



World Water Safety

## INTERNATIONAL LIFE SAVING FEDERATION

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### LIFESAVING POSITION STATEMENT - LPS 16

## LIGHTNING

**NOTE:** This statement is intended for those lifesavers, acting in a professional or volunteer capacity, who are trained in the techniques of water rescue and resuscitation and who assume a duty to safeguard members of the public at aquatic sites. They may be called lifeguards, lifesavers or both. This statement is not directed at members of the public trained in water safety and rescue techniques, but without a duty to respond, who may also be known, in some areas of the world, as lifesavers.

### BACKGROUND

There has been little systematic collection of information on lightning deaths in many regions of the world. <sup>[1]</sup> Holle and Lopez (2003) <sup>[2]</sup> made an assessment of the worldwide impact of lightning and concluded that 24,000 deaths and 240,000 injuries occur per year. Their data indicated that the lightning fatality rate in Australia, Canada, Europe, Japan and the USA has dropped considerably from the 1800's to the present due to a major population shift from rural to urban areas and away from labour intensive agriculture, as well as the occupancy of substantial buildings, better forecasts and awareness of weather and lightning, improved medical care and emergency communications, as well as enclosed metal topped vehicles. However, every year, lightning strikes and kills people on or near bodies of water. From 2006 through 2013, 261 people were struck and killed by lightning in the United States. <sup>[3]</sup> Almost two thirds of the deaths occurred to people who had been enjoying outdoor leisure activities. During this 8 year period there were a total of 57 deaths that involved people in or near bodies of water - 30 fishing deaths, 14 boating deaths, and 13 beach deaths. <sup>[3]</sup>

In the USA, summer is the peak season for outdoor and water-related activities, and when most lightning deaths and injuries occur. <sup>[4]</sup> As recently as 2011, a lifeguard was fatally struck by lightning in Florida. <sup>[5]</sup> <sup>[6]</sup> Environment Canada states that "Swimming, boating, personal watercraft or sail/surf boarding are all dangerous activities when lightning is in the area. Scientists know little about what happens when lightning hits water. It is not clear how deep a lightning strike will travel down through the water. We do know that if a lightning strike hits the water, it will travel along the surface in all directions. People have been killed or injured by direct or indirect strikes (ground current or side flash) while in or on the water, boats, docks, piers, or while fishing, for example". <sup>[7]</sup>

Lightning cannot be prevented, but the vulnerability of lifeguards, beach-goers, and patrons near bodies of water can be minimized. Vulnerable locations include: beaches, indoor and outdoor pools, diving boards, lifeguard stands, and nearby outdoor recreational facilities.

## STATEMENT (recommendations)

Lifesavers should understand thunderstorms and lightning to ensure that they make educated decisions on when to seek safety and when to encourage those they are protecting to seek safety. They should also understand what areas provide adequate safety from lightning. The International Lifesaving Federation recommends that lifesaving organisations have a lightning safety plan and that lifesavers follow it without exception. The plan should give clear, specific safety guidelines to eliminate errors in judgment. The guidelines should address the following questions:

- When should activities be stopped?
- Where should people go for safety?
- When should activities be resumed?
- Who should monitor the weather and who decides when to stop activities?
- What should be done if someone is struck by lightning?

The 30:30 rule outlined in this statement should be considered as a minimum guideline for lifesaving organisations.

## LEVEL OF EVIDENCE

This document is based on expert consensus through soliciting safety advice from around the world, discussion among representatives of Member Organisations, and consensus agreement on best practice globally.

## DISCUSSION

### When should activities be stopped?

The overall principle is that activities should be stopped and shelter sought when the lightning activity is close enough that a risk is apparent.

In general, a significant lightning threat extends outward from the base of a thunderstorm cloud about 10 to 16 kms (6 to 10 miles). Therefore, people should be in a safe place when a thunderstorm is 10 to 16 kms away (6 to 10 miles).<sup>[4]</sup> Also, a plan's guidelines should account for the time it will take for everyone to get to safety. It should be noted that there are reported instances of "blue sky" lightning that may occur without obvious prior activity or clouds. Here are some criteria that could be used to stop activities:

- **If you see lightning.** The ability to see lightning varies depending on the time of day, weather conditions, and obstructions such as trees, mountains, etc. In clear air, and especially at night, lightning can be seen from storms more than 16 kms (10 miles) away provided that obstructions don't limit the view of the thunderstorm.<sup>[4]</sup>
- **If you hear thunder.** Thunder can usually be heard for a distance of about 16 kms (10 miles) provided that there is no background noise. Traffic, wind, and precipitation may limit the ability to hear thunder to less than 16 kms (10 miles). If you hear thunder, though, it is safe to assume that the storm is within 16 kms (10 miles).<sup>[4]</sup>

