CEEAMA
Consulting Electrical Engineers Association of Maharashtra

CEEAMA *Live Wire*

E-NEWSLETTER

Published by Consulting Electrical Engineers Association of Maharashtra

Topic for April 2024
EARTHING AND LIGHTING PROTECTION

Read about Importance of Earthing..
Because safety is utmost priority..!!

Scientists born in February
Prof. H C Verma
More about him inside

Electrical Consultants Newsletter
Volume No. 4 Issue #39
April 2024

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Chief Editor - CEEAMA LIVEWIRE

From the Editors Desk,

Thank you, readers, for the overwhelming response we received from you guys on our March LiveWire! It means a lot when our efforts get appreciated and encourages us to do more.

Our quest to spread knowledge in the industry keeps growing. We would like to thank M/s. Telawane Power Equipment for welcoming our delegation to their Taloja MIDC facilities and M/s. Connectwell Industries to their Dombivali MIDC works.

CEEAMA admin team took great efforts in arranging the necessary logistics for our delegates of around 25+ from Pune & Mumbai with necessary financing from CEEAMA themselves.

This month, we deal into another important subject of the industry – Earthing and Lightning Protection. This subject is multi-faceted; intrigue, mesmerising, debatable, and subject to various ideas and methods over the years right from the days when Lightning used to be called wrath of God and how my God-fearing yet scientifically cultured ancestors used to throw Iron-bars on open grounds to "scare-away" the "Lightning-satans" to the present-day so-called scientists inventing the highly objectionable Early streamer LA. Well, the controversies are abundant. But let's try to understand academically and focus on the prevailing rules, regulations and standards.

Wishing you all a very electrifying, but "SAFE" days ahead!

Subhash L. Bahulekar

Chief Editor – CEEAMA

From the President's desk:

Hello friends!

As we say Goodbye to the previous financial year, I am sure it has set all of us on a growing path. Now it is time to plan for next year's goals, to set higher targets to achieve. Based on the booming Infrastructural growth, most of the electrical Industries are on the path of multiple expansions.

Our country is creating global records in non-conventional energy projects, while creating tremendous opportunities for transmission and distribution. This is a great accelerator for electrical manufacturing industries including Conductors, HT/LT cables, Transformers, HT/LT switchgears, HT/LT panels and allied electrical material.

The development in the digital technology and use of AI changes the dynamics of consultants, manufacturers, suppliers as well as contractors. It falls upon us to convert this challenge into opportunity.

In March, CEEAMA had organized two factory visits - On 16th we covered Telawane Powertech at Taloja MIDC and Connectwell Industries at Dombivali MIDC. Our 27 LFMs from Mumbai, Pune, Nasik and Aurangabad spent their entire day for this visit. The enthusiasm was mutual and the experience was appreciated by all.

April LiveWire shall be focused on Earthing and Lightning protection systems. I make a humble appeal to all LFMs as well as AMs to share the maximum articles on any technical subject.

Wish you good luck for coming financial growth.

Mr. Veejhay Limaaye

Hon. President

CEEAMA

From the Secretary's desk:

Dear Friends,

Wishing you a very prosperous and a happy new financial year.

It is the onset of the Indian Summer now. The India Meteorological Department said a couple of days ago that India is likely to experience a warmer summer this year with El Nino conditions predicted to continue at least until May 2024. One of my friends asked: Why is India becoming so ridiculously hot nowadays? Summer has not even begun and it is already 40°C. I just stretched the question to Electrical Engineering.

Summer can have several impacts on electrical equipment. There would be an increased electricity demand which, typically rises due to increased use of air conditioning, fans, and other cooling devices. This can put stress on the electrical grid and lead to potential brownouts or blackouts if the supply cannot meet the demand. High temperatures can cause electrical equipment to overheat, especially if it is already operating close to its maximum capacity. This can lead to malfunctions, reduced efficiency, or even permanent damage to the equipment.

Summer weather often brings dust storms and increased outdoor activity, which can result in the accumulation of dust and debris on electrical equipment. This buildup can impede airflow, impede natural cooling leading to overheating, or cause electrical connections to become compromised. High temperatures can cause power lines and transformers to expand, leading to voltage fluctuations or power surges. These fluctuations can damage sensitive electrical equipment such as computers, servers, and electronic devices. In some cases, temperature differentials between the interior and exterior of electrical equipment can cause condensation to form. This moisture can lead to corrosion and short circuits, particularly in outdoor or poorly insulated equipment.

Summer can also have various effects on earthing systems, which are crucial for ensuring the safety and proper functioning of electrical installations. In summer, especially in dry regions or during drought conditions, soil moisture levels may decrease. This can affect the conductivity of the soil and, consequently, the effectiveness of earthing systems. Dry soil has higher resistance, which can reduce the efficiency of earthing electrodes in dissipating electrical faults or lightning strikes. High temperatures and dry conditions can accelerate the corrosion of grounding electrodes, such as copper rods or plates buried in the ground. Corrosion can degrade the effectiveness of the grounding system over time, leading to increased resistance and potentially compromising safety. Fluctuations in temperature during the summer months can cause the ground to expand and contract. This movement can affect the physical integrity of grounding electrodes and connections, potentially loosening them or causing them to shift, which can increase resistance and degrade earthing performance.

In India, if summer season is around can rainy season be far away? With the rainy season comes the dance of the clouds followed by lightning, which require proper grounding systems. To mitigate the impacts of summer on earthing and grounding systems, it's important to regularly inspect and maintain grounding electrodes, ensuring they are free from corrosion and securely connected to the electrical installation. Additionally, measures such as using multiple grounding electrodes, employing chemical treatments to enhance soil conductivity, and incorporating surge protection devices can help improve the resilience of earthing systems in challenging summer conditions.

Enjoy our edition on earthing and lightning protection. Happy grounding to you!!

Mr. Chidambar Joshi

Hon. Secretary

CEEAMA

(NBC-2016)

The history of lightning protection dates to the 1700's, although there have been a few advancements to the technology since then. In fact, even today, common products being offered are frequently, merely, small traditional lightning rods connected with a maze of exposed wires – technology that dates from the 1800's.

Lightning protection science was first conceived by Benjamin Franklin in 1749 with his invention of the first pointed lightning rod conductor that became known as a "lightning attractor" and much later as the "Franklin Rod." Franklin spent many years in the lightning protection design process to include his famous kite experiment, which took place as he was waiting for permission to test his theories on the new Christ Church structure in Philadelphia, PA. Although Franklin did not patent any of his inventions, he published advice on lightning protection in Poor Richard's Almanac in 1753. For his "experiment of procuring lightning from the clouds by a pointed rod," Franklin was made an official member of the Royal Society in 1753.

At that time, the common belief was that lightning was a creation of God and therefore should not be interfered with in anyway. Franklin was finally able to convince the church deacons that they should take precautions against lightning damage by installing the lightning protection he designed, citing that rain was also a creation of God but roofs were still used on buildings to protect people and contents of buildings. The discovery of how electrical current travels brings to mind an image of Benjamin Franklin standing in a thunderstorm holding one end of a kite and waiting for lightning to strike.

For many years, all lightning protection consisted of a Franklin Rod designed to attract lightning and take the charge to ground.

In 1836, the Faraday Cage System came into existence as the first update to the lightning rod. The Faraday Cage System is basically an enclosure formed by a mesh of conducting material on the roof of a building. Named after the English scientist Michael Faraday, who invented them in 1836, this method is not totally satisfactory because it leaves areas in the centre of the roof between the conductors unprotected, unless they are defended by air terminals or roof conductors at higher levels.

In a Faraday Cage System, the lightning protection comprises of multiple lightning rods about 300mm each, fixed on discrete points on the roof. They must be bonded together with roof conductors and many down conductors to form a cage and have air terminals at the intersections of centre roof areas. The Faraday method was considered costly to install, required large amounts of equipment on a rooftop and multiple roof penetrations, but until the mid 1900's, there was nothing better.

During the 19th century, lightning protection became an architectural addition to many public and private structures. The overall pointed rod design was complimented with ornamental solid glass balls, which were not only decorative but were believed to be an integral element in the effectiveness of the lightning protection of the structure. The theory behind this addition was that since glass is a non-conductor of electricity that they would repel the charge and for a time, because of the erratic behaviour of lightning it was believed this was scientifically proven.

Both, the pointed design and the addition of the solid glass balls were soon proven by Nicola Tesla to be a flawed lightning protection design. Tesla's patented design was a great improvement over Franklin's original lightning protection of the pointed rod. In 1919, years after receiving his patent, Tesla published an article, "Famous Scientific Illusions" in The Electrical Experimenter explaining the logic he used to dispel the science of Franklin's pointed lightning rod and scientific knowledge he used to design his lightning protection device. In his article, Tesla proved that the pointed tip of the iron rod actually ionised the air around it, which rendered that air conductive and raised the probability of a lightning strike.

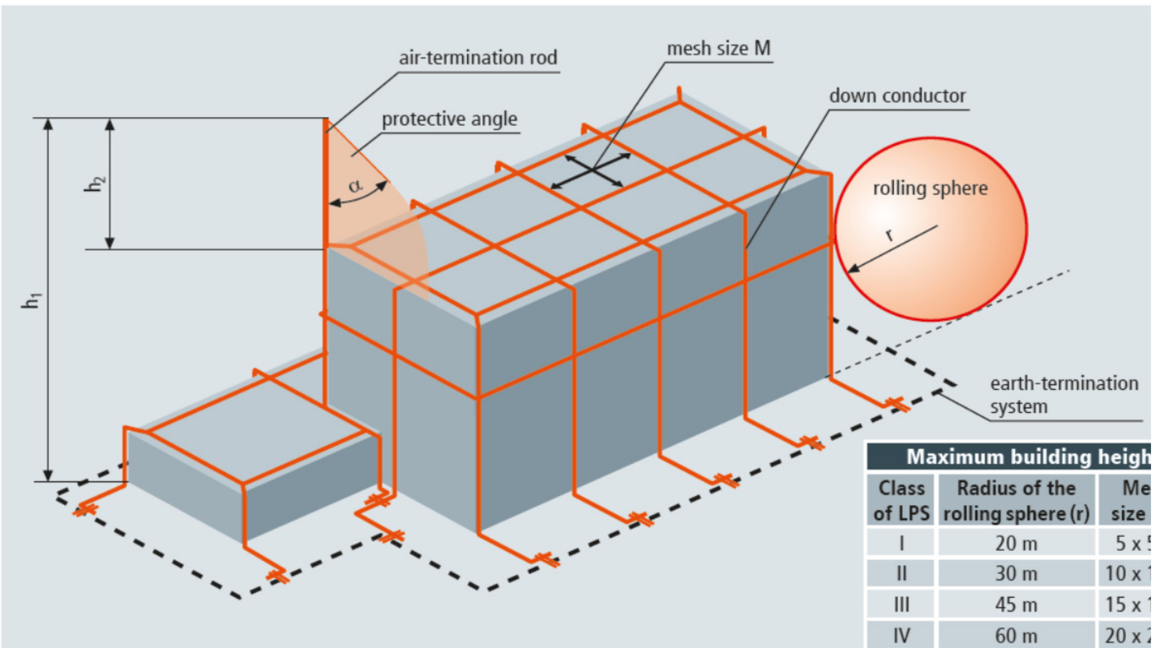
Over the decades, since Franklin and Tesla, there has been much progress in lightning protection systems. Great innovations in design and methodology have advanced the protection of mission critical systems for military and government operations and commercial applications. From transportation system control centres to mobile phone transmission towers, the instances of catastrophic damage to these and other services we had all come to take for granted has been greatly reduced.

In 1953 came the Early Streamer Emission (ESE) type Preventor. The ESE Preventor is an ionizing air terminal which is dynamic in operation. J.B. Szillard began experimenting with ionizing lighting conductors in France, and in 1931, Gustav Capart patented such a device. In 1953, Gustav's son Alphonse improved on his father's revolutionary device, and his invention resulted in what we know today as the ESE Preventor.

Preventors are dynamic in operation, whereas, the former methods are static. For example, when a storm cloud approaches a protected building, the electric ion field between the cloud and ground is increased. The ions constantly flowing from the unit, carry some of the ground ion charges towards the cloud, and this has the effect of temporarily lowering the intensity of the ion field between cloud and ground. It must be clearly understood that it cannot neutralize a cloud. It does no more than reduce the tension for the small time during which the cloud is passing overhead – but this temporary lowering of the tensions is sometimes sufficient to prevent a lightning discharge from triggering off. On the other hand, when this lowering of tension is inadequate to prevent triggering, a conductive ion streamer is provided to conduct the discharge safely to the earth / ground system.

The probability of lighting falling over a structure is determined through a Rolling Sphere Method, these days. The Rolling Sphere Method (RSM) is indeed commonly used in the field of lightning protection engineering. It's employed to determine the protection radius around lightning rods or air terminals, ensuring that they adequately shield a structure from a direct lightning strike.

The principle behind the Rolling Sphere Method is to imagine a sphere rolling over the structure. The radius of this sphere is determined based on the height of the air terminal or lightning rod above the protected structure. The sphere is then rolled along the surface of the structure, and any point that comes within the sphere's reach represents a location where a lightning rod should be placed for protection.



While the Rolling Sphere Method is widely used and relatively straightforward, it does have limitations. It assumes a uniform electric field around the structure, which may not always be the case in complex terrain or in the presence of nearby tall objects. Additionally, it doesn't account for factors such as the shape and conductivity of the structure, which can affect the distribution of lightning currents.

As a result, engineers often use computer simulations or more advanced analysis techniques in conjunction with the Rolling Sphere Method to ensure comprehensive lightning protection design. These may include methods like the Electrogeometric Model (EGM) or finite element analysis (FEA) to provide a more accurate assessment of lightning risk and protection effectiveness.

