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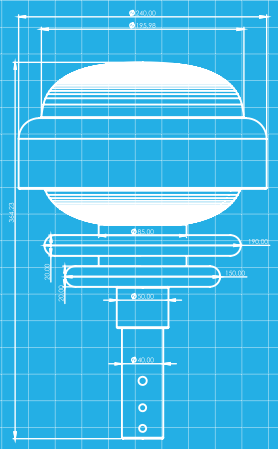
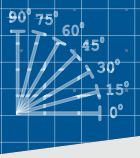


INSTALLATION MANUAL

CMCE SERTEC

BASED ON STANDARDS

EN BS - IEC 62305
NFPA 780
NBR 13571/96, ABNT NBR 5419
NTC 4552
UL-467, UL 96 A
NFC 17102



VERSION DIC 2023

MULTIPLE ELECTRIC FIELD COMPENSATOR - SERTEC

The CMCE SERTEC aims to protect people, animals, structures in facilities on land, air and water from any electrical phenomenon whose mode of transport is air.

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1 DEFINITIONS AND BASIC CONCEPTS

Ground System: The ground system is an electrical protection measure, it is made up of electrodes interconnected by means of conductors below ground level, to obtain a resulting electrical resistance low enough for faults to be referred to the system.

Equipotentiality of electrical equipment. Electronic equipment, generators, transformers, silos, towers, lightning rods, containers, metal structures in general, must be connected to a previously installed ground system, in order to have the same electrical potential and protect the equipment and protect people. of surges, induced currents, step voltages, among others.

Ground electrode. A ground electrode is understood as a conductive body (bar, tube, plate, etc.) buried in direct contact with the ground and sometimes slightly submerged in water at the lower end, maintaining contact with the ground at the upper end.

Ground Meshes. It is a set of electrodes electrically connected to each other by means of conductors.

Ground connection. It is to connect a specific equipment by means of a conductor or conductors to the ground system.

Resistivity of a Terrain: It is the electrical resistance offered by the soil in its layers. And it is measured by the relationship between the mesh voltage with respect to reference ground and the current that passes to ground through it. (V/R)
Where V is measured in Volts (V)
Where R is measured in ohms (Ω).

Suggested maximum values

App	Suggested Maximum Ground Resistance Values Ω (Ohms)
Transmission line structures	≤10
High and extra high voltage substations	≤1
Medium voltage substations	≤5
Lightning protection	≤5
Low voltage neutral	≤10
Explosive atmospheres	≤1

OBS: All grounding systems must be at the same potential. All the components of the system to be protected must be interconnected to the same ground mesh.

2 CMCE SERTEC MODELS

CMCE NANO

Developed for small traffic lights, small radars, road cameras, control booths and structures that can be covered by its protection radius.

Weight: 1.2 kg (Gross)
Height: 17.0cm | Diameter 10cm.

CMCE HOME

Developed to protect residences, buildings, medium-sized telecommunications towers, warehouses and structures that can be covered by its protection radius.

Weight: 2.2 kg (Gross)
Height: 10.5" | diameter 15.6cm

CMCE SERTEC 120

With greater deionizing power, for use in buildings, large complexes, mining, electrical substations, sports fields, airports, telecommunications and structures that can be covered by its protection radius.

Weight: 7.3kg (Gross)
Height: 38.54cm | Diameter: 24cm

HIGH RESISTANCE

Designed for highly corrosive environments, since it is a stainless steel with high resistance to corrosion, especially for the chemical industry.

Weight: 20kg (Gross)
Height: 38.54cm | Diameter: 24cm

CMCE HIGH VIBRATION

With anti-fall system and better particle cohesion achieved in foundry for vibratory structures. Special for drilling towers, vibrating platforms.

Weight: 10.1kg (Gross)
Height: 38,54cm | Diameter: 24cm

2 CMCE SERTEC MODELS

CMCE GRAPHENE

Developed for special applications and for military use, the innovation is based on the properties of Graphene, highly conductive and undetectable to radars.

Weight: 7.4 kg (Gross)
Height: 35.54 | Diameter: 24cm

CMCE-AT 120

Developed with insulation resistance up to 400˚C for high temperature areas such as industrial chimneys, distillation towers, among others.

Weight: 10 kg (Gross)
Height: 38.54cm | Diameter: 24cm

CMCE UL

With greater deionizing power, for use in buildings, large complexes, mining, electrical sub-stations, sports fields, airports, telecommunications and structures that can be covered by its protection radius.

UL-96 certified product

Weight: 10.4Kg (Gross)
Height: 54,9cm | Diameter: 20,8cm

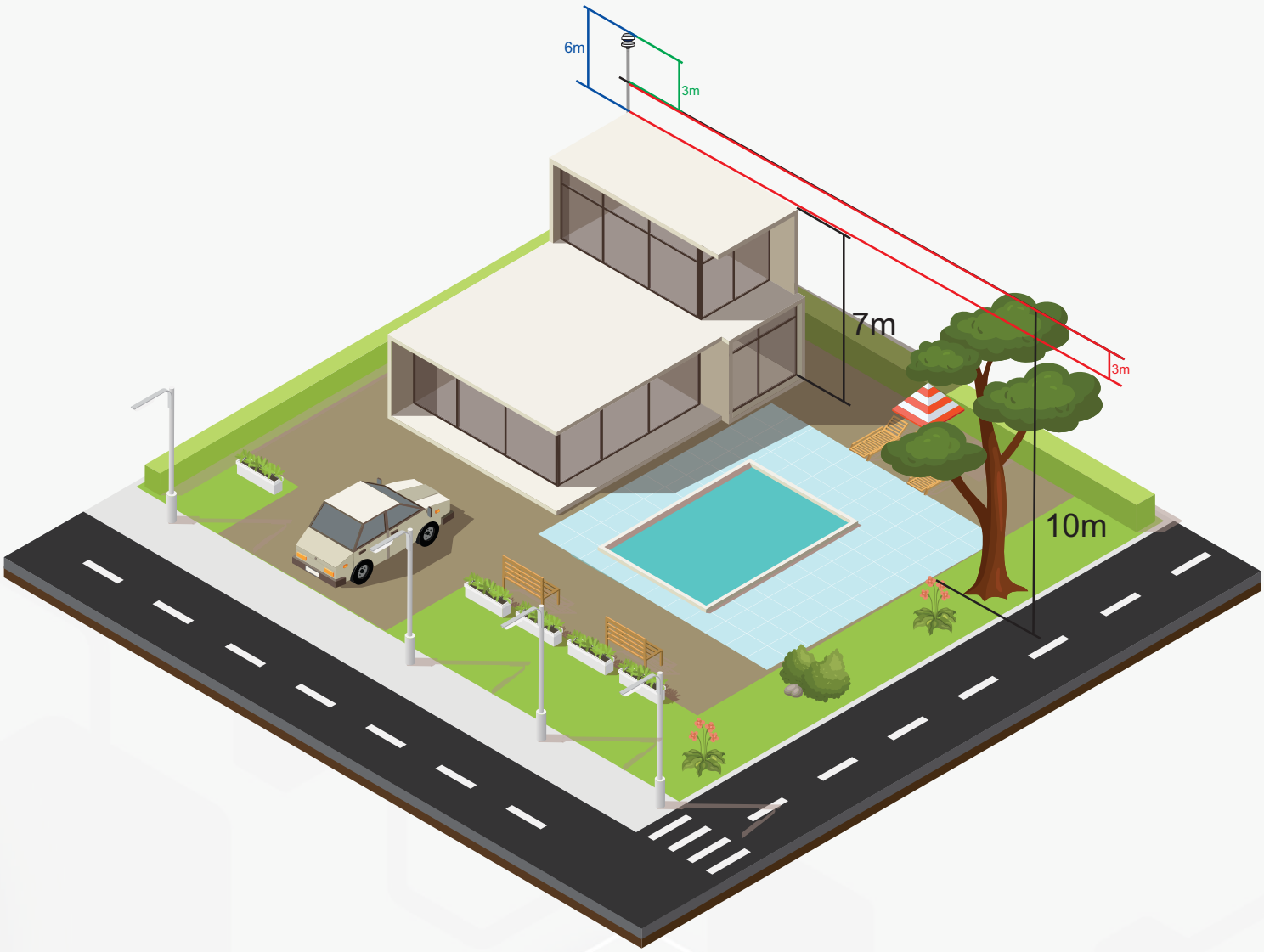
CMCE TWIN MAX

A specific device for areas with a high ceraunic level with a high variable electric field. With a record voltage of 840 Kv at 1 meter without lightning formation, becoming the device with the highest performance.

Weight: 6.4 kg (Gross)
Height: 37.10 | Diameter: 24cm

3 MINIMUM HEIGHT OF CMCE SERTEC

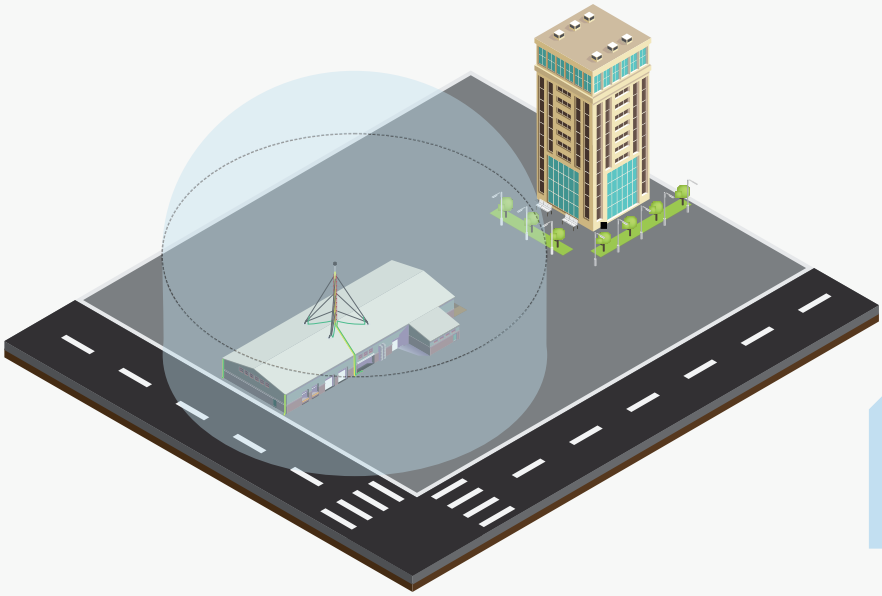
The height that the CMCE SERTEC must exceed, with respect to the tallest structure within the coverage area, must be at least 3 meters above it, in order to avoid the spike effect that could be caused by any element attracting lightning if said element were higher than the CMCE.



4 RADIUS OF PROTECTION

The geometry of the protection resembles a sphere and a cylinder by absorbing charges in all directions through its multiple capacitor system.

