Section 4

The Severe Storm Hazard

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Severe Storms: Glossary of Key Terms

Hailstorms: Thunderstorms characterised by heavy and destructive falls of hail.

Land gales: Gale force winds (62km/h or stronger) over the land.

Lightning: An emission of electricity (accompanied by a flash of light) from cloud to cloud, or cloud to ground, resulting from the variation of electrical charge on droplets within the cloud and on the earth's surface.

Severe storms: Natural hazard which can be divided into two broad categories: severe thunderstorms and land gales.

Thunderstorms: A storm in which there are strong upward currents of air, forming cumulonimbus clouds, and producing heavy rain, thunder and lightning.

Tornado: Destructive, rotating storm under a funnel-shaped cloud which moves over the land in a narrow path.

What are Severe Storms ?

CHARACTERISTICS OF SEVERE STORMS

Severe storms can be divided into two broad categories: **severe thunderstorms** and **land gales**. Severe thunderstorms can produce flash-flooding, damaging hailstones, lightning and thunder, destructive wind gusts and tornadoes. Land gales are simply 'gale force' winds (62 km/h or greater) over the land.

Severe storms are very localised events, not usually affecting wide areas as tropical cyclones and floods do, so their devastating impact is often under-estimated. These storms can occur anywhere in Australia and do so much more frequently than any other major hazard On average, each year severe storms are responsible for more damage (as measured by insurance costs) than tropical cyclones, earthquakes, floods or bushfires

Unfortunately, storms also kill people, between five and ten deaths are caused by lightning strikes each year Deaths also occur when strong winds cause tree limbs to fall, debris to become projectiles and small boats in open water to capsize. In fact, although many people believe that tornadoes do not occur in Australia, 41 tornado-related deaths have been recorded here.

adapted from 'Severe Storms - facts, warnings and protection', published by the Bureau of Meteorology and Emergency Management Australia

Figure 1

Activities

Fill in the blanks in the following sentences using information in Figure 1. Check your answers by finding them in the puzzle on the right.

1 _____ gales are one of the two broad categories of severe storms.
2 _____ strikes are one of the main dangers associated with severe thunderstorms.
3 Severe storms are responsible for more damage on average each year than tropical _____, _____, _____ and _____.
4 Severe storms often only affect a small _____
5 Severe storms occur more _____ in Australia than any other major natural _____.
6 Insurance _____ suggest that severe storms cause more damage than other natural hazards.
7 Flying _____ can be extremely dangerous in high winds.
8 People may drown when _____ capsize during a storm.
9 Falling _____ may cause death, injury and property damage.
10 _____ flooding may result from heavy _____.
11 _____ - stones may be associated with severe thunderstorms.
12 Many people believe that _____ do not occur in Australia, but they have, in fact, been responsible for a significant number of _____.
13 Gale - _____ winds have a speed of 62km/h or greater.
14 _____ is produced when lightning strikes.

L	I	G	H	T	N	I	N	G	L	H	A
T	S	E	K	A	U	Q	H	T	R	A	E
O	Y	L	T	N	E	U	Q	E	R	F	L
R	H	D	E	B	L	D	G	E	H	D	A
N	A	T	R	U	N	I	A	S	L	E	N
A	Z	H	F	S	T	D	A	R	E	A	D
D	A	U	O	H	T	L	A	H	F	T	N
O	R	N	R	F	F	S	S	L	S	H	I
E	D	D	C	I	N	B	O	A	T	S	A
S	S	E	E	R	T	O	X	C	U	O	R
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Severe Thunderstorms