The International Electrotechnical Commission (IEC) standard 62305 series, titled "Protection against lightning," does recommend the use of the Rolling Sphere Method (RSM) as one of the approaches for determining the protection zones for structures. IEC 62305 provides guidance on lightning protection measures for structures and their contents, as well as for the building occupants. India has adopted this IEC 62305 as Indian Standard in 2015, whereas many countries have adopted it as their national standard, many years back.

The Rolling Sphere Method is described in detail in Part 1 of the IEC 62305 series, which covers general principles of lightning protection. Specifically, Annex C of IEC 62305-1 outlines the Rolling Sphere Method and its application for determining the zones of protection around structures. This method is widely used in the lightning protection engineering field and is recognized by various international standards.

While the Rolling Sphere Method is recommended by IEC 62305, the standard also acknowledges other methods and considerations for lightning protection design, such as the mesh method and the collection volume method. Engineers are encouraged to select the most appropriate method based on the specific characteristics of the structure, the lightning risk, and other relevant factors.

Process of Modern Lightning Protection Design and Implementation (in India)

The International Electrotechnical Commission (IEC) provides guidelines for lightning protection design through various standards, including IEC 62305 series. A step-by-step approach is as under:

1. Risk Assessment: Identify the structure or installation to be protected. Assess the risk associated with lightning strikes based on factors such as location, topography, structure height, and the consequences of damage.

2. Protection Level Selection: Determine the required level of protection (LPS) based on the risk assessment. This involves selecting the appropriate lightning protection level (LPL) according to the IEC 62305 standard. The LPL defines the maximum level of lightning electromagnetic impulse (LEMP) that the lightning protection system (LPS) should be capable of withstanding without failure.

3. Lightning Protection System Design: Design the lightning protection system (LPS) components including air termination system (lightning rods or air terminals), down conductors, and earthing system. Ensure that the design meets the requirements specified in the chosen protection level (LPL).

4. Air Termination System: Determine the layout and positioning of air terminals (lightning rods) based on the shape, size, and construction of the structure. Ensure adequate coverage of the protected area to intercept lightning strikes.

5. Down Conductor System: Design the down conductor system to safely conduct lightning currents from the air terminals to the grounding system. Minimize the risk of side-flashes or secondary strikes by providing a low-impedance path for lightning currents.

6. Earthing System: Design the earthing system to safely dissipate lightning currents into the ground. Ensure low impedance connections between all components of the lightning protection system and the ground to minimize the risk of damage due to ground potential rise.

7. Bonding: Ensure proper bonding of all metallic components within the structure to prevent potential differences and reduce the risk of damage from lightning-induced surges. An interconnection between earthing conductors and lightning protection system is as indicated in the National Building Code 2016. (Refer Figure extracted from the NBC 2016).

8. Surge Protection: Install surge protection devices (SPDs) at vulnerable points within the electrical or electronic systems to prevent damage from transient over-voltages caused by lightning strikes.

9. Inspection and Maintenance: Regularly inspect and maintain the lightning protection system to ensure its continued effectiveness. Repair or replace any damaged components promptly to maintain the system's integrity.

10. Documentation: Keep detailed records of the lightning protection system design, installation, and maintenance activities for future reference and compliance verification.

Earthing and Bonding – extract from NBC 2016

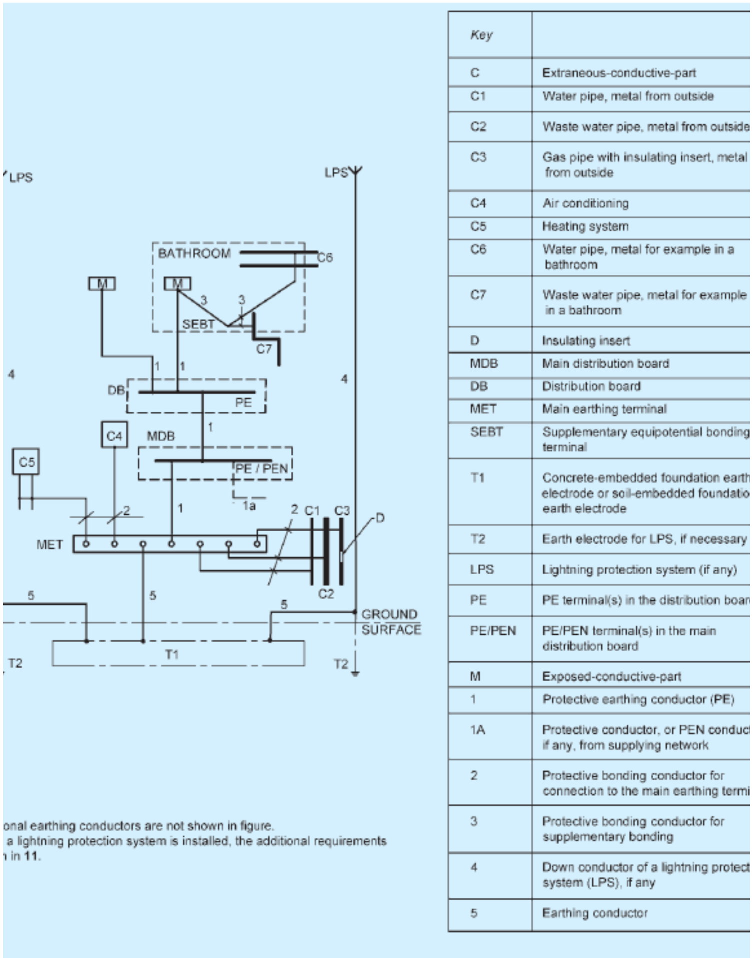


Fig. 5 Example of an Earthing Arrangement for Foundation Earth Electrode, Protective Conductors and Protective Bonding Conductors

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6. ERICO catalogues
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9. Google Research

Contributor:

Chidambar V. Joshi

1. Reference Standards:
   - IS 3043 : 2018 - code of practice for earthing
   - IEEE-80 - IEEE guide for safety in ac substation grounding
   - BS-7430 - for earth rod resistance

2. Earthing Calculation:
   - Collect the inputs required for earthing calculations :
     - Soil resistivity report
       - As per IS 3043 : 40.3.1 werner four electrode method is recommended for calculating soil resistivity.

$$\rho = \frac{\frac{4s\pi V}{I}}{1 + \frac{2s}{\sqrt{s^2 + 4e^2}} - \frac{2s}{\sqrt{4s^2 + 4e^2}}} \quad \ldots.(7)$$

where

ρ = resistivity of soil in ohm-metre,

s = distance between two successive electrodes in metres,

V = voltage difference between the two inner electrodes in Volts,

I = current flowing through the two outer electrodes in amperes, and

e = depth of burial of electrode in metres.

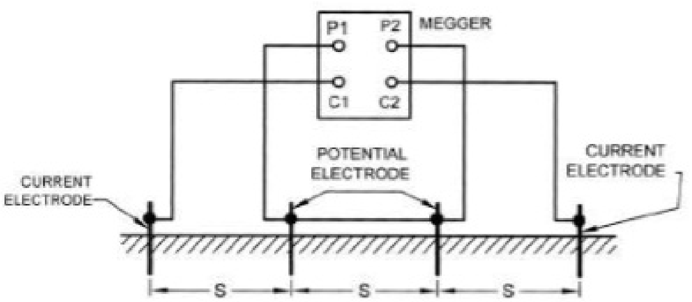

FIG. 47 CONNECTIONS FOR A FOUR-TERMINAL MEGGER

       - Werner method arrangement and formula.

     - Fault current and withstand time
       - Fault current and withstand time shall be calculated based on system study and fault clearing time.

     - K – factor: material constant:

Table 10 Material Constants
(*Clause* 17.2.2.1)

Material	B (°C)	Q_c (J/°C mm^3)	δ_{20} (Ω.mm)	$\sqrt{\frac{Q_c(B+20)}{\delta_{20}}}$
(1)	(2)	(3)	(4)	(5)
Copper	234·5	3·45 × 10^{-3}	17·241 × 10^{-6}	226
Aluminium	228	2·5 × 10^{-3}	28 264 × 10^{-6}	148
Lead	230	1·45 × 10^{-3}	214 × 10^{-6}	42
Steel	202	3·8 × 10^{-3}	138 × 10^{-6}	78

$$k = \sqrt{\frac{Q_c(B+20)}{\delta_{20}} I_n \left(1 + \frac{\theta_f - \theta_1}{B + \theta_1}\right)}$$

where

Q_c = volumetric heat capacity of conductor material (J/°C mm^3),

B = reciprocal of temperature coefficient of resistivity at 0°C for the conductor (°C),

δ_{20} = electrical resistivity of conductor material at 20°C (Ω.mm),

θ_1 = initial temperature of conductor (°C), and

θ_f = final temperature of conductor (°C).

formula to be used to derive k-factor.

Table 11D Protective Bare Conductors in Hazardous Areas where there is Risk of Fire from Petroleum Bound Oil or Other Surrounding Material
Boundary Conditions: Initial Temperature: 40°C; Final Temperature 150°C/200°C.

Material	Copper	Aluminium	Steel
1 s current rating in A/mm^2 (k_1)	131/153	86/101	47/56
3 s current rating in A/mm^2 (k_3)	76/88	50/58	27/32

Table 11A Bare Conductor with No Risk of Fire or Danger to any Other Touching or Surrounding Material
Boundary Conditions: Initial Temperature. 40°C Final temperature 395°C for copper; 325°C for aluminium; 500°C for steel

Material	Copper	Aluminium	Steel
1 s current rating in A/mm^2 (k_1)	205	126	80
3 s current rating in A/mm^2 (k_3)	118	73	46

    - select the k-factor based on selected material and area classification.
  - Corrosion factor
    - We are considering corrosion factor based on soil resistivity at site.

Sr. No.	Range of soil resistivity	Class of soil	Corrosion factor
1	Less than 25	Severely corrosive	0%
2	25-50	Moderately corrosive	15%
3	50-100	Mildly corrosive	15%
4	Above 100	Very mildly corrosive	30%

Select the material corrosion factor as per site soil resistivity data.

- Calculate minimum cross section area.
  - Min cross section area :

As per cl. 13.6.1 steel conductor in the soil of other than very mildly corrosive (i.e. Resistivity above 100) should be atleast 6mm thick if it is steel flat and have a diameter of atleast 16mm if it is in the form of steel rod.

- As per cl. 17.2.2.3 the cross-sectional area of every protective conductor which does not form part of the supply cable or cable enclosure shall be, in any case, not be less than:
  - 2·5 mm^2, if mechanical protection is provided.
  - 4 mm^2, if mechanical protection is not provided

$$\frac{I}{S} = k \frac{1}{\sqrt{t}}$$

where

S = cross-sectional area, in square millimetres;

I = value (ac, rms) of fault current for a fault of negligible-impedance, which can flow through the protective device, in amperes;

t = operating time of the disconnecting device, in seconds; and

NOTE — Account should be taken of the current-limiting effect of the circuit impedances and the limiting capability (joule integral) of the protective device.

k = factor dependent on the material of the protective conductor, the insulation and other parts, and the initial and final temperatures. Values of k for protective conductors in various use or service for t = 1 s and 3 s respectively are given in Table 11A to 11D.

- Formula for calculating minimum cross section area of strip

- Calculate earth electrode resistance.
  - The resistance of a plate electrode (R) is calculated based on IS-3043 section 14.2.1
  - R = ρ / 4 (√ π/a) (ohms)

    Where, ρ = soil resistivity (ohm-m)
    a = area of both sides of the plate (m^2)

  - The resistance of a pipe electrode (R) is calculated based on IS-3043 section 14.2.2
  - R = 100ρ / 2πl ($\log_e$ (2 l /d)) (ohms)

    Where, ρ = soil resistivity (ohm-m)
    l = length of pipe electrode (cm)
    d = diameter of pipe electrode (cm)

- Calculate earth strip resistance.
  - The resistance of a strip or conductor (R) is calculated based on IS-3043 section 14.2.3
  - R = 100ρ / 2πl (loge (4 l /d)) (ohms)

  Where, ρ = soil resistivity (ohm-m)
  l = length of strip (cm)
  d = width(strip) twice the dia. (conductor) (cm)
- Calculate the overall resistance of the system which includes the resistance of all earth electrodes and earth strips connected in parallel.
- Total resistance of the system should be less than 1 ohm.

- Calculate fault current dissipation.
  - Fault current dissipation as per IS 3043 cl. 15.3 - maximum permissible current density:
    $I = (7.57 \times 10^3) / \text{sqrt}(\rho \times t)$ A/m^2

    Where , t = duration of earth fault (in sec)
    ρ = soil resistivity (ohm-m)

- Calculate the fault current dissipated by each rod.

- As per IS 3043 cl. 27.3.1 : the standard earth resistivity values typically vary in the range between 10 and 1000 ohms. In this range of variation, it can be reasonably assumed that the fault current division at the point of entry to the earth grid is 20 to 80 percent.

- Based on fault current and division factor select the number of electrodes required to dissipate fault current.

- **Conclusion:**

  Select the total number of electrodes as the total resistance of earthing grid should be less than 1 ohm and it shall be suitable to dissipate fault level of the system.

  Size of earth strip shall be based on calculated minimum cross section area.

  IS 3043 – 2018 also says that there is no need for providing hundreds of earthpits at site. It is also a standard practice followed by LV side earthing everywhere in the world. In most of the present designs in India – importance of "Fault clearing time" and its relationship with Earth conductor sizing is also not understood properly. Even if one gets Earthpit resistance as 10 ohms, and 10 such earthpits are paralleled, one each located at each load center within the plant (may be two can be provided considering redundancy) are enough. It is high time we should try to impress upon the importance of "Equipotential bonding", "Earth loop Impedance – meeting requirements of upstream breaker trip" on designers rather than providing hundreds of earthpits generating meaningless business for earth electrode manufacturers and in the process NOT PROVIDING REAL SAFETY.