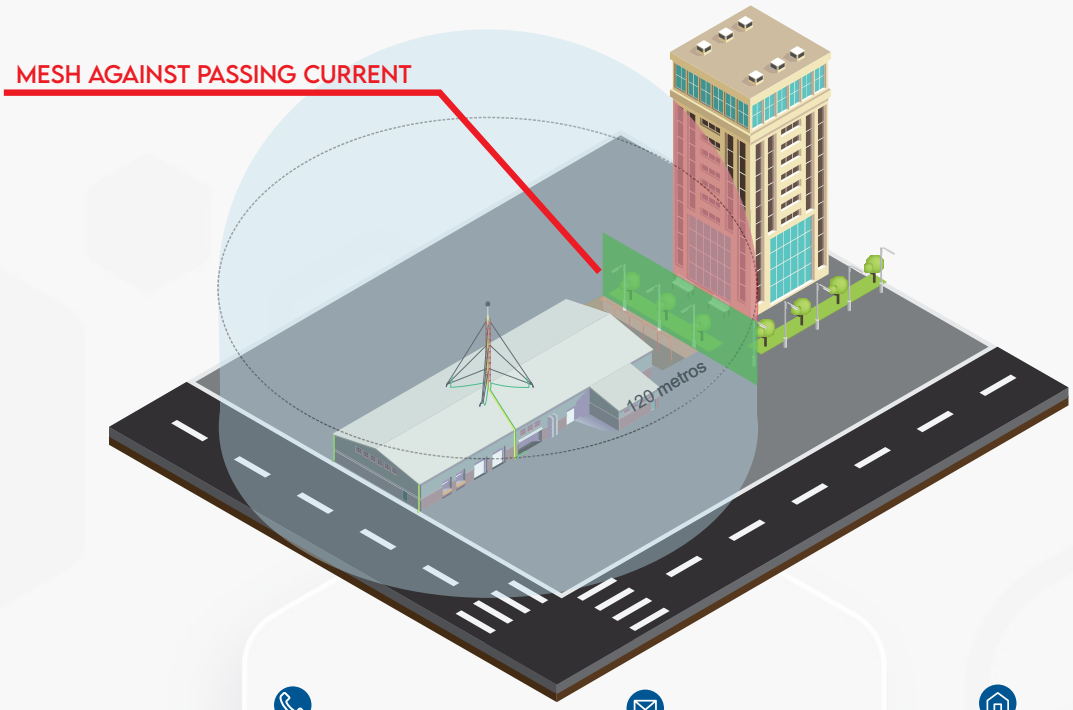
As an example, we will use the CMCE 120. As can be seen in the image, when the CMCE is above the structure to be protected and there is nothing higher in its protected environment, the coverage radius is 120 meters.



Radius of protection	
CMCE NANO	25 meters
CMCE HOME	55 meters
CMCE 120	120 meters

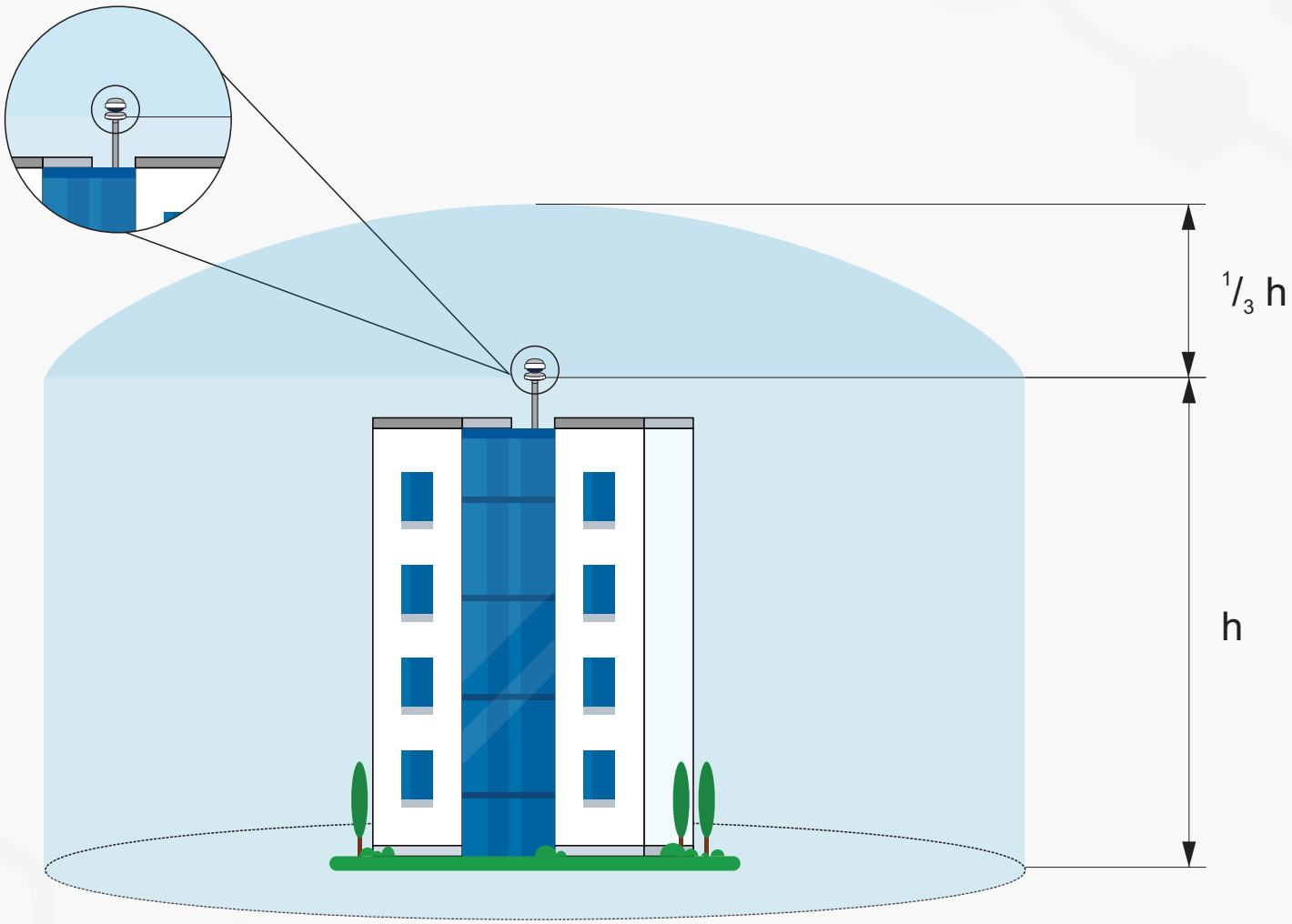
If you need to calculate the protection radius, consult an authorized factory representative.

In case of having a building or structure much higher than the structure to be protected and it is not feasible to exceed it, it is recommended to create a mesh against the flow of steps as shown in the reference image. In which the number of electrodes to be used will depend on the physical space and the structures in question. It should be noted that the coverage area will be reduced and the radius will stop being 120 meters in the red zone and will be limited until the beginning of the structure that exceeds the height of the CMCE.



4.1 Protection geometry:

To take into account the protection geometry, a theoretical envelope must be assumed in such a way that these areas are limited according to their deionization zone and compensation of the electric field. This theoretical estimation is given from statistical data where it is suggested that up to the height of the CMCE the envelope is cylindrical, and above the CMCE, there is a spherical cap with a height that is equal to one third of the height with respect to to the floor of the CMCE.



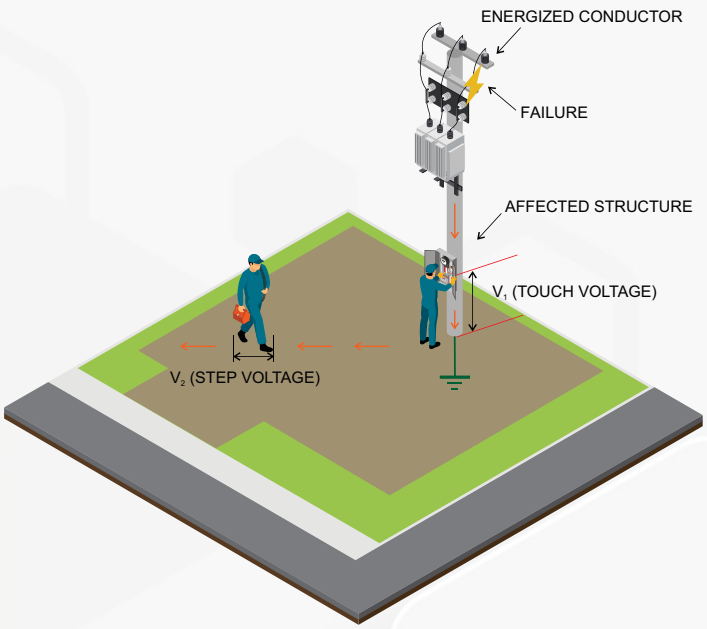
5 PROCEDURES FOR PREPARING AN SPT

Step 1: Previously measure the electrical resistance of the ground, before proceeding to make the ground mesh with a pike or clamp tellurimeter.

Step 2: Determination of the grounding area and modeling of the soil. It implies the verification of where the installation is going to be carried out, what area is available for it, how is the distribution and transmission network in the location and what are the characteristics of the soil where the mesh is executed (depending on the type of soil).

Step 3: It implies the determination of the materials to be used, not only in the mesh itself, but in all the auxiliary elements, such as; the connection elements between conductors (welding, mechanical or compression), the different derivations and connections for the grounding of the various metallic parts of the installation. After having some experience in the design of ground grids, and knowing the construction-level limitations to which they are subject, this step is generally skipped.

Step 4: Determination of allowable step and touch voltages. Knowing the local electrical network and the different possible configurations of this, as well as the characteristics of the ground, it is determined what are the maximum contact and step voltages admissible by the human body, without suffering irreversible damage.



Steps 5: Physical design and calculation of the ground grid. These steps imply the determination of the phase-ground short circuit according to the particular installation, the proposal of a preliminary grounding mesh, and the evaluation of its performance in the event of a fault occurrence. If the security requirements are not met, the mesh must be redesigned until it meets them, and each of the steps must be repeated until all the security conditions are verified (Wenner method recommendation).

Step 6: Definition of construction details. Having determined the geometry of the mesh, the details corresponding to the grounding of the various components of the installation must be determined.

Step 7: Then we proceed to the execution and final measurement of the grounding.

5.1 MINIMUM NUMBER OF GROUNDING ELECTRODES

R≤5Ω

The minimum number of electrodes recommended to be used is 6 to 8 units with a minimum length of 2.40m x 5/8" cross section of 254 µm copper thickness, with a separation equal to the length of the electrode. If in the measurement prior to the construction of the grounding is less than 5Ω (ohms) still proceed to the construction of the grounding.

The purpose of the foregoing is to guarantee good drainage and dispersion of the loads absorbed by the CMCE SERTEC device.

As a general rule, it is known that the lower the grounding resistance, the better and more effective operation of the CMCE SERTEC will be obtained.

