

# **Culture of Safety against Lightning - An Indian Perspective**

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## **Abstract**

Thunderstorms and Lightning are climate related, highly localized phenomena in nature known for devastating consequences. Many scientific experiments have culminated in inventions for lightning safety, yet the mystery behind lightning is still unresolved and lightning as a phenomena is not completely understood. The technology of lightning protection have registered steady improvements but even with all the known precautions, complete safety is still beyond our grasp.

Creating awareness among the general people could go a long way in mitigating lightning threats. The Asian countries like India, Sri Lanka, Bangladesh, Nepal and Bhutan have started Lightning Awareness Centres and one of their objectives is to spread awareness among the people. The High Powered Committee of the Government of India on Disaster Management too has identified Thunderstorms and Lightning as natural hazards of great concern. The Bureau of Indian Standards purveys lightning protection guidance for structures and the builders are advised to adhere to the prescribed code. Research and Development programmes are being supported on lightning protection and many leading Indian institutes and Laboratories are working on lightning safety. The paper lays stress on spreading the culture of safety against lightning. It deals with the issues, Indian standards and methods of lightning protection, and introduces on going awareness programmes and research and development needs for lightning safety in the Indian context.

**Key words:** Lightning Protection, Standards, Awareness, Mitigation, Research, India

## **1. Lightning-An Underrated Disaster**

Lightning is a natural phenomenon where the charge generated due to cloud / air movement and other turbulent atmospheric conditions get down to the earth through a conductive path with disastrous direct and indirect effects. The direct effect being the high current (in the range of several thousands of kilo amperes) passing through structures or equipment or humans and the indirect effects being temporary rise of equipment voltages for a very short duration, known as surges.

The amount of loss of human life and properties due to lightning is significantly high. It is found in the recent years that lightning kills more people each year than tornadoes or hurricanes globally. Based on cases documented by the US National Lightning Safety Institute, in the United States, over the past 30 years, an average of 73 people are killed by

lightning each year and hundred or more are injured, some suffering devastating neurological injuries that persist for the rest of their lives. According to estimation more than 500 people die every year in South Asia and that to 1000 people die per year in SAARC countries, in Sri Lanka about 50 people die per year (Ahmad and Gomes, 2007). Apart from human lives, economical resources like cultivated fields, buildings, infrastructures, communication networks, power plants, trees and farm lands etc are often destructed by lightning events.

The inevitable questions will rise in one's mind. When the statistics above are so alarming, why little attention is being paid to Lightning Safety as compared to other disasters like flood, hurricane and tornado? Why lightning disasters receive little media attention? Because, the lightning disaster incidents are infrequent and mostly sporadic compare to other natural disasters. Also without graphic property destruction, it garners less media attention. Moreover lightning is highly a localized phenomenon and hence its total impact is not as evident as other disasters.

Then why it is important to worry about the lighting? It is necessary to pay the highest attention to lightning because the vast majority of the lightning disasters can be easily, efficiently and inexpensively avoided. The US agencies like National Institute of Lightning Safety (NLSI) and National Oceanic & Atmospheric Administration (NOAA) are actively involved in creating Lightning Awareness among the US Nationals. Although notable efforts have been taken by the scientific and disaster management community of South Asian countries to educate the public about lightning safety and minimize the number of deaths, still the fatalities and property damages due to lightning are high in these countries.

## **2. Thunderstorms in India**

The High Powered Committee on Disaster Management (HPC), India, constituted in August 1999 with an aim towards a systematic, comprehensive and holistic approach towards disasters had identified thirty odd disasters of which Thunder and Lightning was one.

Thunderstorms occur in different parts of India during different seasons, but widespread thunderstorms activity all over the country occurs during the hot weather period, also known as the Pre-monsoon period, from March to May, every year. Some parts of the country experience thunderstorms during the monsoon season also from June to September. During the post monsoon season i.e. October and November, thunderstorms occur in association with cyclonic storms and depressions most over peninsular India.

In India, the thunderstorms sometimes produce hailstorms which vary from less than a centimeter to about 5 cm or more in diameter. A series of thunderstorms along a line often extending hundreds of kilometer is called a 'Squall Line'. The squall lines are more severe convective phenomena than isolated thunderstorms. Thunderstorms lead to other convective phenomena called tornado. Tornadoes are extremely severe vortices of very small dimensions occurring in association with intense and large cumulonimbus clouds or cyclonic storms. When thunderstorms occur all over India, the most probable regions of



Depending up on the Average number of Thunderstorm Days (ATD) in a year, the places in India can be classified as follows,

<b>ATD</b>	<b>Type of Hazard</b>	<b>No. of Places in each type</b>
< 10	Very low hazard	23
≥10-<30	Low Hazard	61
≥30-<50	Moderate Hazard	57
≥50-<80	High Hazard	34
≥80	Very High Hazard	05

## 2.2 Damages due to Lightning in India

The Number of deaths, injuries and damages to properties due to lightning is high in India. It is a major concern that several fatalities are being reported due to lightning from its North Eastern states every year.

