BUSHFIRE SURVIVAL

Each year in Australia many people find themselves in peril due to bushfires. Some of these people meet a tragic death—because they had not exercised simple safety precautions that could have averted danger. There are many cases where death in a bushfire can be traced to a lack of knowledge of a survival drill and the principles behind it.

Research workers, by drawing on their own findings, and the experience of practical fire control officers and their leaders in other departments, have been able to sift out the best and most essential advice so far available on survival and safety.

The following article is based substantially on results of research and articles by Dr. A. R. King, C.S.I.R.O. (*Rural Research Bulletin No.* 38, 1961), and Mr. Phil Cheney, Forestry and Timber Bureau, Department of National Development (*Bush Fire Bulletin*—N.S.W. Bush Fire Committee, 1970).

Most experienced firefighters are well aware of the principles of bushfire survival, but because of experience or a good knowledge of fire behaviour, they rarely place themselves in a hazardous situation where they would be trapped by flames.

It is generally on days of extreme fire danger that rural communities are burnt-out and that members of the general public may be trapped and killed on the roads.

It is most important that under these conditions people know the basic principles of survival and that they instruct their families what to do in the event of an emergency. Panic and confusion can only be avoided if the community as a whole has a planned course of action and the firefighters and brigades can concentrate on fire suppression.

Main fundamentals for survival:

1. *Remain calm and don't panic.*
2. *Place yourself in an area where there is the least amount of combustible fuel.*
3. *Use every means to protect yourself from radiation from the flames.*

How people are killed

There are five possible ways in which people can be killed by fire:

1. The body's heat regulation mechanism fails.
2. The body is burnt.
3. The lungs are seared by superheated gases.
4. People are overcome by smoke and suffer anoxia (lack of oxygen).
5. People are poisoned by carbon monoxide or other toxic gases.

The first factor is the most serious problem, in that people suffer apoplexy or heatstroke in an extreme form as a result of excessive *radiation.*

The other factors are rarely important by themselves, although they may predispose the victim to act irrationally and expose himself to excessive radiation. Even bad burning is not an immediate cause of death unless the body's heat regulating mechanism fails as well.

It is often thought that people may be overcome by smoke and suffer from lack of oxygen or have their lungs seared by hot gases. However, this is most improbable. While smoke causes irritation of the lungs, it does not appear to cause pulmonary oedema, which is common with fire victims. Pulmonary oedema is a condition in which the lungs contain excessive fluid and it may be shown by a frothing at the mouth of the victim.

Most of the heat felt at a fire is radiant heat and in fact the air temperatures around a severe fire are not exceptionally high, as the hot gases are quickly carried away by convection. Measurements have shown that air temperatures within 10 ft. of the ground and within a few feet of flames up to 35 ft. high are less than 30 deg. F. above surrounding temperature. While it is not pleasant to breathe hot air, the body has remarkably high tolerances. Air at 200 deg. F. can be breathed for half an hour and air at 500 deg. F. for three minutes.

Air at this temperature would never be encountered at ground level unless it was directly in the path of a convection column.

Anoxia is practically impossible in any open fire situation. Even in mass fire experiments where the combustible fuel was 140 tons an acre and the fire ignited instantaneously, the oxygen level dropped only to 19 per cent for a few minutes. Flaming combustion can only continue when the oxygen content exceeds 12 per cent and life can be supported at this concentration.

Similarly, the concentration of carbon dioxide in mass fire does not exceed the limits for survival. Poisoning by carbon monoxide is extremely unlikely in an open fire situation.

However, carbon monoxide is produced by fires in smashed fuels, such as clearing burns. Mass fire experiments have shown that carbon monoxide levels can be produced which cause headaches after 30 minutes' exposure, collapse after 90 minutes, and death after four hours' exposure. It is worth noting that bushfire survivors have never complained of splitting headaches associated with carbon monoxide poisoning, and it is apparent that if you can survive the flaming period of a bushfire, which rarely lasts over one spot for more than five minutes, there is no risk of succumbing at a later date.

Building fires are a completely different proposition. Anoxia is possible when there is a combustion in a confined space and various toxic gases can be produced. Recent

experiments have shown that traces of these toxic gases of less than 4 per cent of the generally accepted threshold level can produce death when in combination with heat, anoxia and high carbon dioxide levels.

In most bushfire tragedies the people are usually dead or nearly dead before the flames actually touch them. By laboratory and field measurement and from the study of case histories, it is now abundantly clear that the radiated heat is the main peril leading to exhaustion and collapse.

