Design and Installation Lightning Protection System to Protect Hybrid Solar Rooftop System

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***Abstract*—This article presents design and installation the lightning protection system for hybrid solar power generation system. In the event of lightning strikes in the area where the solar power generation system is installed on the roof, it may cause damage to the solar power generation system and related electrical systems. For this reason, the concept of designing and installing a lightning protection system has been developed according to the standards of the Engineering Institute of Thailand (EIT). Since the rooftop solar power generation system used in this work is installed on an irregularly shaped building. Therefore, this paper chooses to use the rolling sphere method to design a lightning protection system that is suitable for buildings with this shape. After completing the design and installation of the lightning protection system, measure the resistance of the ground electrode. The resulting resistance is approximately 0.2 ohms, (not exceed 5 Ohm), which corresponds to EIT standards. That is, the proposed lightning protection system is suitable for the application area that is the case study in this paper.**

Keywords— Lightning Protection System, Hybrid Solar Rooftop, Earth Resistance

I. Introduction

Solar power generation systems that help supply electrical energy are becoming popular for industrial plants. The factory used as a case study in this work has installed a solar power generation system on its roof, but does not yet have a lightning protection system. If there is a lightning strike in that area, there is a risk of damage to the solar power generation system on the roof and related electrical systems.

This research studies articles on various forms of lightning protection in order to provide guidelines for actual design and installation as follows:

Study of lightning risk reduction in rooftop solar energy equipment and installation methods that include specific hazards from lightning strikes or surge currents, grounding points and electrical protection are specified [1]. New lightweight lightning protection cable, this type of cable is fabricated by covering a section of metal conduit over a plastic rope [2]. Design and use of protective equipment for outdoor solar panels that may be directly struck by lightning [3]. A study on the frequent occurrence of lightning strikes on the DC and AC sides of a solar farm system [4]. Lightning protection methods for high-efficiency solar power plants It presents a more efficient way to check the planning of main lightning protection systems based on Post Marketing Alert System theory (PMAS) in different zones of a power plant [5]. Risk assessment of rooftop solar power generation systems, the main objective of this study is to demonstrate an effective method for risk assessment for rooftop solar power systems [6].

II. Lightning Protection Standards of EIT

A. Design of Lightning Protection System

Design lightning protection systems to achieve optimum results both technically and economically. It will be possible only when lightning protection system design and construction steps and design and construction steps to protect especially the design the building itself should utilize the metal parts of the building as components of the lightning protection system.

The design documentation of the lightning protection system must contain all the necessary information to ensure correct and complete installation. Lightning protection systems should be designed and installed. By designers and installers of lightning protection systems who are well trained and skilled [7].

B. Selection of External Lightning Protection System

In most cases, an external lightning protection system may be attached to the building to be protected. Consideration should be given to selecting an independent external lightning protection system. When an explosion occurs at the point of the lightning strike or on the conductor that carries the lightning current, it may cause damage to buildings.

C. Air-Termination System

Air-termination system consists of a combination of the following elements.

- Lightning rod (including free-standing poles)
- Stranded conductor
- Mesh conductor

D. Application of The Rolling Sphere Method

This method takes a painted ball-like sphere and rolls it along the structure on top of the building. In the design, the lightning protection system must be installed as a main lightning rod or conductor cable first. and roll the ball any part of a building whose surface is stained is considered unprotected. This method is often used for buildings with complex structures [7].

When applying the rolling sphere method to the building design buildings should be looked at in all directions to ensure that none of them protrude into an unprotected neighborhood. (One point may be overlooked if only the front, sides, and top of the design are considered.)

The shielded volume created by an air conductor of a lightning protection system is the volume that is not violated by a rolling sphere. When the rolling sphere is applied to the structure and in contact with the air termination conductor, in the case of a horizontal air termination, two parallel lines are placed above the intrusive horizontal reference plane p of the rolling sphere below the level of the air termination in the volume between the two air conductors may be calculated from the following equation (1).

$$p = r - \left[\mathrm{r}^2 - \left(\frac{\mathrm{d}}{2}\right)^2\right]^{1/2} \quad (1)$$

p; sphere intrusive distance (M)

d; distance between the lightning conductors (M)

The distance d is diagonal in the case of more than 4 lightning conductors.

r; radius of the rolling sphere (M)

E. Protective Angle Method

The method of defining the angle of protection is such that the area of protection is cone-shaped to be safe from lightning strikes. Suitable for simple buildings. Must be installed with the lightning rod covering the part that needs protection. The protection angle varies with the protection level and the height of the lightning conductor. This protective corner method is suitable for rod conductors. and conductor type only.