Since lightning can strike outward 16 kms (10 miles) from a thunderstorm, if you hear thunder, you are likely within striking distance from the storm.<sup>[10] [11]</sup> The observation of

approaching storm clouds, the first flash of lightning or clap of thunder, no matter how far away, should heighten lightning awareness. The level of risk depends on the location (distance and direction) relative to the storm cell and the direction in which the storm cell is travelling. A guideline for when activities should be stopped is recommended below.

### Where should people go for safety?

The National Weather Service, National Oceanic and Atmospheric Administration (USA),<sup>[4]</sup> the Australian and New Zealand Standard AS/NZS 1768-2007 'Lightning Protection'<sup>[9]</sup> and the Royal Society for the Prevention of Accidents (UK)<sup>[12]</sup> all set out guidelines in relation to safety precautions in relation to lightning strikes.

These include:

- **Outdoor Protection**

When outdoors, some of the measures for reducing the risk of injury that may be caused by lightning strikes to ground during a local thunderstorm are as follows:

1. Ideally, seek shelter inside a large building or a motor vehicle keeping away from, and getting out of wide, open spaces and exposed hilltops.<sup>[4][9][12][16][21]</sup>
2. The inside of a car is a safe place to be in a lightning storm, providing the car is made of metal. Lightning will spread over the metal of the vehicle before earthing to the ground through the tyres.<sup>[12]</sup> If in a car, close the windows and avoid contact with metallic parts and remove any hands-free mobile telephone attachments from the body. Avoid driving the car as a strike to the car may blow out the tyres. Do not stay in open vehicles such as tractors, beach buggies, or any other type of open or enclosed vehicle without a metallic roof.<sup>[9][20]</sup>
3. If you are exposed to the elements with nowhere to shelter, make yourself as small a target as possible by crouching down with your feet together, hands on knees and your head tucked in. This technique keeps as much of you off the ground as possible.<sup>[12]</sup> If surrounded by trees, seek a position outside the foliage and crouch, keeping the feet together.<sup>[9]</sup>
4. Do not shelter beneath tall or isolated trees, it has been estimated that one in four people struck by lightning are sheltering under trees.<sup>[4][9][12]</sup>
5. If you are on water, get to the shore and off wide, open beaches as quickly as possible as water will transmit strikes from further away. Studies have shown that proximity to water is a common factor in lightning strikes.<sup>[12][15][21]</sup>
6. Do not shelter in small sheds, pagodas, walkways etc. with low unearthed metallic roofs supported on wooden or other electrically insulating materials.<sup>[9][16]</sup>
7. Do not touch or stand close to any metallic structures, including wire fences and clothes lines.<sup>[4][9]</sup>
8. Do not stand on or under bridges or other elevated structures.<sup>[9]</sup>
9. Do not carry metallic objects such as umbrellas or golf clubs and remove metallic chains and other jewellery, particularly from the head and upper parts of the body.<sup>[9]</sup>
10. If on an open field or on the beach and remote from any shelters, keep as low and as small a profile as possible, i.e. crouch keeping the feet together and do not touch any objects or people near you. A dry ditch, valley or any depression in the ground is safer than an elevated or flat terrain. Do not lie on the ground as this could cause dangerous voltage to develop across the body by earth currents generated by a nearby strike. Footwear or a layer of non-absorbing, insulating material, such as plastic sheets, can offer some protection against earth voltages.<sup>[4][9][16][20][21]</sup>
11. Do not swim or wade in the sea, lake, river, pool or any other body of water. Exit the water and move to a safe place.<sup>[4][9]</sup>

12. If on a boat deck, keep a low profile and avoid contact with or being close to masts, rails, stay wires or any other metallic objects. Avoid unnecessary contact with communication or navigation equipment. Do not enter the water, and in general avoid contact with water. Additional protection may be gained by anchoring under relatively high objects such as jetties and bridges, provided that direct contact is not made with them. Isolated buoys and pylons should be avoided. <sup>[9]</sup>

- **Indoor Protection**

1. Avoid the use of telephones, radios, fax machines, computers and other electrical equipment. If emergency calls are required keep them brief. <sup>[4] [16] [21]</sup>
2. Before the storm arrives, disconnect external aerials and power leads to radios and other appliances. <sup>[9] [21]</sup>

