Best Practice Guidelines for Fire Fighting and Controlled Burn-offs

First edition December 2000
Revised edition January 2005

These Best Practice Guidelines are to be used as a guide to certain fire-fighting and controlled burnoff procedures and techniques. They do not supersede legislation in any jurisdiction or the recommendations of equipment manufacturers.

FITEC believes that the information in the guidelines is accurate and reliable; however, FITEC notes that conditions vary greatly from one geographical area to another; that a greater variety of equipment and techniques are currently in use; and other (or additional) measures may be appropriate in a given situation.

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Fire basics

Fire in forestry

Fire is a threat to forestry, and a tool used to prepare sites prior to planting.

Wild fires are unplanned and uncontrolled activities.

Controlled burnoffs are planned and controlled. They are lit for the purpose of managing slash and vegetation, and preparing sites for forest establishment.

Over the period 1936-2005, more than 30 000 ha of exotic forest were destroyed by wild fire in New Zealand.

Of these fires, only 2% were started from natural causes. These were caused by lightning, and spontaneous combustion in waste woodpiles.

The remaining 98% were caused by people. Escapes from land clearing burnoffs were a frequent cause. Other causes included:

- Forest equipment (chainsaws and machines)
- Smoking
- Arson
- Moving wire ropes
- Purpose-lit fires

The risk of wild fires is related to the climate. There is a wide variation in fire weather severity and associated fire danger across the country. In general, the eastern and northern parts of both islands tend to have the most severe fire climates.

The consequence of a wild fire can range from minor crop damage to complete loss of a forest.

Fire as a tool

A high degree of skill and planning is needed to use fire safely and effectively.

Fire can be used on its own. Alternatively, some pre-treatment of the site may be necessary to kill or crush vegetation.

In the past, fire was a common method of land preparation. However, currently the area treated with planned burnoffs is around 1500 ha per year.

The effects of a fire are directly related to how well it is planned and managed. The aims are to safely and effectively remove the unwanted vegetation, scrub, and slash. There should be no threat or damage to life or surrounding areas.

An effective fire removes the unwanted material cleanly in a controlled manner.

An ineffective fire may be one that:

- Does not burn well and leaves material partly burnt or unburnt
- Burns out of control into areas that were not part of the planned burn.
- Burns too hot and intensely, removing too much of the litter and topsoil

Controlled burnoffs can be expensive and risky, and create large clouds of smoke that can cause irritation to neighbours. They can also cause loss of vital nutrients from the site.

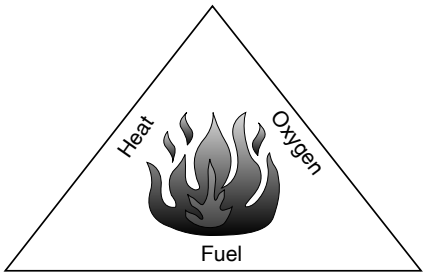
Despite these reservations, there are instances where fire is a viable option for clearing a site. The use of controlled burns also gives the opportunity to train staff in preparation for fighting wild fires.

Fire behaviour

Three inputs are required before a fire can occur. These are:

- Fuel - material to burn
- Oxygen - from the air, to allow combustion
- Heat - from a flame, spark, or friction to start the combustion process.

Fire-fighting aims to eliminate or reduce one or more of these factors.



Three requirements for fire

Fire behaviour is influenced by:

- Weather
- Topography
- Fuels.

They combine to influence fire intensity and thus fire behaviour, the damage the fire causes, and the expected difficulty of control.

Weather

Weather is usually described by four climatic parameters:

- Temperature
- Relative humidity
- Wind
- Rainfall.

These factors can act together to create a particular risk and potential fire intensity, termed fire weather.

The ***air temperature*** will affect how moist fuels are. In warm situations, the fuels will be drier than in cooler areas. Thus, fire intensity will be greater in sunny positions.

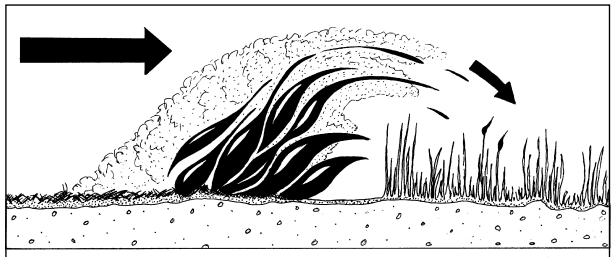
Relative humidity is a measure of how damp the air is. If the air is dry, moisture is drawn from moist fuels, drying them out.

If the air is damp, fuels will take up water from the air. This will reduce their ability to burn.

Wind will increase the drying of fuels. This particularly applies to warm dry winds that occur in summer.

Wind will increase the rate of spread of a fire, particularly in the direction of the wind. Wind will bend the flames over so that more radiant heat is applied to fuels in front of the fire. This is why it is very dangerous to approach a fire from the downwind side.

Wind also ensures there is a good supply of oxygen for the fire.



Wind will bend flames over

Fires can create their own localised winds, including small whirlwinds.

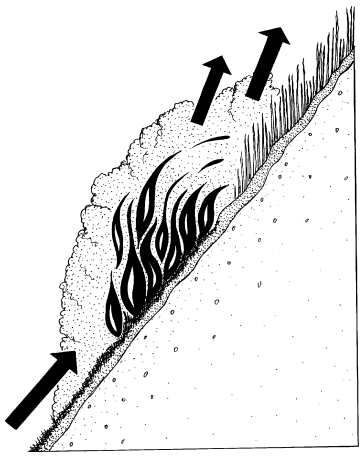
Rainfall will alter the wetness (moisture content) of fuels. However, wetting of fuels will be greater if they are already damp. This is why a heavy and prolonged rain is required to reduce the fire risk during summer when the fuels are dry.

Topography

Topography refers to the shape and orientation of the landscape.

There are four main characteristics of topography that act to influence fire behaviour:

- Slope
- Aspect
- Elevation
- The general shape of the land (gullies, ridges, flat areas).



Fire moves rapidly uphill

Fine (top), medium (middle), and heavy (bottom) fuels

Barriers to fire spread may also be included as a part of topography.

Slope is important as it increases the rate of spread of the fire by preheating the fuels ahead of the fire due to the flame being closer to the fuels.

Aspect and elevation both influence moisture contents of the fuels. Fuel on a sunny exposed slope will be drier than fuel on a shady sheltered site.

The shape of the land can funnel or channel wind flow. Fire nearing a ridge will speed up as air-flow increases. Once the ridge has been reached the fire slows.

Fuels

Fuels can be defined as any material (such as dead and live vegetation) which can be ignited and sustain fire. Fuels tend to vary over the landscape and therefore influence fire behaviour as it moves from one type of fuel to another.

There are five physical properties of fuels that influence fire behaviour:

- Quantity
- Size/shape and depth
- Arrangement
- Continuity
- Chemical properties.

Quantity — (referred to as the fuel load) has a direct influence on fire intensity and is described in terms of the amount of available fuel (tonnes per hectare). Fuels are also described as *fine* (twigs, grass), *medium* (small branches), or *heavy* (slash, stumps). This is fuel size and is measured by the thickness or diameter of the fuel pieces.

Size/shape and depth — influences the surface area-to-volume ratio and thus the wetting and drying rates of the fuels. Small, flat fuels dry faster (and absorb moisture more quickly) than large thick fuels.

Arrangement — is the horizontal and vertical arrangement of the fuels. As airspace increases within fuels, the combustion rate also increases (up to a point).

Continuity — is the evenness of distribution of the fuel over an area. It is an important variable as it is used to describe how much fuel is available ahead of the fire before a natural break occurs or if there is a change in fuel types.

Chemical properties — some fuels tend to have a higher combustion heat than others due to stored energy or volatile extractives.

All of these fuel properties influence the probability of ignition/spotting, the rate of combustion, the rate of fire spread, and thus the overall intensity of the fire.

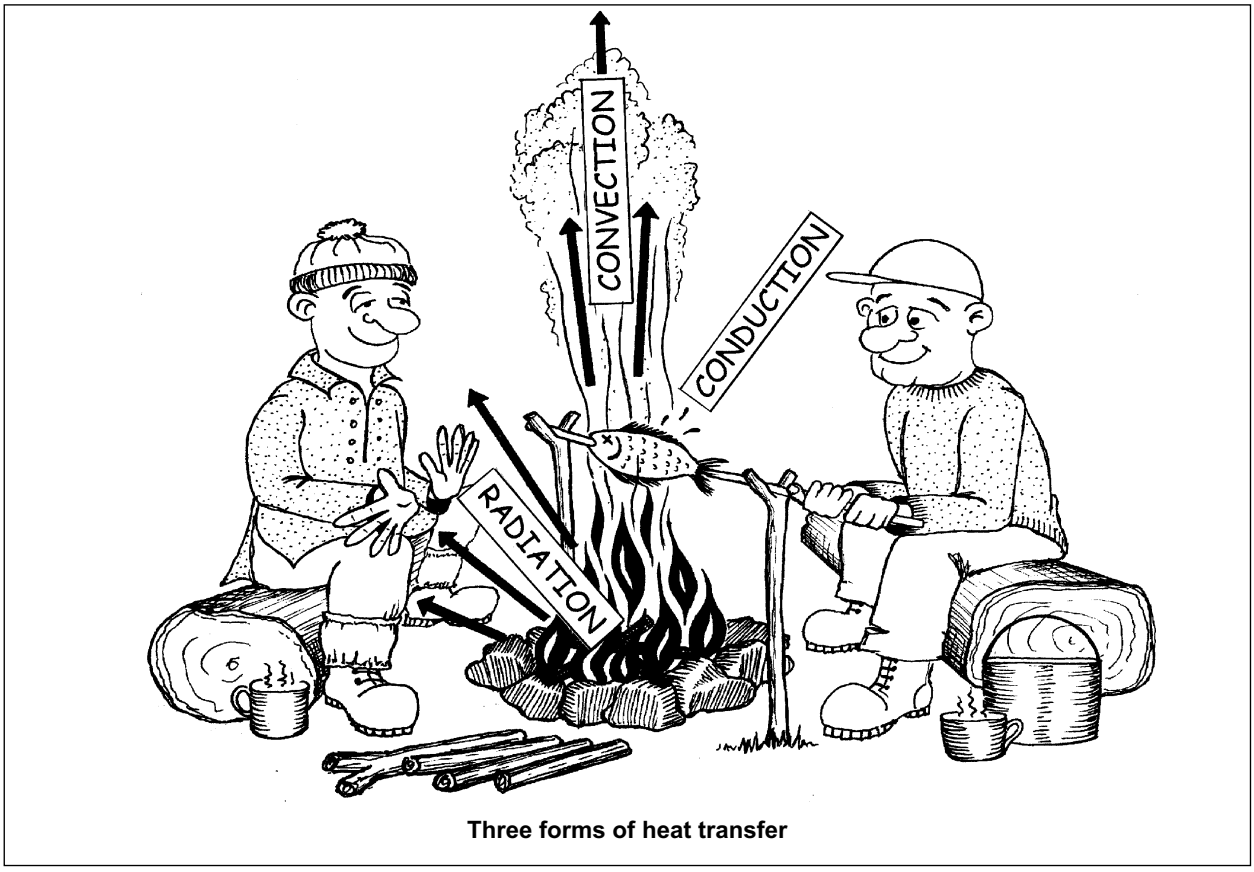
The above properties describe specific characteristics of pieces of fuel. They all combine, to produce a fuel type.

