CFS FACT SHEET
BUSHFIRE BEHAVIOUR
IN DETAIL

Once a fire is burning, its behaviour is determined by three main factors. They are:

- **fuel** – type, quantity, condition and arrangement. Fuels include vegetation and other flammable material
- **weather** – air temperature, relative humidity, wind speed and direction, and atmospheric stability
- **topography** – slope, aspect, affect on wind, and elevation.

As a home owner, the only factor you can control is fuel. By reducing the fuel load and creating a defendable space around your property, you can reduce your bushfire risk.

**How vegetation feeds bushfires**

Bushfires are fuelled by vegetation. How hot the fire becomes or how fast it spreads depends on the vegetation or fuels: the amount, type, condition and arrangement.

For example, long dry grass, twigs and leaves will burn very quickly; while heavy forest and scrub will burn slowly, but at a much higher temperature and at greater intensity.

In South Australia, common fuel types include:

- grass (usually after it is drying out or dead)
- crop
- seaweed
- decomposing humus, peat and duff (fine ground litter)
- small shrubs and scrub (heath lands)
- plantation forest (eucalypts, pine trees)
- bush/scrub (eucalypts with under-storey vegetation, wattles, she-oaks etc).

Given the right conditions, most of these fuels will ignite and burn readily. All will burn with different degrees of intensity.

**Common South Australian vegetation**

![Plantation pines](image1.png)

![Eucalyptus forest](image2.png)
Fine fuels are leaves, twigs and grass that burn and give off heat rapidly. Under the right conditions, these fuels produce the huge flames and much of the radiant heat in a bushfire.

Embers are burning leaves and twigs carried by the wind. They can travel a great distance. Ember attack is the main cause of house loss in a bushfire, occurring before, during and after the fire front passes.

Heavier fuels are branches, trees and logs that burn and radiate heat slower than fine fuels. They can burn for hours or days after the bushfire front has passed.

How different fuels burn

- **Grasses** respond rapidly to changing moisture in the air. Very dry grass (a deep gold and brown colour) absorbs moisture from damp air overnight; however, moisture is lost to wind and dry air very early on high fire risk days. Grass fires can spread very rapidly.
- **Scrub vegetation and trees** drop leaves and twigs (fine fuel) on the ground around them. These fuels can accumulate in large quantities. This fuel burns slower than grasses, but it gives off far more heat.
- **When the bark on trees** is fibrous and dry, flames from a surface fire can pre-heat and ignite the bark. This helps a fire climb higher up the tree, adding to both the height of the flames and the heat of the fire.
- **When shrubs, branches and bark** provide a continuous ladder of fuel up into the tree canopy, a bushfire can burn high in the trees and give off very large amounts of heat. This is called a crown fire.
Effect of humidity on bushfires

It is easy to recognise days when fuels are at their driest. This is more common in summer, on hot and windy days. The strong winds, coming from arid inland Australia, dry out the bush and fan any fire that starts. On a typical summer day the air may contain very little moisture; it has a low relative humidity. This means that vegetation cannot absorb much moisture from the air. When the air is dry, the bush or grasslands are also dry from very early in the day, adding to the fire danger.

Relative humidity

Humidity is the amount of water vapour in the air:

- Low humidity means the air is very dry.
- When humidity decreases to less than 30 per cent the fire danger increases.
- Low humidity evaporates moisture from vegetation and flammable materials, making them easier to ignite.

Effect of wind on bushfires

Strong winds are normally present during bushfires, which makes it harder for firefighters to bring the fire under control. The wind pushes flames closer to unburnt fuel and causes the fire to travel quicker.

In South Australia, winds are hottest from the north/northwest. Wind also dries out vegetation, making it more flammable, and bends flames over, allowing radiant heat to pre-heat unburnt fuel. Embers are also carried by the wind and cause spot fires.

Wind influences the:

- **Speed** at which a fire spreads. The higher the wind speed, the greater the fire danger
- **Direction** in which a fire travels and the size of the fire front. A change in wind direction will rapidly change the fire front and fire direction
- **Intensify** of a fire by providing more oxygen
- **Likelihood of spotting**. Burning pieces of leaves, twigs and bark (embers) are carried ahead of the fire by winds, causing spot fires to ignite.

Effect of topography on bushfires

The shape of the land has a strong effect on bushfire behaviour. A fire will burn faster uphill because the flames can reach more unburnt fuel in front of the fire. The heat radiating from the fire pre-heats fuel on the slope ahead of the fire, causing the fuel to start burning more quickly.