According to the National Crime Record Bureau, India in the year 2001 around 1507 persons died because of lightning. In Orissa alone, about 277 persons were killed by lightning in 2004 and also, it is reported by the state government in Orissa that during 2001-2004, around 900 persons were killed only due to thunderstorms.

At least 279 people were killed, and an estimated 200,000 made homeless, in severe floods in the southern Indian state of Tamil Nadu, in November, 2006. The flooding was caused by torrential rain over four weeks in October and early November, and was compounded by more monsoonal storms which hit the region between November 21 and 24. These monsoonal storms were associated with strong thunderstorms, however the deaths due to them were not reported separately.

69 persons were reported to be killed by lightning from various parts of Maharashtra state in the same period. Around 11 persons were killed and 100 were injured in lightning incidents in Madhya Pradesh state and 11 persons were killed in Jharkhand state during April and May, 2006.

Electrical equipments worth Rs. 2 lakhs, were damaged, when lightning struck the house of Volga Crasta at Kallianpur, Karnataka in October, 2006.

In the year 2005, The Mumbai floods were caused by the eighth heaviest ever recorded 24-hour rainfall figure of 944 mm which lashed the metropolis on 26<sup>th</sup> July, 2005 and intermittently continued for the next day. 644 mm (25.4 inches) was received within the 12-hr period between 8am and 8pm. It is reported that the floods caused a direct loss of about Rs. 450 crores. Within in three days about 406 persons were reported to be killed by these unprecedented floods. However, unfortunately, there was no report made separately on lightning incidents and deaths though some sporadic incidents of lightning were reported from other places like Satara, Kolhapur and Pune districts of Maharashtra State, India.

This year the monsoon is yet to set and bring the torrential rains, but within the period from March and April, 2007 around 53 persons were killed and 10 were reported to be injured (source: various dailies) by lightning strikes that were associated with heavy to moderate pre-monsoonal rains.

The telecommunication network in Kangra district, Himachal Pradesh was paralyzed after lightning struck the main telephone exchange at Jassur on 2 March, 2007. The lightning damaged telecommunication equipments worth lakhs of rupees in the main telephone exchange. 15000 telephone lines out of 24, 000 lines were out of gear and 29 telephone exchanges of Kangra district remained suspended with headquarters at Dharamsala. These statistics indicate the severity of lightning strikes.

### **3. Protection against Lightning**

Since the lightning cannot be avoided, the logical way to avert the risks of lightning strike is to find a protection for personal and structural safety. As explained earlier the current passes through the structures or equipments or living beings could be fatal. The protection and safety against lightning can be achieved in two ways

- Protection through Scientific and technical Methods
- Mitigation through safety measures

#### **3.1. Protection through Scientific and Technical methods**

Since 1970, after the Franklin's invention of Lightning protection rod, there is a remarkable advancement in the science of Lightning Protection. The scientific and technological world has put its entire effort on bringing systems for the protection of valuable infrastructures and equipments against lightning.

##### **3.1.1. Lightning Protection to structures**

###### **3.1.1.1 Direct and Indirect strikes**

A Lightning bolt travels about 14,000 m/hr bringing 300, 000 amperes of electricity to the ground in just a few milliseconds and heats the air around to 30,000° C-five times hotter than the surface of the Sun. The enormous current associated with the lightning flash often destroys the power and communication networks in an area where it strikes. The lightning may directly hit a structure (direct strike) or a part of a lightning flash that hit another structure may affect the near proximity (side flash). The direct lightning or side flashes cause damages at a rapid speed so that once the structure is struck by a lightning, it is impossible to prevent any electrical damages or human injuries, except preventing fire from spreading to other structures close to the affected structure.

The current that results out of a cloud to ground lightning emits strong electromagnetic radiations. Once a lightning struck to a nearby object of 500 m distance, the whole structure would be under a strong dose of electromagnetic radiation. When this radiation passes

through electronic equipments such as computers and sophisticated medical and defense instruments etc. their, components suffer high heat energy and totally destroyed. This may happen even when the equipments are unplugged from their service lines. However, the chances of ordinary electrical equipments getting damaged by such radiation are very less.

### **3.1.1.2 Surges & Hazards**

Surges are momentary increase in the normal working voltage of a system. Sometimes referred to as ‘spikes’, ‘over-voltages’ or ‘transients’, these surges can affect power cables, data / telephone cables and instrumentation wiring, causing anything from data loss to the total destruction of equipment. These are indirect effects of lightning that destroy sophisticated equipment, especially the sensitive electronic equipment. Typical causes include fluorescent light switching, blown fuses and nearby lightning activity. The effects of these surges & transients are not always visible. Burnt / charred Printed Circuit Boards (PCBs) or malfunctioning software, etc. are indications of the effect of surge / transients. It is estimated that 70 to 85% of all transients are generated internally within one’s own facility.

