GOVERNMENT OF WESTERN AUSTRALIA

FESA
Fire & Emergency Services Authority of Western Australia

Guidelines for Operating Private Equipment at Fires

Third Edition • 2011

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Guidelines for Operating Private Equipment at Fires

This Guideline is based on a Country Fire Authority of Victoria document.
FESA wishes to thank the CFA for allowing reproduction and adaptation.

FESA would also like to acknowledge the assistance and contribution of its members, volunteers and staff in the development of these guidelines.

GOVERNMENT OF WESTERN AUSTRALIA

FESA
Fire & Emergency Services Authority of Western Australia

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Third edition

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Foreword

I have great pleasure in introducing the third edition of "Guidelines for Operating Private Equipment at Fires". FESA recognises that, in many parts of Western Australia, private equipment is an essential part of the community's response to fire. The number one priority in any emergency is the safety of those involved. FESA is committed to working with operators of private equipment and providing advice and guidance on safe practices.

In consultation with its stakeholders, FESA has developed guidelines for those who operate private equipment. These guidelines detail safe, efficient and effective practises. They promote cooperation and coordination between those involved in the control of fire. Private equipment operators can now use this publication as a credible and reliable reference when making decisions about fire suppression.

FESA is looking to owners of private firefighting equipment to operate within these guidelines so that Incident Controllers can safely manage emergencies. You are encouraged to carry and use the booklet as a guide while fighting a fire.

Wayne Gregson APM
FESA Chief Executive Officer

Section 1 BACKGROUND

Section 2 GUIDELINES

Section 3 FIRE AWARENESS

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Section 1

BACKGROUND

1.1 Background

The responsibility for individuals to fight fire on their own land has always been a part of Western Australia's firefighting suppression regime. It was recognised early in the State's development that when a fire breaks out on private land, landholders would need to take responsibility for fire suppression on their land. Section 28 of the *Bush Fires Act 1954* recognised this requirement:

> *"Where a bush fire is burning on any land… the occupier of the land shall forthwith… take all possible measures at his own expense to extinguish the fire."*

It has always been the custom and practice in Western Australia that members of the community attend fires with their own equipment to protect their property and that of others. Volunteer Bush Fire Brigades developed from such beginnings.

The guidelines have been developed to help you understand your responsibilities when fighting fires on or near your land. FESA has developed some basic principles to help you fight fires safely and effectively whether Bush Fire Brigades or FESA are present at the fire or not.

1.2 Purpose of the Guidelines

FESA recognises that, in many parts of Western Australia, private equipment is an essential part of the community's response to fire. A key principle of this community response is that it be done with safety as a number one priority.

Your safety at fires is your responsibility. However, FESA is committed to working with private equipment operators to ensure that safety is at the front of everyone's mind at fires.

The guidelines:

- promote the safe, efficient, effective and cooperative involvement of private equipment to control a fire in the shortest possible time; and
- give private equipment operators information so that they can make informed decisions about their actions.

The guidelines identify the broad expectations of private equipment operators in terms of their capabilities and that of their equipment to ensure that the tasks undertaken are appropriate and safely performed. It also identifies the expectation that private equipment operators will accept responsibility and accountability for their actions at fires.

You are encouraged to speak to your local Bush Fire Brigade about the guidelines. This discussion will help in the development of a cooperative working relationship when you are at a fire.

1.3 Application of the Guidelines

For the purpose of the guidelines, "fire" means fire-related emergencies in the rural environment.

"Private equipment" means equipment or machinery (including tankers) owned or operated by a private individual or body that may be used to help contain, suppress or reduce the effects of a fire. It does not include:

- equipment or machinery used for the private defence of domestic dwellings in a bush fire; or
- equipment or machinery contracted by the fire control agency.

The guidelines will apply to the operation of private equipment at fires on private land, including burn-off activities managed by FESA or Bush Fire Brigades. FESA expects that compliance with the guidelines is a requirement for those operating private equipment at fires.

FESA or Bush Fire Brigade personnel will, where possible, try to work cooperatively with private equipment operators to ensure safer and more effective operations. However, where private equipment operators are impeding operations or working unsafely, FESA or Bush Fire Brigade personnel may require that the equipment and/or operator be deployed to another task or to leave the area.

The guidelines do not apply to individuals defending their homes using fixed or portable firefighting equipment.

1.4 Content of this publication

The content of this publication is presented in four sections:

- Section 1 provides the context and background;
- Section 2 focuses on the guidelines themselves in terms of what is expected of private equipment operators engaged in firefighting;
- Section 3 is aimed at heightening the awareness of the private equipment operator in fire behaviour, suppression activities and fire hazards; and
- Section 4 contains useful checklists.

1.5 Why Guidelines?

The guidelines provide a basis for establishing and maintaining a consistent approach in the use of private equipment at fires across Western Australia. They provide equipment operators with information to improve their knowledge in fire behaviour, fire hazards and suppression activities, as well as providing guidance on fire equipment, communications and protective clothing.

1.6 Monitoring and review of the Guidelines

FESA will monitor the effectiveness of the guidelines. The guidelines will be reviewed within five years of their approval, or sooner if necessary, to consider any relevant field experience, technological change, legislative change, management policy or community expectation.

Private equipment operators and other stakeholders are encouraged to provide feedback at any time.

feedback?

email

operations-feedback@fesa.wa.gov.au

in writing

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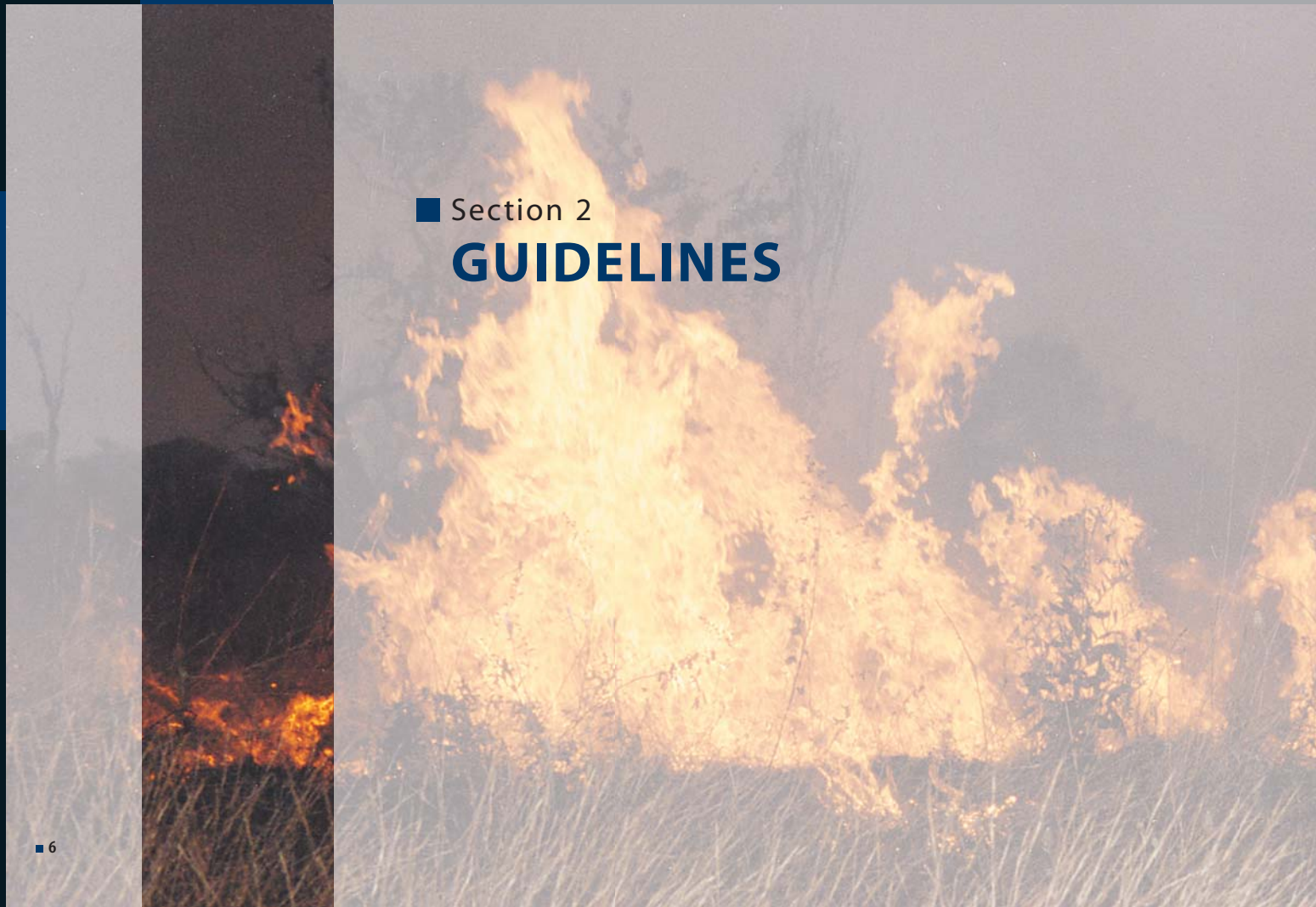


Section 2

GUIDELINES

2.1 Principles

The guidelines are founded on the following principles:

- **Everyone at the fire has responsibility for safety.**
- **Accept responsibility for your decisions and actions.**
- **Ensure someone from FESA or the Bush Fire Brigades at the fire is aware of your presence and what tasks you are undertaking.**
- **Work cooperatively with the emergency services and others.**
- **Do not work alone—team up with others.**
- **Be aware of the situation around you and any hazards likely to cause you harm.**
- **Wear appropriate personal protective clothing.**
- **Know and work within your personal limits and ability.**
- **Ensure your equipment is well maintained and you know and operate it within its limits and capability.**
- **Ensure the tasks you undertake match your capability and that of your equipment.**
- **Maintain communications.**

It is essential for all private equipment operators to fully understand these principles and diligently apply them at the fire.

They are based not only on sound common sense, but also the vast experience of private equipment involvement at fires across the state over many years.

The rest of this section discusses these principles in more detail.

2.2 Safety at fires

Safety at fires is the number one priority of FESA, and must also be yours. Take responsibility for your own safety at fires.

The decision to engage in firefighting should be well considered, and at a time well before the actual outbreak. It is common practice for private equipment operators to be at a fire prior to the local brigade. FESA values this early intervention, fires may even have been brought under control before the arrival of the Bush Fire Brigade, DEC crew or FESA.

Nevertheless, it is essential that prior to deployment, private equipment operators be adequately prepared in terms of themselves and their equipment.

Bush Fire Brigade and FESA volunteers are trained and

qualified in the roles they undertake for Local Governments and FESA. Private equipment operators who have undertaken formal training in bush fire firefighting will already have a good understanding of fire awareness. This publication will assist you in developing your awareness. However, the best way you can become proficient in fighting fires is to be a Local Government or FESA trained firefighter.

Personal preparation includes:

- having the appropriate skills and knowledge;
- being mentally and physically prepared;
- understanding the risks involved;
- being prepared to accept responsibility for your decisions and actions; and
- having suitable personal protective clothing.

Equipment preparation includes:

- ensuring the vehicle is not overloaded;
- ensuring the load and fittings are properly secured;
- ensuring the vehicle and equipment is mechanically sound and reliable; and
- ensuring the vehicle is equipped with recommended safety and communications equipment.

Private equipment operators are encouraged to discuss these matters with their local Bush Fire Brigade and to share information and views as part of their preparation.

Use of the checklists in Section 4 will assist in being adequately prepared.

2.3 Accept responsibility

When you elect to engage in firefighting as a private individual, you accept responsibility for your actions. FESA and Local Government have similar responsibilities to its members. Also, everyone at the fire has a shared responsibility for the safety of others.

The underpinning theme of the guidelines is one of mutual cooperation between the emergency services and private equipment operators.

As you perform your tasks at fires, you will be continually faced with circumstances requiring decisions and actions. In some cases, it may be best to refer a situation to someone from FESA or Bush Fire Brigades at the fire, but in others, you will choose to make the decision and take action.

Such decisions should be well considered and not taken lightly, but above all you are expected to take responsibility for that decision. Remember, you are not exempt or above the law when firefighting. Comply with all legal obligations and **make safety your priority**.

2.4 Making your presence known

If you arrive on scene before the local Bush Fire Brigade, team up with others and work within your capabilities. It may be your good work that saves the day.

When FESA or Bush Fire Brigades are present they have an obligation to their members and other people who are at the fire. It is essential that you make yourself known to them so that you can operate in a coordinated and safe manner. As more resources arrive, the Bush Fire Brigades or FESA may assume your tasks allowing you to drop back to a less intense activity.