- **Indoor and outdoor swimming pools**

Certain locations are extremely hazardous during thunderstorms and should be avoided if at all possible. Statistics show that more than 10% of lightning-related injuries and deaths are water related (e.g. fishing, boating and swimming). Outdoor pools should be evacuated in a time interval of less than 30 seconds and people should be directed to a safe shelter nearby. <sup>[9]</sup> There has been a great deal of debate over whether indoor swimming pools should be evacuated. However, there have been no recorded deaths arising from properly grounded indoor pools and it maybe that evacuating an indoor pool may increase the risk of a lightning strike as patrons may venture outside or go to the showers where metal pipes may conduct the electricity from a strike to the building. <sup>[25]</sup>

- **Beaches**

If you are on a wide open beach, seek shelter as quickly as possible as water will transmit strikes from further away. <sup>[12] [15] [21]</sup> If on the beach and remote from any shelters, keep as low and as small a profile as possible, i.e. crouch keeping the feet together and do not touch any objects or people near you. Do not lie on the sand as this could cause dangerous voltage to develop across the body by earth currents generated by a nearby strike. Footwear can offer some protection against earth voltages. <sup>[4] [9] [16] [20] [21]</sup>

### **When should activities be resumed?**

The typical storm travels at about 40 kms (25 miles) per hour. <sup>[14]</sup> Waiting 30 minutes allows the thunderstorm to be approximately 20kms (10 to 12 miles) away, in other words, far enough away that the risk of a lightning strike is low. <sup>[13]</sup>

Therefore it is recommended that activities can be resumed after 30 minutes.

Each time lightning is observed or thunder heard, the 30 minute clock should be reset. <sup>[14]</sup>

### **Who should monitor the weather and who decides when to stop activities?**

Each facility owner or lifesaving organisation should appoint someone each day who is ultimately responsible for monitoring the weather and advising when activities should cease. Each facility owner or lifesaving organisation should also have protocols in place to assist in decision making (refer lightning safety plan below).

### **What should be done if someone is struck by lightning?**

The severity of the injuries inflicted on a person by a lightning strike will depend upon the intensity of the strike and for any given strike, on the fraction of the current that flows over the skin outside the body and the fraction that flows through the body, and its path. The worst situation would arise when a person is struck on the head, in which case the current through

the body could cause fatal injuries to the brain, the heart and the lungs. A less dangerous situation is where the person is subjected to step or touch potentials, and only a small fraction of the total current passes through the body, although the pathway taken by this fraction is still important. <sup>[9]</sup>

The effects of lightning include burns to the skin, which are usually superficial, damage to various bodily organs and systems, unconsciousness and, most dangerously, cessation of breathing and cessation of heart beat. Independently of these electrically-related effects, temporary or permanent hearing impairment may be experienced as a consequence of the extremely high sound pressure levels associated with a nearby lightning strike. <sup>[9]</sup>

In the first aid treatment of a patient injured by lightning, it is essential that CPR be provided to patients who are not breathing. These procedures should be continued until breathing and heart beat are restored, or it can be medically confirmed that the patient is dead. It should also be noted that the usual neurological criteria for death may be unreliable in this situation.

There is no danger in touching a person who has been struck by lightning. <sup>[9]</sup>

Lightning strike victims are sometimes thrown violently against an object, or are hit by flying fragments of a shattered tree, so first aid treatment may have to include treatment for traumatic injury. <sup>[9]</sup>

### Summary <sup>[6]</sup>

- Ensure scene safety.
- Follow local protocols for trauma injury and triage. If necessary, safe, and appropriate, move the victim to a safe place away from the threat of another lightning strike.
- Summon an ambulance as needed according to local protocols.
- CPR and/or AED may be necessary.
- Heart irregularities, shock, or sudden loss of consciousness are possible. Keep the conscious victim calm and monitor closely.

### Lightning Safety Plan

The below plan is based on the joint initiative of the United States Lifesaving Association, The National Oceanic and Atmospheric Administration and The National Weather Service in the United States and serves as a guideline for developing a lightning safety plan and communicating lightning safety information. <sup>[6]</sup>

These guidelines are aimed primarily at areas with moderate to high lightning hazard levels, but may be applied anywhere.