R>5Ω

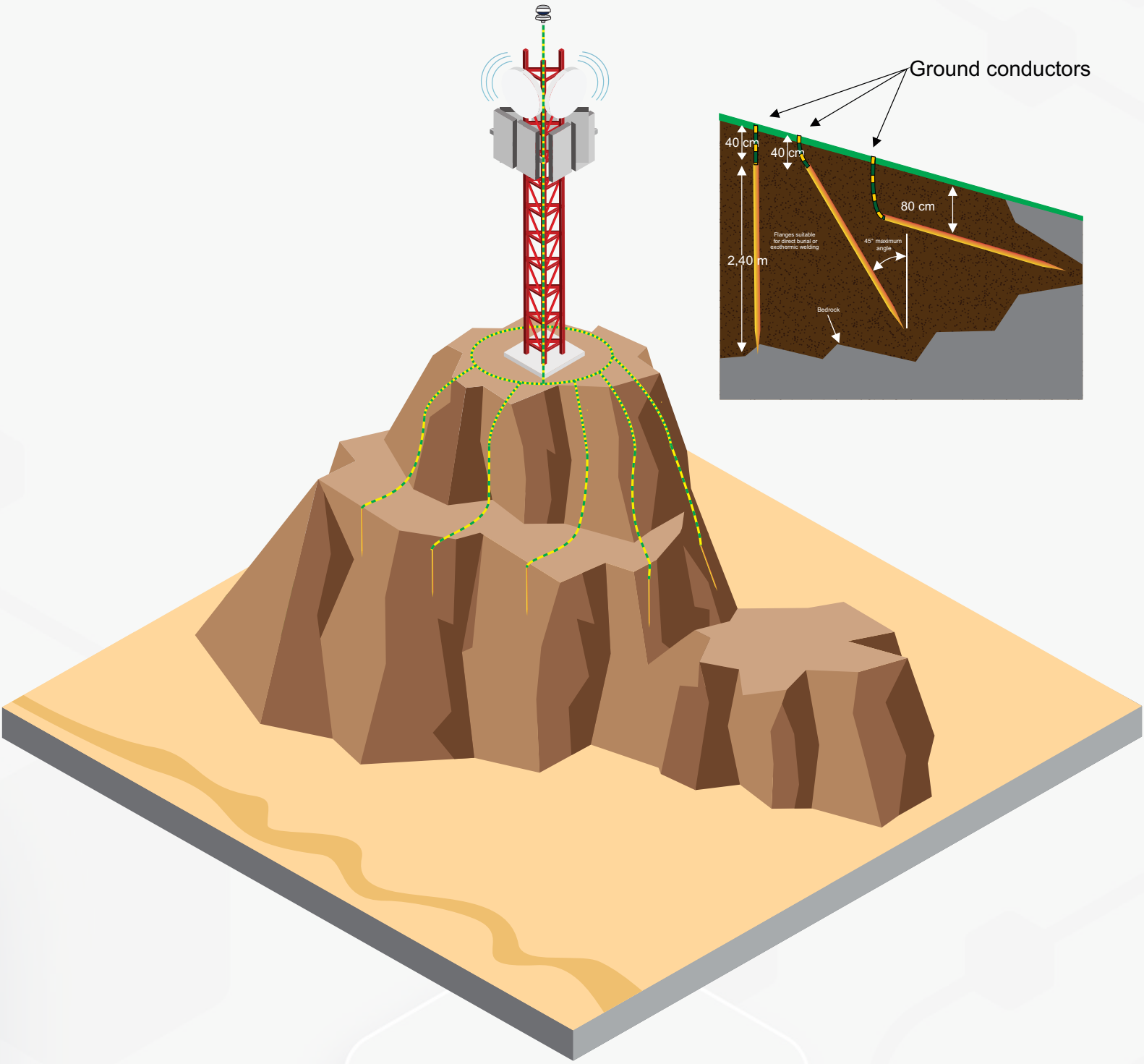
When after the construction of the system a resistance greater than 5Ω (ohms) is obtained, techniques that influence aggregates such as: salt, conductive cement, humic acids, bentonite, conductive gel, etc. are used.

Consult the manufacturer.

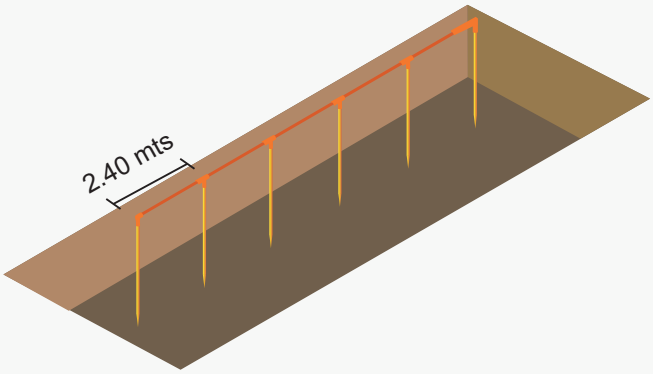
These calculations depend on the granulometry, humidity and material of the electrode.

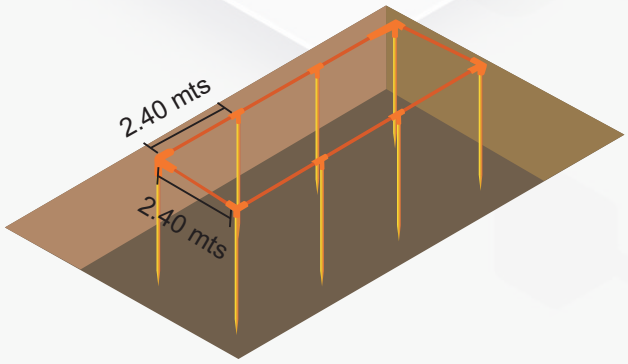
6 ROCK EMBANKMENT

When we have to install a ground system in a rocky place such as mountains, quarries, compacted soil, it is necessary to use what we call radials, which are extensions of radial conductors to the structure.
The extended radials must be made up of conductors and rods that must be stapled to the rock all the way. The rods must sink into areas of less technical soil resistance.

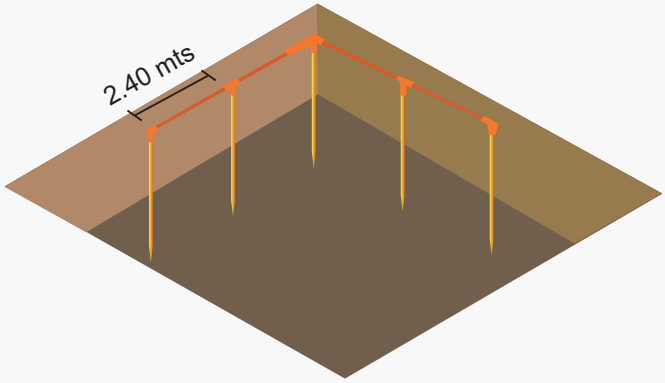


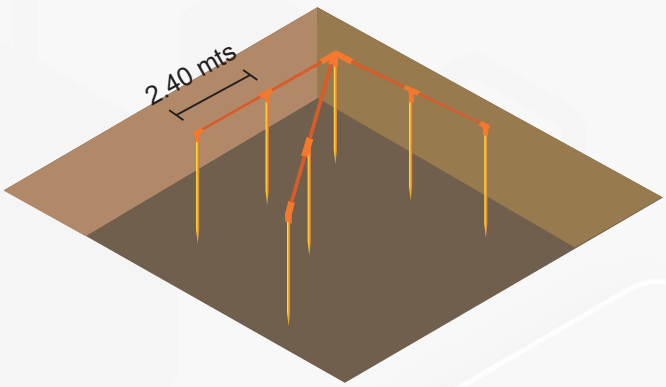
7 DESIGN OF THE PAT DIFFERENT TOPOLOGIES OF INSTALLATIONS.





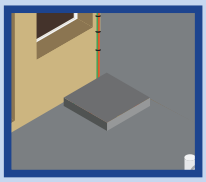
The separation distance between the electrodes must be equal to their length or twice as long as the determined area allows it. Example: If the electrode is 2.40mts, the distance between electrodes should be 2.40mts.

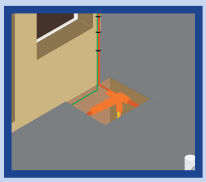




LAND RECORD:

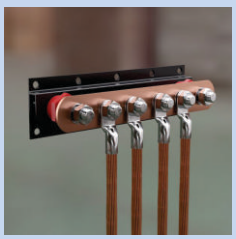
All grounding systems must have the possibility of being inspected by means of an inspection pit. The point of union of the grounding and the connection line is known as the grounding point, and it must be an easily inspectable or accessible element to be able to check, periodically, the resistance of the grounding, the electrical continuity of the connection line and the draining of the charges, as well as any other maintenance activity required.





GROUND BAR:

When there are several grounding terminals for the different components in an installation, it is recommended to replace the soldering with a grounding bar.



8 INTEGRATION TO EXISTING GROUNDING

When there is already a grounding system, it is necessary to take into account the following points to verify the existing grounding:

Grounding status

If the site already has an SPT, the state of the rods, conductors and joints must be verified (state of corrosion, state of welds or connectors if they do not have welding, etc.).

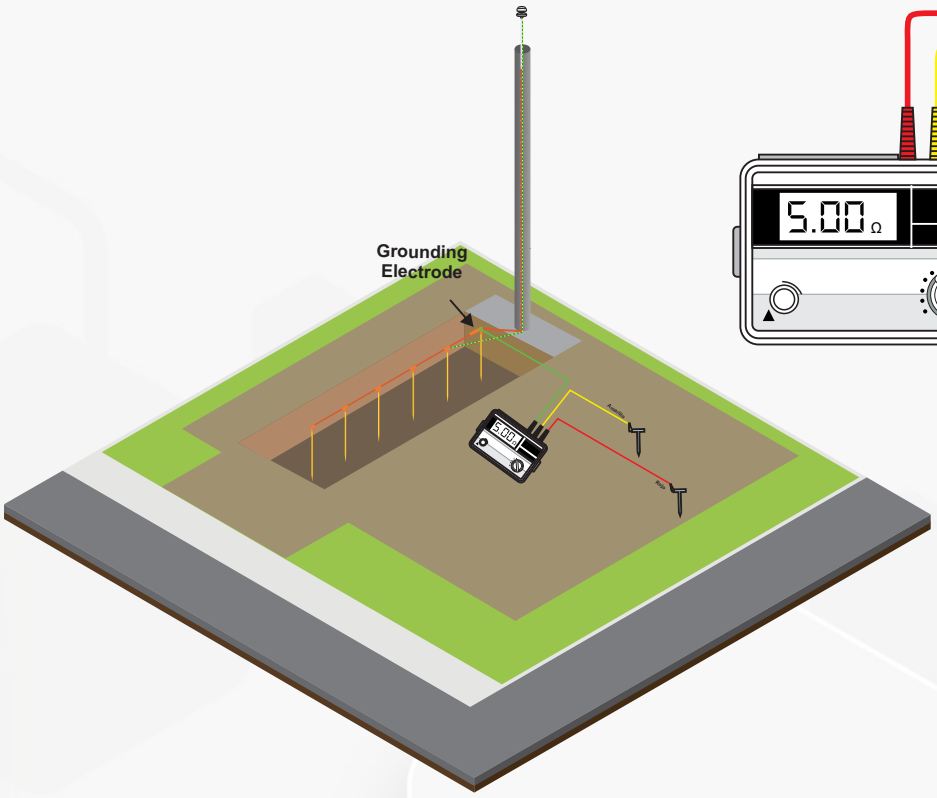
- Check the section of the conductor and the rods.
- Verify quantity of existing rods.
- Measure the ohmic resistance of the SPT.