  Consideration should be whether there is adequate coordination between the physically obtainable value of the earth resistance and setting of the protective devices. This aspect is very much relevant in the case of installations where the value of earth resistivity is abnormally high.

  Courtesy : IS : 3043 - 2018

Contributed by

Aagam Vora

L&T Technology Services

CEEAMA pays tribute to scientists born in April
Prof. Harish Chandra Verma

Prof. Harish Chanda Verma

H C Verma born on 3 April 1952, popularly known as HCV, is an Indian experimental physicist, author and emeritus professor of the Indian Institute of Technology Kanpur. In 2021, he was awarded the Padma Shri, the fourth highest civilian award, by the Government of India for his contribution to Physics Education. His field of research is nuclear physics.

Prof. Verma has developed more than 600 physics experiments which can be used by teachers as DEMO in their classrooms. Besides this, informal open-ended experimental activities have been developed where students are initiated in a direction and they conceive, assemble and perform experiments on their own. He conducts workshops for Physics school teachers where he impresses upon them, use of DEMO-based physics teaching in which students can connect science with life. Through these extensive series of workshops Prof. Verma has motivated large number of Physics teachers and they have transformed a great deal the way physics is taught in schools. So far, Prof. Verma might have given training to more than 8000 teachers. According to the feedbacks received, about 800 of them have changed their approach and now they are enjoying Physics much more. From these, he has made an informal group called Utsahi Physics Teachers. Every year in summer, Prof. Verma conducts a 6-day workshop of about 50 utsahi physics teachers of which about 35 are new additions. This activity is financially supported by National Academy of Sciences India (NASI).

Prof. Verma has developed more than six hundred 'low cost' physics experiments that teachers can employ in their classrooms. In 2011, he set up the National Anveshika Network of India (NANI), a flagship program of the Indian Association of Physics Teachers (IAPT). He is the national coordinator for this program. There are currently 22 Anveshikas in the country.

Prof. Verma has deep interest in the glorious traditions of science in Ancient India. He has researched through the literature available in various journals and gives talks on this topic. His talks on Mathematics before ZERO, Computation sciences in Ancient India, Surgery: A 9000 years old tradition in India. etc. have been widely appreciated by the audiences.

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LIGHTNING PROTECTION LAYOUT

ABSTRACT

The article is intended to understand Preparation of lightning protection layout.

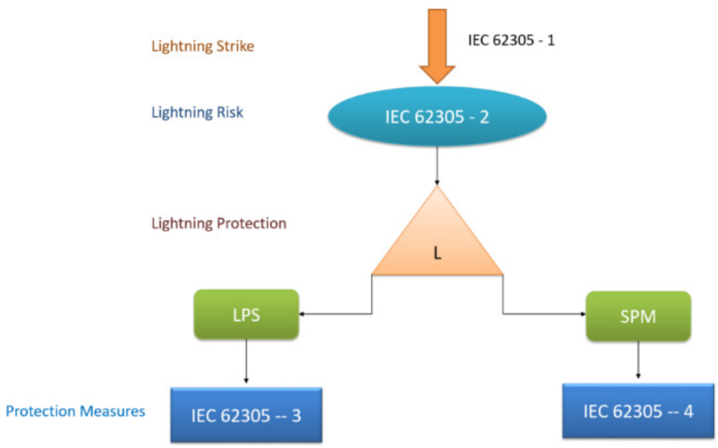
The points covered in this article shall be taken care during Lightning Protection Layout preparation.

1. ABOUT LIGHTNING STRIKES:

1. Lightning strikes can result in mechanical interruptions, chemical spills, flames, explosions, or explosions within or outside of structures. They can also produce electrical discharges caused by neighboring lightning. Step and contact voltages produced by a lightning strike have the potential to harm or even kill nearby humans and animals.
2. Building damage from lightning strikes is prevented or reduced with the installation of lightning protection systems. They guard a building's interior electrical systems, assisting in the prevention of fires and electrocution. A lightning conductor, which is often a metal rod, is installed atop a building to provide lightning protection from lightning strikes. The lightning rod will be struck first by the system, allowing the strike to be transmitted through a wire and safely reach the ground in the event that lightning strikes the structure.

2. STANDARDS TO BE FOLLOWED:

- IEC 62305



- NFPA 780
- IEEE 80
- British Standards (BS 6651)
- German Standards (DIN 57, 185 parti / VDE 0185 part 1.2)

3. STEPS TO BE FOLLOWED FOR LIGHTNING PROTECTION LAYOUT PREPARATION:

1) Lightning protection levels (LPL)

The ideal lightning protection for a structure and its connected services would be to enclose the structure within an earthed and seamlessly conducting metallic shield (box), and in addition provide adequate bonding of any related services at the entrance point into the shield. This in essence would prevent the breach of the lightning current and the induced electromagnetic field into the structure. However, in practice it is not possible or indeed cost effective to go to such lengths. This standard thus sets out a defined set of lightning current parameters where protection measures, adopted in accordance with its recommendations, will reduce any damage and consequential loss because of a lightning strike. This reduction in damage and consequential loss is valid provided the lightning strike parameters fall within defined limits, established as Lightning Protection Levels (LPL).

Each level has a fixed set of maximum and minimum lightning current parameters.

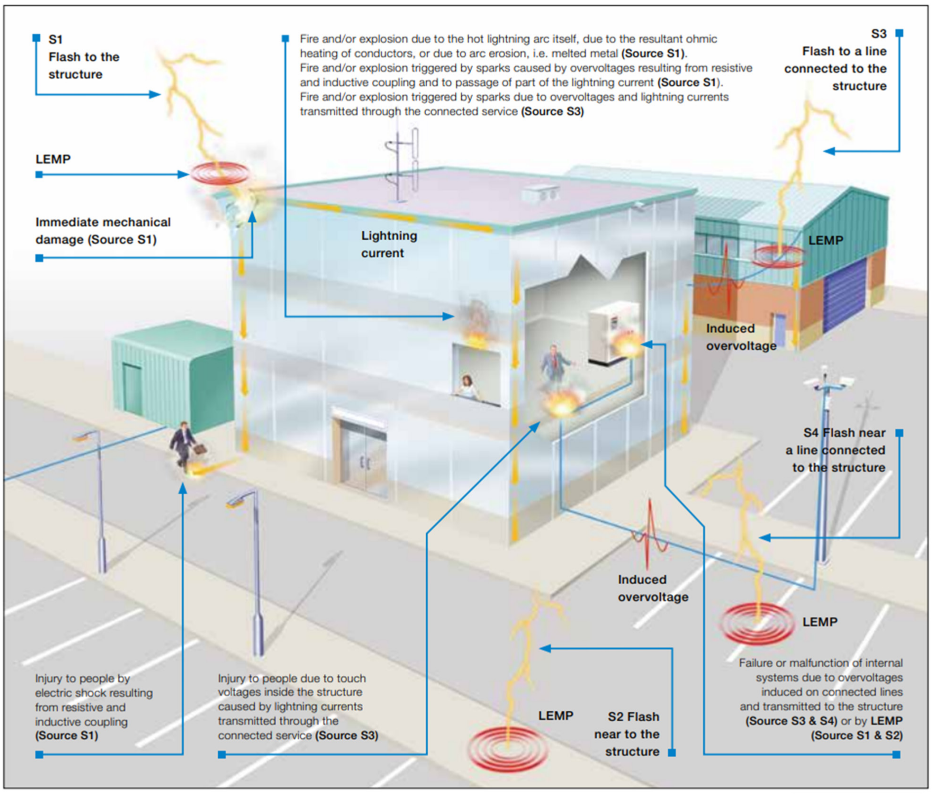
The maximum values have been used in the design of products such as lightning protection components and Surge Protective Devices (SPDs). The minimum values of lightning current have been used to derive the rolling sphere radius for each level.

These parameters are shown in the Table below:

Table Lightning current for each LPL based on 10/350 µs waveform

LPL	I	II	III	IV
Maximum current (kA)	200	150	100	100
Minimum current (kA)	3	5	10	16

Figure The types of damage and loss resulting from a lightning strike on or near a structure



2) Damage and loss

IEC/BS EN 62305 identifies four main sources of damage:

- S1 Flashes to the structure.
- S2 Flashes near to the structure.
- S3 Flashes to the lines connected to the structure.
- S4 Flashes near the lines connected to the structure.

Each source of damage may result in one or more of three types of damage:

- D1 Injury of living beings by electric shock
- D2 Physical damage (fire, explosion, mechanical destruction, chemical release) due to lightning current effects including sparking.
- D3 Failure of internal systems due to Lightning Electromagnetic Impulse (LEMP).

The following types of loss may result from damage due to lightning:

- L1 Loss of human life (including permanent injury)
- L2 Loss of service to the public
- L3 Loss of cultural heritage
- L4 Loss of economic value (structure, its content, and loss of activity)

Table Damage and loss in a structure according to point of lightning strike (IEC/BS EN 62305-1 Table 2)

Point of strike	Source of damage	Type of damage	Type of loss
Structure	S1	D1	L1, L4**
		D2	L1, L2, L3, L4
		D3	L1*, L2, L4
Near a Structure	S2	D3	L1*, L2, L4
Lines connected to the structure	S3	D1	L1, L4**
		D2	L1, L2, L3, L4
		D3	L1*, L2, L4
Near a Line	S4	D3	L1*, L2, L4

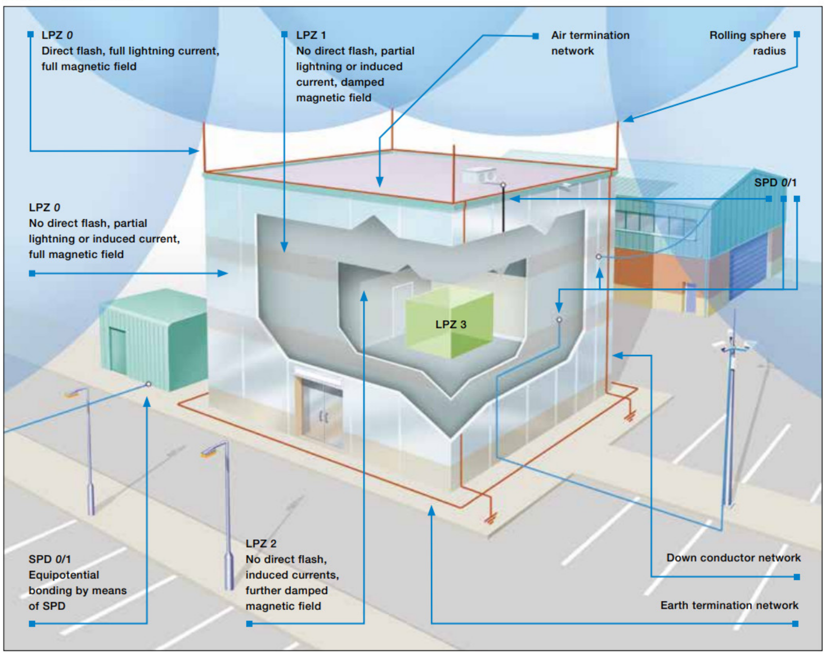
The relationships of all the above parameters are summarized in below Table:

**Only for properties where animals may be lost.

*Only for structures with risk of explosion and for hospitals or other structures where human life is directly in danger due to internal system failures.

3) Lightning protection zones (LPZ):

Figure The LPZ concept



The concept of the Lightning Protection Zone (LPZ) was introduced within IEC/BS EN 62305 particularly to assist in determining the protection measures required to establish protection measures to counter Lightning Electromagnetic Impulse (LEMP) within a structure.

4) Collect all required input for Lightning quantum assessment.

5) The codes provide a simple mathematical overall risk factor analysis for assessing whether a structure needs protection. All the Codes Suggest that an acceptable lightning strike risk factor is **10^{-5}** per year i.e. one in 100,000 per year, therefore, having applied the mathematical analysis to a practical set of parameters, the scheme designer will achieve a numerical solution These parameters which should be considered for determining an overall risk factor can be summarized as follows:

   a) Type of structure

   b) Type of construction

   c) Zone identification

   d) Topography

   e) Occupant and contents

   f) Lightning frequency isocerauic level

   g) Lightning Calculation

   h) Equipment/component selection as per calculation Type of LA

      i) Type of LA

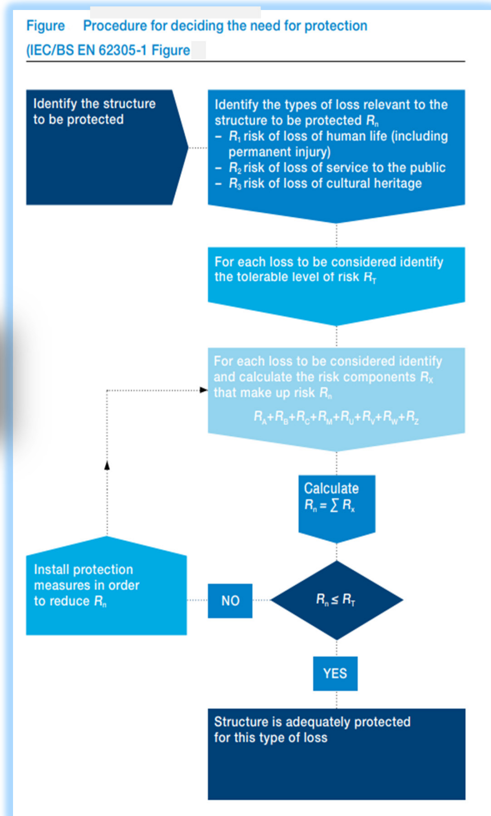
      ii) Number of Down conductors

      iii) Number of Grounding Pit

      iv) Test Link

      v) Type of conductor

- R_1 risk of loss of human life (including permanent injury)
- R_2 risk of loss of service to the public
- R_3 risk of loss of cultural heritage
- R_4 risk of loss of economic value



6) Building/Structure data for Layout Preparation along with calculation data and selected component.

