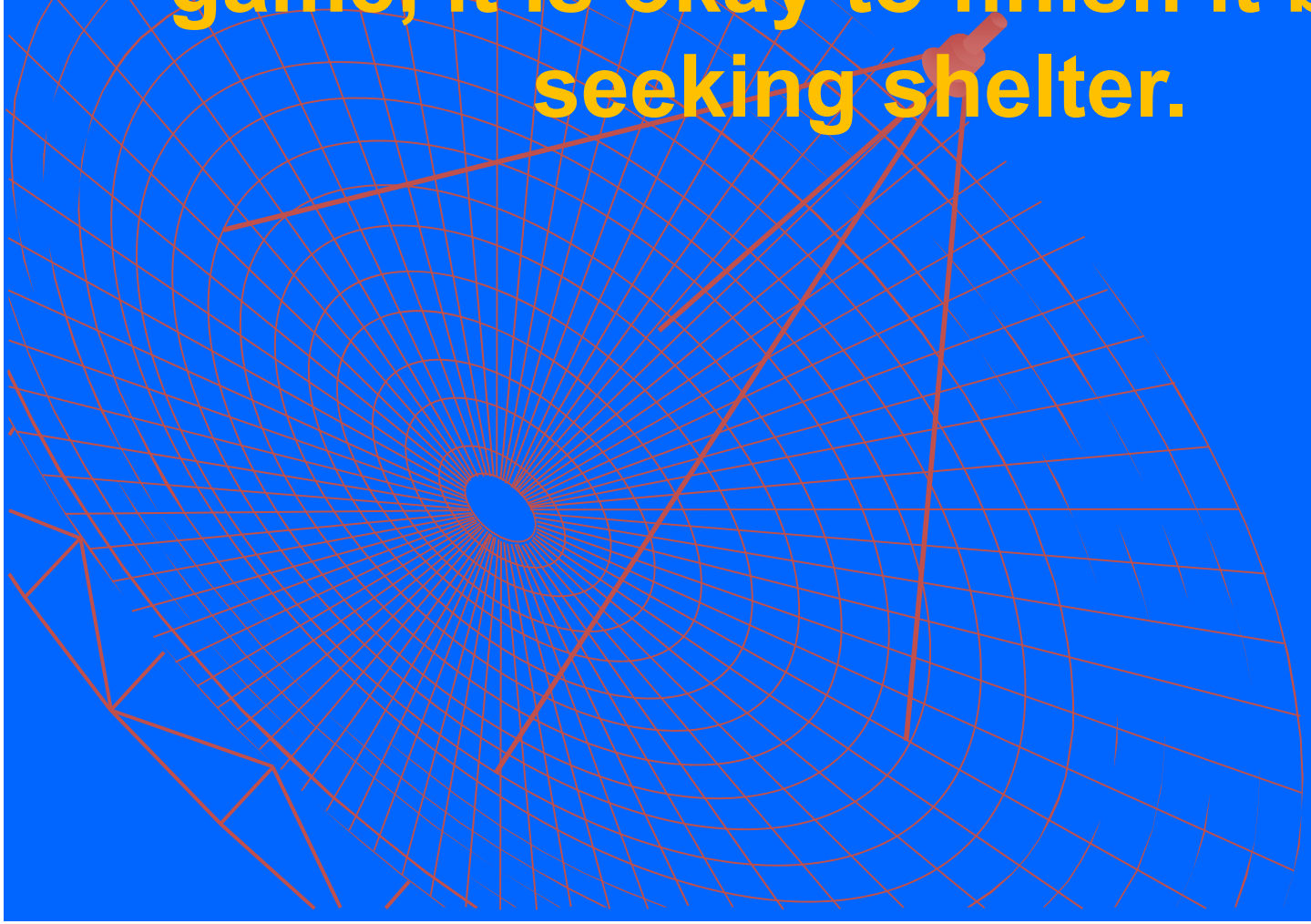


Myth: If it's not raining or there aren't clouds overhead, you're safe from lightning.

