

Lightning and sport - hazards and safeguards

Lightning Facts

All thunderstorms produce lightning and are dangerous.

Lightning often strikes outside the area of heavy rain and may strike as far as 15 kilometres from any rainfall.

Any time thunder is heard, the thunderstorm is close enough to pose an immediate lightning threat to your location.

When thunderstorms are in the area but not overhead, the lightning threat can still exist even when overhead it is sunny, not raining, or when clear sky is visible.

Many lightning casualties occur before the thunderstorm rains have moved into the area. This is often due to people not seeking shelter soon enough.

Large numbers of casualties occur after the rain dissipates. This can be due to people being in too much of a hurry to go back outside and resume activities.

When struck, people do not glow or 'fry to a crisp', instead the heart and breathing are often affected.

Only about 30 per cent of people struck by lightning actually die and the incidence of long term disability is low, particularly when first aid is applied promptly.

If your clothes are wet, you are less likely to be seriously injured if struck, as most of the charge will conduct through the wet clothes rather than your body.

Lightning can and does strike in the same place more than once!

World-wide, thunderstorms are producing approximately 6000 lightning strikes every minute!

INTRODUCTION

It is estimated that lightning strikes the earth around 6000 times per minute and within Australia, it poses a greater threat to individuals than almost any other natural hazard.

Each year people are killed or injured by lightning due to misinformation and inappropriate behaviour during thunderstorms. There has been a decrease in the number of lightning casualties in farming and outdoor work and an increase in sports-related casualties. With large crowds gathering to participate in or watch an outdoor event, the potential exists for mass casualties to occur from a lightning strike at any one venue.

In Australia, lightning accounts for five to 10 deaths a year and well over one hundred injuries annually. A large percentage of lightning strike victims survive but many of these suffer from severe life-long injury and disability. Statistics show that approximately 25 per cent of people killed by lightning are playing sport.¹

When thunderstorms threaten, teachers, officials and coaches must not let the desire to start or complete a carnival or a coaching session hinder their judgment when the safety of athletes, officials or spectators is in jeopardy.

Three recent fatalities from lightning in Western Australia were:

- in December 1998 a 23-year-old jockey was killed when struck by lightning while exercising a horse at Ascot Racecourse during an electrical storm
- in January 2001 a 42-year-old truck driver was killed when the truck he was standing next to was struck by lightning
- also in January 2001, a 39-year-old underground mine manager died after being struck by lightning while inspecting a pond that collected overflow from a tailings dam at Leinster Nickel

Two other instances in New South Wales were:

- in 2001 at Merrylands, five children were struck by lightning while playing soccer
- in 2004 a cricketer on the south coast of NSW was killed when struck by lightning

There is a need to develop specific approaches for lightning safety at sports events, regardless of the size of the event and number of participants. Our aim is to present specific and practical recommendations to reduce the risk of lightning casualties in outdoor sporting and recreational activities in Western Australia.



¹ Commonwealth Government of Australia. Bureau of Meteorology. (2008). *Severe thunderstorms: facts, warning and protection*. Retrieved on the 27/10/2008 from <http://www.bom.gov.au/info/thunder/>.



THE LIGHTNING DISCHARGE

Within a thundercloud, static electricity builds to an extent where one or more neutralising discharges or flashes occur. These flashes can be in the form of an inter-cloud (cloud to cloud), intra-cloud (within cloud) or cloud to ground flash. The cloud to ground flash is the most hazardous and dramatic type of discharge that can effect anyone or anything below its path.

The cloud to ground discharge occurs when the cloud's potential difference with respect to the earth attains a voltage level sufficient to overcome and ionise the air in between. Energy levels are extreme and can support voltages in the order of 100 million volts and discharge currents up to 200,000 amperes. Arc temperatures around 30,000°C give rise to rapid heating and cooling of the surrounding air, which in turn causes the familiar sound shock-wave known as thunder.

The first stage of a lightning discharge involves a downward travelling 'leader', which originates within the thundercloud and rapidly progresses towards the earth in roughly 50 metre steps. As the 'leader' approaches within 200 metres from the ground, one or more 'upward strokes' or 'streamer' discharges initiate from points on the ground and propagate upwards until one connects with the 'leader' and completes the discharge path

Researchers have shown that lightning is essentially blind as it reaches toward the earth. It's only in the last 100 feet or so that it begins to select a place to strike.²

'Streamers' will always initiate from the highest point of a facility or the highest point underneath a storm front path that exist in the vicinity of the downward travelling 'leader', and it is this characteristic which forms the basis of lightning protection.

