

LIGHTNING PROTECTION INTERNATIONAL PTY LTD

**LPI**<sup>®</sup>

# GUARDIAN PLUS

Protection Solutions for HV Power Facilities

Placement  
method in  
compliance with  
IEEE STD. 998  
(Substations)





## The LPI story

Lightning Protection International Pty Ltd (LPI) is a fully Australian owned manufacturer and supplier of direct strike lightning protection, surge and transient protection, and earthing / grounding solutions.

LPI has manufactured and supplied these products and solutions worldwide for more than a decade.

The LPI engineering team conducts professional consultancy services in lightning protection and power system earthing (utilising CDEGS) across all industry sectors, mitigating risks to equipment and personnel.

LPI maintains a third-party Quality Management System to ISO 9001:2008 along with an Environmental Management System to ISO 14001: 2004.

LPI's range of products and services come from its manufacturing base and

research facility located in Tasmania, Australia, and via regional offices worldwide.

The company has been recognised within Australia for its outstanding export successes and has been awarded several prestigious export awards.



PLN site in Banjarmasin, Kalimantan, Indonesia.

## Active in Industry



FS 603875

EMS 641121



Approvals:



# LPI GUARDIAN PLUS AIR TERMINAL

## IEEE Standard 998

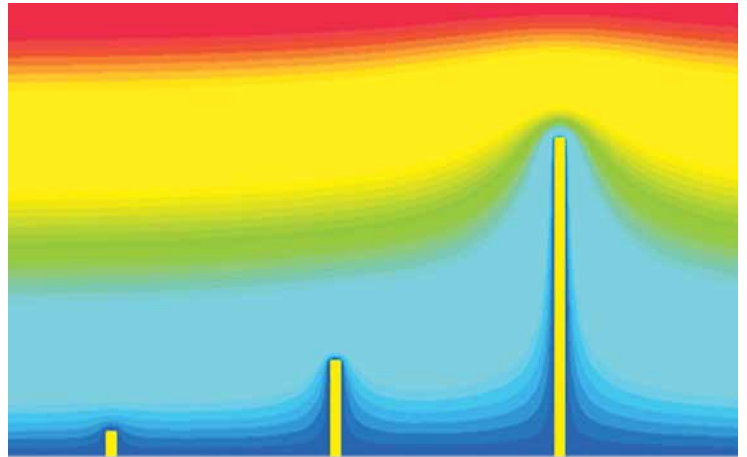
IEEE Standard 998 is the only international standard dealing with shielding of substations against direct lightning strikes. Other international standards, such as IEC 62305 and AS/NZS 1768-2007, do not consider lightning protection of HV power systems in their scope.

## Design Methodology

### Leader Inception Theory (LIT)

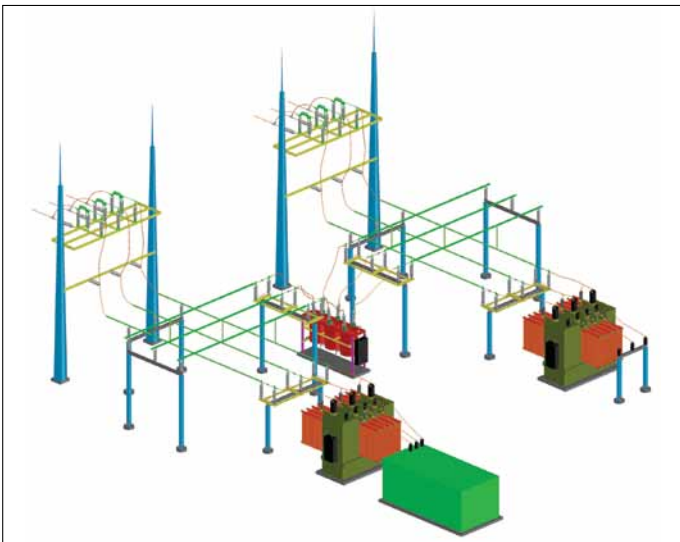
LPI uses the Leader Inception Theory (LIT) for designing lightning protection systems for HV power facilities. LIT is one of a number of design methodologies detailed in IEEE Std. 998.

The Leader Inception Theory and model was initially presented by Rizk [1990, 1994] and was expanded for application to structures and substations [Rizk 2009, 2010].