What is not lightning protection?

- Early steamer Emission – EME
  - Radioactive
  - Pulse Voltage
  - Sparking – Controlled Leader Trigger (CLT)
- Lightning Elimination
  - Dissipation Array System (DAS)
  - Charge Transfer System (CTS)
- Not allowed by
  - DoD
  - IEC
  - IEEE
  - NFPA
  - UL

SEAWORLD ORLANDO LIGHTNING INCIDENT

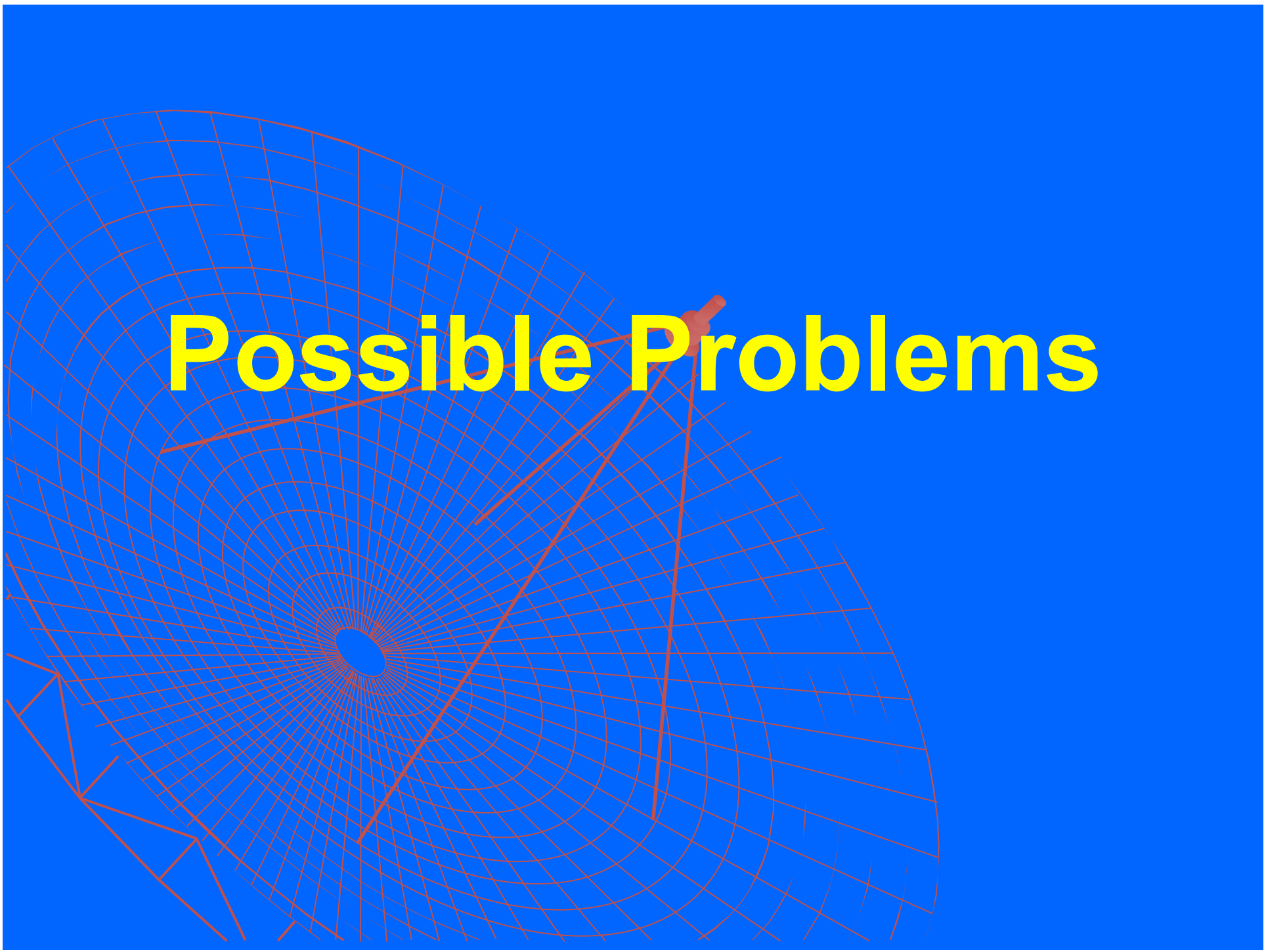
FAILURE OF THE SECOND GENERATION EARLY STREAMER EMISSION LIGHTNING ROD

By

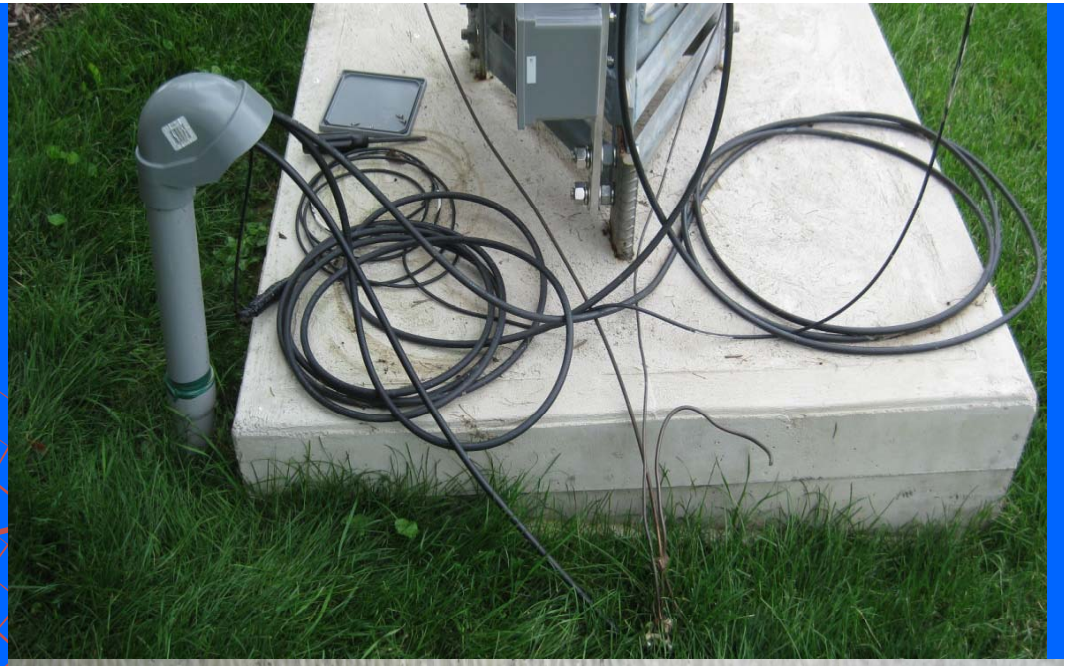
Z.A. Hartono & I Robiah

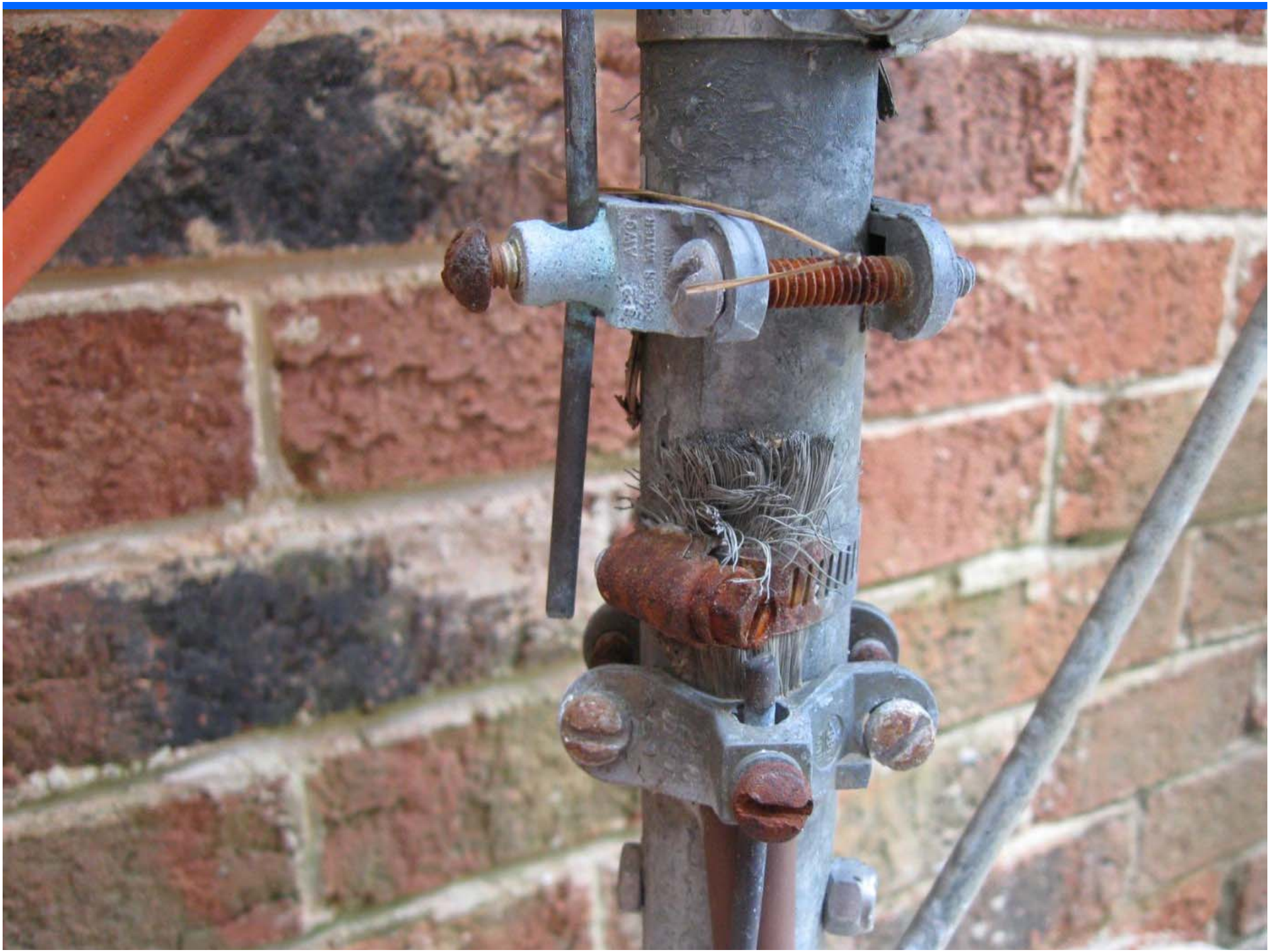
September 2012

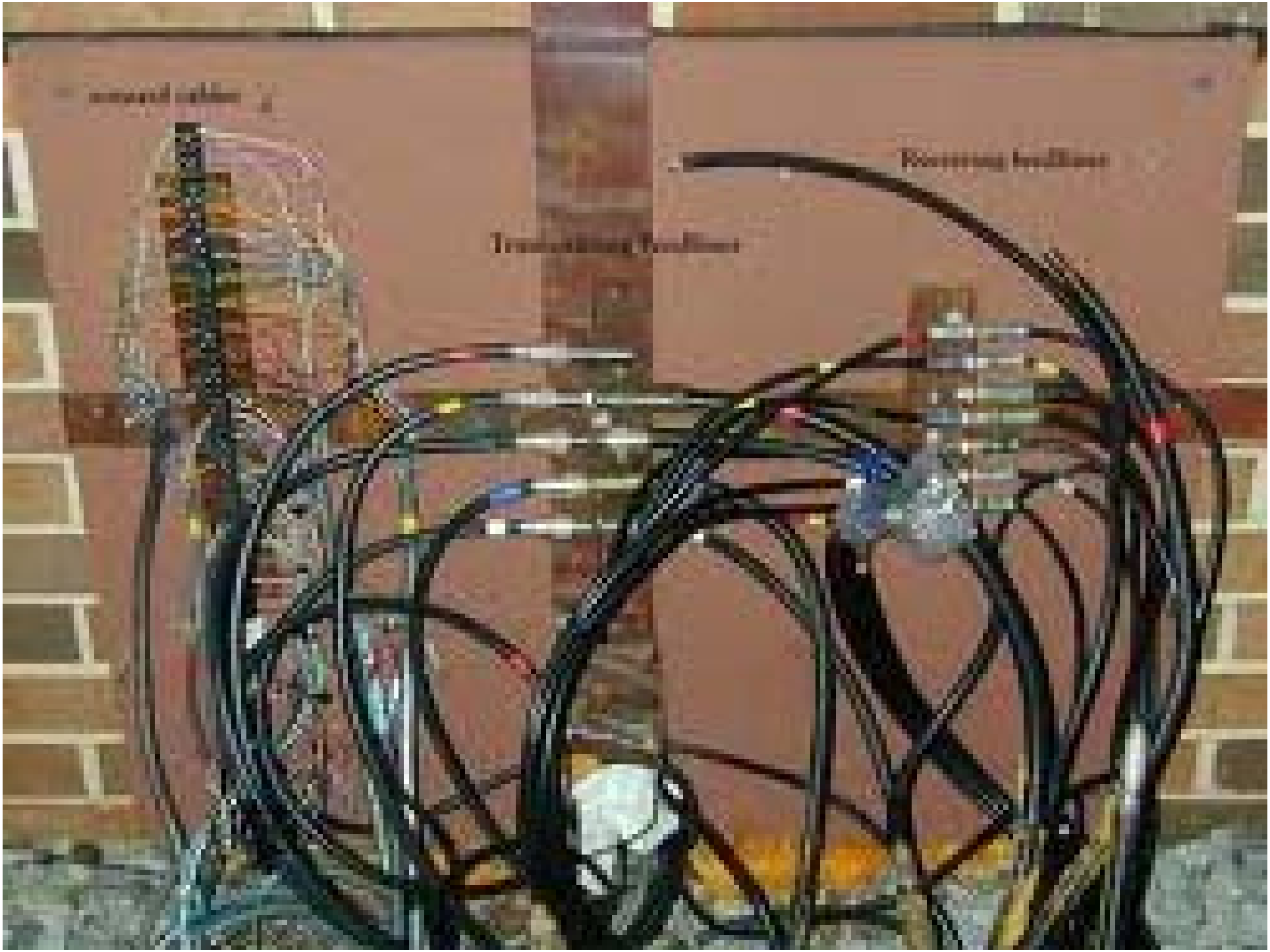
E-mail: zahartono@lesse.org


Possible Problems


Antenna Coax
& Lighting
Cables
SENROY
Ground
Wire








SE CABLE TYPE XHHW


ECP-1
MUNITIONS
STORAGE AREA
ALL VISITORS
MUST CALL 4-4119
FOR ENTRY

When turning off the radio:
Please follow the "rules of disagagement"

- Physical unplug all cables from the single point ground to ham equipment
- Ground all antennas – Best outside the station building
- Ground everything which enter the shack
- Unplug AC power at wall outlets

If one forgets and you have not followed the "rules of disagagement ", a near-by strike might migrate and bypass your lightning protection system