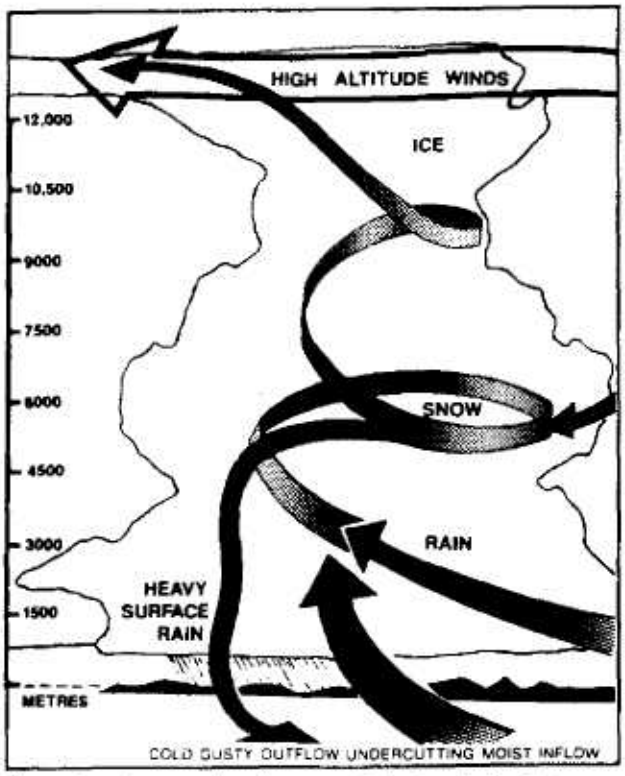

Figure 1: A mature thunderstorm which is producing heavy rain, lightning and possibly hail.

Figure 2: Flash-floods in Melbourne associated with a severe thunderstorm, 1971

Figure 3: Hailstones collected after a severe thunderstorm in 1990, Ballarat, Victoria.

HAZARD DATA

- **Severe thunderstorms** are defined by the Bureau of Meteorology as those which produce:
  - hailstones with a diameter of 2 cm or more; or
  - wind gusts of 90km/h or greater; or
  - flash-floods; or
  - destructive wind gusts or tornadoes.
- Even if thunderstorms aren't classified as 'severe' they may still cause injury and property damage through lightning strikes.
- Thunderstorms form when dense cold air overlies warm moist air which is less dense. This results in strong upward currents (see Figure 1) with the heat energy stored in the air and water vapour converted into wind and electrical energy. A severe thunderstorm occurs when the atmosphere is particularly unstable, and is characterised by complementary up- and down-draughts.
- Weather phenomena associated with severe thunderstorms (see Figure 1) include:
  - **Heavy rain** - the intense updraught of a mature severe thunderstorm produces rain drops through condensation of water vapour. Once rain drops become too large to be supported they fall. This produces heavy rain which can exceed 200mm per hour, causing flash-floods (Figure 2).
  - **Hail** - hailstones form in a thundersorm when raindrops freeze at high levels and then grow steadily in size as they are recycled through up- and down-draughts. Hailstones larger than cricket balls have been recorded in Australia (Figure 3).
  - **Lightning and thunder** - lightning is the discharge produced when differences between ground and atmospheric electrical charges are large enough to overcome the insulating effect of the air. Lightning strokes can occur within a cloud, between clouds or between a cloud and the ground. Thunder is the sound produced by the explosive expansion of air heated by the lightning stroke.
  - **Wind gusts** - in a mature thunderstorm, falling rain and hail drag surrounding air downwards. This strong down-draught spreads out upon reaching the ground, producing cool gusty winds.
  - **Tornadoes** - these rapidly rotating columns of air are the rarest and most violent of thunderstorm by-products. They descend in a familiar funnel-shape from thunderstorm clouds (Figure 4). A tornado vortex can range in width from a few metres to several hundred metres. It usually whirls clockwise in the Southern Hemisphere and contains winds that may reach more than 450km/h.

adapted from 'Hazards, Disasters and Survival', Natural Disasters Organisation, 1992

contd.....

Severe Thunderstorms (contd)

Activities

1 Study the information in 'Hazard Data'and in Figure 1
   a How might lightning strikes be linked to (i) injuries to people and (ii) damage to property?
   b Why is heavy rain associated with severe thunderstorms?
   c Severe thunderstorms occur when the atmosphere is *particularly* unstable. What are the conditions which lead to a particularly unstable atmosphere?
   d Explain why severe thunderstorms occur in most areas of Australia when the supply of solar energy is at its greatest - i.e. between September and March ?
   e Explain the formation of the 'complementary up- and down-draughts' which occur in a mature severe thunderstorm.
   f Why would hailstones grow steadily in size as they are 'recycled through up- and down-draughts'?