Heat transfer

The process of heat transfer helps a fire to spread as it dries, and pre-heats the surrounding fuels so they may catch fire. Heat transfer occurs in three ways:

- Radiation
- Convection
- Conduction.

Radiation — the energy given off by an object (the fire) that travels out in all directions from the source. This is the heat felt from the fire.



Three forms of heat transfer

Radiant energy acts to raise the temperature of the surrounding fuels to a point at which they may burn and contribute to the overall intensity of the fire.

Convection — Convection is the upward movement of heat through the air.

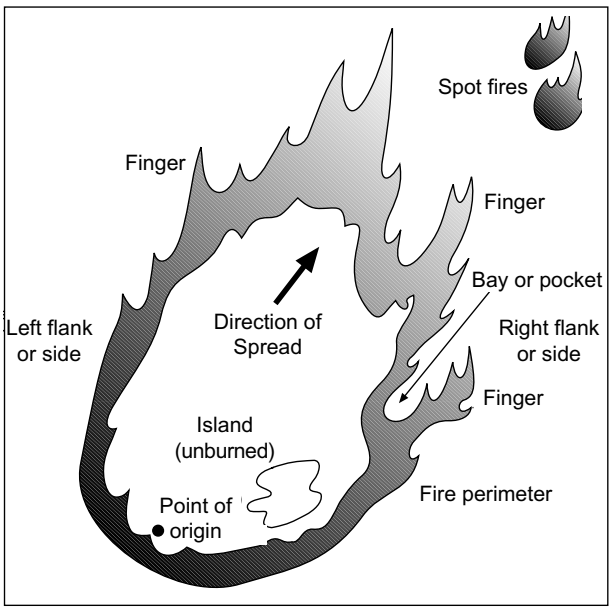
In large fires, convection may transport embers that are capable of igniting spot fires.

Convection may also steal oxygen.

If the fire is large enough, convection may create its own localised, strong, surface winds (as air is drawn in).

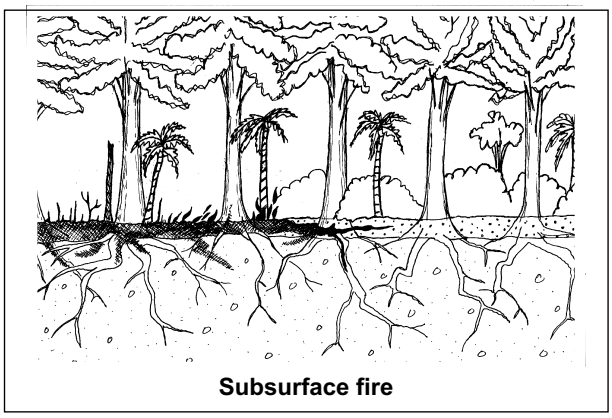
Conduction — Conduction is the transfer of heat through solid objects. This can act to pre-heat and dry fuels.

Parts of a fire



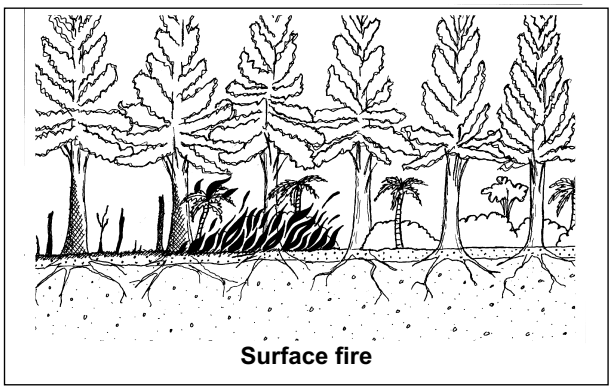
Types of fire

Fuel arrangement, quantity, topography, and weather all combine to create different "types" of fire. There are subsurface fires, surface fires, and crown fires.



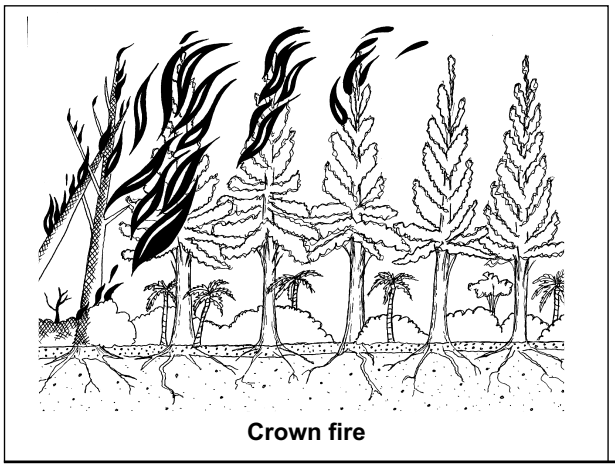
Subsurface fire

- ***Subsurface fires*** burn the organic material in the soil.
  - An example of this type of fire is a peat fire burning below the surface of the ground.
  - These fires tend to be difficult to extinguish, as considerable effort is required to expose the burning fuels.
  - Infrared cameras can be used to locate subsurface fires.



Surface fire

- ***Surface fires*** burn in the surface fuel layer.
  - Surface fires do not burn the crowns of trees. They burn fuels that are in close contact with the ground surface.
  - Examples of these fuels are grass, litter, shrubs, slash, and scrub. A surface fire is the most commonly occurring type of fire.
  - Fires in grass and shrubs can spread very quickly depending on wind-speed.
  - Surface fires spread through the fine fuels.



Crown fire

- ***Crown fires*** travel through the crown (tree tops), usually in conjunction with the surface fire.
  - Crown fires occur in conditions where the surface fire has reached sufficient intensity for crown fire initiation in specific fuel types.
  - These are fast-moving fires that tend to be very difficult to control.

Stages of Fire Control

The main aim of fire control is to attack a fire while it is small and manageable.

This requires a fire-fighting response system able to receive fire information, process it, and then dispatch the appropriate resources.

The first response (initial attack) is likely to be aggressive to contain the fire. This will be followed by more sustained attack and mop-up activities.

The main stages of fire control are:

- Knock-down
- Containment/control
- Mop-up.

Knock-down

An initial knock-down attack needs to be rapid and concentrated on the flanks or edge of the fire. This reduces the intensity of the fire.

Containment/control

Once the fire intensity has been reduced through knock-down, the fire is stopped from spreading.

Mop-up

Now contained, the fire is put out and patrolled to ensure it does not re-ignite.

Methods of Attacking Fires

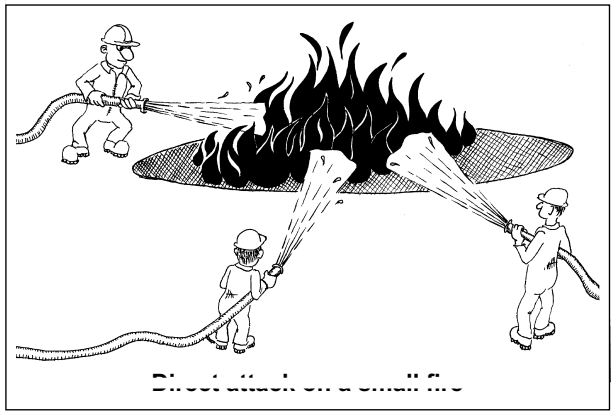
Initial attack is the action taken to halt the spread or potential spread of a fire by the first fire-fighting force(s) to arrive at the fire. The action taken or technique employed by the fire-fighting forces is usually one of three accepted techniques — either a direct, a parallel, or an indirect attack.

Direct attack is the knocking down of the flames through direct action on them.

This includes aerial and ground attack.

This is the most common technique used on small fires (of a few square metres of low intensity).

The fire is approached from any angle, working around the outside of the fire until it is contained. This is only possible if wind influence is negligible.



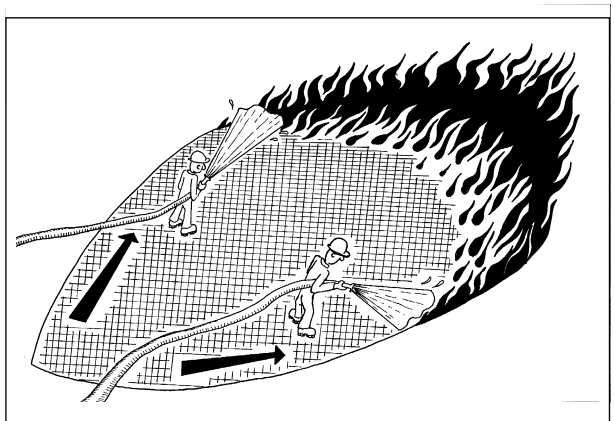
Direct attack on a small fire

On a larger ***moving fire***, attack is started at the base of the fire, from within the burnt area, this being the safest position.