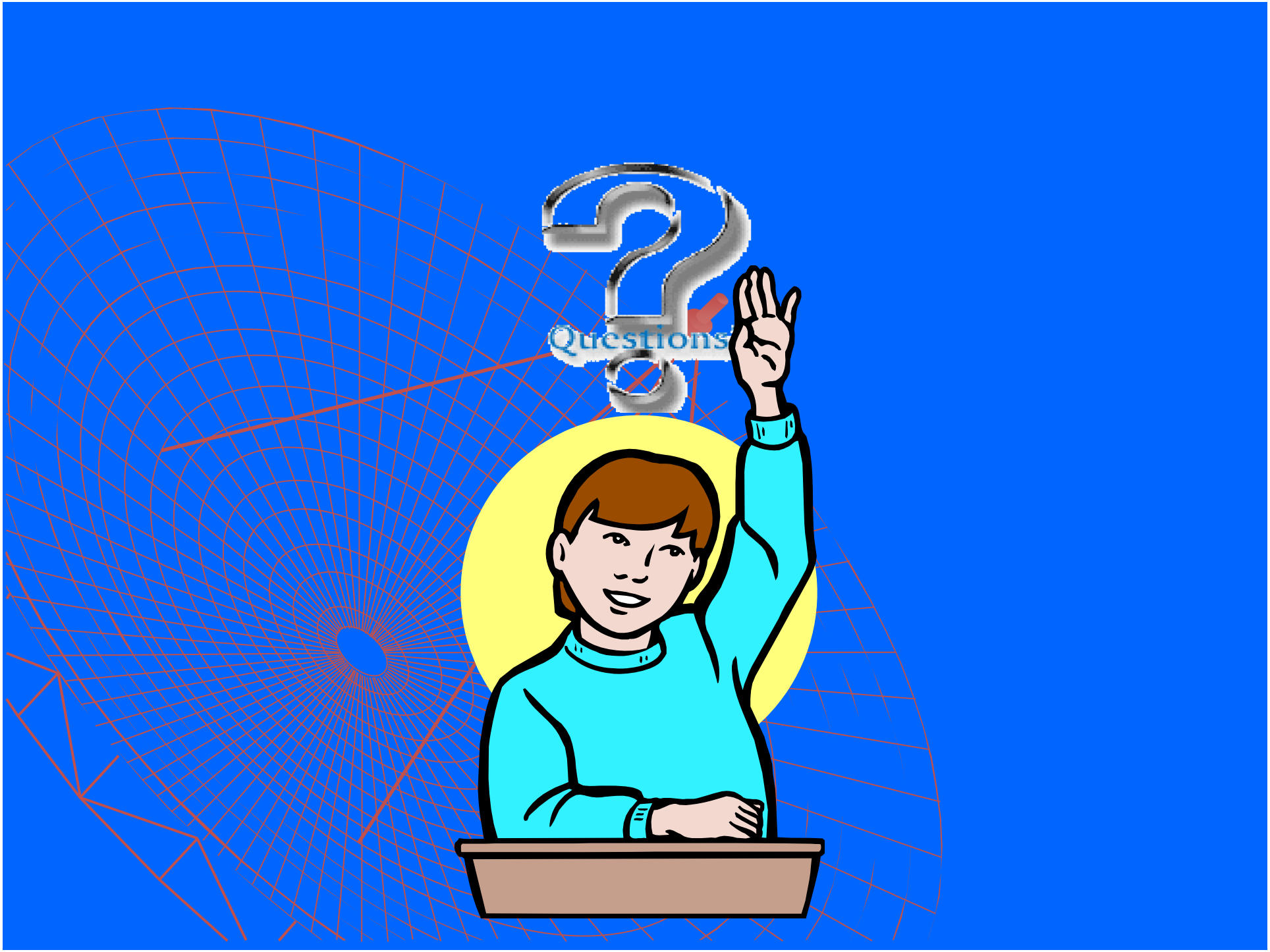
Disclaimer

- Not an expert in grounding and/or in lightning protection
- Have some personal experience with lightning, lightning damage and lightning protection
- Never worked professionally in any capacity in lightning or protection from lightning
- Suggested lightning protection procedures may reduce total damage

MOTHER NATURE
She can be kind…

Or Not

…and unpredictable!


Questions