Guide to design and installation for Lightning rods with triggering device

Captation system

- The Lightning rods ESE have to be located on the highest points of the structure, taking into account the location of the grounding, and that the path of the downconductors are as short and straight as possible, while avoiding the proximity of power lines, telephone data, etc ... and its crossing with them.

- The tip of the lightning rod ESE should be located at least 2 mt above any element that is within the protected area, including antennas, cooling towers, roofs, tanks, etc ...

Down conductors

NATURE

The down conductors may be tapes, tape braid, stranded wire or solid round. The minimum section must be 50 mm².

<table>
<thead>
<tr>
<th>Material</th>
<th>Observations</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrolytic copper</td>
<td>Recommended for its good electrical conductivity</td>
<td>Tape 30 x 2mm.</td>
</tr>
<tr>
<td>bare or tinned</td>
<td>and its resistance to corrosion.</td>
<td>Tape Braid 30 x 3.5 mm.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stranded wire 50 mm².</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Solid round Ø 8 mm.</td>
</tr>
<tr>
<td>Stainless steel</td>
<td>Recommended in certain corrosive environments.</td>
<td>Tape 30 x 2mm.</td>
</tr>
<tr>
<td>18/10, 304.</td>
<td></td>
<td>Solid round Ø 8 mm.</td>
</tr>
<tr>
<td>Aluminum A 5 / L</td>
<td>It should be used on aluminum surfaces (guardrails, walls, ...)</td>
<td>Tape 30 x 3mm.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Solid round Ø 10 mm.</td>
</tr>
</tbody>
</table>

SITUATION

- Will be placed on the outside of the structure.

- When it is impossible to make a downconductor on the outside, conductors can be introduced in a non-flammable insulating pipe, with a minimum section of 2000 mm², for this purpose. In any case, it must meet the proximity requirements. The downconductors on the inside decrease the effectiveness of lightning protection, increase the risk of overvoltages penetration and difficult the verification and maintenance of installation.

NUMBER

- According to CTE SU8:
  - At least one downconductor for every lightning rod ESE.
  - A minimum of two downconductor when:
    - The horizontal projection of the conductor exceeds its vertical projection.
    - The height of the structure is greater than 28 mt.
  - Equipotentials bondig will be made between the conductors at ground level and every 20 meters.

- According to UNE 21186:
  - Each lightning rod ESE shall be grounded by two downconductor.
  - It will be necessary 4 downconductors on buildings higher than 60 meters.
  - Are placed whenever possible in the 4 corners of the building.
PATH

- The route will describe the shortest path, straight and direct to grounding, avoiding elevations above 40 cm with slope equal to or greater than 45°. The radii of curves shall not be less than 20 cm and direction changes less than 90°.
- The route will be chosen so as to avoid proximity to electrical conduits, telephone, data, etc... and its crossing with them. In any case, when you can not avoid an intersection, conduits must be placed inside a metallic shield that extended 1 m to each side of the crossing, and the shield should bind to the downconductor.

FIXING

- For fixing downconductors it will be taken as a reference three fixings per meter.

LIGHTNING COUNTER

- The lightning counter must be installed over the most direct downconductor, above the join control, and in all cases, about 2 meters above the ground.

PROTECTION

- Mechanics: Each down conductor shall be protected against any mechanical shock through a protection tube to a height greater than 2 meters from the ground.
- Against touch voltages: Isolation of exposed downconductors through crosslinked polyethylene of 3 mm thick.

SAFETY DISTANCES

- According CTE SU8:
  - Safety distance (m) = 0.1 x L
  - L = vertical distance from the point where it is considered the proximity to the grounding of the metal mass or the nearest equipotential bonding.
  - Safety distance to outdoor gas pipelines ≥ 5 m.
- According to UNE 21186:
  - Safety distance for 1 downconductor (m) = 0.16 x L
  - Safety distance for 2 downconductors (m) = 0.08 x L
  - Safety distance for 4 downconductors (m) = 0.04 x L
  - L = length of the downconductor from the point where it is considered the separation distance to the point where is located the nearest equipotential point.