#### 1. Develop an Emergency Action Plan

- Have a means to gather daily weather forecasts and updates.
- Identify means to monitor lightning in the area.
- Identify the closest safe locations before the beginning of the lifesaving season, and consider posting signs that promote lightning safety and indicate locations that provide protection from lightning.
- Locations that offer protection from lightning:
  - Fully-enclosed buildings that are grounded with wiring and plumbing.
  - Lifeguard towers that are fully-enclosed.
  - Fully-enclosed metal vehicles (no soft top convertibles).
- Locations that do not offer protection from lightning:

- Beaches.
- Water.
- Open-sided pavilions (such as picnic areas).
- Restrooms, changing facilities, and showers.
- Lifeguard towers or stands that are not fully enclosed.
- Tents.
- Boats.
- Small personal water craft (e.g. Jet Skis).
- Determine what actions to take based on the threat level, including:
  - How patrons will be notified.
  - Whether to evacuate facilities or just issue warnings and advice on safe shelter.
  - How staff will protect themselves.
  - When to notify staff and patrons that the threat has subsided and normal activities can resume.

## 2. Educate Staff

- Annual training for lifesaver and beach patrol units should include lightning awareness and a review of protocols in their hazardous weather safety plan. This includes:
  - Education on facts about the dangers of lightning.
  - Locations that provide protection.
  - Emergency action plan for lightning in the area, along with severe weather watches and warnings.

## 3. Warning and Communication Tools

- Broadcasts from local Government Agency responsible for weather forecasting.
- Forecasts can be monitored via the internet if available on-site
- Information about the proximity of lightning strikes is available via the flash-to-bang rule (explained below), local on-site detection devices, smart phone applications and commercial notification services. Identify means to communicate with and notify staff and patrons.
- Communication tools include:
  - Two-way radios.
  - Public address, loudspeaker system (fixed and/or on mobile vehicles).
  - Telephones, including mobile phones.
  - Air horn or megaphone notification.
  - Whistle system.
  - Sign boards and flags.
  - Text, e-mail and social media alerts.
  - Internal television and/or radio broadcasts.

## 4. Daily Operations

- Designate a “weather watcher” each day.
  - At the beginning of the shift, designee notifies staff of weather forecasts that may impact operations that day
  - Identify safe shelter locations
  - The weather watcher has primary, but not sole, responsibility for observation of and updates on weather conditions.
- Determine the distance of lightning from a location by using the “flash-to-bang rule” (see below)

- Use this rule in combination with other resources (local lightning detection systems and commercial services) if they are available, with the closest strike detected or observed used as guidance for the evacuation of a site.
- Depending on the attendance levels and the proximity of adequate shelter, a larger timeframe may be prudent to provide time to prepare.
- Consider the organisation of thunderstorms in the area. More organised thunderstorms (squall lines, bow echoes, super cells, large clusters) should prompt a greater lead-time as compared to an isolated thunderstorm.
- When in doubt, remember “When Thunder Roars, Go Indoors!” [6]

## 5. To provide safety consider the following

- Get a daily weather forecast
- Define indicators for evacuation
- Plan how to communicate with the lifeguard team
- Plan how to communicate with the public
- Plan how to evacuate
- Identify a safe place
- How to treat lightning injuries
- When to resume normal operations

## DEFINITIONS

### Lightning

Lightning is a giant spark of electricity in the atmosphere or between the atmosphere and the ground. In the initial stages of development, air acts as an insulator between the positive and negative charges in the cloud and between the cloud and the ground; however, when the differences in charges becomes too great, this insulating capacity of the air breaks down and there is a rapid discharge of electricity that we know as lightning.

Lightning can occur between opposite charges within the thunderstorm cloud (Intra Cloud Lightning) or between opposite charges in the cloud and on the ground (Cloud-To-Ground Lightning). Cloud-to-ground lightning is divided into two different types of flashes depending on the charge in the cloud where the lightning originates. <sup>[10][11]</sup>

### Thunder

Thunder is the sound made by a flash of lightning. As lightning passes through the air it heats the air quickly. This causes the air to expand rapidly and creates the sound wave we hear as thunder. <sup>[10][11]</sup>

### The “Flash-to-Bang” Rule

Sound travels at 330 meters per second or at 1 km in 3 seconds (approximately 1 mile in 5 seconds). <sup>[12]</sup> Light travels at 300,000 km per second. <sup>[12]</sup> Therefore lightning will always be seen before thunder.

To calculate the distance between yourself and the storm, begin counting at the sight of the lightning flash. Stop counting at the sound of related thunder. Divide the count by three (3) to determine the proximity of the lightning strike in kms (divide by 5 to determine the proximity in miles). For example, 3 seconds = 1 km, 30 seconds = 10 kms, 5 seconds = 1 mile; 50 seconds = 10 miles. This is known as the ‘Flash to Bang’ rule.

