

STUDY CASE : The different lightning earthing systems

Introduction :

In a lightning protection system, the lightning earthing system is a fundamental and decisive element as it is the dispersion vector of the lightning current. Whichever the protection system selected, the lightning earthing system is a key element in the proper functioning of a lightning protection installation and a particular attention must be paid to its installation.

Differences in the installation of the lightning earthing system according to the NFC 17-102 standard and the EN 62305-3 standard:

Reminder :

NFC 17-102 : Standard concerning the installation of Early Streamer Emission Air Terminals (ESE).

NF EN 62305-3 : Standard concerning the installation of Simple Rod Air Terminals, meshed conductors and catenary wires.

I - Earthing System NFC 17-102 :

The conductor must be made of materials compliant with the NF EN 50164-2 standard (see Table IX).

Tableau IX

Material	Section	Observation
Copper	50 mm ²	Flat minimum thickness 2mm twisted strand minimum diameter 1,7 mm Round min. diameter 8 mm
Galvanized Steel	90 mm ²	Flat minimum thickness 3 mm twisted strand minimum diameter 1,7 mm Round min. diameter 10 mm
Stainless Steel	100 mm ²	Flat minimum thickness 2 mm Round minimum diameter 10 mm

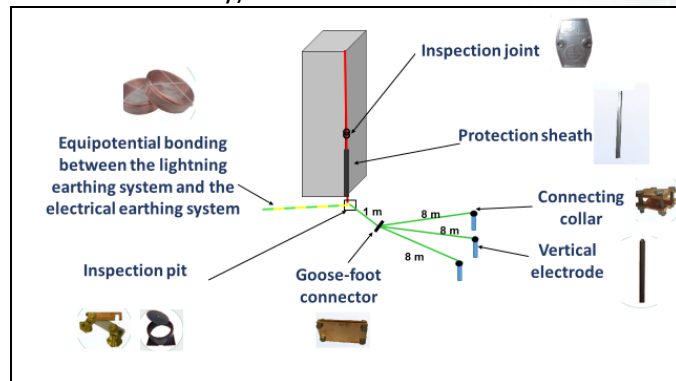
An earthing system is done for each down conductor on the basis of at least two electrodes by earthing system. The earthing systems shall meet the following requirements:

- the resistance value measured by using a conventional equipment shall be as low as possible, **lower than 10 Ω**.
- Earthing systems equipped with an excessively long single vertical or horizontal component (> 20 m) (induction effect in the high frequencies) shall be avoided in order to ensure an impedance value or inductance value as low as possible.

Different types and dimensions exist for earthing systems :

Type A : specific earthing system, divided into two categories A1 and A2 :

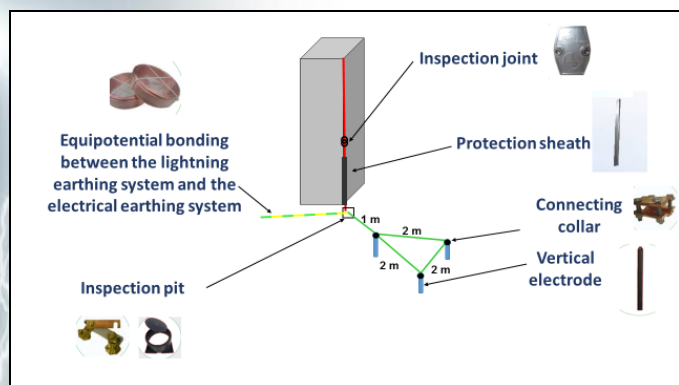
- A1 – the conductors of same nature and section as the down conductors are arranged in goose-foot shape of large dimensions and buried at a depth of 50 cm minimum (three conductors from 7m to 8m length, buried horizontally).



Vertical electrodes can be added to the goose-foot conductors to improve the resistance value of the lightning earthing system.

- A2 – set composed of several vertical electrodes of a minimum overall length of 6m at a minimum depth of 50 cm :

These earthing systems can be arranged in line or in triangle shape, and separated from one another by a distance equal to at least the length buried.



Type B : ring earth electrode :

This earthing system must be done either with a ring outside the structure in contact with the soil, with a length of at least 80% of the building perimeter, or with a foundation earthing system, provided that it is composed of a conductor of 50 mm². Each down conductor must be connected at least to a horizontal electrode of 4m minimum length or to a vertical electrode of 2m minimum length.

Additional provisions:

Earth electrodes can be added if the soil resistivity constitutes an obstacle for getting an earthing system resistance lower than 10 Ohms. Furthermore, it can be necessary to add an enhanced compound compliant with the NF EN 50164-7 in order to reduce this resistivity.

When these measures do not provide a resistance value lower than 10 Ohms, it can be considered that the earthing systems of type A allow a sufficient flow of the lightning current when they include buried electrodes for a total length of **160 m at least for a level of protection I, and 100 m for the levels of protection II, III and IV.**

In any case, each vertical and horizontal element of the earthing system shall not exceed 20 m.

