

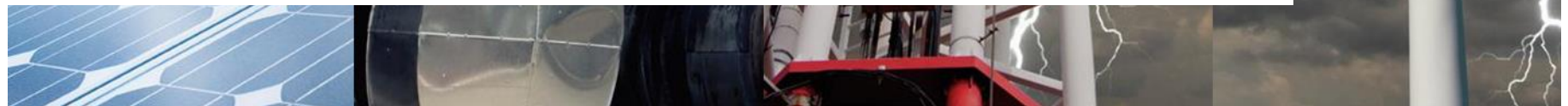


Protection Engineers Group 2017, Dallas, TX

By Richard Chadwick, DEHN Inc.

Richard.Chadwick@dehn-usa.com

**Title: Integration of High Voltage Insulated (HVI)
Down Conductors into a Turnkey Isolated
Lightning Protection System.**





AGENDA

Where HVI Fits in a Turnkey LPS System

HVI Basics

HVI Application – LED Signage

HVI Application – Cellular Telecom

HVI Application – Deepwater Drillships

HVI Application – Power Production

Summary



HVI as Part of a Turnkey LPS



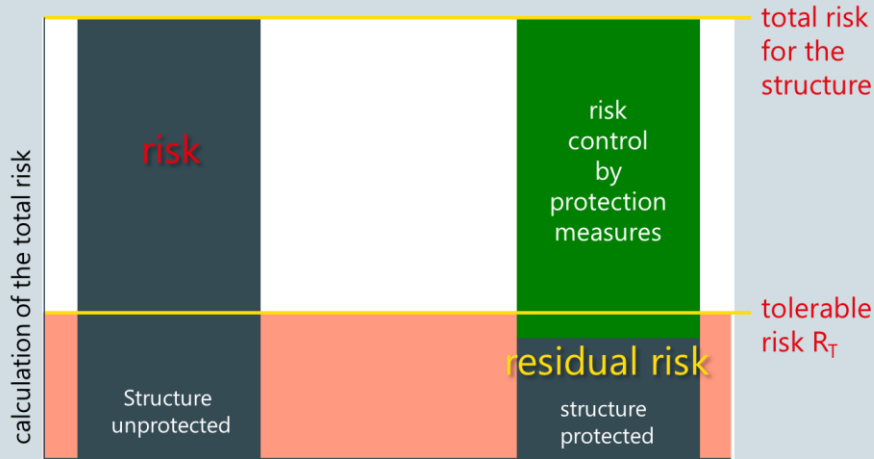
HVI is one type of down conductor which can be used in an integrated LPS/SPD system

For more information on design of coordinated LPS/SPD systems, or on HVI in particular, please download our Lightning Protection Guide, third edition at <http://www.dehn-usa.com/en-us/lightning-protection-guide>

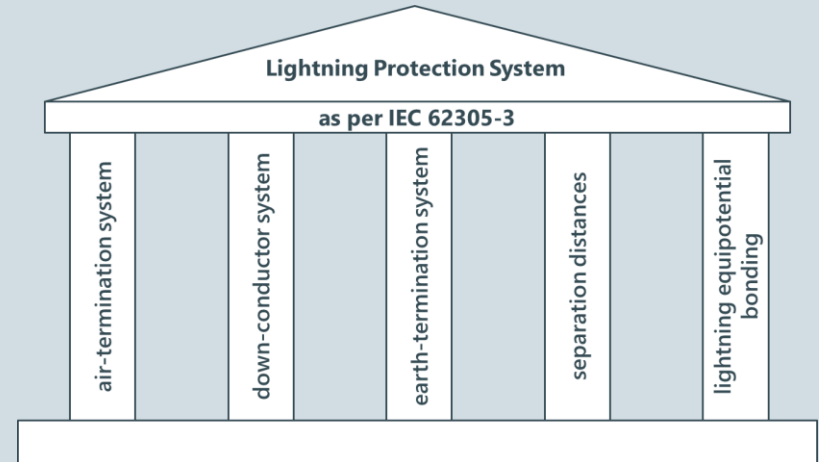
HVI can be ONE PART of a Turnkey LPS System



■ Risk Analysis



■ Design



■ Furnish and Install

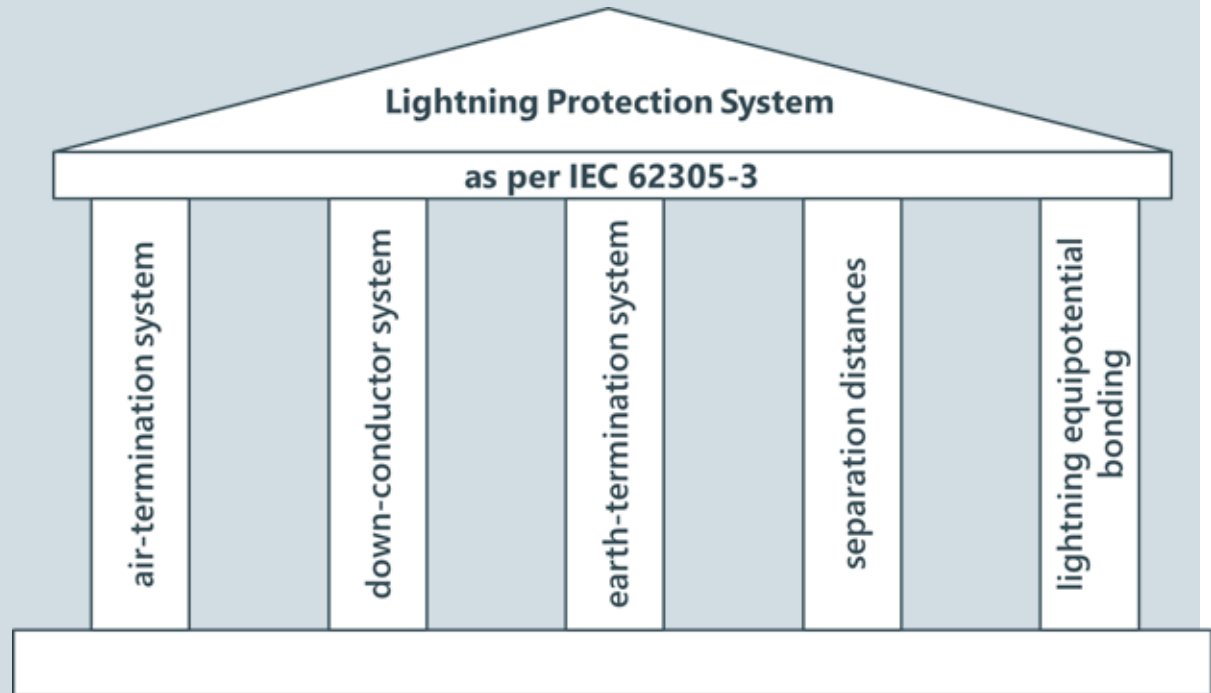




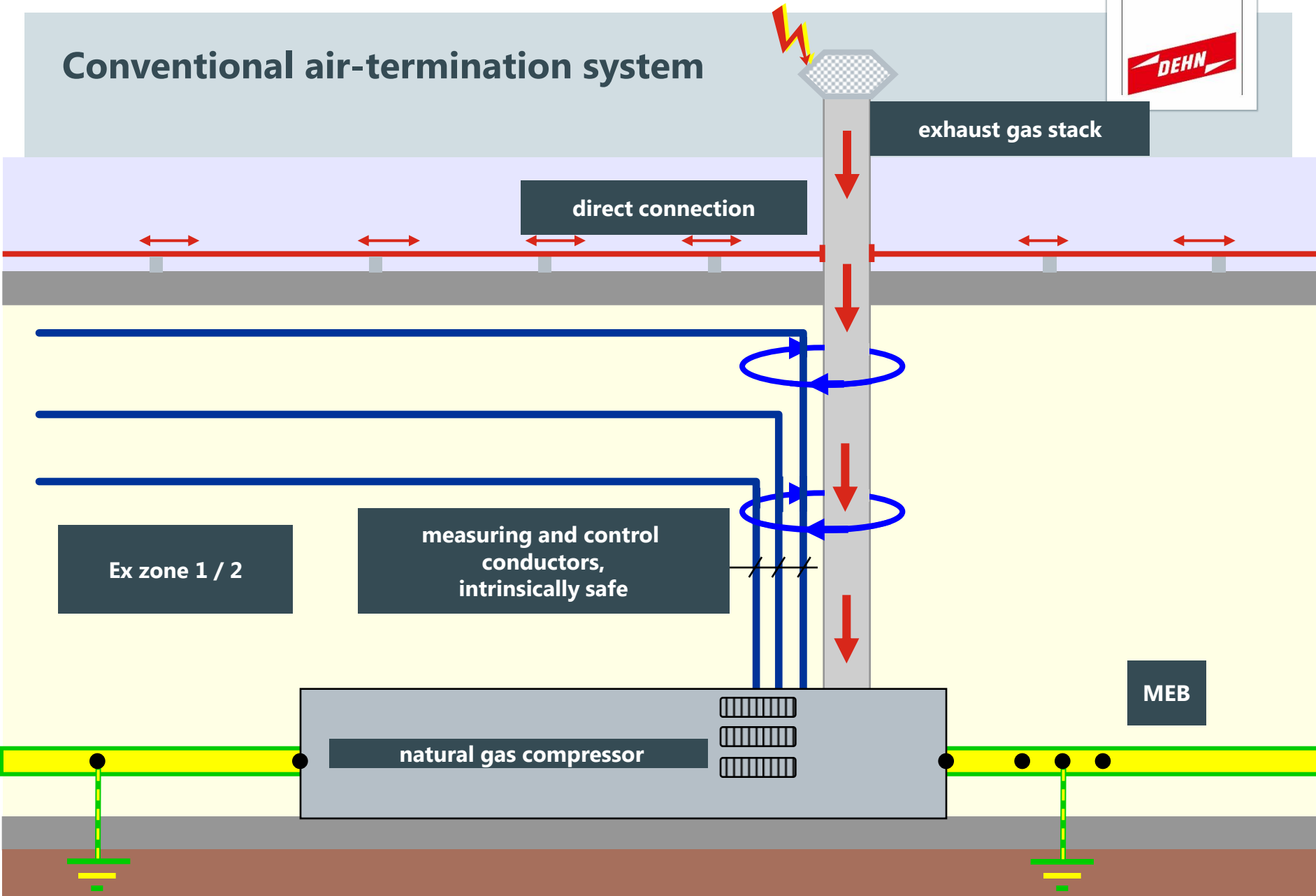
HVI is an Insulated Down Conductor with Insulation Providing an Equivalent Separation Distance