4. DESIGN CONSIDERATION:

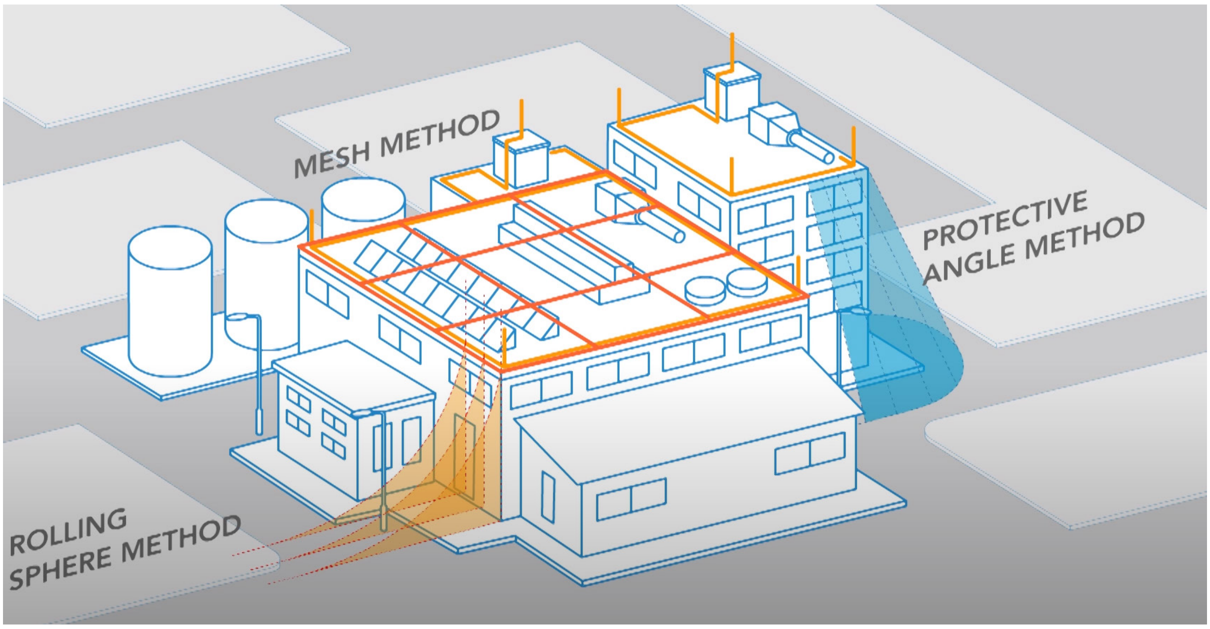
1. Ordinary Structures: An ordinary structure shall be any structure that is used for ordinary purposes, whether commercial, industrial, farm, institutional, or residential.
2. Ordinary structures shall be protected according to 2.1 or 2.2.
   2.1. Ordinary structures not exceeding 23 m (75 ft) in height shall be protected with Class I materials

Type of Conductor	Parameter	Copper		Aluminum	
		SI	U.S.	SI	U.S.
Air terminal, solid	Diameter	9.5 mm	⅜ in.	12.7 mm	½ in.
Air terminal, tubular	Diameter	15.9 mm	⅝ in.	15.9 mm	⅝ in.
	Wall thickness	0.8 mm	0.033 in.	1.63 mm	0.064 in.
Main conductor, cable	Size each strand	278 g/m	17 AWG	141 g/m	14 AWG
	Weight per length	29 mm²	187 lb/1000 ft	50 mm²	95 lb/1000 ft
	Cross-section area		57,400 cir. mils		98,600 cir. mils
Bonding conductor, cable (solid or stranded)	Size each strand		17 AWG		14 AWG
	Cross-section area		26,240 cir. mils		41,100 cir. mils
Bonding conductor, solid strip	Thickness	1.30 mm	0.051 in.	1.63 mm	0.064 in.
	Width	12.7 mm	½ in.	12.7 mm	½ in.
Main conductor, solid strip	Thickness	1.30 mm	0.051 in.	1.63 mm	0.064 in.
	Cross-section area	29 mm²	57,400 cir. mils	50 mm²	98,600 cir. mils

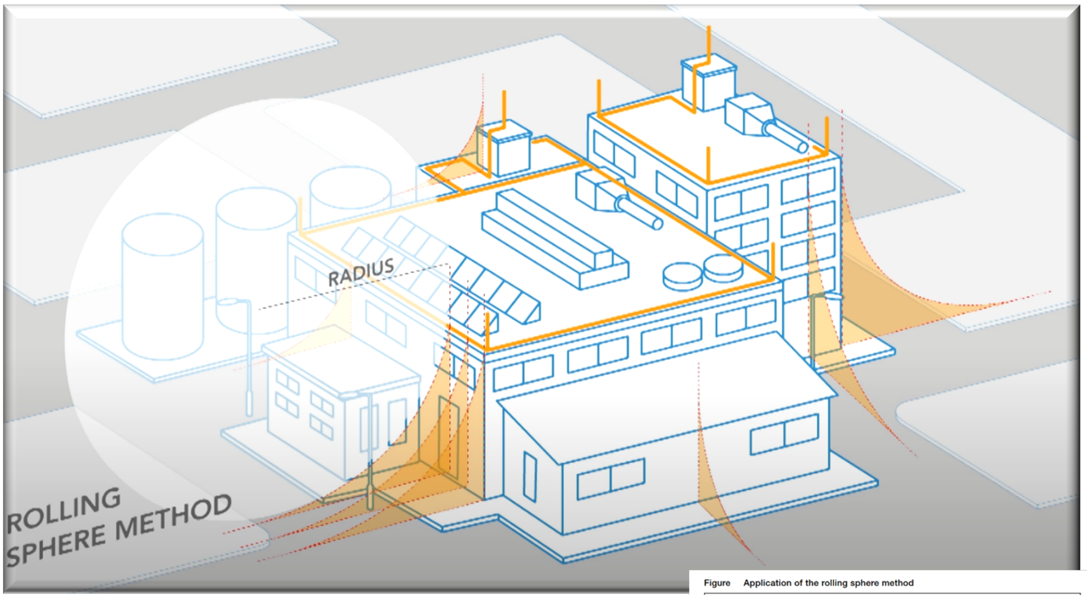
   2.2. Ordinary structures exceeding 23 m (75 ft) in height shall be protected with Class II materials.

Type of Conductor	Parameter	Copper		Aluminum	
		SI	U.S.	SI	U.S.
Air terminal, solid	Diameter	12.7 mm	½ in.	15.9 mm	⅝ in.
Main conductor, cable	Size each strand		15 AWG		13 AWG
	Weight per length	558 g/m	375 lb/1000 ft	283 g/m	190 lb/1000 ft
	Cross-section area	58 mm²	115,000 cir. mils	97 mm²	192,000 cir. mils
Bonding conductor, cable (solid or stranded)	Size each strand		17 AWG		14 AWG
	Cross-section area		26,240 cir. mils		41, 100 cir. mils
Bonding conductor, solid strip	Thickness	1.30 mm	0.051 in.	1.63 mm	0.064 in.
	Width	12.7 mm	½ in.	12.7 mm	½ in.
Main conductor, solid strip	Thickness	1.63 mm	0.064 in.	2.61 mm	0.1026 in.
	Cross-section area	58 mm²	115,000 cir. mils	97 mm²	192,000 cir. mils

5. Method for Lightning Protection Calculations:



Rolling Sphere Method (IEC-62305-3): The rolling sphere method is a simple means of identifying areas of a structure that need protection, considering the possibility of side strikes to the structure. The basic concept of applying the rolling sphere to a structure is illustrated in Figure.



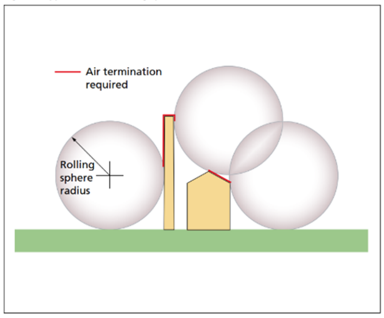


Figure Application of the rolling sphere method

Class of LPS	Rolling sphere radius
I	20 m
II	30 m
III	45 m
IV	60 m

❖ **Protection Angle Method (IEC-62305-3):** The protective angle method is a mathematical simplification of the rolling sphere method. The protective angle (α) is the angle created between the tip (A) of the vertical rod and a line projected down to the surface on which the rod sits (see Figure). The protective angle afforded by an air rod is clearly a three-dimensional concept whereby the rod is assigned a cone of protection by sweeping the line AC at the angle of protection a full 360° around the air rod.

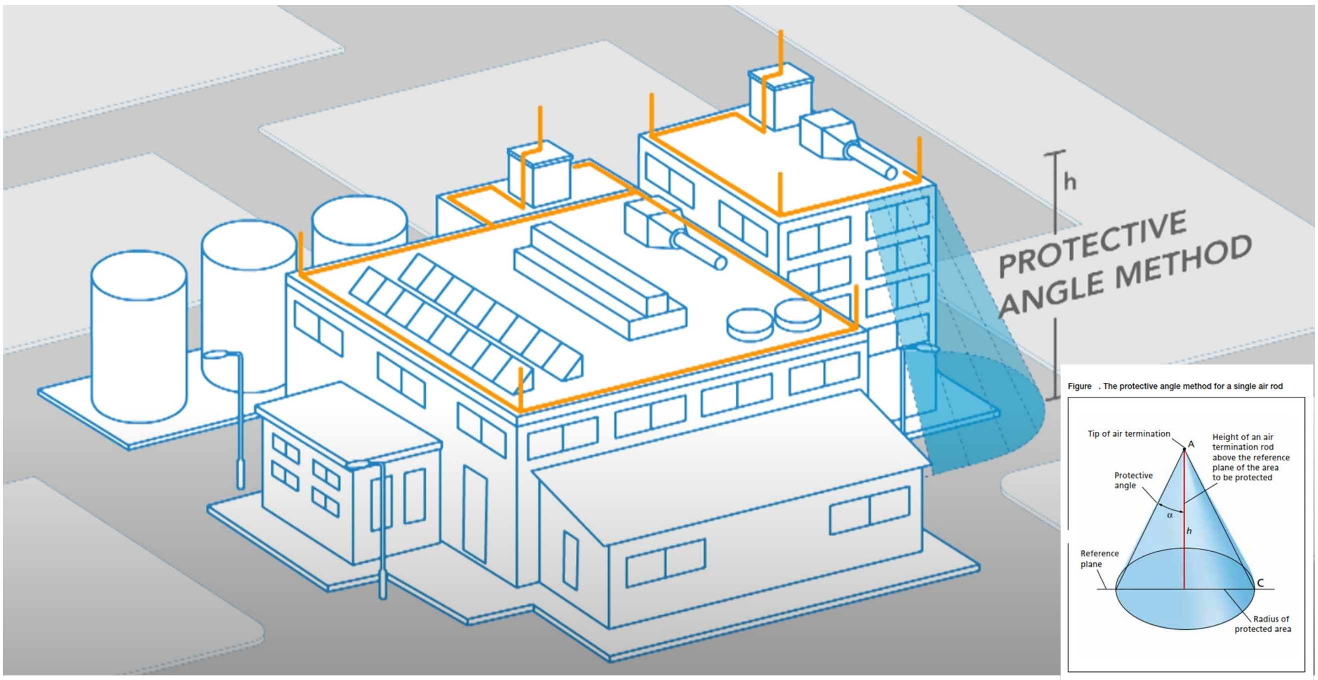
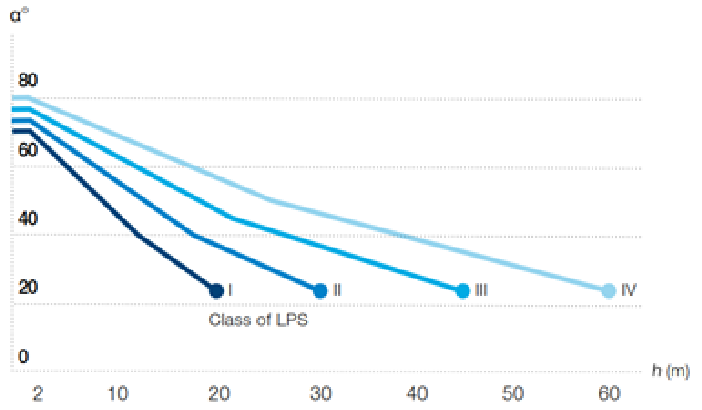


Figure . The protective angle method for a single air rod

The protective angle differs with varying height of the air rod and class of LPS. The protective angle afforded by an air rod is determined from Table shown below. Varying the protection angle is a change to the simple 45° zone of protection afforded in most cases in BS 6651. Furthermore, the new standard uses the height of the air termination system above the reference plane, whether that be ground or roof level (shown above).

The protective angle method is better suited for simple shaped buildings. However, this method is only valid up to a height equal to the rolling sphere radius of the appropriate LPL.