Understand that uncoordinated and/or incompatible actions by individuals can be dangerous and are discouraged.

2.5 Working cooperatively

Successful firefighting depends heavily on all personnel working cooperatively. As the fire grows in size and complexity, so too does the number of personnel and equipment. While formal organisational structures are put in place to manage the incident and emergency services' resources, a strong commitment to, and spirit of cooperation between agencies and individuals alike, must prevail.

The emergency services operate under pre-determined procedures and protocols and will establish Incident Action Plans to define the tasks to be performed by their available resources. Therefore, it is essential for private equipment operators to apply their efforts towards compatible objectives.

FESA and Local Government Bush Fire Brigades will, where possible, keep you informed on operational and safety issues so that you can make decisions about your actions at the fire. If they ask you to conduct particular tasks, someone will give you a briefing about the incident situation and the tasks involved. This will ensure you are working safely, effectively and efficiently.

- **If you are unsure on any point, seek clarification by asking questions.**

2.6 Team up with others

The old saying "there's strength in numbers" is true. By working cooperatively and jointly with others, the operation will be safer and more effective. Members of the team can watchout for one another, increasing safety. Communications will also be more effective.

2.7 Look for hazards and assess the risk

Section 3 contains detailed information on the hazards related to bush fires. Not only are these hazards associated with bush fire, but many are also present at other incidents such as structural fires, hazardous materials incidents, motor vehicle crashes and other industrial accidents.

Hazards you may encounter include:

- smoke;
- high levels of radiant heat and heat related issues;
- heat related illness (e.g. dehydration, heat stress and heat stroke);
- danger from falling objects (especially trees and tree limbs), sharp objects, hot surfaces and flames;
- high noise levels for prolonged periods of time;
- mines and mine shafts;
- poor visibility due to smoke and dust;
- live power lines being down;
- operating equipment in steep or rough terrain and/or dense vegetation; and
- close proximity to firefighting vehicles, heavy machinery and emergency vehicle traffic.

Identifying and being aware of the hazards is the first step. Next, it is important to assess the risk that hazard presents to you. Exercise your knowledge, life experience and your common sense to decide, "What is the likelihood of this hazard causing me or others harm?" If the answer is extreme, high or medium, you should seriously consider withdrawing to a safer location and/or circumstance.

2.8 Wear appropriate clothing

Radiant heat can kill. You need to cover up to protect yourself from radiant heat.

The correct level of protective clothing enables the release of increased metabolic heat generated through increased activity.

At the same time, it provides the protection required from radiant heat and from working in hostile and hazardous environments.

The design and fabric of the clothing worn is particularly important because unsuitable or ill fitting clothing can create heat stress, which can range from discomfort to impaired performance, illness, collapse or even death. It can also restrict performance by adding weight and limiting movement.

It is imperative that all personnel, including private equipment operators, be suitably equipped and dressed for fires.

As a minimum, you should wear the following at a fire:

- cotton or natural fibre overalls with long sleeves (bib and brace type overalls are not acceptable) **or** cotton or natural fibre work shirt with long sleeves and trouser ensemble (non fire resistant synthetic materials are not acceptable);
- sturdy leather boots, preferably lace up type;
- leather work gloves;
- industrial type helmet with chin strap;
- industrial type goggles;
- dust masks and hearing protection (ear muffs or ear plugs) may be required for some tasks; and
- a high visibility industrial type vest is also desirable, particularly for heavy machinery operators.

Protective clothing should cover the main part of the body whilst allowing a reasonably good airflow to aid cooling. It should have closures at the wrists and ankles to prevent entry of heat and embers.

Approved Personal Protective Clothing for firefighting may be purchased from suppliers. Your local Bush Fire Brigade or FESA Office will have details of the supplier.

To minimise the build up of body heat it should be loose fitting, sleeves should be rolled down and trouser legs should not be tucked into boots.

If other clothing is worn under the protective apparel, it should also be loose fitting and be of natural fibre. This includes underwear and socks.

Only when in a safe area should you unbutton your clothing or drop your overall tops to provide maximum cooling benefits.

2.9 Know your limits and capabilities

Firefighting can be arduous, both physically and mentally. It requires a good level of fitness to cope with physical exertion in a hostile and ever changing environment. It can exert enormous mental pressures requiring decisions to be made for constantly varying circumstances.

Therefore, you should work well within your limits. Much of this will be dependent on your levels of experience and knowledge. Those who have previously been involved in firefighting will have a better understanding of fire behaviour as well as a greater appreciation of how well they personally can cope with the situation.

To assist in developing your fire awareness, some basic information is included in Section 3 of this publication. Before participating in firefighting you should ensure that you are familiar with this material.

2.10 Your equipment

If you are planning to use your equipment to fight fires you should ensure that the:

- operator's safety and that of others is not compromised;
- equipment is suitable and capable of performing the task;
- equipment is reliable; and
- equipment has the capability and robustness to operate in a hostile environment.

Private equipment operators are not exempt nor above the law when engaged in firefighting operations. Compliance with all legal obligations, including traffic regulations is imperative for safe operations.

Private equipment should meet the following requirements to ensure its suitability for firefighting.

2.10.1 Vehicles equipped for wet firefighting

- Vehicles must not be overloaded (i.e. the vehicle's Gross Vehicle Mass must not be exceeded). **This is a critical safety issue.** An overloaded vehicle will be less stable, harder to steer and has reduced braking capacity.
- The load including tank, pump and fittings are to be properly secured. Unsecured loads are illegal and may cause instability. Objects falling from the vehicle can be lethal.
- The vehicle should be roadworthy and registered if operating on public roads. Participation in firefighting does not exempt private equipment operators from the law.
- The vehicle and pump should be in sound mechanical condition, be regularly serviced and easily started. Equipment maintenance is essential, and should be undertaken pre fire season to ensure reliable service at a fire.
- Consult your local Bush Fire Brigade about what form of communication you should use. It may be that your vehicle should be equipped with a good quality UHF Citizens Band (CB) radio, or that you have access to a mobile phone. These can be an important tool to aid good communications at the fire.
- The vehicle should have a first aid kit and a woollen blanket to use for personal protection at fires.
- The vehicle should be equipped with an amber rotating beacon. At fires you have a responsibility to **"see and be seen"**. Amber rotating beacons as well as the vehicle's illuminated headlights will assist in making your vehicle more visible particularly in smoky environments.
- The vehicle should have hand railings and heat shields, if personnel are to operate from the tray while the vehicle is moving. These features are absolutely essential to

minimise the risk of being thrown from the vehicle and from being effected by the radiant heat from the fire. It is also imperative that the layout of the tray enables the operator to communicate with the driver.

2.10.2 Tractor and utility drawn trailer units

The same criteria as detailed in 2.10.1 above applies to this category. The safety of the tractor driver also needs consideration. Direct attack on a running fire with the unit moving is generally discouraged and should only be undertaken with the tractor driver in a fully enclosed cabin. Tasks performed by trailer units should be well considered due to their reduced maneuverability, mobility and stability. People should not ride on trailer units.

Vehicles towing trailers may pose additional problems should a quick exit from the fireline be required. Always monitor for potential escape routes.

2.10.3 Farm machinery and implements

By and large, this category of equipment will be engaged in dry firefighting tactics (e.g. slashing, ploughing, ripping, harrowing, grading etc. with an implement being drawn by a tractor).

All criteria in 2.10.1 and 2.10.2 will be applicable to varying degrees. It is essential that the task performed by this equipment is acknowledged by someone from FESA or the Bush Fire Brigade at the fire and that the machine is supported by a unit with wet firefighting capability and communications. All terrain vehicles (ATVs, Quad Bikes) fitted with spray units should only be used on very small spot fires or for blacking out due to their limited capacity. They should not be operated in close proximity to other larger firefighting vehicles on running fire edges.

2.10.4 Heavy plant and equipment

This category includes self-propelled machinery such as bulldozers, graders and scrapers. All criteria in 2.10.1, 2.10.2 and 2.10.3 will apply to varying degrees. In circumstances where they are contracted directly at fires, they are subject to rigorous conditions for both the equipment and operator.

Where the heavy plant or equipment is being operated independently by a private individual, it is essential that the task performed by the equipment is acknowledged by someone from FESA or the Bush Fire Brigade at the fire and that the machine is supported by a unit with wet firefighting capability and communications.

If FESA or a Local Government observes equipment, which it considers as inappropriate for the task or unsafe, it may require that it be withdrawn from that area of the fire or deployed to another task.

2.11 Your tasks

The tasks performed by private equipment operators may vary and may include:

- initial attack;
- tactical support—direct attack and parallel attack;
- blacking out operations; and
- patrolling.

The tasks will vary in terms of hazards and risks involved, the degree of physical effort, the reliance on the equipment used, and the mental exertion required. So the actual tasks you perform will very much depend on your capabilities and experience, and the type, condition and capability of your equipment.

For example, it is not appropriate for someone dressed in shorts and tee-shirt, to undertake a direct attack with a hose line at the head of an intense running grass fire.

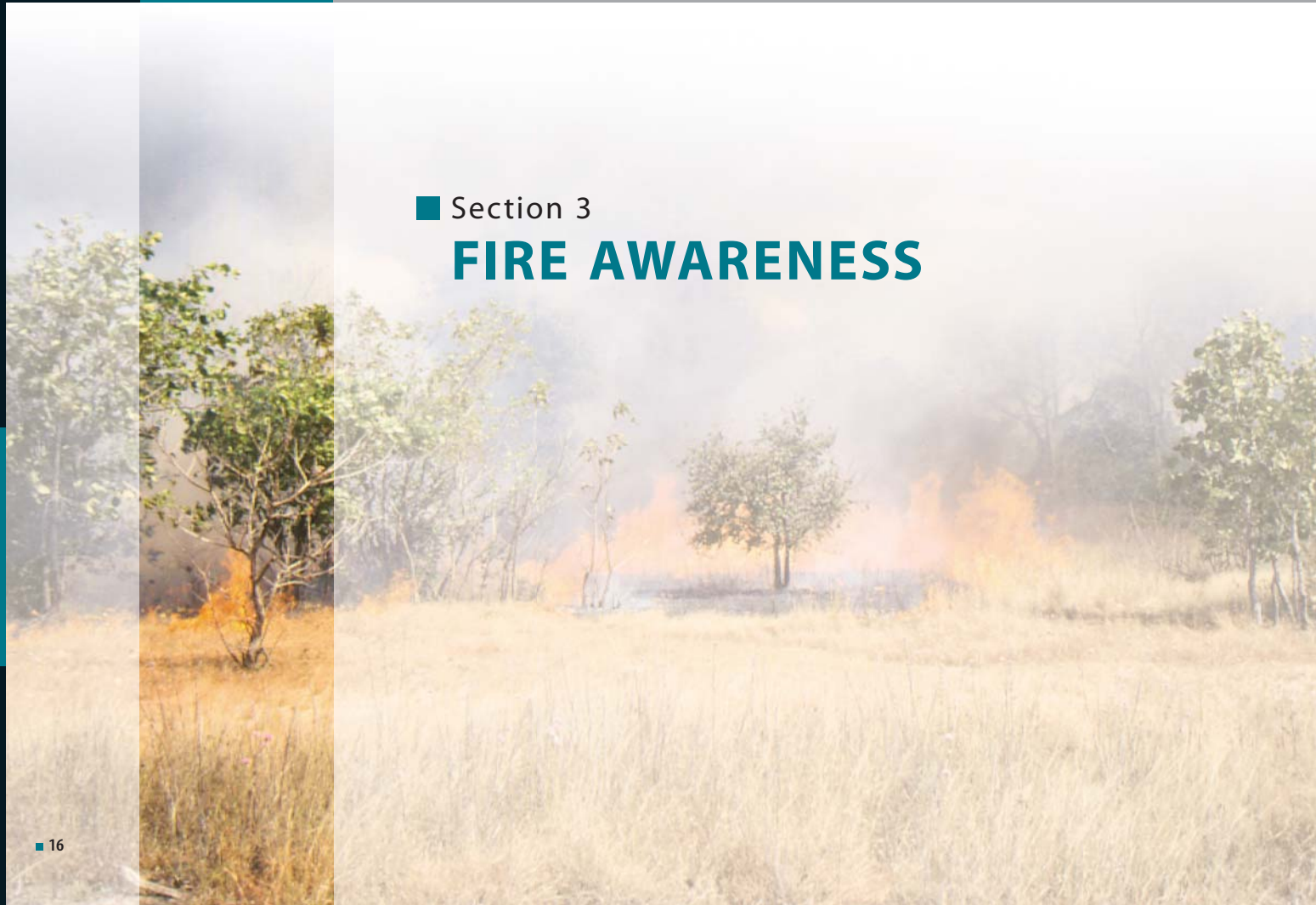
Nor is it appropriate for a person on a quad bike fitted with a spray unit to be fighting the flank of an intense fire amongst heavy tankers. But the quad bike sprayer may be an excellent tool for blacking out fence posts or tussocks in the burnt area.