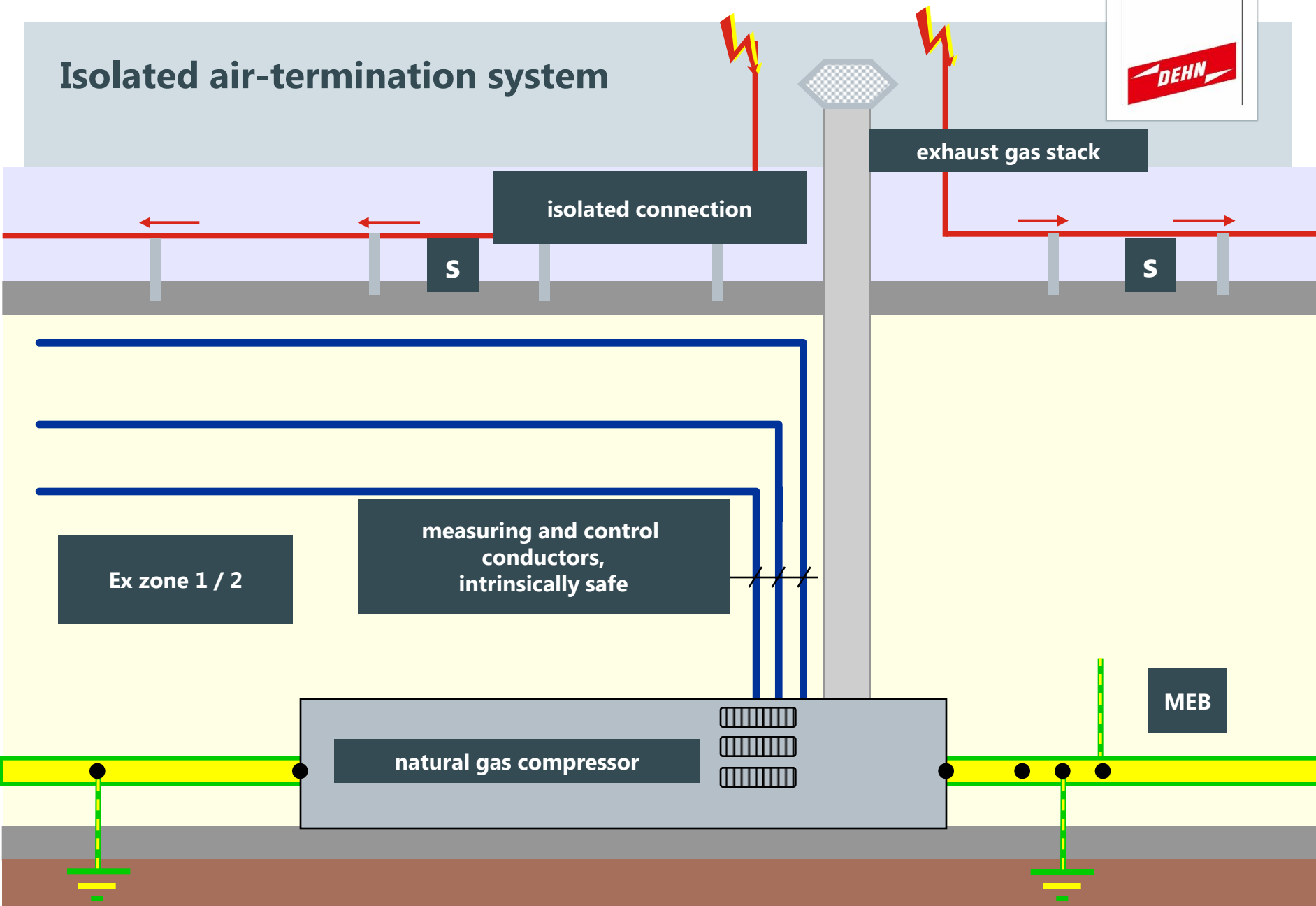
- Air termination system and down conductors can be Isolated or Integrated
- Down conductors must comply with separation distances
- High Voltage Isolated down conductors provide equivalent separation distances



Conventional air-termination system



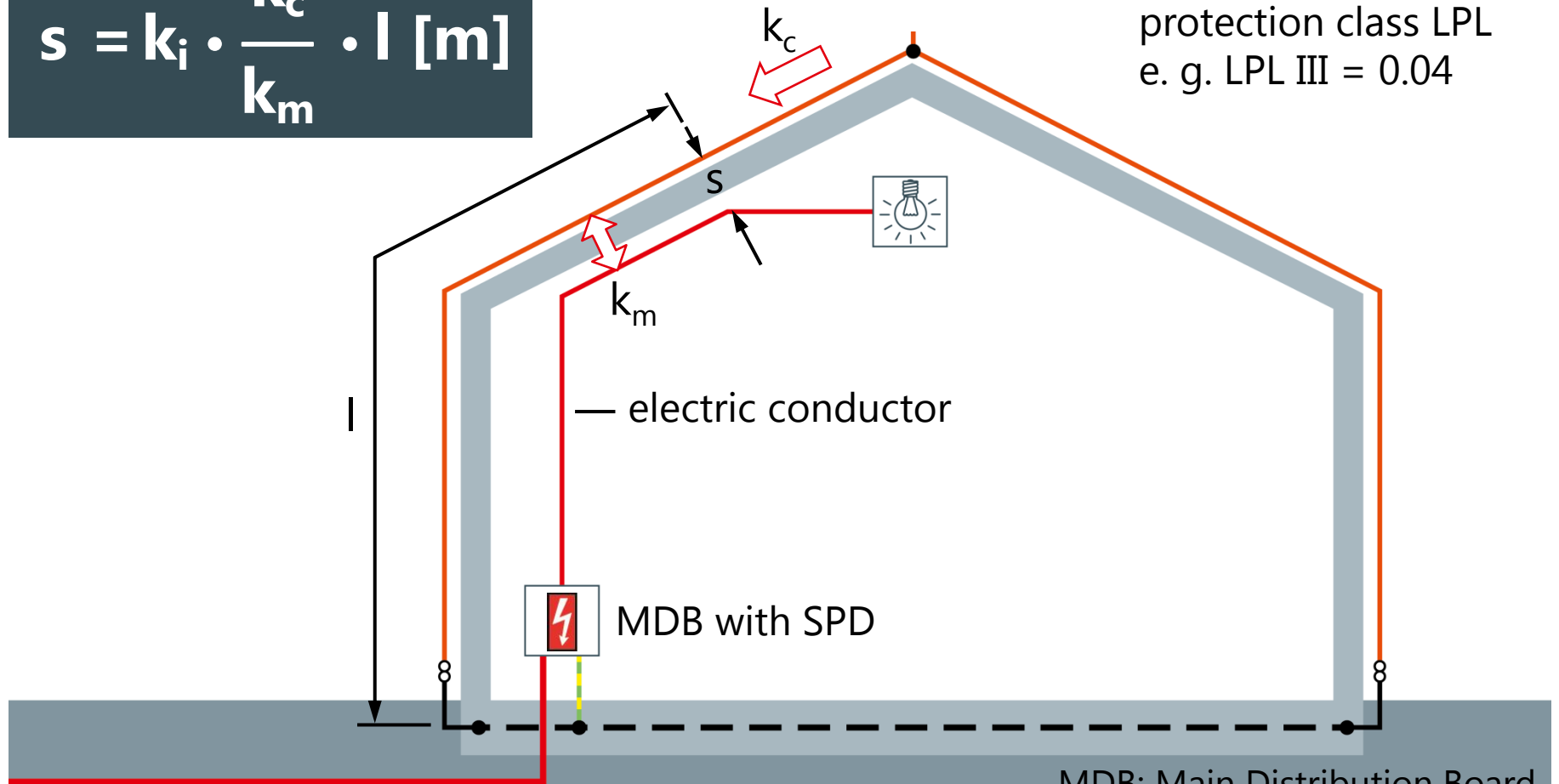
Isolated air-termination system



Separation distance (s) Problematic installation of metal conductors

$$s = k_i \cdot \frac{k_c}{k_m} \cdot I \text{ [m]}$$

k_i = dependent on protection class LPL
e. g. LPL III = 0.04



MDB: Main Distribution Board
SPD: Surge Protective Device

Isolation of external LPS

Values of coefficients k_i and k_m



| Class of LPS | k_i |
|--------------|-------|
| I | 0.08 |
| II | 0.06 |
| III and IV | 0.04 |

| Insulating material | k_m |
|---------------------|-------|
| Air | 1 |
| Concrete, bricks | 0.5 |
| DEHNiso | 0.7* |

* value of DEHNiso determined by DEHN + SÖHNE in laboratory tests

NOTE 1 When there are several insulating materials in series, it is a good practice to use the lower value for k_m .

NOTE 2 In using other insulating materials, construction guidance and the value of k_m should be provided by the manufacturer.

Isolation of external LPS

Values of coefficient k_c



| Number of down-conductors | k_c |
|---------------------------|-------|
| 1* | 1 |
| 2 | 0.66 |
| 3 and more | 0.44 |

* only in case of an isolated LPS

NOTE Values of Table 12 apply for all type B earthing arrangements and for type A earthing arrangements, provided that the earth resistance of neighbouring earth electrodes do not differ by more than a factor of 2. If the earth resistances of single earth electrodes differ by more than a factor of 2, $k_c = 1$ is to be assumed.

Annex E (informative)

E.6.3.2 Simplified approach

The simplified approach according to 6.3.2 is possible, if the widest horizontal elongation of the structure (length or width) does not exceed four times the height.



HVI Basics



Basic HVI installation video available at:

https://www.youtube.com/watch?v=GBcPTPmOIyk&list=PLUJ5-rGtZwb6ZyzT8PMsdVni0d_NeBi0r&index=2

HVI Advantages



HVI allows tighter mounting spacing than would be available next to bare LPS down conductor or if the rods was bonded to tower steel.

This can also reduce the size of ancillary fiber/dc power cross connect boxes used by customers.



HVI Basic Features



The HVI[®] Conductor incorporates **two basic features**:

- High-voltage-resistant insulation of the inner copper conductor provides equivalent to separation distance in air up to three feet.
- Safe injection of lightning voltage at the infeed, thus preventing creeping flashovers (voltage flashovers) along the surface between the first earthing point and the infeed