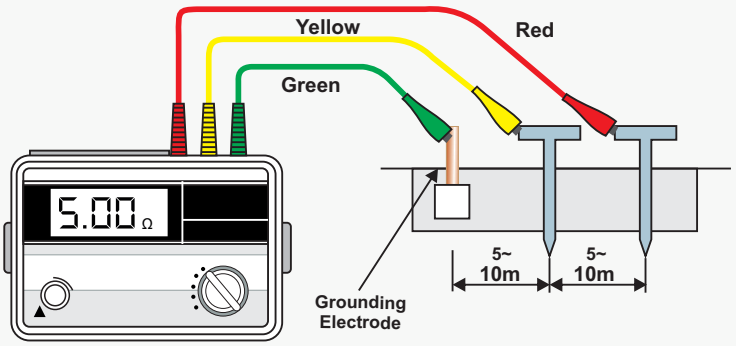
If all these points mentioned above are satisfactory and approved by SERTEC SRL, the interconnection of the CMCE down conductor can be made directly to the existing system, without the need to add more rods.

If the conductors and rods are in acceptable (not optimal) conditions, as many rods must be added as the system requires.

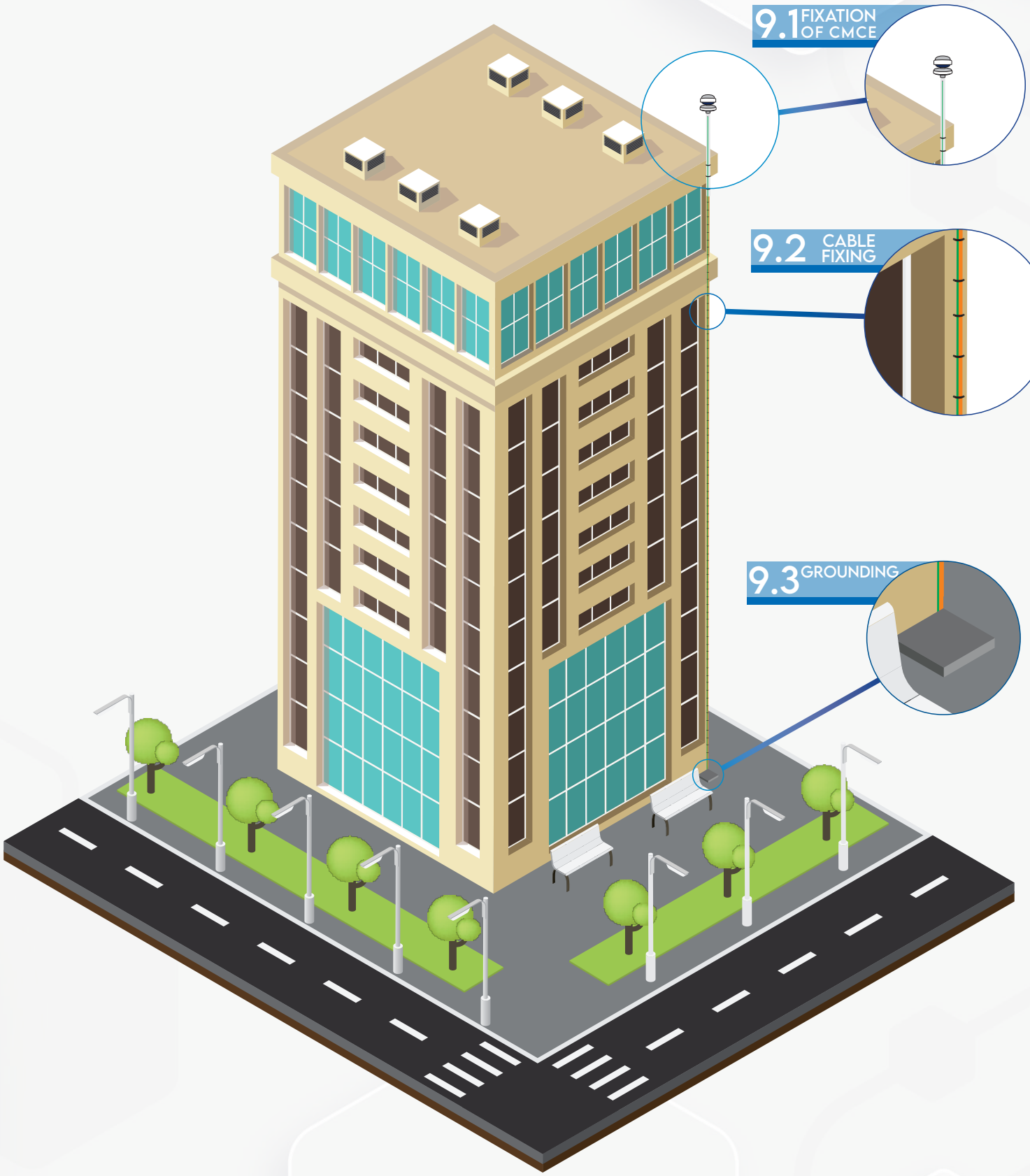
Measure the value of the grounding system

After grounding with the corresponding number of rods for the installation, interconnection of the rods, etc., the resistance of the ground mesh must be measured using a tellurometer or tellurometer in order to verify if managed to decrease the resistance initially measured, to a value less than 5Ω.





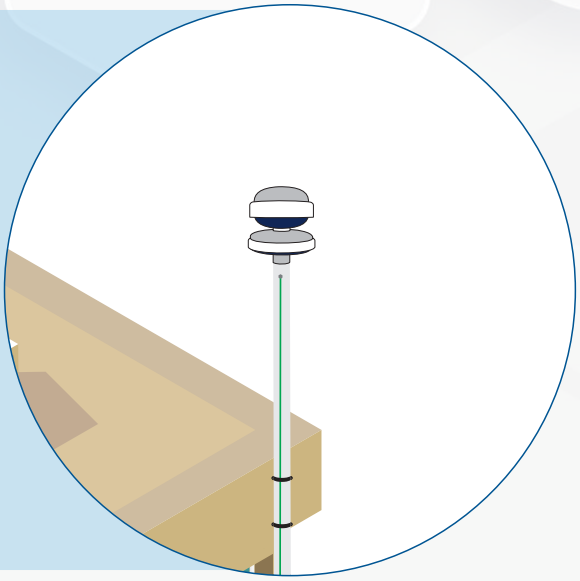
9 GUIDE OF PROCEDURES



9.1 FIXATION OF CMCE

The fixing of the CMCE can vary according to the type of structure to which it must be fixed or according to the internal requirements of the industry. But in each case, it must be guaranteed that this fixing is the safest possible capable of supporting the weight of the equipment plus the mast and winds of up to 150 km/h.

The external and environmental factors that surround the environment such as; places of high vibration, temperature, contamination, explosive chemicals, etc. For the correct choice of materials to be used for fixing the CMCE.



REQUIRED COMPONENTS

Tinned copper joint must be lubricated with graphited grease between the terminals and the bare conductor. Only applies to cables up to 50mm2. For 2/0 AWG conductors it is not necessary to use this material, but it must be lubricated anyway.

Grease with a high graphite content, which forms a solid film that is very difficult to remove. To be used for the lubrication of the mechanical union between the conductor and the different facilities to be connected to ground that are exposed.

Indicated for mechanisms that suffer wear, are in frequent contact with water or outdoors, or are difficult to access for lubrication.

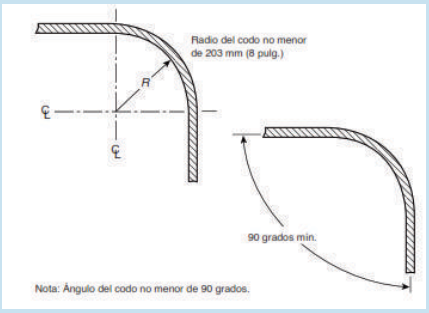
Protects against corrosion and rust, maintains its consistency in the face of temperature changes. Withstands temperatures from -15°C to +150°C.

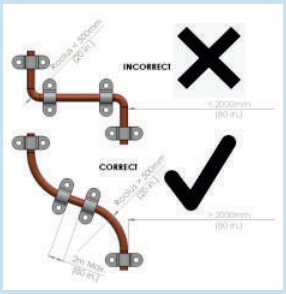
MAST FIXING

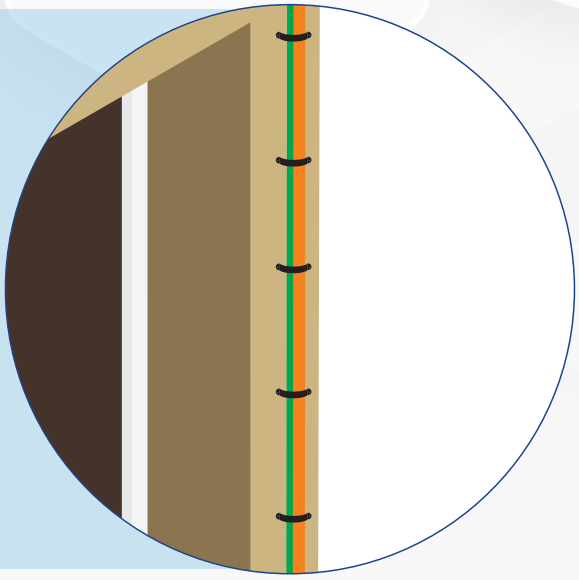
The ways to attach the mast to the CMCE can vary in many ways. A vertical position on the mast must be ensured by means of flanges, supports, type D clamps, type Ω, self-pivoting type, this will depend on the type of structure to be protected, for more information consult the manufacturer.

9.2 CABLE FIXING

The down conductor must be fixed in its trajectory ensuring a verticality up to the ground connection, if there are horizontal sections in its trajectory or the need for imminent deviations, follow the indications of the NFPA 780 standard with clamps every 1.5 meters in the trajectory of the driver.







FIXING ACCESSORIES

It is used fixing accessories such as:

- Ω type clamps
- U-type clamps
- D type clamp
- Metallic Zip Ties
- Others

Which must be resistant materials that can withstand inclement weather.

