

# Isolated Down-Conductors Improved Lightning Protection for Rooftop or Outdoor Telecommunications Equipment



Presented by:  
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PENTAIR

## AGENDA

- Lightning Attachment Process
- Side Flashing
- Bonding & Isolation – NFPA, IEC
- Electronics on Modern Rooftops & Towers
- Isolated Down-conductor and Terminations
- Case Studies and Site Examples



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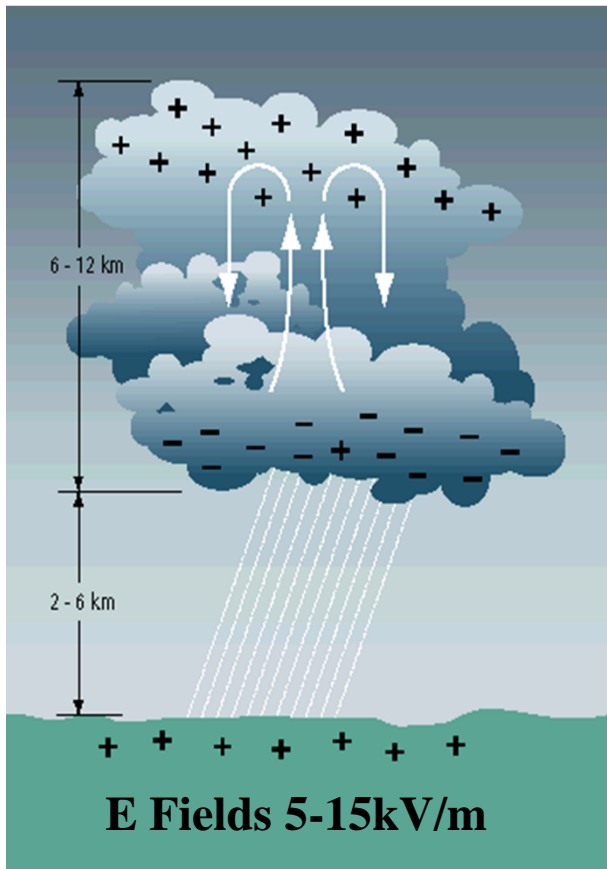
# LIGHTNING ATTACHMENT PROCESS



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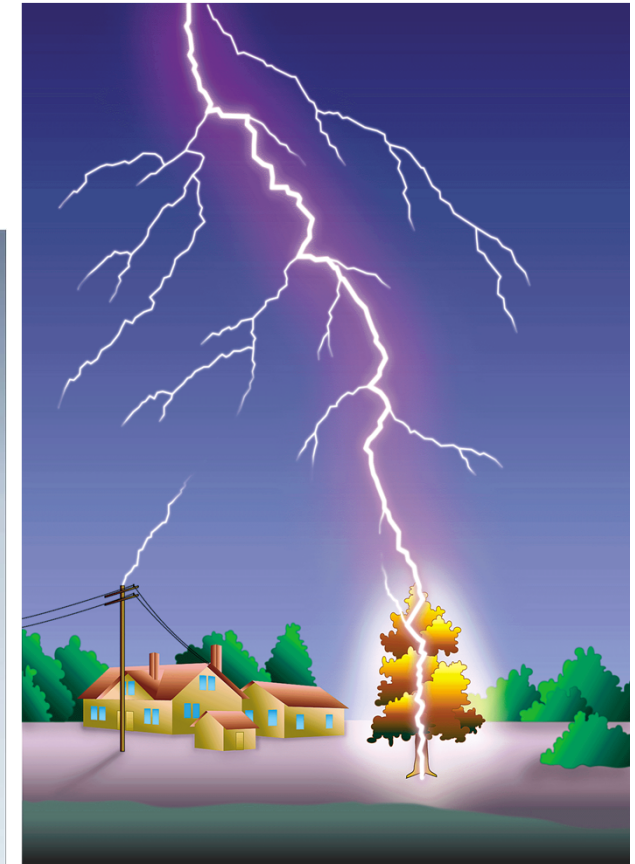
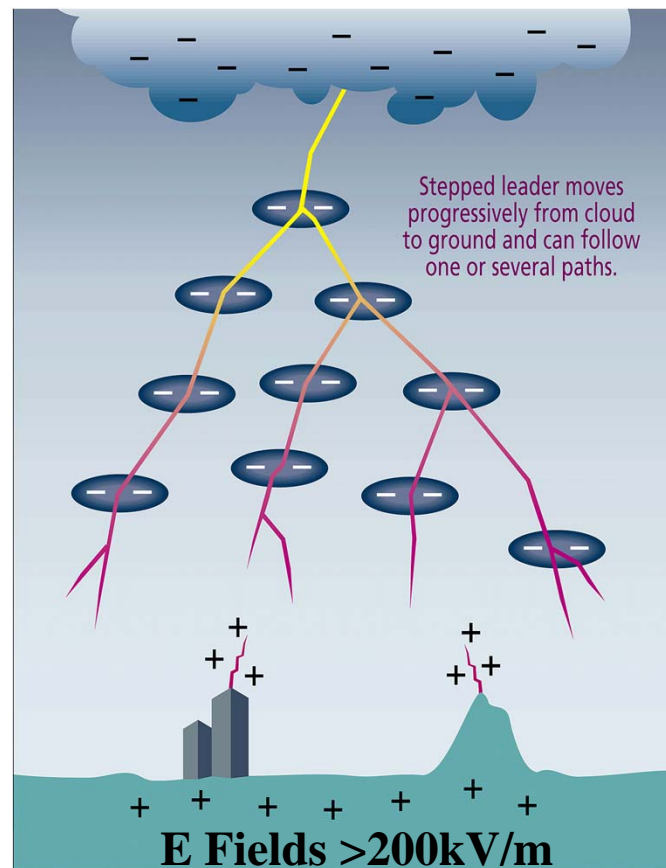
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# Storm Cloud Electric Fields