EQUIPOTENTIAL BONDING

- Where it is not possible to comply with the minimum safety distances will proceed with equipotential bonding:
  - Through bonding conductor.
  - Through surge protection devices equipotential.
- The metallic elements, including antennas, will join the equipotential system, preferably through a spark gap.
Grounding

- Unless absolutely impossible, the grounding should be oriented toward the outside of the building.

- There will be 1 grounding system for each downconductor.

- It is recommended the bonding of vertical electrodes of a total length of at least 6 meters, dispose in a triangle and spaced by a distance at least equal to its length buried, and bonded together with a conductor buried in a trench of at least 50 cm deep.

- The value of the resistance of grounding should be as low as possible and below 10 Ω. Where it is not possible to get these values, must be installed:
  - 160 meters of buried electrode for level I of protection.
  - 100 meters for the other levels of protection.
  - Whenever the length of each vertical or horizontal element is less than 20 meters.

- Each grounding will have a registration earth pit and a disconnection unit.

- The measurements always will be carried out in isolated form of any other conductive element.

SAFETY DISTANCES

- The elements of the grounding of lightning rods ESE must be distant in the worst case 5 meters of all electrical or metallic buried canalization.

EQUIPOTENTIAL BONDING

- All grounding systems must be bonded together and with the general grounding of the building.

- The building grounding must be equipotential bonded with the grounding of lightning protection system by a spark gap.

- It will be made an interconnection with the ground circuit at the bottom of the excavation, directly at the foot of each downconductor using a device to let disconnect and is set in a inspection pit with the earth symbol.
Guide to design and installation according to UNE EN 62305

Generalities

The design of the installation must be such that the building or structure to be protected is within the protected volume determined by some of the following methods, which can be used separately or in combination:

- Rolling sphere method. Appropriate for complex shape structures.

- Method mesh. Suitable for protect flat or sloping surfaces no bends and side flat surfaces against lateral strikes.

- Protection angle method. Suitable for buildings with simple shapes with height limitations in the capture system according to the table.

<table>
<thead>
<tr>
<th>Class of LPS</th>
<th>Rolling sphere radius</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>20 mt</td>
</tr>
<tr>
<td>II</td>
<td>30 mt</td>
</tr>
<tr>
<td>III</td>
<td>45 mt</td>
</tr>
<tr>
<td>IV</td>
<td>45 mt</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class of LPS</th>
<th>Dimensions of the grid</th>
<th>distance between downconductors</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>5 x 5 mt</td>
<td>10 mt</td>
</tr>
<tr>
<td>II</td>
<td>10 x 10 mt</td>
<td>10 mt</td>
</tr>
<tr>
<td>III</td>
<td>15 x 15 mt</td>
<td>15 mt</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class of LPS</th>
<th>Protective angle</th>
<th>* In these cases the are used the method of rolling sphere and / or mesh.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>25°</td>
<td>*</td>
</tr>
<tr>
<td>II</td>
<td>35°</td>
<td>25°</td>
</tr>
<tr>
<td>III</td>
<td>45°</td>
<td>25° 35°</td>
</tr>
<tr>
<td>IV</td>
<td>55°</td>
<td>45° 35° 25°</td>
</tr>
</tbody>
</table>

Difference in height (m) between the tip and the plane considered horizontal.