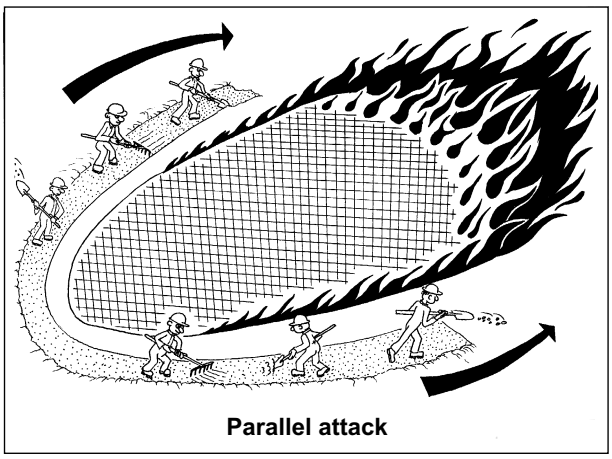
The attack then moves to the two flanks of the fire at the same time.

Finally the head of the fire is put out from behind.

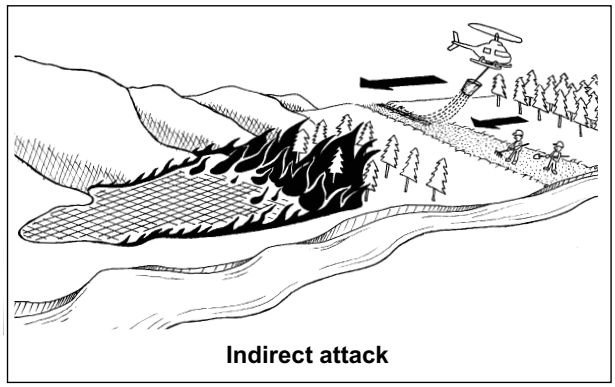
This method ensures that the fire is always ahead of the fire-fighting activities.



Direct attack on a large moving fire



Parallel attack



Indirect attack

Parallel attack involves constructing a fireline approximately parallel to and just outside the fire edge to enable fire-fighters and equipment to work effectively and safely.

It is only used when the fire is too hot or moving too quickly for direct attack.

The fireline should decrease the intensity of the fire so that direct attack is successful.

Fire-fighters must be careful not to get ahead of the fire.

Indirect attack is used when the fire is intense and travelling quickly.

The fire may be too dangerous to approach or is in inaccessible terrain.

Indirect attack can involve burnouts, back burning, the use of natural barriers, fireline construction well ahead of the fire front, or the application of water with fire retardant chemicals on fuel ahead of the fire.

Construction of a fireline

A fireline is constructed at the time of the fire to clear vegetation and is intended to stop the progress of a low- to medium-intensity surface fire.

This is different to a control line, which is a more permanent constructed or natural barrier to the fire. Examples of natural barriers include streams, firebreaks, roads, and railway lines.

A fireline may be formed by machine or by teams of people.

In the latter, team members establish a fireline using hand tools, power tools, and hoses. The use of a fireline is the best option where there is inadequate water supply or a chance of underground burning.

A fireline will not be an effective option against a crown fire.

The Crew Boss will decide where to locate the fireline. He/she will try to use natural barriers or clear areas as much as possible. The fireline should follow the line of least resistance for the crew members. It should be located to make effective use of the fire crew's efforts. The aim is to make the fireline as short as possible to contain the fire. This allows more time to build an effective fireline.

The progressive method

This is useful where water is not available and there is a deep duff layer.

The fire crew works as a team to clear the fireline. The work method and pace need to suit the team. Regular rotation of tasks within the crew will help avoid overloading or over-exertion of individual crew members.

Hand and power tools are used to clear light fuels. Ground vegetation is removed within a 2-m-wide strip. If present, lower branches and vines are removed from both sides of the fireline to reduce the chance of the fire jumping the line. A wider line may be necessary in tall scrub.

Downed fuel is removed and scattered away from the fireline.

Other crew members then dig and scrape the duff layer away.

A shallow trench is dug down the middle of the cleared line. On flat ground, the soil is spread on both sides of the line. On a slope, the soil is pulled downhill for easier work and to make it more effective against rolling fuel.

The trench provides a wider zone of mineral soil, and allows underground fuels to be removed. On slopes the trench can also stop burning fuel from rolling down into unburnt fuels on the other side of the fireline.

Controlled fire lighting

Fires may be lit deliberately to clear unburnt fuels in an indirect attack on a wildfire or for land clearing purposes. The controlled lighting of fire is a specialised task. The risks of injury or damage require that those involved are fully trained and supervised by the Incident Controller.

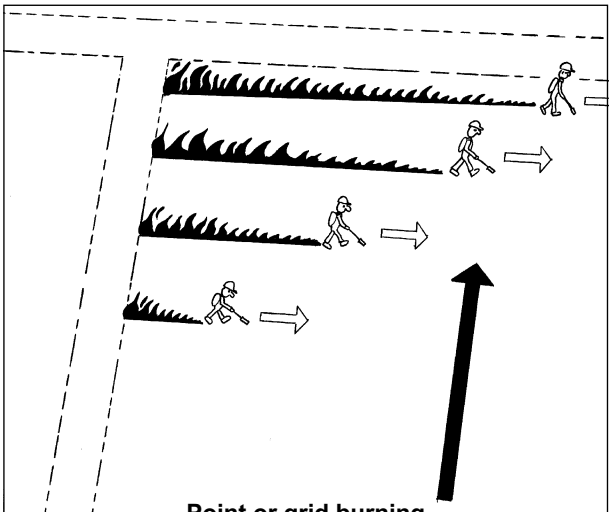
Burn patterns

Being a planned and controlled activity, a fire lighting pattern can be chosen to best achieve the objectives. The main patterns used are shown below.

Ring (convection) burning — involves lighting the outside edge of the burn area. The fire burns towards the centre of the area, creating a convection column. This pattern is suited to high fuel loadings as the progression of the fire is otherwise slow. It is important to get around the entire burn area as fast as possible. Ring burning provides a high-intensity burn.

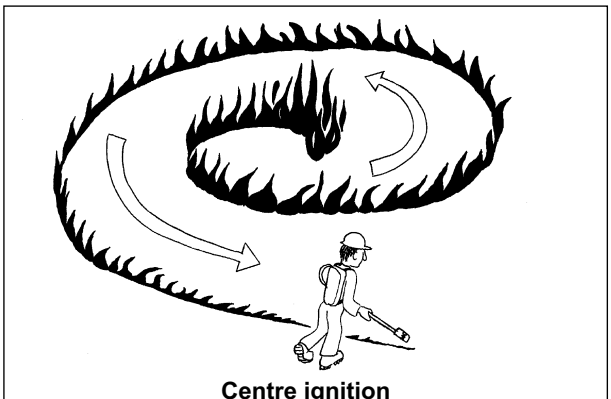
Ring burning

Point strip or grid burning — The first strip is a solid line. Subsequent upwind "strips" may be lit as spots at a prescribed spacing. Point burning provides a low-intensity burn. This is also a potentially hazardous activity, and good supervision and communication are essential.



Point or grid burning

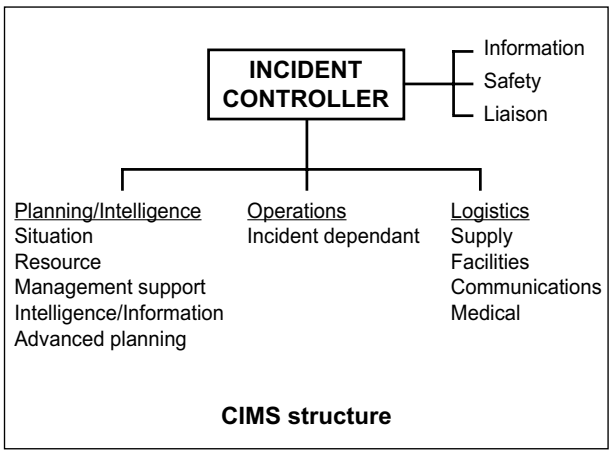
Centre ignition — involves lighting in an ever-increasing spiral pattern out from a centre point. This pattern is suited only to flat terrain with easy access.



Centre ignition

Communication

A key part of successful initial and continued attack on a fire is good communication. Establishing a clear chain of command with effective communication from the Incident Controller to the fire-fighter is part of effective and safe fire control. The complexity of the communications will increase with the size of the fire and the number of groups and individuals involved in controlling it.



CIMS structure

The Co-ordinated Incident Management System (CIMS) has been developed to handle emergency situations. CIMS provides the model for command, control, and co-ordination of an emergency response. It provides a means of co-ordinating the efforts of different agencies (forestry fire crews, New Zealand Fire Service, helicopters, police, St John's Ambulance, etc.) as they work towards a common goal of stabilising an incident and protecting life, property, and the environment.

[*Reference* – The New Zealand Co-ordinated Incident Management System (CIMS), 1998, New Zealand Fire Service Commission.]

Briefing

The Incident Controller must be fully briefed about the operation before commencing any fire operation.

If fighting a fire, not all information may be available during the initial attack. If attending a controlled burnoff, a full plan should be outlined which allows for options if conditions change.

Lines of responsibility need to be clear to all attending.

The Incident Controller will be identified. This person has ultimate control over the fire operation.

The Crew Bosses will be identified. They are responsible for the activities of individual fire crews, and are responsive to the Incident Controller.

Fire crews will be identified. Respective roles and any sub-teams within the crew need to be defined.

Communication means will be discussed.

Crews will be told about the area of the fire (terrain, hazards, and features) and the fire itself (behaviour, intensity, and speed) and the plan of attack.

Escape route(s) will be identified and outlined prior to work commencing on the fireline.

Radio telephones (RT)

Portable RTs are the preferred means of field communication. Users need to ensure that communication is clear and concise. This will avoid jamming of the channels and incorrect information being relayed.

RTs may be used between different members of a fire crew to direct operations (e.g., "Water on", "Pump off"), or where there is an emergency ("Emergency, Emergency, Emergency").

RT equipment needs to be protected from heat, water, and general knocks. A RT that doesn't work may cost lives; they should be tested regularly, and prior to attending any fire.