CONDUCTORS SECTION

The primary conductor of the CMCE and the grounding system must be bare copper with a cross section of 50mm2 or 2/0 AWG.

When the device is installed in reinforced concrete, concrete or wood structures, an insulated secondary conductor with a cross section of 10mm2 or 7 AWG must be used in order to ground the mast (if it is metallic). This down conductor must be connected to the second grounding electrode since the first electrode will always be for the CMCE.

Primary Conductor
50 mm² - 2/0 AWG

Secondary Conductor
10 mm² - 7 AWG

9.3 GROUNDING

Ground electrodes should not be less than 12.7 mm (½ in) in diameter and 2.4 m (8 ft) long. Electrodes must be free of paint or other non-conductive coatings. Depth of the grounding electrodes. Ground electrodes must extend vertically to a depth of not less than 3 m (10 ft) into the ground. The soil must be compacted and pressed against the grounding electrode along its entire length.

Standard: NFPA 780

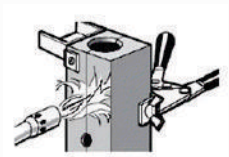
EXOTHERMIC WELDING

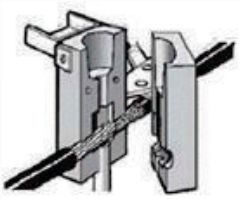
A permanent connection between two metallic components. This process is particularly known for the durability of the joint produced and for the preservation of good electrical conductivity between the joined components.

When the correct measurements are not taken to make a weld, there is not a good adhesion between the welds of the conductors and the ground electrodes. There is a loss of conductivity and if there is an induced discharge it deteriorates and loses good contact.

To carry out a good exothermic welding, brushing of the mold, conductors and electrode must be carried out. Once these components are clean and free of slag, preheat the mold, conductor, and electrode for 3 to 5 minutes. Once the ignition is finished, wait a few minutes to remove the mold. Clean all the components again, removing all the resulting slag.

The union of the conductor with the electrode must not show fissures or cracks, the optimal fusion of the materials must be produced by means of welding for the correct functioning of the CMCE.





9.3 GROUNDING

MECHANICAL UNION

The connection is made by pressure and tightening and the resulting link is contact. The junction presents a lower conductivity than that of the conductors involved and the connection is transitory, since it presents electrical degradation over time.

The mechanical joint must be lubricated with graphite grease, to avoid accelerated degradation and extend its useful life. It is also advisable to make a cement coating with moderate resistance to sulfates and heat of hydration which;

They can be used in normal structures and in members exposed to soil or groundwater where the concentration of sulfates or the heat from hydration are higher than normal but not severe.

COMPRESSION JOINT

The union between conductors is made, by fixing by compression stress between the materials using accessories that adhere to each other without losing their shape, external tools are used to generate compression.

As in the mechanical joint, the compression joint must be lubricated with graphite grease, to avoid accelerated degradation and extend its useful life. It is also advisable to make a cement coating with moderate resistance to sulfates and heat of hydration which;

They can be used in normal structures and in members exposed to soil or groundwater where the concentration of sulfates or the heat from hydration are higher than normal but not severe.

10 EQUIPOTENTIAL EQUIPMENT

Elements to be grounded

There are two categories of ground circuits in installations, each of which encompasses a series of devices with common characteristics:

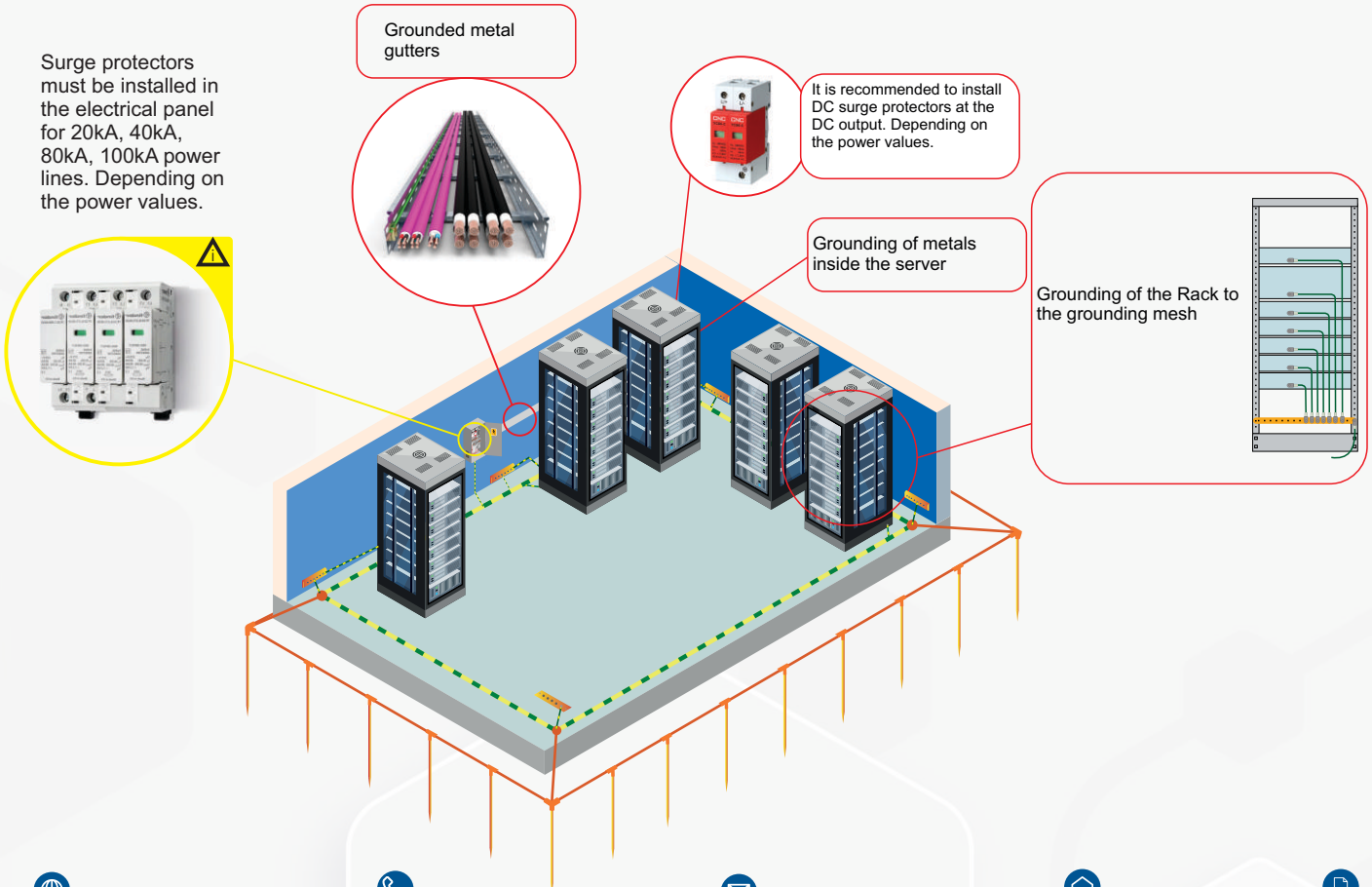
Protective ground:
This classification includes the grounding of all metallic elements that may accidentally remain live, such as: frames and fittings for disconnectors or circuit breakers; transformer casings; enclosures of the LV boards and MV cells; doors, gates, windows and railings in buildings.

Service ground:
Devices that are intentionally grounded are included in this classification: surge arresters; grounding switches; neutral of transformers of all kinds.

The IEEE-80 standard recommends the implementation of a common ground mesh, which interconnects both ground systems.

All equipment, structures, and elements such as transformers, generators, containers, silos, metallic structures, towers, tanks of any content, water pumps, etc. They must be independently connected to the ground mesh by means of a bare cable whose section must be determined depending on the distance of the element from the ground mesh.
It is worth remembering that the neutral of any equipment must be grounded to the ground mesh independently with an insulated cable, as well as the bare cables corresponding to the chassis of the equipment must go to another independent ground bar, both bars interconnected with the mesh ground, and supported with insulators.

In conclusion, any element capable of conducting electric current must be interconnected to the ground mesh independently, this means that these protection systems must only be interconnected underground.



11 PROTECTION OF ELECTRICAL POWER TRANSFORMERS

It is very important to protect the electrical power transformer when we install a CMCE SERTEC, since the discharges or impacts may not always be direct.

There are also indirect discharges outside the CMCE coverage area, such as an impact received by the medium voltage line. This implies an overvoltage to the transformer of the installation.

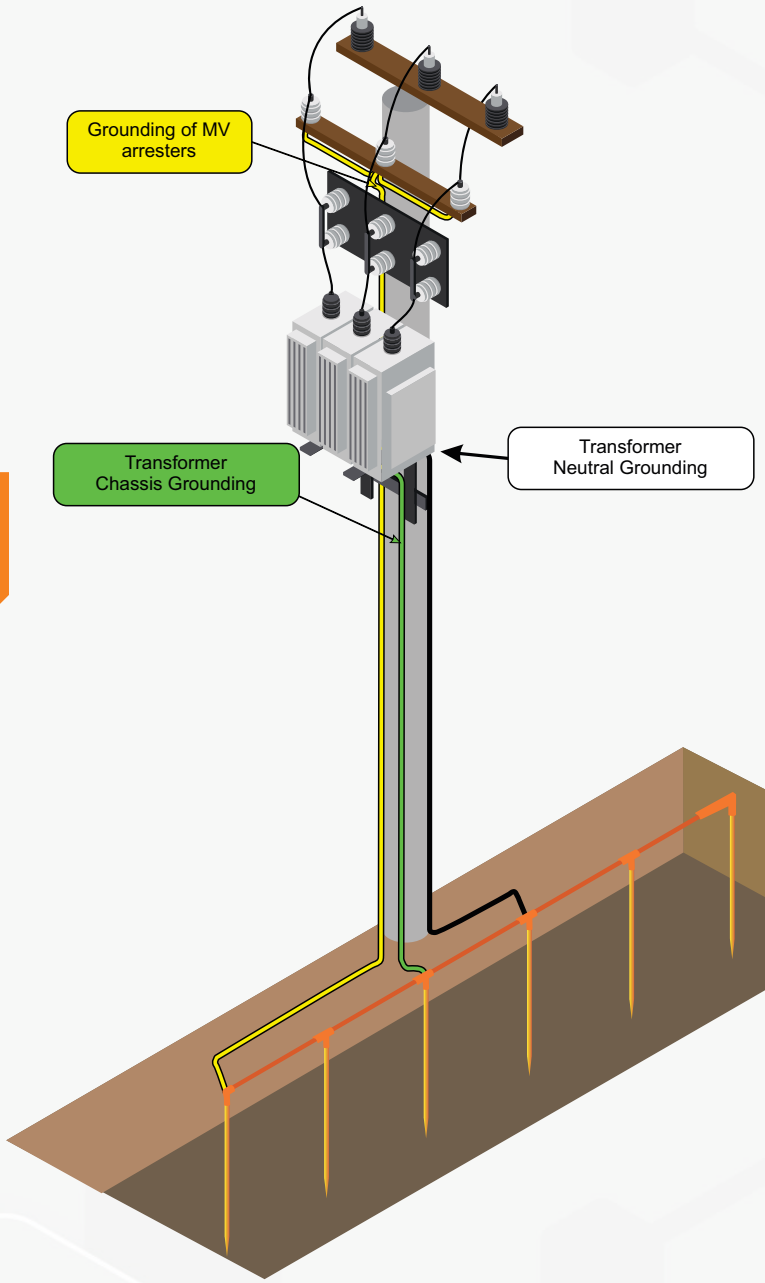
This discharge can be fatal for the transformer if it is not properly grounded. To avoid damage, the transformer is made independent as follows.

