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INSTALLATION RULES

STANDARD NFC 17-102 OF SEPTEMBER 2011 :

▪ Capture device :

An Early Streamer Emission Air Terminal called E.S.E consists of an air tip, a boot device, a fastening element and a connection to the down-conductors.

An E.S.E should always be placed at least 2 m above the highest point of the area to be protected.

An E.S.E is characterized by its effectiveness ΔT (in microseconds).
ΔT is the difference between the times of initiation of an E.S.E and a simple lightning rod, measured in the laboratory under the same conditions.

The effectiveness ΔT must be between 10 and 60 microseconds even if the value of the test results is greater. Furthermore, an E.S.E must have a standard deviation less than 0.8 times of the reference simple lightning rod.

The protection radius Rp of an E.S.E depends on its height h relative to the surface to be protected, its efficiency and the level of protection (Np) selected.

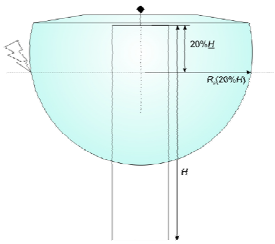
$$Rp = \sqrt{h \cdot (2r - h) + \Delta \cdot (2r + \Delta)} \qquad \text{for } h \geq 5m$$

$$Rp = h \times Rp / 5 \qquad \text{for } 2m \leq h \leq 5m$$

h: height of the tip of the E.S.E / reference plane
r : Radius of the rolling sphere (depends on Np)
- r = 20 m for the protection level I
- r = 30 m for the protection level II
- r = 45 m for the protection level III
- r = 60 m for the protection level IV

There are 4 levels of protection, ranging from level I (statistically most efficient) to level IV. These levels are defined by the minimum and maximum peak currents receivable.
Level I => to 3kA to 200kA
Level II => to 5kA to 150kA
Level III => to 10kA to 100kA
Level IV => to 16kA to 100kA

For high-rise buildings (H greater than 60 m), additional protection against lightning strike of the last 20% of the structure is set up.
Furthermore, at least four down conductors, interconnected by a ring conductor must be implemented at the corners of the building.



NFC 17-102 (1995) standard was limited to lightning protection of buildings of height less than 60m. The standard of September 2011 is based on the feedback experience and provides a method of adequate protection.

▪ Down Conductors

Each E.S.E shall be connected to minimum 2 down conductors to allow a better distribution of the lightning current.

For a better current distribution, the two paths to ground should be situated on two different facades unless in case of no possibility.

When many E.S.E are located on the same building, the down conductors may be mutualized if the calculated separation distance for the whole system is allowing that number.
The number of specific down conductor according to EN 50164-2 should be at least equal to the number of E.S.E installed. The use of natural down conductor is possible as second down conductor if the properties requirements are fulfilled.

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In case of an E.S.E located on a pylon, chimneys or other metallic structure, it can be used as second down conductor. In the case of a metallic structure, whose section is greater than 100 mm ², no specific down conductor is required.

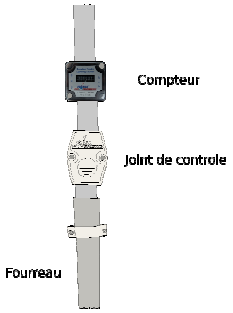
The fixings of the down conductors should be attached on the basis of three fixings per meter (every 33 cm).
Fasteners by drilling of the down conductor are prohibited.
All the conductors should be connected together with clamps of the same nature, using rivets, soldering or brazing.

When the down conductor is placed on a wall made of combustible material, and not being a copper one, then at least one of the following conditions should be satisfied in order to avoid any dangerous temperature rise:

- the separation is at least 0, 10 m.
- the conductor section > 100 mm².

The routing of the down conductor should be as straight as possible, following the shortest path, avoiding sharp bends or upward sections. The bend radius should not be less than 20 cm. A maximum height of 40 cm is permissible for passing over an obstacle with a slope of 45 ° or less.