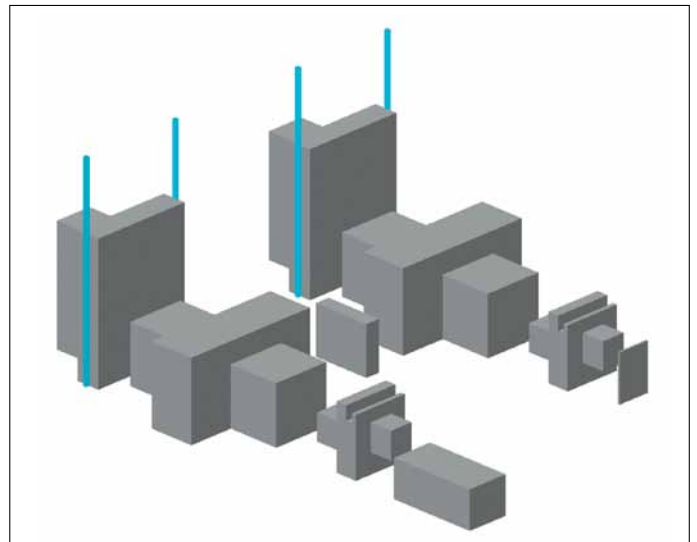


A fundamental parameter used in the LIT model is the space potential around the object created by the cloud and downward leader charges.

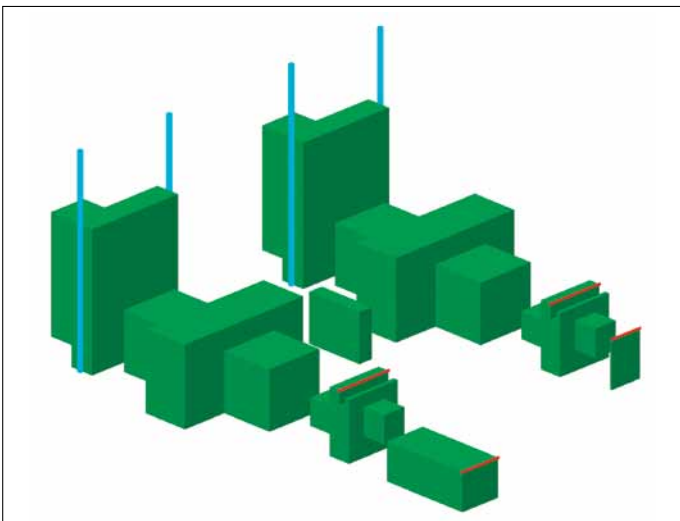
## Designing for Substations using the LIT Model



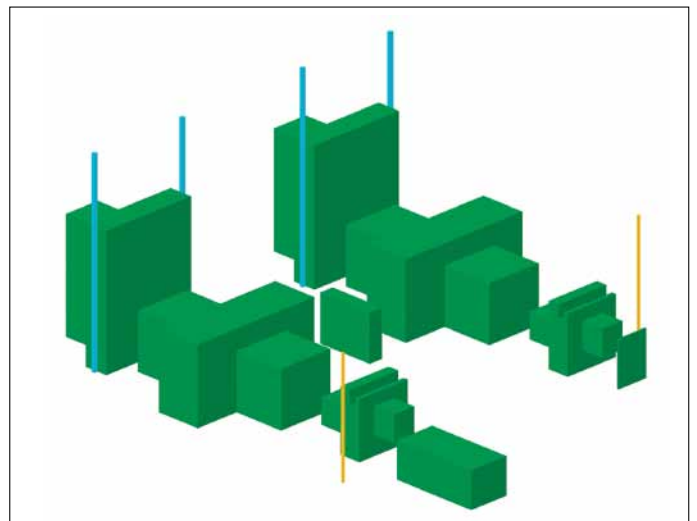
Case Study: 69 kV substation in IEEE Std. 998.



Step 1: Simplify the equipment and buses.



Step 2: Perform strike probability analysis (SPA) utilising a dynamic EGM and published lightning stroke statistics.