Therefore, the best way to buy against lightning disaster is to have safer building and infrastructures. The lightning protection standards provide methodology to protect structures and buildings from lightning strikes.

### **3.1.2. Standards on Lightning Protection**

The following standards are being followed in India for lightning protection and safety.

**The Indian Code of Practice: Indian Standard: IS 2309: 1989;** Protection of Buildings and Allied Structures against Lightning-Code of Practice (Reaffirmed in 2005)

This Code outlines the general technical aspects of lightning, illustrating its principal electrical, thermal and mechanical effects. Guidance is given on how to assess the risk of being struck and it offers a method of compiling an index figure as an aid in deciding if a particular structure is in need of protection.

The Code also offers guidance on good engineering practice and the selection of suitable materials. Recommendations are made for special cases such as explosives stores and temporary structures, for example, cranes, spectator stands constructed of metal scaffolding. Where current carrying conductors are directly associated with structures coming within the scope of this Code, certain recommendations relating to them are included.

### **International Standards**

- British Standard 6651 (1999): Code of Practice for Protection of Structures against Lightning (This code will be replaced by BS EN 62305 (Parts 1-4) in August 2008)

- American Petroleum Institute (API) Recommended Practice 2003-Protection Against Ignitions Arising Out of Static, Lightning and Stray Currents. The Chapter 5 discusses direct and indirect effects of lightning as well as protection of specific equipments.
- National Fire Protection Association NFPA- 780: Standard for the Installation of Lightning Protection Systems. It describes minimum standard to residential, commercial and industrial facilities.
- Oil Industry Safety Directorate (OISD) 180

### **3.1.3 Assessment of Lightning Risk and Need of Protection**

Indian Standard on Lightning Protection (IS 2309) provides the methodology to assess the lightning protection requirement for structures and buildings.

#### **3.1.3.1 Estimation of Exposure Risk**

The probability of a structure being struck by lightning in any one year is a product of 'Lightning Flash Density' ( $N_g$ ) and the 'Effective Collection Area' ( $A_c$ ). The Lightning Flash Density ( $N_g$ ) is the number of flashes (flashes to ground) per square kilometer. The Annual Thunderstorm days per year of a location can be translated in terms of estimated average annual density ( $N_g$ ). The relationship between thunderstorm days per year (ATD) and lightning flashes per square kilometer per year ( $N_g$ ) are give in IS 2309.

The effective collection area ( $A_c$ ) of a structure is the area on the plan of the structure extended in all directions to take account of its height. For ex. for a simple rectangular building with a length of  $L$ , width of  $W$  and Height  $H$  meters, the effective collection area would be having length  $(L+2H)$  and width  $(W+2h)$  meters and four rounded corners formed by quarter circles with a radius of ' $H$ ' metres.

$$\text{Therefore, } A_c = (L \times W) + 2(L \times H) + 2(W \times H) + \pi H^2$$

The probable number of strikes per year ( $P$ ) is the product of  $N_g$  and  $A_c$ . The acceptable risk figure accepted by IS 2309 is  $10^{-5}$ , i.e. 1 in 100,000 per year.

#### **3.1.3.2 Overall assessment of Risk**

After finding the probable number of strikes to the structure ( $P$ ), next step is to find overall assessment of risk based on the following 5 weighing factors.

- Use of structure
- Type and Nature of Construction
- Value of its contents
- Degree of Isolation
- Type of Terrain



IS 2309 elaborately explains the weighing factors and values for each factor is given in the code. The overall factor is calculated by multiplying the above 5 factors. The final risk assessment is the product of Probable number of strike to structure (P) and overall multiplying factor. If it exceeds  $10^{-5}$ , lightning protection is necessary.

‘Furse StrikeRisk v2.0’ is a lightning Risk Assessment tool developed by M/S. Furse (Lightning Protection manufacturers) engineers based on BS 6651. This simple tool enables the user to carry out the lightning protection risk assessment.

### **3.1.4 Functioning of Lightning Protection systems**

When a downward channel comes from a cloud, the air termination sends an upward channel much faster than the other parts of the building thus the lightning is attracted to one of the rods (or to the metallic mesh).

Then the lightning current is safely passed into earth through the rest of the system. Thus, instead of repelling, a lightning protection system attracts a lightning channel.

The system is called the “Franklin Rod System”, named after Benjamin Franklin who first proposed lightning rods in 1750.

### **3.1.5 Selection & Design of Lightning Protection system**

The essential guidelines that are outlined in IS 2309 are given below.