There is a theoretical 'cone of protection' 45 degrees out from any object that is 100 feet tall, because the tall object should be hit instead of you. But on the other hand, the threat of being shocked by ground current makes this idea less than optimal. If you are caught outside in the danger zone, and cannot get to shelter, the best thing to do, is to crouch down near some small trees or shrubs with taller trees in the area. Minimise contact with the ground and stay low by crouching on the balls of your feet. Cover your ears with your hands and tuck your head down.

The immediate warning signs that may precede a lightning strike are:

- a build up of static electricity e.g. hair standing on end
- 'buzzing' from nearby rocks, fences, etc

- at night, a blue glow may show from an object that is about to be struck

PROTECTION OF BUILDINGS AND STRUCTURES

When necessary, the effects of lightning strikes to buildings and structures can be controlled by purposely installing one or more air terminations (finials or lightning rods) in elevated positions on the structure and electrically connecting them to ground via down conductors and earth electrodes. The air terminations then serve to attract and divert the lightning discharge, which otherwise would strike vulnerable parts of the building or structure being protected.

The decision whether or not to provide lightning protection should be based on a risk assessment of the likelihood of the building or structure being 'struck' and the consequences if this occurs. For more information about risk management see the Department of Sport and Recreation's publication 'Can You Risk It? An Introduction to Risk Management for Community Organisations'.³

Items to consider when completing a risk assessment for the building or structure are usage, occupancy, contents, construction material, height and situation.

With some structures there will be little doubt as to the need for protection. For example, structures that require protection from lightning strikes are:

- located in or near places where large numbers of people congregate
- located in or near waterways or aquatic centres
- concerned with the maintenance of essential public services
- located in areas where lightning is prevalent
- very tall or isolated
- structures of historic or cultural importance

³ Government of Western Australia. Riskcover. (2007). *Can you risk it? An introduction to risk management for community organisations*. Perth, Western Australia: Department of Sport and Recreation.

² Global Position And Tracking Systems Pty. Ltd. (2005). *Lightning Safety Guideline*. Retrieved on the 27/10/2008 http://www.gpats.com.au/lightning_safety.html





PROTECTION OF PEOPLE AND EQUIPMENT WITHIN BUILDINGS

While persons inside buildings are generally protected against the direct effects of lightning, other circumstances exist where the indirect effects of lightning can be transmitted within buildings via entry points such as the electricity mains, telephones, aerials, flues, air-conditioners, metallic roofs, gutters and downpipes, and exit points such as water and gas services.

To minimise the effects of a lightning strike within a building, equipotential bonding of all entry and exit points within the structure is required. However, persons inside buildings should take basic precautions by avoiding unnecessary contact with such entry and exit points. Other things to avoid include:

- use of telephone systems (other than radio mobile and cordless telephones)
- contact with electricity/gas/water services and appliances
- washing, bathing, showering and contact with metallic sinks, basins and plumbing
- contact with larger metallic objects generally, i.e. window frames, ducts, vents, skirtings etc

In general, protection of valuable equipment within a building is completed via primary and secondary protection devices that are interconnected to the lightning protection system or earthing system providing a low impedance path to ground. These devices should be provided on all services that have possible entry points into the building such as power, telephone, reticulation, TV wiring, data and security cabling.

When an event occurs, these over-voltage devices clamp at a certain voltage and shunt this energy to ground via the lightning protection system or earthing system, protecting the equipment down stream.

When these devices are not in place the equipment then becomes sacrificial in the energy's quest to find a path to ground. Items that can become sacrificial are modems, servers (with or without UPS back up), telephone systems, TVs, radios, air conditioning control circuits, security systems, reticulation controllers, fire control systems, pumping systems, pool filtration systems etc.

If one or more of the above pieces of equipment are an essential service for the building or business then it is highly recommended that primary and secondary protection be provided to all incoming services, ensuring an earthing system that provides a low impedance path to earth.

SAFE AND NOT SO SAFE LOCATIONS DURING A THUNDERSTORM

No place is absolutely safe from lightning strikes, however some places are safer than others.

Safe structures:

Large, enclosed structures (substantially constructed buildings) tend to be much safer than smaller or open structures. A building with electric and telephone wiring and plumbing provides a safe pathway for the current to the ground. The risk of lightning injury depends on whether the structure incorporates lightning protection, construction materials used and the size of the structure.

In general, fully enclosed metal vehicles — such as cars, trucks, buses, vans and fully enclosed farm vehicles — with the windows rolled up provide good shelter from lightning. Avoid contact with metal or conducting surfaces outside or inside the vehicle.

Unsafe locations and situations:

High places and open fields, isolated trees, unprotected gazebos, rain or picnic shelters, communications towers, flagpoles, light poles, seating bleachers (metal or wood), metal fences, open ground, golf courses or carts, water (ocean, lakes, swimming pools, rivers, etc).