1) The drop cable of the medium voltage arrester must go directly to the ground mesh with a 35 mm2 cable
two) The chassis of the transformer must be grounded with a independent 35 mm2 cable direct to the ground mesh.
3) The neutral must be grounded independently with an insulated cable of at least 35 mm2 directly to the ground mesh.

The union (bridge) between the neutral and the chassis that transformers, factory generators usually have must be disconnected and each one must be connected independently to the ground mesh, for the purpose of protection.

The following graph shows the aforementioned.

Transformer connection with independent neutral, chassis and arresters



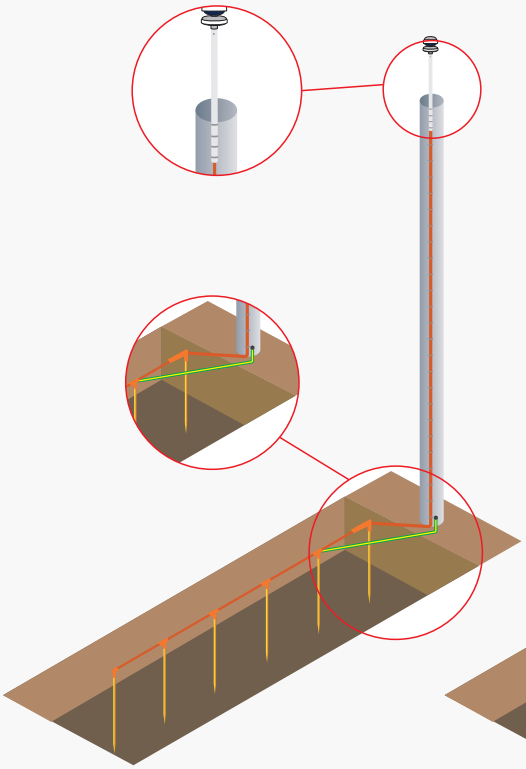
Surge protectors must be installed in the electrical panel for 20kA, 40kA, 80kA, 100kA power lines. Depending on the power values.

It is recommended to install wired telephone line protectors

* Illustrative images

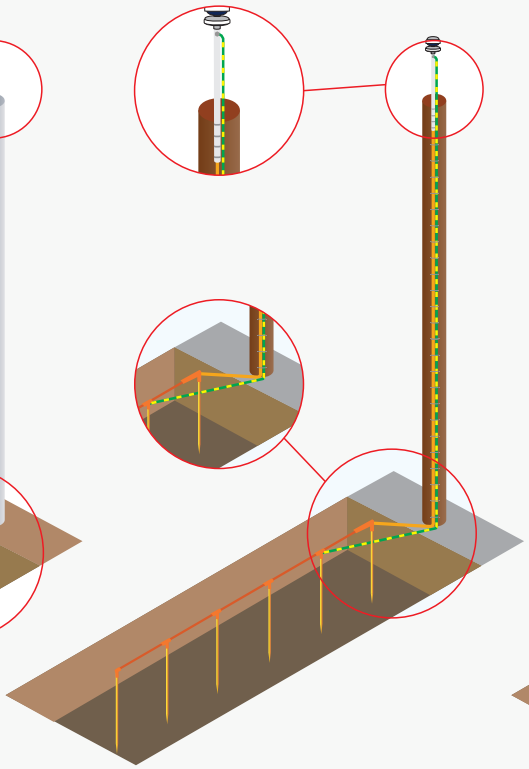
12 POST TYPES

For the installation of the CMCE SERTEc, different types of structures and different types of poles can be used, among them they can be concrete/concrete poles, wooden poles, poles of different metal alloys and in many cases the structure itself can be used to protect.



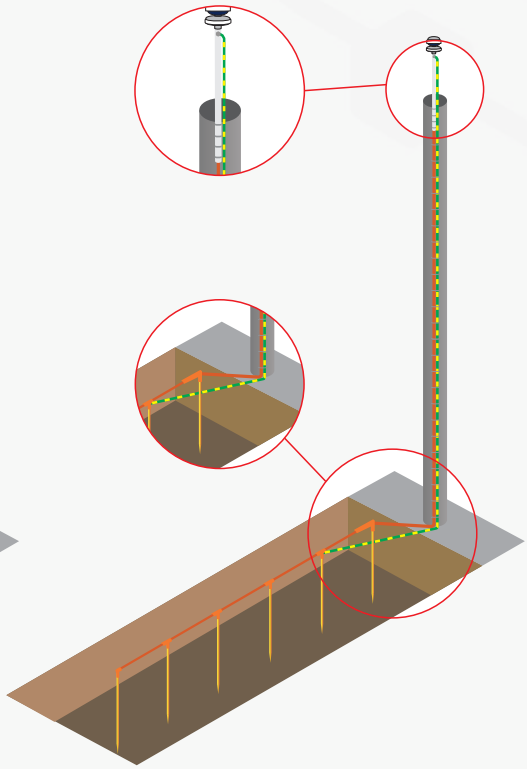
Metal poles

When there are metal poles or structures such as towers, the use of two conductors must be taken into account. The main down conductor of the CMCE and the secondary conductor to ground the pole or structure at its base connected to a grounding electrode other than the main down electrode as shown in the image.



Wooden poles

When there are wooden poles, the use of two conductors must be taken into account. The main down conductor of the CMCE and the secondary conductor to ground the mast (metal tube of the CMCE) to a grounding electrode other than the main down electrode as shown in the image.



Concrete poles

When there are concrete poles, the use of two conductors must be taken into account. The main down conductor of the CMCE and the secondary conductor to ground the mast (metal tube of the CMCE) to a grounding electrode other than the main down electrode as seen in the image.

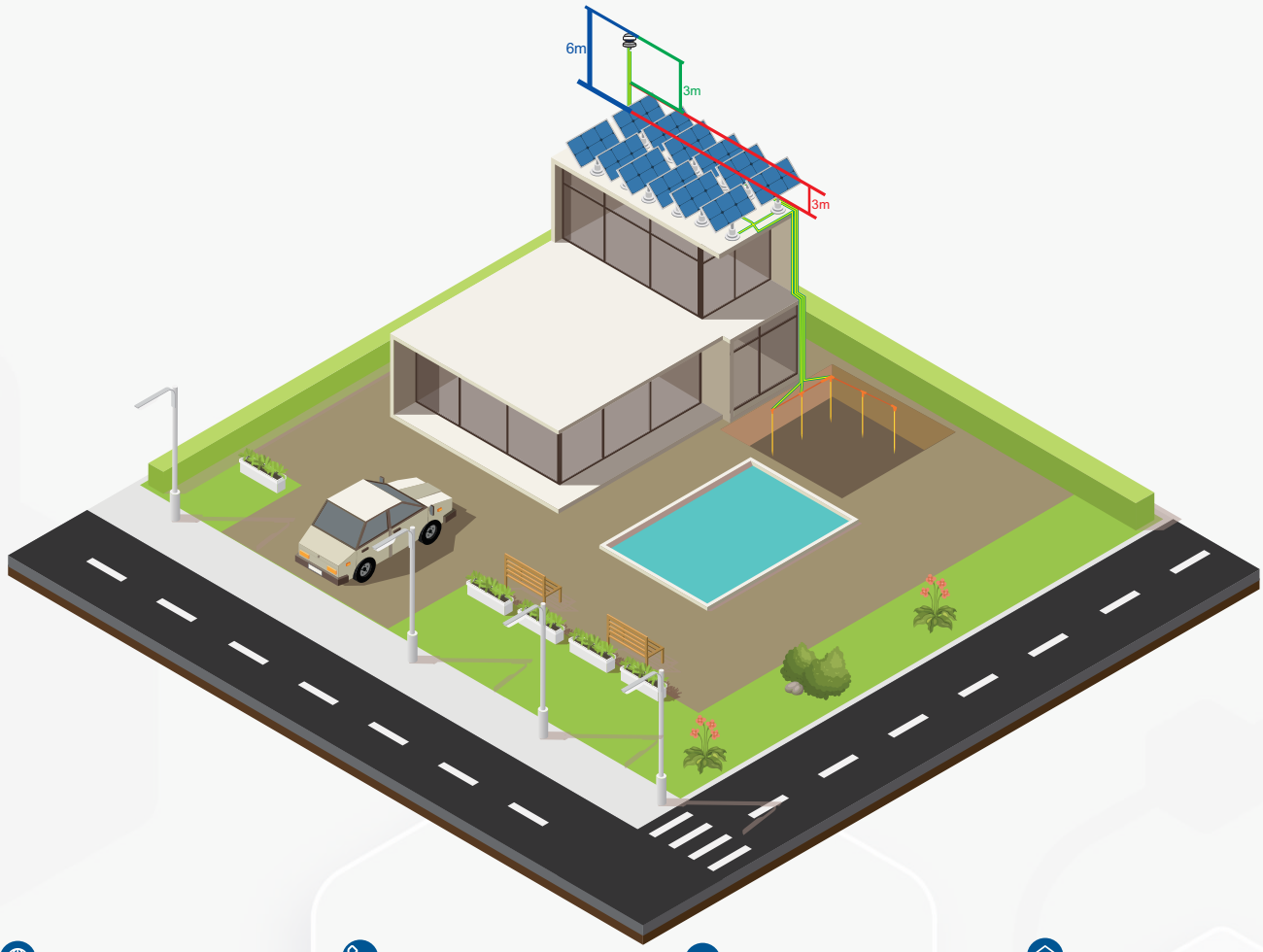
To determine the dimensions of the conductors, see Pag. 13

13 TYPES OF STRUCTURES

The following descriptions correspond to examples of installation in different types of structures to give a general summary of what must be taken into account for each type of installation, if your type of structure is not specified and you have doubts about the installation, you can Consult with factory technical support.