**Cloud electrification – charge particle separation, quasi static E Field est. between cloud & ground**

**Downleader approaches, E Field increases to point of initiation of upward streamers**



**Upward leader propagates toward downleader to complete ionised path between cloud & ground**









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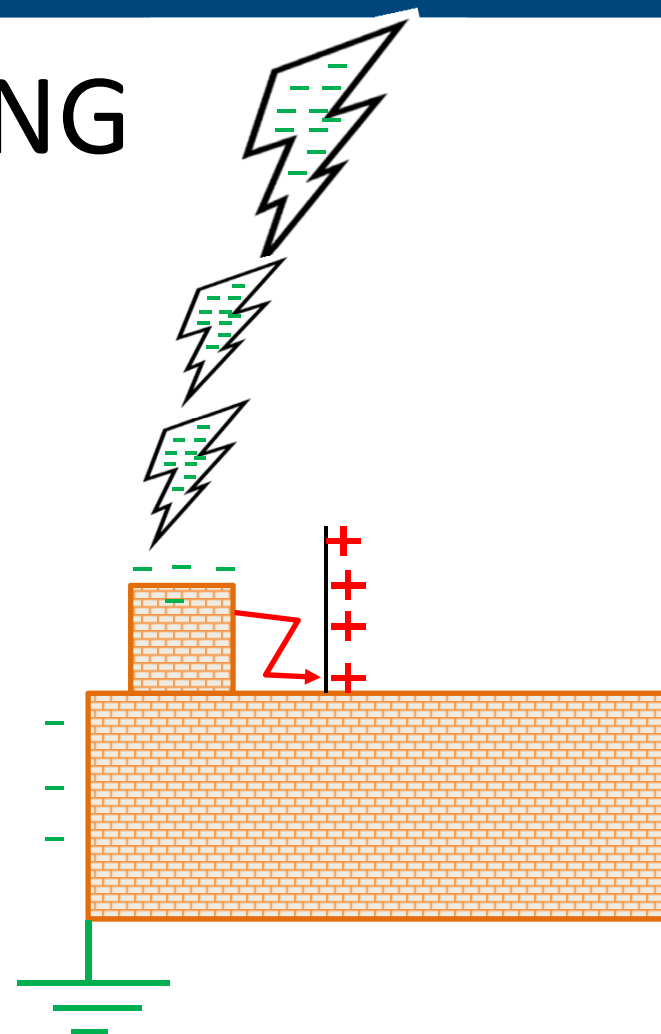
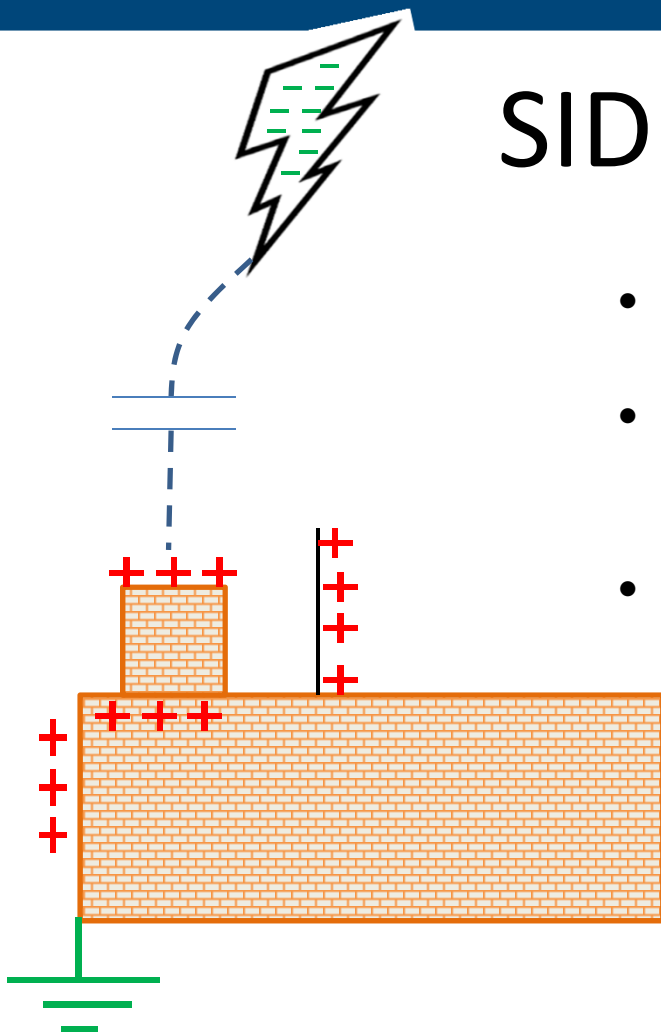
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# SIDE FLASHING

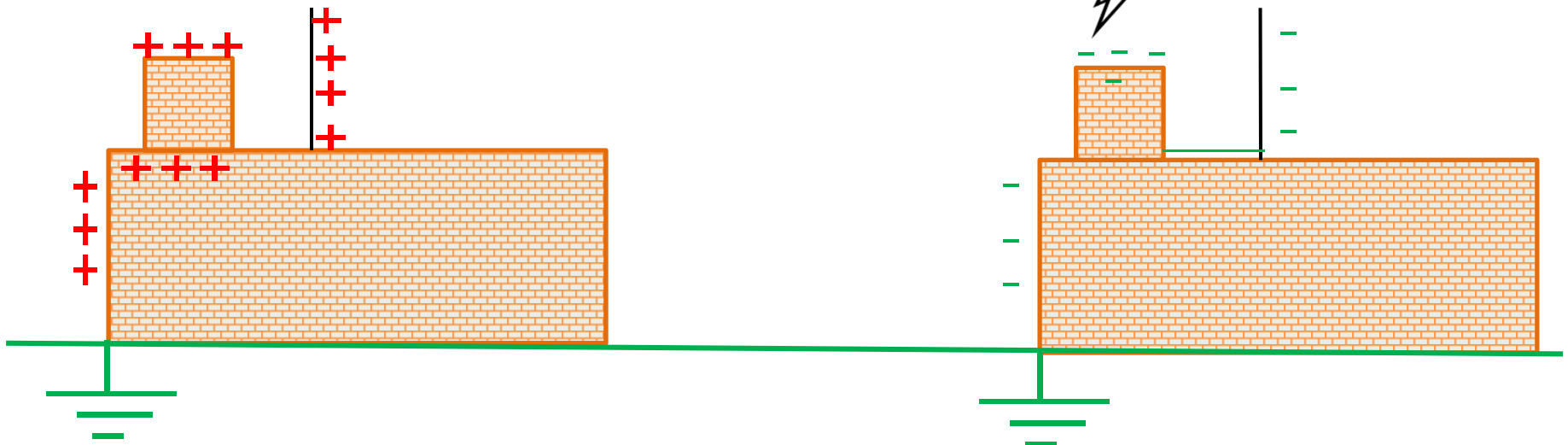
# SIDE FLASHING

- *Mast not bonded*
- *Capacitive Coupling*
- *Side Flash when stroke completed*



# PREVENT SIDE FLASHING

- Bonding







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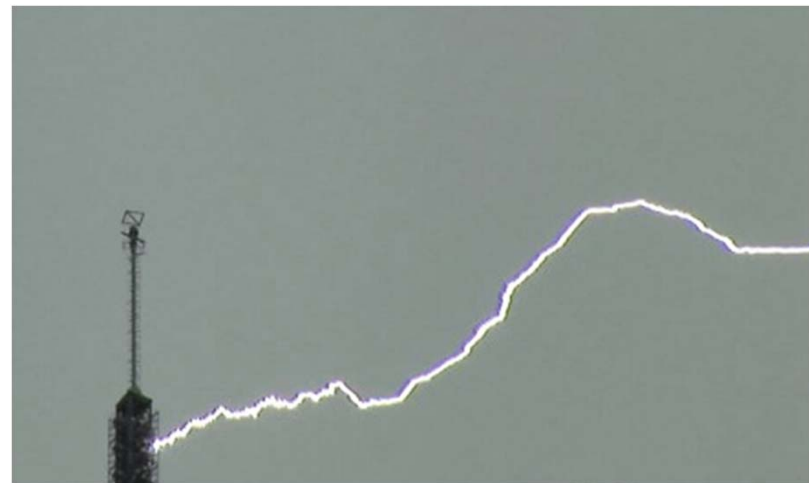
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# SIDE FLASHING IS DIFFERENT TO SIDE STRIKE OF LIGHTNING



*Images of lightning over downtown Indianapolis, Indiana on August 9, 2012, including a strike to the side of Chase Tower. Two instances of upward leaders from the building's antennas are also captured. Copyright Dan Robinson, You Tube*



*From Dan Robinson, Lightning Chaser Website*

# IEC Approach – EITHER Bonding OR Isolation

IEC62305-1 “The function of the internal LPS is to prevent dangerous sparking within the structure, using either equipotential bonding or a separation distance,  $s$ , (and hence electrical isolation) between the LPS components and other electrically conducting elements internal to the structure.”