F. Mesh Method

This method uses horizontal ceiling conductors stretched over the tallest part of the building, providing good protection. The horizontal conductor must be installed around the building.

III. Design

In the design and installation of lightning protection systems the columns are designed to cover the roof of the factory building as shown in Figure 1 and Figure 2 the details of equipment and installation are shown in Figure 3 and Figure 4.

When using the rolling sphere method to design and install a lightning protection system which will result in Class 4 that is, the radius of the rolling sphere (R) is 60 m and the grid size (M) is 20 x 20 m, as shown in Table I.

TABLE I. Lightning Rod Design

Class of LPS	Radius of the rolling sphere (R)	Mesh size (M)
1	20 m	5 x 5 m
2	30 m	10 x 10 m
3	45 m	15 x 15 m
4	60 m	20 x 20 m

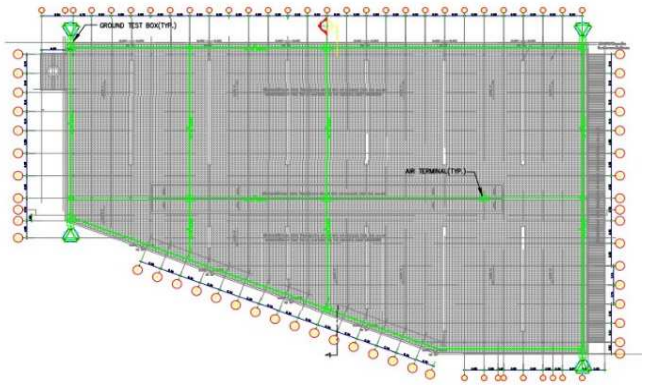

Fig. 1. Lightning protection system design.

Fig. 2. Solar rooftop on the factory.

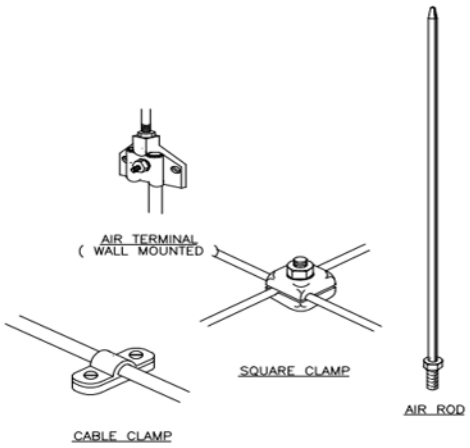

Fig. 3. General description of lightning arrester installation.

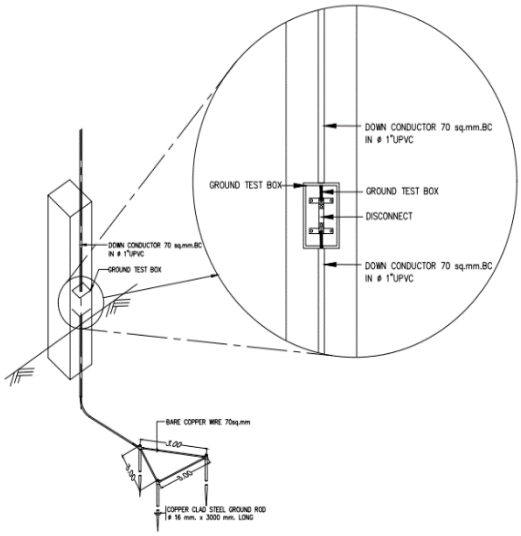

Fig. 4. Down Conductor.

IV. Installation of The Lightning Protection System

A. Installation Concrete Inspection Pit

Earth electrode that has it must be installed so that the depth of the top end is at least 0.5 meters it should be installed as evenly distributed as possible to reduce the effect of electrical coupling within the soil in Figure 5.

Fig. 5. Installation concrete inspection ground pit.

The grounding installation standards as shown in Figure 6.

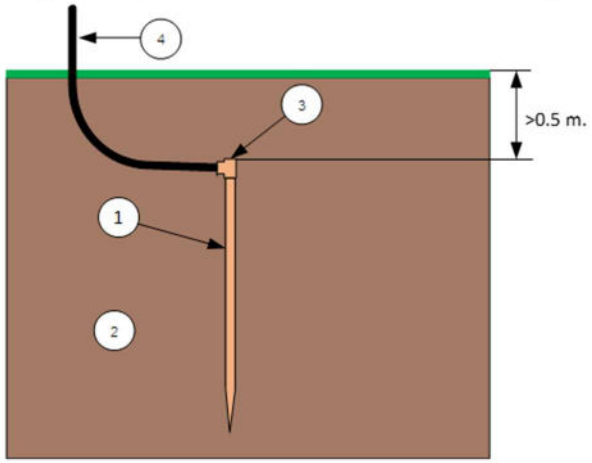

Fig. 6. Grounding installation standards.