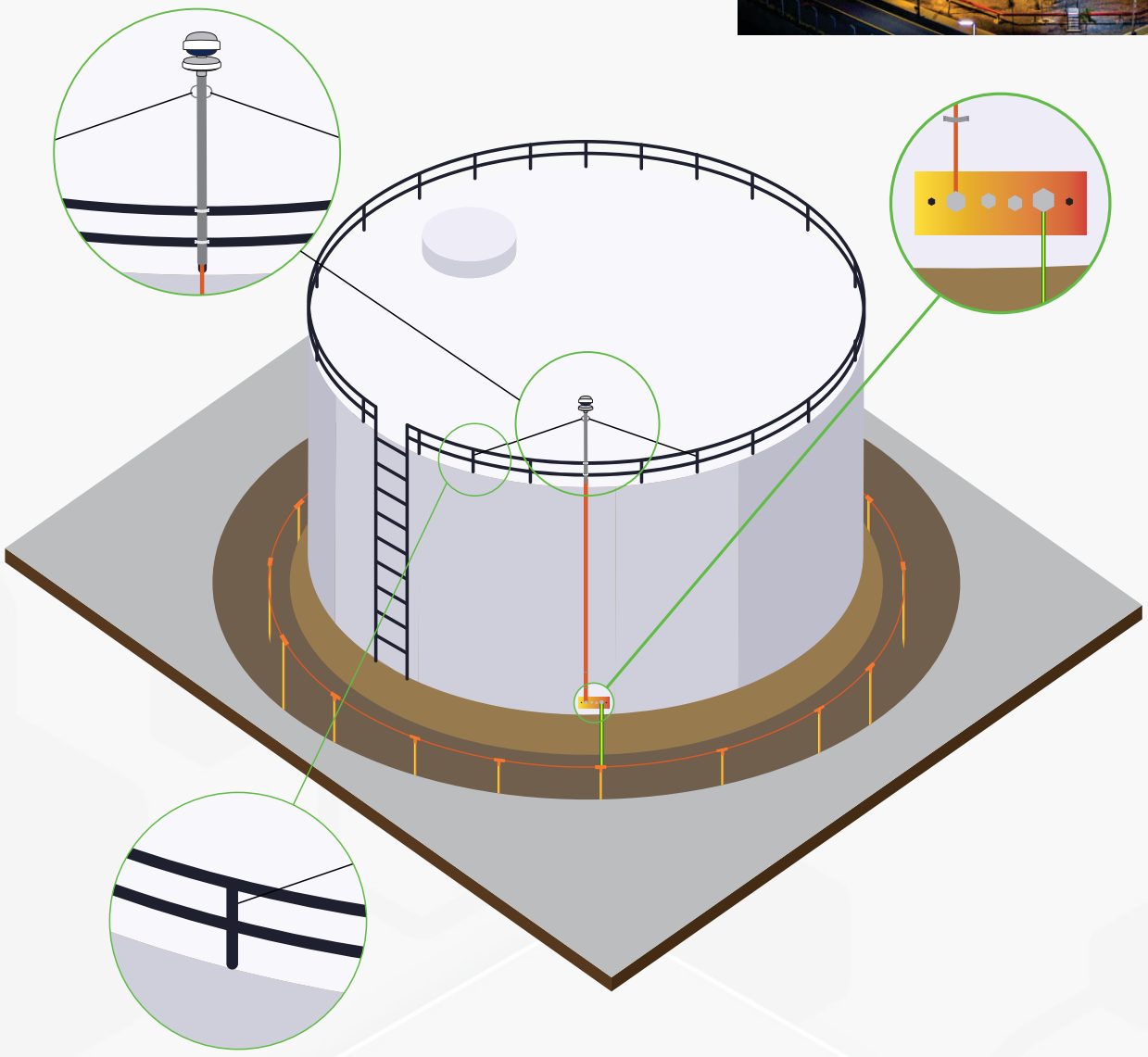
13.1 Private house - Country

- The resistance to ground must be taken into account beforehand.
- The element with the highest point which must be exceeded is identified
- The location and assembly structure of the CMCE SERTEC with its respective mast (tower, structure itself, column, chimney, etc.) is determined.
- Electrical line protection elements must be installed (see page 17)
- If there is a generator or transformer, according to page 17.
- If there are solar panels, ground the chassis of the panels, inverters and the CMCE in different grounding electrodes.



13.2 Storage tanks:

- Storage tanks:The resistance to ground must be taken into account beforehand.
- Exceed the highest point of the tank.
- It can be used as a mounting structure to the tank itself by fixing the CMCE mast or an external post can be installed close to the tank to be protected.
- Generally, this type of structure already has a perimeter grounding system.
- Direct coupling to the existing ground system can be made, as long as the cathodic protection of the tank is not by current injection.
- If there is cathodic protection by current injection, it is advisable to add at least 3 electrodes to the same system and that these be for referencing the CMCE.



13.3 Industrial Warehouse (option 1) :

- The resistance to ground must be taken into account beforehand.
- Exceed the highest point of the Warehouse or Industrial Warehouse.
- The location of the CMCE is determined, either at the ends or a central point of the roof depending on the area to be protected that is sought to be used with the Protection Radius. Using a galvanized mast or an existing or installed tower, this will depend on the height to be exceeded.
- Verify if the metal structure is grounded and at how many points of it.
- Verify if the electrical panels and critical equipment have an adequate grounding system and adequate SPD.
- In case of not having a structural grounding system, see the following image for the proposed recommendations. (see image1)

In the example, two ways of grounding the tower in the warehouse, this will be at the discretion of the installer.

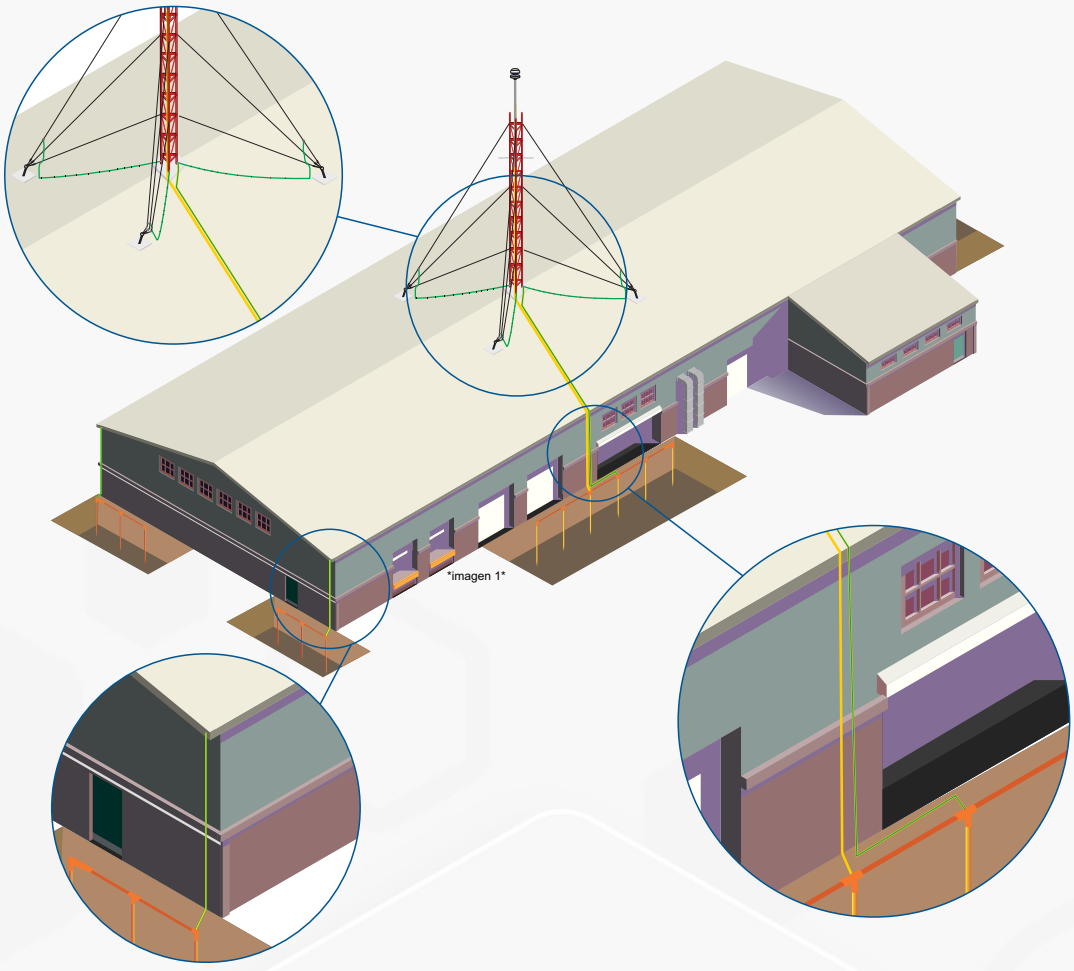
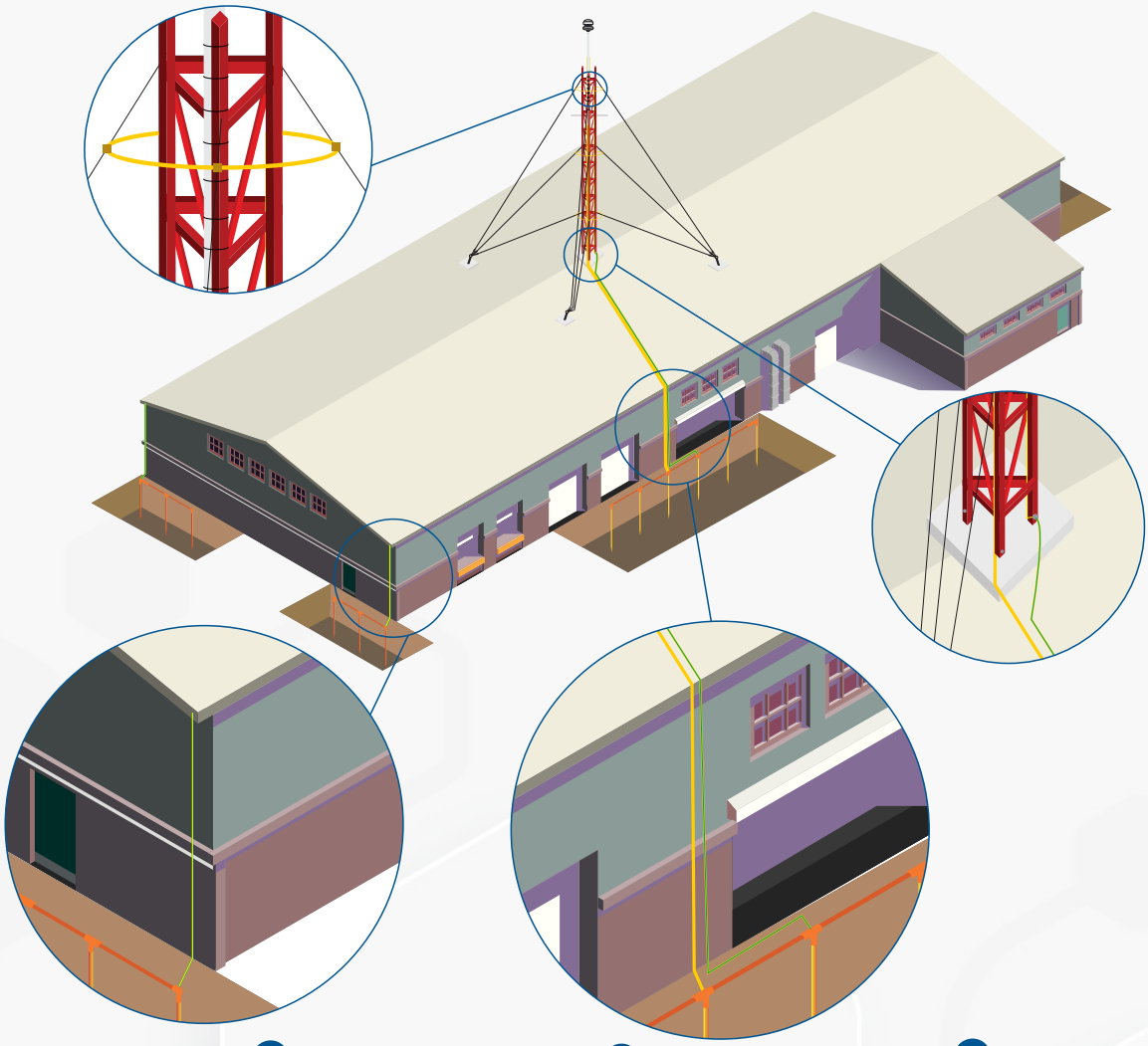