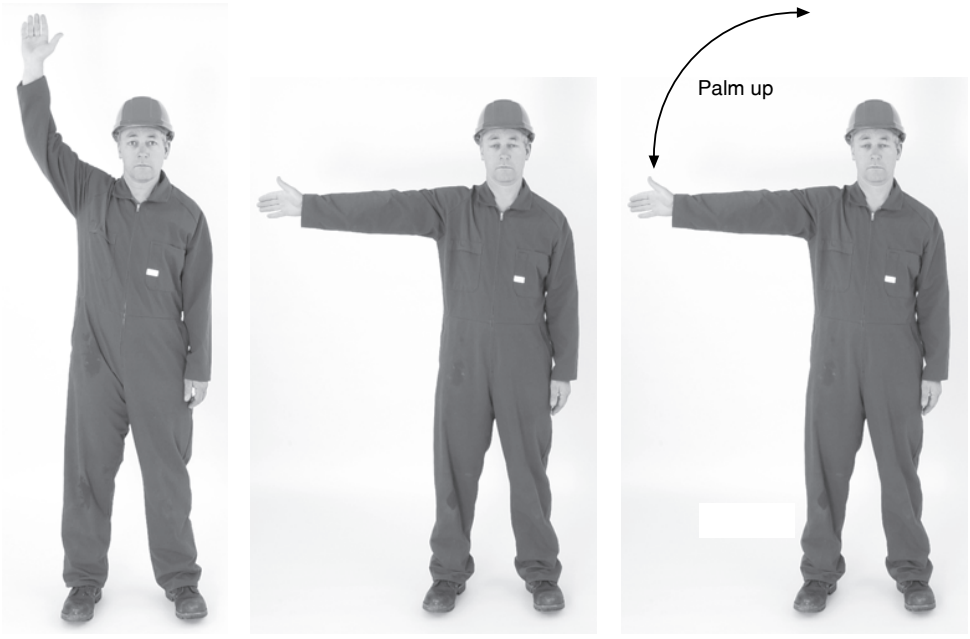
Remember to stand at least 5 m away from a running pump when using a RT.

Hand signals

There are a series of commonly-used hand signals. These are shown on the following page.

Runners or messengers

Messengers may be used to deliver verbal or written messages.



Water on | Water off | Increase pressure

Decrease pressure | Knock-off or finished with pump

Common hand signals

Fire safety

Fire safety is everyone's concern and responsibility. Individuals must take responsibility for themselves and their work mates.

The Incident Controller is ultimately responsible for safety on the fireline, but everyone can and must do his or her part to contribute to this. Crew (or sector) Bosses must oversee personal safety on the fireline.

Common issues with tragic fires

- Most incidents happen on smaller fires or on isolated portions of larger fires.
- Fires respond quickly to shifts in wind direction or wind speed.
- Flare-ups generally occur in deceptively light fuels.
- Fires burn uphill surprisingly fast especially in gullies, and on steep slopes.

Keep downhill of the fire

Safe areas

People attending a fire shall stay within the following safe areas:

- Areas already burnt
- Downhill or upwind of the fire area
- Cleared ground, such as firebreaks, roads, and tracks.

Escape routes

A fire plan should always consider escape routes. The access to the fire is likely to be the best escape route.

Generally, escape will be towards the base or flanks of the fire. It is much safer to escape to a safe area than try and outrun the fire.

General safety

People attending fire are in danger if they are:

- not wearing the required personal protective equipment
- not adequately briefed before commencing any operations
- up hill of a fire
- working alone
- in areas with high walking hindrance
- working in an unfamiliar area
- working near powerlines
- in an area with no escape route.
- inexperienced and/or untrained in the relevant aspects of fire operations
- feeling fatigued, dehydrated, or affected by the heat
- downwind of a fire
- in steep or rough terrain
- working in unburnt slash or vegetation
- not in contact with others
- physically unfit or have a medical condition

Special Precautions for Fire Lighting

- Dress as for wild fires — no synthetic materials.
- Ensure visual contact between parties. Smoke during the early stages of the burn may reduce vision.
- Have a “buddy” work with individuals with lighting equipment.
- Have a plan which everyone is aware of
- Use cleared tracks when lighting in rough terrain.
- Make sure the fire lighting equipment is in serviceable condition ***WITH NO LEAKS***.
- Do not start lighting equipment within 5 m of a refuelling zone
- Have good communications.

Training and supervision

The Approved Code of Practice for Safety and Health in Forest Operations requires that employees be supervised by a competent person until they are sure the employee can work safely and is not likely to harm themselves or anyone else.

Wild fires and controlled burns are infrequent events that can place workers and equipment in hazardous situations. Extra attention must be given to the training and supervision of new or inexperienced employees.

All operators must be under a documented training programme and should be aiming to pass the relevant NZQA Units that apply to fire fighting and/or controlled burnoffs (land preparation).

Workers involved in fire-fighting or controlled burnoffs need to be fit, active, alert, properly trained or supervised, and appropriately equipped.

Knowledge of hazards

As part of the supervision and training programme, workers need to be **shown** the hazards they will face on the job and the controls to avoid being harmed by those hazards.

Before commencing any fire-related operation all workers should be involved in identifying any significant hazards **on the site** and the way those hazards will be controlled. There must be documented evidence on site listing the hazards and controls and showing that all operators have been run through those hazards and controls.

The two main hazard categories are **Health Hazards** and **Operational Hazards**.

Health hazards

Workers attending a fire need to be fit, and alert to hazards and instructions. To maintain peak performance and prevent accidents through fatigue, operators must take special care of their bodies including their physical fitness, diet, water intake, personal hygiene, sleep, and also how they treat their bodies away from work.

Health hazards

Hazard	Control
Lack of rest/sleep	• Build short frequent rest breaks into your work routine. • Take at least two evenly spaced 30 minute rest breaks during the working day.
Early starts	• Go to bed earlier to replace the sleep you lose in the morning. • Once early starts have finished allow time for your body to recover.
Alcohol abuse	• Avoid drinking alcohol at least 24 hours before carrying out any hard physical work.
Poor nutrition	• Start each day with a high carbohydrate breakfast like porridge, cereal, toast, bananas, pasta, or potatoes. • Eat high protein foods like lean meat, chicken, eggs, milk, and cheese at night. • Eat at the start of a break, and rest to allow digestion. • Always eat a high carbohydrate snack straight after work.
Drugs	• Avoid all non-prescription drugs as they seriously affect both your mental and your physical ability to work. • Inform the boss if you are on any medication that may affect your work. Stay home if necessary. • Before receiving any medication, tell your doctor what you do for a living. • If you are on long-term medication for a serious health complaint inform the boss or crew of your condition in case you are involved in an emergency at work. A hot smokey environment may have an extreme effect on asthma sufferers.
Over exertion/sprains and strains	• Start each day with a 10-15 minute warm-up and then a few stretches. • Start the day slowly until muscles are warmed up properly. • Do some stretches at the end of the day. • Take particular care when starting back at work after the holidays.
Hypothermia/chills (shivering, coldness, numbness of extremities, pale skin colour, clumsiness and irrational behaviour)	• Wear rain wear to protect yourself from rain/water (be careful not to overheat). • Put on warm clothes when you stop for a break. • Carry spare dry clothing even on fine days. The weather can turn bad very quickly. • If you or someone else shows signs of hypothermia, remove them from the operational area and warm them.

Health hazards (cont...)

Hazard	Control
Lack of hygiene/infection	• Clean and dress any cuts or scratches received on the job as soon as possible and keep them covered. • Make sure the first aid kit is kept fully stocked. • Carry water and soap on the job to wash hands before smokos. • Bath or shower every night. • Eat a balanced diet to keep your body healthy. • Wear clean clothes against the skin every day.
Occupational Overuse Syndrome (OOS)	• Use the correct techniques. • Maintain hand and power tools in good working order, with sharp blades/chains. • Use pre-work warm up and stretching techniques throughout the day.
Heat stress (flushed face, sweating, weakness, tiredness, dizziness, nausea)	• Dress appropriately to the level of physical activity you are doing. • Wear loose fitting clothing which allows air circulation (open trouser legs and wrist cuffs). • Move to a cooler area until body temperature drops and stabilises.
Heat exhaustion (weak pulse, shallow breathing, clammy skin, pale face, slow reactions)	• Remove person from the fire area until they have recovered. • Contact medical personnel/Crew Boss.
Heat stroke (increased heart beat, hot dry skin, high body temperature,flushed face, headaches and dizziness, patient is irritable and confused)	• **Urgent medical attention is required.** • Loosen clothing and cool with water. • Evacuate the patient.
Dehydration 	• Regularly drink fluids at a rate of 0.5 litres per hour and up to 1 litre per hour in hot conditions. • Drink before you feel thirsty. • Do not drink fluids, like soft drinks and cordials, that have more than 8% carbohydrate content. • Drink high carbohydrate drinks after work to replace energy levels. • Drink plenty of water at night to recharge the body. • Drink a couple of glasses of water before leaving for work.

Operational hazards

Hazards at fires include burns, smoke inhalation, heavy machinery, and helicopters.

Presented below are operational hazards related to fires. Note that further details on helicopter hazards are presented in "**Best Practice Guidelines for Working with Helicopters**"

Operational hazards

Hazard	Control
Ineffective personal protective equipment (PPE)	• Do not perform operation if PPE is ineffective. • Replace any worn, damaged or expired PPE. • Routinely check the condition of your PPE.
Changes in fire behaviour and getting trapped by fire	• Have an escape route. • Be alert to changes in the fire movement. • Do not go into unburnt areas uphill or downwind of the fire. • Do not run through flames unless you can see clear ground beyond them. • If trapped in a vehicle, wind up all the windows and do not get out until the fire has passed. • Watch for wind changes and whirlwinds.
Noise (from pumps, aircraft or machinery)	• Wear appropriate hearing protection. • Move away from the noise zone if not required to be there.
Radiant heat (from fire) and embers	• Wear protective clothing. • Stay back from the fire edge, away from radiant heat. • Have an escape route planned. • If you are getting too hot, move away from the heat source into a cooler position. • **If someone receives a burn:** ¤ cool the burn with water for 10 minutes ¤ seek immediate medical help ¤ watch for and treat shock.
Smoke inhalation	• Stay on the upwind edge of the fire. • Move to a safe area to recover. • Have a smoke mask available. • Stay close to the ground if in smoke.
Other workers	• When using hand tools work at least 3 m away from other workers **or** if felling in tall scrub work at least two times the height of the scrub away from other workers.
Heavy machinery	• Be familiar with the plan and where the machines are. • Stay clear of any machines that are operating. • Do not approach the machine until the operator indicates that it is safe to do so. • Be aware that smoke limits visibility - the operator may not be able to see.
Hand tools	• Use the right tool for the job. • Ensure tools are in good condition - do not use damaged tools. • Use a file with a handle to sharpen.