**3.1.5.1 Air Termination (vertical, horizontal)** The structures may be protected from lightning by either channeling the current along the outside of the building and into the ground or by shielding the building against damage from transient currents and voltages caused by a strike. The method constrains the path of lightning currents and voltages through use of lightning rods, or air terminals, and conductors that route the current down into a grounding system, as shown in the figure.2 When a lightning leader comes near the building, the lightning rod initiates a discharge that travels upward and connects with it, thus controlling the point of attachment of lightning to the building. A lightning rod functions only when a lightning strike in the immediate vicinity is already immanent and so does not attract significantly more lightning to the building. An air termination networks consists of vertical or horizontal conductors or combination of both.

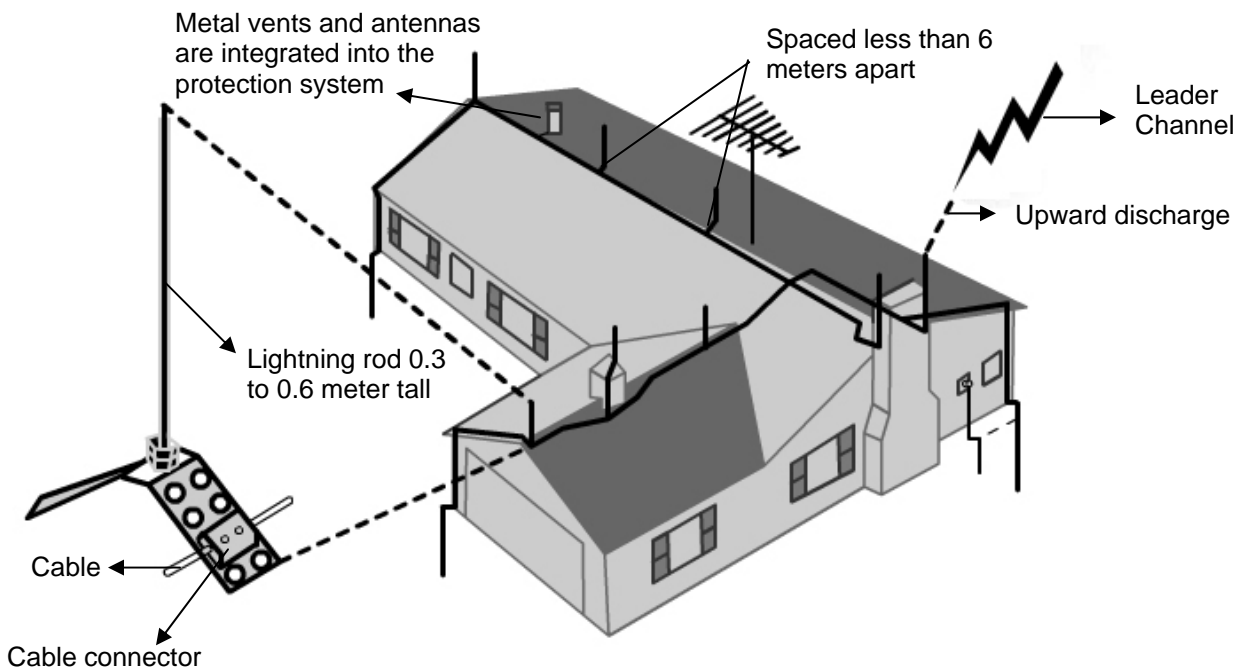


Figure 2. Lightning rod protection system for a residential building (Encyclopedia Britannica, 1999)

### 3.1.5.2 Protective angle

In simple terms, zone of protection is the volume within which a lightning conductor gives protection against a direct lightning stroke by directing the stroke to itself. For a vertical conductor rising from ground level, the zone has been defined as a cone with its apex at the tip of the conductor its base on the ground. For a horizontal conductor the zone has been defined as the volume generated by a cone with its apex on the horizontal conductor moving from end to end.

However for practical purpose of providing an acceptable degree of protection for an ordinary structure, the protective angle of any single component part of an air termination network namely either one vertical or one horizontal conductor is considered to be  $45^\circ$  (Fig.3). Overhead wires and grounded vertical cones may also be used to provide a cone-shaped area of lightning protection, as shown in the figure. Such systems are most efficient when their height is 30 metres (98 feet) or less.