2.12 Communications

Communications systems are crucial in ensuring that information about new strategies and the associated instructions is rapidly disseminated.

A communications plan will be in place for every incident. Check with your local Bush Fire Brigade to determine the communication arrangements and protocols applying in your area. A combination of VHF radio, CB radio and mobile phones may be used.

Remember, communication at fires is not only confined to radio and mobile phone traffic. Direct contact and interaction between individuals and crews is essential.



Section 3

FIRE AWARENESS

This section has been included with the guidelines to help you better understand the nature and behaviour of bush fire, together with suppression activities and bush fire hazards.

You may also wish to consider the benefits of joining your local Bush Fire Brigade to increase your firefighting skills and knowledge even further. Not only will you raise your skill levels and knowledge, you will also be providing a valuable service to your community. To find out more about being a volunteer, contact your local government.

3.1 Types of bush fire

Each type of fire creates its own particular hazards, which will require constant monitoring to ensure safe work practices are observed and carried out at all times.

Bush fires can generally be described in terms of the fuel in which they are burning—grass, scrub, forest or plantation.

The following pages explain some of the characteristics of different types of fire, and defines important parts of a bush fire's perimeter.

Ground fire

This type of fire burns the organic material within the soil layer, as happens in a peat fire, and often also burns surface litter and small vegetation.

Characteristics

- May smoulder with no flame and little smoke.
- These fires can burn unnoticed and may later ignite surface fires. You need to take care to avoid stepping into undetected hot spots in the ground.
- They may also burn through the soil underneath firelines and cause new outbreaks.

Surface fire

This type of fire travels just above ground surface in vegetation such as grass, low scrub and forest litter.

It presents a significant hazard to firefighters because conditions can change rapidly due to strengthening winds or wind changes, rapidly increasing fire intensity and rate of spread.

Characteristics

- By far the most common type of fire.
- Burns in fuels lying on the ground.
- Consumes litter and low vegetation, such as grass and scrub.
- Does not extend into the crowns of trees.

Crown fire

This is a fire which burns in the crowns (tops) of trees ahead of, and above, an intense surface fire in the undergrowth and presents a significant hazard to firefighters.

Radiant heat and direct flame contact resulting from the surface fire will ignite tree tops. Strong winds carry the fire along the upper storey vegetation.

Characteristics

- It is a fast-travelling fire that is extremely destructive and often consumes all in its path.
- An intense surface fire follows crown fires shortly afterwards.
- Short or long distance spotting often accompanies crown fires. For example, spotting up to 25 kms have been recorded.
- Falling material from a crown fire can start additional surface fires in front of the main fire. Crown fires are exposed to higher wind speeds in the upper air and because of this can move faster than surface fires.

Parts of a bush fire

The shape of a bush fire is defined by its perimeter, which is the outside edge of the burnt area. Within this there may be burning areas, smouldering areas and blackened areas, as well as pockets of unburnt fuel. There will also be a point of origin that may or may not be identifiable without detailed investigation.

As illustrated in Figure 1, parts of a bush fire include:

- the head;
- the flanks or sides;
- fingers;

- the rear or heel (sometimes referred to as the back);
- spot fires ahead of the main fire;
- unburnt pocket or island; and
- point of origin.

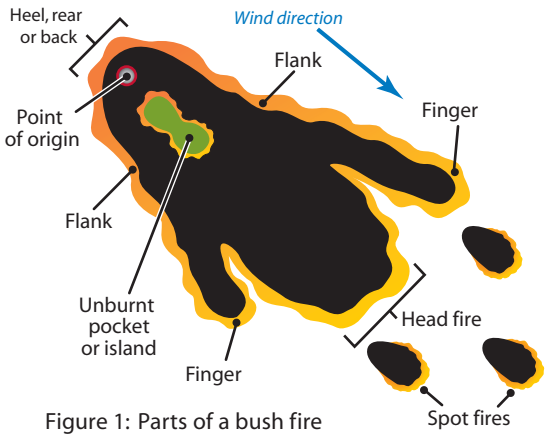


Figure 1: Parts of a bush fire

The head of the fire

The head of a fire is where the fire is making its greatest progress (usually downwind or upslope) measured by its forward rate of spread. The head is also called the fire front. Flames are tallest and intensity of the fire is greatest at this point. The head of the fire is influenced by wind direction, fuel factors and topography, and will change accordingly.

Flanks or sides of a fire

Both sides of the fire between the head and the rear are called the flanks. They are roughly parallel to the main direction of spread. The intensity of the fire at the flanks is less than at the head. Often they are described by their geographic location (for example, the eastern or western flank of a fire) or by their orientation as viewed from the point of origin or rear of the fire (for example, the left or right flank of a fire).

Fingers

These are long and narrow slivers of the advancing fire, which may extend beyond the head or flanks, and are caused by varying wind direction or variations in fuel or topography. They are sometimes called 'tongues'.

Tail, rear or heel

This is the section of the perimeter opposite to, and usually upwind or down slope from, the head of a fire. It is the least intense part of the fire's perimeter, with the lowest flames and slowest rate of spread. It may be described as the back of the fire.

Point of origin

This is the area where the fire started. The likely point of origin should, if possible, be left undisturbed for fire investigation.

3.2 Factors that affect bush fire behaviour

There are three main factors that influence fire behaviour. Fire behaviour and fire spread can alter dramatically depending on changes in:

- fuel;
- weather; and
- topography.

An understanding of how these factors influence fire behaviour is crucial in predicting fire spread and therefore, planning and conducting fire suppression activities.

Fuel

Fuel is one of the most important factors that will influence the way fire behaves and travels.

Variations in fuel will also influence the risk to firefighter safety and firefighting suppression activities. Fuel varies in its:

- type;
- size;
- quantity;
- arrangement; and
- moisture content.

Type

Common types of fuel involved in a bush fire include:

- grass;
- forest litter lying on the ground;
- small shrubs and scrub;
- trees and bark;
- decomposing humus and duff (fine ground litter);
- slash (material remaining after logging); and
- plantation prunings.

Given the right conditions, most of these fuels will readily ignite and burn at differing speeds and degrees of intensity.

For example, a grass fire is likely to spread more rapidly than a fire in a tall, dense forest—but the forest fire would generally burn more intensely than the grass fire due to greater quantities of fuel.

Size

Fuel is normally classified as fine or coarse (heavy) in relation to size.

Fine fuels, less than 6 mm in diameter (i.e. thinner than a pencil) such as leaves, twigs, grasses and some tree barks, burn readily and cause spotting as the burning embers are carried through the air.

Eucalypt fuels, in particular stiff ribbon type bark, are well known for causing long distance spotting, whereas stringy bark causes much of the short distance spotting.

Coarse or heavy fuels, greater than 6 mm in diameter (i.e. thicker than a pencil) such as sticks, branches and logs tend to ignite less readily, burn more slowly and burn for much longer periods.

Quantity

The more fuel there is—the greater the fire intensity.

Arrangement

The size of the fuel particles and the way pieces of fuel are arranged in relation to one another will affect how they burn.

Fuels that are tightly packed together or compacted, such as peat, heavy leaf litter or hay bales, smoulder slowly because of the lack of oxygen. Grass hay, closely grouped and standing, will burn quickly and fiercely.

Well-separated pieces of fuel, such as sparse forest, are harder to ignite than more closely grouped collections of the same material. This is because radiant heat diminishes the further it travels and does not allow the pre-heating of fuel.

A continuous ladder of fine fuel from the ground surface to the crown of the vegetation encourages the development of crown fires.

Moisture content

Fire behaviour is affected by how damp fuels are i.e. their moisture content (or dryness). The moisture content will vary depending on factors such as weather conditions, vegetation type, the moisture content of the soil and whether the fuel is dead or living vegetation.

All dead fuels take up or give off moisture according to the:

- daily temperature and relative humidity cycles—fine dead fuels change their moisture content rapidly in response to these cycles, while heavy dead fuels change slowly and rarely reach extremes of wetness or dryness;
- time since last rainfall and the amount of rain received—over several days, the effects of recent rainfall will disappear, this happens more rapidly in fine fuels than in heavy fuels; and
- dryness of the soil—dry soil will dry out fuels in contact with it, and wet soils will moisten such fuels.

The moisture content of fuels affects:

- ease of ignition;
- probability of spotting;
- rate of combustion;
- rate of fire spread; and
- amount of heat radiated from the flames.

Measuring fuel moisture content

Weather conditions, temperature, relative humidity and the current seasonal dryness must all be considered when determining fuel moisture content.

Several techniques can be used to measure moisture content, including visual assessments of grass and crops, and the use of specialised fuel moisture meters.

The "crackle" sound as you walk through fine fuels is a good indication of the fuel moisture content; the sharper the crackle, the drier the fuel.

Weather

Weather is a major factor that impacts on the spread of fire. The four key elements of weather are:

- air temperature;
- relative humidity;
- wind (speed and direction); and
- atmospheric stability.

Air temperature

The sun warms solid objects such as fuels and the surface of the land. This has the effect of raising the temperature of the fuels and the surrounding air. An increase in temperature, and the resulting decrease in relative humidity, will reduce the fuel moisture content and therefore, increase the ease of ignition.

Relative humidity

There is always a certain amount of water vapour in the air. Relative humidity (RH) is a measure of the water vapour content of the air, expressed as a percentage of its maximum water vapour holding capacity at the same temperature.

A high RH figure indicates a high level of water vapour in the air, a low RH indicates a low level of water vapour in the air.

On humid days (days of high RH), fine dead fuels will absorb moisture from the air (adsorption) and will therefore, burn more slowly or may not burn at all.

On days of low humidity (low RH), the dry air will actually draw moisture out of fuels (desorption), they will become drier and therefore, ignite more easily, burn faster and more fiercely.

In a bush fire situation, fire intensity increases as the temperature rises and relative humidity falls during the day, and reduces as humidity increases and temperature drops at night.

Wind

Wind is the most critical aspect affecting the shape, forward rate of spread and fire behaviour.

Changes in wind direction and increased strength present serious hazards to firefighters.

A wind change can rapidly cause relatively quiet flanks to become active fire fronts—always keep unburnt fuel between you and the fire to a minimum.

Wind speed

Wind speed, or strength, is a major cause of rapid changes in fire behaviour. It will affect the intensity of a fire, the speed at which it travels and its shape. As illustrated in Figure 2, the stronger the wind, the longer and narrower the fire will be.

Wind supplies oxygen for the burning process; removes ash, smoke and moisture from fuels in the area; and slants the flames, hot air and gases over the unburnt fuel ahead of the fire, therefore, pre-heating the fuels and allowing the fire to spread faster. The wind may also lift burning materials, such as bark and other embers, and carry them ahead of the main fire starting spot fires. The stronger the wind, measured at 10 m above ground level in the open for forecasts, the faster a fire will spread.

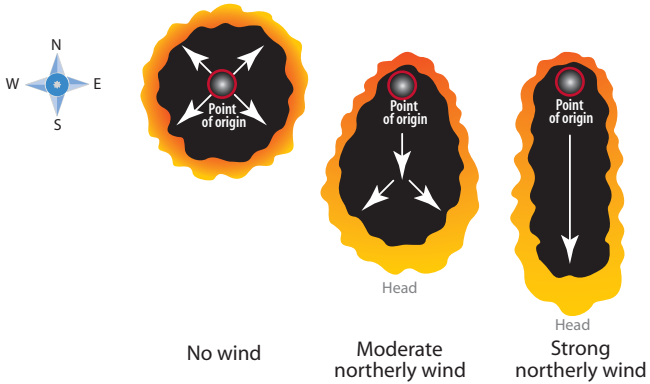


Figure 2: Effects of wind strength on fire shape

Wind direction

It is critical that firefighters receive information regarding any potential changes in wind direction. This information is not only required for planning the attack on a fire, but also to ensure the safety of firefighters in the event of the fire changing direction.

Changes in wind direction can cause shifts in the fire front. These shifts are dangerous if they occur suddenly and unexpectedly, and can cause long and relatively quiet fire flanks to suddenly become active fire fronts.

Wind direction refers to the direction the wind is coming from (i.e. a “north wind” means a wind originating from the north and travelling in a southerly direction).

for example

At 1000 hrs (10.00 am) a fire is being blown by a fairly strong northerly wind **(a)**.