Operational hazards (cont...)

Hazard	Control
Hand tools (cont...)	• Carry tools in one hand at the balance point, blade forward. • Pass tools to others handle first. • Don't leave hand tools lying around on the ground - prop them up against something. • Secure tools when transporting them.
Out of planned area burning	• Install adequate fire breaks. • Have an observer looking for spot fires from a vantage point. • Have the fire perimeter manned with trained and equipped staff to stop the spread of fire. • Light the fire in a controlled manner.
Powerlines	• Look for fallen lines in the burnt area. • Do not spray water near powerlines or electrified railway lines. • Confirm lines are dead before attempting to extinguish burning power poles.
Helicopters (see Best Practice Guidelines for Working with Helicopters for more details)	• Observe all the rules and procedures described in **Best Practice Guidelines for Working with Helicopters**. • Conduct a safety briefing before starting a helicopter operation. • The pilot is in charge. • Approach the machine from the front, never from the rear. • Approach only when pilot indicates that it is safe to do so. • Approach from the downhill side on sloping terrain. • Hold any long items (shovels) level below the waist. • Make sure there are no loose items in the landing area. • Stay clear of any sling loads until they are landed. • Keep the crew together on one side of the landing zone. • Do not approach any slung equipment unless you are involved in its operation (monsoon buckets / fire lighters).
Foam (if handling concentrate or involved in filling monsoon bucket)	• Wear appropriate protective clothing (waterproof coat and trousers, gloves, boots, goggles).
Fixed wing aircraft	• Conduct a safety briefing before starting a fixed wing aircraft operation. • Beware of moving propellers. • Approach a fixed wing aircraft only from behind the wings. • The pilot is in charge. Follow his/her instructions.

Protective clothing for firefighting personnel

Personal protective equipment

All personnel attending a fire are required to wear approved personal protective equipment meeting the requirements of the National Rural Fire Authority, Rural Fire Management Code of Practice, Forest & Rural Fires Act 1977.

The minimum requirements are the following:

- Leather work boots (woollen socks)
- Ankle to wrist outer clothing (wool or fire resistant), loose to allow air flow and cooling
- Cotton or woollen undergarments (no polypropylene)
- Approved fire control or forestry helmet
- Earmuffs (at least Grade 4), or other hearing protection, if working around pumps or machinery.

In addition, the following items should be considered:

- Balaclava and gloves to protect against radiant
- A small pack to carry extra clothing and some heatfood
- Safety goggles
- Dust mask to protect against ash and dust
- Water bottles to allow water to be carried

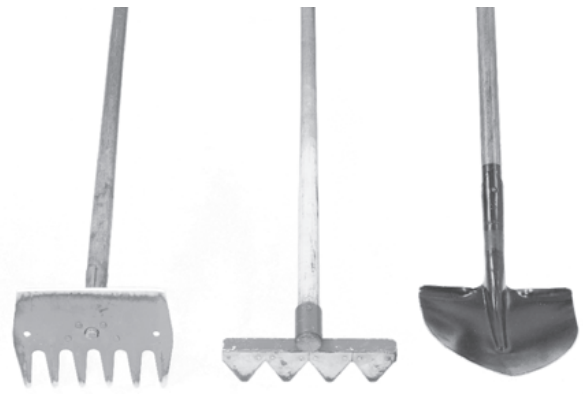
You **should not** wear the following items:

- Shorts and short-sleeved shirt
- Synthetic clothing (including chainsaw chaps/trousers, unless operating a chainsaw).
- Clothing which restricts normal movement
- Protective clothing or equipment which may restrict vision

Worker requirements

All staff attending a fire should be:

- Physically fit and unaffected by drugs or illness
- Fully briefed on the plan for lighting and/or managing the fire and what to do in case of break-outs or other emergencies
- Adequately clothed
- Trained in the use of all equipment they are using, and in safety procedures.



McCleod tool, fire rake, and shovel

Fire equipment and use

Hand tools

McCleod tools are used for scraping and grubbing into ground fuels

Fire rakes have a serrated cutting edge used to scrape surface fuels from firebreaks and fire lines.

Shovels can be used to:

- Clear firebreaks
- Create fire lines
- Dig out underground fires
- Beat out flames
- Put dirt on hot spots to smother flames
- Clear water points

- Build small dams to create fire ponds
- Protect your face from heat.

A ***mattock*** is used for grubbing in heavy roots, gravel and rocky ground.

Slashers are used to create or clear access to water points and to clear fire breaks and fire lines.

A ***Pulaski*** is used for chopping and grubbing.

Beaters (short lengths of fire hose attached to slasher handle) are used to beat out flames in light vegetation, such as bracken and grass.

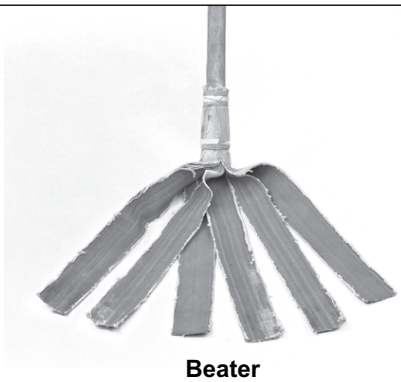
Mattock, slasher, and pulaski

Knapsack pumps

Knapsack pumps can be used to:

- Damp down hose lines laid through burnt over areas, wet down fence lines, or lay fire retardant on firebreaks and fences.
- Extinguish hot spots and embers falling outside of the burn area.
- Extinguish hot spots during mop-up.

Note that a wetting agent should always be used with a knapsack pump to maximise the wetting efficiency.



Beater

Portable pumps

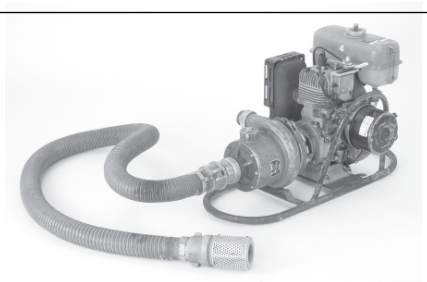
Portable pumps are used to transfer water from reservoirs or streams to where the fire is being fought. They are also used to refill monsoon buckets for aerial (helicopter) application.

The different types of portable pumps are categorised according to their capacity:

Pump type	Capacity	Example
High pressure low volume (HPLV)	150 litres per minute at 1400 kPa	Wajax pump
Low pressure high volume (LVHP)	900 litres per minute at 250 kPa	Aqualite pump
High pressure medium volume (HPMV)	360 litres per minute at 700 kPa	Brown Brothers pump

A ***suction hose*** is fitted to the pump inlet. This hose will have a coarse filter on the inlet end to reduce the amount of material entering the pump and hoses.

Some suction hoses (such as those used with a Wajax) are fitted with a *foot valve* (non-return), which allows the pump to be primed.



Portable pump with suction hose

Fire lighters

There is a range of tools available for lighting fires.

These may be used during an indirect attack to burn between a fire and a fireline. They are also used to light controlled burns for land clearing.

Fire lighting tools are specialist equipment and should only be used by fully trained workers.

The ***dip torch*** uses diesel dispensed from a handheld container.

A ***gas wand*** is a handheld LPG burner.

The ***backpack burner*** is worn by the operator. It is fitted with a wand to dispense diesel/kerosene.

A ***motorised burner*** is a motorised weed-spraying unit. It uses a diesel/kerosene mixed fuel.

An ***aerial burner*** is a purpose-built unit slung beneath a helicopter. It uses jellied petrol.

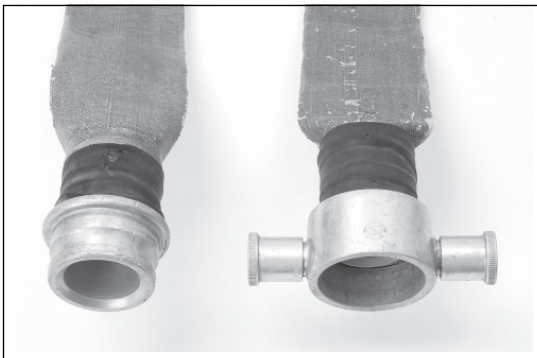
Power tools

- ***Brush cutters*** are effective at cutting a fireline through light vegetation.
- ***Chainsaws*** can be used to fell larger scrub to clear a fireline or gain access for fire hoses.

Operators of chainsaws and brush cutters must be experienced/trained in their use. They must also wear the appropriate PPE and use specified techniques (*see* **Best Practice Guidelines for Land Preparation** and **Best Practice Guidelines for Chainsaw Use** for further details).

Workers wearing chainsaw chaps or trousers should not work near the fire, as these garments are flammable. The execption would be clearing vegetation from the fire edge with a chainsaw.

Screw coupling



Instantaneous coupling

Hose pack

Hoses

There are two main types of fire hoses used in forestry.

Percolating

- Identified by six stripes on the hose (three per side when folded).
- Allows water to weep through the hose lining to help protect the hose from burning.
- Used near the fire.

Non-percolating

- Identified by two stripes on the hose (one per side when folded).
- Is rubber lined so there is less pressure/water loss when pumping over long distances.
- Should not be used inside a fire or on burnt ground. Generally used away from the fire as a relay hose.

Hoses come in a range of sizes — 25 to 70 mm in diameter and 25 to 30 m in length.

Two types of hose ***couplings*** are used.

- The smaller 25 mm and 41 mm hoses attached to HPLV pumps use a 41-mm ***screw coupling***. The male end of the coupling is always at the fire end of the hose, the female to the pump.
- The larger 45 mm and 70 mm hoses connected to LPHV pumps use an ***instantaneous coupling***. The female coupling is always at the fire end of the hose, the male at the pump end.
- Hoses of 25 mm and 41 mm diameter are usually carried in hose packs. Three or four hoses are coupled together and layered clockwise one upon the other in the pack.
- The male coupling is on the bottom allowing the hose to be run out towards the fire.

- Packs are colour coded according to the size/type of hose they contain:

  Green – 41 mm percolating

  Blue – 41 mm non-percolating

  Red – 25 mm non-percolating.