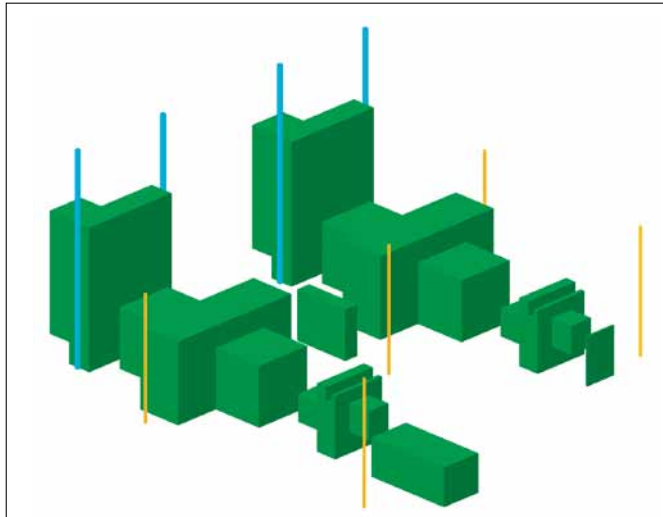
Step 3: Position air terminals in optimum locations based on the SPA and attractive radius calculations in accordance with LIT.

# LPI GUARDIAN PLUS AIR TERMINAL

## Cost Effective Design

For the 69 kV substation, the LIT methodology requires two (2) lightning protection masts to be installed in optimum locations. The blanket approach applied when using the Rolling Sphere Method (RSM) results in a requirement for five (5) masts.

LPI proprietary software for optimal placement and selection of hardware.



## Advantages of LIT Methodology

- The model is backed by decades of experimental results from long-spark testing in high voltage laboratories
- Validation against rocket-triggered and natural lightning experiments
- Site-specific design calculation customised to suit individual projects
- Sound scientific basis which results in substantial efficiencies in designs, with excellent cost benefits

## Guardian Plus Air Terminal Range

The new Guardian Plus air terminal range has evolved from the original Guardian CAT design and has been developed after taking into account the latest international research. Key elements include the effect of space charge and air terminal geometry, characteristics of long sparks, lightning characteristics and statistics, and the lightning attachment process itself.

- The design of the Guardian Plus air terminals is based on detailed modelling and calculations which optimise corona performance in the quasi-static phase of a thunderstorm
- Three domes sizes to cater for all practical installation scenarios
- Tip radius of curvature and tip protrusion is optimised to minimise corona discharge
- Robust materials to achieve long service life



## Guardian Plus Range

LPI offers Guardian Plus terminals in both **anodised aluminium** and **stainless steel**.

### GPLUS-XYZ

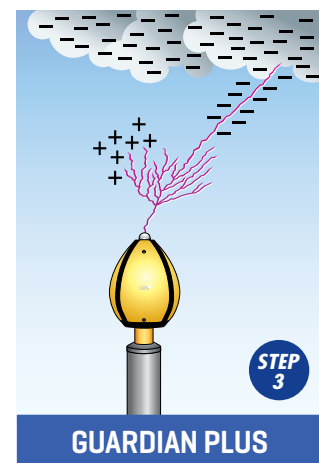
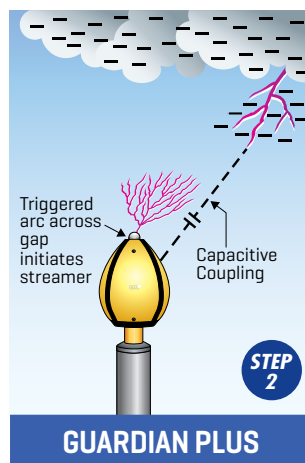
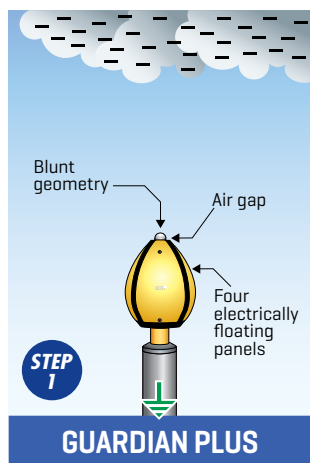
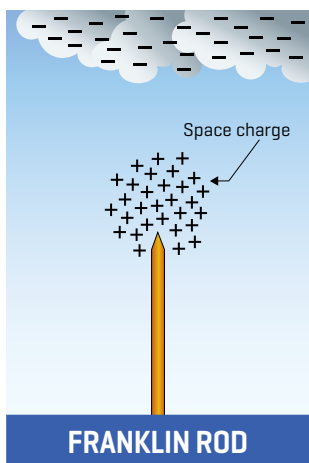
**X:** Guardian Plus terminal model. Model 1,2 or 3.

**YY:** G for gold [anodised aluminium] model, SS for stainless steel model.

**ZZ:** IM for insulated mast [use with FRP mast and HVSC Plus]. CM for conductive mast [2 inch BSP GI pipe adaptor].

Contact LPI or an authorised distributor for further detail.

