

# BASICS OF LIGHTNING PROTECTION FOR BUILDINGS

*When the lightning discharge occurs through parallel conductors which are in close proximity to each other, they are subjected to large mechanical forces. Hence, it is essential to provide mechanical fixings /support to these conductors*



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Lightning is a natural phenomenon. It occurs when a charged cloud discharges its stored static energy either to another cloud or to the ground. Charges separate and accumulate due to the violent movement of air. When the charges accumulated in a cloud exceeds its withstand level, electrical discharges are triggered.

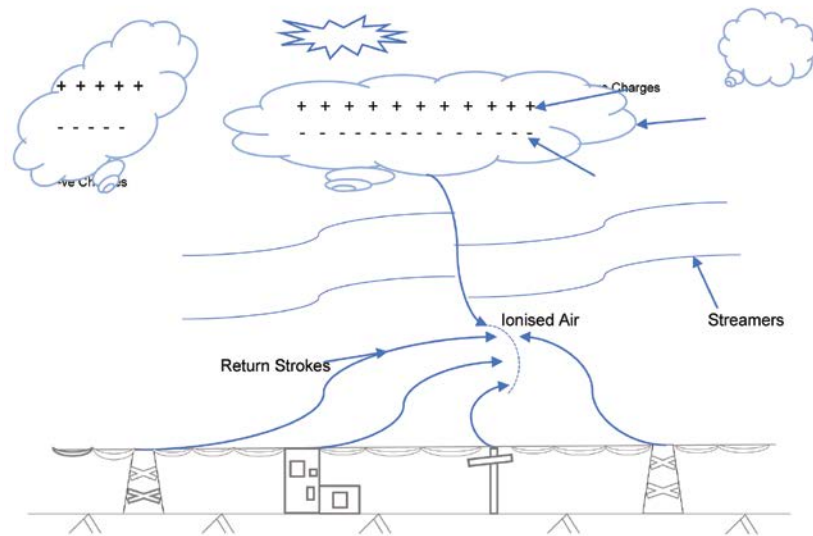
When lightning cloud comes nearer to the ground, Streamers and Return Strokes are formed from the charged cloud and all the objects on the earth respectively. The surrounding air is completely ionised. The circuit is completed when the incoming streamer meets the return stroke from an object. Now, lightning cloud delivers its energy to the object concerned in one stroke or several strokes.

## Impact Of Lightning

- It strikes the earth at the average rate of 6000 times a minute i.e. three billion times a year. The impact of lightning strikes is felt up to about two km away, causing massive transient over voltages on mains power supply, signal and telephone lines. If lightning hits a building/high raised tower, buildings without proper protection, the surge current would seek a path to earth through the building and could result in unpredictable damage.
- It is very difficult to assess how much energy is stored in a charged cloud and how many strokes are needed to discharge it. So also to understand the manner in which the charges got separated and accumulated in the clouds. Lightning stroke not only injects the current into the stricken point, but also induces voltage in the lines and towers by electric and magnetic fields produced around a stroke channel. The lightning discharge has currents up to 530 kA; however 200 kA is an acceptable limit.
- The type of lightning strike is determined by the way the charge is distributed within the cloud. Streamer discharges mounting electrical charges from a thunder cloud and it undergoes spontaneous branching at the tip. The tip splitting is a natural phenomenon.

## Thermal Effects

When the lightning discharges through the lightning conductor on the building structure, it simply raises the temperature of the related



object to a very high level. But as it happens only for a short duration (for a few micro seconds), its effect is usually negligible and hence it is not given much importance. However, when it hits trees or thick forests, it may result in fire.

## Mechanical Effects

When the lightning discharge occurs through parallel conductors which are in close proximity to each other, they are subjected to large mechanical forces. Hence, it is essential to provide mechanical fixings /support to these conductors. The air channel or plasma space along which the lightning discharge travels is suddenly raised to very high temperature. This results in a strong air pressure wave which will damage buildings, trees and other structures. Therefore, six layers of protection is normally given to the power station and substation equipment, especially transformers and instrument transformers.

