FROM THE IMPORTANCE OF EQUIPOTENTIALITY IN A LIGHTNING PROTECTION SYSTEM

Michael TROUBAT,[1] and Emmanuel PERRIN [2]

[1] *Research Department, FRANCE PARATONNERRES, Limoges, France*
[2] *CISTEME, Limoges, France*
m.troubat@france-paratonnerres.com, http://www.france-paratonnerres.com

Keywords: Equipotentiality, Lightning protection, rising earth potential, dangerous sparks
Thematic area: The study of lightning and its effects

This paper deals with the importance of realizing a complete perfect Lightning Protection System (LPS) and in particular the equipotentiality of conductive parts.

When a lightning discharge occurs, a conductive channel is created from cloud to earth. The LPS aims to be part of the channel and is designed in order to protect the structure and persons from the devastating effects of lightning.
To realize this protection, the LPS is made of four main parts and each of them is very important in order to be effective in the protection of a structure.

- Capture device
- Down-conductor
- Earthing system
- Equipotentiality (direct or indirect one)

Measurements and modeling [1, 2] show that when an earthing system is well dimensioned (ie with resistance lower than 10 Ohms) the electromagnetic radiated field is reduced.

According to field experiences and calculations in this paper, we consider that well positioning the LPS and realizing equipotentialities, have to be considered as the main rules or as the golden rules in lightning protection.

Recently the earthing system of the Eiffel Tower has been revised [3].

In order to validate the design, we modeled the Eiffel Tower through a Finite Time Difference Model (FDTD) method and apply on a theoretical lightning current with the following characteristics: 200kA @ 10/350µs waveform.

We finally show by comparison of cases the importance of the 4 earthing systems and of the equipotentiality realized between them.

Indeed, aside from the risk of direct lightning strikes, it exists secondary risks like dangerous sparks or rising earth potential. Those risk can be simply avoided:

- by well positioning the components of the LPS
- by respecting separation distances between the lightning down-conductors and the conductive object that can be impacted
- by the installation of direct or indirect equipotentiality bonding
- by joining all the earth system
- by looking for the lowest earth resistance (both in low and high frequencies) achievable

Dangerous secondary sparks can appear between the down-conductors and conductive parts around. The length of the spark that can be created depends of the lightning current, of the distance between the two electrodes and of the earthing system resistance value.
The lightning current will imply more or less current in the down conductor and so a more or less important radiated field. The most important is the electric field (E in V/m), the longer will be the spark.

Moreover, this study enables to show that for an identical lightning current, a very low earthing resistance will reduce this dangerous park.

Then, for the 10Ω standard value, we can consider that 50% of the lightning current flowing to this earthing system is dissipated inside.

The other 50% will go around and will look for conductive parts. Of course, the strength of the current will be reduced along this path. If the lightning earthing system and the main electric earthing are not joined (direct equipotentiality), a potential difference will occur and dangerous rising of the earth potential will occur.

If Surge Protective Device (SPD) are not implemented on main distribution board, critical overvoltage will directly go inside the structure and may cause electric shocks and injuries to person or failure of devices.

References

[1] M. Troubat (2015), “Electromagnetic field radiated by the lightning channel and its impacts on a typical building”

[2] M. Troubat, E. Perrin (2012), “Reduction and mastering of electromagnetic field due to lightning in a structure”

[3] F. Barriere (2016), “Execution document, n°DOE-NN-160701”