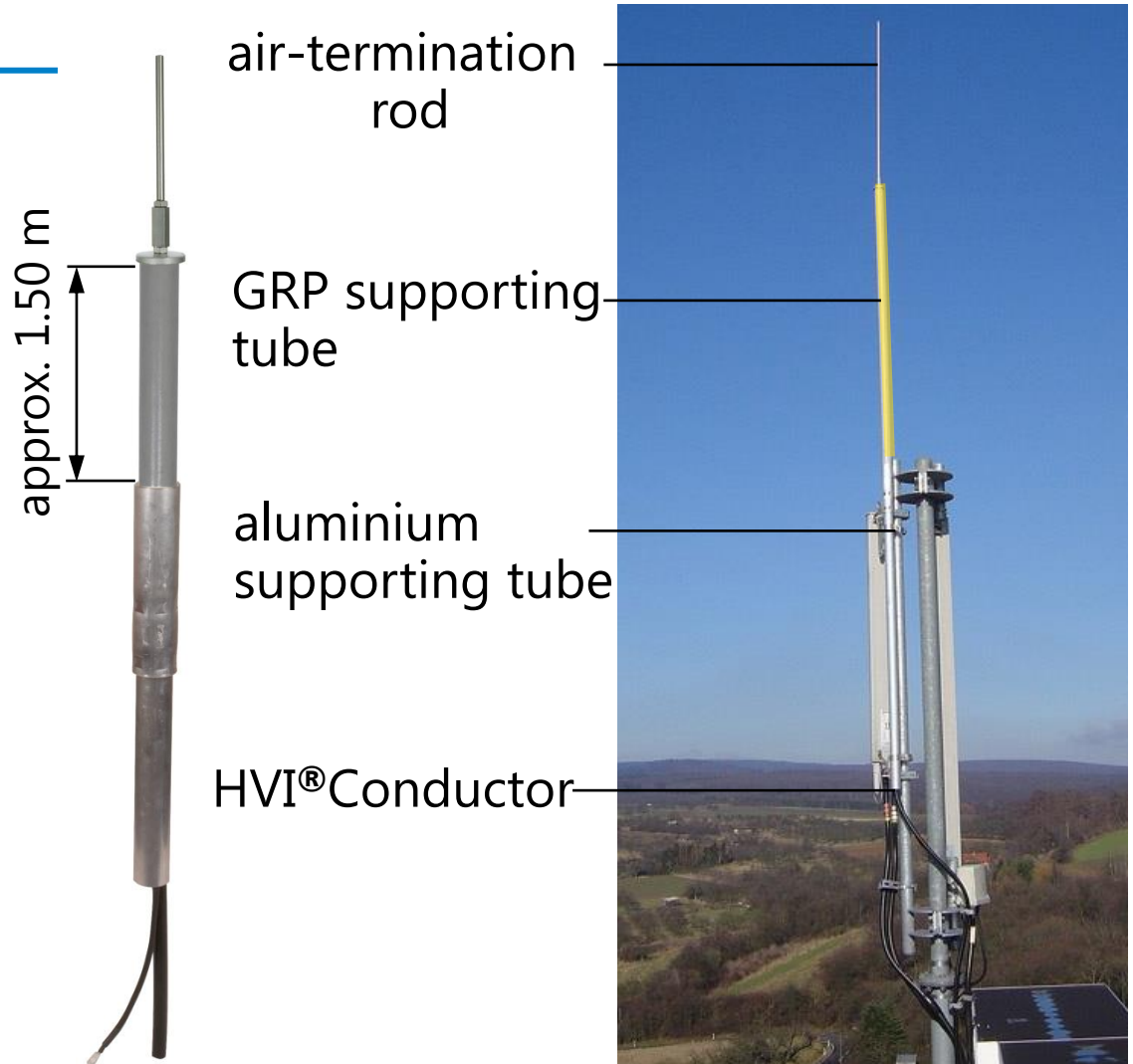


HVI® Conductor inside the supporting tube

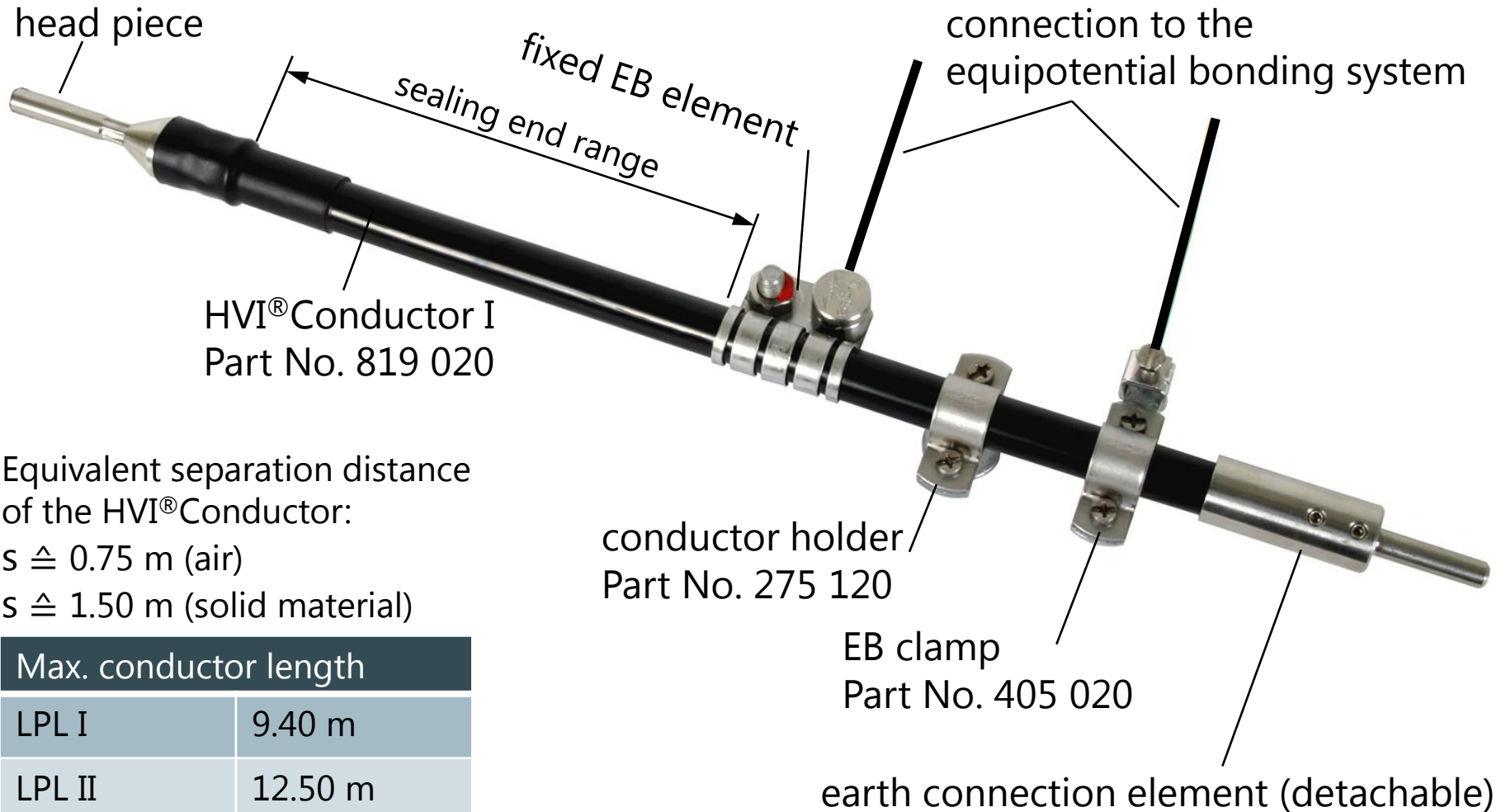


HVI® Conductor inside the supporting tube

- With integrated sealing end
- With air-termination tip or air-termination rod
- Types of HVI® Conductors
Type I,
e.g. Part No. 819 320
Type III,
e.g. Part No. 819 362



HVI[®] Conductor I



Equivalent separation distance of the HVI[®] Conductor:

$s \triangleq 0.75 \text{ m}$ (air)

$s \triangleq 1.50 \text{ m}$ (solid material)