As a general rule, the fire will increase its speed as it travels uphill by four times for a 20 degree slope. The opposite applies to a fire travelling downhill: because the flames reach less fuel, there is less radiant heat to pre-heat the fuel ahead of the fire, so the fire travels slower.
How a bushfire spreads

Bushfires spread along the surface of the ground in three ways: direct flame contact, radiant heat and burning embers.

- **Direct flame contact** – flames touch unburnt fuels and raise their temperature to ignition. This process is hastened by wind blowing the flames deeper into the fuel ahead or an upward slope presenting fuel to the flames sooner.
- **Radiant heat** – radiant heat from the fire raises adjacent fuel to ignition temperature, often before the flames reach it.
- **Burning embers** – when embers land on fine fuels they can start small fires. If left unchecked, these fires smoulder, grow and spread. Embers are carried by winds ahead of the actual fire - sometimes several hundred metres ahead - and can land on flammable material, causing small fires to start.

Fires spread vertically from the surface through middle and upper-level fuels. Fires only crown into the tops of tall trees if there is a continuum of fuel from the surface up to the tree tops.

As a general rule, flame height is between three and five times the height of the fuel; this makes cutting or grazing grass well worthwhile!
Fire features

- Fire is typically teardrop-shaped when there is wind.
- The back of the fire burns slowest, coolest and with the shortest flames.
- The fire front burns fastest and hottest and is the most dangerous place.
- The fire flank is also dangerous: in the event of a wind change the upwind flank will immediately burn at its maximum rate of spread.

Three stages of a fire

During a fire, residents and properties are at risk from several things, depending on the stage of the fire. The ways of mitigating the threats posed at each stage are detailed in fact sheets on Preparing your Property; Physical and Emotional Preparation and On the Day of a Bushfire, but the main principles are listed below.

It is vitally important to plan well before the fire arrives as to what action you will take and whether you will leave early. Preparing a Bushfire Survival Plan will assist with this decision making and understand when and which plan to enact. Never wait until the bushfire arrives before preparing both your property and yourself.

Stage one – before the fire arrives

The lead time is highly variable, but a general guide is up to 30 minutes.

In the time leading up to the arrival of the fire front, the main threats are ember attack, thick smoke, increasing fire noise and increasing darkness. It will also be hot and frightening. Deal with these threats by:

- ember proofing your home
- preparing a defendable space around your home
- patrolling inside and outside the house, extinguishing any spot fires
- dressing in protective clothing and wearing a protective mask
- preparing yourself psychologically for the ordeal
- sheltering in the house if conditions become too bad.

Stage two – during the fire

This is a relatively short period, but that does not make it less horrific. It will last from 5 to 20 minutes, depending on conditions. Although brief, this is the most dangerous stage and people should seek shelter inside.

As the fire front passes, properties will be subject to radiant heat, flame contact, ember attack, smoke, loud noise, darkness, and power failure.
Radiant heat

Radiant heat is the greatest threat to people and can kill well before the fire front arrives. You must seek shelter from it.

Radiant heat is many times hotter than the air temperature. The front of a moving fire radiates up to six times more heat than its back. Radiant heat only radiates in straight lines and will not penetrate solid objects. Although it may not set a building on fire, it can crack and break windows, allowing embers to enter your home. Bushfires radiate a more significant amount of heat than grassfires.

Stage three – after the fire front has passed

Many hours, sometimes days, after the fire front has passed, properties continue to be at risk from ember attack and smouldering fuel. You should extinguish small fires and check roof spaces and other likely places for embers.

Smoke as an indicator

The colour of smoke can indicate the fire’s behaviour.

<table>
<thead>
<tr>
<th>Smoke colour</th>
<th>Indicates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dense, white</td>
<td>Very moist fuels, mild behaviour</td>
</tr>
<tr>
<td>Pale grey/blue</td>
<td>Moist fuels, mild-moderate fire</td>
</tr>
<tr>
<td>Black/dark brown</td>
<td>Dry fuels, high fire behaviour</td>
</tr>
<tr>
<td>Copper/bronze</td>
<td>Very dry fuels, high to severe fire behaviour</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Smoke column</th>
<th>Indicates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thin, lazily rising</td>
<td>Small fire with low speed</td>
</tr>
<tr>
<td>Bent over close to ground and increasing in volume</td>
<td>Wind-driven fire that is speeding rapidly</td>
</tr>
</tbody>
</table>

Blue smoke – low-intensity fire

Dark brown smoke – high intensity

Smoke column bent close to the ground and increasing in volume – wind-driven fire that is spreading rapidly

Smoke column widening at base, mostly white but turning brown on downside – fire is spreading in grass and moving into heavier fuels

Further information can be obtained from: [www.cfs.sa.gov.au](http://www.cfs.sa.gov.au) or SA CFS, GPO Box 2468, Adelaide, SA 5001. 08 8463 4200.