The fire has an elongated shape with a narrow head. The fire intensity being higher at the head of the fire, the flanks being much cooler as the fire spreads slowly outwards west and east.

By 1330 hrs (1.30 pm) the fire has advanced to point **(b)**, when a south westerly wind change occurs.

The wind change causes the cooler eastern flank to suddenly become the new head of the fire **(c)**. The fire which was burning on a narrow head, is now burning on a wide front. The new head fire will move away at its maximum intensity and rate of spread.

This change in direction will substantially increase the difficulty of fire suppression activities, but more importantly, presents an immediate threat to any firefighters working on what was the eastern flank.

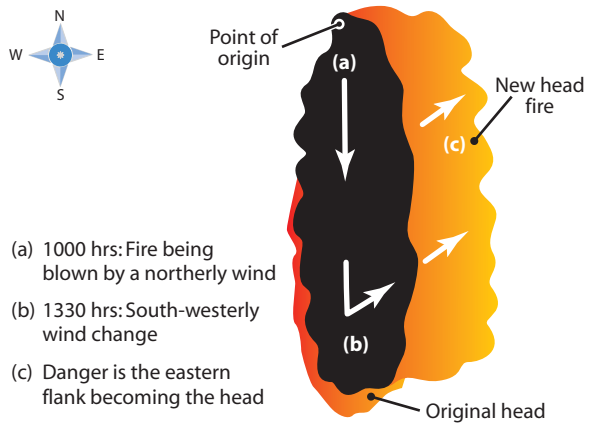


Figure 3: Result of change in wind direction

Always be watchful of wind changes and if unpredicted changes occur in your area, warn the people around you and inform a member of the Bush Fire Brigade or FESA.

Atmospheric stability

Atmospheric stability refers to the vertical (upward) movement of air masses that occur when hot air rises and is replaced by cooler air.

This results in an inversion layer forming i.e. a reversal of the normal variation of air temperature with altitude (normally the higher you go the colder it is).

Vertical air movement can affect local wind patterns and can also determine cloud development and therefore, the possibility of thunderstorm development.

In stable atmospheric conditions, fire behaviour will generally be predictable.

Visual indicators of stable conditions are:

- presence of stratus type clouds (clouds in layers);
- smoke columns drift apart after limited rise;
- vertical movement of air is limited;
- fog layers may be present; and
- winds are generally light and predictable.

In unstable atmospheric conditions, fire behaviour can be unpredictable.

Visual indicators of unstable conditions are:

- presence of cumulus (cotton wool) type clouds showing noticeable vertical growth;
- smoke columns can rise to great heights;
- winds are gusty and unpredictable;
- potential for thunderstorms and therefore, lightning strikes; and
- dust whirls ("willy willies") may occur.

Topography

The third major factor that impacts on the spread of fire is topography. Topography is the surface features of a particular area or region such as mountains, rivers, populated areas, roads, railways and vegetation. The topography of an area will affect the direction and speed at which a fire will travel. The effects can be quite complex as the topography will also effect the local wind speed and direction.

The three main concerns that arise in relation to topography are:

- slope;
- aspect; and
- the interaction between terrain and wind.

Slope

Slope will affect the speed, or rate of spread, of a fire. If a fire is travelling upslope as opposed to on level ground, there will be a shorter distance for radiant heat to travel from the

flames to unburnt fuel. Therefore, fuels upslope of a fire will be preheated to their ignition temperature quicker than they would be on level ground. The opposite is true for a fire travelling downslope.

The following rules of thumb will help you calculate the affect slope will have on the speed of a fire.

- **For every 10° of upslope, double the rate of spread.**

for example

A fire is travelling at 2.5km per hour on level ground towards a 20° upslope; it reaches the foot of the hill and continues to burn in the same direction; as it moves up the slope, the rate of spread will increase to 10 km per hour (approximately).

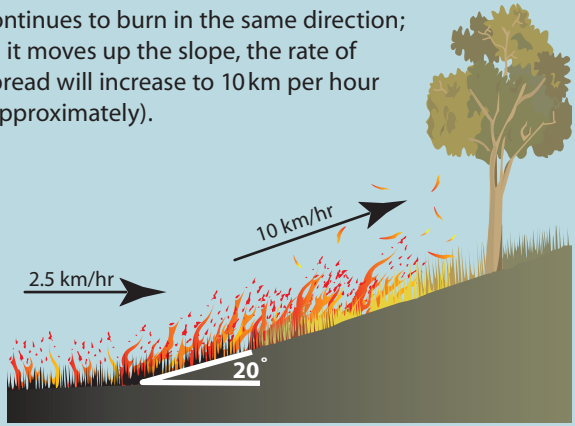


Figure 4: The effect of upslope

- **For every 10° of downslope, halve the rate of spread.**

for example

A fire is travelling at 10 km per hour on level ground towards a 20° downslope; it reaches the edge of the level ground and continues to burn in the same direction down hill; as it moves down the slope, the rate of spread will decrease to 2.5 km per hour (approximately).

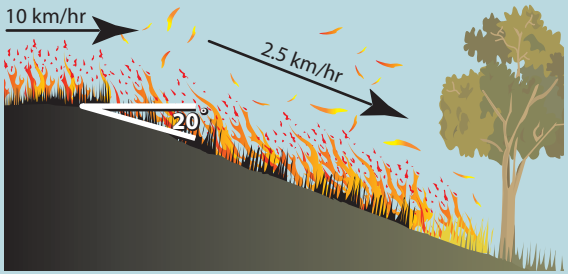


Figure 5: The effect of downslope

Aspect

Aspect is the direction that a feature or slope faces. This influences the amount of solar radiation that it receives and, as a result, northerly and westerly aspects (which receive more sun) will be warmer and drier than southerly and easterly aspects.

This in turn influences the nature of the vegetation growing on different aspects (e.g. northern and western aspects generally have drier and more flammable vegetation than southern and eastern aspects, where vegetation tends to be lush and less flammable).

As a result, fires on northern and western aspects will generally burn more fiercely than fires on southern and eastern aspects.

Terrain and wind

The way the wind interacts with terrain can be quite complex. Exposed faces of hills and ridges may have increased wind speeds, while their leeside, less exposed or sheltered areas may be almost calm.

Under some circumstances, the leeside may have dangerous turbulent winds blowing in the reverse direction of the prevailing wind. Spot fires can be drawn back upslope against the prevailing wind.

In mountainous country, winds tend to flow up or down valleys, irrespective of the general wind direction outside these areas. In fact, any change in terrain may have an affect on the wind.

Coastal sea breezes are often experienced in the late afternoon in coastal areas and may effect fire behaviour, depending on local terrain.

Under clear skies, local winds can actually be generated by the terrain—upslope during the day and downslope during the night.

Winds generated by any of these conditions will create complex fire behaviour that has the potential to threaten firefighter safety.

3.3 General health hazards

It is vitally important that you are aware of, and know how to avoid, illnesses and problems that may result from vigorous firefighting activity and exposure to smoke, dust and heat.

If you have a medical condition (e.g. asthma, diabetes, heart disease or epilepsy) that may be aggravated by the type of work undertaken on the fireground, you should seek medical advice to ensure you are able to carry out such work.

The following pages will cover:

- **sunburn;**
- **smoke and dust hazards;**
- **fatigue;**
- **dehydration; and**
- **heat related illness:**
  - **heat cramps;**
  - **heat stress;**
  - **heat exhaustion; and**
  - **heat stroke.**

Sunburn

Prolonged exposure to the sun can lead to sunburn. Although not life threatening, sunburn can impact on your effectiveness (e.g. you may not be able to wear a knapsack if you have badly sunburnt shoulders).

Be aware that you can easily be sunburnt even when the sky is overcast. When working outdoors during the day you should make sure that you apply a water-resistant sunscreen with a sun protection factor (SPF) of at least 30+ to all areas of exposed skin.

You should apply sunscreen liberally to any exposed skin every two hours. As you are likely to be perspiring freely while working on the fireground, you should try, where possible, to apply it more often. Make sure that your face, neck, ears, arms and the backs of your hands are covered.

If wearing complete protective clothing, sunburn should not be a problem. You are more likely to be sunburnt when mopping up or during a break when you have removed your helmet, gloves and outer clothing.

Signs and symptoms

- Redness of the skin;
- tenderness in the affected area; and
- blistering, sometimes involving more than one layer of skin.

Treatment actions

- Apply cool, moist compresses to the burnt area;
- rest in a cool place; and
- drink cool water and an electrolyte replacement drink.

Smoke and dust hazards

Smoke and dust are ever-present irritants to your eyes and lungs at fires. Prolonged exposure to heavy smoke can be hazardous to firefighters.

In addition to restricting visibility, heavy smoke contains carbon monoxide (CO) which is a poisonous gas.

Inhalation of smoke and dust can:

- reduce your performance on the fireground;
- bring on fatigue more quickly;
- bring on illness, alter perception and judgement; and
- severe inhalation may result in death due to carbon monoxide poisoning.

Minimise the effects of smoke by:

- avoiding unnecessary exposure; and
- using approved PPE (e.g. P2 particulate filters, smoke masks and goggles) where provided—if necessary, use handkerchiefs or other cloth to cover your mouth and nose.

In situations where there is heavy smoke, be aware that fresh air pockets may be found near the ground.

Fatigue

The conditions and work you undertake at an incident can be physically stressful and demanding. Fatigue is a key factor affecting your performance at an incident.

Exposure to radiant heat and smoke for a lengthy period of time may increase your level of physical stress and the likelihood of fatigue.

If you are suffering any form of illness on the fireline you should seek medical attention or advice as soon as possible.

Even the fittest person will tire easily without enough rest, sleep and appropriate and sufficient food and fluids (e.g. water alternated with sports drinks).

If you are tired, you are more likely to make mistakes, which can cause accidents, injury and put others at risk. It is important to take full advantage of rest breaks.

You should not drive vehicles or operate equipment if you are fatigued.

Signs and symptoms

- Tiredness and lack of energy;
- slowness to react and taking longer than usual to complete tasks;
- impaired judgement and inability to make decisions;

- inability to concentrate and lapses in attention; and
- erratic performance.

Treatment actions

To minimise the possibility of becoming fatigued at an incident, you should:

- take regular breaks to rest and allow your body to recover;
- pace yourself;
- drink water regularly; and
- where possible, avoid working in excessive dust, smoke and heat.

During your breaks, you must:

- rest out of the sun;
- cool off (unbutton clothing and remove helmet when away from the fireline if safe to do so);
- drink water, alternated with an electrolyte replacement drink;
- regularly eat snacks;
- avoid strenuous physical recreation; and
- get ample sleep.

It's possible to force tired muscles to keep on working, but your brain cannot function adequately without sleep.

Maintain a high level of fitness. If you are physically fit, you are less likely to experience fatigue in the short term. This, however, does not mean that you can avoid taking adequate breaks and rest. It simply means that you cope better with the physical stress, and recover more quickly than a less fit person.

Dehydration

The body's cooling system involves perspiring. Dehydration will occur if fluids and electrolytes lost through perspiration are not replaced. The importance of this when working on the fireground is clear. On days of total fire ban and extreme fire danger, you should increase your hydration in case you get called out.

Water and an electrolyte replacement drink should be consumed regularly. You should always drink more than you need in order to prevent dehydration. Failure to do this leads to the body overheating and the onset of heat illness.

Your thirst is not a true indication of how much water your body needs. There is a time lag between the onset of dehydration and feeling the need for water. You may, in fact, begin to suffer the effects of dehydration before you realise it.

You know when you are perspiring—use this as an indication that your body needs appropriate fluids.

On the fireground you need to replace fluids frequently. Drink at least 150–200 ml of water every 10–15 minutes. Water should be alternated with an electrolyte replacement drink (if in doubt drink a litre per hour). If using hand tools you may need to increase this to two litres per hour.

Fluid and electrolyte replenishment is vital for your health and safety—especially so for less fit people.

In the past, emphasis has been placed on drinking beverages such as cordial, tea or coffee and soft drinks as more desirable options to water when working on the fireground. Medical research now indicates that this is not the best option as the sugar content reduces the rate at which water is absorbed into the bloodstream and caffeine can increase the rate of body fluid loss (i.e. increased urination).

Therefore, during firefighting, plain water alternated with an electrolyte drink is best. Cool water is naturally preferable, if it is available. However, never chill your drinks as this can quickly quench your thirst without providing you with adequate fluid, cause stomach cramps and fool your body into thinking its cooler than it actually is.