Max. conductor length

| | |
|------------|---------|
| LPL I | 9.40 m |
| LPL II | 12.50 m |
| LPL III/IV | 18.75 m |

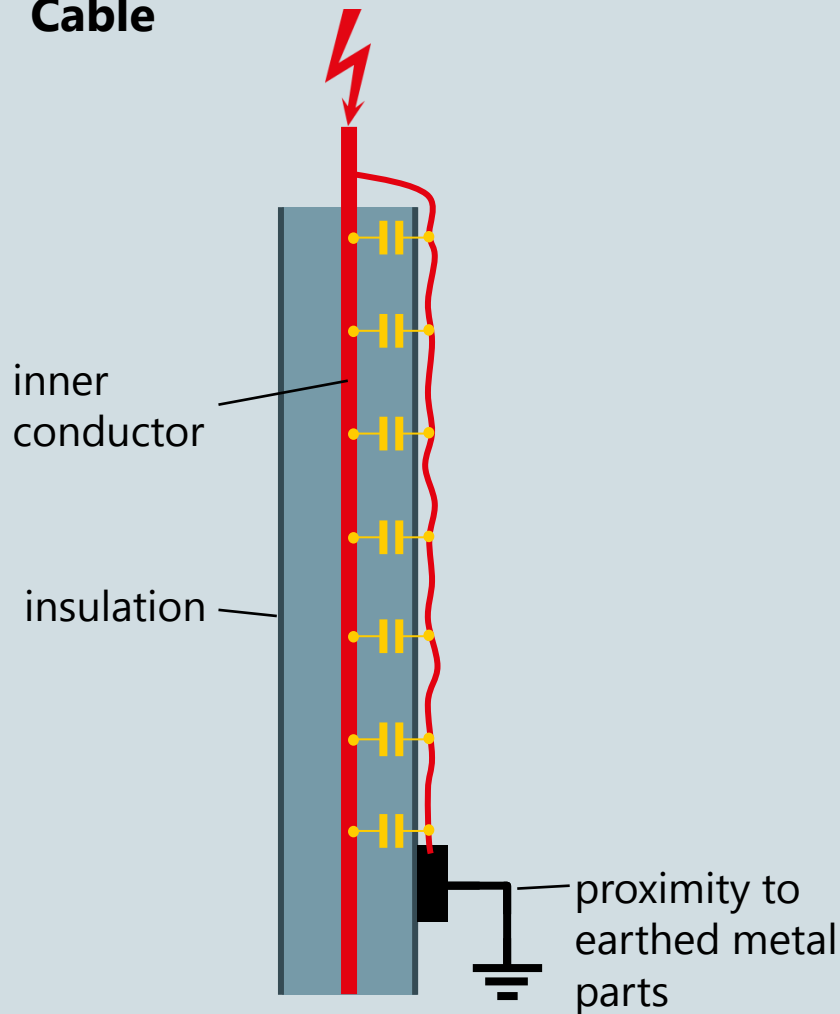
LPL: Lightning Protection Level

General formation of a creeping discharge

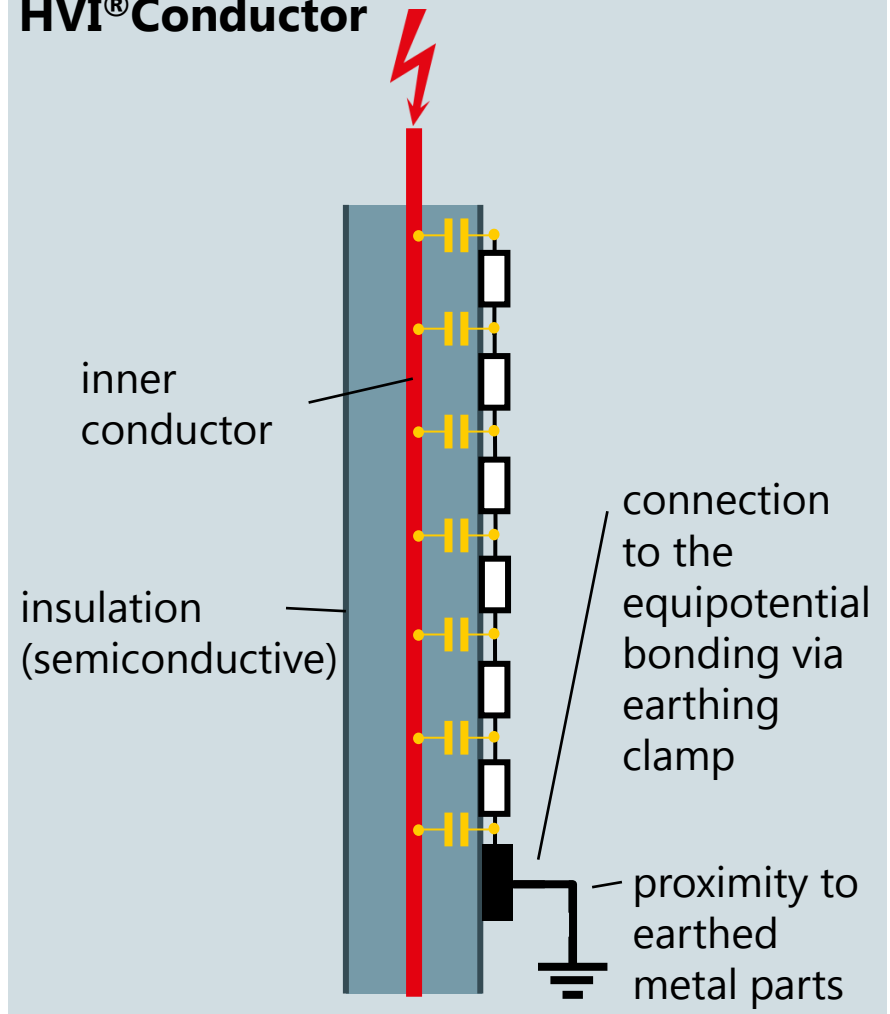
Conventional cable / HVI[®] Conductor



Cable



HVI[®] Conductor



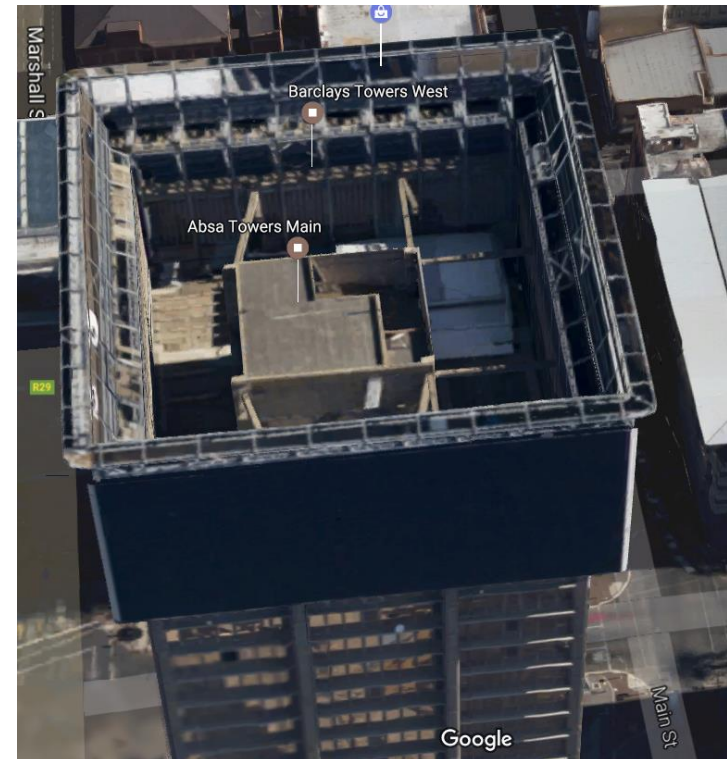
HVI Application: LED Signage



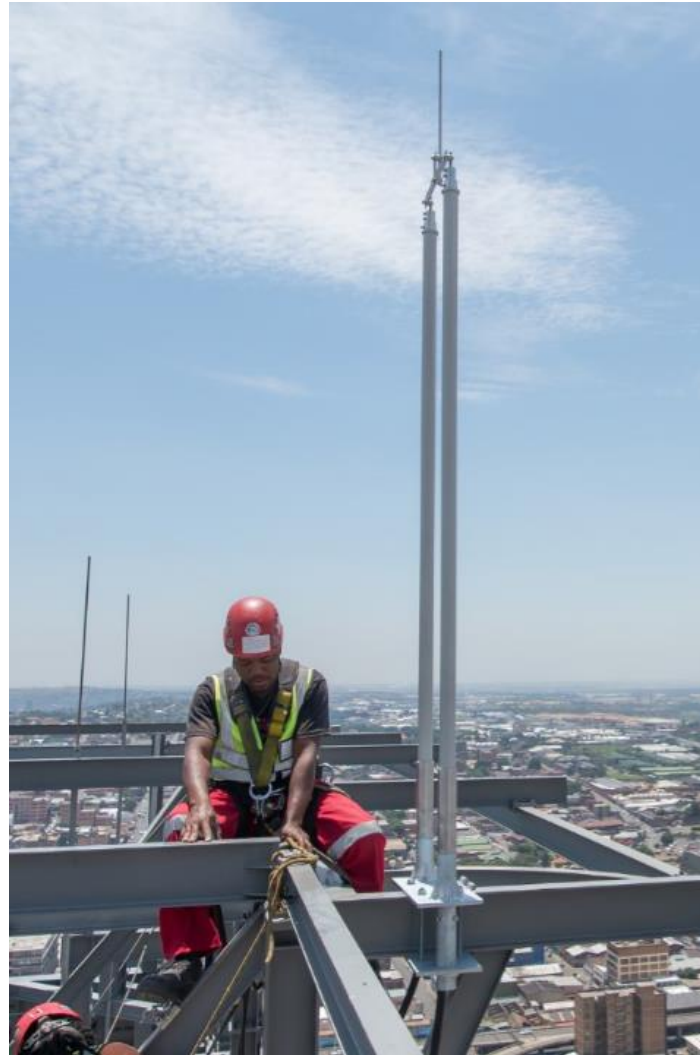
Absa Building Johannesburg



Critical Operation – Must not be damaged - \$18k per module
Zero Failure with HVI



HVI along the top rim of ABSA





Video Clip HotLinks

Project Lumen Video

<https://www.youtube.com/watch?v=0I2-YDv95BE>

Silverstar LPS Video

<https://www.youtube.com/watch?v=IA7UAM55hyI>

3D LPS Design Video

<https://www.youtube.com/watch?v=spzEc6HIqcc>

HVI Application: Cellular Telecom



Video of Cellular Application on Hospital at:

[https://www.youtube.com/watch?v=CCnuqzSBvWs&index=3
&list=PLUJ5-rGtZwb6ZyzT8PMsdVni0d_NeBi0r](https://www.youtube.com/watch?v=CCnuqzSBvWs&index=3&list=PLUJ5-rGtZwb6ZyzT8PMsdVni0d_NeBi0r)

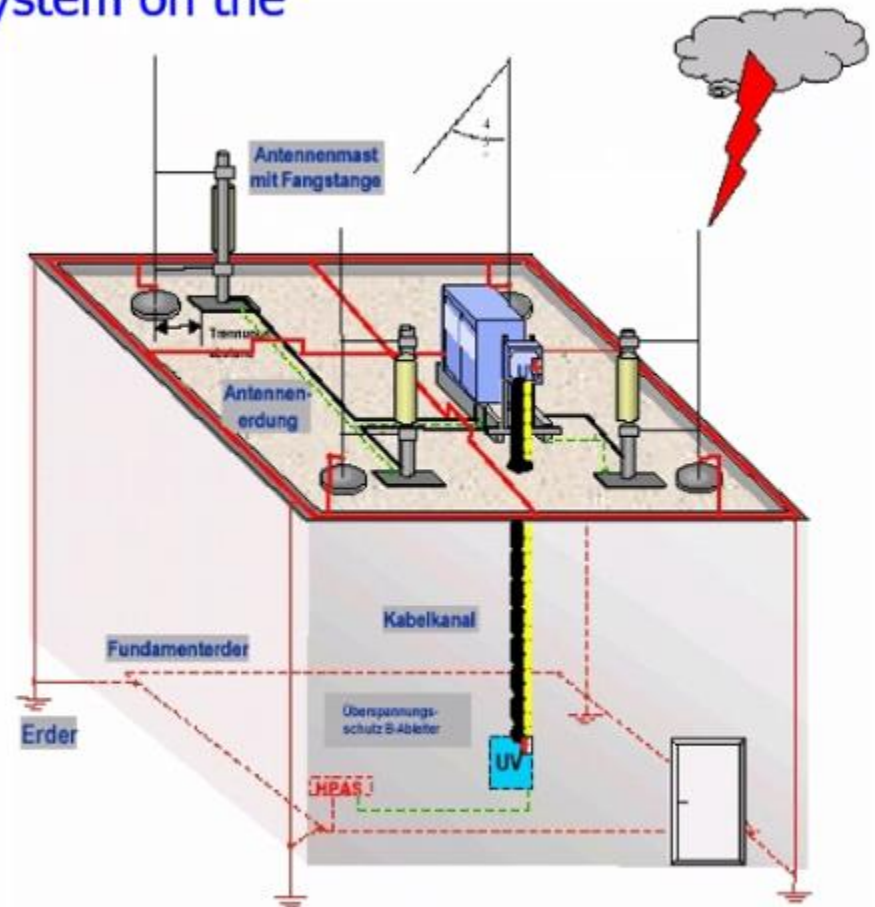
How HVI solves the problem better



Let's assume the lightning protection system on the roof is isolated type:

Then it is no need the DC SPD for RRU side, Because:

- When lightning strike the building, the lightning current will flow into isolated LPS system (red line in the figure) totally, no lightning current flow into bonding network (black line in the figure).
- The induced lightning current on DC power conductor is much more less than the conductive lightning current, the internal lightning circuit of RRU can withstand easily.
- The DC SPD on RRU side could be deleted.



Lightning current distribution at the cell tower

Isolated lightning protection

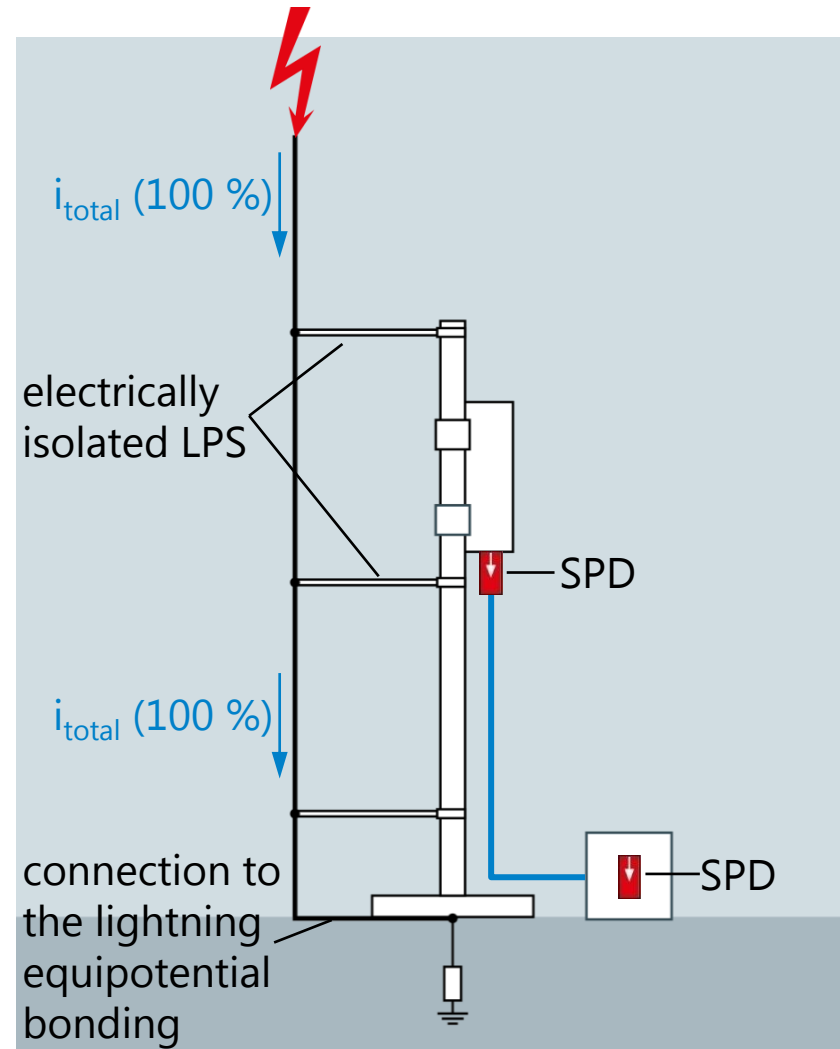


In case of an isolated lightning protection system, no partial lightning currents will flow

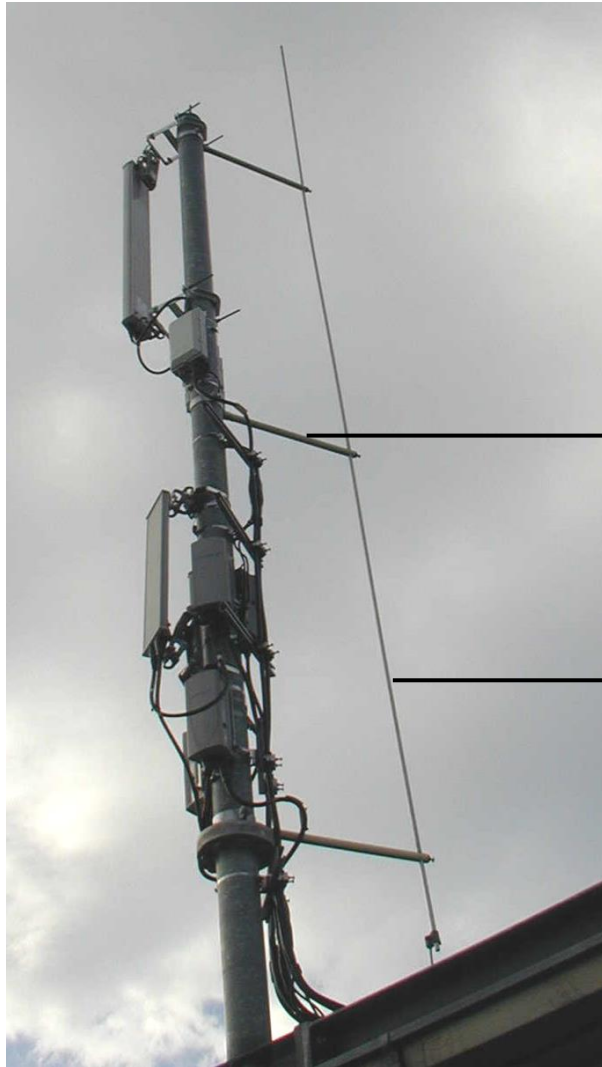
- in the metal installation
- through the electric lines.

In case of an isolated lightning protection system,

- lightning current arresters (type 1 SPDs) are not required
- Surge arresters (type 2 SPDs) must be installed to protect the tower against induced surges.



