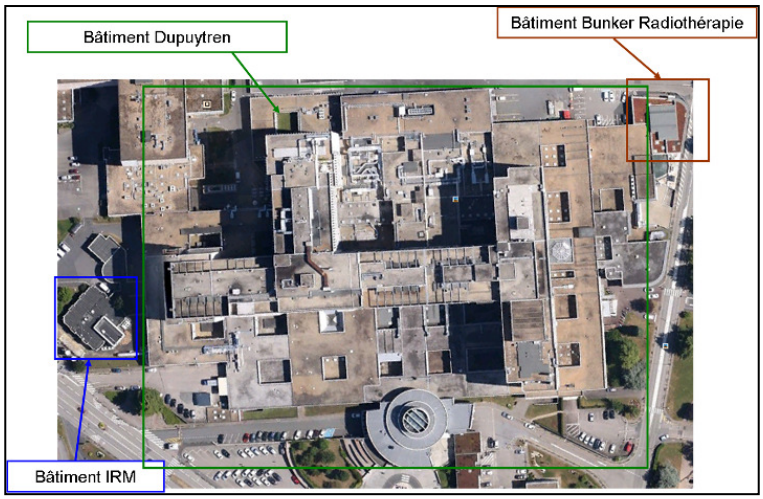
TECHNICAL LETTER N°4

CASE STUDY : LIGHTNING PROTECTION OF UNIVERSITY HOSPITAL OF LIMOGES (FRANCE)

▪ Introduction

In October 2013, France PARATONNERRES won the market of lightning protection of all the buildings of University Hospital of Limoges (France).
This set is 8 buildings distributed over the town of Limoges (Haute Vienne, FRANCE).
This technical letter shows lightning installation against direct and indirect strike of principal building of CHU Limoges: The hospital DUPUYTREN.

The hospital DUPUYTREN is composed of several services distributed over 10 floors.
It has a length of 240m, a width of 130 m and a height of 60 m. It is one of the tallest buildings so very exposed to stormy events in Limoges. Sensitive building are present at the foot of this hospital: Bunker Radiotherapy and IRM (Medical Resolution Image)



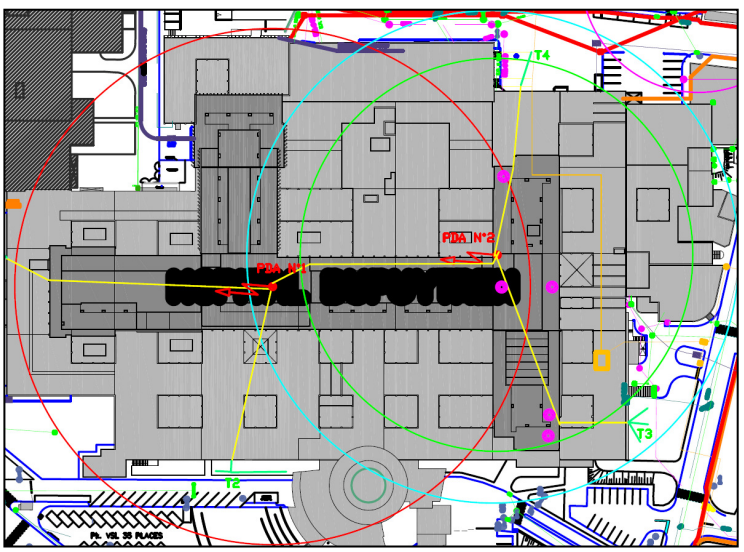
Lightning Risk Assessment on this building recommends a lightning protection **level I**.

▪ External Installation of lightning protection

Since its construction, the hospital DUPUYTREN was protected by a radioactive lightning rod PREVENTOR. A lightning strike on this structure caused the destruction of all power supply of fire safety.

This radioactive rod has been displaced according to ASN procedures (French Nuclear security authorization) and has been substituted by an Early Streamer Emission Air Terminal **IONIFLASH MACH NG 60 (ref. 90160)** tested according to the latest edition of the standard NFC 17-102 of September 2011.

For the protection of direct lightning effects of this building, two ESE IONIFLASH MACH NG 60 were installed. For a level of protection I, these ESE with an advance time of 60 µs, have a radius protection of 79 meters.



9 rue Columbia - Ester Technopole – 87068 LIMOGES-
Mail : contact@france-paratonnerres.com TEL: 33 (0)5 55 57 52 53 - FAX : 33 (0)5 55 35 85 62

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ESE n°1 is positioned on top of a communication antenna at a height of more than 20 meters from the roof of the building. This ESE is mounted on a stainless steel 304L pole (**ref. 11043**) itself fixed to the support of the mast antenna by a set of universal clamp (**ref. 12006**). This ESE becomes one of the highlights points of the city of Limoges with an estimated height of 380 meter NGF (General leveling of France).