If the distance between the lightning and thunder increases over a couple of strikes, the storm is moving away from you. If it decreases, it is moving towards you.

## THE 30/30 RULE

Most people do not get injured (or worse) during the peak of a storm due to the fact that most people do not want to be outside in the middle of a storm. Before and after a storm, are the times when most lightning strike injuries take place. <sup>[12]</sup> Due to this fact, it is important to ensure that people are aware of the potential risk associated both on the approach of a storm and also after the storm has passed.

The overall message is to seek shelter when the lightning activity is too close. The issue is defining or establishing what is “too close”? The second question then is how long do you wait before activities can be resumed?

Lopez and Holle <sup>[22]</sup> studied storms in Oklahoma, Colorado and Florida and found that lightning most frequently occurs within 10 kms (6 miles) of a thunderstorm approximately 80% of the time, (although there are occurrences when cloud-to-ground lightning strikes known as “bolts from the blue” can strike up to 32 kms (20 miles) away from a thunderstorm).

Holle et al <sup>[19]</sup> and Vavrek et al <sup>[24]</sup> strongly recommend that the “flash to bang” count be longer than 15 seconds and that immediate action to move to a safer position should be taken. This extremely short “flash to bang” count puts the lifeguard and the public at high risk because the lightning strikes are very close.

It is generally recommended that patrons be notified (or evacuated based on the emergency action plan) and staff take shelter when thunderstorms move within 10 kms (6 miles), <sup>[9] [12] [14]</sup> that is, a count of 30 seconds.

As noted above, the typical storm travels at about 40 kms (25 miles) per hour. <sup>[14]</sup> Waiting 30 minutes allows the thunderstorm to be approximately 20kms (10 to 12 miles) away, in other words, far enough away that the risk of a lightning strike is low. <sup>[13]</sup>

Therefore it is recommended that activities can be resumed after 30 minutes.

The ‘30/30 Rule’ has been adopted in a number of countries <sup>[11] [12]</sup> and by many sporting organisations <sup>[17] [18] [22]</sup> and is the recommended protocol for lightning safety in the Australian/New Zealand Standard on Lightning Protection. <sup>[9]</sup> The 30/30 guideline is designed to provide guidance on the suspension and resumption of activities in an outdoor environment. Note that this guideline indicates that action should be taken when the thunderstorm is 10 kms away (30 seconds between “flash and bang”) while in the USA the recommendation is that action should be taken when the thunderstorm is 10 miles away (50 seconds between flash and bang).

Practicality is the basis of the 30-second rule. The rule is a compromise between a short “flash-to-bang” count of 10 to 15 seconds and a “flash-to-bang” count of 50 seconds (or the most conservative rule of all, leaving the site at the first sight of lightning activity or sound of thunder <sup>[14]</sup>).

While some people subscribe to the notion of leaving a site at the first sound of thunder or the first flash of lightning, the International Lifesaving Federation feels it is impractical to clear a beach or swimming facility every time lightning is seen or thunder is heard. Newspaper reports show that most people do not take notice of such a restrictive rule. <sup>[19]</sup> The approach taken by individual lifesaving organisations will depend a great deal on their own risk assessment and risk tolerance level. As previously mentioned, some countries such as the

USA recommend a more conservative approach of 50 seconds when the evacuation of the beach or facility is recommended.<sup>[6]</sup>

This position statement recommends a minimum 30 seconds between “flash and bang” when all persons should be seeking shelter but a longer time interval may be used where the lifeguard organisation wishes to reduce the risk further, particularly in crowded areas.

The 30/30 rule sets out the following principals:

- **Close Facility/Beach**

Where the flash to bang count is 30 seconds, indicating that the lightning is 10 km (6 miles) away. This is associated with significant risk that the strike could be at the lifeguarded area.

- **Open Facility/Beach**

After 30 minutes has passed since the last sighting of lightning or hearing thunder. A typical storm travels at about 40 km/h (24miles/h). Waiting 30 minutes allows the thunderstorm to be approximately 20km (12 miles) away, in other words, far enough away that the risk of a lightning strike is low.

The 30/30 rule has been an effective way to get people to remember the basic safety precautions with a storm.

## POTENTIAL CONFLICT OF INTEREST STATEMENT:

The author has no conflict of interest with the stakeholder industry, technology, persons or organisations that are identified and/or impacted by the position statement.

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## APPROVAL

Position Statement approved by the ILS Board of Directors on 16/09/2014.