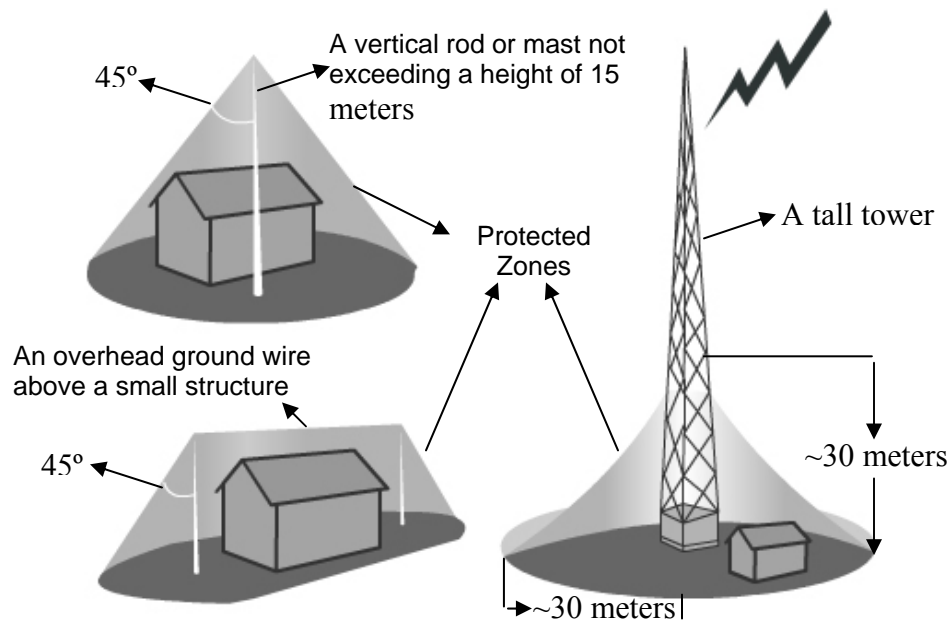


Figure 3. Protection angle for Vertical Air terminator (Encyclopedia Britannica, 1999)

### 3.1.5.3 Down conductors (Number & routing to avert side flashing)

The function of a down conductor is to provide a low impedance path from the air termination to the earth electrode so that the lightning current can be safely conducted to earth. In practice, depending upon the form of the building, it is often necessary to have many down conductors in parallel, some or all of which may be part of the building structure itself. For example, a steel framed building might need no added down conductors, the framework itself providing an efficient natural network of many paths to earth; conversely a structure made entirely from non-conducting materials would need down conductors deployed according to its size and form.

In brief, the down conductor system must, where practicable, be directly routed from the air termination to the earth termination network, and be symmetrically placed around the outside walls of the structure starting from the corners. In all cases consideration to side flashing must always be given.

### 3.1.5.4 Earth Terminations

The primary purpose of a grounding system is to divert the lightning strike discharge directly to ground through a low resistance circuit suitably rated to carry the momentary current values. This has the effect of reducing the strike period to a minimum, and reducing or eliminating the problem of side strikes as the charge attempts to go to ground.

An earth electrode should be connected to each down conductor. Each of the earths should have a resistance not exceeding the product given by  $10 \Omega$  multiplied by the number of

earth electrodes to be provided. The whole of the lightning protective system, including any ring earth, should have a combined resistance to earth not exceeding  $10\ \Omega$  without taking account of any bonding.

If the value obtained for the whole of the lightning protective systems exceeds  $10\ \Omega$ , a reduction can be achieved by extending or adding to the electrodes or by interconnecting the individual earth terminations of the down conductors by a conductor installed below ground, sometimes referred to as a ring conductor. Buried ring conductors laid in the manner described above are considered to be an integral part of the earth termination network and should be taken into account when assessing the overall value of resistance to earth of the installation.

#### **3.1.5.5 Surge protection**

Lightning protection rods and down conductors, can protect structures from direct strikes and from side flashes. But buildings can be penetrated by lightning currents that propagate along the service lines such as power, telecommunication etc. These lines are more probable to be exposed to lightning electrical environment than individual buildings as they stretch a long distance over the land. The special devices used for preventing such dangerous current impulses from entering in to a building are called surge diverters or surge suppressors. A surge diverter is connected at the entrance of the service line to the installation. A High level of protection can be obtained if they are connected at the power socket of electrical or electronic equipment as well. In the case of a lightning invasion it provides a convenient path for the lightning current to divert into the earth without permitting it entering into the building or the equipment. Surge suppressors, which have to be connected to protect power lines, communication lines and data lines, are different from one another.

#### **3.1.5.6 Electromagnetic Compatibility**

Electromagnetic radiation is associated with lightning and can cause damages to the sophisticated electronics in a building. Prevention of such intrusion of undesired electromagnetic impulses through both radiation and conduction is termed Electro Magnetic Compatibility (EMC). “Faraday Cage” (Fig.4) is the usual method of radiation prevention, in which building will be screened with the conductive materials so that the structure behaves like cage. This method of protection is provided to the part of the building where sophisticated electronics are installed (such as computer rooms, medical theatres and scanning rooms, control chambers of power plants, airports, military bases, and communication bases etc.).

