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Cover Story
Switchgears - raising the standard of sustainability and innovation

In Focus
Solar energy harnessing system & its integration with grid

Special Feature
Building Atmanirbhar Bharat

Guest Article
Safety, standardization and non-standard lightning protection

COVID-19
Stay Safe

Safety, Standardization and non-standard **Lightning Protection**

Electricity has become an integral part of life; however, at the same time, it is responsible for causing damages to the physical property and fatal accidents. Despite being a basic need today, safety measures against electrical faults are generally overlooked. Electrical faults are becoming major threats to the rural as well as urban populations and settlements. The excessive dependence on the electronics and electrical appliances and lack of scientific safety measures have further escalated the threat of electrical hazards.

When it comes to use of products in the electrical engineering, it becomes extremely crucial that the products are in accordance with the recommended international standards. However, the scenario in the developing countries is quite different which is often superseded by some (1) superstitious claims (2) some hypothetical statements (3) fanciful and illusionary products.

World Trade Organization (WTO) treaty on Technical Barriers to Trade (TBT), recognizes only ISO, IEC and ITU standards as international standards. All member countries are supposed to abide the regulations, standards and conformity assessment documents by these recognized international organization.

The rules or the "code of practice" in making these "international documents" are simple and straightforward. These documents are supported by established and scientifically proven engineering practices, proven by research, accepted by the scientific community, out of patent controls, non-discriminatory, do not create unnecessary obstacles to trade and promote fair and transparent business.

Almost every UN member country are signatory to TBT agreements, including India.

National standards from different countries such as BS (UK), VDE (Germany), NFC (France), EN (European nations) and ANSI (USA) are widely used in India claiming "International". These are national standards of the respective country or area, which is influenced by the local condition and historic practices and are not truly "International Standard" for India. Often these national standards have discriminatory subjects, to support their local industry. As a result, following some national standards in India could harm the fair-trade practices and national interest.

Lightning protection is always a subject of debate due to the acceptance of ESE air termination by the French code NFC17-102.

This article compares an ESE rod used in India and a comparison to NFC 17-102 standard. It is scientifically proven that the ESE rods are not better than a simple iron rod, be it installed at world's tallest building or the shortest.

Nonstandard LPS Indian version of ESE air termination

A rod capturing a lightning and passing the lightning current to soil without damaging the building through a 70 mm2 copper flexible cable is called as active / advanced / modern lightning protection in India. As per the claims of the manufacturers, such rod attracts lightning from a distance of up to 110 meters, thereby protects an area of up to 200 meters (dia). They are also called early streamer emission (ESE), or controlled streamer emission (CSE) lightning protection systems.

As such the illusory idea of one rod protecting 200 meters (dia) looks impressive, added with names such as advanced, modern and active lightning rods, with a test certificate from CPRI strengthen this belief. In India, nearly 70% of industrial and commercial LPS installations are of ESE type. Almost 100% Solar PV installations follow ESE system.

Unfortunately, the actual scientific facts are not very favourable to ESE air termination rods.

The available literatures and documents claim that these rods "attract lightning" and protect structures within a radius of up to 110 meters. Due to the apparently fascinating story, the system seekers believe that this "active" method is "modern and advanced" in comparison to the "passive" "conventional" franklin rod which is 250 years old. Electrical managers are attracted towards this illusion and raise only one question "how many meters will it protect??". There are claims that even these rods protect an entire village or a town!!!

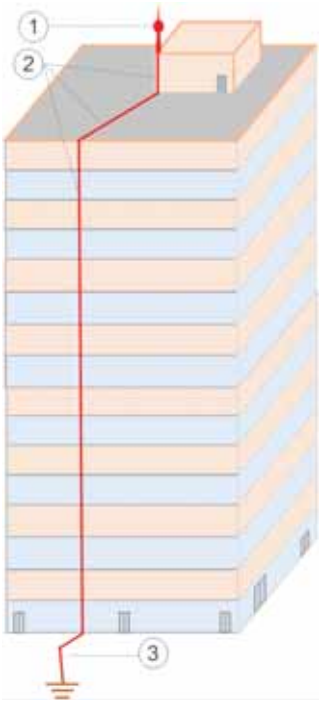

Fig1: Typical ESE in Highrise building

1. ESE air terminal rod mounted on a mast,
2. Down conductor - One number - 70 mm2 flexible conductor (1100-volt grade),
3. Earth pit.

In high rise buildings, down conductor runs through closed shafts, often electrical shafts.