Radiation causes heat stroke, which is essentially a state of utter exhaustion. Shielding yourself from radiation and avoiding behaviour or activity such as fear, panic or flight that saps your strength are therefore vital. Many of the rules for safety and survival are based on these considerations.

What to do—what not to do

Experience and experimental evidence both point to the fact that if you can protect yourself from radiation during the peak of the fire, you will survive. The following points deal largely with protection from radiation, and should be borne in mind when approaching any fire, even when no hazard to life exists.

1. *Protective clothing.* The value of clothing as a shield against radiation should not be overlooked. Woollen material is best. Besides giving somewhat better protection than cotton, it does not catch fire readily and will save many a nasty small burn caused by falling sparks. Some artificial fibre cloths are not good shields and the melted remains can seriously contaminate burns. Clothes which cover arms and legs, and button up to the neck, should be worn. For firefighters there are good quality flame-proofed overalls on the market which, when worn with the minimum amount of underclothing for comfort, are cool and allow more efficient work in safe situations.

2. *When approaching any fire* make a practice of noting safe areas which could be used as a refuge in the event of emergency. In grasslands note areas of fallow, dams or native pasture carrying light fuel. In the forest note positions of creeks, moist soaks, dugouts, etc., and try to avoid areas of dense vegetation or roads lined with windrows. Experienced firefighters do this automatically, and because they know exactly where to go in an emergency they avoid panic.

3. *When flames have already cut off your escape route.* If caught on continuous fuel try to move on to bare or burnt ground. Enlarge the area by burning the fuel around you. As a last resort it may be necessary to light a fire and step on to the burnt ground. Light a line of fire, of say 30 ft. or longer across the slope, or at right angles to the wind direction, to achieve a faster rate of spread. Always carry matches for this purpose.

4. *Do not attempt to run through flames* unless you can see clearly behind them. This generally means that flames are less than 5 ft. high and less than 5-10 ft. deep. Few people, if any, have run through high flames and survived. The practice cannot be recommended.

5. *Resist the temptation to run from a fire* unless your chance of survival is obviously high. Conserve your energy and consider alternative courses of action.

If you run, choose a downhill route if equally safe-looking, since fire moves uphill fast. Try to walk to the edge of the fire front.

6. *When circumstances become most severe* remember to use every possible means to shield yourself from radiation. Cover exposed skin as well as possible. Take refuge in running streams, ponds, or culverts. On bare ground, bury yourself if possible, or use depressions, wheel ruts, large rocks or logs to protect yourself from radiation.

If caught in the open in a forest fire under extreme conditions, you can expect to be showered with burning embers and charcoal for up to 15 minutes after the fire passes. It is most important to have flame-proof clothing which will not catch alight under these conditions.

7. *Avoid elevated tanks.* A body immersed in lukewarm water cannot sweat and at a temperature of 115 deg. F. a state of collapse will be reached after about three minutes.

8. *Limit your breathing rate when smoke is dense* and wait for the arrival of cool pockets of fresh air before filling your lungs. The air near the ground is the freshest and coolest.

9. *Do not delay in front of flames* when it is necessary to enter them to escape, but after having covered exposed skin as best you can in the circumstances, take some quick deep breaths and move briskly through on to the burnt area. Choose the path that is least obstructed by dense growth, logs, or uneven ground. Avoid flames that are tending to "crown out" (enter the tree tops).

10. *Don't panic*—it seriously drains nervous and physical energy and clouds your judgement.

MOTOR VEHICLES

A hard-topped vehicle, with windows which can be tightly closed, can afford good protection in an emergency. If it is in good condition, there is little chance of it catching alight if parked on bare ground. Even on heavy grass fuels the vehicle will provide protection from radiation until the flame front has passed and it is possible to step on to the burnt ground.

Avoid touching the outside of the vehicle immediately after the fire—it could be extremely hot.

There appears to be little evidence that the petrol tank will explode, even while a car is burning out. None of the burnt-out cars inspected after the Hobart fires had exploded tanks. However, there are probably well-authenticated examples of in-

Dwellingup Hospital, burnt out during the 1961 fire. Note the nurses' quarters, undamaged, in the background.

stances when tanks have exploded, and certainly there are cases where a damaged tank has rapidly engulfed the car in burning petrol.

BUILDINGS

Most buildings which are well maintained, and do not have accumulations of rubbish close to them, should be easy to protect by carrying out such measures as closing the windows and doors, and maintaining a vigilant patrol to put out spot fires as they start. Houses with enclosed eaves and foundations are safest as they prevent entry of flying embers.