From Figure 6, it can be explained as follows: No.1 is lightning rod, No.2 is earth, No.3 is clamp, and No.4 is earth electrode conductor.

B. Installation Conductor Cable

Roof conductors and lightning rod connections may be attached to the roof by means of conductor or insulating spacers and clamps the conductor may also be mounted on the surface of the wall if the wall is made of non-combustible material. Recommended conductor spacings are given in Table II. and as shown in Figure 7.

Fig. 7. Installation conductor cable.

TABLE II. Distance Between Clamps

Placement	Distance between clamps for tape conductors stranded conductor and soft round conductor (mm)	Distance between clamps for solid round conductors (mm)
Horizontal guides on a horizontal surface.	1,000	1,000
Horizontal conductor on a vertical surface.	500	1,000
Vertical conductors up to 20 meters above the ground.	1,000	1,000
Vertical conductors that are 20 meters or more above the ground.	500	1,000

C. *Installation Lightning Rod*

Lightning conductor poles nearby the building or equipment to be protected the objective is to reduce the possibility of lightning strikes on buildings within the protection zone where independent lightning protection systems are installed as shown in Figure 8.

Fig. 8. Installation lightning rod.

D. *Installation Ground Test Box*

Ground test box are available to measure the earth resistance of the earth-terminal system and the continuity of the connection point in the earth-terminal system at the connection point of the earth-terminal electrode. Each grounding conductor must be equipped with a ground test box.

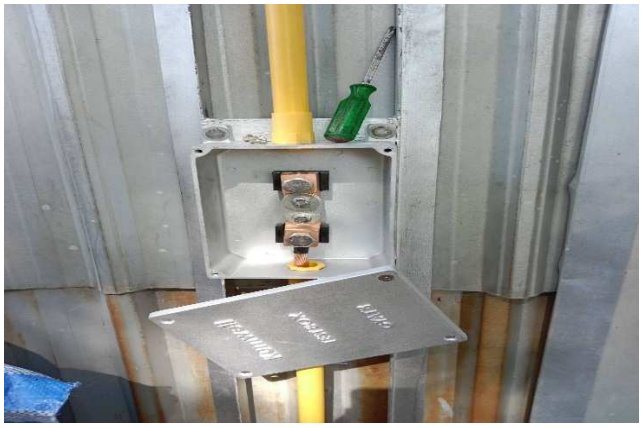

Fig. 9. Installation ground test box.

V. RESULT

Use the device Earth Tester 4105A measure the earth resistance of the designed and installed lightning protection system. The resistance value was obtained at the measurement point as shown in Table III and Figure 10.

TABLE III. THE RESULTS EARTH RESISTANCE

No.	Point of Measurement	Ohm Resistance Value
1	Earth Bus	0.20 Ohm.
2	Earth Bus	0.21 Ohm.
3	Earth Bus	0.19 Ohm.
4	Earth Bus	0.20 Ohm.

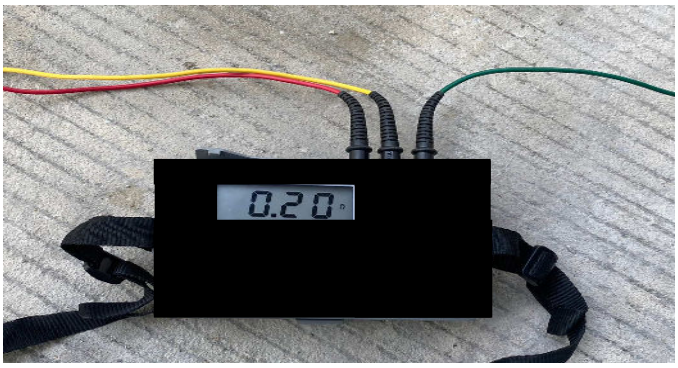

Fig. 10. Measuring Earth Tester Model 4105A.

VI. CONCLUSION

This paper presents the design and installation of a lightning protection system for a solar rooftop power generation system used as a case study by designing and installing the conductor positioning method, the rolling sphere method which is suitable for the protection of factory buildings and solar power generation systems with uncertain shapes the measured grounding resistance of the designed and installed lightning protection system is in accordance with the standards of the Engineering Institute of Thailand this shows that the proposed lightning protection system can actually be used.

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