The required length can be a combination of horizontal electrodes (cumulated length L_1) and vertical electrodes (cumulated length L_2) with the following requirement :
 $160 \text{ m (or } 100 \text{ m for the levels of protection II, III and IV)} < L_1 + 2 \times L_2$

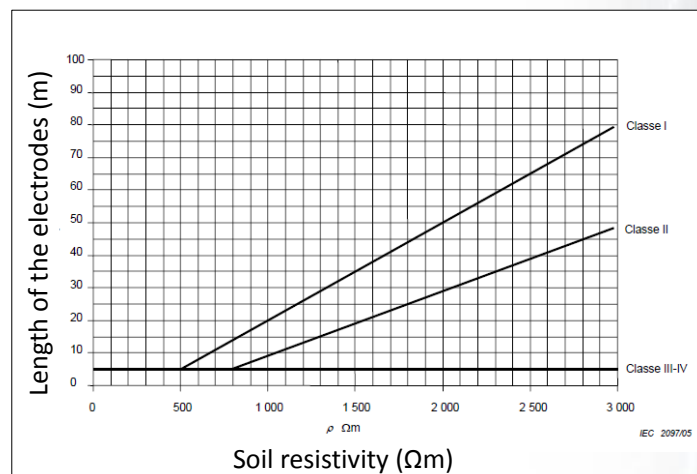
For an earthing system of Type B, when a value of 10 ohms can not be obtained, the cumulated length of the n additional electrodes can be :

- **160 m for the level of protection I or 100 m for the levels of protection II, III and IV** for an horizontal electrode;
- **80 m for the level of protection I or 50 m for the levels of protection II, III and IV** for the vertical electrodes;
- or a combination as explained before for an earthing system of type A.

II - Earthing system NF EN 62305-3 :

The earth conductor must comply with the materials of the NF EN 50164-2 standard in the same way as the lightning earthing systems of the NFC 17-102 standard.

The total length l_1 of the radial electrodes will have to be in line with the level of protection and the soil resistivity as indicated in the figure 2 of the NF EN 62305-3 standard (see below). For vertical electrodes, $0,5 l_1$ should be taken.



The levels of protection III and IV are independent of the soil resistivity.

Two provisions can be applied :

Provision Type A :

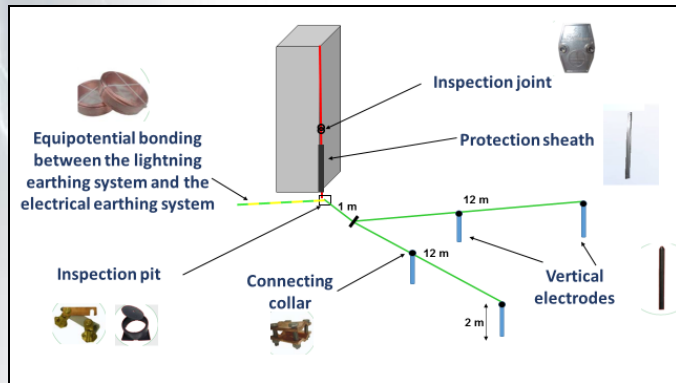
This earthing system is done for each down conductor made of at least 2 vertical or horizontal conductors.

These earthing systems must be done and spread as evenly as possible and at a depth of 50 cm at least.

It will be important to properly space the two vertical or horizontal conductors to avoid electrical coupling effects into the soil.

Example : With a level of protection I and a measured resistivity of 1000 $\Omega.m$, the length of the electrodes will therefore be of 20m.

The lightning earthing system can be composed as follows :



Provision Type B :

The provision type B can be a ring earthing system or a foundation earthing system for a same structure. This provision is prescribed if the structure integrates electronic networks. If the conductor length is inferior to the searched one, $l_1 \leq r_e$ (r_e geometrical medium radius of the area concerned by the earthing system), it is necessary to add vertical shall conductors at the bottom of the down conductors.

This ring earthing system must be buried preferably at a minimum depth of 50 cm and at 1 m at least from the walls.

Natural provision :

The interconnected steel frames of the concrete or other underground metallic structures can be used as natural lightning earthing systems, if they follow the conditions of the materials of the NF EN 50164-2 standard.

If the metallic frame of the concrete is used as earthing system, a special attention should be given to the interconnections, in order to avoid a mechanical concrete fracture.

■ **Conclusion :**

The objectives of a lightning earthing system are :

- Allowing the right flow of a lightning impulse current
- Ensuring the safety of the persons by limiting the touch voltage

The lightning is an impulse current, this is why it is important to have a low impedance of the earthing system. Therefore, it is not recommended to use a single long length element.

The use of deep electrodes is appropriate if the surface resistivity is especially high and if wetter lower layers of the soil exist. For the lightning dispersion, the triangle or the goose-foot configuration are the most appropriate.

Our team of experts is at your disposal for any advises you may need.