HVI Solutions at the T-Mobile and Vodaphone cell towers



spacer

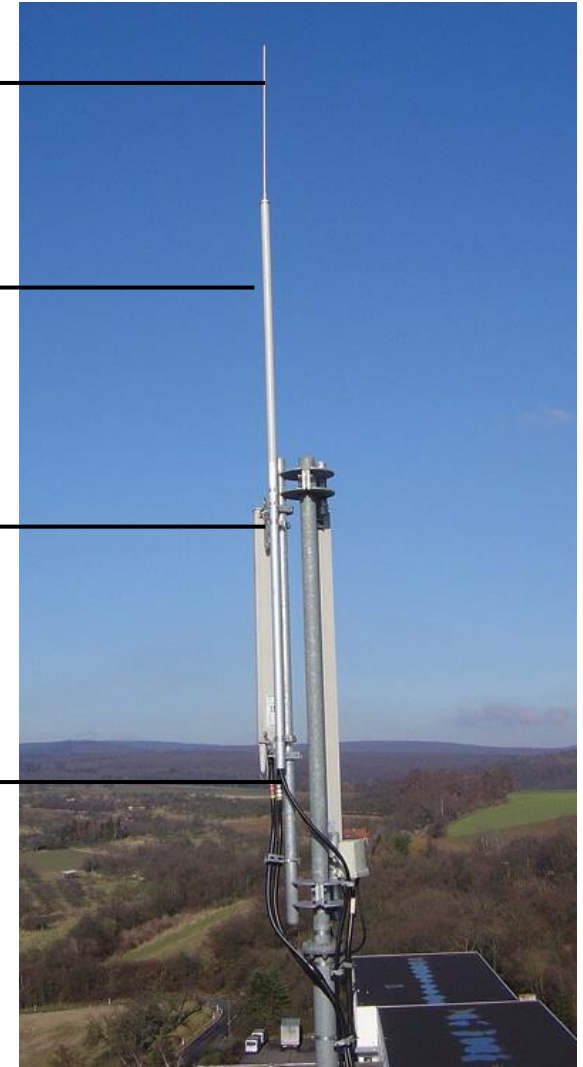
air-termination rod

air-termination rod

GRP supporting tube

aluminium supporting tube

HVI[®] Conductor



HVI® Lightning Protection for cell sites



no metal parts may be located in the sealing end range!

EB element installed inside the supporting tube



air-termination tip

GRP supporting tube

aluminium supporting tube

HVI® Conductor



HVI Application Deepwater Drillships

Drillship: Deepwater Horizon



Drillship: Deepwater Asgard

Finishing 3 yr deployment – Indonesia @ \$600,000 / day



Drillships

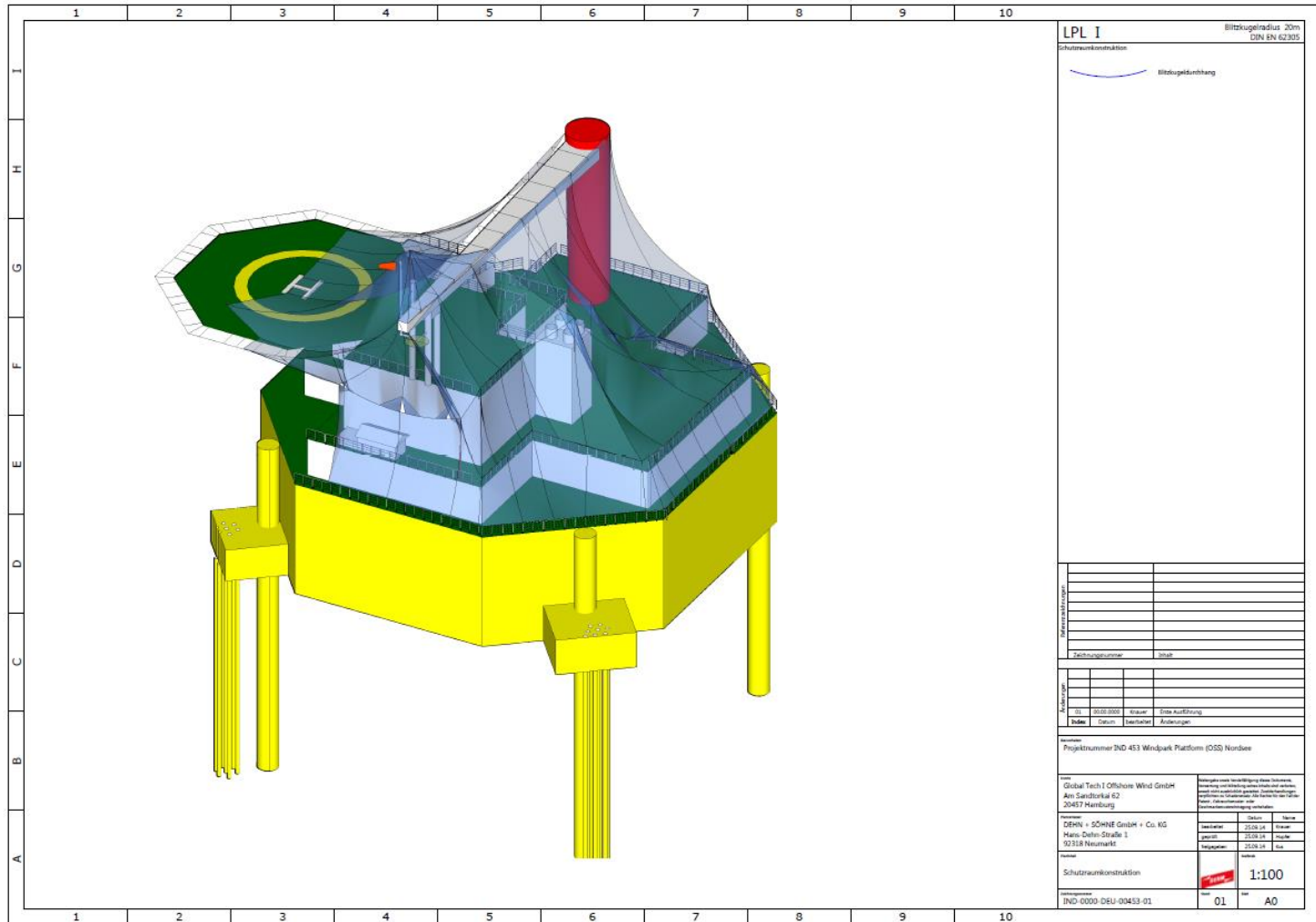


Drillships are often used to drill in very deep water, which can often be turbulent. Drillships use a dynamic positioning systems. Drillships are equipped with electric motors on the underside of the ship's hull, capable of propelling the ship in any direction. These motors are integrated into the ship's computer system, which uses satellite positioning technology, in conjunction with sensors located on the drilling template, to ensure that the ship is directly above the drill site at all times.



3D concept development

Example 2: HVDC platform (North Sea)



Drillships



HVI down conductors route lightning around DPS sensors in drilling tower.

First application of coast of Nigeria. Three lightning strikes (no damage) in first two weeks!

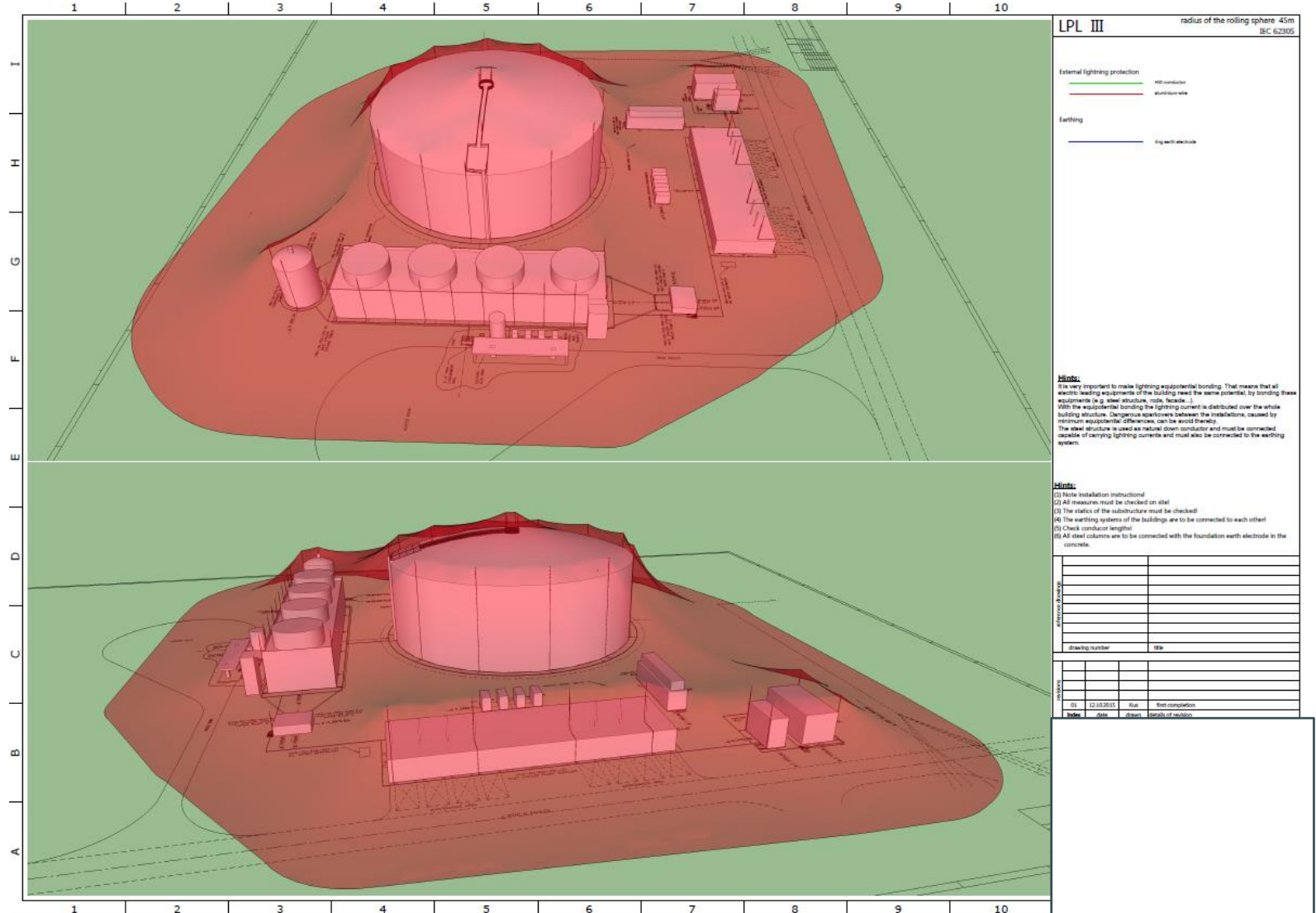
Note: For metal hull ships like this, the hull is an equal potential surface. SPDs are placed at above deck sensors, and at the point where the instrumentation lines enter the hull.