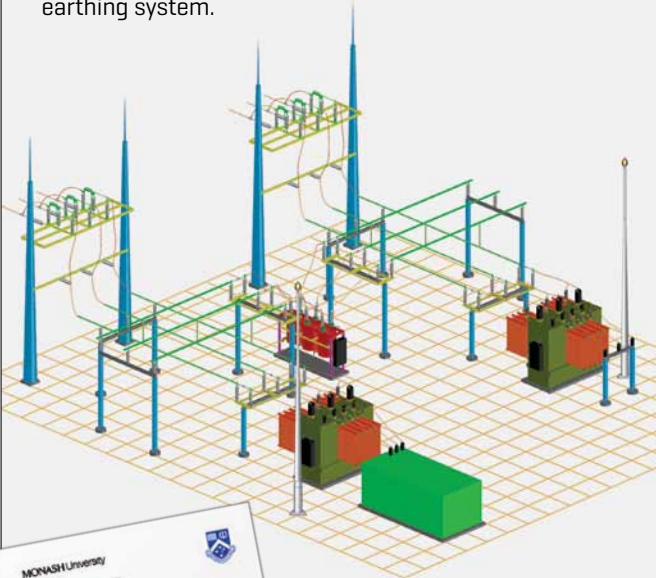
## How does an LPI Guardian Plus Terminal operate?



# LPI GUARDIAN PLUS AIR TERMINAL

## Downconductors

LPI offers a comprehensive range of downconductors for the safe and efficient passage of lightning energy into the earthing system.



HVSC Plus has been tested by a certified, independent high voltage laboratory in Australia. Withstand voltage  $\geq 500$  kV

LPI offers a selection of downconductors and fixing accessories:

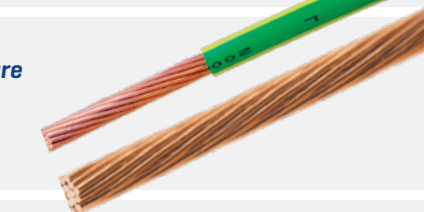
High Voltage Shielded Cable (HVSC Plus)



Flat tapes - Bare, Tinned & PVC Covered



PVC Coated and bare stranded copper conductor



E Downconductor Fixings and Connectors



## Lightning Strike Recorder (LSR1)

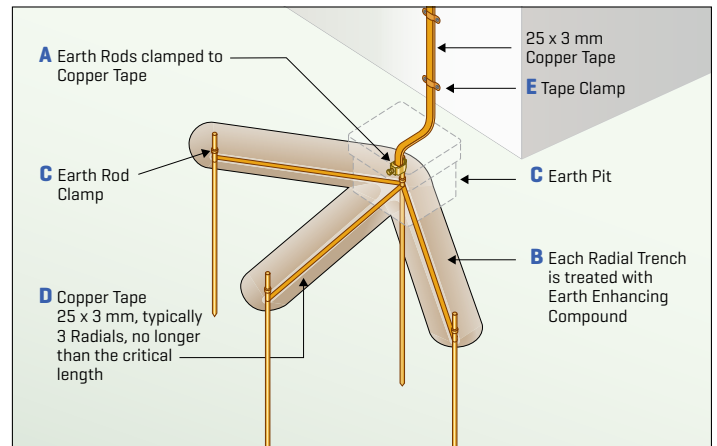
The LPI LSR is easily mounted on a downconductor and effectively counts the number of lightning strikes captured by the Guardian Plus air terminal. An LSR tester is available upon request. Contact LPI for details.



- Ordering Codes:**
- LSR1
  - LSR Tester

## Earthing for Lightning

A special earthing design for lightning is recommended, utilising radial and vertical earth electrodes, with an overall impedance of  $10 \Omega$  or less. Such a design for dissipating lightning transients into the ground ensures that earth potential rise is minimised. Then, all earthing systems should be bonded together in a ring-earth arrangement, to minimise damaging potential differences under transient conditions.