A down conductor may be placed within a structure, but must be implemented within a non-flammable and insulating duct. So, the separation distance must be calculated in order to determine the level of insulation required of duct dedicated.



A mechanical protection sheath must be placed on each down conductor to a height of 2 meters below the control joint.

For each E.S.E, it is necessary to place a lightning impulse counter on the most direct down conductor to enable the monitoring and maintenance of the site.

▪ Separation distance

The electric insulation between the capture system or the down conductors and the metallic parts of the structures, the metallic installations or the interior systems can be realized by maintaining a distance **d** greater than the separation distance **s**:

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

- k_i: coefficient linked to the applied level of protection.
- k_c : coefficient linked to the number of down conductors and to the disposition of the earthing system
- k_m : coefficient to separation material
- l: length (in meter), corresponding to the conductor's length between the observing point and nearest to the equipotentialization point.

The equipotential bonding should be as straight and direct as possible. They must be made where the separation distance is not satisfied and the ground level.

The minimum of the cross section of the bonding conductors connecting different bonding bars and ground bars are listed below:

Material	Cross section	
	Internal link	External link
Copper	6 mm²	16 mm²
Aluminum	8 mm²	22 mm²
Steel	16 mm²	50 mm²

▪ Earth termination systems

The grounding conductor material must be conform to EN 50164-2 standard.
One earth termination will be provided for each down conductor based on at least on two electrodes per earth termination. Each termination systems should meet the following requirements:

- The resistance value measured should be inferior to 10 Ω.
- Each termination systems having a single excessively long horizontal or vertical component (>20m) should be avoided in order to minimize the inductive voltage drop.

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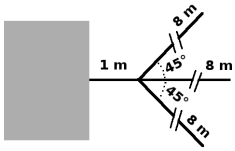
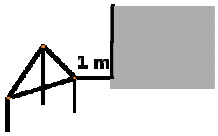
There are two types of earth termination:

Type A : specific each terminaisons divided in A1 or A2

• A1 – conductors of the same nature and cross-sectional area as the down conductors, except for aluminium, arranged in the shape of goose-foot of large dimensions and buried at a minimum of depth of 50 cm (three 7-8 meters long conductors, buried horizontally at a minimum depth of 50 cm)



• A2 – set of several vertical rods with a minimum of 6 meters at a minimum depth of 50 cm arranged linearly or as a triangle and separated from each other by a distance equal to at least the buried length.



Type B : ring earth electrode

- either a ring conductor external to the structure in contact with the soil for at least 80% of its total length.
- either a foundation earth electrode provided it is based on a 50 mm² conductor. Moreover, the bottom of each down conductor should be at least additionally be connected to either a 4m minimum radial of a 2m minimum rod.

When the high soil resistivity makes it impossible to achieve an earth termination system resistance lower than 10Ω:

- add earth rods
- apply a ground improvement in accordance with NF EN 50164-7.

When all the above measures are adopted and a resistance value of less than 10Ω cannot be achieved, the cumulated length of the additional electrodes should be:

- 160 m for level of protection I
- 100 m for other levels of protection.

Each earth termination must be connected together and connected to the electrical earth and terrestrial networks when several buildings are protected.

▪ Execution file

An execution file shall be established by the contractor once the E.S.E installation is completed and shall include at least the following:

- required protection level;
- justification of the protection;
- type and characteristics of E.S.E ;
- E.S.E test procedure ;
- number and localization of down conductor;
- existence and localization of lightning event counter;
- justification of electrical insulation;
- justification of lightning equipotential bonding including SPDs ;
- type and value or earth terminaisons systems;
- justification or earth terminaisons systems dimensions of the value is higher than 10Ω

▪ Maintenance

The maximum intervals between inspections are as follows:

Protection level	Visual inspection (year)	Complete inspection (year)	Critical systems complete inspection (year)
I and II	1	2	1
III and IV	2	4	1

Any faults found in the E.S.E during an inspection should be corrected as soon as possible in order to maintain its optimal effectiveness. Maintenance of components and protections system has to be conducted according to manufacturer documentations.