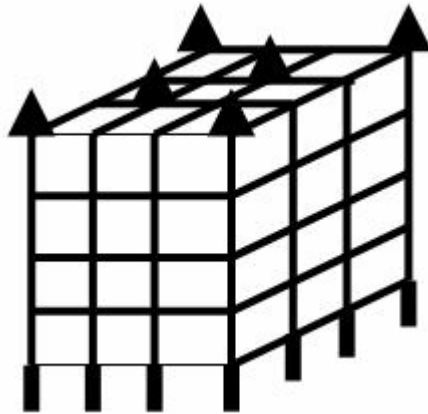


Figure 4. Faraday Cage type  
Lightning protection

### 3.1.5.7 Maintenance of Lightning Protection system

No lightning protection system is maintenance-free. Every type of LP system whether it is surge diverters installed on power lines or Franklin rods atop buildings or surge protection devices installed to protect electronic equipment, needs to be maintained based on applicable standards. Monitoring the surge counter reading would give an idea of the local lightning activity in your area. Earthing plays an important role in the efficacy of lightning protection system.

Doing regularly the following test can ensure an effective lightning protection system

- Tests on earthing system
- Inspection of air terminations
- Down conductors
- Checking on Surge diverters and suppressers

## 3.2. Mitigation through safety measures

The another way of mitigating lightning strikes is creating awareness by dissemination of knowledge about lightning strikes and protection mechanism to the public and administrators.

### 3.2.1 Creating Public Awareness

#### 3.2.1.1 Personal safety

Lightning strikes are infrequent in nature, though they occur every year during the monsoon, pre and post monsoon periods in India. Due to their sporadic occurrences, the common people really don't have concern over the danger associated with lightning strikes and it is common sight in India people being out doors watching thunder and lightning, continuing their works in paddy fields, the fishermen going to sea during lightning etc. It leads to lightning casualties and deaths leading the poor people to lose their family members. It is important to create the awareness on lightning protection and personal safety

among different target groups such as educated and uneducated people, villagers, rural youths, school going children etc.

### **3.2.1.2 Building and Infrastructure Safety**

The methods and facilities to secure safety for the buildings and infrastructures are already mentioned in the previous section. However, the rural men and uneducated never read or get to know the building codes and stay oblivious of these technical safety measures. Hence it is important to create awareness among the public about different safety codes in the building standards for different disasters along with lightning strikes.

It is true that total protection cannot be assured against lightning, so the insurance sector should come forward and provide insurance for buildings which are all having adequate lightning protections. In India some of the Insurance companies like ICICI are providing such insurances. This will encourage people to adopt safety measures.

## **3.2.2 Enforcement of Lightning Protection Standards**

### **3.2.2.1 Role of Builders and Building companies**

If a common man does not know about building standard and lightning protection can be forgivable, but if a builder or building company does not follow the code, is an offense. They are supposed to know about the building codes and should carry out Risk Assessment for each disaster probable in their area of construction and should take appropriate mitigation measures. If they are unaware, they should be given adequate knowledge about the area and probable disasters. The Certifying Authority also should ensure that all necessary precautionary measure is taken for each disaster probable in that area.

Apart from the personal buildings, public structures like flyovers, bridges, airports, Sea ports and archeological monuments can also suffer lightning strikes. So it is important to adopt proper safety and mitigation measures.

### **3.2.2.2 Involvement of Technical people in Lightning Protection**

Telecommunication and Electricity and Power supply are the major public sectors suffering huge losses and asset damages due to Lightning strikes and Surges. So it is important that technical people working in these sectors should be given adequate training on Lightning Protection. Telecommunication systems including mobile phone services should be enforced to take precautionary measures.

### **3.2.3 School Awareness Programmes on Lightning Safety:**

Catching them Young will help in many ways for the country. Children are the future of any country. If they are trained when they are young, they would be very useful in dissemination of awareness for other target groups such as rural children and uneducated men and women in the villages.

Each school should have a disaster management plan. They should adhere to Building standard and codes. Authorities should check every school about lightning protection and safety measures. Dos and Don'ts and Personal Safety during Lightning should be taught to each child and a mock drilling exercise for fire should be taken periodically.

#### **4. Lightning Awareness Programmes in India**

Lightning awareness workshops were conducted by UNESCO, New Delhi in India with aim to disseminate lightning protection awareness in India and surround regions. The participants were mostly from educational sectors who were encouraged to involve actively in the awareness promotion programmes.

With support from South Asian Lightning Information and Resource Centre (SARI)/Energy Small Grants program and UNESCO, New Delhi the South Asian Lightning Awareness Program (SALAP) was developed to provide much needed awareness and expertise in this region on lightning protection and safety.

The Lightning Awareness Cell formed under the Umbrella of Regional Energy Centre, Kerala (Non profit organization under the Travancore Cochin Literary, Scientific and Charitable Societies Act-XII of 1995) in June 2005. It is promoting lightning protection Awareness by conducting Lightning Workshops for Local and Technical People.