Nozzles

There are three main types of hose nozzle:

- ***Adjustable nozzles*** can be adjusted from a straight jet to a fanned spray. The fan spray is useful for reducing radiant heat.
- ***Straight nozzles*** provide a straight jet of water. They are not adjustable. They are suited to providing reach and penetration into burning material.
- ***Foam nozzle*** for applying water with foaming agent added.

Water additives

Water additives are commonly used to increase the water's ability to wet the material it is hitting.

A surfactant such as soap can be used to increase the wetting action. Soap can be introduced to the water supply either through pre-mixing or via a ***hydroblender***. The hydroblender can be connected to the hose network between two 25 mm/41 mm hoses.

A second water additive may be Class A foam. Foam increases the efficiency of water by:

- Reducing evaporation
- Being visible, which reduces water usage
- Reducing the surface tension of the water to allow greater penetration and increased coverage
- Holding the water above the fuel to allow slow release of the water, to inhibit re-ignition.

Foam can also be applied at high rates to form short-term firebreaks.

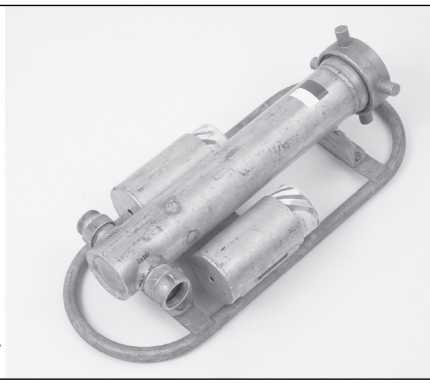
Foam can be added to the water supply using a ***foam proportioner***. The foam proportioner is connected to the water supply and releases foam at the specified rate.

Fire retardant

Fire retardants are used to stop unburnt fuel from burning. Retardants are mixed with water and sprayed on to vegetation ahead of the flames as a firebreak. It can be used on the fire head, flanks, control lines, or to assist with burnout operations. The water in the mixture evaporates, leaving the retardant that resists combustion.

Adjustable nozzles (left and centre) and straight nozzle (right)

Foam nozzle



Hydroblender

Foam proportioner

Dividing breach

Dividing breach

The divider is fitted to the outlet side of the pump to control water flow to the hose(s). It can be used to bypass the delivery hose(s) by directing water down a section of bypass hose. Usually this hose is directed back in to the water source to conserve water. Alternatively, a dividing breach can be used to split the water flow into two hoses.

Fire appliance

Fire appliances

Fire appliances are specialist vehicles fitted with tanks and pumps for rapid response to fire breakouts. They are usually four-wheel-drive.

Heavy machinery

Machines such as bulldozers, excavators, skidders, or graders may be called in to clear the fireline or build access tracks.

Monsoon bucket

These are specialist items used with helicopters to rapidly deliver large volumes of water on to the fire in difficult places.

They can be filled by dunking them in a pond or lake, or if this is not possible they are filled by high volume pumps at specified loading points.

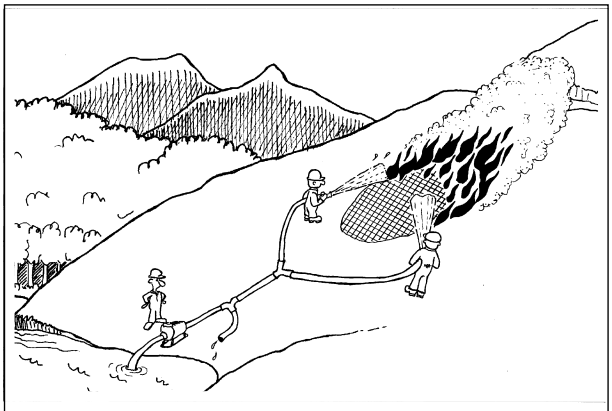
Fire retardants can be added manually, or some systems have a direct injection facility controlled by the pilot.

Fixed wing aircraft

Fixed wing aircraft used for agricultural applications are capable of dropping large quantities of water in a single water drop. Water is pumped into the aircraft holding tanks using portable pumps or fire appliances.

Water delivery systems

Pumps and hoses can be used in several ways to deliver water from a source to the fire.



Standard hose lay

Standard hose lay

Water is delivered from a water source to one or more nozzles using a single pump. The pump is able to deliver enough volume at the nozzle to provide a suitable pressure.

Multi-pump systems

If water is being pumped uphill or over long distances, a multi-pump system may be needed to ensure adequate pressure at the nozzle(s). The more hose being used, the lower the pressure at the nozzle. When using 41 mm hose from the pump (Wajax type), added pumping capacity is needed when:

- there are more than 18 lengths on flat ground
- there are more than 9 lengths up a steep slope.

Additional pumps can be added in three main ways.These are:

- Two pumps
- Long-coupled tandem (closed relay)
- Relay pump (open relay).

In the ***two-pump*** system, a second pump (of similar or lower power) is added just beyond the first pump.

If the second pump is more powerful, swap it for the first. If both pumps are of equal power, the second is run at slightly lower revs.

The dividing breach and bypass hose are fitted beyond the second pump.

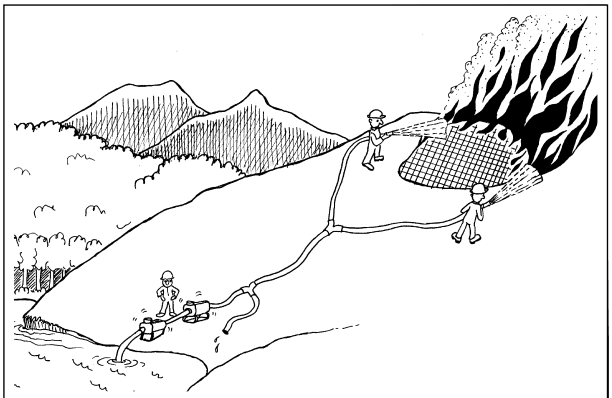
In the ***long-coupled tandem*** (closed relay) system the second pump is located uphill of the first pump. It is sited just below the maximum lift point of the first pump.

The hose from the first pump is fed directly into the second pump. This requires a relay adaptor to connect 41 mm hose to the inlet of the second pump.

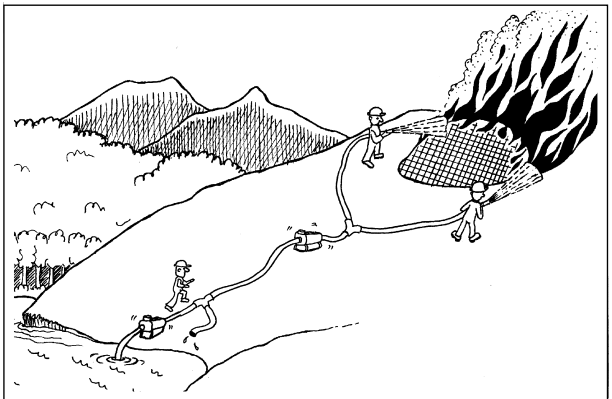
The ***relay pump*** (open relay) system also relies on a second pump located up the hill from the first. In this system the water from the first pump is directed into a relay dam or tank.

The second pump draws from this reservoir to deliver water to the nozzles.

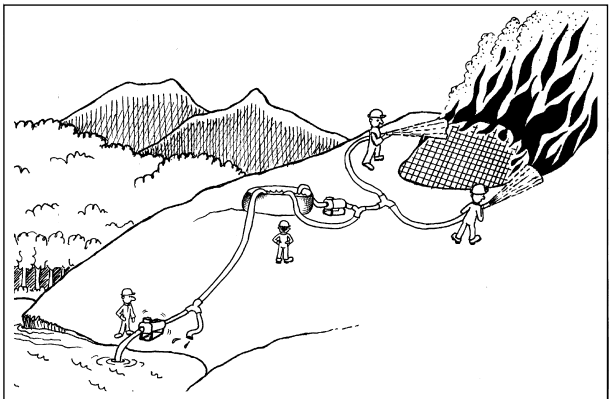
A bypass hose is fitted to the second pump, which allows water to be directed back into the reservoir. This can be used to match the capacity of the second pump with the water inflow into the reservoir.



Two-pump system



Tandem system



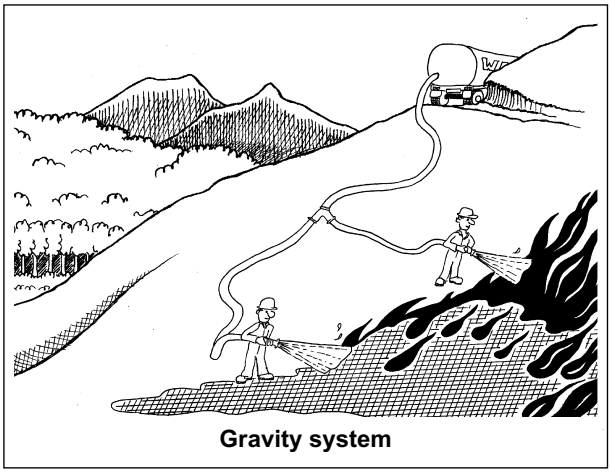
Relay system

Gravity system

The gravity system requires the water reservoir to be uphill from the nozzle(s). Water flows into the hose under gravity and flows downhill. This system is most likely to be used when a tank or portable reservoir are located uphill of the fire.

It is important to not draw water faster than it enters the hose. If this occurs a vacuum may occur in the hose, causing it to pinch closed.

Being a non-mechanical system, the gravity system can be more trouble-free than pump systems. However, hose pressures can build up to the point that hoses blow apart.



Gravity system

Fire procedures

What to do if trapped on foot

Whenever you are working at a fire, it is vitally important that you plan and maintain an escape route. You should be alert to changes in the fire behaviour and movement.

However, if the escape route cannot be used (and no alternative exists), then the crew must dig in and wait for the fire to pass. Stay calm.

Follow the steps below when digging in.

(1) Select an area of little or no unburnt fuel.

(2) Find shelter behind any available features (rocks, banks) to reduce the effects of the radiant heat.

(3) Dig a shallow trench and cultivate the soil in a 1-m-wide zone around the trench.

(4) If available, use water to wet down the area. Set up a hose to provide a cover spray over the crew.