# NFPA 780 – ON Isolation

## 4.21.2.4 Structures More Than 12 m (40 ft) in Height.

(A) Grounded metal bodies shall be bonded to the lightning protection system where located within a calculated bonding distance,  $D$ , as determined by the following formula:

$$D = \frac{h}{6n} \times K_m$$

where:

$D$  = calculated bonding distance

$h$  = vertical distance between the bond being considered and the nearest lightning protection system bond

$n$  = a value related to the number of down conductors that are spaced at least 7.6 m (25 ft) apart, located within a zone of 30 m (100 ft) from the bond in question, and where bonding is required within 18 m (60 ft) from the top of any structure

$K_m$  = 1 if the flashover is through air, or 0.50 if through dense material such as concrete, brick, wood, and so forth

## 4.21.2.5 Structures 12 m (40 ft) and Less in Height.

(A) Grounded metal bodies shall be bonded to the lightning protection system where located within a calculated bonding distance,  $D$ , as determined by the following formula:

$$D = \frac{h}{6n} \times K_m$$

where:

$D$  = calculated bonding distance

$h$  = either the height of the building or the vertical distance from the nearest bonding connection from the grounded metal body to the lightning protection system and the point on the down conductor where the bonding connection is being considered

$n$  = a value related to the number of down conductors that are spaced at least 7.6 m (25 ft) apart and located within a zone of 30 m (100 ft) from the bond in question

$K_m$  = 1 if the flashover is through air, or 0.50 if through dense material such as concrete, brick, wood, and so forth

# NFPA 80

**4.21.3\* Isolated (Nongrounded) Metallic Bodies.** An isolated metallic body, such as a metal window frame in a nonconducting medium, that is located close to a lightning conductor and to a grounded metal body will influence **bonding** requirements only if the total of the isolated distances between the lightning conductor and the isolated metal body and between the isolated metal body and the grounded metal body is equal to or less than the calculated bonding distance. The effect shall be determined by 4.21.3.1.

**4.21.3.1** The effect shall be determined by using Figure 4.21.3.1 according to either 4.21.3.1(A) or 4.21.3.1(B).

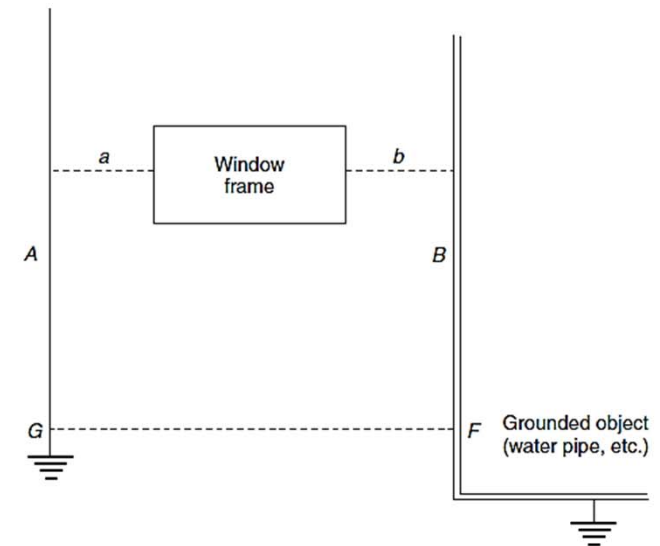
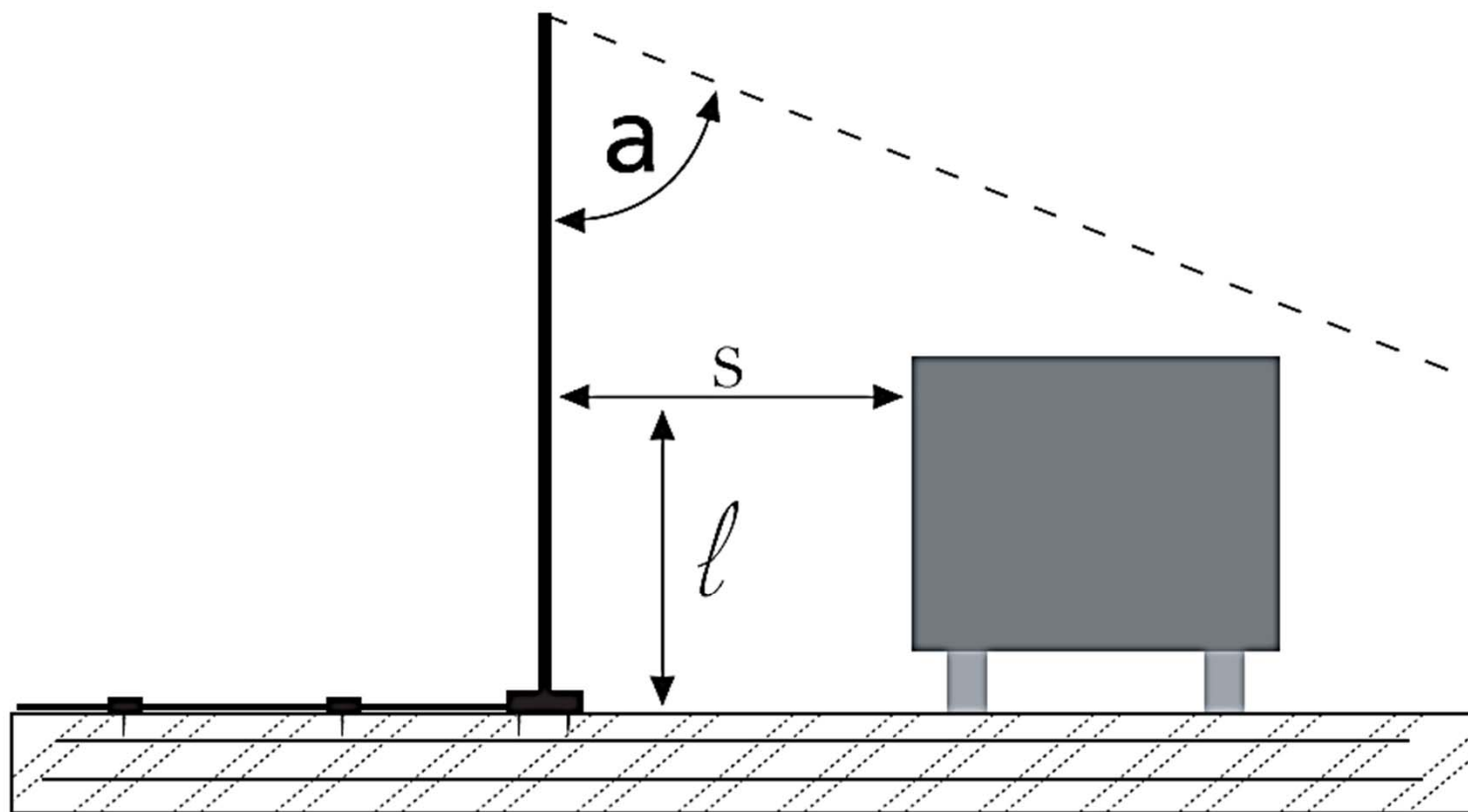


FIGURE 4.21.3.1 Effect of Isolated (Nongrounded) Metallic Bodies, Such as a Window Frame, in Nonconductive Media.