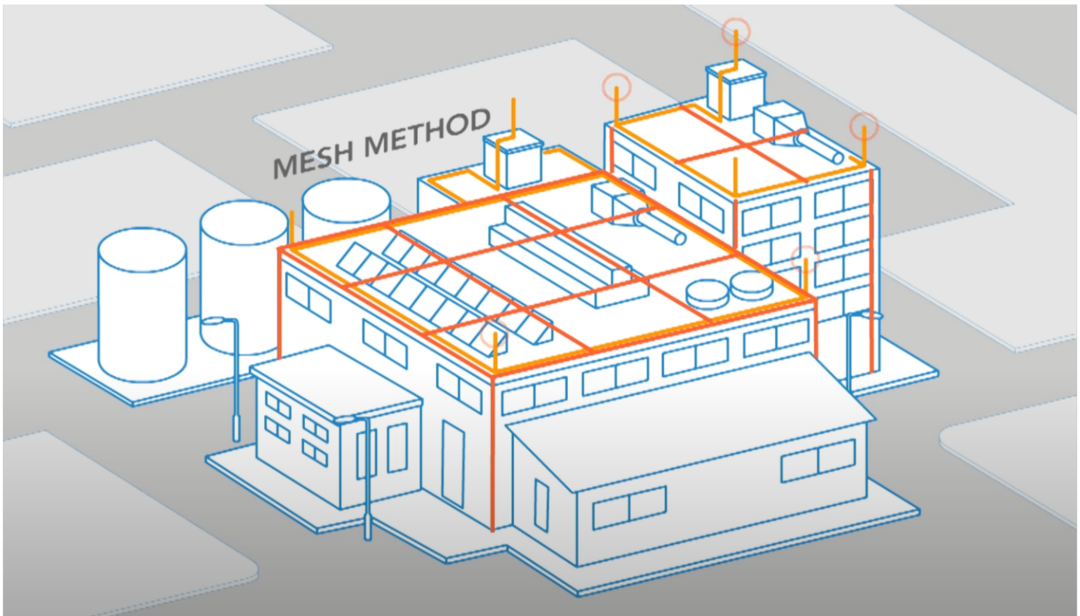


Note 1: Not applicable beyond the values marked with ●
Only rolling sphere and mesh methods apply in these cases
Note 2: *h* is the height of air-termination above the reference plane of the area to be protected
Note 3: The angle will not change for values of *h* below 2m

❖ **Mesh Method (IEC-62305-3):** IEC/BS EN 62305 lists four different air termination mesh sizes that are defined and correspond to the relevant class of LPS (see below Table). This method is suitable where plain surfaces require protection if the following conditions are met:

– Air termination conductors must be positioned at roof edges, on roof overhangs and on the ridges of roof with a pitch more than 1 in 10 (5.7°)

– No metal installation protrudes above the air termination systemModern research on lightning inflicted damage has shown that the edges and corners of roofs are most susceptible to damage. So, on all structures particularly with flat roofs, perimeter conductors should be installed as close to the outer edges of the roof as is practicable.

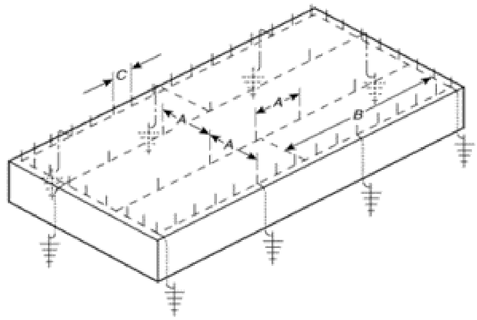


Class of LPS	Mesh size
I	5 x 5 m
II	10 x 10 m
III	15 x 15 m
IV	20 x 20 m

4 levels of down conductor spacing dependent on structural class of Lightning Protection System:

- Class I 10 m
- Class II 10 m
- Class III 15 m
- Class IV 20 m

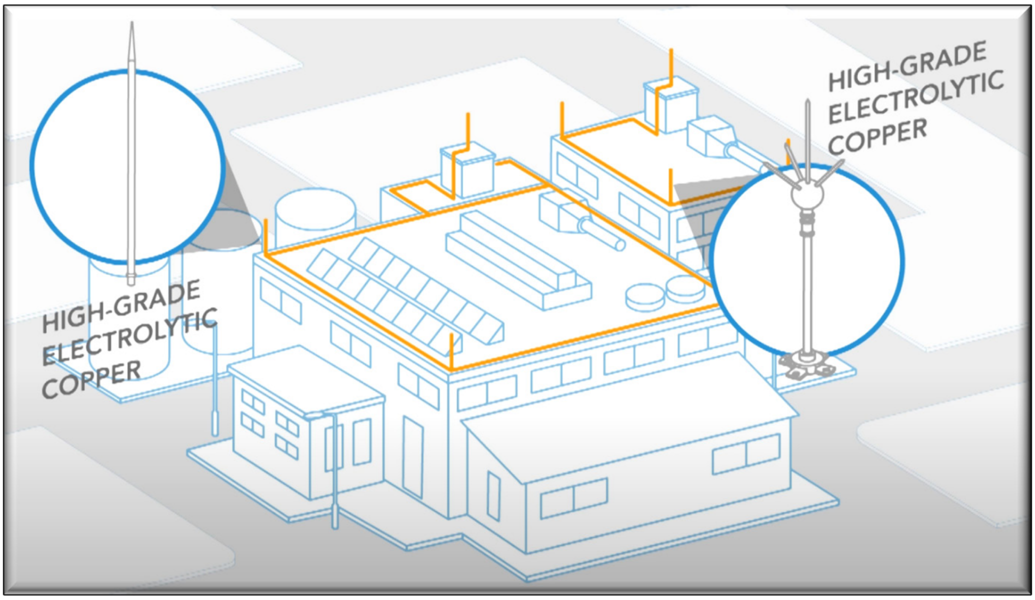
Flat or gently sloping roofs that exceed 15 m (50 ft) in width or length shall have additional strike termination devices located at intervals not to exceed 15 m (50 ft) on the flat or gently sloping areas, as shown in Figure, or such area can also be protected using taller air terminals that create zones of protection using the rolling sphere model so the sphere does not contact the flat roof area.



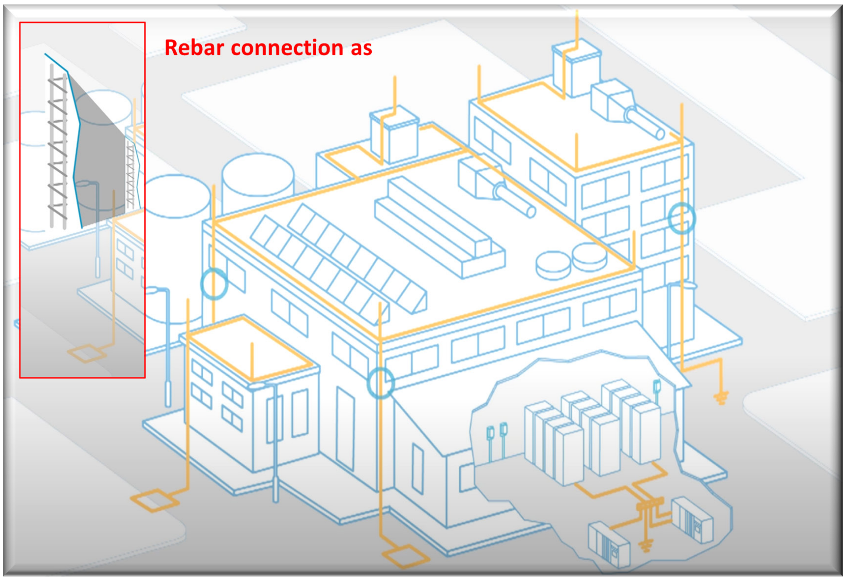
A: 15 m (50 ft) maximum spacing between air terminals
B: 45 m (150 ft) maximum length of cross run conductor permitted without a connection from the cross run conductor to the main perimeter or down conductor
C: 6 m (20 ft) or 7.6 m (25 ft) maximum spacings between air terminals along edge

6. <u>Lightning Protection Component</u>

1) Air Termination Rod

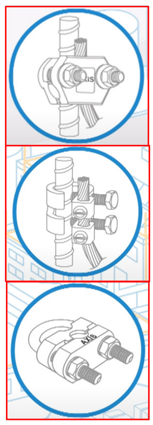


2) Down conductors (Rebar connection as down conductors)