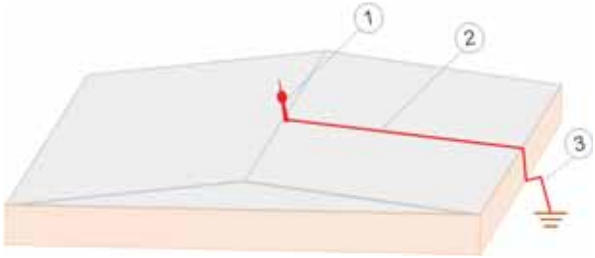

Fig1: *Typical ESE in Industrial Building*

1. ESE air terminal rod mounted on a mast,
2. Down conductor - One number - 70 mm2 flexible conductor (1100-volt grade),
3. Earth pit.

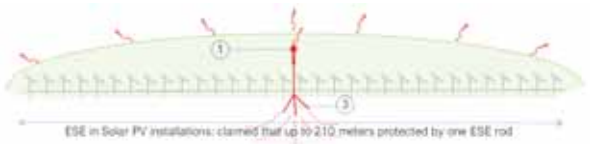

Fig. 1 to 3: typical ESE installations in India (without touching any metal parts)

ESE LPS in India

Majority of ESE systems used in India, a single down conductor is used that runs from the lower end of the air-termination to the ground. Thus, due to the insulation, lightning effects are separated from the rest of the structure. There are cases where the length of the down conductors is more than 100 meters.

The down conductor is then connected to a chemical earth pit which claims to dissipate the lightning current easily into the earth due to some "magic chemical compound".

The claim (protects 100+ meters)

The French standard NFC17-102 is the first national standard which accepted the claims of ESE rods. The claim is *"since ESE rods are efficient than a franklin rod in sending an upward streamer towards the downward leader of the lightning, probability of interception by ESE rod is higher than a conventional rod".*

The difference in the time of initiation of the upward streamer by a metal rod and an ESE rod is the "time advancement" of an ESE air termination (ΔT). Then considering a streamer speed of 106 m/s, the ESE manufacturers claim that their rods have a height advancement of $\Delta T \times 10^6$ m over the conventional rod. The value of ΔT is computed by observations of 2 m long rod – rod gap applied with laboratory sparks and then extrapolating the results to many tens of meter long upward leader.

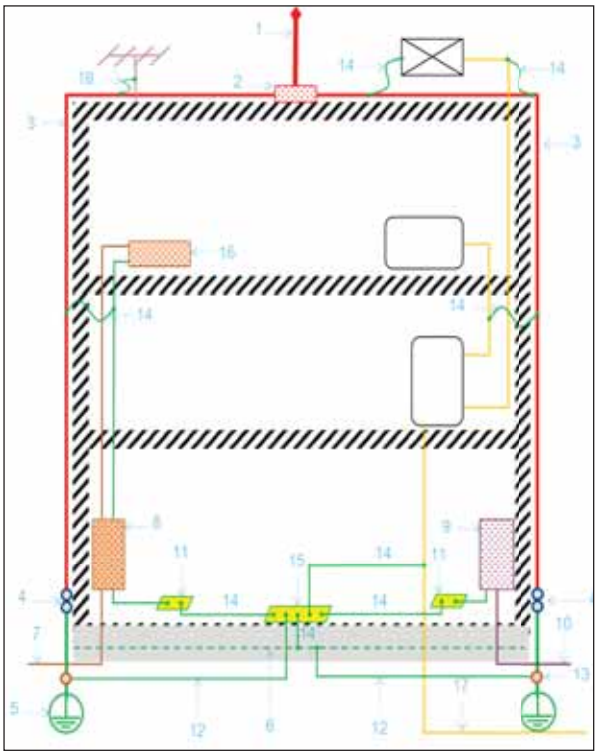

Fig. 4: Typical ESE installations recommended in NFC17-102 standard with equipotential bonding and several down conductors.

Scientific communities, including the leading Standard committees in the world, strongly reject these claims, as the available experimental and theoretical knowledge falsify the computation method of ΔT. Even the speed of the answering leader is measured to be 104 - 105 m/s, by fast video recording techniques available at present. This results in 10 -100 times decrease in the efficiency (height advancement) of these rods. The working principle of these rods are included either in IS standards or in IEC and most other international/nat ional standards.