# SEPARATION DISTANCE



*Figure 1. Separation distance concept for an isolated lightning protection solution.*



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# ELECTRONICS ON MODERN ROOFTOPS & TOWERS



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# MODERN Roof Tops

Infested with Various electronics including

- Cellular Equipment
- Fuel Cells
- Cooling equipment
- Solar PV Equipment

**Sometimes Bonding is not desirable**

# Electronics on MODERN Roof Tops



*Vertical Axis  
Wind  
Turbines*



*Cellular  
Antennae Or  
Remote  
Radio  
Heads*



*Solar PV  
Controllers*



*Fuel Cell  
Controllers*





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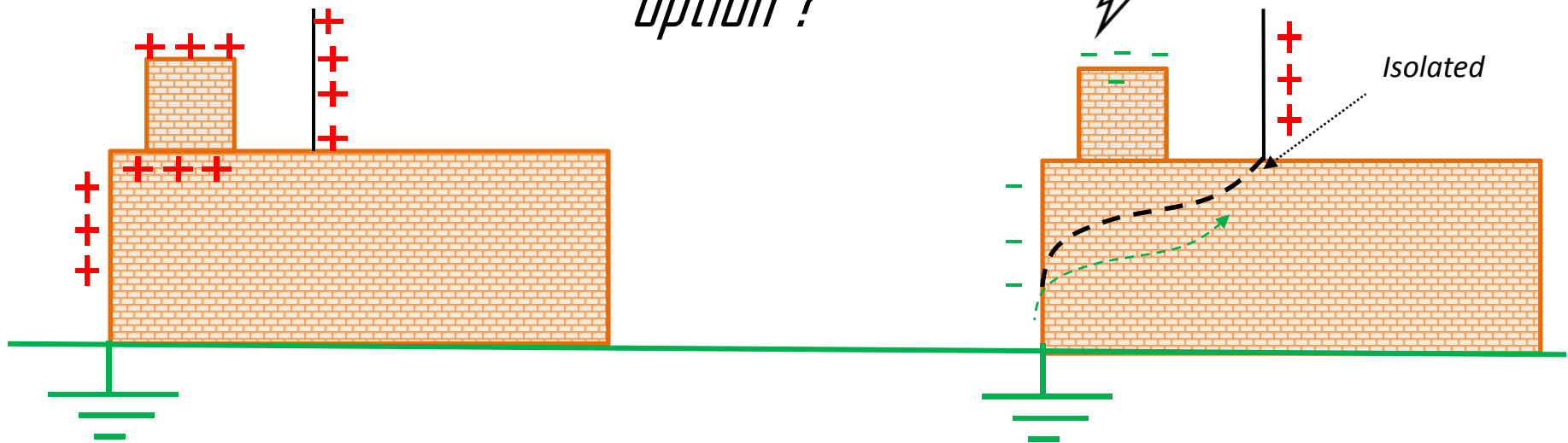


# ELECTRICALLY SENSITIVE OBJECT

- What if the object to be bonded is electrically sensitive?
- We may be worried about bonding it

# PREVENT SIDE FLASHING

*Is isolating an  
option ?*



YES IF YOU CAN GET REAL ISOLATION, STILL NEED TO  
WORRY ABOUT MAGNETIC EFFECTS



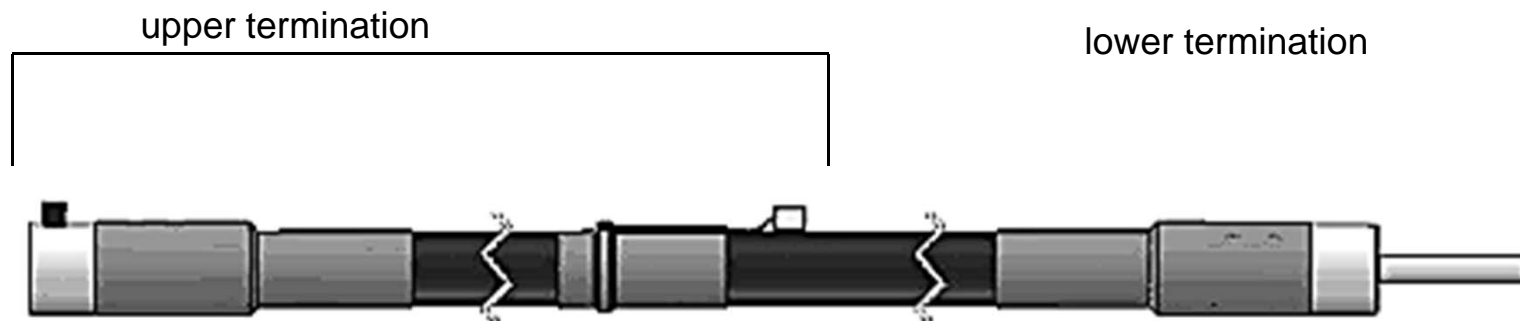
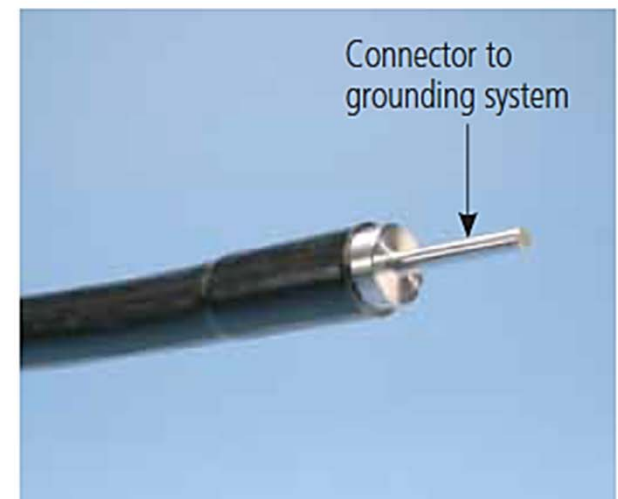
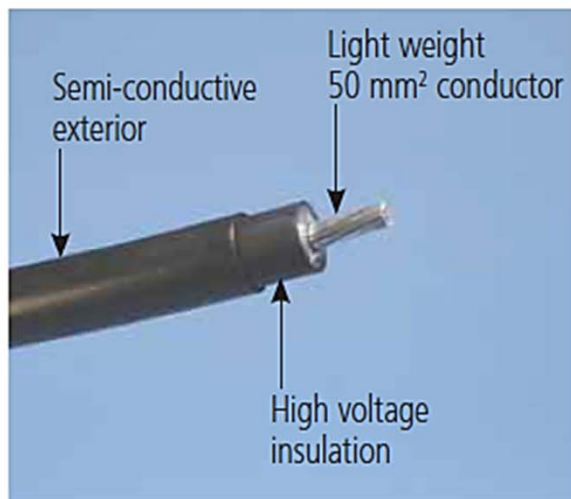
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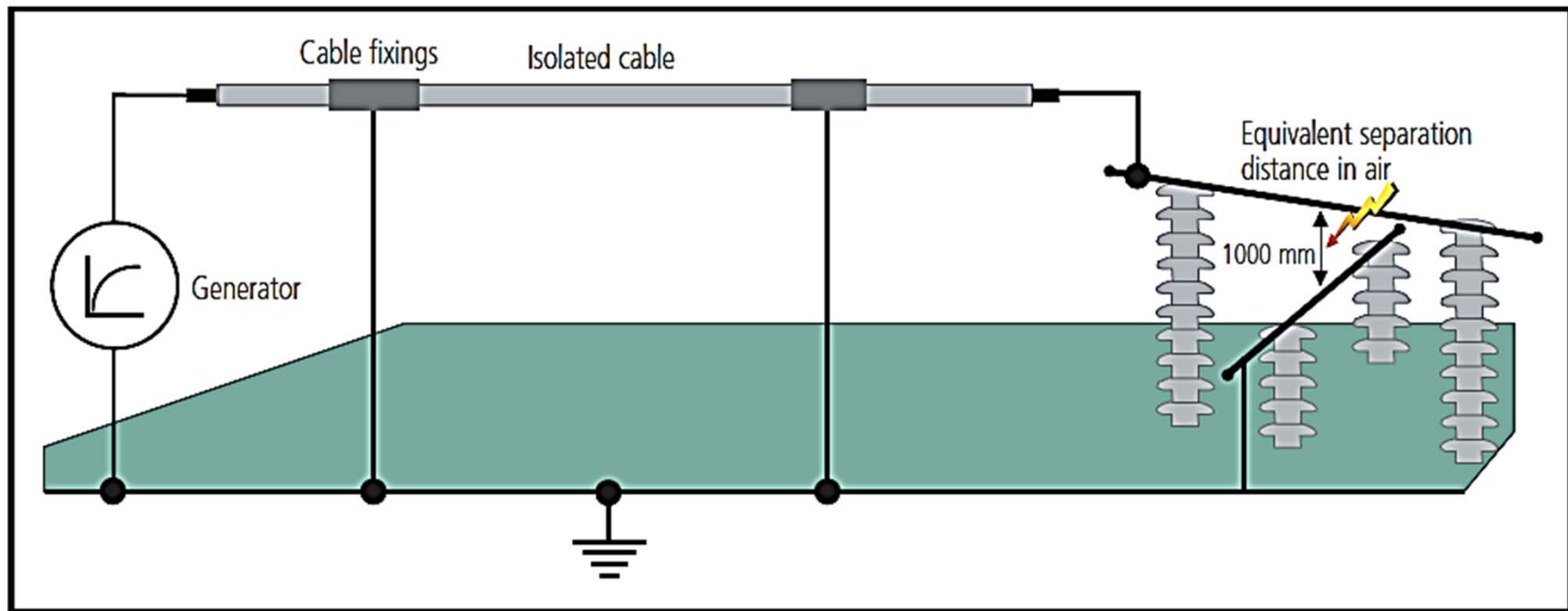
# ISOLATED DOWN-CONDUCTOR & TERMINATIONS