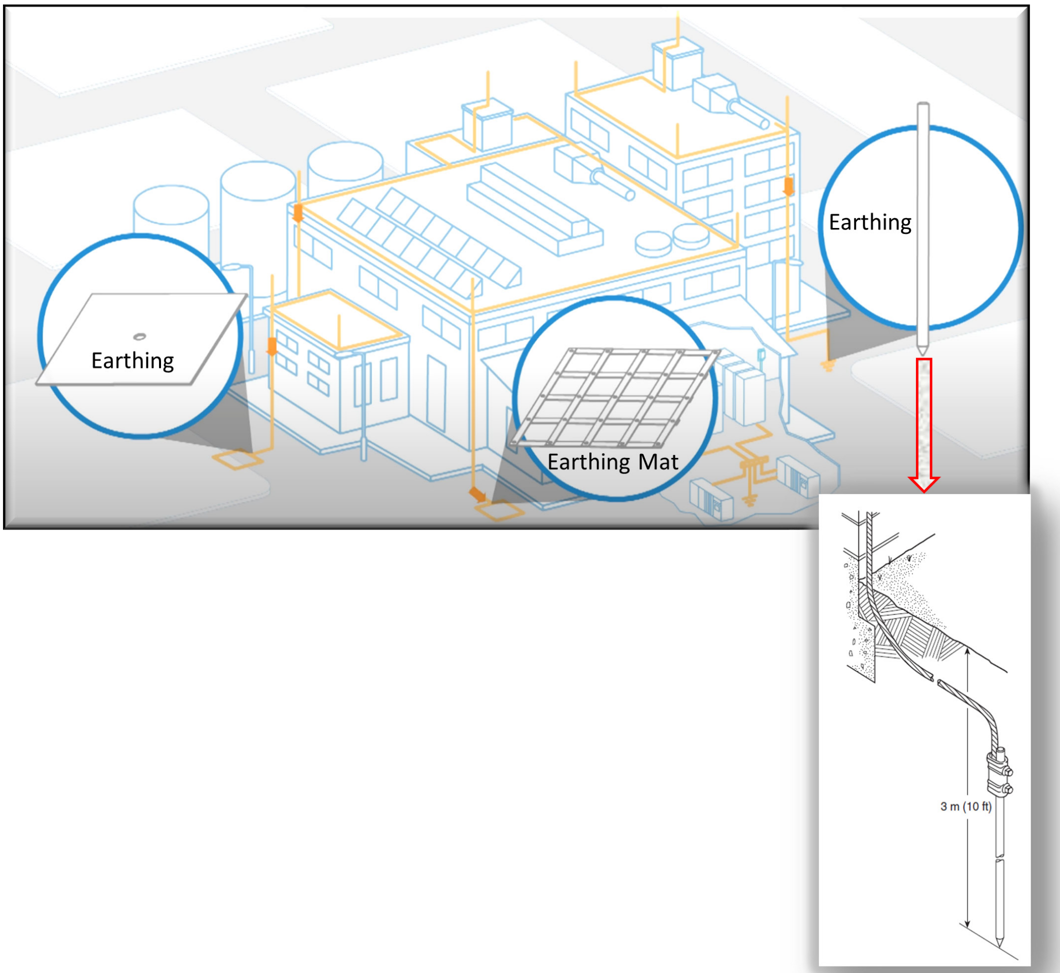


Rebar

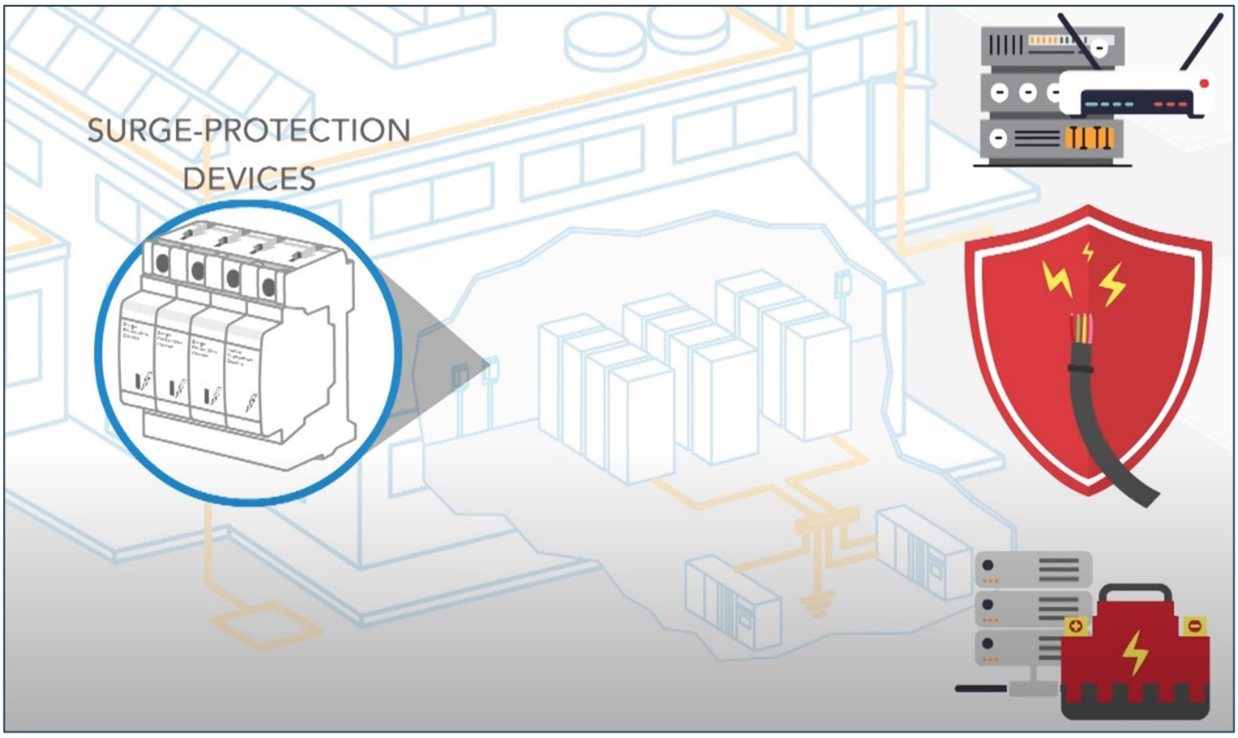
connection



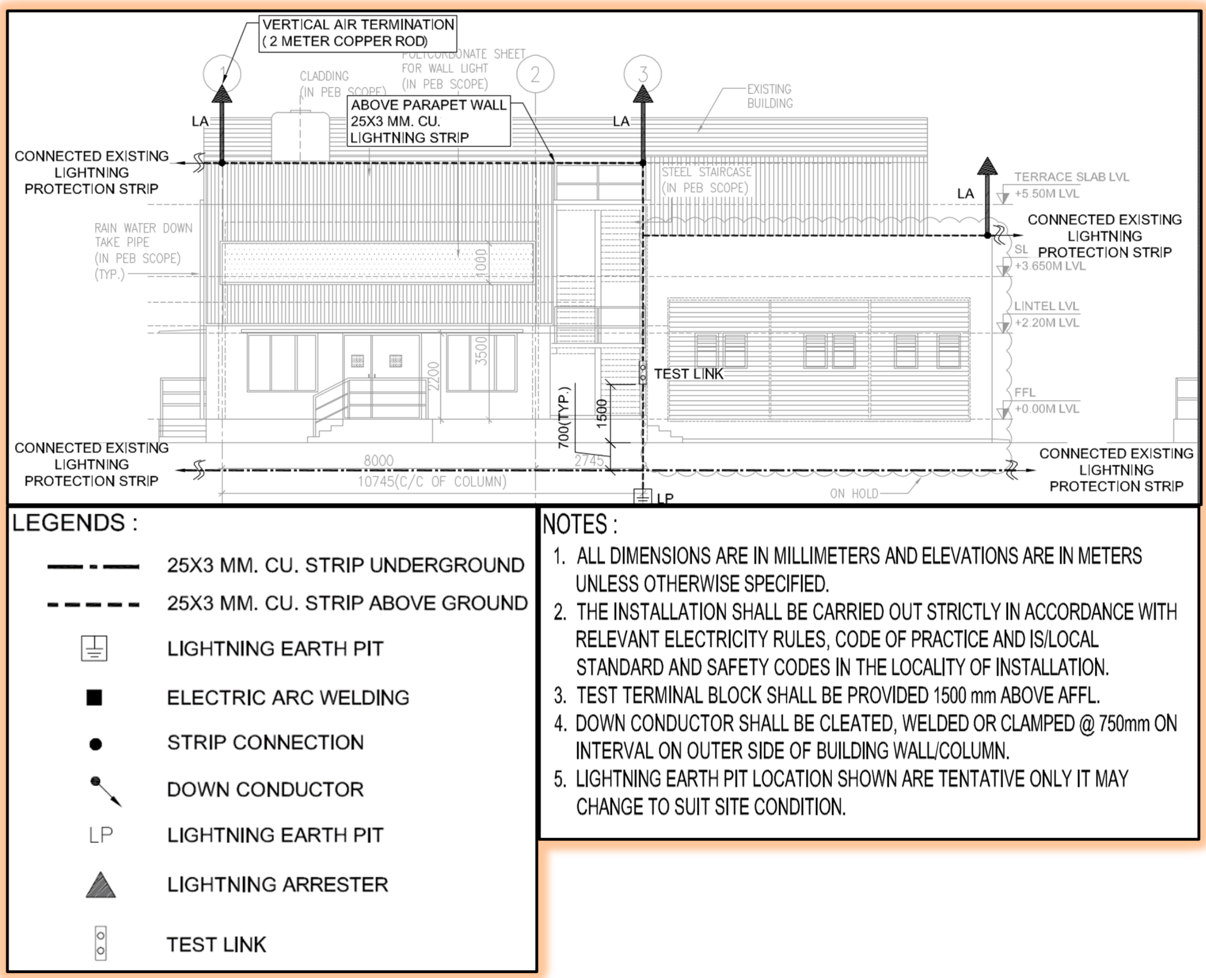
3) Earth termination



4) SPD (Surge Protective Devices)



7. Lightning Protection Layout (E.g.)



Useful links for component selection details.

https://axis-india.com/introduction-of-lightning-protection-iec-62305-ul-467-axis-

https://www.tlpinc.com/

Contributed by:

Umesh Bhatt

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EARTHING LAYOUT

ABSTRACT

The article is intended to understand Preparation of Earthing layout.

The points covered in this article shall be taken care during Earthing Layout preparation.

The purpose of Earthing in electrical systems is crucial for safety and functionality. Even, Step and contact voltages produced have the potential to harm or even kill nearby humans and animals. Earthing serves three main purposes:

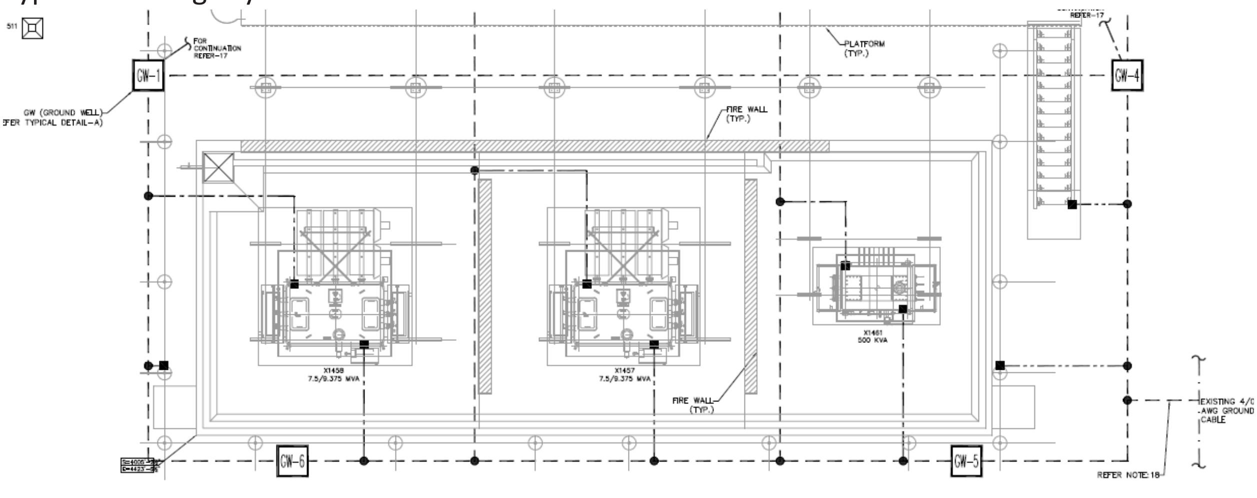
1. **System Earthing**: This aspect focuses on electrical safety throughout the system not caused by a fault. It prevents static buildup, protects against power surges from lightning strikes, and allows for equipotential bonding to prevent potential differences between metal works.
2. **Equipment Earthing**: This type of earthing is essential for electrical safety in the event of a fault. It aims to prevent equipment damage and the risk of electric shock. Equipment earthing ensures that in case of a fault, the current flows to the ground through a protective conductor, triggering the automatic disconnection of supply to prevent harm.
3. **Functional Earthing**: This serves purposes beyond electrical safety, such as electromagnetic interference filtering or using the Earth as a return path in specific systems like single-wire earth return distribution systems.

STANDARDS TO BE FOLLOWED:

- IEC 60364
- BS 7430
- IS 3043

STEPS TO BE FOLLOWED FOR EARTHING LAYOUT PREPARATION:

1) According to the requirements of Central Electricity Authority (CEA) rules, all medium voltage equipment shall be earthed by two separate and distinct connections with earth. In case of high voltages, the neutral points shall be earthed by not less than two separate and distinct connections with earth, each having its own electrode.
2) Typical Earthing Layout



ELECTRICAL GROUNDING LAYOUT PLAN
(SCALE : 1/4"=1'-0")

3) Internationally, Earthing system has been divided into three categories:
   a) TN system
   b) TT system
   c) IT system
   For detailed information refer IS 3043.

4) Material and dimensions of the earth electrode shall be selected to withstand corrosion and to have adequate mechanical strength. For commonly used materials, the common minimum sizes from the point of view of corrosion and mechanical strength for earth electrodes, where embedded in the soil are given in the table below.

Material	Surface	Shape	Minimum size				
			Diameter mm	Cross-sectional area mm^2	Thickness mm	Thickness of coating/sheathing Individual value µm	Thickness of coating/sheathing Average value µm
Steel	Hot-dip galvanized [a] or Stainless [a, b]	Strip [c]		90	3	63	70
		Sections		90	3	63	70
		Round rod for deep earth electrodes	16			63	70
		Round wire for surface electrode [g]	10				50 [e]
		Pipe	25		2	47	55
	Copper-sheathed	Round rod for deep earth electrode	15			2 000	
	With electro-deposited copper coating	Round rod for deep earth electrode	14			90	100
Copper	Bare [a]	Strip		50	2		
		Round wire for surface electrode [g]		25 [f]			
		Rope	1,8 for individual strands of wire	25			
		Pipe	20		2		
	Tin-coated	Rope	1,8 for individual strands of wire	25		1	5
	Zinc-coated	Strip [d]		50	2	20	40

[a] Can also be used for electrodes to be embedded in concrete.
[b] No coating applied.
[c] As rolled strip or slit strip with rounded edges.
[d] Strip with rounded edges.
[e] In the case of continuous bath-coating, only 50 µm thickness is technically feasible at present.
[f] Where experience shows that the risk of corrosion and mechanical damage is extremely low, 16 mm^2 can be used.
[g] An earth electrode is considered to be a surface electrode when installed at a depth not exceeding 0,5 m.

The resistance of pipe or rod electrode is calculated by:

$$R = \frac{100\rho}{2\pi l} \log_e \frac{2l}{d} \text{ Ohms}$$

Where,

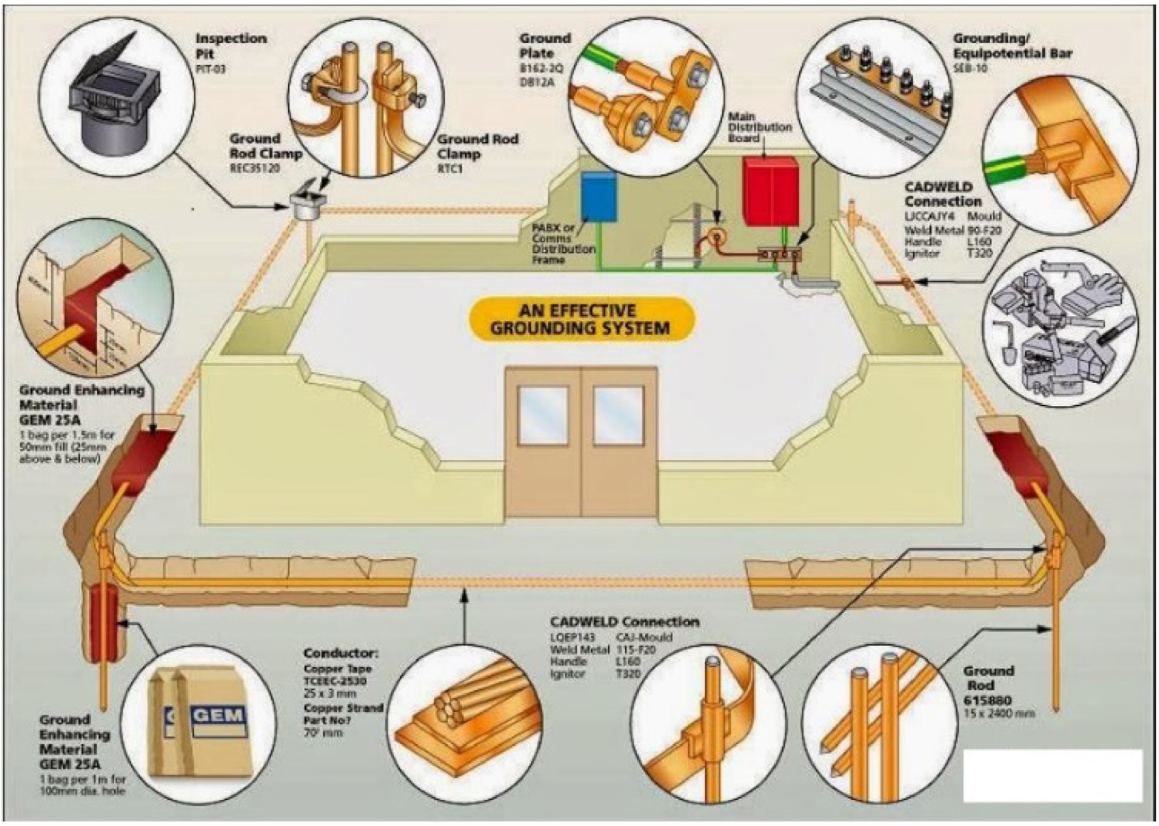
l = length of rod or pipe (in cm)

d = diameter of rod or pipe in cm,

ρ = resistivity of the soil (in Ω.m)

The curves are calculated from this equation for electrodes of 13, 25 and 100mm dia. respectively in soil of 100 Ω.m respectively. Change of diameter has a relatively minor effect and size of pipe is generally governed by resistance to bending or splitting. It is apparent that the resistance diminishes rapidly with the first few feet of driving, but less so at depth greater than 2 to 3m in soil of uniform resistivity. A number of rods or pipes may be connected in parallel and the resistance is then partially proportional to the reciprocal of the number employed so long as each is situated outside the resistance area of other.