1	One or more air terminal
2	Connection component
3	Down conductor
4	A test joint for each down conductor
5	One earth termination for each specific down conductor
6	Foundation earth electrode (earthing of structure)
7	Electric power cable
8	Main electric power distribution box with SPD
9	Main telecommunication distribution box with SPD
10	Telecommunication cable with SPD
11	One or more equipotential bonding bars
12	One or more equipotential bonding's between earth terminations
13	Dis-connectable bonding device
14	One or more equipotential bonding's (direct or via isolation spark gaps)
15	Main earthing bar
16	Electrical equipment
17	Metallic pipe
18	One or more equipotential bonding's through spark gap for aerial mast

Explanations from the standard NFC17-102

Even if we consider to accept the NFC17-102, the methods practised in India becomes highly questionable. The system as per NFC17-102 is shown in figure 4, consisting of

1. ESE air terminal.
2. Down conductors (several down conductors are necessary).
3. One specific earth electrode for each down conductor and a foundation earthing system.
4. Several equipotential bonding between the building metal parts and LPS.

As such, the NFC standard explains about a proper equipotential bonding system and a LPS, rather than using a PVC insulated down conductor which may cause dangerous potential differences between the down conductor and the nearby metallic parts of the structure.

The NFC standard also explains about the conditions of multiple down conductors, methods of calculating separation distance, methods of equipotential is at ion, conditions with which efficiency (radius of protected area) is reduced etc.

In contrast, the installations in India follow a deceptive concept and claim that one rod (protecting 100+ meters), one down conductor and one earth electrode are conforming to NFC17-102 standard. Other than the air terminal, one down conductor and an earth pit - balance safety measures recommended in the NFC standard are missing in India, making the installation highly vulnerable to lightning strike.

CPRI test

NFC17-102 recommend the ESE rod to be tested to prove its ΔT, as this is the most important parameter deciding the controversial protection radius. However, the rods sold in India are tested with a totally different concept.

ESE rods sold in India are tested at CPRI for a short time current of few 10's of kA's. This test at CPRI have no relation to the ESE concept. However, users accept this test report as a proof of the efficiency of ESE rods.

Tenders and purchase notices published in media show that ESE rods with CPRI test report have become a normal practice in India. This nonstandard method is also accepted by safety agencies such as the electrical inspectorates in few states.

ESE installations in Malaysia

There were several damages in buildings in Malaysia where ESEs are installed. Malaysia adopted IEC 62305 as the national standard for Lightning Protection during 2014.

As a result of the failures of ESE rods, the energy commission of Malaysia made a directive *(energy commission direction/ST/No.4/2019, electricity supply act 1990 [act 447])* as

" In accordance with the provisions under section 47, electricity act 1990 [act447], the commission hereby stipulates that the design, installation, supervision, testing, operation and maintenance of lightning protection device in buildings shall be made in accordance with the method of lightning protection system set by standard Malaysia MS IEC 62305 – Protection against lightning".

"It is reminded that, someone who found failed to comply with the commissions directive is to commit an offense and shall in conviction, be liable to a fine not exceeding two hundred thousand ringgit (MYR 200,000.00) or to imprisonment for a term not exceeding two years or to both in accordance with the provision of section 50 E, electricity supply act 1990 [act 447]".

As a result of this directive, in Malaysia, it is mandatory to use LPS as per MS IEC 62305, violations will be treated as an offense and the violators are liable for a fine and/or imprisonment.

Government of India shall enforce this kind of a regulation in India to stop non-scientific lightning protection system.

Dangers of nonstandard LPS installation

ESE rods installed in Industrial buildings, Commercial buildings, High-rise buildings, Explosive areas (oil and gas industry), Power generating stations, Telecom and buildings of historic importance pose a serious threat to the building and its contents.

National Building Code of India (NBC-2016) in clause 11.5.1 (air-termination) (volume-2, part-8 building services, section-2 electrical and allied installation) mentioned,

"Radioactive air terminals shall not be allowed. Any other kind of air-terminal like dissipation system / ESE air-terminal / CSE air-terminal shall not be acceptable".

ESE lightning rods is sold and used in India due to its superstitious claims, hypothetical statements, fanciful and illusionary specifications propagated by the supplier for business, but in practical they are "just for name's sake purpose".

Conclusion

ESE rods shall be treated equal to a normal rod as the experiments by various scientists and universities proved that ESE rods are not better than a simple iron rod.

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3 WTO | Understanding the WTO - Standards and safety

4 Technical Information Services - Bureau of Indian Standards (bis.gov.in)

5 NFC17-102: French standard Protection against lightning Early streamer emission lightning protection systems

6 IS/IEC 62305 Indian standard, Protection against lightning ■

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Member

IEC:TC64 (LV electrical installation)
MT3, MT12, MT40, MT41, PT60364-8-3, WG43.
TC 81 (Lightning protection) MT 3, MT 14, WG 18, AHG 19, MT 21.
SC 37 A (SPD's) WG03 & 05.
BIS: Electrical committee (NBC-2016), ETD 20 (NEC, IS3043, IS732) & ETD 30