In the worst situations a house will provide refuge from the peak of the fire, even if it burns down later.

It is most important that rural householders keep their houses in such a condition that they can be protected by the women and children. A well protected home not only provides the family with a safe refuge, but also prevents diversion of fire-fighting equipment from the fire line to building protection.

Case histories

Tasmanian fires, February 1967

The disastrous fires which burnt on the 7th February claimed the lives of 62 people. This is probably the largest loss of life in fires in a single day in Australia, and although

View of Dwellingup after the fire, looking towards Community Hotel from R.S.L. Hall.

71 people died as a result of the January 1939 fires in Victoria, this total accumulated over several days.

Of the Tasmanian deaths, nine were certified as being due to natural causes, such as heart failure and heat exhaustion, but considering health prior to the fire, these deaths can be attributed to the fire. The ages of these people is not known, but the ages of the remainder ranged from 23 to 88. The age distribution is given in the table below, prepared by Messrs. A. McArthur and P. Cheney, Forestry and Timber Bureau, in a preliminary report on the tragedy.

Age Class (years)	*No.*	*Average Age*
1–25	1	23
26–50	13	38
51–75	26	64
76+	13	82
Total	53	61

This age class distribution is almost the exact reverse of the normal Australian population curve and indicates the susceptibility of older people to prolonged heat and smoke.

(*Continued on page* 14)

NEW PUBLICATION

The Forests Department's latest publication, *Selected Flowering Eucalypts of Western Australia*, a 48-page (including cover) booklet is now on sale at the department's head office, 54 Barrack Street, Perth, and all branches.

The $9\frac{3}{4}$ in. by $7\frac{1}{2}$ in. booklet includes 69 colour illustrations—including one map showing State rainfall and place names—and 62 line illustrations of buds and fruits to assist identification.

The 29 species and five varieties selected for publication are represented in 67 of the colour plates, and there is one full page picture of the karri forest after bark-shed in late summer (see page 15 and back cover of this edition of *Forest Focus*).

The price of the publication is $1. Bulk lots of 50 will be available for retail purchasers at $37.50 (75 cents each).

One hundred and sixty-five species and a number of varieties of the genus *Eucalyptus* have been recorded in Western Australia. Included in this are two new members, *Eucalyptus laeliae* and *E. roycei*, which were named in the last five years, while another four are currently being described. It is quite possible that the number will further increase in future years.

Most of the species are endemic to Western Australia and a number of them have unique characteristics of colour or shape of the buds, flowers or fruits. Foresters operating through the southern part of the State have built up an interesting collection of photographs of the 29 species selected for reproduction in *Selected Flowering Eucalypts of Western Australia.*

It is hoped that this booklet will add further to the prestige of the world renowned flora of the "Wildflower State".

A table of distribution in the book shows that more than half of the species listed occur in the 11–20 in. rainfall belt, the area where the greater part of the State's agricultural development has taken place. This means that their occurrence throughout their natural range is becoming increasingly fragmentary and many are now extremely rare and vulnerable.

The remnants must be rigorously conserved otherwise most of them will, within the not-too-distant future, cease to exist in the wild state, and posterity could well be forced to rely on cultivated specimens to ensure the perpetuation of the species.

Reproduced on the opposite page is page 31 of the new publication, indicating style and content.

Remains of the small township of Holyoake.

(*Continued from page* 12)

The locations where the deaths occurred are of importance:

Situation	*No.*
1. Mustering stock	2
2. Firefighting	11
3. Travelling	2
4. Escaping from house (i.e. some distance from house)	11
5. Within yards of house	10
6. Found in house	17
	53

Most of the people in categories 5 and 6, who were found in the home or within yards of the house, were either old and infirm or suffered from a physical disability. These people probably had little idea that the fire was threatening them until they were surrounded by flames and were then unable to take any action to save their lives or homes.

In category 4, over 60 per cent of the houses from which the people fled were not burnt and it is highly probable that these people would have survived if they had stayed in their houses.

Most of the 1,300 houses, cottages and shacks destroyed by the fire were vacant or had been abandoned by the occupants in the face of the fire. There were numerous instances where one or two householders had stayed behind and managed to save their own home—and often those abandoned by their adjacent neighbour.

There were also several instances of elderly pensioners with dilapidated homes which most fire controllers would rate as a "death trap" classification, who not only survived, but also saved their homes because they followed the basic fire survival rules.