Key components of a lightning earth include:

**A Earth Rods** - Copperbonded (threaded or unthreaded), Solid Copper or Stainless Steel



**B Earth Enhancing Compounds** for lowering earth system resistance



**C Mechanical Clamps and Earth Pits** Polymer earth pit

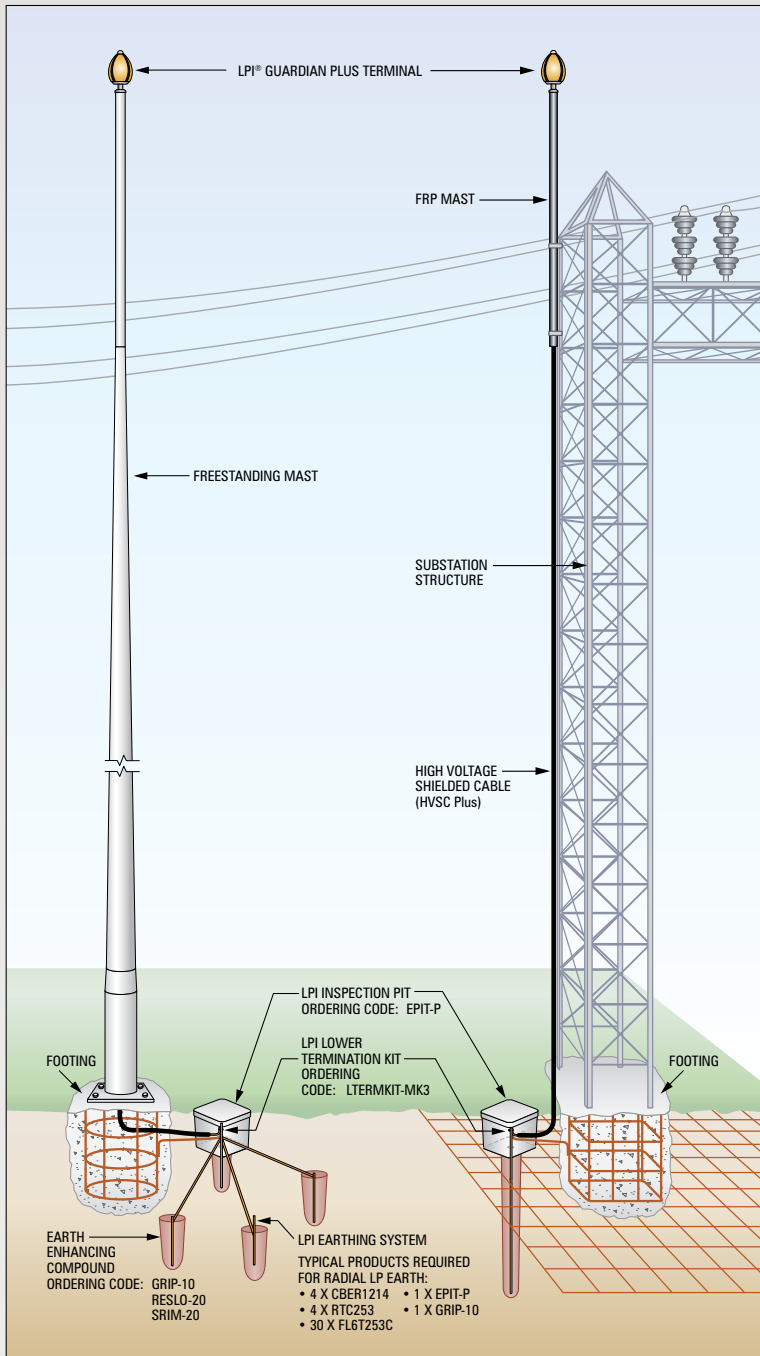


**D Earthing Conductor** - Use of copper tape is recommended as it provides greater surface contact with the soil mass as opposed to circular or stranded copper conductors



# LPI GUARDIAN PLUS AIR TERMINAL

## Guardian Plus Installation



## Testing of the Guardian Plus Air Terminal

The Guardian Plus range of air terminals is the result of an extensive research and development program. The air terminal optimisation was completed via testing at the state-of-the-art "National Engineering Laboratory for Ultra High Voltage Technology" (NELUHVT), located near Kunming in China. High voltage testing included corona performance under static electric fields and upward leader initiation under dynamic fields. The NELUHVT is an outdoor facility and hence the air terminals were not only tested under different electrical conditions but also a range of environmental effects.



### Disclaimer

- LPI maintains a policy of ongoing product development. Specifications are subject to change without notice.
- Application detail, illustrations and schematic drawings are representative only and should be used as guides.
- 100% protection cannot be guaranteed for direct-strike lightning, lightning detection, and surge and transient protection of equipment. This guarantee cannot be provided because lightning is a random, natural, atmospheric event.

Distributed by:

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**LPI®**

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