2 Explain each of the following observations made during a severe thunderstorms:
   - *Huge thunder clouds hung above us, as hailstones the size of golf balls crashed onto our roof.*
   - *We watched from the window as ribbons of lightning lit up the sky, each one followed almost immediately by a deafening clap of thunder.*
   - *The rain was driven almost horizontally by the strong winds which accompanied the storm*
   - *The wind swirled in a tight funnel-shaped pattern, picking up objects and dumping them 50 metres away It was gone as quick as it came.*

3 Study Figure 2.
   a Outline the different types of damage this type of flooding might cause in the centre of a major Australian city?
   b Why do you think flash-floods are most likely to occur in built-up (city) areas?

4 Study Figure 3 and describe at least 5 different types of damage which may result from hail of this size.

5 a In 1976, two people were killed near Sandon in Victoria when a tornado lifted their car from the side of the road and carried it 100 metres before dumping it into a ditch. What does this tragedy reveal about the characteristics of tornadoes?
   b Study Figure 4 and describe at least 3 more types of damage that may result from a tornado.
   c At least 41 tornado-related deaths have been recorded in Australia. Why do you think many people still believe that tornadoes do not occur in Australia?

Figure 4: Tornado damage, Mandurah, WA, 1993

Figure 5: SES volunteers repair damage after a severe thunderstorm in Sydney, 1991

6 Study Figure 5, showing a large tree which has collapsed onto a house after a severe thunderstorm.
   a Suggest two possible causes of the collapse of the tree
   b What problems have been created for the owner of the house?
   c What are the SES volunteers trying to do to repair the damage?

Land Gales

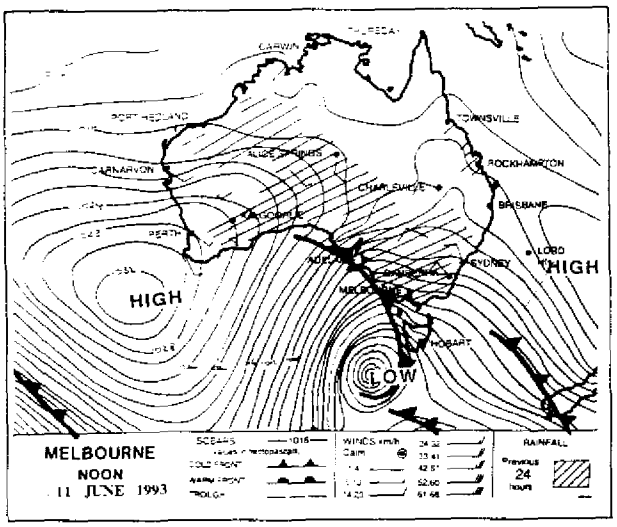

Figure 1: Weather map on a day when land gales occurred in southern Victoria, 11 June 1993.

HAZARD DATA

- **Land gales** are the other category of severe storms (along with severe thunderstorms).
- Land gales are simply gale force winds (62km/h or stronger) over the land.
- Land gales usually last a lot longer and affect a much wider area than thunderstorms.
- Gales blow when large differences in atmospheric pressure are concentrated over a small distance. This can happen:
  - between deep low pressure systems and strong highs, or
  - near intense cold fronts.
- On a weather map, land gales are indicated by *isobars* (lines joining places of equal air pressure) being very close together. This is called a steep *pressure gradient*
- In the southern half of Australia, land gales generally occur in winter or spring. In the tropical north, the strongest winds usually hit in summer and autumn, and are often due to tropical cyclones.

adapted from 'Severe Storms: facts, warnings and protection', Bureau of Meteorology and Emergency Management Australia.

Activities

1 Study Figure 1.
   a What evidence from the weather map suggests that southern Victoria experienced land gales on 11 June, 1993?
   b From which direction were winds blowing in southern Victoria at the time the weather map was drawn? How can you tell?
   c What other conditions was southern Victoria experiencing on 11 June, 1993?

2 Study the information in Figure 2.
   a Explain how land gales and drought conditions combined to produce the severe duststorm described.
   b What problems resulted from the duststorm?
   c Why did the Electricity Trust of South Australia disconnect power to a number of areas?

3 Land gales can be particularly damaging in rural areas. Suggest some of the problems that may result from the following:
   - a land gale occurring in January in a fruit-growing district, specialising in stone fruits such as apricots and peaches;
   - a land gale occurring in a wheat growing district (i) just prior to sowing and (ii) at the time of harvesting;
   - a land gale occurring in winter in a sheep farming area.