The Lightning Awareness Cell, Guwahati has been formed under The Energy and Resources Institute (TERI) in August 2005. The cell is promoting Lightning Awareness among school and college teachers, Panchayat Members and Villagers, Media Professionals in different regions of the country. It had organized two days workshop on lightning in Gauhati in April, 2006. Some of the planned programmes under the cell are, entrepreneurship development programmes involving participants from all the states, mapping on lightning affected areas of India.

Centre for Innovation in Science & Social Action (CISSA), Thiruvananthapuram, Kerala is a nonprofit, non governmental organization of scientists and citizens combining rigorous scientific analysis, innovative policy development and effective citizen advocacy to build a cleaner, safer and healthier world. It has joined hands with The Lightning Awareness Cell, Regional Energy Centre, Kerala and South Asian Lightning Information and Resource Centre and conducted a one day workshop on Lightning protection in for academicians and professional from industries, telecommunications, aviation, military, hydrology and meteorology sectors in October, 2006 at Thiruvananthapuram.

*Centre for Disaster Mitigation and Management (CDMM), VIT University, Vellore, India*

One of the areas of major thrust at CDMM is innovative education and training on Disaster Mitigation and Management. CDMM has produced a number of knowledge products in this area and conducted seminars, discussion meetings and Roundtable conferences on Natural Disasters. As a part of the Safety and Awareness Programme to mitigate lighting disasters,

the tips for lightning safety are being disseminated. The activities of the Centre can be viewed at [www.vitcdmm.org](http://www.vitcdmm.org)

## **5. Lightning Research Programmes in India**

In India, Some of the leading academic and research institutions have been carrying out R&D programmes relating to thunderstorms and lightning. The Research areas and testing facilities developed in two of such institutions are briefly mentioned in the following.

### *Department of High Voltage Engineering, Indian Institute of Science, Bangalore*

The Department of High Voltage Engineering under the Indian Institute of Science, Bangalore is a leading research institute involved in research on Electromagnetic and Lightning. Their current research programmes are on electromagnetic field theory, electrostatic field theory in complex geometries and space charge phenomenon, transient field in composite lossy dielectrics and machine windings, field associated with lightning and lightning induced voltages, etc. They also have designed and built Lightning protection systems for the satellite Launch Pad at Sriharikota, India. They provide Lightning test facility for aircrafts at Bangalore, lightning protection for HANSA aircraft etc. Their Research and Development projects involve: Development of high voltage and high current facilities for lightning aircraft interaction analysis, Development of sensors for the measurements of lightning currents in strokes intercepted by the lightning protection systems.

### *The Atmospheric Science Division, Centre for Earth Sciences Studies (CESS), Thiruvananthapuram, Kerala*

The Atmospheric Science Division, CESS is conducting combination of research in Atmospheric Electricity, Lightning and related Instrumentation. They have under taken studies on lightning hazard in Kerala. The summary of the work is given below:

To understand the lightning activity in Kerala, lightning data for the past 17 years (1986-2002) was collected. Reports of casualties from newspapers, records of lightning accidents available from village revenue records and other sources like telecom department are used for the study. These data sets were screened to eliminate duplicate incidents. Then it was analysed for spatial and temporal distribution of lightning occurrence. Data on cumulonimbus (Cb) cloud observations were collected from the India Meteorology Department for the stations Thiruvananthapuram, Alapuzha, Kochi, Kozhikode and Kannur for the same period. This data was used to study the occurrence of thunderclouds. From the beginning of northeast monsoon to the occurrence of the next southwest monsoon season is a period in which lightning activity is seen to be high in Kerala. The lightning occurrence data when posted on a physical map of Kerala clearly shows that midland regions of Kerala are more affected than the coastal plains and highland regions. The Palakkad gap region experiences the least strikes. This indicates that the Western Ghats play an important role in influencing the formation of Cb clouds (Murali Das et al., 2007)



Along with the above study, an electric field meter is being used to monitor atmospheric electric field. The movement of thunderclouds and their effect on electric field is being studied with this data. The lightning events as recorded by the meter and the actual area where lightning struck are being studied to evaluate the usefulness of the electric field data.

Apart from the research work, the CESS scientists are involved in awareness camps that are conducted in areas of high lightning frequency and disseminating knowledge on lightning protection.

## **6. Conclusions**

Though lightning incidents are less, whenever they strike, they cause severe damages to life and properties. Casualties due to Lightning can be easily, efficiently and inexpensively avoided, and lightning safety can be achieved mainly by creating public awareness, technical education on Lightning Protections, educating people on lightning and surge protection. Stringent steps to ensure adherence of building standards and codes wherever necessary and promoting research and development on lightning protection are essential. There is a need to give lightning its due attention as a natural disaster and give it a priority in National Disaster Management Programmes.