ESE n°2 is positioned on a penthouse roof terrace of the hospital fixed to the support with bolting bracket (**ref. 12013**). This ESE is mounted on several stainless steel poles allowing it to reach a height of 6 meters (**ref. 11043+11037+11039**).

According to the NFC 17-102 standard, two down conductors per ESE were performed. These down conductors, in tinned copper strip 30x2 mm² (**ref. 13001**) are set at 3 meters per linear meters with clamps for masonry (**ref. 14001 + 14004**) and stands off (**ref. 14043**) for the roof.
The installation of these down conductors was carried out by our technicians specialized in rope access work at height.

For each down conductors, a mecanique protection sheath in stainless steel (**ref. 16003**) and a control joint (**ref. 16001**) have been installed in order to enable an independent control of the earthing system.

For each ESE, a lightning impulse counter (**ref. 30002**) on the down conductor with the way the most direct to the earthing system have been installed just above the control joint.

The height of these ESE and length of the down conductor involve a large separation distance. To limit this separation distance, it was decided to connect the two ESE IONIFLASH MACH NG 60 with tinned copper strip and connect one of the four down conductor to a metal staircase (fire escape) himself connected to a specific earthing system.
The calculated separation distance is also reduced.

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In order to avoid any dangerous sparks and parasit effects, it is requested to install a lightning protection with a perfect equipotentialization between all the metallic and/or conductive parts.
The separation distance calculation of this lightning protection is given by:

$$s = k_i \times \frac{k_c}{k_m} \times l$$

- The coefficient k_c is equal to 0.41 for a crow's foot earthing system.
- The coefficient km is equal to 1 in the air and 0.5 in concrete of brick.
- The coefficient k_i is equal to 0,08 for the level of protection I
- The maximal lenght of this lightning installation is 190 m.

The maximum separation distance in the air is then 6.2m.
Unused equipment's on the roof were then protected with equipotential bonding in order to respect this separation distance.
In addition, to limit the spread of the lightning current inside the building, earthing kits and coaxial surge arresters were installed on the shield of the coaxial antennas present near the down conductors.

▪ Internal Installation of lightning protection

Equipotential bonding SPDs Class 1 France PARATONNERRES (**ref. 23109**) were installed at the top of 6 main electrical boards supplying the entire hospital DUPUYTREN.
These distribution boards can't be cut (because of a relay generator), these arresters were installed on the tails of 6 bars Low Voltage transformer. These devices are connected in series to a circuit breaker with fuses 120A.
In addition, 24 SPDs class 2 (**ref. 23201**) were installed at the secondary of transformers supplying 24 operating rooms.

The power supply of the fire safety system was also protected by a SPD class 2 France PARATONNERRES class 2 (**ref. 23201**).
These SPDs class 2 are connected in series to a circuit breaker with fuses 40A.
All these arresters were installed while observing the rule of 50cm described below:

The NFC 15-100 specifies that the cumulative length of parallel conductors of the network connection of the arrester must be less than 50 cm.

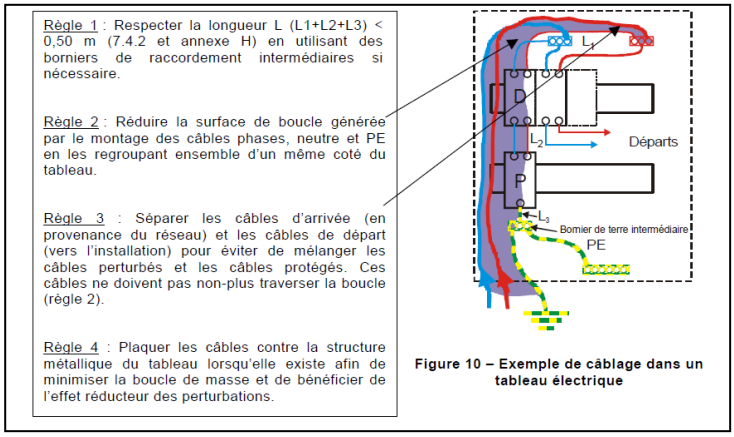

Figure 10 – Exemple de câblage dans un tableau électrique

Example of connection of SPD in an electrical panel (source: Guide UTE C 15-443)

Too much length can reduce induced currents during a lightning impact. The SPD (the residual voltage is increased) may not therefore play a protective role since its residual voltage U can be greater than the residual voltage Up of the device to be protected.

▪ Conclusion

All the buildings of the university hospital of Limoges are protected against lightning with a dozen of IONIFLASH MACH NG device. More than a hundred surge arresters allow the electrical protection of these sites. An audit of all of these lightning installation will be conducted annually.