Where an extensive underground cable system is available, the lead sheath and armour form a most effective earth electrode. Cable sheaths are more commonly used to provide a metallic path to the fault current returning to the neutral.



An effective earthing is teamwork of various parts and accessories

5) The cross-sectional area of the protective conductor shall be not less than the appropriate value shown in Table. If the application of this table produces non-standard sizes, conductors having the nearest higher standard cross-sectional area are to be used.

TABLE 7 CROSS SECTION OF PROTECTIVE CONDUCTOR

CROSS-SECTIONAL AREA OF PHASE CONDUCTORS OF THE INSTALLATION S (mm^2)	MINIMUM CROSS-SECTIONAL AREA OF THE CORRESPONDING PROTECTIVE CONDUCTOR Sp (mm^2)
$S < 16$	S
$16 < S < 35$	16
$S > 35$	*See* **12.2.2.1**

The above values are valid only if the protective conductor is made of the same metal as the phase conductors. If not so, the cross-sectional area of the protective conductor is to be determined in a manner which produces a conductance equivalent to that which results from the application of table.

6) Consideration shall be given to **electrolytic corrosion** when using different materials in an earthing arrangement. Earthing conductors buried in soil have their cross-sectional area according to below table.

	Mechanically protected	Mechanically unprotected
Protected against corrosion	2,5 mm² Cu 10 mm² Fe	16 mm² Cu 16 mm² Fe
Not protected against corrosion	25 mm² Cu 50 mm² Fe	

The connection of an earthing conductor to any earth electrode shall be soundly made and electrically satisfactory. The connection shall be by exothermic welding, pressure connectors, clamps or other mechanical connectors. Mechanical connectors shall be installed in accordance with manufacturer's instructions. Where a clamp is used, it shall not damage the electrode or the earthing conductor.

7) Equipment is classified with regard to protection against Electrical shock as per below table.

TABLE 2 CLASSIFICATION OF EQUIPMENT

	CLASS 0	CLASII I	CLASS II	CLASS III
Principal characteristics of equipment	No means of protective earthing	Protective earthing means provided	Additional insulation and no means for protective earting	Designed for supply at safety extra low voltage
Precautions for safety	Earth free environment	Connection to the protective earthing	None necessary	Connection to safety extra low voltage

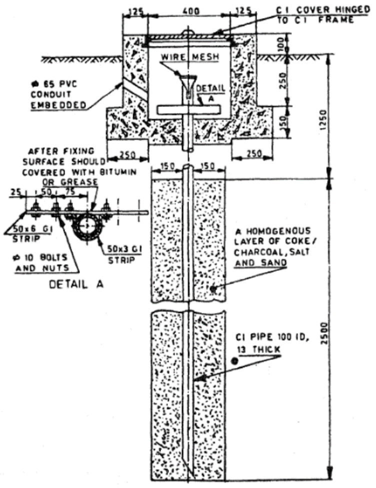
TABLE 3 EXAMPLES OF SOIL RESISTIVITY

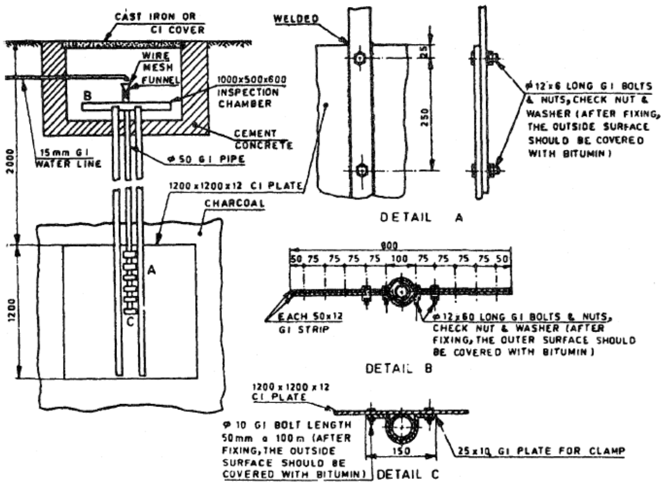
TYPE OF SOIL	CLIMATIC CONDITION			
	Normal and High Rainfall (for Example, Greater than 500 mm a Year)		Low Rainfall and Desert Condition (For Examples, Less than 250 mm a Year)	Underground Waters (Salids)
	Probable value	Range of values encountered	Range of values encountered	Range of values encountered
(1)	(2) Ω.m	(3) Ω.m	(4) Ω.m	(5) Ω.m
Alluvium and lighter clays	5	*	*	1 to 5
Clays (excluding alluvium)	10	5 to 20	10 to 100	
Marls (for example, keuper marl)	20	10 to 30	50 to 300	
Porous limestone (for example, chalk)	50	30 to 100		
Porous sandstone (for example, keuper sandstone and clay shales)	100	30 to 300		
Quartzites, compact and crystalline limestone (for example, carboniferous marble, etc)	300	100 to 1 000		
Clay slates and slatey shales	1 000	300 to 3 000	1 000 upwards	30 to 100
Granite	1 000			
Fossile slates, schists gneiss igneous rocks	2 000	1 000 upwards		

*Depends on water level of locality.

8) **Soil Resistivity:**
The resistance to earth of a given electrode depends upon the electrical resistivity of the soil in which it is installed.

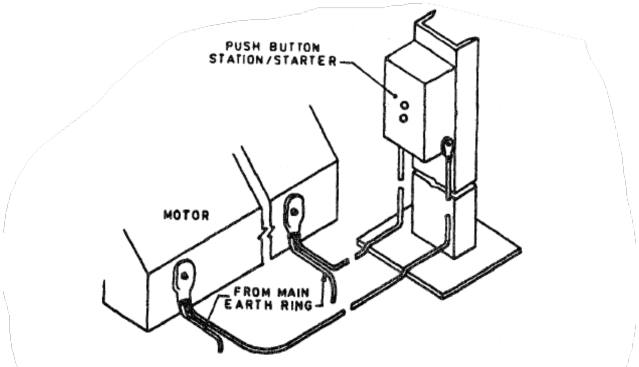
9) Typical details:





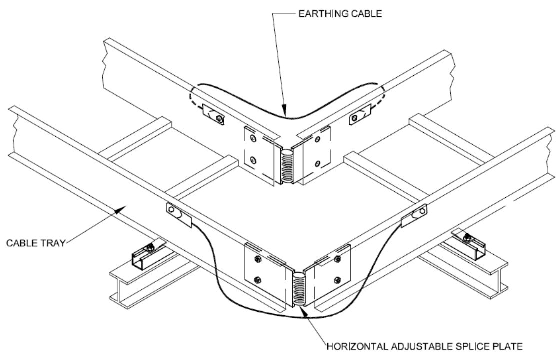
All dimensions in millimetres.

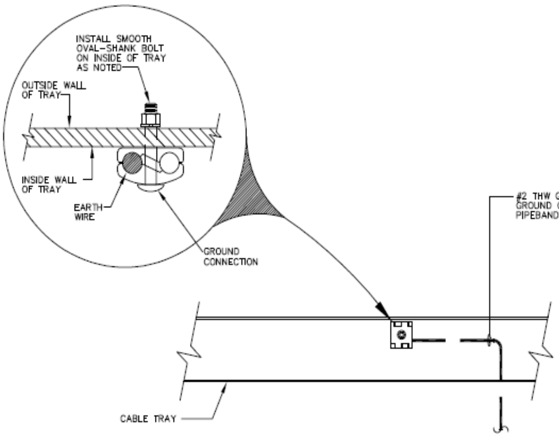
FIG. 15 TYPICAL ARRANGEMENT OF PLATE ELECTRODE

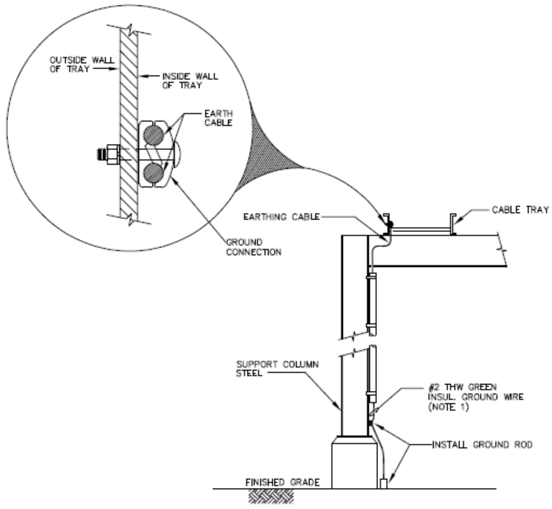


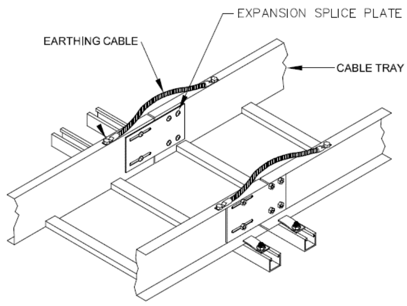
16A Earthing Arrangement for Motors with Push Button Station/Starter Earth Connections to Starter Looped from Earth Connections of Motor

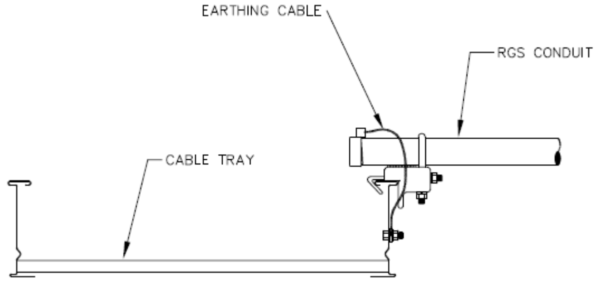
FIG TYPICAL EARTHING CONNECTION DETAILS — *Contd*

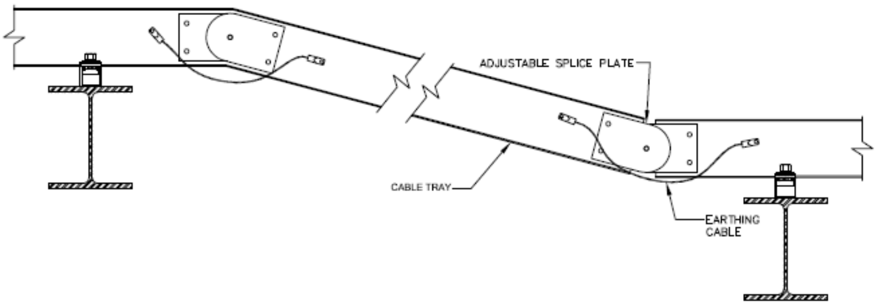


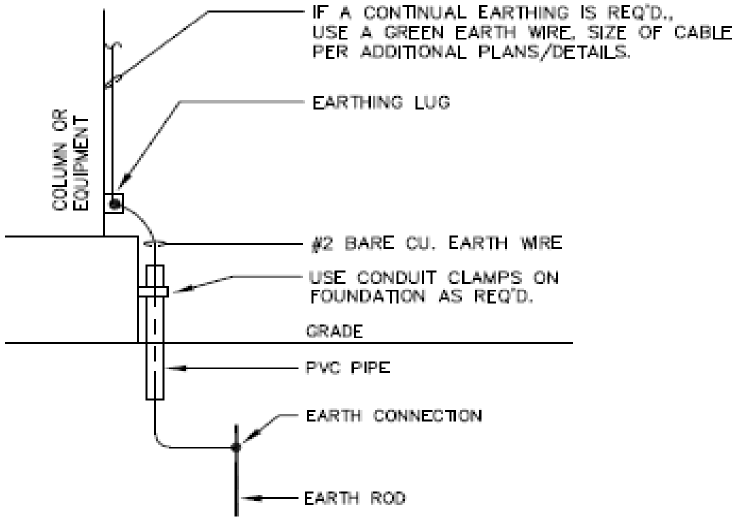

INSTALL SMOOTH OVAL-SHANK BOLT ON INSIDE OF TRAY AS NOTED
OUTSIDE WALL OF TRAY
INSIDE WALL OF TRAY
EARTH WIRE
GROUND CONNECTION
#2 THW GREEN INSUL. GROUND CONDUCTOR TO PIPEBAND STEEL.
CABLE TRAY


OUTSIDE WALL OF TRAY
INSIDE WALL OF TRAY
EARTH CABLE
EARTHING CABLE
GROUND CONNECTION
CABLE TRAY
SUPPORT COLUMN STEEL
#2 THW GREEN INSUL. GROUND WIRE (NOTE 1)
INSTALL GROUND ROD
FINISHED GRADE