SA starts clean-up after damaging gales

ADELAIDE: Gale-force northerly winds of up to 90km/h lashed large areas of South Australia yesterday. Many parts of the state were covered in thick red dust, as winds gusted over the state's rural interior and frustrated farmers waiting for opening rains.

Near-drought conditions have occurred across most of the state this year, and the combination of the dry, bare land surface and gale-force northerlies swept hundreds of tonnes of valuable topsoil into the atmosphere.

The blanket of dust covered Adelaide, and its northern suburbs. Visibility was reduced to virtually nil, causing problems for planes arriving at the Adelaide airport. The dust was also blamed for a series of traffic accidents, including a six-car pile-up and a level crossing collision.

At the height of the gales, the Electricity Trust of South Australia were forced to disconnect power to a number of areas because of the fire risk. Such a precaution is a direct result of the disastrous Ash Wednesday bushfires in 1983, when fires were sparked by power lines rubbing together in the strong winds.

MAY 25, 1994

Figure 2

Case Study: Sydney, 1990

Sydney storm worst on record

A STORM which cut through Sydney yesterday has been hailed as the most damaging thunderstorm ever to hit Australia. By sundown it had slashed a violent path across the city, dumping 10-centimetre hailstones and causing an estimated $360 million in damage to cars and homes.

The storm came with very little warning. At 10.30am the Bureau of Meteorology issued a routine forecast for Sydney, predicting 'a shower or two and a slight chance of a thunderstorm'. Even in the early afternoon, as the storm cell began forming, people continued to enjoy the sunny weekend weather.

It was only at 3.00pm that the weather bureau, using its radar tracking system, was able to detect a rapidly growing thunderstorm. A 'severe storm' warning was immediately issued on the radio.

The storm cell continued to grow, as towering clouds moved towards the city. Within these clouds, ice crystals were sucked higher by huge updrafts of air. They grew so big that they could not be held aloft and so plunged back to earth.

As they fell, they were caught once more in the updraft and lifted again. This process continued, until by 3.30pm, hailstones the size of oranges were falling on Sydney's south-western suburbs. Here they smashed through windows, tore branches and leaves from trees and left hundreds of cars pock-marked.

The winds left greenery and wood scattered over roads. Roofs of houses were torn off and more than nine kilometres of powerlines were brought down. In the hard-hit western suburbs, power had still not been restored to some areas this morning.

Extensive flash-flooding after heavy downpours of rain, caused building damage and cut off roads. This morning, the Riverwood Golf Course and some areas of parkland were still underwater.

In all, the State Emergency Service responded to more than 4000 calls for help in Sydney's southern and western suburbs. By the time the storm was over the northern suburbs it had begun to weaken and less calls for help were received.

The storm has insurance companies reaching for the record book, with several claiming it will be the largest payout for a natural disaster they have ever faced. One major company has predicted that the storm would end up costing them $120 million in car repairs and $35 million for home claims.

MARCH 19, 1990

Figure 1

Activities

1 Read the information in Figure 1.
   a One insurance company described the storm as 'the worst natural disaster ever to strike New South Wales'. Comment on the accuracy of this description.
   b The Bureau of Meteorology were only able to provide about 30 minutes warning of the storm to some areas of Sydney. Why do you think it is difficult to provide accurate warnings well before a thunderstorm hits? What difficulties would have been caused by the short warning period in this case?
   c Describe the process by which 'hailstones the size of oranges' were formed.
   d Group the hazards resulting from the thunderstorm under their different causes i.e. hazards caused by (i) heavy rain, (ii) strong winds, (iii) hail.
   e Make up a list of at least five reasons why people may have called the State Emergency Service (SES) during and after the thunderstorm. What problems might the SES have experienced in responding to calls for assistance?

2 Write a short descriptive account based on one of the following options.
   - *I was in Sydney on March 18, 1990, and this is what happened to me.*
   - *I've been caught in a major thunderstorm, and this is an account of my experiences.*
   - *This is what I imagine a major thunderstorm would be like.*

   In each case, try to describe your observations, actions and feelings before, during and after the thunderstorm.

Severe Storm Approaching!

a.