imagen 1

13.3 Industrial Warehouse (option 2) :

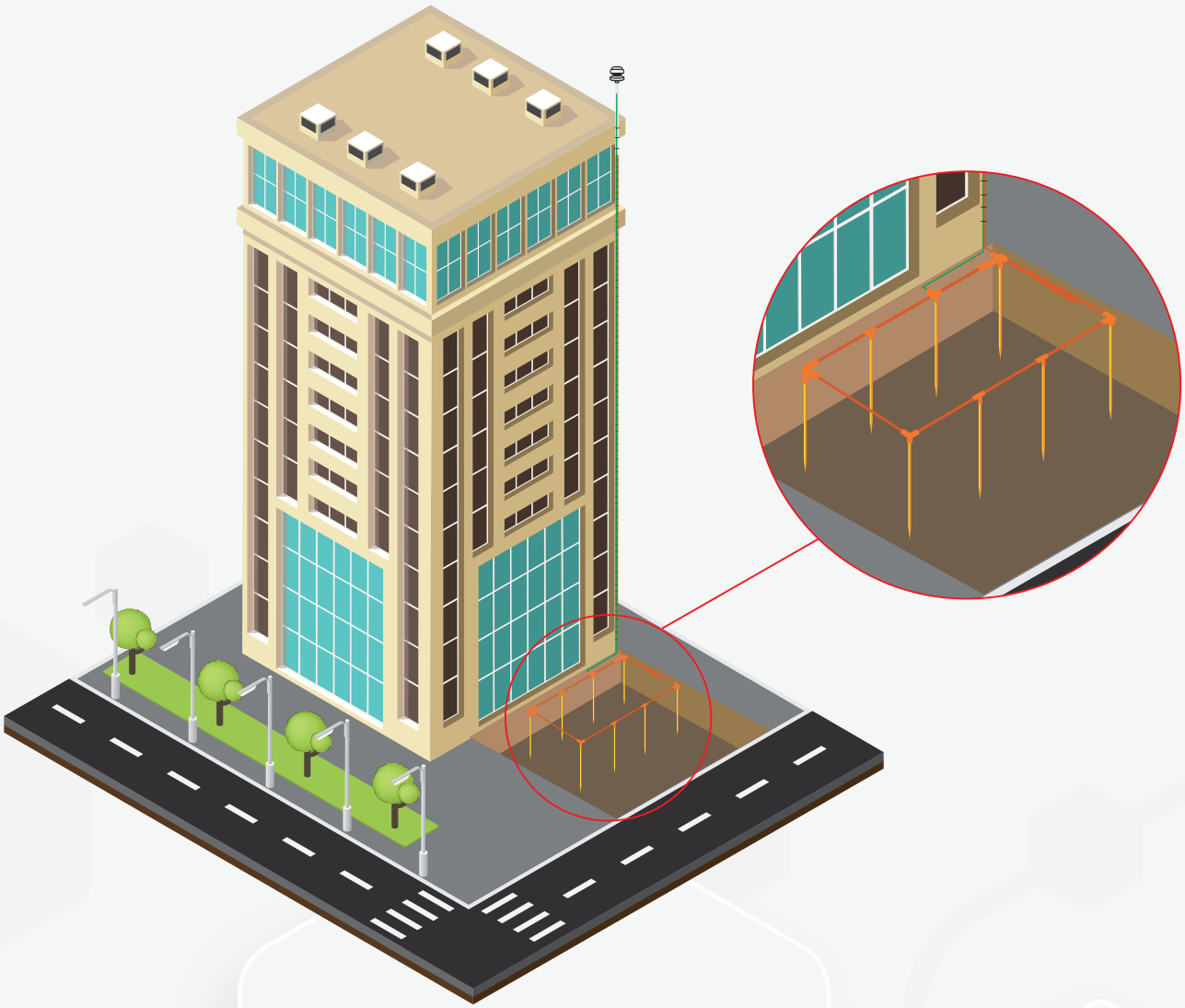
- The resistance to ground must be taken into account beforehand.
- Exceed the highest point of the Warehouse or Industrial Warehouse.
- The location of the CMCE is determined, either at the ends or a central point of the roof depending on the area to be protected that is sought to be used with the Protection Radius. Using a galvanized mast or an existing or installed tower, this will depend on the height to be exceeded.
- Verify if the metal structure is grounded and at how many points of it.
- Verify if the electrical panels and critical equipment have an adequate grounding system and adequate SPD.
- In case of not having a structural grounding system, see the following image for the proposed recommendations. (see image1)

In the example, two ways of grounding the tower in the warehouse, this will be at the discretion of the installer.



13.4 Building:

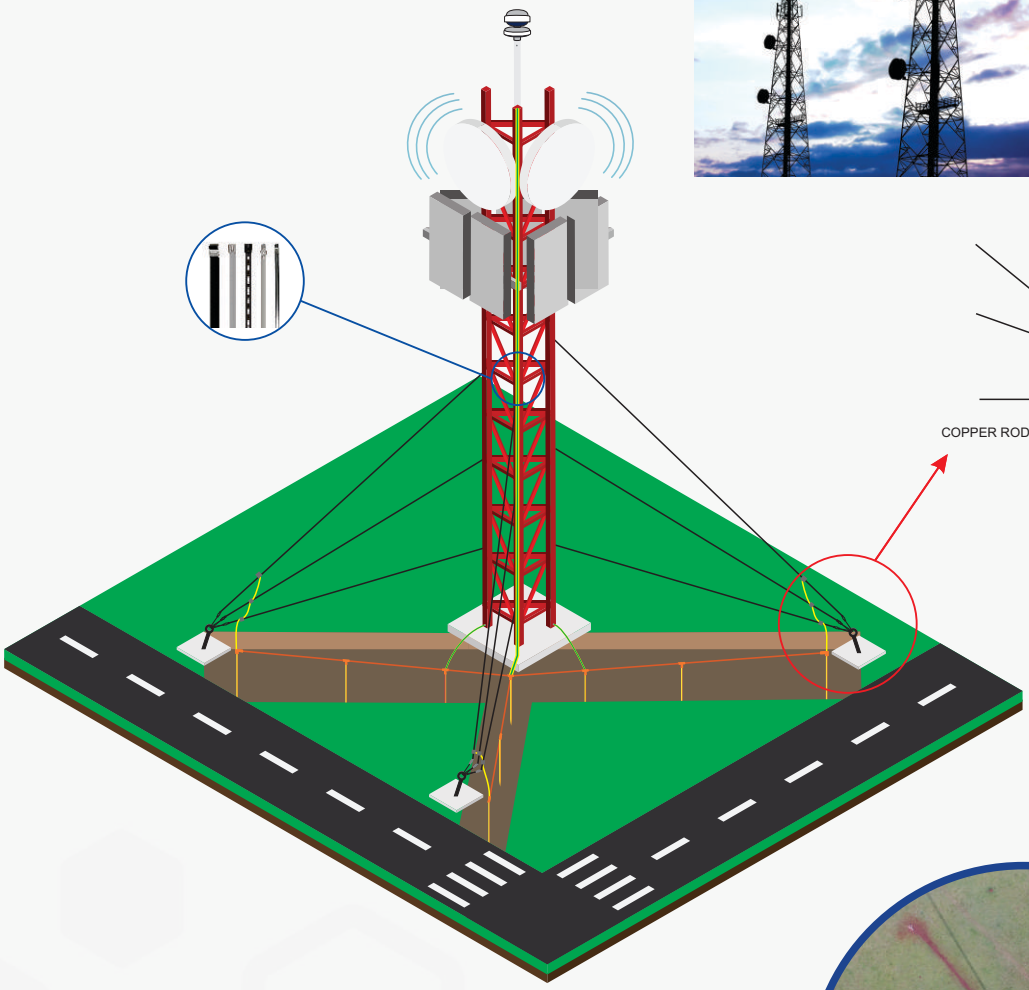
The resistance to ground must be taken into account previously, the CMCE SERTEC with the respective mast must be mounted in the highest part of the building, surpassing any element located in the upper part of the building.
A ground mesh must be made, for the equipotentiality of the equipment and the structure in case it is necessary, grounding each one independently to the ground mesh.
If there are transformers and generators, the respective neutrals and chassis must also be connected to independent bars intended for chassis and neutrals. These bars must be supported by insulators at the time of fixing.
The lines must have overvoltage protectors depending on the electrical installation.
In the case of having a data center, there must be a grounded bar to which the neutral must be connected and a differentiated bar to connect the chassis.

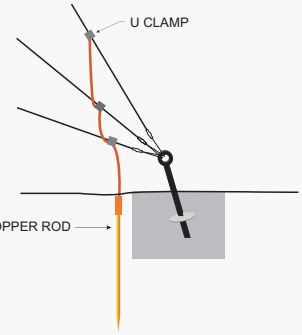


13.2 Braced towers

It is necessary to take into account the resistance of the ground with reference to the tower first in order to determine, according to the result obtained from the ground measurement, the number of rods or ground electrodes to be used.

The CMCE SERTEC must be installed at the highest point of the tower by means of a 1 ½ inch galvanized mast exceeding the tower 3 meters.
All the braces must be grounded and interconnected with the ground mesh.





sertec S.R.L.

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WE ARE CONSTANT RESEARCHERS AND DEVELOPERS

CERTIFICATIONS

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