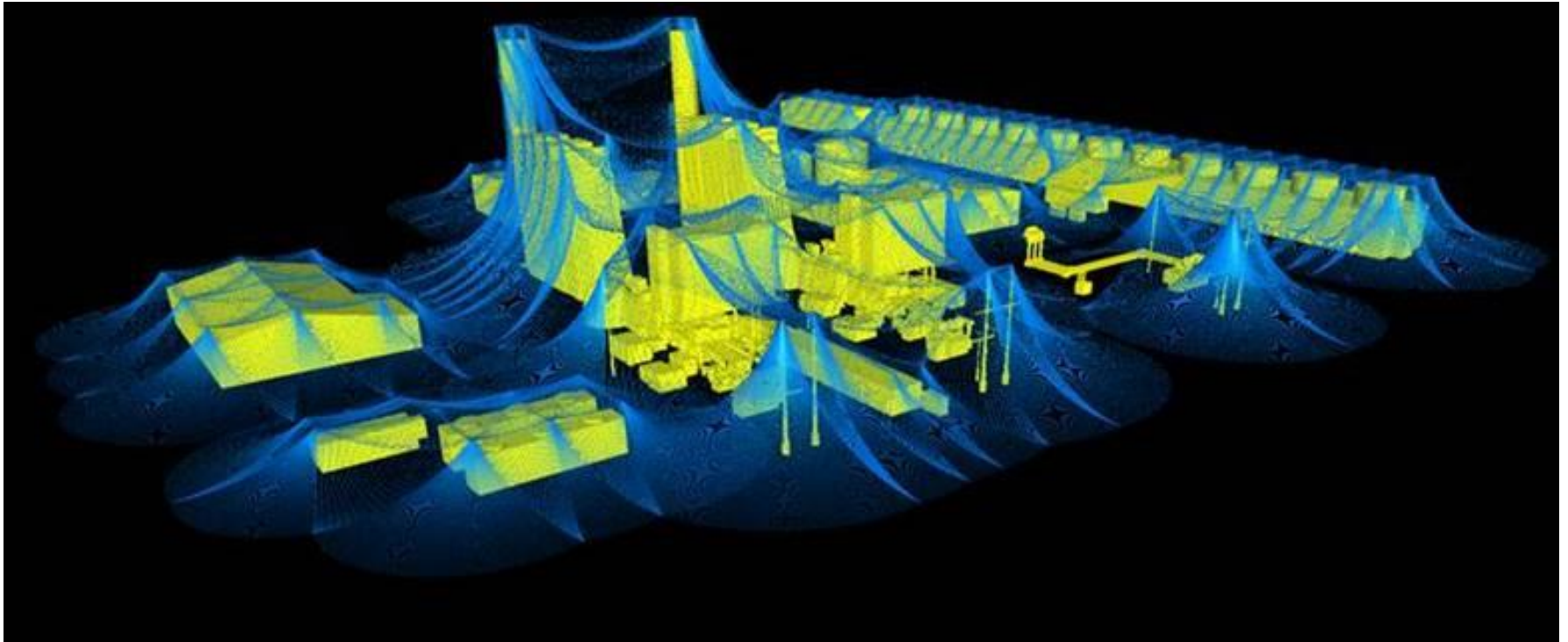
HVI Application: Power Production



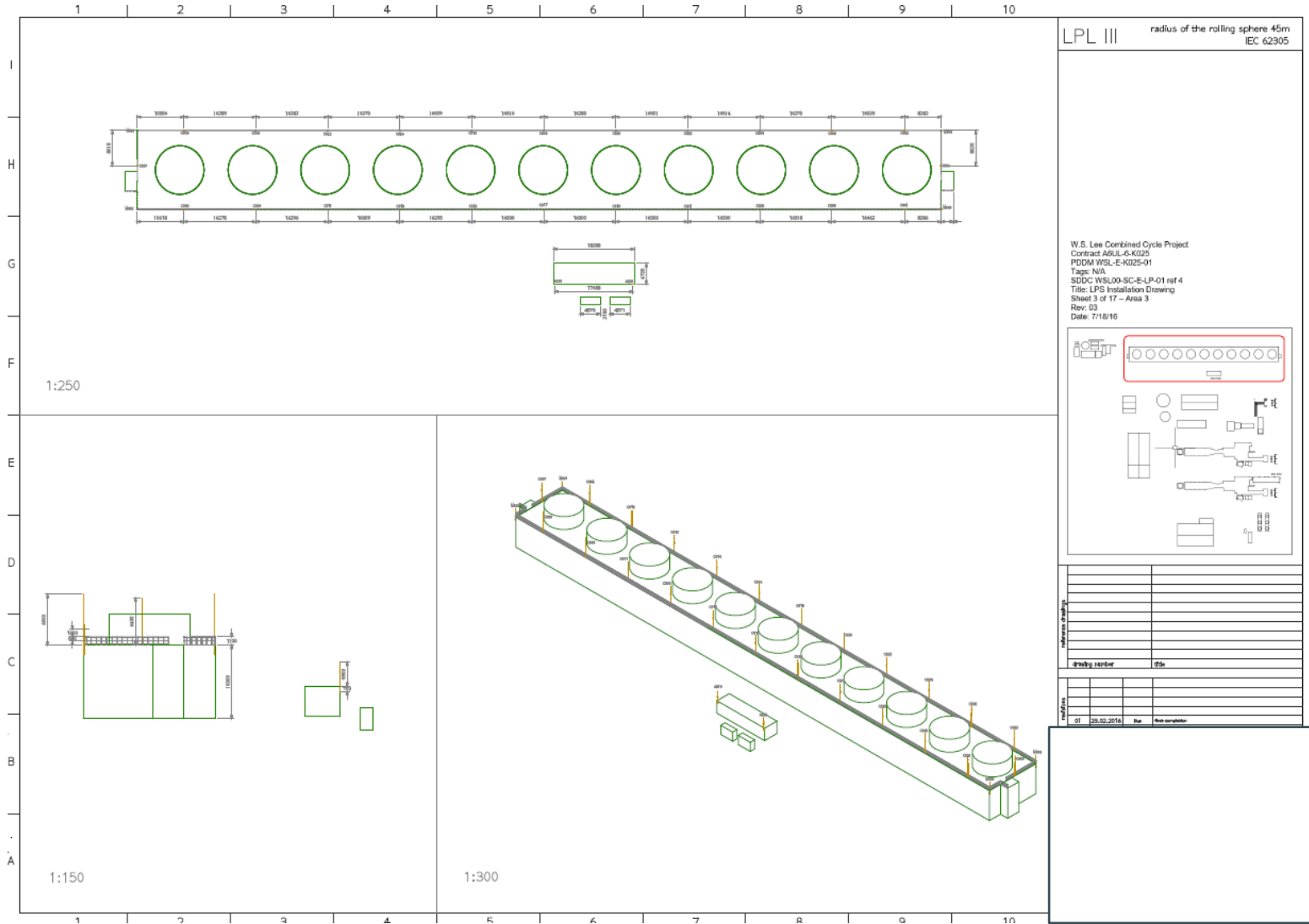
Rolling Sphere coverage Tank and Cooling Towers Total Coverage at USA Natural Gas Power Plant



Power Plant Site Overview

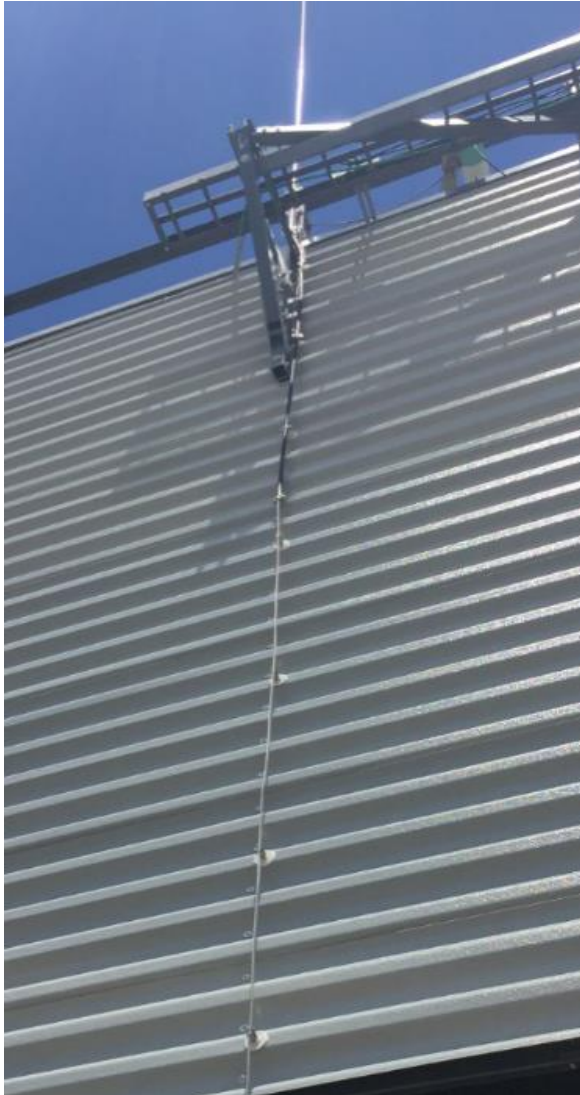


Structure Protection



HVI installed to pass electrical cable trays

Sealing end E-B as the HVI clears the support rod



HVI Installation Examples



HVI on the side of Electrical PDC structures



HVI on the top of electrical pump room structures



HVI Protection Alert Notification Siren Protection for USA Nuclear Power Plant



HVI Isolated System on Water Well here in Texas





Summary



Here you have seen the HVI lightning protection but remember this remains only one part of the entire system solution to provide complete lightning protection:

1. HVI lightning protection air terminals and down conductors
2. Grounding and Bonding
3. Surge Protection Devices – type 1 and 2 for direct current and point of use

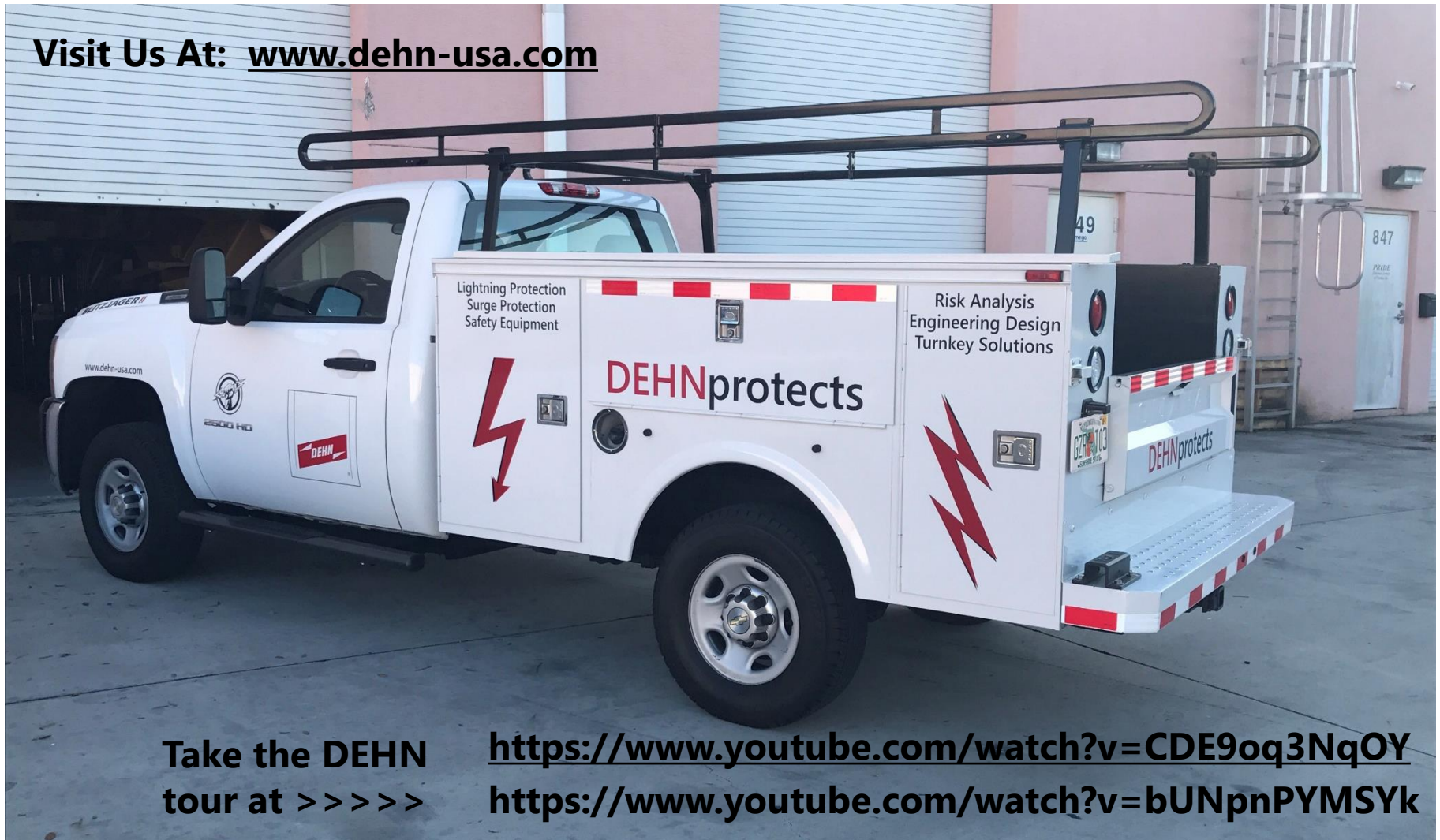
Come see our vendor booth showing our complete lightning protection capabilities and solutions.