MATERIALS, DIMENSIONS AND MINIMUM SECTIONS FOR CONDUCTORS AND THE COMPONENTS OF CAPTURE SYSTEMS

<table>
<thead>
<tr>
<th>Material</th>
<th>Tape</th>
<th>Round</th>
<th>Stranded wire</th>
<th>Round termination rods</th>
<th>Round penetration rods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>50 mm²</td>
<td>50 mm²</td>
<td>50 mm²</td>
<td>200 mm²</td>
<td>200 mm²</td>
</tr>
<tr>
<td></td>
<td>E = 2 mm</td>
<td>Ø 8 mm</td>
<td>D = 1,7 mm</td>
<td>Ø 16 mm</td>
<td>Ø 16 mm</td>
</tr>
<tr>
<td>Tinned Copper</td>
<td>50 mm²</td>
<td>50 mm²</td>
<td>50 mm²</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>E = 2 mm</td>
<td>Ø 8 mm</td>
<td>D = 1,7 mm</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Aluminium</td>
<td>70 mm²</td>
<td>50 mm²</td>
<td>50 mm²</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>E = 3 mm</td>
<td>Ø 8 mm</td>
<td>D = 1,7 mm</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Aluminium alloy</td>
<td>50 mm²</td>
<td>50 mm²</td>
<td>50 mm²</td>
<td>200 mm²</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>E = 2,5 mm</td>
<td>Ø 8 mm</td>
<td>D = 1,7 mm</td>
<td>Ø 16 mm</td>
<td>-</td>
</tr>
<tr>
<td>Galvanized steel</td>
<td>50 mm²</td>
<td>50 mm²</td>
<td>50 mm²</td>
<td>200 mm²</td>
<td>200 mm²</td>
</tr>
<tr>
<td></td>
<td>E = 2,5 mm</td>
<td>Ø 8 mm</td>
<td>D = 1,7 mm</td>
<td>Ø 16 mm</td>
<td>Ø 16 mm</td>
</tr>
<tr>
<td>Stainless steel</td>
<td>50 mm²</td>
<td>50 mm²</td>
<td>50 mm²</td>
<td>200 mm²</td>
<td>200 mm²</td>
</tr>
<tr>
<td></td>
<td>E = 2 mm</td>
<td>Ø 8 mm</td>
<td>D = 1,7 mm</td>
<td>Ø 16 mm</td>
<td>Ø 16 mm</td>
</tr>
</tbody>
</table>

NOTES: E = Minimum thickness; D = Ø minimum each strand
Capture systems

The capture systems can be formed by any combination of the following elements:
- Rods or Franklin rods (including separate masts);
- Catenary cables;
- Conductors meshed.

The individual termination rods should be connected together at roof level to ensure the division of the current.

PLACEMENT

The termination rods installed on a structure must be placed on the perimeter of the structure, at the corners, on the elevated points more vulnerable and high, and the angles (especially on the top of the facades), according to the methods described above.

LATERAL STRIKES

- Structures higher than 60 mt:
  It will install a system of capture to protect the 20% of top of each façade of the structure and the equipments installed in it, of adequate dimensions to security level chosen.

- Structures taller than 120 mt:
  Furthermore should be protected all parts which can be damaged above the 120 mt.

Downconductors

SITUATION

- Downconductors must be installed wherever possible, so as to be a direct continuation of the conductors of the capture system.

- The downconductors may be installed in enclosed courtyards with over 30 meters in perimeter.

NUMBER

- The system should have multiple downconductors in parallel for current sharing, with a route as short, direct and rectilinear to the ground, avoiding the formation of loops.

FIXINGS

Suggested Fixing points:

<table>
<thead>
<tr>
<th>Disposition</th>
<th>For cables or conductor tapes</th>
<th>For rigid conductors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal conductors on horizontal surfaces</td>
<td>0.5 mts</td>
<td>1 mts</td>
</tr>
<tr>
<td>Horizontal conductors on vertical surfaces</td>
<td>0.5 mts</td>
<td>1 mts</td>
</tr>
<tr>
<td>Vertical conductors up to 20 meters from the ground</td>
<td>1 mts</td>
<td>1 mts</td>
</tr>
<tr>
<td>Vertical conductors above 20 mts</td>
<td>0.5 mts</td>
<td>1 mts</td>
</tr>
</tbody>
</table>

It is recommended the use of dilatation compensators every 20 meters in order to avoid mechanical effects resulting from temperature variation.

LIGHTNING COUNTER

- The lightning counter must be installed over the more direct downconductor, above the join control, and in all cases, about 2 meters above the ground.
GENERALITIES

From the point of view of protection against lightning, and in order to minimize any dangerous overvoltage when lightning current is dispersed in the ground, it is preferable and adequate in all cases, a single grounding integrated in the structure.

It is recommended an earth resistance as low as possible, and always less than 10 Ω.

The grounding system must be connected equipotentially according with the requirements of the standard.

