

Safety procedures for reduction of risk due to lightning outside and inside a structure

■ Introduction

Last data show that the number of people injured and killed by lightning all over the world is increasing, mainly due to behavior and ignorance of the lightning dangers.

This letter introduces the right action in the presence of thunderstorms, as well as protective measures against lightning. It also contributes to the prevention of lightning injuries and damages.

It should be noted that so far there are no means to avoid lightning.

■ General:

Generally, the power brought by lightning is very high but acts for less than a millisecond.

High voltages can occur and currents as large as 200 kA can flow.

Consequently, thin wires melt and objects struck by lightning are heated up so strongly that flammable substances ignite or explode.



Lightning currents can penetrate into buildings and structures, along telecommunication lines and power lines, destroying electrical and electronic equipment.

In open spaces, when not protected by Lightning Protection System (LPS), people are susceptible to **direct strikes**, to **side flashes**, **induced discharges**, **touch voltages** and **step voltages**.

The **direct lightning strike** is the most dangerous of the lightning threats. The lightning current flows through a person and causes unconsciousness, burning, cardiac arrest or paralysis.



It is dangerous to stay under an isolated tree because if the human body is less than several meters from the trunk, it may experience a **side flash**.

Generally, all unprotected structures should be avoided as a means of shelter, especially small isolated structures such as huts and small barns.

When lightning strikes the ground, the lightning current is spread out in the soil. Step voltage appears near the point because of high potential rise.

In the same way, when lightning strikes buildings or trees, high potentials on the ground is produced around the earthing systems or roots of trees.

Human beings may suffer dangerous step voltages close to buildings or trees.

People can experience step voltage when lightning strikes in the vicinity.



This situation is more hazardous if the ground resistivity is higher, the distance to the strike point is smaller and/or the distance between the two feet is larger.

Panels exist to advertise people of the risk of being too close from metallic parts and LPS (distance lower than 3m).



Metallic structures do not only present a threat due to arcing but also due to **touch voltages**.

To reduce the risk of electrical shock due to touch voltages it is advisable to stay away from potential lightning current conductors during a storm.

Electrization by touch voltages occurs when people, with feet in contact with conductive ground, touch a conductive structure that may be at a different potential due to a lightning strike.

■ Effects of lightning strikes to human beings

Possible injuries

When a human being is directly struck by lightning, the voltage climbs up to about 300 kV from feet to

head. The far larger portion of the lightning current does not flow through the body but on its surface. Due to this effect, many people have survived after a direct lightning strike.

Physiological effects range from being dazzled to instantaneous death, through neurological troubles, visual loss, deafness, paralysis, fainting and comas.

The body-crossing from feet to head leads to serious or even fatal injuries.

Electrically, the human body behaves like a gel, with an internal resistance of about 300 Ω.

The thermal shock is so short that only superficial burns can occur, but metallic objects can reach high temperatures leading to deeper burns.

Lightning victims can also have erythematous tree-like discharges or Lichtenberg figures, which are initiated by a leader circulating between clothes and skin.



The lightning current also burns hair.

The Lichtenberg figures, which testify to the current flow usually disappear after one or two days.

Commonly, there is cessation of heart action and breathing so that the victim appears clinically dead.

Brain injury is often present as well.

Latent injuries may also occur only after some days.

These include chronic pains, high blood pressure, memory failures and even personality changes.

How injured people can be helped:

Call the emergency services immediately and obtain medical help. First aid can be lifesaving.

In May 2016 in the Monceau Park of Paris, a group of 11 people among 8 children has been struck.



First aid given by a fireman save everybody.

How to act in the presence of a thunderstorm.

How to detect a lightning risk

First, internet sites are available to provide near real-time lightning location information.

Moreover local detectors can also be used, both for industrial sites and private activities.

A dangerous industrial activity can be stopped or exposed activity can be avoided.



Some sensors can be portable. Being light, they can be easily used for people involved in outdoor activity.

Fixed sensors are more bulky but also more reliable, especially in their capability of giving an early warning. They can be used for industrial sites but are also efficient for golf courses and camping sites, for example.



Correct behavior considerably reduces the risk of being injured by lightning. Lightning is unpredictable; don't trust your good luck!

Where to find safe locations



The safest location to seek shelter is inside a building equipped with a complete LPS. Don't call from a corded phone. Keep clear of electrical power or telecommunication lines or metallic pipes, and metallic chimneys. Don't take a shower or bath during a thunderstorm.

The preferred option is to install Surge Protective Devices (SPDs) in the incoming panelboard to protect the electrical devices. An SPD should be provided at the entry of each power and telecommunication line.



What to do outdoors

Although there is a higher probability of a lightning strike to tall objects, like trees or masts, don't forget that it may strike anywhere.

When the possibility of a thunderstorm is great, **try to reach a safety place protected by a LPS or in alternative:**

- Keep away from fences and other metallic structures, ditches and other wet places, open fields, hilltops and shores (at least 3 m).
- Don't use umbrellas or golf clubs or other conducting objects in your hands.
- Isolated trees are particularly hazardous. A safety distance of 10 m should be kept.
- The ideal position in the open air is crouching down, with the head as close as possible to the ground and one's arms encircling one's legs.

If you are absolutely obliged to move in a thunderstorm, take short steps, or run (with only one-step in contact to the ground). If several persons stand together, they should keep a distance of at least 3 m from each other.

Hazardous situation in a car

A metallic car constitutes good protection (Faraday-like shield) if windows are wound up. As a good electrical conductor, a car keeps the passengers protected against lightning.



It is recommended to delay your journey for the duration of an intense thunderstorm.

Thunderstorms in mountainous regions

In the mountains, lightning is extremely dangerous for hikers and mountaineers. The weather can change very quickly.

If your lightning sensor advice you, or if storms can be seen forming or if you feel hair starting to stand up on arms or the back of the neck:

- Move promptly and safely trying to reach a mountain hut with LPS.
- Crouch down.
- Don't touch a rock face with hands or feet.
- Stop climbing up the mountain

Thunderstorms can initiate rock falls and dangerous avalanches.

What to do on water

At the approach of a thunderstorm, don't use sailing boats (unless properly protected against lightning). If you are caught off-shore in a watercraft and not protected with a LPS, stop all activities and move below deck if possible.

In the water, the lightning current is spread over large areas; at 100 m from the strike point the current is still hazardous.

The IONIFLASH MACH NG range protects many boats and vessels all over the world.



What to do during an outdoor activity

The same elementary rules apply to open air events as for other outdoors activities. Platforms equipped with a LPS are protected areas.

- No metallic parts should be touched.
- Keep 3 m away from all conductive parts.
- Place your feet close together.

People involved in outdoor sports activities should seek a safe location protected by a LPS at the first sign of lightning or thunder in the area or alarm of the sensor. Play may be resumed when the storm detector confirm that the thunderstorm is far away.

Golf courses are particularly dangerous places during thunderstorms, due to the area profile and the presence of isolated trees or clusters of trees as well as the golf equipment. Injuries and death by lightning strikes occur on golf courses when golfers try to continue playing as a storm approaches or seek shelter under isolated trees or at the edge of a group of trees.

