EVALUATION OF THE EARTH RESISTANCE VALUE FOR ESE LIGHTNING ARRESTOR TECHNIQUE FOR THE SOLAR PLANTS IN INDIA

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ABSTRACT

The earth is the most ubiquitous conductive surface, and so it was assumed in the very beginnings of electrical transmission and distribution systems as a nearly universal standard for all electric systems. As the construction of the solar power plants has been initiated by the power developers in India since 2011[1]. The safety parameters of the equipment and manpower have become the most prominent issue for all against lightning strokes. Conventional earthing always played a vital role in avoiding all hazardous incidents. This paper theoretically analyzes the resistance value for the earth pits with the respective techniques which adequately meet with the earth resistance benchmark as per the international standards followed by the world. The Early Streamer Emission Lightning Arrestor (ESELA) is the most recognizable technique for the earthing system, which protects structures such as Inverter Rooms, Control Rooms, Module Mounting Structures or any other installed equipment from damage by intercepting flashes of lightning and transmitting their current to the ground.

Keywords: Earth Resistance Value; ESE LA;

1. Introduction

Lightning is one of nature's most vigorous and calamitous incidents. Lightning discharges contain astounding amounts of electrical energy and have been measured from several thousand amps to over 200,000 amps - enough to light half a million 100 watt bulbs. Even though a lightning discharge is of a very short duration (typically 200 microseconds) and it is a very real cause of

damage and destruction. The effects of a direct strike are obvious and immediately apparent - buildings damaged, trees blown apart, personal injuries and even death.
A reliable lightning protection scheme must encompass both structural lightning protection and transient overvoltage (electric systems) protection [2]
The theory of early streamer emission proposes that if a lightning rod has a mechanism producing ionization near its tip, then its lightning capture area is greatly increased [3].

When the voltage between the cloud and the ground increases until an ionized path is created emanating from the cloud. That ionized path travels in leaps towards the earth. The extremity of the leader has the same potential as the cloud. As the leader nears the earth, the atmospheric potential increases above the ground and the air terminal is electrically charged. When the extremity of the leader arrives at a critical position, the ESE air terminal reaches its maximum electrical charge, and the streamer emission of the accumulated current is produced on its extremity which ionizes the air around the summit. The electrical arc, generated at the tip of the ESE air terminal, provokes a streamer emission which rises toward the leader more quickly than on a simple rod (it is the early streamer emission). The link between the earth and the cloud is formed and the lightning current passes along the ionized path. Several electrical discharges can rapidly follow the first one. The voltages between the cloud and ground are equalized and electrical discharges cease [4].

Following standards are applicable for the earth resistance value of ESE type Lightning Arrestor:

1. As per the India Standard code of practice for earthing, the value of the earth resistance as using a common earth where the earth electrode resistance, including the parallel resistance of any bonded metalwork, etc, to earth is 1 Ω or less, as is usual at power stations, large outdoor substations or substations supplying a network of cables whose sheaths have a low impedance to earth [5]. This standard has been followed at all the solar plant in India, but this precise value sometimes does not observe exactly through earth resistance tester after completion of the

earthing works at the premises. Henceforth, there are other standards which can be followed for the authentication of earthing values at respective plants.

2. As per the IEEE Guide for Safety in AC Substation Grounding - IEEE Std 80-2000 (Revision of IEEE Std 80-1986), the evaluation of ground resistance for the most transmission and other large substations, the ground resistance is usually about 1 Ω or less. In smaller distribution substations, the usually acceptable range is from 1Ωto 5Ω, depending on the local conditions. The solar plants are mostly designed and interconnected at 33 kV voltage levels which come under smaller distribution substations.

3. Also, as per IEC 62305-1, edition 2.0 – 2010-12, the conventional earthing impedance related to the earth termination system is 04 Ω for the soil resistivity less than or equal to 100 Ωm as shown in Table 1.1

Table 1.1 Conventional earthing impedance values Z and Z1 according to the resistivity of the soil

ρ Ωm	Z1* Ω	Conventional earthing impedance related to the type of LPS** Z ***Ω		
		I	II	III - IV
≤100	8	4	4	4
200	11	6	6	6
500	16	10	10	10
1000	22	10	15	20
2000	28	10	15	40
3000	35	10	15	60

NOTE Values reported in this table refer to the conventional earthing impedance of a buried conductor under impulse condition (10/350μs).

* Values referred to external parts length over 100 m. For length of external parts lower than 100 m in high resistivity soil (>500Ωm) values of Z1 could be doubled.
** Lightning protection earthing system complying with 5.4 of IEC 62305-3:2010.
***The conventional earthing impedance of the earth termination system.
For the purpose of IEC 62305, four lightning protection levels (I to IV) are introduced. For each LPL, a set of maximum and minimum lightning current parameters is fixed.