## Isolated Down-conductor





# Testing Procedure



Test lab setup for determining equivalent separation distance

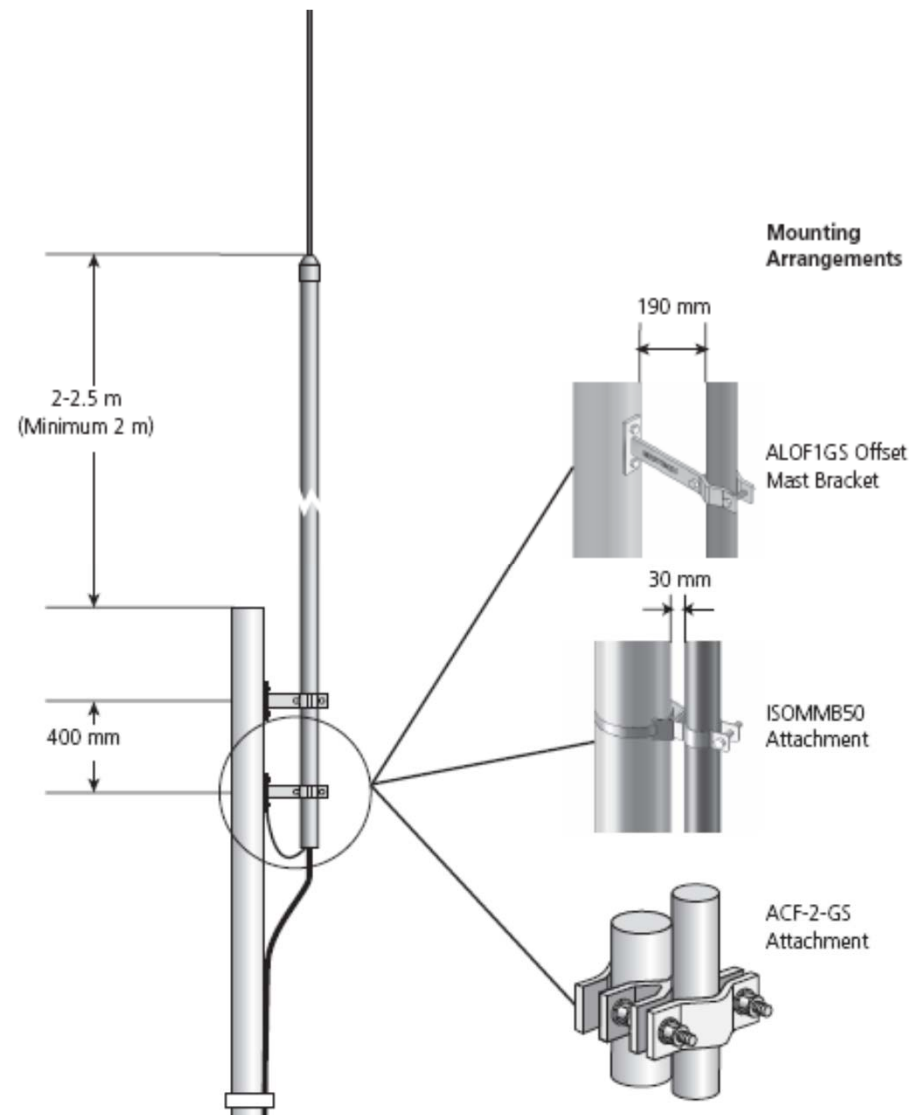
If the parallel air gap breaks down repeatedly before the cable, then the equivalent safety distance of the cable is greater than the air gap distance. Length Limitation



