**Advanced Engineering Days**

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# Protection of buildings on a university campus from lightning strikes

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Overvoltage
Overcurrent
Protection

**Abstract**

The purpose of the paper is to analyze and recommend effective strategies for the protection of buildings in general from lightning strikes and in particular university campuses where there is a large concentration of people and electronic technology equipment. To meet this natural challenge, we propose an integral approach that includes system monitoring and appropriate building infrastructure to reduce the impact of lightning strikes. Also, this paper examines and recommends new innovative technologies and materials for the construction of a safe lightning rod, using improved materials and structures supported by digital technologies to improve structural integrity. In this perspective, we will examine some of the main aspects involved in the design of a lightning protection system for the maximum minimization of risks from this natural phenomenon, knowing the consequences that such an incident can cause significant material damage and can negatively affect everyday life. and the operation of a higher education institution.

## Introduction

Lightning has been around for as long as mankind has existed, since humans began building. Early buildings made mainly of wood and stone, not tall and built in valleys, were very rarely prone to being struck by lightning. The taller the buildings became, the more significant a threat lightning became to them. Lightning damaged any building made of wood, stone, or any other type of material, because the huge currents overheated the materials causing fires and powerful explosions. In many European countries, church buildings, usually the tallest ones, were the buildings most often struck by lightning. In Europe, the lightning rod was discovered by Vaclav Prokop Divis in the years 1750-1754. In the United States, the lightning rod, otherwise called the lightning arrester, was invented by Benjamin Franklin as part of his research on electricity. Franklin concluded that by means of a sharp ionized metal rod at the tip, the electric flame would be drawn out of the cloud quietly, before it could be close enough to strike.

Lightning protection systems control electrical discharges with a large current that affect sensitive electrical, electronic systems and cause them to malfunction or destroy them, by directing them through a path of low resistance to earth, avoiding their passage into parts of buildings. Lightning protection systems are attached to buildings to interrupt electrical discharges that might otherwise strike higher parts of the building, such as a chimney or metal roof [1-3].

## Material and Method

### Each lightning rod is formed

• From the conductor that receives a direct lightning strike and is placed at a height higher than the height of the protected object.
• Earthing system and

• Conductors that electrically connect the two elements above.

By calculating the lightning rod, we understand exactly the definition of this protection zone in such a way that no point of the object we seek to protect is located outside it. The size and shape of the protection zone depend on these factors:

• The height of the orientation of the lightning channel towards the lightning rod
• Surge resistance of the lightning channel or potential parameters of the lightning current impulse.
• The complex resistance of the lightning current flow to the ground.

Characteristic for lightning is that the leader which is released from the cloud moves without being influenced by the ground objects [4-6].

**Earthing resistance**

The grounding system is an important element for the electrical system and for the electricity users because through it:

The safety of people is realized during the use of electrical equipment by equating the potential of conductive parts with the potential of the ground, thus preventing the exposure of people to high voltages.

Equipment is protected from possible damage (increases the lifespan of the equipment).

It is possible to discharge the lightning currents, realizing in this way the protection from them and the corresponding consequences.

Electromagnetic interference is reduced (such as the harmonics that are created).

Because the grounding system is designed to guarantee safety, its effectiveness must be verified. The grounding resistance value is the parameter considered the most important to test the quality of the grounding system.

**The physical nature of grounding resistance**

According to the definition, resistors have two terminals and their resistance is determined based on the value of the voltage applied to these terminals and the circulating current between them as a result of this voltage. The value of resistance $R = \rho l / A$ depends on the type of material (their resistance) and its physical dimensions (length and surface of the resistive element) [7-8].

**Results and Discussion**

1. Value of earthing resistance

There is a disagreement about the fact that what the earthing resistance should really be. Ideally it should be 0 Ohm. There is no defined standard for grounding resistance that is recognized by all organizations. However, organizations such as NFPA (National Fire Protection Association) and IEEE (Institute of Electrical and Electronics Engineers) have recommended a resistance value of 5 Ohms or less. While other organizations state that this resistance should be less than 25 ohms.

2. Conductors in earthing plants

By conductor in earth plants, we will understand a metal body or a metal composition, electrically connected to the ground and used intentionally to distribute the electric current.

Reinforced concrete structures, different metal pipes and any metal element that is connected to the ground and can perform this function can be used as auxiliary conductors. It is important to emphasize that in land plants, the current distributors are connected to each other through conductors in the ground to practically realize a distributor or a single large conductor. This creates advantages of the global earthing resistance approach, bringing about the reduction of touch and step voltages at the boundaries at the extremities of the earthing plant.

3.Grounding plant components

- Grounding conductor
- Connections of plant elements.
- Earthing electrodes

4.Factors affecting the resistance of the earthing.

There are four variables that affect the value of the earthing resistance:

a. Length/depth of the grounding electrode
b. Diameter of the grounding electrode
c. The number of electrodes and their placement method.

5.Length and depth of the grounding electrode

One way to reduce the grounding resistance is to embed the electrode as deeply as possible. The ground does not have a constant resistance as the composition of the material is different in different places and it can be unpredictable and there is moisture in different measures. Generally, by doubling the length of the electrode the resistance is reduced by approximately 40%.

6.Diameter of the grounding electrode

Increasing the diameter of the electrode has very little effect on the reduction of the grounding resistance. For example, by doubling the diameter of the electrode, the resistance is reduced by only 10%.

7.The number of grounding electrodes, grid or square plant?

The simple grounding system consists of placing a single point on the ground.