However, during rest periods, it is a good idea to drink water and sweetened beverages such as weak cordial or tea as they can assist in restoring energy.

Milky or fat-containing drinks should be avoided. Alcoholic drinks must not be consumed as they increase dehydration and impair your ability to safely carry out tasks.

Water suitable for drinking may not be available in the area in which you are operating. You should carry containers of fresh water, particularly when assisting out of your area.

Never drink water from vehicle tanks or knapsacks as it may be contaminated.

Heat-related illness

In addition to the health hazards we have just discussed, firefighters also face the risk of heat-related illness such as (in order of severity from lowest to highest):

- heat cramps:
- heat stress;
- heat exhaustion; and
- heat stroke.

The risk for firefighters is increased due to the nature of the work and the conditions it is performed under i.e. hot, humid and dusty conditions, often within the range of radiant heat and while wearing personal protective clothing and equipment.

Illnesses caused by exposure to extreme temperatures are progressive and can quickly become life threatening if not treated immediately.

The human body is built to withstand changes in temperature and has an inbuilt "thermostat" that controls the body's natural heating and cooling systems.

The body cools itself by directing additional blood flow to the skin, which is cooled through the evaporation of perspiration.

Under normal circumstances, its mechanisms for regulating body temperature works well. However, when the capacity of this automatic cooling system is overwhelmed, your body starts to overheat and you become susceptible to heat-related illnesses.

The body's natural cooling system may fail if:

- the environment is too hot;
- perspiration cannot evaporate freely;
- you are ill or unfit;
- your body's thermostat malfunctions due to disease, drugs or alcohol;
- you fail to maintain adequate fluid intake; and
- you over exert yourself, particularly in conditions of high humidity.

To minimise the risk, you should:

- take regular rest breaks, preferably in the shade away from the work environment or heat source;
- loosen clothing to allow more air circulation and better evaporation of perspiration; and
- maintain adequate and appropriate fluid intake.

Due to their nature, a person may not know they are becoming affected by a heat-related illness—you need to look out for each other. You need to be able to recognise the symptoms and know the treatments not only for your own wellbeing, but also for your colleagues on the fireground.

If the heat-related illness is not too severe and is recognised and treated early, it may be possible to continue working at a reduced rate—if the symptoms are not recognised or are ignored, the severity will escalate and may end in death.

Heat cramps

These are common muscular cramps that may occur in the heat, during or after exercise, especially when an unfit person has worked hard and perspired a lot.

The onset of heat cramps is caused by failure to maintain adequate intake of fluid and appropriate rest and cool down periods.

Signs and symptoms

- Muscular pain and spasms in the affected area;
- feeling of tightness in the affected muscles; and
- inability to relax contracted muscles.

Treatment actions

- Take a rest break;
- slowly drink an electrolyte replacement drink or, if unavailable, plain water;
- consume some food from your ration pack;
- gently stretch the muscles; and
- massage the affected area or muscles gently.

Although stretching and gentle massage of affected muscles may assist in relieving muscle cramps, this is secondary to fluid replacement and cooling down.

Heat stress

You are suffering heat stress when your body's cooling systems (perspiration and circulation) are being stressed but are not yet overwhelmed by the heat load. As discussed earlier, the body cools itself by perspiring and directing additional blood flow to the skin so that this blood can be cooled as the perspiration evaporates.

As exercise produces heat internally, it is possible to become heat stressed even in relatively cool conditions if clothing and equipment impair heat loss. A hot and humid atmosphere will make the situation worse.

Radiant heat and extremes of air temperatures above normal body temperature (37°C) can add an external heat load to the heat generated internally, further contributing to heat stress.

As heat stress continues to affect the body, internal body temperature will rise and physical performance will drop.

If the heat stress is too great or if the body's cooling system becomes impaired by dehydration or exhaustion, continuing heat stress can lead to either heat exhaustion or heat stroke.

Signs and symptoms

- Feeling very hot;
- flushed, red skin; and
- vigorous perspiration, loss of energy and possibly a headache.

In very hot conditions, especially if windy, perspiration may evaporate so fast that the skin seems dry even though significant perspiration and fluid loss is occurring.

Treatment actions

- Take a rest break;
- loosen clothing to allow more air circulation and better evaporation of perspiration;
- seek medical attention; and
- take regular sips of water and occasional sips of a diluted electrolyte replacement drink.

If you believe a colleague is becoming affected by heat stress, assist them to do the above.

If heat stress is not too severe and is recognised early, it may be possible to continue working at a reduced rate, with regular rest breaks to cool off. If the symptoms are not recognised or are ignored, serious heat illness may develop.

Heat exhaustion

As its name implies, this condition develops as a result of becoming exhausted from working in the heat. If the body is heat stressed for too long without adequate fluid intake, dehydration develops. This upsets the body's chemistry, leading to weakness as well as reducing its capacity to continue perspiring.

Even if fluid intake is adequate, exhaustion will eventually set in if physical exercise continues beyond a person's normal endurance limits. Heat exhaustion is a combination of physical exhaustion, dehydration and upset body chemistry. If severe, it can lead to collapse and a form of shock.

Firefighters suffering from heat exhaustion are sometimes unaware of their condition and keep trying to work, even to the point of collapse. It is important that firefighters keep an eye on each other. If anyone is slowing down, not looking well or speaking or acting oddly, you should presume that person has heat exhaustion and take appropriate action as described below.

Signs and symptoms

- Feeling faint, light-headed and dizzy;
- pale face—a result of lowered blood pressure;
- clammy skin—an indication that there is some perspiration;
- loss of appetite;
- headaches;
- irritability and vagueness; and
- muscular cramps and spasms.

If more severe:

- vomiting;
- confusion, drowsiness and weak pulse;
- shallow breathing and unconsciousness; and
- in severe cases, death can result.

Treatment actions

As stated previously, it is likely that a person suffering from heat exhaustion may not realise it. You need to look out for each other and if you suspect a colleague is being affected by heat exhaustion:

- move the casualty away from the work environment or heat source;
- lay the casualty in the best available shade
- if the casualty is conscious, give frequent drinks of water;

- seek medical attention;
- do not give salt tablets;
- remove or loosen clothing; and
- sponge or spray water on the casualty only if they are hot.

If a casualty is unconscious, position the person on his or her side, ensure the airway is open, clear the airway and attend to breathing and circulation. Seek medical assistance as quickly as possible.

It can take many hours to recover from even mild heat exhaustion. It is best for the casualty to have had at least one night's sleep before working again, even if initial recovery is fairly rapid. More severe heat exhaustion will require medical treatment with intravenous fluids and admission to hospital.

If a casualty continues to work on after heat exhaustion develops, one of two things are likely to follow. Either the heat exhaustion will become sufficiently severe for the casualty to collapse or the body will seriously overheat, leading to heat stroke.

Heat stroke

Heat stroke is the least common and most severe heat-related illness. It occurs when the body's cooling systems are overwhelmed and the body's temperature rises to dangerous levels at which time the body starts to "cook" internally. In cases of severe heat stroke, this is irreversible and death will rapidly follow.

This process can occur quite rapidly—it is essential that the casualty be externally cooled as quickly as possible and urgent medical attention is received if life is to be saved.

Signs and symptoms

- High body temperature (often 40°C or more);
- red, hot and possibly dry skin;
- weakness or collapse;
- reduced conscious state or unconsciousness;
- rapid pulse and breathing rates; and
- seizures (fits).

Seizures may occur in cases of severe heat stroke as the brain becomes severely affected by raised temperature. The vigorous muscle contractions involved in seizures rapidly raise body temperature even further. If seizures occur, the person will die unless immediate cooling is achieved.

Treatment actions

This is a medical emergency—immediate, effective cooling is essential.

- Remove the casualty from the work environment and heat source;
- remove clothing down to underwear;
- sponge or spray the casualty with water;
- fan or expose the casualty to a breeze; and
- call an ambulance and get on-site medical assistance while waiting for the ambulance.

If the casualty is unconscious, position the casualty on his or her side and ensure the airway remains open.

It cannot be overstressed, if heat stroke is suspected, urgent medical attention is essential.

3.4 Bush fire suppression activities

Teamwork

Successful firefighting relies on individuals working together as part of a team.

As a member of a team, you must stay in contact with your colleagues at all times, either by sight or radio.

You must make sure that:

- you understand your task and how it fits in with the work of other firefighters around you;
- the person in charge of you knows where you are and what you are doing;
- you know where other firefighters are and what they are doing;
- you stay in regular contact with others; and
- you know the escape plans and, in the event that you have to leave the area quickly, you can be contacted.

Never let anyone work alone. Don't allow people around you to "get out of sight"—look after your mates and work together.

Frequent communication is important. Make regular reports so that you give and receive important information about the fire and your safety—keep an eye on the people around you.

Anchor points

While working in bush fire situations it is important to work from an anchor point.

An anchor point is an advantageous location from which a fireline can be constructed. It is used to minimise the possibility of being outflanked by a fire while the line is being constructed.

Possible anchor points include:

- site of a recent bush fire (i.e. little or no vegetation);
- bare ground;
- blacked out fire edge; and
- a non-flammable area such as a lake or river.

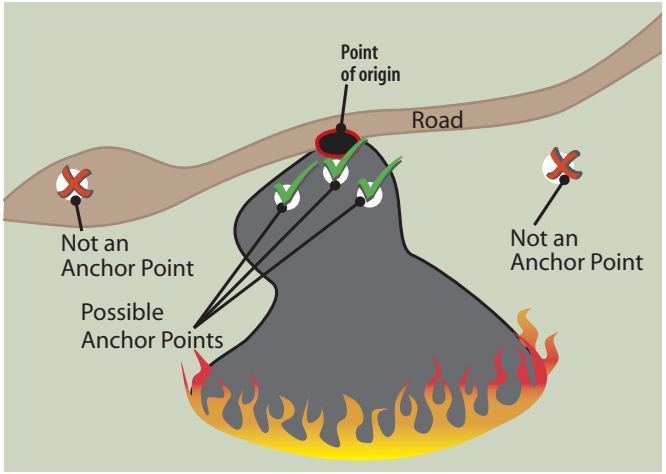


Figure 6: Anchor points

Dangerous positions

Dangerous positions that require caution include:

Fire downhill	Building a control line from upslope of a fire towards the fire.
On a slope	Where rolling burning material can ignite fuels below you.
Wind changes	The wind changes speed or direction.
Hot weather	The weather gets hotter or drier.
Unburnt fuels	There are unburnt fuels in between you and the fire.
Poor access	The terrain or vegetation impedes travel or visibility.
At night	In country you have not seen in daylight.
Unfamiliar	You are not familiar with the weather or local fire behaviour.
Spot fires	Spot fires occur over your control line.
Main fire	You cannot see the main fire or communicate with anyone who can.
Unclear	Your instructions are not clear.
Exhausted	You feel exhausted.
No anchor point	Attacking a fire or constructing a fire control line without a safe anchor point.
Alone	Working alone with no communications link to crew members or supervisor.
Uninformed	You are not fully informed about strategy, tactics and hazards.
No escape routes	Safety zones and escape routes have not been identified.
Fire potential	The potential of the fire has not been assessed.
Low water	Water levels are getting low.

LACES

The features of LACES are critical to safe operations on the fireground. Each point of the LACES must be not only known but clearly understood and applied at all times.

Teach yourself to observe. Observe fire and the environment around you. Understand how fire may behave, and what the hazards and threats are. Think about how you will react to life-threatening situations. Be 'Aware' if there is a change in any factor—e.g. weather, topography, vegetation/fuel type or personnel!

LACES is a safety check before fighting or lighting a fire, which must be continuously re-evaluated as conditions change.

L—Lookouts

Establish lookouts (preferably a designated firefighter) and task all crew members to be alert. All firefighters must evaluate and re-evaluate their situation and have the ability to initiate communications should their environment change threatening their safety.

A—Awareness

Remain aware of the fire situation including current and potential weather, terrain and aspect, fuel types and fuel loads, hazards and crew locations. All personnel have a responsibility to be alert and act decisively before situations become critical. (i.e. have an ongoing 'situational awareness').

C—Communications

Stay in communication with your people, communicate changes in situation, provide regular updates and use briefing procedures (e.g. SMEAC).

E—Escape Routes

Know your escape route at all times and ensure your fireline colleagues are also fully informed. Vehicles must be positioned to allow rapid escape.

S—Safety Zone

Always have a safety zone (anchor point) to which you can retreat if fire behaviour escalates. Well burnt ground is a safe area. Safety zone must be large enough.

Note: LACES has now been adopted by AFAC and FESA and effectively replaces trying to remember the ten standard fire orders and 'WATCHOUTs'.