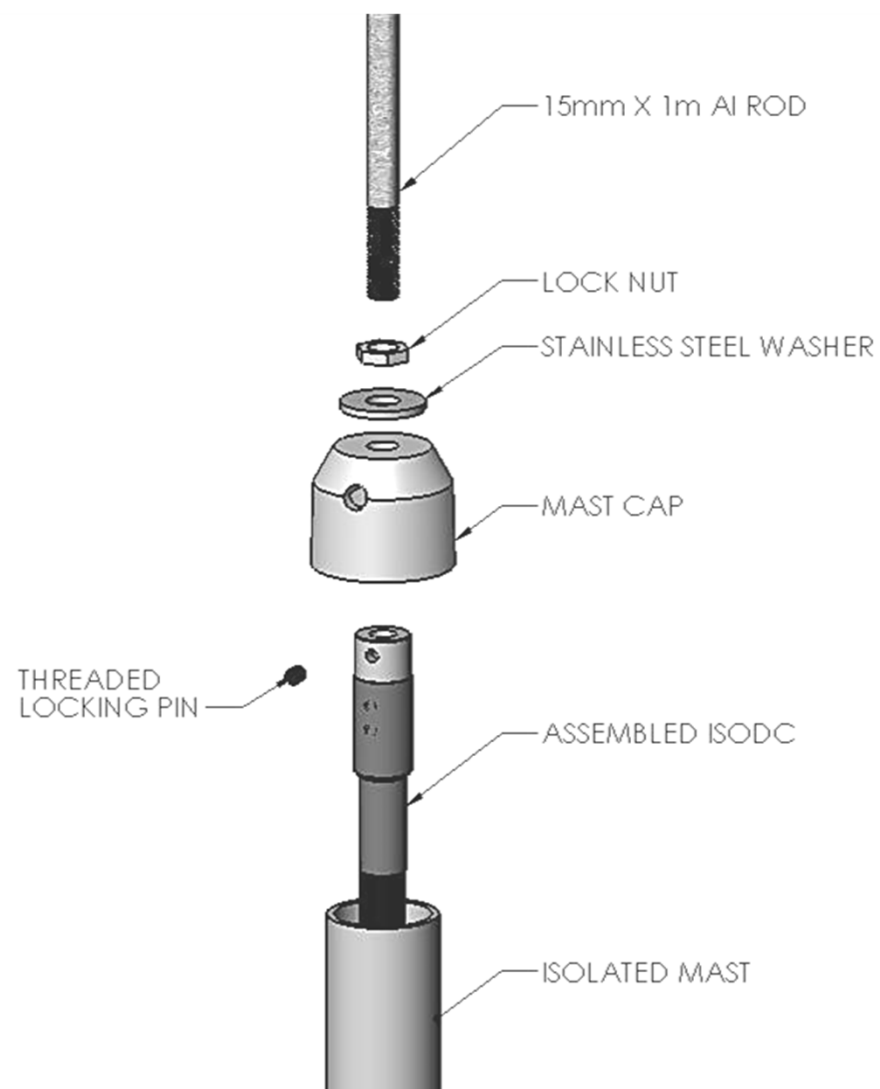
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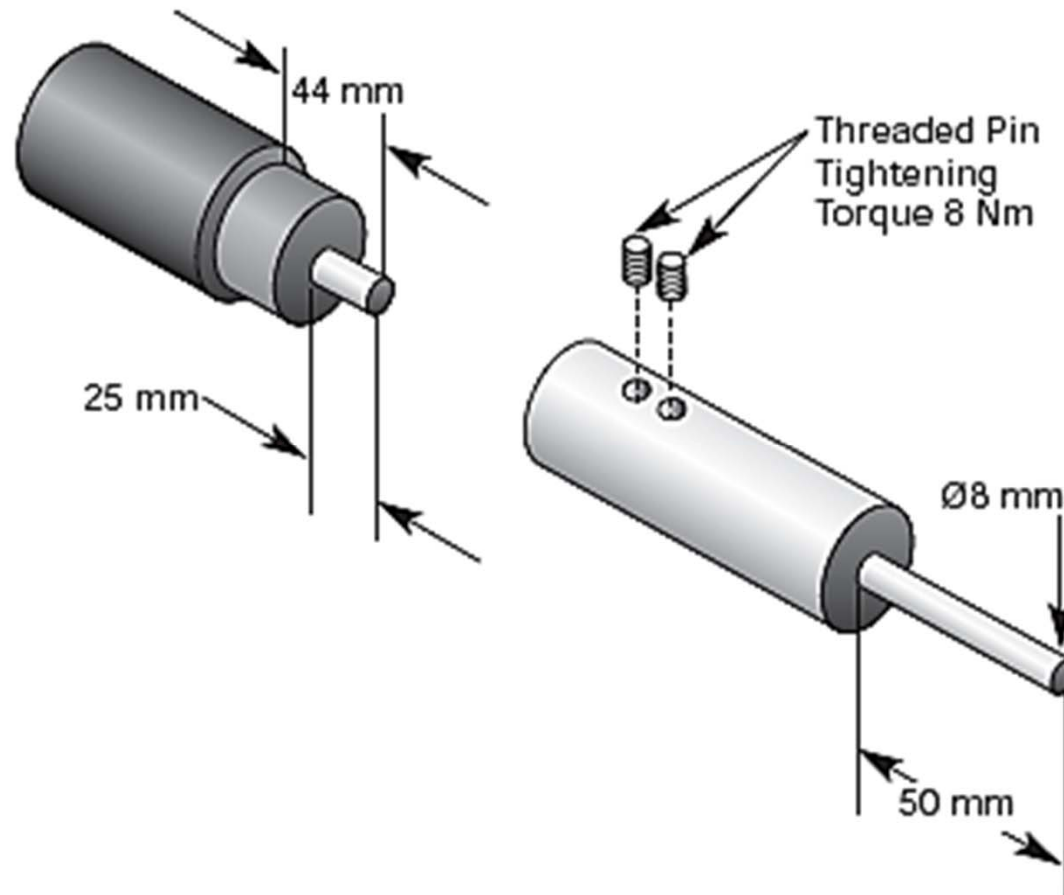
## NEED TO ISOLATE THE AIR TERMINAL TOO



# ISOLATION WILL REQUIRE SIGNIFICANT EFFORT

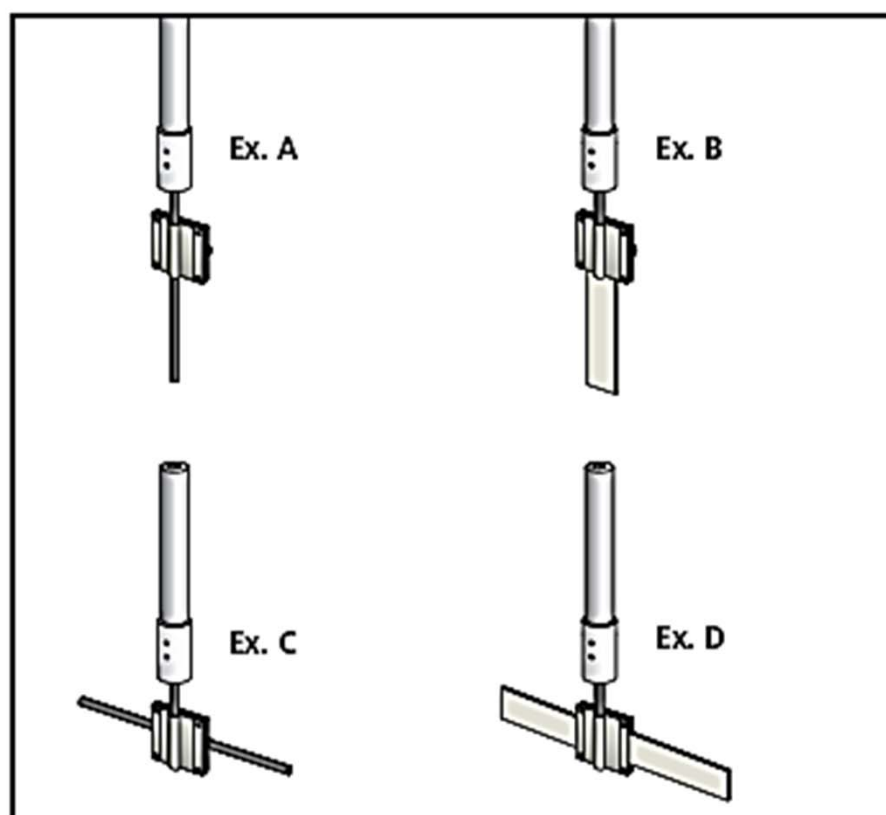
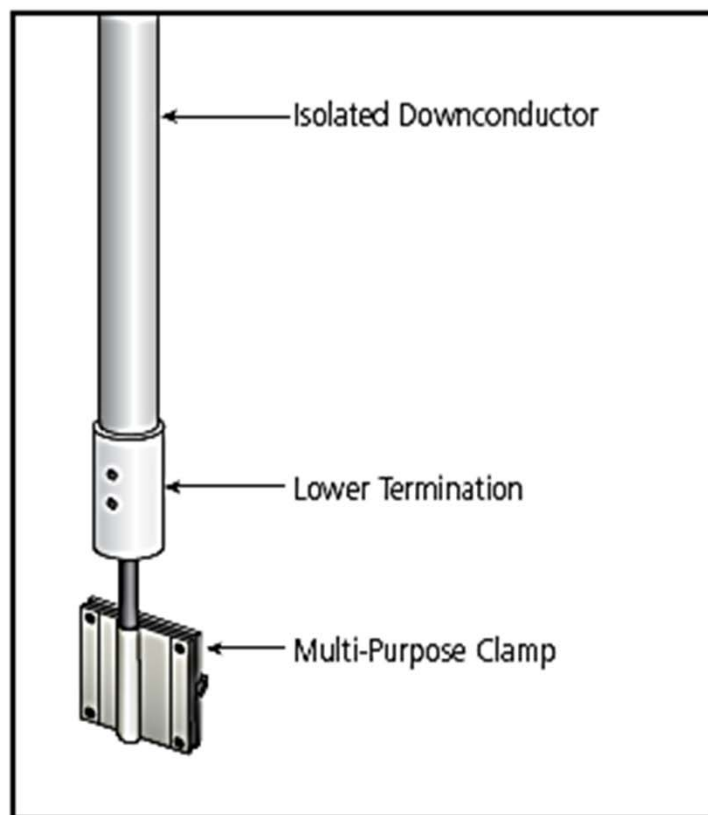