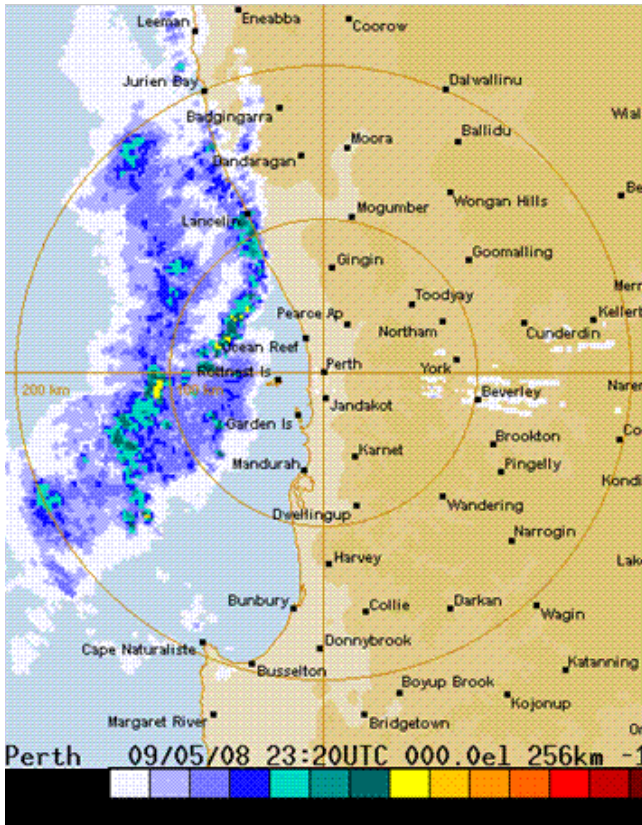
Umbrellas, golf clubs, bats or any other object that increases an individual's height.

When inside a building avoid:

- use of the telephone other than mobile/cordless (80 per cent of persons injured during electrical storms have been using the telephone)
- taking a shower
- washing your hands
- doing dishes
- contact with conductive surfaces with exposure to the outside such as metal door or window frames, electrical wiring, telephone, wiring, TV wiring, plumbing etc

PROACTIVE PLANNING

Organisers of sporting activities or events should have a lightning safety plan that designates a specific person responsible for monitoring the weather for signs of a developing thunderstorm. The nominated 'weather watcher' should have the authority to postpone an event and have competitors, officials and spectators moved to safe areas. Appropriate people to nominate as weather watchers include the event supervisor, trainers or other medical personnel or the ground manager.



Example of Perth radar image and surrounds to 256km

When lightning threatens, the weather watcher is responsible for recognising the danger and activating the lightning safety plan. This should include a signal to the referees and umpires, as well as a method of informing those at risk (i.e. players, officials and spectators) of the action required.

On the day of the sporting activity the weather watcher should consider the following:

Check the radar images of rainfall locations and intensity on the Bureau of Meteorology site.

- 1) go to <http://www.bom.gov.au>
- 2) click the WA Map
- 3) click WA Weather & Warnings
- 4) check Current Warnings
- 5) check Observations
- 6) click Radar Images
- 7) check Rainfall location & intensity
- 8) scroll down to WA location and click on the relevant location

Observe the weather around the local area. The first flash of lightning or clap of thunder, no matter how far away, should heighten lightning awareness.

If there is a flash of lightning, use the 'Flash to Bang' or '30/30' rule for assessing the risk. The rule of thumb is that every three seconds of delay between a lightning flash and the audible thunder associated with the flash equates to a distance of approximately one kilometre. This is recognised as a considerable risk that the next strike could be at the weather watcher's location, therefore the activity or event should be suspended and people moved to the designated safe areas.

It is recommended to wait until 30 minutes after the last lightning or thunder event before re-commencing the activity.

LIGHTNING SAFETY PLAN

There is a need for all schools, clubs and associations to implement an action plan and adopt all precautionary methods available to prevent any casualties from a lightning strike. In summary, the plan should include:

- why do we need a lightning safety plan?
- what is the lightning safety plan?
- how does the '30/30' rule work?
- when should activity be suspended and subsequently resumed?
- which locations are safe to seek shelter?
- which locations are unsafe?
- who is responsible for implementing the lightning safety plan?
- what to do if somebody is struck by lightning

DISSEMINATION OF LIGHTNING SAFETY PLAN

Make sure all participants, spectators and officials are aware of the dangers of lightning and how to minimise their risk and yours. Possible ways in which this can be achieved include:

- reading lightning safety messages over a public address system or similar
- place safety instructions and notices in the busiest areas of the venue
- place signage around the venue highlighting 'Safe Locations', 'Unsafe Locations' and your 'Action Plan' if called on
- provide directions on how best to access the safe locations when needed
- define the criteria for both suspension and resumption of activity
- predetermined signal to referees and umpires to move to a safe area



CROWD STRATEGIES

Large events require careful consideration of crowd numbers, length of time required to ensure protection for all present and appropriate shelters. Crowds should be mustered to these areas prior to the storm front approaching 10km away (30 second flash to bang). Given the difficulty in moving large numbers of people, assessment of the existing structures is advisable as modifications can be made to the structures and this can dramatically improve the protection provided by the structures, thus making it a safer area in the process.