4. The NFC 17-102, July 1995 states that the resistance value measured using conventional equipment should be 10 ohms or less. This resistance should be measured on the earthing termination insulated from any other conductive component.

Nomenclature	
ESE	Early Streamer Emission
IEEE	Institute of Electrical and Electronics Engineers
IEC	International Electro technical Commission
NFC	International French Standard
LA	Lightning Arrestor
GI	Galvanized Iron
LPS	Lightning Protection System

2. Structure

A 07 meters GI mast pipe in three equivalent lengths is joined on which ESE type LA assembly is mounted. This singular pipe length is supported by three guy wires tied at three anchors grouted in the ground. The ESE LA assembly is connected with the Copper strip (25 X 3 mm) for transmitting the lightning stroke to the ground directly. This copper strip is connected to the tripod earthing arrangement as shown in Fig.1.

This tripod earthing arrangement consists of three Cu cladded (250 microns) MS rod (2 meters) which are externally interconnected with the copper strip joining ESE LA assembly, an earthing chemical compound is also poured in it to reduce the earth resistivity as shown in Fig.2

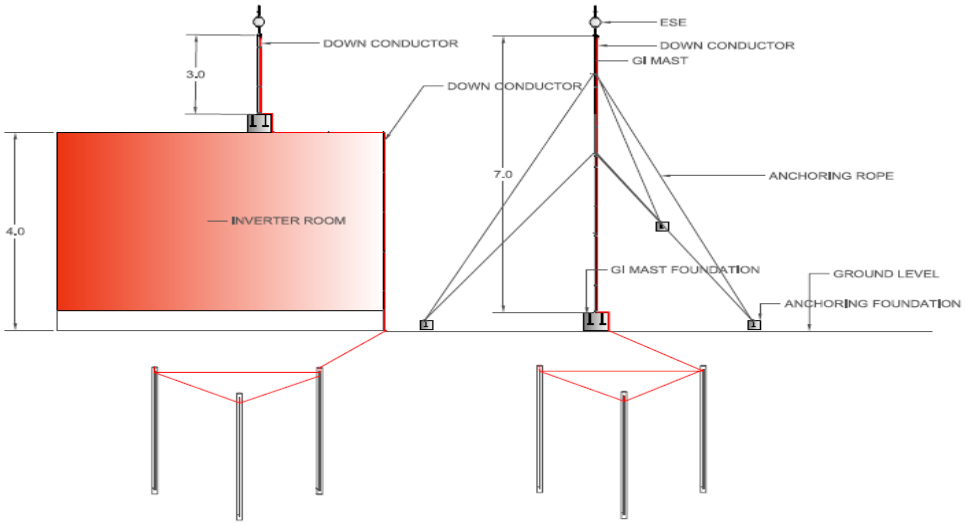

Fig-1

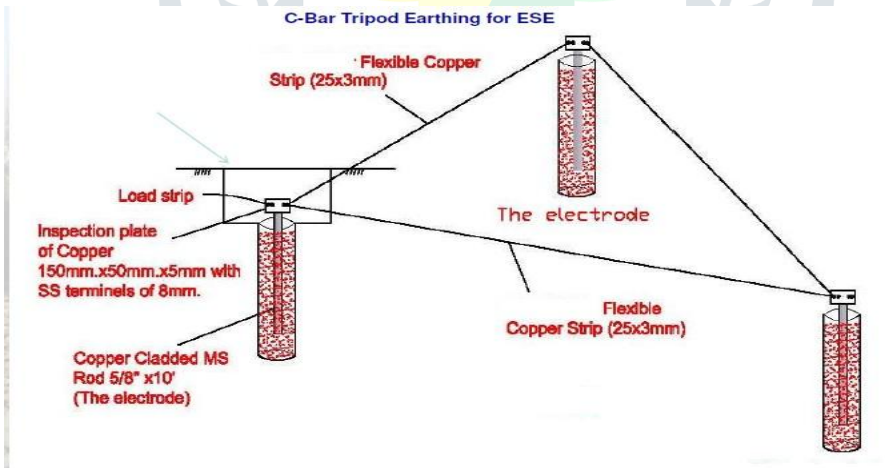

Fig-2

Conclusion

The following above mentioned standards elaborated above help us out in the approval of the mentioned ESE type LA technique as per the standards. These standard guidelines will make the Indian Solar Plant execution and completion faster than the previous time period since 2011.

References

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