(5) Ensure other members of the crew are able to do the same.

(6) Lie face down in the trench, and shield yourself using your clothing and helmet. You can also use your shovel to protect your face.

(7) Do not get up until the fire has passed.

Lie face down in the trench you have dug

Do not run into unburnt areas

Do not run uphill or down wind of the fire

Do not run through the flames unless you can see clear ground beyond

What to do if trapped in a vehicle

If escape by vehicle is not possible, stay put, stay calm and follow the steps below.

- Park on the side of the road away from the direction the fire is coming from, or in the middle of a cleared area.
- Wind up the windows, close the doors, and close any vents.
- Switch on the vehicle's hazard lights.
- If available, use your RT/cell phone to let organisers know where you are and what you're doing.
- Keep below the level of the windows and cover yourself with any loose clothing, blankets, etc.
- Do not leave the engine or air conditioner running.

Do not get out of the vehicle and move away until the fire has passed or eased

If the vehicle itself ignites, it may be necessary to attempt escape on foot.

Creating a fireline using hand tools

The Crew Boss determines where the fireline is to go. He/she then instructs the crew members on their tasks.

Considerations for crew boss in determining fireline placements:

- Use of natural barriers and breaks
- Terrain - avoid the steepest parts of any slopes
- Fuel types - avoid areas of heavy fuel load if possible
- Follow path of least resistance.

The procedure for creating a fireline is as follows:

(1) Cut the vegetation off at ground level in a 2-m-wide strip.

(2) Move cut vegetation away from the fire and spread it out.

(3) Scrape away any surface fuels (grasses, weeds).

(4) Cut in to the duff layer and loosen.

(5) Remove loosened duff and spread it away from the fire.

(6) Expose mineral soil.

(7) Dig a trench (30 cm deep) to remove any underground fuels (roots).

Remove all unburnt fuels from the fireline

Remove larger standing fuels from just beyond the fireline to increase effectiveness

Fire lines need to be cleared to a width of 1.5 times the height of the tallest vegetation within the adjacent fire area to prevent trees or tall scrub falling across the line and igniting the unburnt side.

Setting up a portable pump

This section is divided in to the following steps:

- Equipment requirements
- Setting up the pump
- Pre-operation check
- Using the dividing breach
- Refuelling the pump
- Choosing a pump site
- Priming the pump
- Starting the pump
- Stopping the pump
- Pump care.

Equipment required

- Pump
- Fuel for pump motor
- Suction hose
- Fire hoses and nozzle
- Bypass hose (short length)
- Hydroblender or foam proportioner or inductor
- Dividing breach (at least two)
- Hydroblender hose (2 m)
- Soap capsules or foam concentrate
- Spade or shovel .
- Adaptor couplings
- Portable dam, or ladder and salvage sheet
- Torch
- Length of rope
- Hose coupling spanners
- Monsoon bucket (gooseneck) filling elbow protection
- Communication equipment (RT)
- Tool kit for pump motor
- Earmuffs (at least Grade 4) or other hearing

Choosing a pump site

The choice of where to locate the pump will be affected by the following:

- Volume of water available
- Distance and direction to the fire
- Need for a dam
- Availability of a safe escape route
- Amount of unburnt fuel in the area
- Quality of water (salt, brackish, or fresh)
- Access to the water
- Area to set up pump
- Freedom from overhead and up-slope hazards
- Communication constraints.

Setting up the Pump

(1) If necessary, the pump site should be cleared of large vegetation before the pump is set up. This will reduce fire risk and remove hindrance to movement about the site.

(2) The pump should be sited on flat ground above the water supply. If deemed necessary, the pump can be anchored to a stake or stump using a length of rope.

(3) Assemble the pump kit (suction hose, dividing breach, tools, and other accessories). Store spare fuels at least 3 m away from the pump, and away from the waterway and out of direct sunlight.

(4) Connect the suction hose to the pump inlet. If possible, secure the end of the suction hose above the bottom of the reservoir/stream using a float to reduce chances of unwanted material being sucked into the pump. Alternatively, use the spade or shovel to clear a suction site, or lay the suction hose inlet on the face of the shovel submerged in the water.

(5) Connect the dividing breach to the outlet side of the pump.

(6) Connect the bypass hose and place discharge end back in the water supply.

Priming the Pump

Priming of the pump (and having a constant inflow of water) is necessary to avoid the pump over-revving and damaging itself by overheating.

Priming using suction hose with a foot valve

(1) If a dividing breach is fitted, open one side so that water can move up the suction hose into the main chamber of the pump.

(2) Holding the suction hose as close to the inlet as possible, move the suction hose up and down in the water. This action progressively fills the hose because of the foot value (non-return) on the suction hose.

Keep the inlet end of the suction hose clear of the bottom of the reservoir/stream to reduce the chance of material entering the pump.

(3) Stop the priming action when water flows from the open dividing breach outlet.

Priming using a hand priming pump

(1) Attach the hand pump to the pump outlet.

(2) Pump until water flows from the hand pump.

Priming using a container (to be used as a last resort)

(1) Remove the outlet cap from the top of the pump.

(2) Fill the pump with water from a container until full.

(3) Replace the filler cap.

If the pump will not prime

(1) Check the one-way value on the suction hose for clogging and jamming.

(2) Check that the suction hose is sufficiently submerged and is not sucking air.

Pre-operation check

Check the following:

- The pump set-up (is it secure)
- The correct fitting of the hoses and dividing breach
- Spare fuel
- That the pump is fully primed
- The correct positioning of the suction hose inlet
- Communication equipment present and in working order
- Any additional equipment required.
- That the fuel tank is full.

Starting the pump

Cold starting procedure

(1) Before commencing the start-up procedure, check that the pump is correctly set up. Ensure those operating the pump wear appropriate hearing protection.

(2) Open the air-vent on the fuel tank.

(3) Turn the fuel on using the tap beneath the fuel tank.

(4) Close the choke.

(5) Set the throttle to one-third speed.

(6) Turn ignition or cut-out switch on if fitted.

(7) Grab the starter handle firmly with one hand. Have a firm stance, with both legs slightly bent, one foot on the pump frame between motor and pump, one hand on the fuel tank.

(8) Pull the starter cord with several quick short pulls.

(9) Once the engine has fired, open the choke.

(10) If water is not required in the hose, bypass the water flow to allow the engine to warm.

(11) When directing water to the hose line, allow the entire line to fill before increasing the engine speed.

Warm starting

When warm, the engine should fire with the choke in the open position. Then follow the remaining steps from the cold starting procedure above.

Using the dividing breach

One valve must **always** be open.

Follow the steps below when “water on” is signalled:

(1) Open delivery valve

(2) Close bypass valve on divider (this sends water towards the nozzles)

(3) Increase motor speed according to hose operators signals

(4) Set motor speed as required to maintain pressure.

Follow the steps below when “water off” is signalled:

(1) Decrease motor speed to 1/3 or less

(2) Open bypass valve on divider

(3) SLOWLY close hose valve on divider

Be aware of cycling additives into the waterway through the by pass.

Stopping the pump

Before stopping the pump, notify the nozzle and hose operators so they can move to a safe position.

Turning off the ignition or activating the kill switch can stop the motor. If neither of these work, closing the choke or turning off the fuel tap can be used.

Refuelling the pump

- Refuelling must only take place while the motor is switched off.
- Check that the fuel mixture is correct. Colour of fuel tank and re-fuelling can should be the same - that is, blue tank = blue can.
- Fill the tank without spilling.
- Refuelling should be carried out in conjunction with hose changes and other stoppages whenever possible.
- Notify hose and nozzle operators that the pump will be shut down
- Allow spillage or fumes to evaporate before starting the motor.
- Do not overfill fuel tank, leave a 5% air gap.

It is also advisable to check and replace (if necessary) any water additives while refuelling. When using a hydroblender, a new soap capsule should be added for each fill of the pump's fuel tank.

Pump care

The pump and motor must be kept in good working condition.

After each use:

- Ensure the pump and associated equipment are all together
- Check with last users that all worked OK
- Check suction hose fittings and coupling, dividing breach, and other fittings
- Test run the pump
- Refill the tank with the correct fuel mix
- Drain the pump unit and hand spin pump shaft to check bearings.
- Check the pump and motor for damage, loose nuts, bolts, and screws, and fix if necessary
- Flush clean water through the pump
- Run the carburettor out of fuel by running the motor or using carburettor drain screws
- Turn off the fuel tap
- Wipe any grime from the motor and pump

The pump and pump kit should be replaced in their storage place (clean and dry) and the details of their use recorded.

Using hoses to deliver water

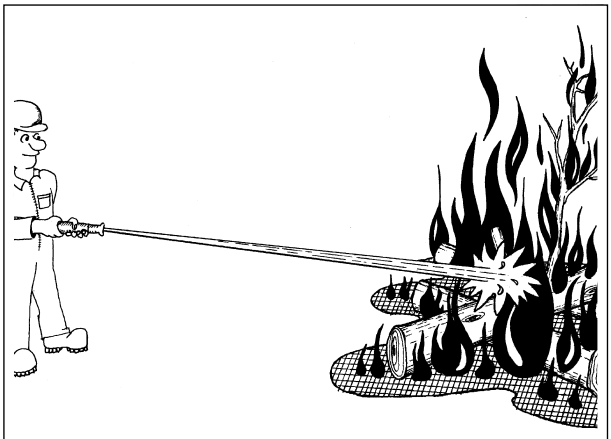
Laying a hose line

- Connect the hose at the pump.
- Walk to the nozzle or discharge end, paying out/unrolling the hose. Walk in as straight a line as possible to reduce the chance of kinks.
- If crossing a road, either pass the hose through a culvert or under a bridge (if present) or use hose ramps so that vehicles will not damage the hose.
- If crossing a fence, lay the hose under the bottom wire.
- If crossing a railway line, pass the hose under the track between the sleepers.
- Avoid laying hose through unburnt areas where there is a risk of fire spread.
- Damp down the hose line before crossing burnt areas.
- Secure the hose to stop it slipping downhill when charged.
- Avoid sharp or abrasive objects.