## Controlling Methods Of Lightning

- Capture lightning strikes
- Route their energy to ground
- Dissipate the energy in the grounding

system

- Bond all ground points together so as to make this process more effective
- Arrange adequate surge protection for the incoming power supply line
- Provide adequate surge protection for all the low voltage data/communication circuits and the connected equipment/ devices
- Provide adequate surge protection for all the electronic equipment in the plant/ installation/building

## Switching Surges

These surges are generated during switching operations carried out in the system. Hence, they are generally classified as internal over-voltages or system generated over-voltages. These surges are mainly due to the reaction of the system, when its operating status is suddenly disturbed due to switching operation.

## Type Of Switching Surges

- It creates significant over voltages both



at the location of the capacitor banks and other locations of the system during energisation and de-energisation of the capacitor banks and also the magnification of voltages

- The switching devices will be subjected to the transient surges of voltage/current of unique nature during these operations
- The current surges are harmful to the equipment itself while the voltage surges impact both the equipment and other system components such as transformers and circuit breakers
- The over-voltages produced during the switching operations of capacitors are oscillatory
- The magnification of voltages normally occur at another part of the system possibly at a different voltage level and results in equipment damage especially electronic devices and communication system equipment

### Broken Conductors/Single Phase Switching

- It can result in non-linear ferro-resonant oscillations with the attendant sustained over voltages
- It normally occurs when the magnetizing impedance of the transformer matches with the line-ground capacitance of the system

### Neutral Instability

- This type of non-linear phenomenon arises when the neutrals of delta/star transformer are temporarily or permanently cut off
- The circuit becomes unstable when the load on the secondary stage is comparatively low
- This kind of neutral instability produces very high voltages on the system
- At times, harmonic voltage oscillations are also produced

### Protection Against Switching Surges

Unlike lightning surges, switching surges can be controlled at the place of its origin. It facilitates the system engineer to arrange proper protective steps. The scope of this effective protection against switching surges centers around,

- The effective control of the sources at which the switching surges are generated,

re-strike free operation of circuit breakers, controlled closing of circuit breaker contacts, eliminations that are conducive for ferro resonance.

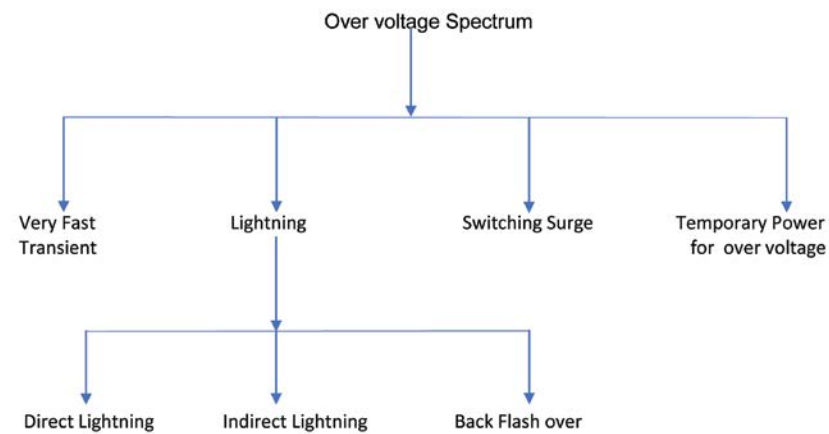
- Provision of effective protection to the equipment that experiences the switching surges, surge arrestors with low protective levels and adequate energy withstand capability

### Over Voltage Spectrum

Among the Protective Devices Adopted are:

#### Direct Lightning Stroke

- Spikes or masts
- Ground wire screen
- Ground wires
- Spark gaps
- Surge arrestors (gapped and gapless)



#### Indirect Lightning Stroke

- Spark gaps
- Surge arrestors (gapped and gapless)
- Surge suppressors
- Gas tubes