The two people who died while travelling were experienced bushmen, but they were caught on a narrow road in a canvas-topped vehicle which did not give any protection from radiation.

The 15 people killed in categories 1, 2 and 3 would have survived if they had obeyed the basic rules for survival in fires.

However, the classification shown as firefighting is misleading, as few of these people were trained firefighters and they probably had little fire experience.

It must be remembered that these fires were spreading at speeds beyond the experience of most people in Tasmania and considering the number of fires burning at the one time (110 separate origins) it would not be surprising if even experienced people made errors in judgement as to where the fire had come from and the speed at which it was travelling.

Considering the fire behaviour there were many places around Hobart and the seaside towns where people survived (relatively easily) in a fire situation which few other people in the world have ever experienced.
Lara fires, 8th January 1969

Seventeen people were killed when they left their cars after being trapped in a fast-moving grass fire alongside Princes Highway, connecting Melbourne with Geelong, Victoria. Several others in the same situation remained in their cars and survived. The cars were trapped on the major four-lane expressway and there is little doubt that all occupants would have survived if panic and confusion had not taken place.

"Miraculous" escapes

Heat rays, like light rays, travel in straight lines, and are greatly impeded by opaque materials such as clothing, wood, earth, stones and metal. Knowing this, certain "miraculous" escapes are explicable. On one occasion an old man, finding himself surrounded by a raging fire, draped a blanket over himself and stood where he was till the flames had died down. His several comrades who took other measures all perished.

On another occasion, a party with a bulldozer was trapped in a small clearing in a pine forest. The driver of the machine dug a shallow trench and pushed the earth back on top of the others. Then he also slid into the trench and covered himself with loose earth. All survived.

Two people in another fire wound up the windows of their truck and hid under the dashboard. Although the cabin became intensely hot—its glass melted—they left the vehicle only when the upholstery caught fire. By this time the flames outside had abated and they were able to walk through them to safety on the burnt ground.

In all these situations people lived chiefly because, whether intentionally or otherwise, they succeeded in shielding themselves effectively from radiation and avoided further stress by panicking or running wildly. Had there been too many people to crowd into the cabin of the truck the others could have crawled underneath, where they would have been fairly well shielded and where the air would have been relatively cool.

Similarly, if trapped in a house, one should close all windows and doors and stay inside—abandoning the retreat only when it is burning fiercely and conditions inside are becoming unbearable. By this time, with any luck, the surrounding vegetation will be almost consumed and the flames dying down.

When the choice must be made, it is better to choose the oven than the griller!

Dwellingup fire

In dangerous fire weather, it is often impossible to predict sudden wind changes which could immediately change the whole fire situation. Such a wind change caused extensive damage in the town of Dwellingup on 24th January 1961.

At 8 o'clock a cyclone struck the area and gale-force winds changed the fire direction and brought it down on the town in four heads.

Burning debris showered over the town long before the actual fire reached the area, starting numerous spot fires throughout the settlement and igniting buildings at widely separated points.

Two heads of fire engulfed the town and much heroic work was done in saving what remained. Women and children were concentrated in safe positions and fire-fighting gangs were deployed on threatening flanks as well as throughout the town with pack sprays and power pumpers. It is to the credit of all involved that throughout the terrifying experience of the night, there was no panic and not a single human casualty.

Back Cover

FORESTSCAPES

Karri, *Eucalyptus diversicolor*. Although not noted for beautiful flowers, karri, particularly after bark-shed in late summer, forms one of the world's most magnificent and scenically beautiful hardwood forests. (This photograph appears in the Forests Department's latest publication *Selected Flowering Eucalypts of Western Australia* to illustrate the point that forests, too, may be beautiful—although the trees lack spectacular flowers. However, it is noteworthy that karri blossom is a prolific yielder of nectar and so highly valuable to beekeepers.)

The bark is smooth and greyish white when old. However, in late summer this old bark splits and sheds in irregular patches exposing the new, fresh salmon-yellow bark beneath, so giving the stems a mottled appearance. Following severe fires, bark-shed may be greater than normal, resulting in stands of trees having uniform salmon-yellow bark. As the months pass, however, the colour gradually reverts to the original greyish-white.

Seen in the slanting rays of the morning sun, which illuminates the long smooth straight boles against the bright green mass of dew-spangled undergrowth, the karri forest presents a beautiful sight not readily forgotten.

Care has been taken to reserve extensive areas in the virgin state, not only for reasons of conservation and recreation, but also to provide reference points for scientific ecological studies.