# Lower termination ALSO SIGNIFICANT

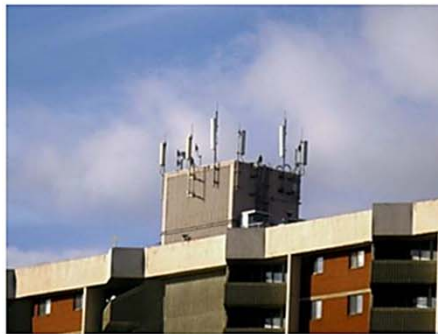




# SOLID CONNECTION TO LPS OR GROUNDING SYSTEM

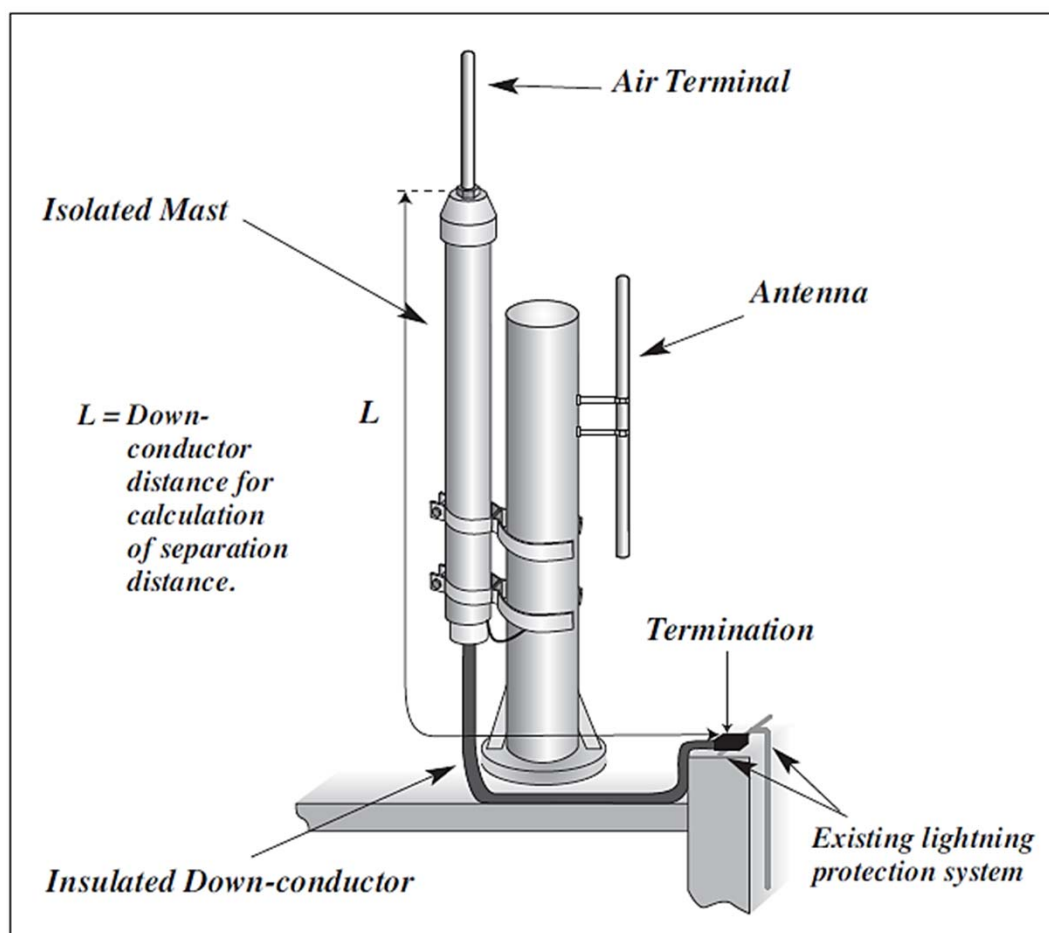


# POSSIBLE TELECOM APPLICATIONS



- CELLSITES with large amount of Remote Radio Units,
- Other Electronic assets near the strike point
- Roof tops with Remote Radio Heads
- Small cells
- Focus has been on Surge Protection

# Possible Arrangement Roof Top





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## Possible Arrangement Tower

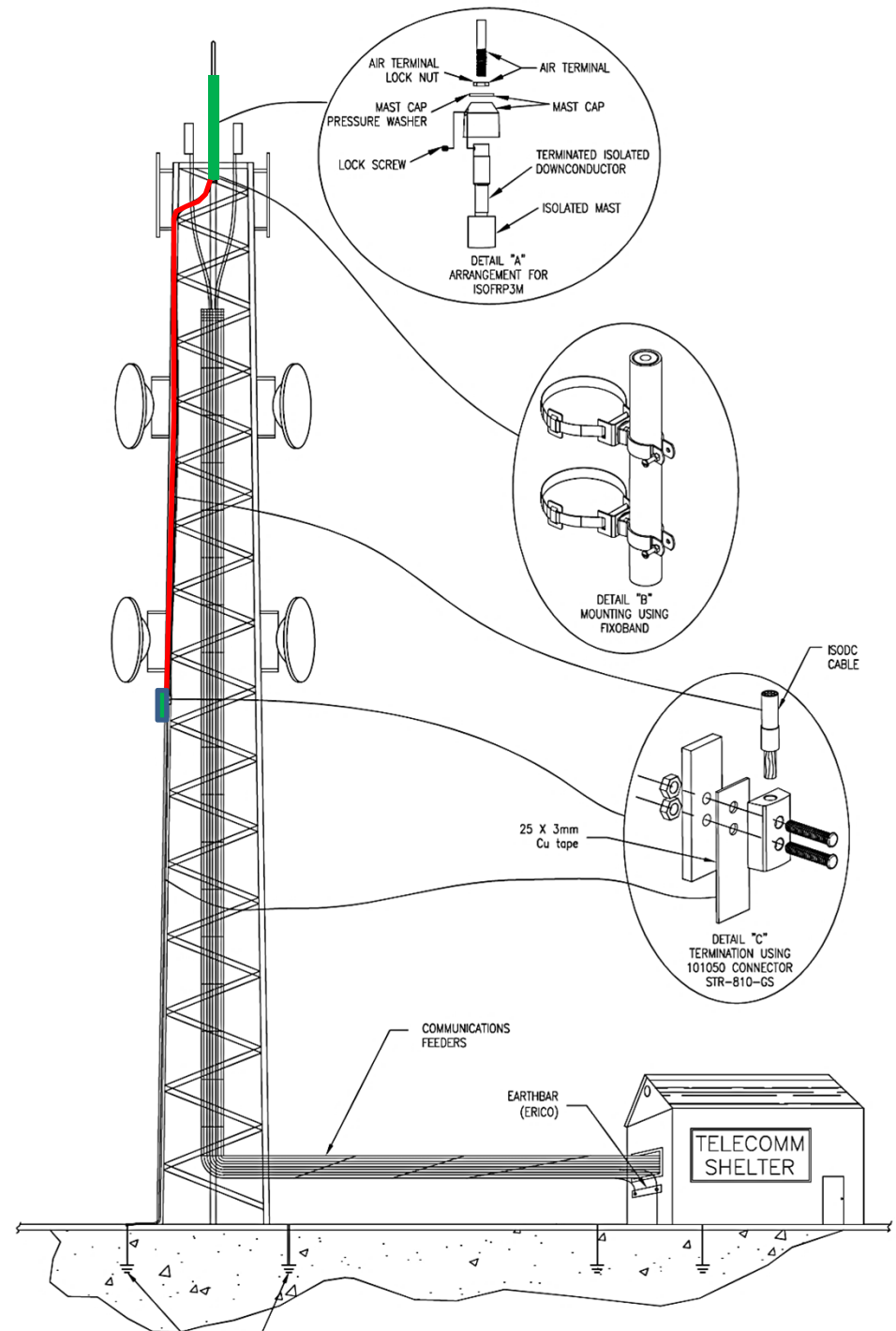
Al Martin (PEG member) paper **Power Feeds to Remote Radio Heads** has excellent analysis on combination & magnitudes of lighting currents on DC feeds on Towers

Will be interesting to see if these currents reduce if we could get real isolation

There may be Merits in

- Bypassing of Antenna
- Bypassing Of Remote Radio Head
- Then Connect to Tower

<http://incompliancemag.com/article/power-feeds-to-remote-radio-heads/>





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# CASE STUDIES

# ISOLATED DC Application

- Water Telemetry (Reservoir Near Sydney, Australia) .
- History of problems with telemetry and other equipment on site.
- Isolated DC was part of the solution.