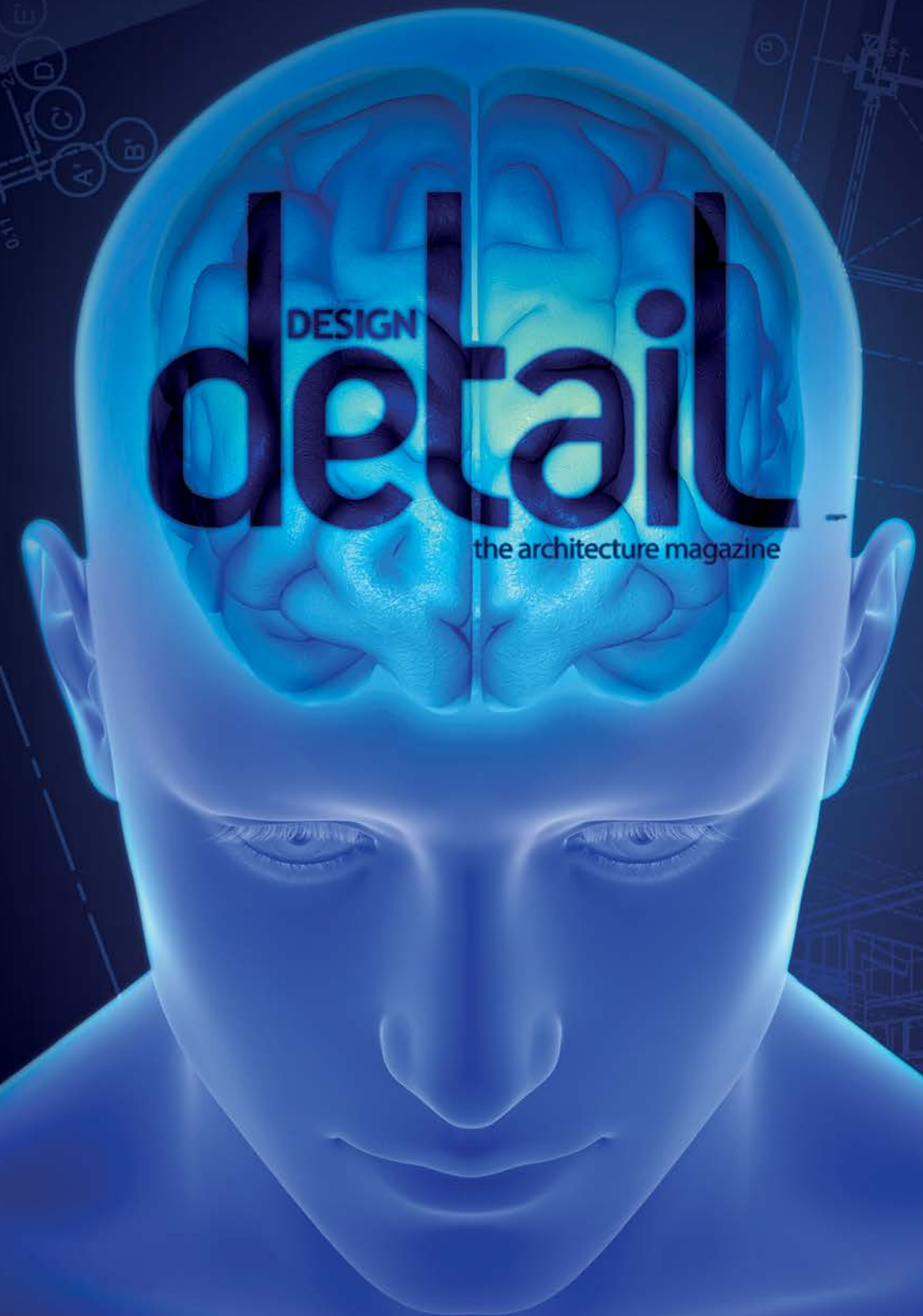
#### Switching Surges

- Spark gaps
- Surge arrestors (gapped and gapless)
- Surge suppressors
- Gas tubes

Courtesy: Mr.V.Sankaranarayanan, B.E., FIE, for providing relevant and supporting details.

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If the way to a man's heart is through his stomach...  
The way to an architect's mind is through Design Detail



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