Managing the fire

The safety and success of fire suppression hinges on the command, control and communications systems that are set up to control the incident.

Incident management structure

The Australasian Inter-service Incident Management System (AIIMS) brings together and manages people, procedures, facilities, equipment and communications in a common organisational structure. This structure expands and contracts in accordance with requirements to manage the incident.

This provides a clear path of delegation of responsibilities and helps to ensure that the health and safety of all personnel is better able to be monitored by the appropriate allocation of activities.

AIIMS functional roles include the following:

- **Incident Controller**—responsible for the overall management of the incident.
- **Planning Section**—responsible for the collation of incident resources, current information and predictions of any future development of the incident, and preparing the incident action plan.
- **Operations Section**—responsible for management and supervision of combating forces (this is the function within which a bush fire firefighter operates).
- **Logistics Section**—responsible for the provision of facilities, services, materials and finance.
- **Public Information Section**—focussed on gathering, assembling and disseminating information to stakeholders to support the incident.

Communications

Communications are vital to the successful outcome of bush fire suppression or any other incident.

A communications plan is developed to provide communications for the whole of the incident, as determined by its size and complexity.

Strategies and Tactics

One of the principles of AIIMS is management by function using strategies, tactics and tasks:

- **objective**—a statement of what is to be achieved;
- **strategy**—a statement of how the objective is to be achieved and may be either defensive or offensive and use different methods of attack(e.g. direct attack, indirect attack, parallel attack or a combination);
- **tactic**—the tasking of allocated personnel and resources; and
- **task**—the job given to any firefighting force or unit (i.e. who is to do the job).

Fire intensity

Fire intensity is a function of the amount of fuel burnt, the energy value of the fuel and the rate of spread of the fire. In general terms the indicators of intensity may be flame length depending on how far they are leaning over and flame height. It is useful to know the indicators of intensity as the intensity of the fire may dictate the method of attack used.

(kw/m = kilowatts per metre)

- **Low** intensity fires have a flame height of less than 1.5 m (less than 500 kw/m).
- **Moderate** intensity fires have a flame height of 1.5–7 m (500–3000 kw/m).
- **High** intensity fires have a flame height of 7–14 m (greater than 3000 kw/m).
- **Very high** intensity fires have a flame height greater than 14 m (greater than 7000 kw/m).

The flames from an intense surface fire may progressively consume elevated shrub and bark fuels, and may eventually reach and ignite the crowns of trees.

Methods of attack

The Incident Controller will ensure that a risk assessment is conducted in order to determine and approve an appropriate strategy. The strategy selected for use at a fire whether in grassland, forest or at any other incident will depend on this risk assessment, taking into account the safety of firefighters as a first priority. The strategy will identify the method to be used to attack the fire:

- direct attack;
- parallel attack; or
- indirect attack.

Direct attack (low intensity fires)

A direct attack is used mainly on low intensity bush fires that can be easily and safely reached by firefighters. Firefighters work from an anchor point directly on the edge of the fire and this edge then becomes the established control line.

In grass fire situations, water is commonly used to extinguish the burning edge of the fire in which case a mineral earth control line may not be required. Firefighters may also use foam to extinguish the fire.

In forest fire situations, a mineral earth control line may be constructed using hand tools or mechanical equipment such as bulldozers, along the fire's perimeter.

Care must be taken not to drag burning material across the control line into unburnt fuels and to work as close to the fire edge as possible. Water or Class A foam may not effectively extinguish a forest fire but will assist in establishing a temporary control line.

To perform a direct attack you can use:

- water contained in knapsacks, tankers, aircraft or in hose lines from a static water source (e.g. a hose lay);
- bulldozers and other earth moving equipment; and
- hand tools such as rakehoes, slashers, axes and chainsaws.

The terms **head attack** and **flank attack** are used in bush fire suppression to describe two variations of direct attack techniques for suppressing a bush fire. You should be aware of how these two methods of attack differ.

A head attack *(see Figure 7)* involves directly knocking down the head of the fire and then working towards the point of origin. The anchor point is the blacked out fire edge at the head of the fire.

This type of attack is used only for low intensity bush fires and in moderate weather conditions where you can get close enough to attack the burning edge and can be sure that there will be no unexpected flare ups or spotting activity.

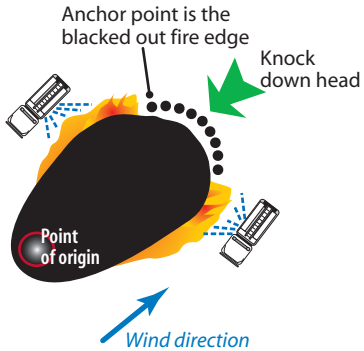


Figure 7: Head attack

A flank attack *(see Figure 8)* involves approaching the fire on the flanks and working directly on them.

One version of a flank attack is to work from the rear using the blacked out edge as an anchor point to work progressively towards the head of the fire in an attempt to "pinch" it out.

This technique is used when it is impractical or unsafe to establish an anchor point at the head of a fire front (for example, a high intensity grass fire).

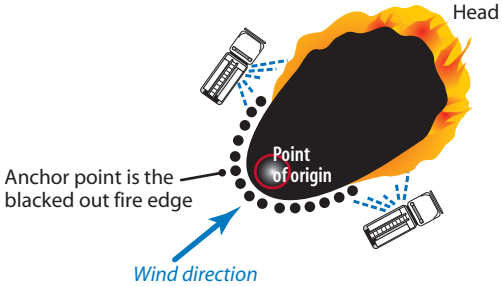


Figure 8: Flank attack

Advantages

- Provides maximum safety for firefighters (e.g. the ability to move into the black if required);
- generally, the least area is burnt of all methods;
- fuel is removed from the immediate path of the fire, allowing the earliest possible control; and

- parts of the fire edge that have self extinguished may be quickly incorporated into the control line.

Disadvantages

- Firefighters working at the fire's edge can be exposed to heat and smoke;
- fences and natural barriers may present obstacles; and
- an irregular control line may be produced which can be difficult to patrol.

Parallel attack (low and moderate intensity fires)

The parallel method of attack commonly involves the construction of a control line parallel to the fire, or just a short distance away from the fire's edge *(see Figure 9)*. You should be able to see the fire edge to observe changes in fire behaviour.

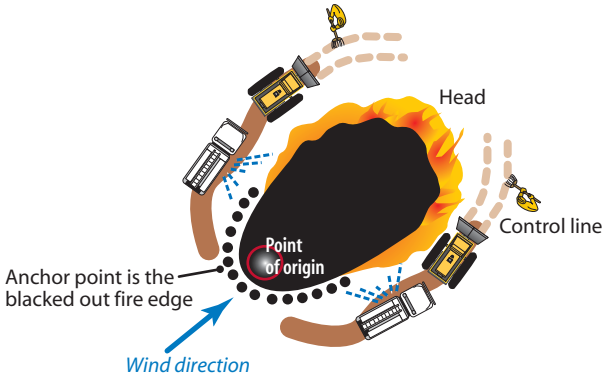


Figure 9: Parallel attack

The distance from the fire edge will depend on:

- the intensity of the fire edge and spotting;
- the type of fuel;
- weather conditions;
- topography; and
- equipment used.

In general, control lines are constructed as close as possible to the flanks of the fire. Irregularities in the fire's perimeter can be bypassed using this technique.

You can use a range of equipment to construct control lines (e.g. handtools, ploughs, graders, bulldozers and chain saws).

The fuel between the main fire and the control line may be burnt out by other firefighters under close supervision. This generally occurs from the point of origin using the blacked out edge as an anchor point as the work on the control line proceeds.

Control line construction must stay ahead of any burning out activities. If this is not possible, you must patrol the control line to ensure that it is not crossed when the main fire reaches it.

When using parallel attack, you must always remember that the fire is constantly changing due to factors such as fuel and topography. The distance that you can work from the fire edge is dependent on fire intensity—the further away you work from the fire edge, the greater the personal risk if the fire changes direction or intensity increases.

When using the parallel attack method, you must:

- commence control line construction from an anchor point;
- monitor the progress of the fire and note any weather changes; and
- ensure you have two escape routes.

Advantages

- Control line may be shorter and straighter than in direct attack; and
- crews may be less exposed to heat and smoke.

Disadvantages

- There will be an increased risk of the fire escaping; and
- the total fire area will be greater than that in a direct attack.

Indirect attack
(high/very high intensity and inaccessible bush fires)

The indirect method requires the use of either a natural fire barrier, or the construction of a control line some distance from the fire's existing perimeter, or a combination of both.

The fuel between the control line and the main fire is backburned when conditions are safe to do so. By backburning some distance from the bush fire's existing perimeter, the fire is robbed of fuel.

This technique is generally used when access is not available to the fire edge, the fire is too intense or is spotting, or for environmental reasons. The fire is allowed to burn to predetermined control lines.

Backburning is potentially hazardous and needs experience, knowledge and skill to ensure a successful outcome. This activity is only to be carried out when identified as part of the overall control objective strategy in the Incident Action Plan and following authorisation by the Incident Controller. You will only carry out this task under direction and supervision. Do not undertake backburning without the authority of the Incident Controller.

Advantages

- Generally the only means to control fires with long distance spotting;

- controls more intense bush fire;
- reduces the exposure of firefighters to bush fire hazards;
- allows more time for planning and assembling resources appropriate to the incident;
- allows the location of a control line to be chosen with greater regard to crew safety and environmental considerations;
- allows more time for the construction of a control line; and
- control line may be shorter and straighter than in a direct attack.

Disadvantages

- Requires considerable resources and planning;
- the total fire area will be greater than that in either of the previous methods;
- greater area to be controlled and patrolled, therefore an increased risk of the fire breaking through the control lines;
- the fuel between the fire and the control line may have to be backburned or burnt out—the two fires joining may result in intense fire activity at the junction zone (where the fires meet) and an increased chance of spotting;
- the backburn may fail or escape, creating the difficulty of controlling the main fire and the backburn.

Asset and property protection

Many bush fires occur close to, or enter, urban-rural interface areas and may pose a serious threat to life, livestock and/or property. Isolated rural properties may also be placed under threat from an approaching bush fire.

The Incident Controller will take account of this when planning fire suppression strategies and tactics.

One option to minimise losses may be to apply tactics specifically for property and asset protection. For example, using pumpers or tankers to protect homes and other property using local, static or reticulated water supplies.

Local pre-plans may have already been developed to determine the safe, effective and efficient use of resources for asset protection.

Mineral earth control line

As you can see from the previous section, a control line is an important part of fire suppression activities.

One form of control line is a man-made or natural fuel-free path. It prevents the spread of fire. When constructing control lines, the term mineral earth (or bare earth) is sometimes used.

This term refers to ground where all vegetation cover has been removed and only rocks and soil are exposed.

The mineral earth should be exposed for the length and width of the control line.

The control line may vary in width and length, depending on the incident.

A control line can be constructed by using:

- hand tools (e.g. axes, slashers, rakehoes and chainsaws) to remove unburnt surface fuels from the fire; and
- machinery, such as bulldozers, graders, bobcats and farm tractors fitted with a plough or a blade.

Constructing a control line using hand tools

Constructing a control line using hand tools requires a team effort. It is necessary to work in a planned manner if the team is to work safely, effectively and efficiently.

Rakehoes and axes have sharp edges—failure to observe safe handling and work procedures can result in severe injury.

Key points to remember

- Make the most of natural fire breaks such as:
  - exposed rock shelves;
  - open ground; and
  - creek beds.
- Keep the control line as straight as possible to provide firefighters with a clear view and enable them to move along the control line easily.
- Keep the length of the control line to a minimum.
- Corners should be widened, as fires are more intense in this area and can often spot over at these points.
- Avoid heavy concentrations of fuel as the fire's intensity will increase close to the control line.
- Cut saplings and small trees at ground level to minimise the potential for the sharp stumps to cause accidents.
- Keep the control lines clear of dead trees or stumps.
- Rake and scrape unburnt surface fuels away from the fire.
- Remove rough bark and ladder fuels from trees adjacent to the control line as these can cause spotting across the control line or rake around these, if it is not possible to avoid them.
- Be sure that the fuel is removed down to the mineral earth.

Patrol the perimeter

- As soon as a control line is established, patrol it regularly to ensure there is no risk of the fire rekindling.
- Create a mineral earth control line around stumps, trees and fence posts to avoid breakaways.
- Use the rake end of your rakehoe to rake away any remaining fuel, such as leaf litter, from the burnt area, being careful to not take any hot embers into the unburnt fuel, then use the sharp edge to scrape or chip down to the bare earth.