SEVERE THUNDERSTORM WARNING
BUREAU OF METEOROLOGY, SYDNEY
Issued 5.00pm on Friday 26/3/93

Severe thunderstorms with severe wind gusts, damaging hail, and very heavy rain are expected during the next hour in the following Council area:

SYDNEY METROPOLITAN

A LINE OF THUNDERSTORMS EXTENDING FROM JUST NORTH OF PENRITH EASTWARDS TO THE COAST AT 5PM HAS PRODUCED HAIL UP TO 2 OR 3CM IN DIAMETER AND STRONG WINDS IN SOME SUBURBS. THESE STORMS ARE EXPECTED TO PERSIST FOR AT LEAST THE NEXT HOUR.

The State Emergency Service advises you to:
- put your vehicle under cover;
- stay inside away from windows; and
- ring your local SES unit for emergency assistance if your house is damaged

b.

SEVERE THUNDERSTORM ADVICE
BUREAU OF METEOROLOGY, PERTH
Issued 12.45pm on Saturday 1/5/93

FOR THE INLAND PARTS OF THE WEST GASCOYNE

SEVERE THUNDERSTORMS ARE POSSIBLE DURING THIS AFTERNOON AND EVENING. WIND GUSTS IN EXCESS OF 90KM/H, HAIL AND FLASH FLOODING MAY RESULT IN DAMAGE TO PROPERTY.

Figure 1: **a** Short-term thunderstorm warning
b Longer-term thunderstorm advice

HAZARD DATA

- The Bureau of Meteorology is responsible for provision of warnings of dangerous weather to the Australian community, with the aim of minimising injury and damage.
- The warnings are transmitted to authorities such as Police, State and Territory Emergency Services, and to radio and television stations.
- Forecasters use data from satellites, radar, lightning detection networks, ground observations and computer models to prepare the warnings.
- *Short term warnings* (up to 3 hours ahead) and *longer term advices* (up to six hours ahead) areissued for severe thunderstorms (see Figure 1).
- Land gale warnings are issued on a district scale throughout the country. These warnings generally cover periods of six to twelve hours and are not as specific or detailed as severe thunderstorm warnings.

Activities

1 a Why do you think each of the following characteristics of severe thunderstorms make them difficult to monitor and predict:
- many have a lifetime of three hours or less;
- the diameters of some storms are less than 10 kilometres.

b What types of technology are used by forecasters to make tracking and prediction more accurate?

c What additional problems might result from a very short warning time before a severe thunderstorm?

2 Read the information in Figure 1.
a Why do you think the Bureau of Meteorolgy issues two types of severe thunderstorm warnings?
b From the examples shown, what are the main differences between the two types of warning?
c List the different types of information contained in the short-term warning. Write your own short-term warning, imagining that a severe thunderstorm is only two hours away from your area.

3 Land gale warnings are tailored to meet local needs, and cover a period of six to twelve hours. Write a land gale warning for your local area containing the following information:
- Title.
- Place of issue.
- Time and date of issue.
- Expected wind speed and direction.
- Details of area likely to be affected.
- An estimate of the times over which the gale is likely to blow.
- Prediction of likely damage to crops, animals, buildings and people.
- Prediction of associated hazards such as duststorms, flying debris, fallen trees and reduced visibility.

Severe Storm Action

a.

SEVERE STORM SURVIVAL AND PROPERTY PROTECTION

Actions before the storm season

-
-
-
-
-
-

Actions as the storm approaches

-
-
-
-
-

Actions when the storm strikes

-
-
-
-
-
-

Actions after the storm passes

-
-
-
-
-

b.

- If you need emergency assistance contact your State/Territory Emergency Service.
- Trim tree branches well clear of your house. Clear loose objects from your yard.
- Place vehicles under cover.
- Keep clear of windows and large areas of glass.
- If driving, pull over, park clear of trees, powerlines and watercourses.
- Listen to your radio for storm warnings.
- Shelter and secure pets and animals
- Check your house for damage.
- Disconnect all electrical appliances.
- Clean and check roof guttering and downpipes.
- Make sure you have a portable radio and torch with fresh batteries.
- Listen to your radio for storm updates.
- If outdoors, find emergency shelter (not under a tree).
- Don't go sightseeing, stay at home to help others.
- Beware of fallen powerlines, flooded watercourses and damaged buildings and trees
- If necessary, shelter under a table or cover yourself with a mattress, blanket, quilt or tarpaulin.
- Tape (in an 'x' pattern) or cover large windows.
- Ensure you have a first-aid kit.
- Stay inside and shelter in the strongest part of the house (bathroom, cellar) and don't use the phone.
- Purchase masking tape (for windows), plastic sheeting and large garbage bags (for rain protection)
- Listen to your radio and heed official advice and reports of damage and disruption to services.

adapted from 'Severe Storms Action Guide', Emergency Management Australia.