The use of a single electrode is the most common form of grounding that can be found outside the home or place of business. Complex earthing systems consist of a large number of electrodes, connected to each other, woven in the form of a network, or as a single metal plate.

These systems are typical for power substations, distribution centers and telephone tower sites. Complex grounding networks dramatically increase the contact surface with the surrounding ground and reduce grounding resistance.

When the plant consists of a net, it is inserted into the ground at a depth of 50-80 cm, making sure that the ground around it is loose and not rocky. The material is copper or hot-dip galvanized steel. The choice of material will depend on the current intensity, mechanical resistance, resistance to chemical corrosion, etc. In eroded terrain where there are bases, it is better to use lead-coated copper or hot-dip galvanized steel, depending on the technical-economic analysis.

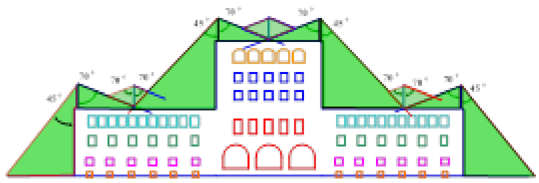
Galvanized steel is recommended in acid soils.

Aluminum as a distributor is not accepted as it tends to be covered by an insulating oxide layer.

As for plants with contours, their dimensions vary from 6m to 12m in areas where the measures to connect to the ground are dense, but they can be larger in areas with few measures to connect.

It is not said that the contours should be square, on the contrary, it has been proven that the most favorable shape in terms of touch voltage is rectangular [9-12].

Figure 1, illustrates the coverage areas from lightning strikes. after the placement of the lightning rods and in Figure 2, a view of the complete coverage of the building that provides safe protection from lightning is illustrated.



**Figures. 1** Lightning strike coverage areas

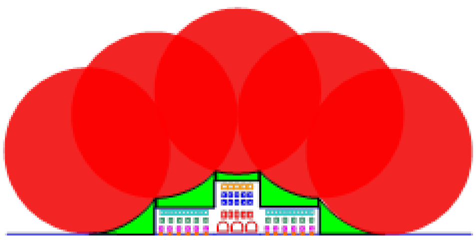


**Figure 2.** View of full coverage

**Conclusion**

As a result of the impact of the standard lightning wave, large over voltages and over currents occur, which by placing earthlings with small grounding resistances up to 2 [Ω], it is possible to reduce the over voltages at different points of the protective network.

For the analysis of the protection of objects above ground from direct lightning strikes, the European standards IEC 62 350-1, up to the IEC-62 530-4 series should be used.

As the value of the grounding resistance increases, the voltage at the connection point of the down conductors with the grounders increases. This leads to an increase in the voltage of the step, of the touch, bringing great danger to the electric shock of the living organisms.

## References


1. Iosseli, U. V., Kothanov, A. S., & Stlyrski, M. G. (1990). Capacitance Calculation, Energy Press
2. Sarajcev, P., & Goic, R. (2011). A review of current issues in state-of-art of wind farm overvoltage protection. Energies, 4(4), 644-668.
3. Basholli, F., & Daberdini, A. (2023). Monitoring and assessment of the quality of electricity in a building. Engineering Applications, 2(1), 32-48.
4. Gao, C., Li, L., Li, B., & Zhao, Z. (2006, February). Computation of power line tower lightning surge impedance using the electromagnetic field method. In 2006 17th International Zurich Symposium on Electromagnetic Compatibility, 124-127. https://doi.org/10.1109/EMCZUR.2006.214885
5. Basholli, F., & Daberdini, A. (2022). Influence of terrain and atmospheric conditions on the propagation of radio waves. 1st International Scientific Conference in Mathematics and Physics, and their applications, 151-160
6. Moreno, P., Naredo, J. L., Bermúdez, J. L., Paolone, M., Nucci, C. A., & Rachidi, F. (2004). Nonuniform transmission tower model for lightning transient studies. IEEE transactions on power delivery, 19(2), 490-496. https://doi.org/10.1109/TPWRD.2003.823210
7. Basholli, F., Merkuri, L., & Daberdini, A. (2022). Magnetic and electric fields in high - voltage power transmission lines, impact on the environment". Optime, XIV Year of Publication, 2, 232-249
8. De Conti, A., Visacro, S., Soares, A., & Schroeder, M. A. O. (2006). Revision, extension, and validation of Jordan's formula to calculate the surge impedance of vertical conductors. IEEE transactions on electromagnetic compatibility, 48(3), 530-536. https://doi.org/10.1109/TEMC.2006.879345
9. Basholli, F., & Daberdini, A. (2022). Monitoring and evaluation of the quality of electricity in a building. Advanced Engineering Days (AED), 5, 77-80.
10. Kaouche, S., Nekhoul, B., Kerroum, K., & Drissi, K. E. K. (2007). Induced disturbance in power network by lightning. Journal of Communications Software and Systems, 3(1), 52-58. https://doi.org/10.24138/jcomss.v3i1.269
11. Basholli, F., & Kola, J. (2022). Adaptation of computer power supply to laboratory equipment. OPTIME, XIV Year of Publication, 2, 250-258
12. Visacro, S., Soares Jr, A., Schroeder, M. A. O., Cherchiglia, L. C., & de Sousa, V. J. (2004). Statistical analysis of lightning current parameters: Measurements at Morro do Cachimbo Station. Journal of Geophysical Research: Atmospheres, 109(D1). https://doi.org/10.1029/2003JD003662