DEHN protects

Thanks for Attending!!



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Take the DEHN
tour at >>>>>

<https://www.youtube.com/watch?v=CDE9oq3NqOY>
<https://www.youtube.com/watch?v=bUNpnPYMSYk>



Other Applications



Slides to be used only if time permits

Lightning damage to a floating-roof tank Trzebinia refinery, Poland



- 06.05.2002
- Capacity: 10,000 m³
- Loss: 4 Mio EUR

Lightning damage to a floating-roof tank Orion Refinery, Norco, USA



External lightning protection Isolated system with telescopic mast



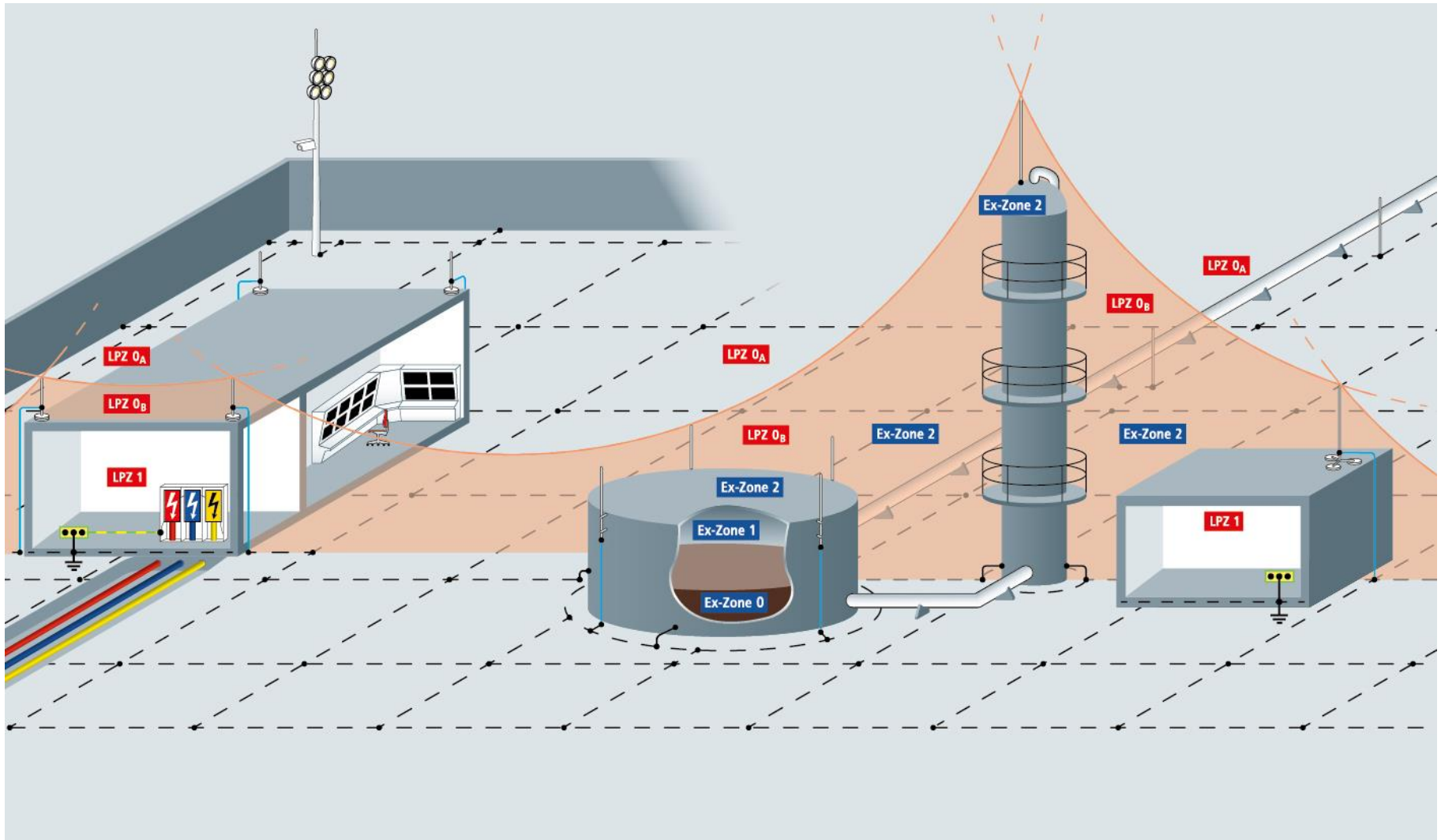
steel telescopic mast

External lightning protection Isolated system with telescopic mast



Petrochemical plant

Lightning protection zones



Compressor station

Centrally located exhaust gas stack



Compressor station Exhaust gas stack and isolated air-termination system

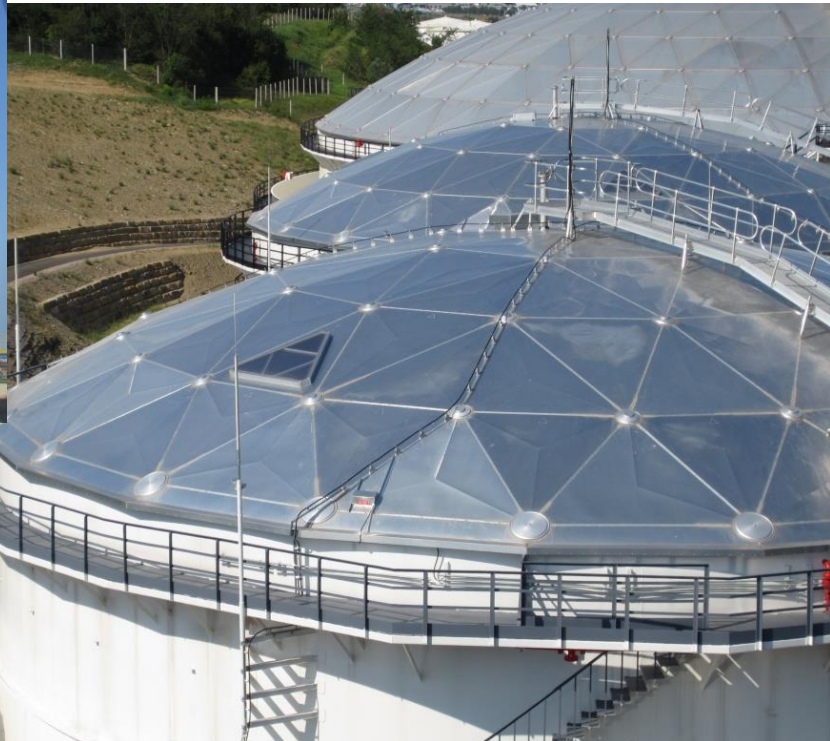


Compressor station

Exhaust gas stack and isolated air-termination system



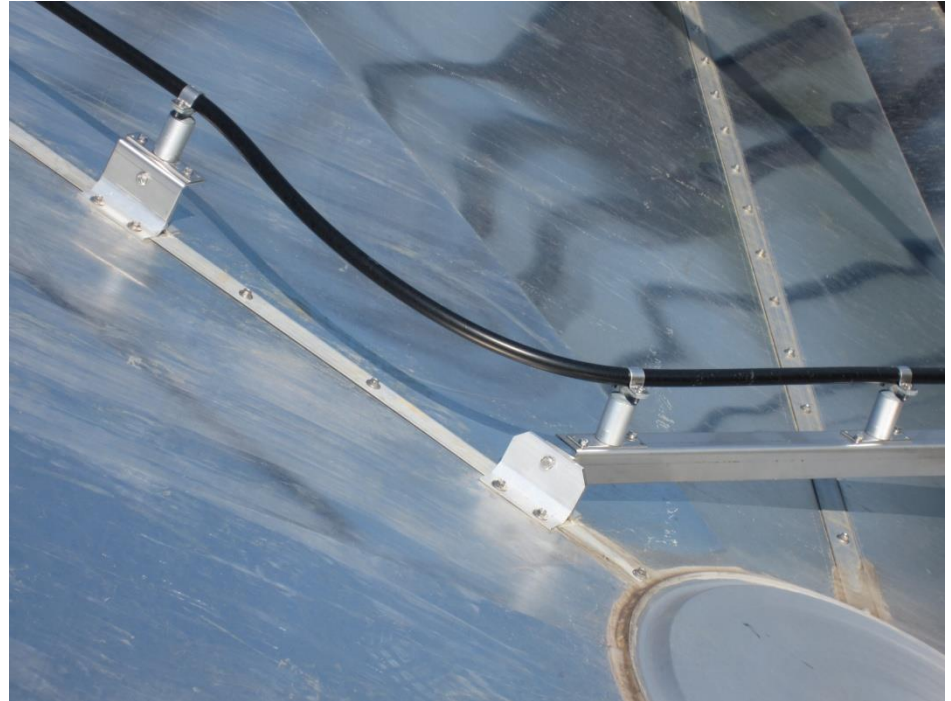
External lightning protection Isolated system with HVI-technology