GROUNDING TYPES

The standard includes two grounding dispositions:

Disposition type A:
- Formed by horizontal or vertical electrodes installed on the exterior of the structure to be protected and connected to each downconductor.
- Will be buried to a depth of at least 0.5 mt and distributed so uniformly as possible.
- Each downconductor should be provided with a earth electrode.

This disposition is suitable for low structures, existing structures, LPS with capture system with rods or cables laid, or for LPS isolated.
Disposition Type B:
- Which comprises either an outer conductor ring to the structure to protect, in contact with the ground at least 80% of their length, or an foundation electrode.
- The ring will be buried at a depth of at least 0.5 mt at an approximate distance of 1 m from the outer walls.

This disposition is suitable for mesh-capture systems and LPS with many downconductors and recommended in live rocks terrain and in structures with electronic systems or with high risk of fire.

SAFETY DISTANCES
- Must be respected safety distances contemplated for the downconductors.

EQUIPOTENTIAL BONDING
- Where it is not possible to comply with the minimum safety distances will proceed with equipotential bonding:
- By equipotential conductors.
- Through surge protection devices equipotential.

- All groundings must be bonded together and with the general grounding of the building.
- The building grounding must be equipotentially connected with all groundings of the system by a spark gap.
- The ground circuit interconnections and from this to the downconductors, will be made by a device which let to disconnect and will be set in a inspection registration that bears the earth symbol.
- Do not is allowed the use of conductors or other aluminum element in direct contact with the ground.
- In order to prevent the generation of galvanic couple is not allowed direct connections between conductors of copper and aluminum or copper and galvanized steel.
- Measurements will be always made in isolation form from to any other conductive element.

MATERIALS, CONFIGURATIONS AND MINIMUM DIMENSIONS FOR GROUND ELECTRODES

<table>
<thead>
<tr>
<th>Material Configuration</th>
<th>Copper Rod</th>
<th>Ground conductor Ø</th>
<th>Plate Ø</th>
<th>Steel Rod</th>
<th>Ground conductor Ø</th>
<th>Plate Ø</th>
<th>Stainless steel Rod</th>
<th>Ground conductor Ø</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stranded wire</td>
<td>-</td>
<td>50 mm²</td>
<td>-</td>
<td>-</td>
<td>70 mm*</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>D = 1,7 mm</td>
<td>-</td>
<td>-</td>
<td>D = 1,7 mm</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Round</td>
<td>Ø 15 mm</td>
<td>50 mm²</td>
<td>-</td>
<td>Ø 16 mm*</td>
<td>Ø 10 mm*</td>
<td>-</td>
<td>Ø 15 mm</td>
<td>Ø 10 mm</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>Ø 8 mm</td>
<td>-</td>
<td>Ø 14 mm**</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Tape</td>
<td>-</td>
<td>50 mm²</td>
<td>-</td>
<td>75 mm²*</td>
<td>90 mm²*</td>
<td>-</td>
<td>-</td>
<td>100 mm²</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>E = 2 mm</td>
<td>-</td>
<td>E = 3 mm</td>
<td>E = 3 mm</td>
<td>-</td>
<td>-</td>
<td>E = 2 mm</td>
</tr>
<tr>
<td>Tube</td>
<td>Ø 20 mm</td>
<td>-</td>
<td>Ø 20 mm*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E = 2 mm</td>
<td>-</td>
<td>E = 2 mm</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Plate</td>
<td>-</td>
<td>-</td>
<td>500 x 500 mm*</td>
<td>-</td>
<td>-</td>
<td>500 x 500 mm*</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>E = 2 mm</td>
<td>-</td>
<td>-</td>
<td>E = 3 mm</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Meshed plate</td>
<td>-</td>
<td>-</td>
<td>600 x 600 mm*</td>
<td>-</td>
<td>-</td>
<td>600 x 600 mm*</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>S = 25 x 2 mm</td>
<td>-</td>
<td>-</td>
<td>S = 30 x 3 mm</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Cross profil</td>
<td>-</td>
<td>-</td>
<td>50 x 50 x 3 mm*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTES: E = Minimum thickness; D = Ø minimum for each strand; S = Section; * Galvanized; ** Copper Coated