Figure 1: a 'Severe storm survival and property protection'
b List of possible actions

Activities

1 a Complete the chart 'Severe Storm Survival and Property Protection' (Figure 1a.) by filling in the blank spaces with the actions listed in Figure 1b. Share your responses as a class to check that their is agreement about when each action should be taken.

b Working in small groups, plan a poster around one of the categories in your completed chart (make sure all categories are covered in the class) When your poster is completed, display it in an appropriate place along with those that other groups have produced.

2 Explain the reasons for each of the following actions:

- Using masking tape in an 'X' pattern across windows.
- Having a portable, battery powered radio.
- Cleaning and checking roof guttering and downpipes.
- Disconnecting all electrical appliances
- Clearing up loose objects from your yard.

contd

Severe Storm Action (contd)

3 a Complete Figure 2 by entering phone numbers on the dotted lines You will find the numbers you need in your local directory under *'all other emergencies'* (referred to on inside cover) or by looking up the name of the specific authority or company.

b When you have completed the chart, cut it out and display it in a prominent place near the telephone in your home

4 Read the information in Figure 3.

a Why do you think lightning is not widely recognised as one of Australia's most dangerous natural hazards?

b What are the most common lightning-related injuries? If a person is struck directly by lightning what type of first aid is likely to be needed immediately?

c What does it mean to say 'the phone system becomes part of a highly charged electrical system' when the lines are struck by lightning?

5 a It has been suggested that deaths and injuries from lightning strikes will increase as the proportion of retired people in the Australian population grows, and their participation in golf, boating and fishing increases? Explain why this might be the case.

b Give reasons why each of the following actions should be avoided if lightning threatens:
- flying a kite
- sheltering under trees
- working on a computer
- taking washing off of the line.

c As a class, devise a list of actions that *should* be taken in the event of dangerous lightning.

EMERGENCY ASSISTANCE
(Who and when to call)

STATE/TERRITORY EMERGENCY SERVICE

.....

Call your nearest unit for **emergency** assistance with house damage, and/or advice about temporary accommodation, food and clothing.

ELECTRICITY AUTHORITY

.....

Call your local office for power failure, fallen power lines or other electrical problems.

WATER BOARD/AUTHORITY

.....

Call your nearest depot if your household water supply is damaged or interrupted.

GAS COMPANY/AUTHORITY

.....

Call your local office for gas emergencies.

INSURANCE COMPANY

.....

Call immediately to arrange approved tradespeople to repair your home This is **your** responsibility.

POLICE, FIRE, AMBULANCE

.....

If unable to phone emergency services:
- Listen to radio for official warnings/advice.
- Form a self-help group with family and neighbours.
- Watch for emergency services crews who will check your area as soon as possible

AVOID USING THE PHONE DURING STORMS.

Figure 2
adapted from Severe Storms Action Guide', Emergency Management Australia.

SOME FACTS AND MYTHS ABOUT LIGHTNING

- Lightning poses a greater threat to individuals than almost any other natural hazard in Australia.
- On average, as a result of lightning strikes, five to ten people are killed and over a 100 injured each year.
- Most injuries occur when people use telephones during thunderstorms.They may receive an electric shock, hearing damage or burns when lightning strikes the lines in their area and the phone system becomes part of a highly charged electrical circuit.
- When struck, people do **not** glow or 'fry to a crisp', but the heart and breathing are often affected.
- Only about 30 per cent of people struck by lighning actually die, and the incidence of long-term disability is **low**, particularly when first aid is applied **promptly**
- If you apply heart massage or mouth-to mouth resuscitation to a lightning victim you do not receive a shock from the victim.
- If you hear thunder 10 seconds after a lightning flash, it is only about three kilometres away. The shorter the time, the closer the lightning
- If your clothes are wet you are **less likely** to be seriously injured if struck, as most of the charge will conduct through your clothes rather than your body.
- Lighning often **does** strike the same place twice
- The best places to shelter from lightning are in 'hard top' vehicles and solid buildings.

Figure 3
adapted from 'Lightning Protection Action Guide', Emergency Management Australia