Positioning of lightning rods



External lightning protection Isolated system with HVI-technology



Internet Solutions – Rosebank Johannesburg



Internet Solutions - Johannesburg



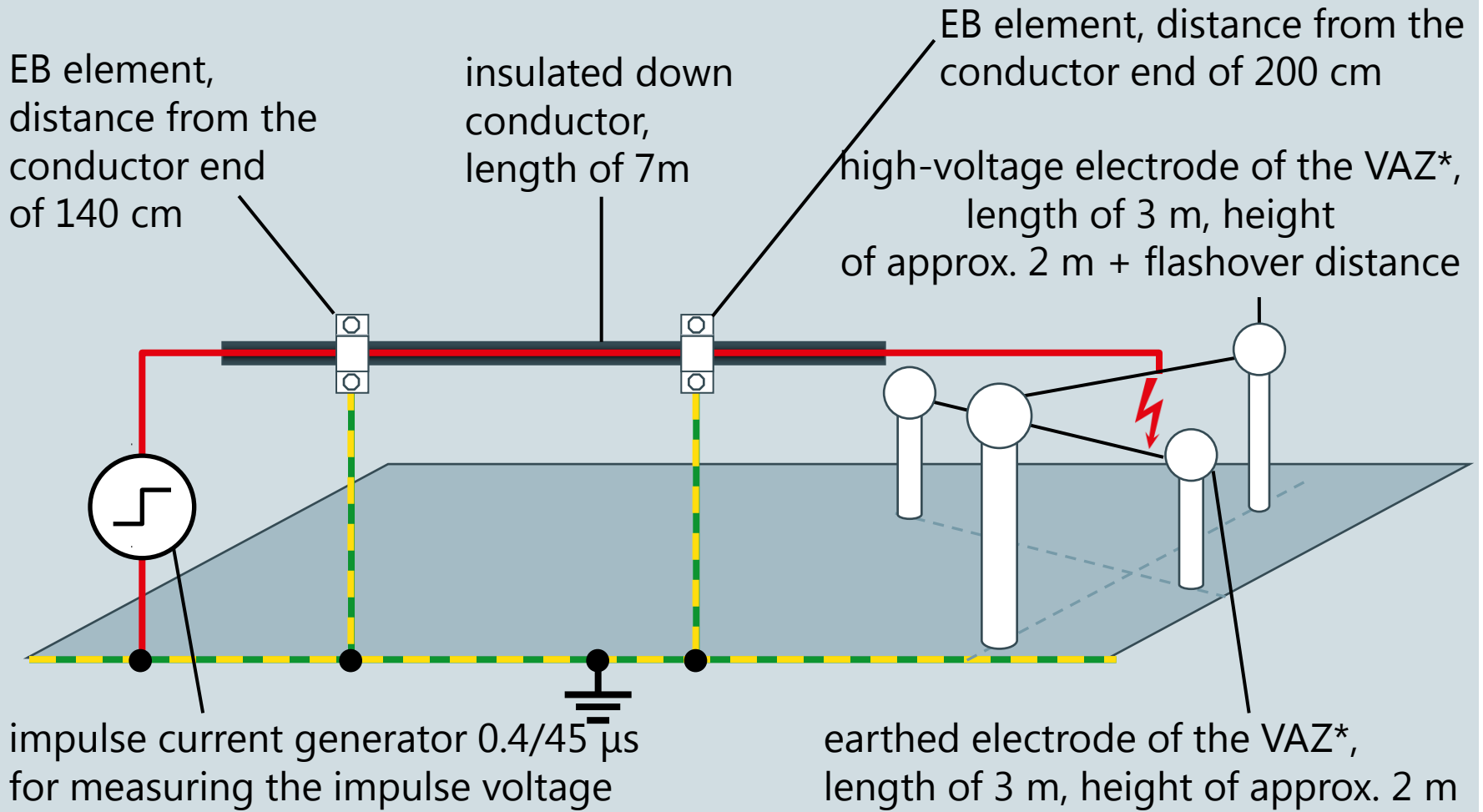


HVI Testing



Testing to prove equivalent separation distance

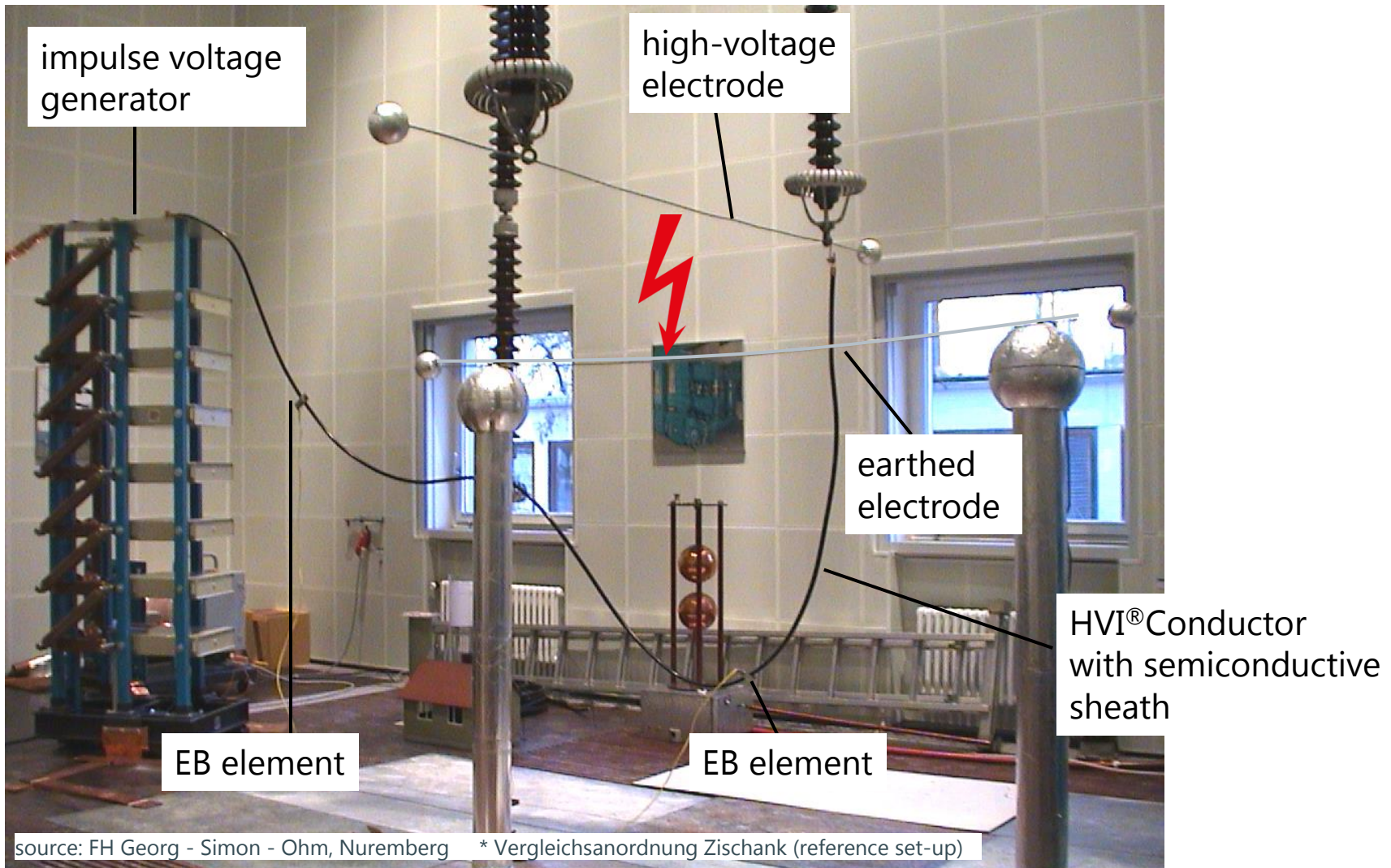
Insulated down conductors Test set-up (overview)



source: FH Georg - Simon - Ohm, Nuremberg

* Vergleichsanordnung Zischank (reference set-up)

HVI[®] Conductor - Testing the dielectric strength in the reference set-up*

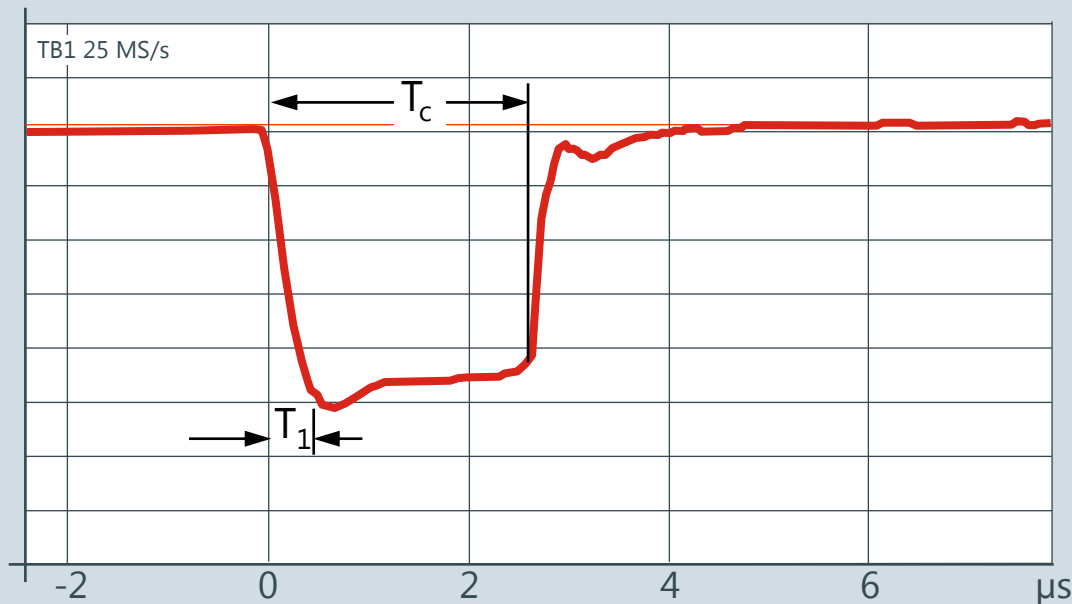


HVI[®] Conductor Test set-up 2



Test impulse voltage: - 720 kV

Result: No creeping discharge across the HVI[®] Conductor



Flashover in the reference set-up (VAZ*) equivalent to $s = 75$ cm in air

$$T_1 = 0.45 \mu\text{s}$$

$$T_c = 2.7 \mu\text{s}$$

$$U_s = -720 \text{ kV}$$

source: FH Georg - Simon - Ohm, Nuremberg * Vergleichsanordnung Zischank (reference set-up)



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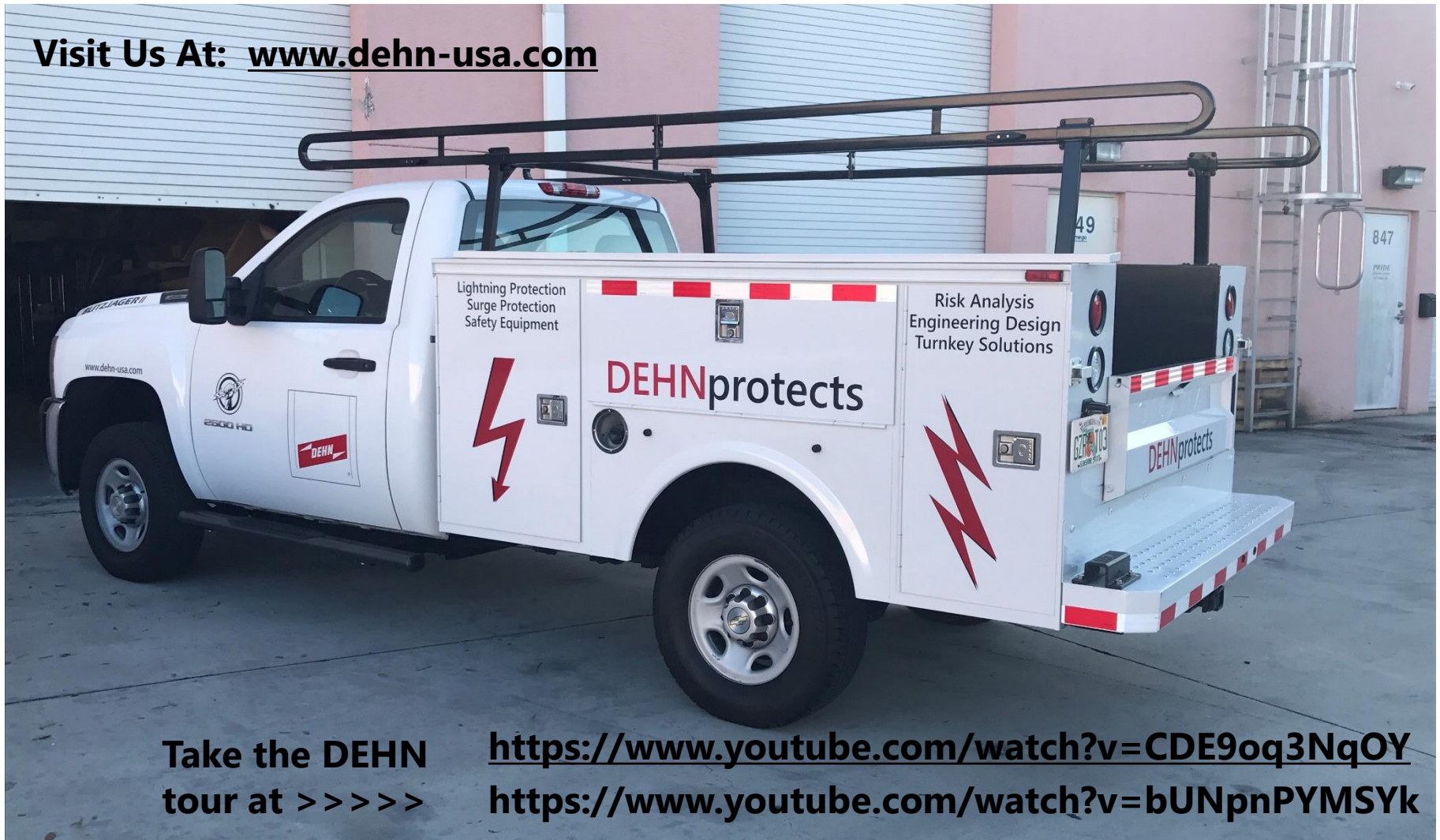
Come see our vendor booth showing our complete lightning protection capabilities and solutions.

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