International Scientific Conference „Natural Disasters in the 21st Century: Monitoring, Prevention, Mitigation“
Proceedings, ISBN 978-9941-491-52-8, Tbilisi, Georgia, December 20-22, 2021

PASSIVE AND ACTIVE LIGHTING PROTECTION

Mkurnalidze I., Kapanadze N.

Institute of Hydrometeorology at the Georgian Technical University, 150-a D.Agmashenebeli Ave, 0112
i.mkurnalidze@gmail.com

Summary: *The article discusses various types of lightning protection, from a Franklin lightning rod to a heavy-duty laser lightning protection device. Description of passive (protects only one object) and active (protects several objects at once) lightning protection systems.*

Key words**:** *Lighting, lightning rods, protection.*

Lightning is a formidable natural phenomenon with tremendous destructive power. The danger of a lightning strike arises due to high voltage (hundreds of millions of volts), high amperage (tens of thousands of amperes) and tremendous temperature (25000-30000ºC).

Lightning discharges pose a significant danger not only to human life, but also to many of his activities. Such as air and sea transport, gas and oil pipelines, power lines, building, agriculture and forestry, communication services, etc. [1,2]. According to some sources deaths caused by thunderstorms claim 6,000-24,000 lives annually. Material damage is estimated at hundreds of millions of dollars [3].

According to WMO and UN reports, the number of natural disasters has especially increased in recent decades. Most of them are thunderstorms. For example: in the United States in 2021, 44 thousand were recorded. forest fires, of which 80% are caused by the so-called dry thunderstorms. The damage amounted to about 75 ml. dollars.

Since the Russian scientist Lomonosov suggested the electrical nature of lightning, and the American scientist Franklin (18th century) established that lightning is a dangerous manifestation of atmospheric electricity, mankind has been looking for a means of protection against this phenomenon. In 1752, Franklin installed a 9-foot-high metal rod on the roof of his house and wired it to a well. The wire ran through the house and connected to an electric bell. Lightning struck the rod and triggered the bell. This invention became the forerunner of modern grounded lightning rods. It should be noted that, despite the many technologies and devices, the principle laid down in 1752 is fundamental and effective. Currently, there are two types of lightning protection: passive and active [4].

Fig.1. Passive and active lightning rods.

The passive construction includes the following elements:

- Lightning rod (catches atmospheric electrical discharge)
- Down conductors (redirect the received energy to the ground)
- Earthing switches (prevent further current propagation)

Lightning rods can be in the form of a metal rod, a cable on two roof supports or a special mesh. For each object, the number of such devices is calculated individually. Down conductors are steel conductors. The grounding electrode system is formed by several electrodes connected to each other. The active type of protection is very similar in design to the passive one, the main difference is the lightning rod device. This is not just a steel rod, but a special electronic device that, when a thundercloud approaches, begins to create high-voltage pulses around itself. Reverse ionization of air flows occurs, and lightning is literally itself attracted and redirected through a safe channel. Such a receiver is installed one meter higher from the most protruding part of the building. It is believed that active lightning protection extends to an area that is four to five times larger in area at the same placement height.

For a passive lightning rod, you will need at least two conductors (according to the number of down conductors and ground electrodes), for an active system, one is enough. Custom-built houses usually have roofs with large differences in height. Therefore, the calculation and installation of a passive system is a laborious process and requires the consumption of a large number of parts. With an active structure, installation is much easier with a minimum of elements. There are many different options for devices in both passive and active systems. Structural elements are made of different materials; the electronic elements used have different characteristics, depending on the type of protected objects.

It should be noted. That over the past decades, due to climate change on Earth, the data on the characteristics of thunderstorms has also changed. Therefore, when installing various types of lightning protection, this circumstance must be taken into account [5].