- Look into the burnt area to identify elevated, surface or ground fuel hot spots, and look out for fresh outbreaks in the unburnt areas caused by new or previous spotting activity.

Blacking out

Blacking out or mopping up operations involve making sure that a contained fire does not reignite or spread.

Poor blacking out may also increase the risk to your crew or other crews working around you if the fire rekindles.

Thorough blacking out involves locating, breaking open, or exposing and extinguishing any smouldering fuel above or below ground This is done manually with hand tools, by wetting the fuel, or both. In a grass fire situation, wetting the fuel may be sufficient.

The importance of thorough blacking out cannot be over–emphasised. Many fires considered contained or safe have rekindled or started fresh outbreaks due to poor or insufficient blacking out being undertaken.

The first stage of blacking out should concentrate on making the fire perimeter safe. Most successful blacking out is carried out on foot to allow close inspection of potential hot spots. When they are found you must deal with them and be sure they are completely extinguished.

You should:

- extinguish elevated burning/smouldering fuels first;
- extinguish any smouldering and hot materials;
- place any smouldering fuel found outside the control line into the burnt out area;
- break up fuel concentrations to release the heat; and
- turn smouldering logs into a position where they will not roll into an unburnt area.

When the edge is controlled, any patches of unburnt fuel can be burnt out or contained within the control line. A strip inside the perimeter must then be blacked out to extinguish all burning or smouldering material. Commencing at the edge and blacking out for 20–30 m is the most common practice.

As with other firefighting activities, consider your hose line as your lifeline. Whether moving up or adding an additional hose length to prevent hose damage, be sure to wet down ahead of your hose to create a cool damp area free of hot embers and threat from naked flame.

Factors to consider when blacking out

Depth of blacking out

The depth of blacking out will depend on a number of factors:

- **the size of the bush fire**—it may be possible to mop-up the entire area of small or spot fires, in large fires the depth of blacking out will depend on fuel, weather and topography;

- **nature of the fuels**—heavy, smouldering fuels like stumps and logs, or tall burning hollow trees showering sparks across the control line from inside the mopped up perimeter increase the risk of reignition, therefore, depth of blacking out needs to take account of this; and
- **terrain or topography**—control lines on slopes with burnt ground above unburnt ground pose a risk of smouldering material tumbling down hill into unburnt fuel across the control line, mopping up must be extended further upslope to reduce this risk.

Weather conditions

The likelihood of severe weather approaching may make a greater depth or area of blacking out and additional patrols necessary, particularly on the eastern flank, as a wind change from the west/south-west would blow towards this direction carrying embers on to unburnt fuel.

Different fuels

- Logs and stumps:
  - You may have to roll a log over to extinguish the underside. To avoid it rolling down hill or into an unburnt area, use a rock or earth mound as a chock or dig a trench to roll the log into.
  - You may have to split a log open to extinguish any burning material inside. If you have insufficient water, use your rakehoe to create a suitable bare earth break around it.
  - When blacking out stumps, firstly cool down the stump and surrounding area. You may need to use a shovel to access hot root holes or an axe to open the stump up.
- Trees:
  - Be sure to black out all smouldering bark and elevated fuels to prevent it blowing into unburnt fuel;
  - Burning stag trees near the fire edge should be extinguished to stop showering sparks and embers igniting adjacent unburnt fuels. If this is not possible, post a patrol crew twice the tree height clear of the stag and up slope, or have a competent person fell the tree. Then split it open and extinguish it.

The use of chainsaws to assist firefighting operations must only be carried out by trained, competent and endorsed people.

- When blacking out in grassland or bush, take care not to spread burning embers back into the unburnt area.
- Animal manure needs to be broken apart and thoroughly wet down.
- Be sure to black out fence posts, as they are a valuable asset.

Safety

- Falling trees and limbs can kill. These can continue to fall for many days after the main fire has passed. Look up and maintain a close watch while working under canopies. Report any dangers.
- You need to exercise extreme care when applying water to hot beds of burning fuel, as instantaneous production of steam may cause a violent reaction, throwing dust, smoke and steam back into your face.
- Watch out for rolling logs and material burning underground in stump holes.
- Stay at least two tree heights clear and upslope of any burning stag trees.
- Watch out for insects, reptiles and vermin that may have been disturbed as a result of the fire.

3.5 Taking refuge

Taking refuge is the last resort. Your highest priority is to avoid being placed in a life-threatening situation. You should ensure that you take all necessary actions to avoid life-threatening situations where you may need to take refuge while on foot, in a vehicle or on a tanker.

Your chance of survival is significantly reduced if entrapped in a grass fire, and extremely low if entrapped in a forest fire. You need to know the actions to take to improve your chances of survival if for reasons outside your control you find yourself in a critical situation.

Remember, you must wear appropriate protective clothing, worn and fitted correctly, at all times on the fireground.

The following pages will cover:

- **taking refuge from radiant heat;**
- **taking refuge on foot;**
- **taking refuge in a structure; and**
- **taking refuge in a vehicle.**

Taking refuge from radiant heat

Even during normal firefighting activities, radiant heat is a potential killer. You are in real trouble if radiant heat enters your body faster than you can maintain your core body temperature by sweating.

Personal protective clothing and equipment is designed to offer some protection against radiant heat. If you are too close to the fire, your core body temperature will still rise. To overcome this you need to move further away from the heat source (i.e. the flame) to a more comfortable distance. Four times the flame height is the accepted comfortable distance. As flame height increases so does radiant heat. In cases of sudden flare ups, you may collapse and die within minutes, if you do not find shelter.

As radiant heat only travels in straight lines from its source, taking refuge behind a solid object will shield you from the radiant heat. Keep as low as possible, lay face down and cover up all exposed skin until the flare up subsides.

Objects that may shield you from radiated heat include:

- heavy machinery (e.g. a bulldozer);
- a large log;
- a stone wall;
- a structure;
- an earth mound;
- a large rock; and
- a tree.

It is worth reiterating that your priority should be to avoid being placed in a life-threatening situation. The following actions should be considered as a last resort when entrapped in a bush fire.

Taking refuge when on foot in a bush fire

If you are on foot and are not in the vicinity of a vehicle or structure, you should consider the following actions:

- Remain calm and do not panic—do not run blindly from the fire as exhaustion makes you prone to heat-related illnesses and collapse.
- If you are in grave and imminent danger, to gain immediate radio attention send an “Emergency, Emergency, Emergency” message.
- Look after fellow firefighters.
- As fires travel faster uphill, try to cut across a slope out of the path of the head of the fire—do not try to outrun the fire uphill unless you are certain a safe refuge is close by.
- Try to reach bare or unburnt ground towards the back of the fire.
- Do not run through flames unless you are able to see the ground on the other side and they are low enough for you to safely cross (breaks may occur where there is less fuel).
- As a last resort, clear a survival area by removing fuel and sheltering behind a solid object if possible (see previous list) or lie in a depression, stump hole or in a drain face down.
- Lie face down, ensuring all exposed skin is covered (completely cover yourself with a woollen blanket if available).

Taking refuge in a structure threatened by bush fire

In a bush fire situation, a house or structure of a similar size can provide you with adequate shelter from sparks, embers, radiant heat and flames.

Such a building might eventually burn, but it can protect you until the main fire danger passes.

It is important to remain outside the building for as long as possible. In the early stages of the fire, there may be a shower of sparks and embers blown towards the building.

By remaining outside for as long as possible you can:

- extinguish any small outbreaks;
- wet down the immediate area;
- remove or protect any fuels that may be adjacent to the building (e.g. gas cylinders, firewood and awnings); and
- if time permits, fill gutters with water (block downpipes).

When you are forced to take refuge indoors:

- If you are in grave and imminent danger, to gain immediate radio attention send an “Emergency, Emergency, Emergency” message.
- Take in a hose and fittings if you know that the fitting attached to the end of the hose can be coupled to an internal tap (e.g. the washing machine tap in the laundry if applicable);
- Shut all windows and doors. (Be aware that sparks and embers can also enter buildings through ventilation covers, sub-floor spaces and under doors and eaves.)
- Soak towels and rags with water, in case you need to extinguish small fires and fill available containers, buckets and baths (if applicable).
- Watch for and extinguish any outbreaks of fire, especially in the roof, ceiling, windowsills and verandas or timber decks. (The heat will dry out timber surfaces making them more likely to ignite from ember attack.)
- If the building should catch fire and the main fire has passed, wrap yourself in a woollen blanket and leave.

Finally, when the fire front passes (it will generally pass quickly, depending on the fuel available) it should be safe enough to move outside and quickly extinguish any outbreaks and wet down any smouldering materials. This will help to prevent the house or building burning down but you should remain alert for any possible outbreaks.

Taking refuge in a vehicle threatened by bush fire

Vehicles provide an increased level of protection from flames and radiant heat compared to being caught on foot in the open.

Emergency personal protection procedure —cabin of any vehicle:

- If you are in grave and imminent danger, to gain immediate radio attention send a "Stop, Stop, Stop" or "Emergency, Emergency, Emergency" message.
- Give continuous blasts on the horn as a warning signal.
- Ensure others are aware of the nature of the impending danger.
- Park your vehicle in an area of least combustible fuel, preferably on burnt or bare ground, in a quarry pit, wet gully or cutting and away from surrounding or overhanging trees or other vegetation.
- Ensure the off-side (driver's side) of the vehicle is facing away from the fire to reduce the main impact of radiant heat to you and provide further protection for the pump area (if applicable).
- Wind up all windows, close vents, turn on headlights and hazard lights, and leave/start engine running.
- Ensure all personal protective clothing is worn and properly adjusted, and all areas of exposed skin are covered.
- Get down as low as possible in the well of the cabin and cover yourself fully with a woollen blanket, keeping below the bottom of the windscreen.
- When the fire front has passed, extinguish any fires on or around the vehicle that may be a threat to your safety.
- Advise someone from the emergency services at the fire when the danger has passed.

3.6 Bush fire hazards

'Safety first'

Safety must be given priority over all other fire suppression considerations and activities.

When working at an incident, you must avoid putting yourself at risk unnecessarily. By following safe work practices you can minimise the risk of injury.

General hazards

There are a range of potential hazards that can arise from the use or misuse of vehicles and machinery during bush fire suppression operations. At night, these hazards pose an even greater risk.

When working around **any** machinery such as a chainsaws,

bulldozers, graders, farm machinery or aircraft you must ensure the operator is aware of your location at all times—day or night.

If you need to approach an operator, do so only when you have made eye contact and signalled your need to communicate. Only approach when you receive the signal it is safe to do so, remain in the line of sight of the operator at all times.

At night you should carry a torch or remain in a well lit area. In all cases you must follow the operators instructions.

Working near power lines

Electrical hazards may be encountered at bush fires or other incidents. These hazards may be caused by:

- high winds bringing down power lines;
- falling trees or branches bringing down power lines;
- burnt power poles falling and bringing down power lines; or
- motor vehicle impact bringing down power lines.

You must always consider downed electrical wires as live until informed otherwise by a power company representative.

A downed live power line will result in electricity being on the ground surface for several metres around the area where the wire is making contact. If it is in contact with an object such as a fence or a vehicle, the whole object should be considered as live.

You should also be aware that overhead high voltage power or transmission lines can short circuit to ground through smoke **without** making direct ground contact.

Precautions

- Do not approach within 8 m of an area where there are downed wires, power lines or towers that are covered in smoke (this distance will increase if the ground is wet or water is present);
- notify the power supply company to cut power and follow their advice regarding safe work practices;
- cordon off the area with tape, rope or by other suitable means;
- do not work directly under high voltage or transmission lines where smoke is present;
- do not park your vehicle near loose dangling electrical wires;
- avoid applying a direct stream of water onto electrical equipment or making contact between electrical equipment and wet hose lines as water conducts electricity;
- take special care at night, use a torch or your vehicle's lights to locate the ends of fallen wires; and
- ensure people working in the area are warned of the danger.

Vehicles

Vehicles at, or travelling to or from a fire, are a potential hazard to emergency personnel and other road users.

When working on or around vehicles at an incident:

- know the dimensions of your vehicle;
- always wear a seat belt where fitted;
- ensure any items of equipment carried in the vehicle are stowed away, locker doors are closed and secured, and exterior equipment on the vehicle is secured;
- ensure tanks are secured to the vehicle to an engineered standard that limits movement in a crash
- do not ride on the back of a vehicle unless it is designed for this purpose;
- when working on the rear of a vehicle, be aware that there is a potential for slipping, falling or being thrown, especially if the vehicle is moving over a rough or steep terrain;
- park properly—a vehicle that is not properly parked (due to haste or panic) can be a hazard as it may move without warning;
- park safely—both the vehicle and crew are at risk of injury from falling branches or building components if the vehicle is parked too close to unstable trees or buildings;
- mount and dismount the vehicle using the steps and rails provided to the crew area and cabin to avoid injury—**do not jump from any vehicle**;
- be cautious when stepping onto uneven or broken ground;
- whenever possible get someone to guide you when reversing;
- do not stand behind a vehicle—if the vehicle is reversing, the driver may not see you and you could be injured;
- always be alert for hazards created by other vehicles such as vehicles being driven carelessly in conditions of poor visibility, and if alighting on the driver's side of the vehicle, be cautious of passing traffic; and
- do not ride on trailers.