*Communications Tower – Oil  
Platform (Not sure at First but it  
worked)*



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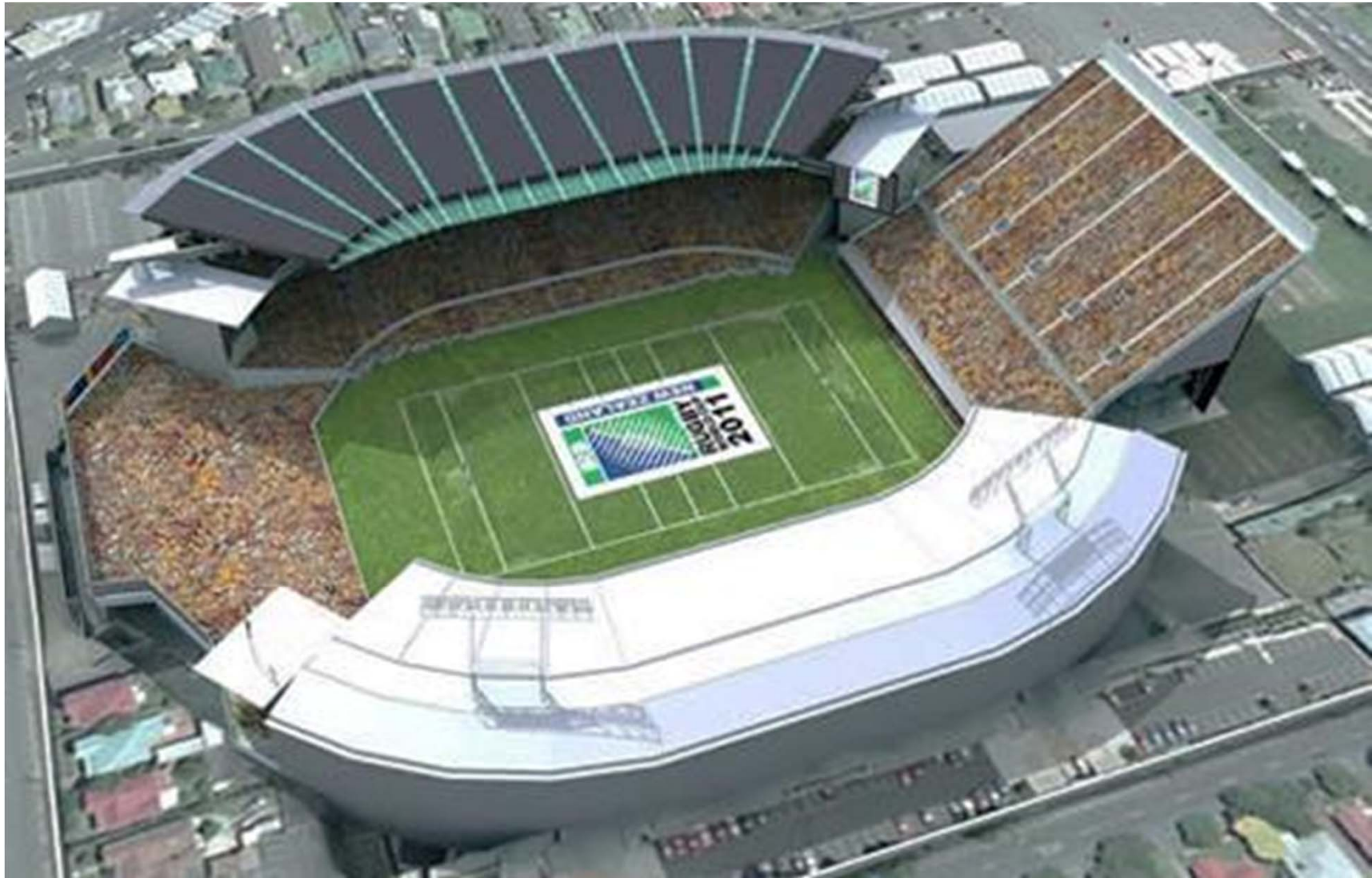
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# EDEN PARK NZ BEFORE RUGBY WORLD CUP 2011





# EDEN PARK New Zealand





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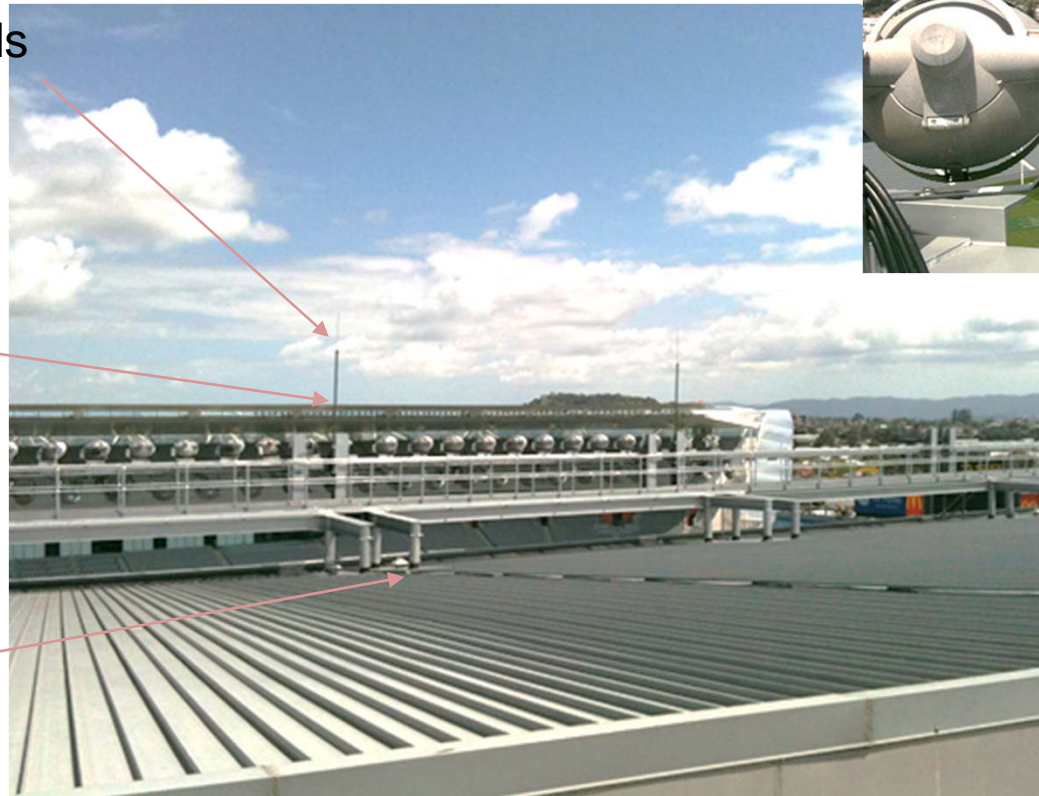
## EDEN PARK ISOLATED DC



Lightning Rods

Isolated  
Mast

Bonded to  
Steel Roof





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# SUMMARY

- Isolation if Possible
- Isolation May have benefits when protecting electronics in high places
- Discuss if Application Permissible and/or Possible in Telecom in USA