Spectators located in an already certified safe area can be advised to remain seated at times of lightning risk. The size of the event or activity and the numbers of persons who have to be relocated



during a lightning risk needs to be considered as more time is required to relocate larger numbers of people. Therefore your '30/30' rule may have to become a '40/30' rule for a particular event or activity.

The organising committee of the Sydney 2000 Olympic Games gathered information from the Bureau of Meteorology and implemented a plan of action during the event.

THREE PHASES OF LIGHTNING SAFETY FOR THE SYDNEY 2000 OLYMPIC GAMES

Yellow: State of increased lightning awareness

Intended to give 60 minutes advanced warning of a storm front approaching 10km from a venue (the direction and speed of travel of the storm front are taken into consideration, so that the anticipated time taken for the storm to reach 10km from the venue is 60 minutes).

Orange: Activation of the lightning protection plan

Intended to give 30 minutes advanced warning of a storm front approaching 10km from a venue. Depending on the venue's requirements, all competitors should be moved to protected areas or safe locations.

Patrons should be advised to remain in position if they are already in a safe area, or move to a protected area as shown on a map.

Individuals in transit should be advised to complete their transit as soon as possible. People in cars and buses should be advised not to commence transit and to remain in their vehicles.

Red: State of increased lightning risk

Declared when lightning activity is within 10km of a venue.

By this stage, all movements and evacuations should be complete, with the venue now secure from lightning.

FIRST AID RECOMMENDATIONS FOR LIGHTNING VICTIMS

Most lightning victims can survive their encounter with lightning, especially with timely medical treatment. Individuals struck by lightning do not carry a charge and are safe to touch in order to render treatment.

The Lightning Safety Group of America recommends the following steps to try and save the life of a lightning strike victim:

First

Call 000 or nearest Emergency Service and provide directions and information about the likely number of victims.

Response

The first tenet of emergency care is 'make no more casualties'. If the area where the victim is located is a high-risk area (mountain top, isolated tree, open field, golf course etc) with a continuing thunderstorm, the rescuers may be placing themselves in danger.

Evacuation

It is relatively unusual for victims who survive a lightning strike to have major fractures that would cause paralysis or major bleeding complications unless they have suffered a fall or been thrown a distance. As a result, in an active thunderstorm, the rescuer needs to choose whether evacuation from very high-risk areas to an area of lesser risk is warranted and should not be afraid to move the victim rapidly if necessary. Rescuers are cautioned to minimise their exposure to lightning as much as possible.

Resuscitation

If the victim is not breathing, start mouth-to-mouth resuscitation. If it is decided to move the victim, give a few quick breaths prior to moving them. Determine if the victim has a pulse by checking the pulse at the carotid artery (side of the neck) or femoral artery (groin) for at least 20-30 seconds. If no pulse is



detected, start cardiac compressions as well. In situations that are cold and wet, putting a protective layer between the victim and the ground may decrease the hypothermia that the victim suffers which can further complicate the resuscitation.

CONCLUSION

The important components of any lightning safety policy include a proactive approach, vigilant monitoring of the local weather, a specific chain of command, a method of delivering the message to those at risk, definition of safe structures and definition of the criteria for both suspension and resumption of activity.

The individual must ultimately take responsibility for his or her own safety and take appropriate action when threatened by lightning. School teachers, security guards, coaches, lifeguards and other adults must take responsibility for children in their care. A weather radio and the use of lightning detection data in conjunction with an action plan are vital components of a lightning safety policy.

Large events require careful consideration of crowd numbers. The more far-reaching the event and the more people involved, the more economical it may be to use formal lightning location systems in early-warning surveillance.

No lightning safety plan will provide 100 per cent guaranteed total safety, but every effort can be made to ensure that all preventative steps are taken.

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WEBSITES OF INTEREST

Department of Consumer and Employment Protection, Western Australia - <http://www.docep.wa.gov.au>

Department of Industry Resources, Western Australia - <http://www.doir.wa.gov.au>

Department of Metrology, Australia - <http://www.bom.gov.au/weather/wa/>

Department of Sport and Recreation, Western Australia – www.dsr.wa.gov.au

Royal Life Saving of Western Australia - <http://www.lifesavingwa.com.au/>