Heavy machinery

Machinery, such as bulldozers, graders, farm machinery, tractors, ploughs and bobcats create their own unique set of hazards. Personnel working near any machinery, in a vehicle or on foot, risk being crushed if the machine operator is not aware of them.

All machine operators have restricted fields of vision to the front and rear due to the engine and roll over protection systems. Dust, smoke and darkness may further impede the operator's view.

Approaching heavy machinery

Do not approach machinery until you have established eye contact and received acknowledgement from the operator. Operators will have extreme difficulty hearing over the noise of the machine.

Only approach when directed by the operator. Heavy machinery can slew or turn quickly and without warning. You should never attempt to hitch a ride as the moving tracks, or wheels, can be hazardous.

Dust and poor visibility

Vehicles and earth moving equipment create intense dust. This is a hazard to personnel and traffic due to reduced visibility and the possibility of inhaling dust particles.

If dust is present, or visibility poor:

- try to work into the wind;
- make an exclusion zone around the machine;
- close off road or track; and
- turn on vehicle or machinery lights.

Trees and rocks

Bush fires are often associated with strong winds which can break away or dislodge previously broken branches that have been supported by other branches.

Falling or rolling trees, logs, rocks and branches can cause serious injury or even death. It is possible for living or dead trees to catch fire, fall to the ground, or drop branches with little or no warning.

Burning stags (dead trees) are particularly dangerous.

Rocks, trees or logs that are dislodged by heavy machinery working on slopes have the potential to roll downhill.

A tree or rock pushed by a machine may dislodge other trees or rocks. This combination creates a domino effect and creates the risk of a severe impact injury at some distance from the machine. Therefore, always stay more than two tree lengths from heavy machinery and never work downslope.

Also be aware that trees that are being pushed by a machine may suddenly snap and spring back in the opposite direction, in a whiplash effect.

To reduce the likelihood of injury:

- always wear your safety helmet;
- do not park vehicles near or under burning trees or branches; and
- keep a look out for hazards created by trees, branches and rocks.

Chainsaws

Chainsaws are used at bush fires to cut open burning logs, cut trees and branches which have fallen on roads and to cut firebreaks. They are a useful, but a potentially dangerous tool.

If you have not been trained and endorsed to use a chainsaw, do not operate one. A qualified chainsaw operator should always wear the correct protective clothing:

- helmet;
- face shield/eye protection;
- ear protection;
- gloves;
- chainsaw trousers (or chaps);
- high visibility clothing; and
- safety boots (steel cap).

Mine shafts

Many areas of Western Australia are dotted with open and partially collapsed disused mine shafts. These are a constant hazard to firefighters as in many cases they will be concealed by surface fuel overgrowth. You need to keep a constant watch out for these and be sure to carry a torch when working in these areas at night.

3.7 Safe work practices around aircraft

Aircraft are used for a number of activities in fire operations including the following:

- fire command and control;
- detecting fires;
- applying water or foam;
- aerial ignition of unburnt areas within the fire perimeter;
- transporting crews and equipment;
- observing and mapping fires; and
- waterbomber or helitac coordination.

Safety precautions

There are general safety principles that apply when working around aircraft:

- Always follow the directions given by the pilot, flight crew or aircraft coordinator.
- Wear correct eye, ear and head protection—do not wear loose headgear such as baseball caps.
- Stand clear of landing and take off areas and do not smoke within 30 metres of an aircraft or refuelling equipment.
- Be aware of propellers, and rotors, particularly when engines are idling during warm up and brief stops.

Never lean on them as this may cause the engine to turn over and cause injury.

- Do not handle moving parts such as flaps, aerials, and airspeed sensing tubes as these can be easily damaged.
- Assist with loading and unloading only under the supervision of the pilot.

Working around helicopters

Observe the following procedures when working around helicopters:

- Stay in the pilot's field of view at all times.
- Stay away from spinning main and tail rotors.
- Stand outside the main rotor disc area and await pilot's signal (usually a 'thumbs-up') before approaching the helicopter in a crouched position.
- Do not approach the helicopter unless the rotors have stopped or are spinning at operating speed—a slowing rotor can tilt downwards, in windy weather reducing head height.
- Be aware of ground irregularities on uneven, sloping terrain. Approach and leave the helicopter from the lowest downslope side and within the pilot's view.
- Carry long objects, stretchers and hand tools horizontally.
- If the helicopter is creating dust, cover your eyes and crouch down with your back to the helicopter until the dust clears.

Water bombing

Water bombing is the term used to describe the dropping of water or foam in bush fire suppression activities. Helicopters or fixed wing agricultural-type aircraft can carry out water bombing.

If caught in a drop zone:

- move away from the fireline;
- do not run or panic;
- watch out for dead or suspended branches;
- place hand tools well clear of you;
- hold your helmet on or protect your head with your arms;
- watch your footing; and
- wash with cold water if hit with foam.

Section 4

CHECKLISTS

4.1 Dangerous positions

Dangerous positions that require caution include:

Fire downhill	Building a control line downhill towards the fire.
On a slope	Where rolling burning material can ignite fuels below you.
Wind changes	The wind changes speed or direction.
Hot weather	The weather gets hotter or drier.
Unburnt fuels	There are unburnt fuels in between you and the fire.
Poor access	The terrain or vegetation impedes travel or visibility.
At night	In country you have not seen in daylight.
Unfamiliar	You are not familiar with the weather or local fire behaviour.
Spot fires	Spot fires occur over your control line.
Main fire	You cannot see the main fire or communicate with anyone who can.
Unclear	Your instructions are not clear.
Exhausted	You feel exhausted.
No anchor point	Attacking a fire or constructing a fire control line without a safe anchor point.
Alone	Working alone with no communications link to crew members or supervisor.
Uninformed	You are not fully informed about strategy, tactics and hazards.
No escape routes	Safety zones and escape routes have not been identified.
Fire potential	The potential of the fire has not been assessed.
Low water	Water levels are getting low.

4.2 LACES

The features of LACES are critical to safe operations on the fireground. Each point of the LACES must be not only known but clearly understood and applied at all times.

Teach yourself to observe. Observe fire and the environment around you. Understand how fire may behave, and what the hazards and threats are. Think about how you will react to life-threatening situations. Be 'Aware' if there is a change in any factor—e.g. weather, topography, vegetation/fuel type or personnel!

LACES is a safety check before fighting or lighting a fire, which must be continuously re-evaluated as conditions change.

L—Lookouts

Establish lookouts (preferably a designated firefighter) and task all crew members to be alert. All firefighters must evaluate and re-evaluate their situation and have the ability to initiate communications should their environment change threatening their safety.

A—Awareness

Remain aware of the fire situation including current and potential weather, terrain and aspect, fuel types and fuel loads, hazards and crew locations. All personnel have a responsibility to be alert and act decisively before situations become critical. (i.e. have an ongoing 'situational awareness').

C—Communications

Stay in communication with your people, communicate changes in situation, provide regular updates and use briefing procedures (SMEAC).

E—Escape Routes

Know your escape route at all times and ensure your fireline colleagues are also fully informed. Vehicles must be positioned to allow rapid escape.

S—Safety Zone

Always have a safety zone (anchor point) to which you can retreat if fire behaviour escalates. Well burnt ground is a safe area. Safety zone must be large enough.

Note: LACES has now been adopted by AFAC and FESA and effectively replaces trying to remember the ten standard fire orders and 'WATCHOUTs'.

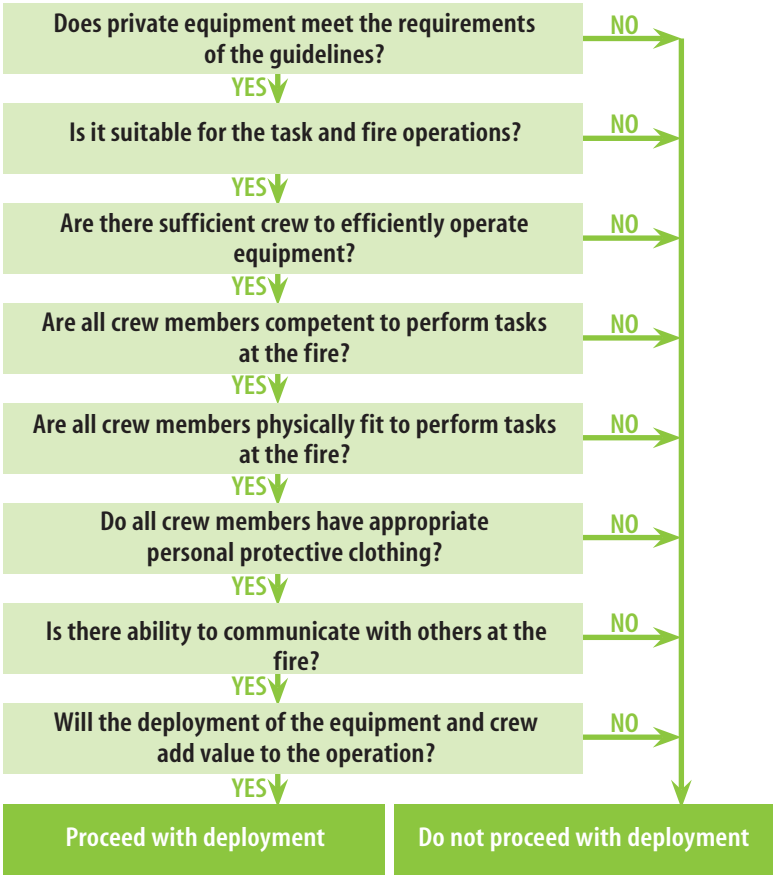
4.3 Is your vehicle ready?

1.	When loaded is the weight of your vehicle less than the rated Gross Vehicle Mass?	Yes ☐	No ☐
2.	Is the load including tank, pump and fittings properly secured?	Yes ☐	No ☐
3.	Is your vehicle roadworthy? To WA DPI standards.	Yes ☐	No ☐
4.	Are the vehicle and pump mechanically sound?	Yes ☐	No ☐
5.	Have the vehicle and pump been serviced regularly?	Yes ☐	No ☐
6.	Is your vehicle fitted with a VHF Radio or CB?	Yes ☐	No ☐
7.	Is there a first-aid kit in the vehicle?	Yes ☐	No ☐
8.	Is there a woollen blanket for fire protection in the vehicle?	Yes ☐	No ☐
9.	Is your vehicle fitted with an amber rotating beacon?	Yes ☐	No ☐
10.	Is your vehicle fitted with heatshields? (If required.)	Yes ☐	No ☐

4.4 Do you have the correct personal protective clothing and equipment?

1.	Approved firefighting Personal Protective Clothing, cotton or natural fibre overalls with long sleeves?	Yes ☐	No ☐
	or Natural fibre work shirt and trouser ensemble?	Yes ☐	No ☐
2.	Sturdy leather boots?	Yes ☐	No ☐
3.	Leather work gloves?	Yes ☐	No ☐
4.	Industrial type helmet with chin strap?	Yes ☐	No ☐
5.	Industrial type goggles?	Yes ☐	No ☐
6.	Respirator or dust mask?	Yes ☐	No ☐
7.	Hearing protection? (If required.)	Yes ☐	No ☐
8.	High visibility vest? (If required.)	Yes ☐	No ☐
9.	Drinking water/food/snacks?	Yes ☐	No ☐

4.5 Are you ready to deploy?



Notes

Remember:

- Everyone at the fire has responsibility for safety.
- Accept responsibility for your decisions and actions.
- Ensure that someone at the fire from the agency managing the fire (e.g. Bush Fire Brigade, FESA, DEC) is aware of your presence and what tasks you are undertaking.
- Work cooperatively with the emergency services and others.
- Do not work alone—team up with others.
- Be aware of the situation around you and any hazards likely to cause you harm.
- Wear appropriate personal protective clothing.
- Know and work within your personal limits and ability.
- Ensure your equipment is well maintained and you know and operate it within its limits and capability.
- Ensure the tasks you undertake match your capability and that of your equipment.
- Maintain communications.