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## **Tips for Your Personal Safety**

Your life is precious. Please spend a few minutes of your time to go through this message from CDMM carefully, and free yourselves from the fear of thunderstorms and lightning for all times. It is unfortunate that people are either killed or disabled by lightning just because they keep watching the beauty of rain, thunder and lightning outdoors or take a shelter under a tree or continue with boating, swimming, fishing, climbing, playing, golfing or talking over telephone, unmindful of the damage lightning could inflict.

Remember, no place on the earth is safe against thunder storms and lightning, especially when you are outdoors. All thunder storms are dangerous despite their usually small area of coverage (typically 24 km in diameter). Lightning could strike all exposed objects including buildings, water tanks, hill tops, vehicles, electrical poles, animals and people. There are no exceptions or exemptions. Here are a few tips for your safety:

1. When you see lightning and hear thunder of a storm even before you could count 30, it is a sure warning signal that you should rush indoors to protect yourselves.

2. If no shelter is available in the neighborhood of where you are, then seek protection by getting in to a hard topped vehicle with windows closed. You are much safer inside a car than outside because steel frame of a vehicle usually provides protection, if you be careful not to touch metal.
3. Keep distance from vulnerable locations like isolated trees or isolated tall structures. Lightning can strike the same place twice and can spread out nearly 20m after striking the ground.
4. If you get a tingling sensation or standing hair experience, it is to be taken as a premonition of impending threat of lightning. In such a situation, quickly acquire the lowest profile by crouching down the balls of your feet but never make a mistake to lie flat on the ground.
5. Lightning can affect a building in three ways (a) direct hit (b) through external wires and pipes, and (c) through the ground. Lightning can also travel through reinforcement in concrete walls, flooring etc. Beware.
6. Do not use wired phones. Mobile phones are the safest to use.
7. Lightning can strike through external doors and windows. The porch leading to Chancellor's office may not also be safe.
8. Unplug all the electrical and electronic equipment as soon as the thunder and lightning seem likely. Do not forget to disconnect radios and TVs from external antennas.
9. Avoid contact with all sorts of pipes and avoid taking a shower during thundering and lightning.
10. Monitor thunder storms and lightning from indoors. You should go out only after ensuring lull for atleast 30 minutes since the last thunder.
11. No rain does not mean no danger of lightning. Lightning may occur as far as 15 Km from the nearest rainfall area. Be alert.
12. Do not be under the mis-impression that the rubber shoes you wear and the rubber tyres of your car will protect you from lightning.
13. If someone is struck by lightning, at once come to his or her rescue. It is a very wrong notion that those struck by lightning carry an electrical charge.
14. A lightning protection system or no lightning protection system, a lightning can always strike. A lightning protection system, however, ensures a low resistance path for discharge of lightning energy. Good systems of protection carry lightning

charge through lightning rods and cables from the building to the ground, and dissipate the charge. Ensure that the building is well protected.

15. If any part of a building is hit by lightning, call fire department immediately. Check whether any body is hurt.
16. The immediate cause of death due to lightning in most cases cardiac arrest. It is important therefore to check whether the victim is still breathing and has a pulse. Act accordingly.
17. Loss of memory, dizziness, fatigue, chronic headache or difficulty in sleeping could be the consequences of any sad lightning experience.

## References

Ahmed, M., and Gomes, C., 2007. Lightning Safety Awareness Programme Especially in South Asia to Minimize Loss of Human Lives and Properties. Presented in the International Roundtable: Lessons from Natural Disasters-Policy Issues and Mitigation Strategies, held at VIT University during 8 to 12 January, 2007

Bhagavanulu, D. V. S., 2007. Lessons from Flood Disasters in India – An Overview. Presented in the International Roundtable: Lessons from Natural Disasters-Policy Issues and Mitigation Strategies, held at VIT University during 8 January to 12 January, 2007.

Bhandari, R. K., 2006. Disaster Management in India: A New Awakening. Disaster & Development, Vol.1, pages 1-26.

Gomes, C., Kithil, R., and Ahmed, M. Developing a Lightning Awareness program model for Third world based on American-South Asian experience.

Source: [http://www.lightningsafety.com/nlsi\\_pls/American\\_model\\_for\\_asia.pdf](http://www.lightningsafety.com/nlsi_pls/American_model_for_asia.pdf).

High Powered Committee on Disaster Management, India, Report, 2001.

Indian Standard: IS 2309: 1989; Protection of Buildings and Allied Structures against Lightning-Code of Practice (Reaffirmed in 2005)

Murali Das, S., Sampath, S., and Mohankumar, G., 2007. Lightning Hazard in Kerala. J. Mar. Atmos. Res. Vol. 3, No. 1, Jan., 2007, 111-117.

Sreejith, P. G., 2003. Lightning and Surges: Myths and Facts. Monthly eNewsletter to 'Manage your risks profitably' from Cholamandalam M S Risk services Limited, Risk Note 1, April 2003.

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