EXPANSION SPLICE PLATE
EARTHING CABLE
CABLE TRAY

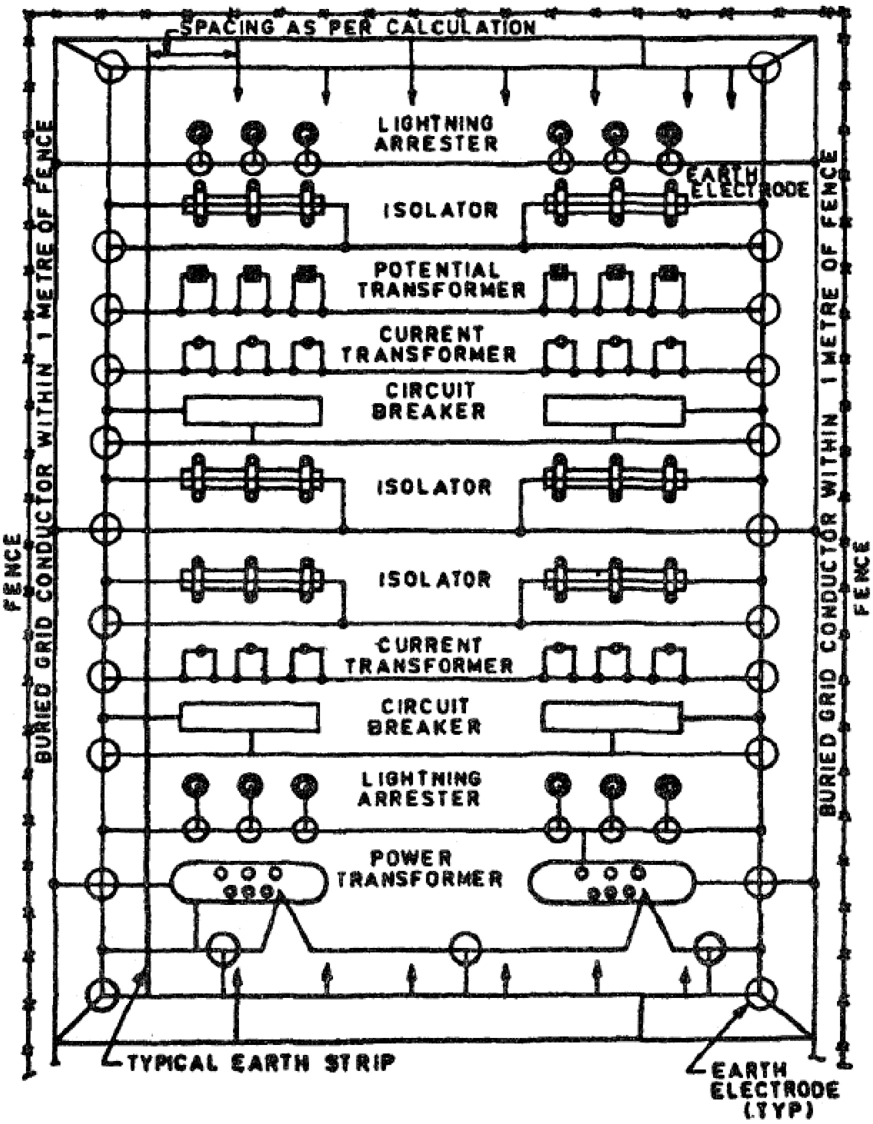

EARTHING CABLE
RGS CONDUIT
CABLE TRAY


ADJUSTABLE SPLICE PLATE
CABLE TRAY
EARTHING CABLE


IF A CONTINUAL EARTHING IS REQ'D., USE A GREEN EARTH WIRE, SIZE OF CABLE PER ADDITIONAL PLANS/DETAILS.
EARTHING LUG
COLUMN OR EQUIPMENT
#2 BARE CU. EARTH WIRE
USE CONDUIT CLAMPS ON FOUNDATION AS REQ'D.
GRADE
PVC PIPE
EARTH CONNECTION
EARTH ROD

10) General Earthing Arrangement:

A typical earthing arrangement for an outdoor switchyard is shown in below fig.



11) **Protection against indirect contact** is achieved by the adoption of one of the following protective measures:

a) Safety extra low voltage
b) The use of class II equipment or by equivalent insulation.
c) A non-conducting location
d) Earth free local equipotential bonding
e) Electrical separation
f) Earthed equipotential bonding and automatic disconnection of the supply.

12) The following **extraneous conductive parts** those are required to be bonded to the main earthing terminal of the installation:

a) Gas pipes,
b) Other service pipes and ducting
c) Risers and pipes of fire protection equipment
d) Exposed metallic parts of the building structure.
e) Lightning conductors

13) The following **exposed conductive parts** those are required to be connected by means of protective conductors to main earthing terminals of the installation:

a) All metalwork associated with wiring system (other than current-carrying parts) including cable sheaths and amour, conduit, ducting, trunking, boxes and catenary wires.
b) The exposed metalwork of all Class I fixed and portable current-using equipment. Even here at the

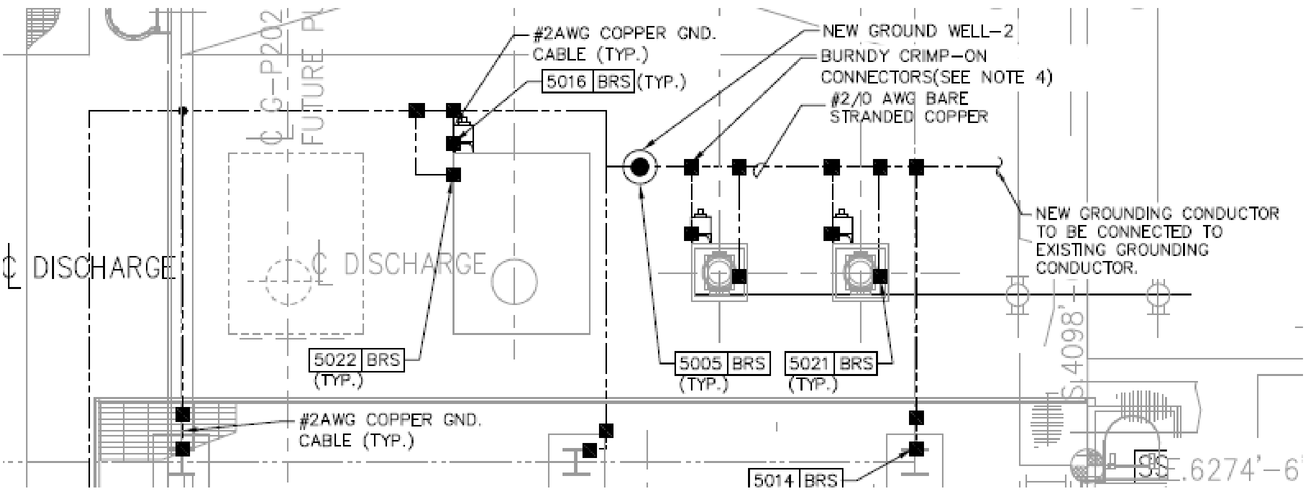
time of the erection of the installation this equipment is of Class II construction or its equivalent, because there is a possibility that in the life of the installation the equipment may be replaced by Class I equipment, all fixed wiring accessories should incorporate an earthing terminal that is connected to the main earthing terminal by means of the protective conductors of the circuits concerned.

c) The exposed metalwork of transformers used in the installation other than those that are an integral part of equipment. The secondary windings of transformers should also be earthed at one point of the winding, unless the transformer is a safety isolating transformer supplying a part of the installation where the protective measure 'electrical separation' is being used.
Exposed conductive parts that (because of their small dimensions or disposition) cannot be gripped or contacted by a major surface of the human body (that is a human body surface not exceeding SO mm x SO mm) need not be earthed if the connection of those parts to a protective conductor cannot readily be made and reliably maintained. Typical examples of such parts are screws and nameplate, cable clips and lamp caps. Fixing screws for non-metallic accessories need not be earthed provided there is no appreciable risk of the screws coming into contact with live parts.

14) Other exposed conductive parts not required to be earthed are:

a) Overhead line insulator brackets and metal parts connected to them if such parts are not within arm's reach
b) Short lengths of metal conduit or other metal enclosures used to give mechanical protection to equipment of Class II or equivalent construction.

Typical Earthing Layout:



Contributed by:

Mrs. PRIYA SHAH

L&T Technology Services

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VAISHALEE VASANT WAGHMARE

MANAS BURKULE

Congratulations

QUIZ APRIL 2024

1. Scientist born in February:
    A. SN Bose
    B. Kalpana Chawla
    C. JC Bose
    D. Ramanujam

2. Electro-magnetic relays according to operating principles are:
    A. Attracted armature relays
    B. Moving-coil relays
    C. Thermal relays
    D. All of the above

3. Screen Bonding, Water Sealing, & Side wall pressure analysis are employed for:
    A. MCT design
    B. Cable Handling
    C. Switchgear Panel installation
    D. Transformer oil filteration

4. Short Circuit calculation can be done using
    A. kVA Method
    B. Impedance Network method
    C. Both A. & B.
    D. None of the above

5. This serves as a main protection device for any minor or major electrical faults that may develop inside a transformer:
    A. Explosion vent
    B. Silica-gel breather
    C. Bucholtz relay
    D. Conservator

6. Power Transformers:
    A. Commonly found on utility poles stepping down HV from Transmission lines
    B. Utilised in substations to handle HV transmission over long distance
    C. Restrict fault level for small loads such as lighting
    D. Connected to Switchyard busbar to step down HV for control voltage

7. Rated lightning impulse withstand voltage (peak) for 3.6kV equipment:
    A. 40kV
    B. 75kV
    C. 24kV
    D. 60kV

8. Indicative Syllabus for Chartered Electrical Safety Engineer:
    A. Electrical Machines, Cables and Wiring
    B. Power System analysis
    C. Fire fighting skills
    D. Relevant American and Japanese standards

9. Monopolar Link, Bipolar Link, & Homopolar link are types of:
    A. MOSFET link in Rectifiers
    B. EHV Transmission link
    C. UPS static switch
    D. DC Transmission link

10. Addressable Photoelectric optical types detectors are used for detection of:
   A. Heat
   B. Rodent
   C. Water
   D. Smoke

Rules for the QUIZ:

- The Quiz will be open for 10 days from the date of EMAIL.
- Each correct answer received on DAY 1 will get 100 points
- Next days the points will reduce as 90 – 80 – 70 and on 10th day points will be ZERO even if the
- answer is correct.
- All participants will receive E certificate signed by CEEAMA President with the points earned
- mentioned on the same.

Please use following google form link to participate in the QUIZ.

https://forms.gle/JH8KRB7k4H1kTGb26

"Thank you all for the overwhelming response to the E-NEWS in general and E-Quiz in particular. MCQ based quiz is always tricky and surprisingly can take us aback when we realise our conceptions (misconceptions) about the subject / system / product.

The aim of the feature was to create inquisitiveness in your mind and help you check your technical quotient quickly. The response will also help us to present articles and webinars on subjects which are important, but which lack enough awareness / knowledge in general.

It can open a pandora box for our discussions and arguments and probable solutions. Engineering evolves with conception. It gets fuelled with community discussions and capitalist actions. All stakeholders start realising the need to take a closer look and help improve standards as we have seen in the past century. Surely it makes the world a better place.

Wish you all a better luck this time.

Do spread the word.

March 2024 Quiz Answers

1. B. SS Bhatnagar
2. D. All of the above
3. C. Delta
4. B. 5 ms
5. C. 173mA
6. B. Ajit N. Kulkarni
7. A. Output voltage fluctuation from no-load to full-load is least
8. A. True
9. D. All of the above
10. D. All of the above

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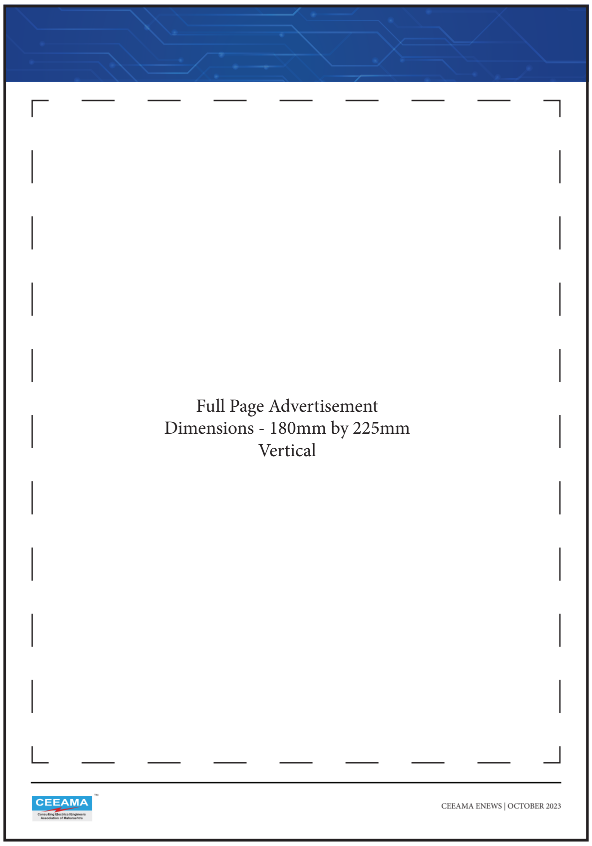

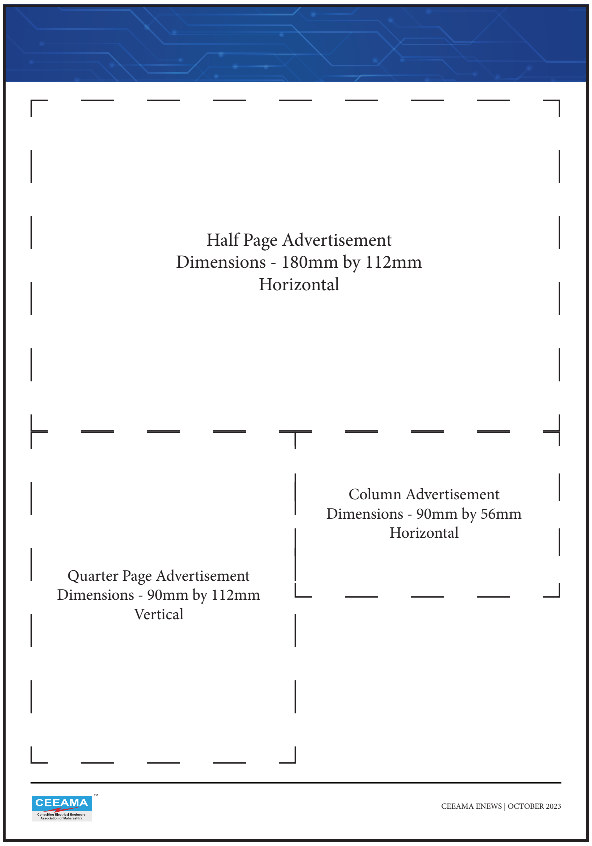

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