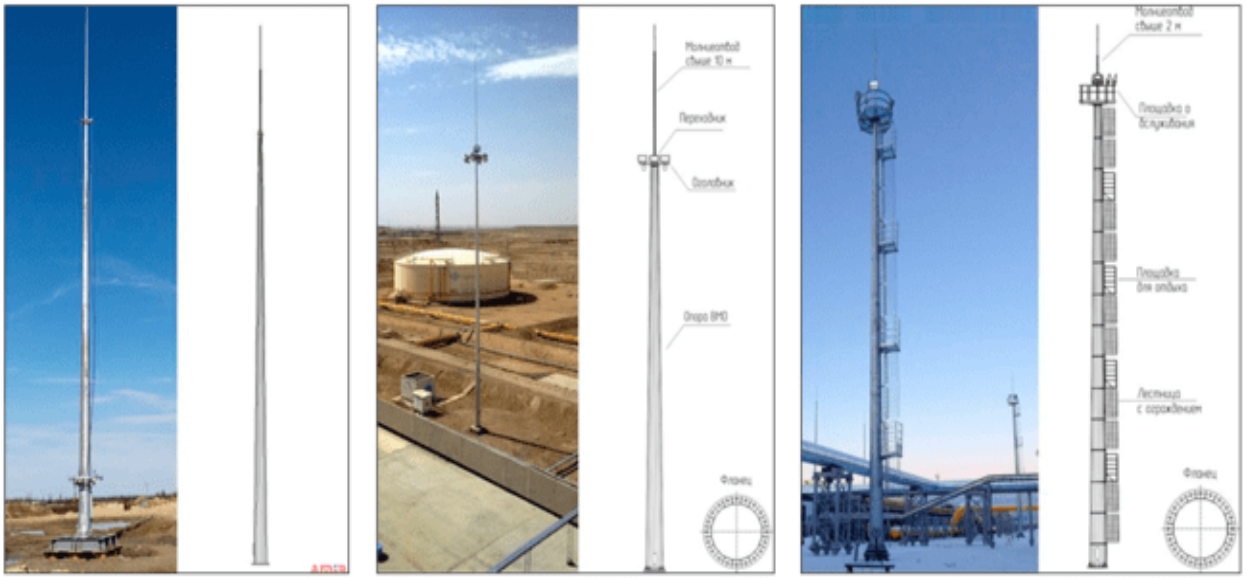

Fig.2. Examples of lightning rods of various designs

In connection with the rapid development of laser technologies in recent years, the idea arose of developing a new type of lightning protection based on high-power femtosecond lasers. Such a laser was developed as part of the Laser Lighting Rod (LLR) project in Switzerland. On Mount Sentis (2502 m) in the Alps (there is a 124-meter antenna on the mountain, to which more than 100 lightning discharges are attracted annually), a one-of-a-kind terawatt laser lightning rod is installed. Every second, the laser sends 100short pulses into the atmosphere.

Fig.3. Laser lightning rod on Mount Sentis (Switzerland).

In the course of its operation, a long ionized channel is created through which the lightning deflects from the protected places. The range of the laser is sufficient to protect large areas with forests and infrastructure [6]. This is a big breakthrough in lightning protection.

The problem of lightning protection is topical for Georgia as well, since the region is considered to be a thunderstorm. The average annual number of thunderstorm days in Georgia, according to the weather station, is about 40 [7]. This fact is confirmed by the map of the global distribution of thunderstorms obtained by NASA from satellite data [8].

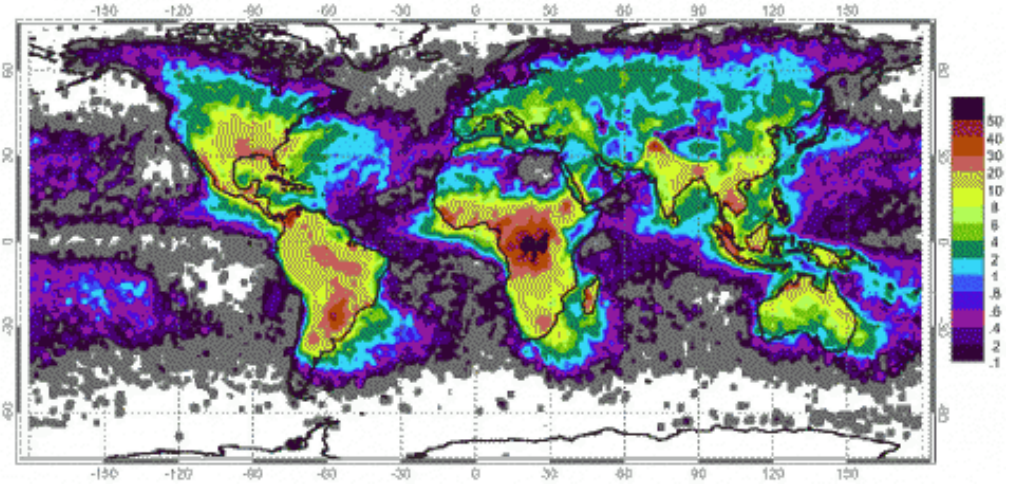

Fig.4. Global frequency of lightning strikes per year per square kilometer.

References

1. Govorushko C.M. Risk for human activity associated with thunderstorms. // Problems of risk Analysis, volume 8, №4, 2011, (Rus)
2. "Lightning Facts and Information". // National Geographic., October 9, 2009.
3. Holle R.L. Annual rates of lightning fatalities by country. // (PDF). 0th International Lightning Detection Conference, 21–23 April 2008, Tucson, Arizona, USA, Retrieved on 2011-11-08.
4. Features of passive and active lightning protection in comparison. // (voltstream.ru), (Rus)
5. Lightning rods - purpose, types, advantages. // (www.amira.ru), (Rus)
6. Laser lightning rod at the top of Sentis. // (www.swissafisha.ch), (Rus)
7. Tatishvili M., Kartvelishvili L., Mkurnalidze I., Meskhia R. Dynamics and Statistical Distribution of Hail and Thunderstorms in Georgia Against the Background of Global Climate Change. // ”Mtsignobari” Publishing House, Tbilisi, 2018, (Geo).
8. Where Lightning Strikes. // (science.nasa.gov).