Applying water

- During the initial attack, a straight jet of water can be used to knock-down the flames from a safe distance. Direct the water at the burning materials, not the flames. A straight jet can also be used on high-intensity fires, crown fires, and burning spars.
- When it is safer for the nozzle operator to approach the fire, the spray is used to remove heat from surface fuels along the fire edge. Note: this may cause embers to fly into unburnt fuels.

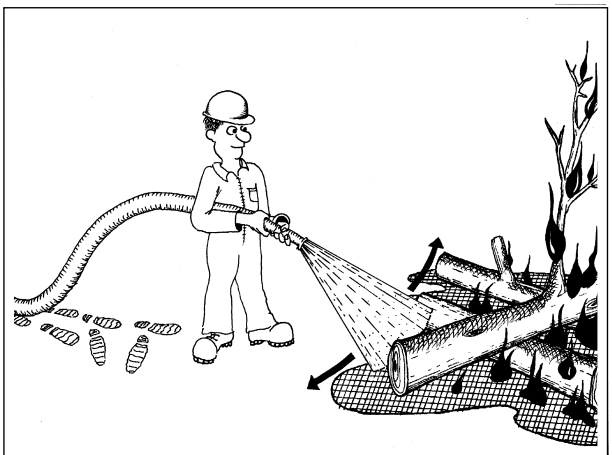
- The spray option can be used to shield the operator from radiant heat generated by the fire.
- A straight jet of water should be used to penetrate into a deep-seated fire or reach distant hot spots.
- When using a solid jet be aware of the potential for blow-back of dirt, embers, hot water, and steam.



Initial attack with a straight jet of water

Protecting the Point of Origin

- The point of origin is the point where the fire is suspected of starting. This must be protected so investigators can determine the cause of the fire.
- Avoid damaging the point of origin. If necessary, only use a fine spray to put any fire out.
- When safe, isolate and mark the area so others do not damage it.
- Record the names of any unauthorised people met in the area. Sketch a map showing the layout of the point of origin and any special features/ objects that will help investigators.



Using a spray along the fire edge

Extending a Hose Line

When extending a hose line with uncharged hose:

(1) The nozzle operator will dampen the ground where the hose is going. This will reduce the chance of the hose burning. Signal “water off”.

(2) Disconnect the nozzle.

(3) Connect the exposed end of the new hose and walk towards the new nozzle position.

(4) Allow some slack in the hose behind the nozzle operator.

(5) Do not extend hose in front of the nozzle operator.

(6) Reconnect the nozzle, and signal “water on” to the pump operator using hand signals or radio.

Moving a charged hose line

- Moving a charged hose can be a tough job because it is heavy.
- Use a team of people to move a charged hose. Drag the hose by laying it over your shoulder and walk leaning forward.
- Be careful not to damage it on obstacles or hot spots.
- It may be easier to signal water off, disconnect the hose, “pineapple”, and carry it, or disconnect and then drain and drag to new position before re-connecting and re-charging.

Hose care

During use:

- Do not bend hose at a sharp angle (kink)
- Avoid dragging hose over obstructions or rough ground
- Keep clear of hoses when using hand tools
- Watch for chafing of first length of hose (nearest the pump)
- Do not walk or drive on hose
- Check that the hose does not move into hot spots
- Do not throw or drop couplings
- Hand tighten couplings (only use hose spanner to loosen).

After use:

- Check hoses for burns, chafing, or cuts
- Check couplings
- Check the rubber washer in the female couplings.

If a hose is damaged, tie a knot in the exposed end after it has been rolled up (*see below*)

Handling hose after use

When moving a 25 mm or 41 mm hose, it is best rolled into a “pineapple” shape.

(1) Start by laying out the hose as straight as possible, avoid any twists. Drain water from hose.

(2) Start folding the hose over on itself at the male coupling end. Make the first fold about 20 cm long. Complete about six folds (this forms the core).

(3) Continue folding the hose while rotating the core so the hose crosses over itself.

(4) Continue rolling and twisting the “pineapple”, ensuring the folds are tight.

(5) Tuck the female end of the hose beneath an underlying fold to stop it coming undone.

(6) Carry the hose using an inner fold as a handle.

Mop-up and patrol tasks

The fire can not be considered or declared “out” until the mop-up tasks are completed.

On small fires, extinguish all smouldering fuels.

On large fires:

- extinguish the perimeter first
- move inwards making sure you put out any spot fires.

The mop-up tasks are as follows:

- Extinguish all smouldering surface fuels.
- If subsurface fire is likely, create a fireline beyond the perimeter. Be careful to dig up any roots crossing the fireline. Mix with water to extinguish.
- Use hand tools to dig into smouldering fuel and turn it over.
- Use spray to wet smouldering fuel.
- Use a straight jet to penetrate burning duff, stumps, or logs. Force the nozzle as close as possible to the burning material (be careful not to spray water or material back into your eyes). Use a duff probe to penetrate deep duff.
- Down any burning spars using either a machine or a chainsaw. Chainsaw operators must be qualified and experienced and follow the industry guidelines for tree felling. An unstable spar should be marked off. People must keep two spar lengths back from it.

Once the fire has been extinguished, the last step in the operation is to patrol the burnt area. Patrolling may need to continue for several days to ensure that the fire does not start-up again.

Patrol tasks include:

- Feeling for hot spots with the back of your hand (cold-trailing). Infrared cameras or heat torches can also be used.
- Digging out and/or wetting hot spots.
- Covering the entire burnt area and the perimeter as a team looking for any signs of burning. If any are found, extinguish them as quickly as possible.
- Use of infrared thermal imaging if necessary.

Glossary of terms

Aspect	The direction a slope is facing (e.g., north, south, etc.).
Base, back, rear, (or heel)	The section of the perimeter opposite to and generally upwind (or down slope) from the head of the fire.
Barrier	A feature which stops the progress of a fire. May be natural (stream) or constructed (firebreak).
Bay(s)	A marked indentation in the fire perimeter usually located between two fingers.
Beater	Short lengths of old fire hose connected to an axe handle. Used to beat down light burning fuels.
Back-burn	A counter fire deliberately lit to fight or control another fire.
Break-out	Fire starting outside of the area of the controlled burn or where an uncontrolled burn jumps a fire break or line.
Burn	An area which has had fire over it.
Burner	A tool for lighting fires in controlled burnoffs or for burning fuels. Usually runs on diesel, kerosene, gas, or jellied petrol.
Bypass hose	A short length of hose connected to a dividing breach on the nozzle side of the pump. Often used to bypass water back into the reservoir when hoses are being connected or moved.
Centre ignition	A fire lighting pattern where fire is lit in an ever-increasing spiral from the centre.
Charged hose	A hose that is full of water ready for use.
CIMS	Co-ordinated Incident Management System
Cold-trailing	A method of determining whether a fire is still burning involving careful inspection and feeling with the hand, or use of a heat detector to defect any heat sources.
Conduction	Transfer of heat through the burning material or object.
Containment	Keeping the fire within a defined area.
Control line	Any line from which the fire is being fought.
Controlled burnoff	Use of fire for land clearing.
Convection	Upward movement of air and heat caused by a fire.
Couplings	A device to connect ends of adjacent hoses or to connect pumps to hoses. Can be either screw or instantaneous type fittings.
Crew Boss	A person in charge of a fire crew consisting of two to eight people. Crew boss is responsible for their safety, performance, and welfare.
Crown fire	A fire burning in the tops of trees or shrubs
Direct attack	Direct treatment of burning fuel using tools, machines, and/or water.
Dividing breach	A flow divider used to split the water flow from one to two separate lines.

Glossary of terms (cont...)

Duff Forest floor material usually consisting of needles, small branches, and soil.

Duff or peat probe A length of steel pipe (13–19 mm diameter) connected to a fire hose for sending a jet of water into deep duff layers.

Dug in A person trapped in a fire prepares a site to shelter on the ground. Involves digging a shallow trench to lie in.

Finger The long narrow extensions of a fire projecting from the main body.

Fire Boss *See* Incident Controller

Fire danger General term for assessment of fixed and variable factors affecting fire ignition.

Fire front The portion of a fire edge showing the greatest rate of spread and fire intensity.

Fire hazard General term for potential fire behaviour, looking at weather and fuel moisture content.

Fireline

(1) A cleared strip beyond the perimeter of the fire. Used to contain the spread of the fire and gain access for hose operations.

(2) That portion of the fire upon which resources are deployed or are actively engaged in fire suppression.

Fire perimeter The entire outer boundary of a fire area.

Fire retardant Any substance (except water) that reduces the rate of burning by reducing flammability or combustion. Applied to unburnt fuel ahead of the fire.

Fire risk The potential for / probability of a fire starting due to potential ignition sources.

Flank The part of a fire's perimeter that is roughly parallel to the main direction of spread.

Foam When added to water flow can increase the wetting action of water. Useful where water reserves are low.

Foam inductor A device, usually connected at the pump, that sucks the foam concentrate from a reservoir and introduces it into the water flow.

Fuel Any material capable of burning.

Gravity system A hose set-up where water is supplied to the nozzle through the action of gravity (no pump). Requires the water reservoir to be higher than the nozzle.

Ground fire A fire which is burning in the ground cover (grasses, weeds, and scrub).

Head *see* Fire front

Heat exhaustion The second stage of heat stroke. Symptoms include weak pulse, shallow breathing, clammy skin, pale face, and slow reactions.

Heat stress The first stage of heat stroke. Symptoms include flushed face, sweating, weakness, tiredness, dizziness, and nausea.

Glossary of terms (cont...)

Heat stroke	A dangerous condition of over-heating. Symptoms include increased heart beat, hot dry skin, high body temperature, flushed face, headaches, and dizziness. Patient is irritable and confused.
Hose adaptor	Used to connect 41 mm hose to 70 mm hose.
Hose strangler	A clamping device that strangles the hose to stop water flow.
HPLV	High pressure, low volume. A class of water pump commonly used at fires based on capacity and pressure (e.g., Wajax).
Hydroblender	A device which allows soap capsules to be mixed with the water flow.
Hypothermia	A dangerous body condition in which the core temperature becomes too cold. Early symptoms include shivering, coldness, and numbness of extremities, pale skin colour, clumsiness, and irrational behaviour.
Incident Controller	Person responsible for all of the overall management of suppression and service activities at a fire.
Indirect attack	Any action on unburnt fuels ahead of or away from the fire which will slow or contain further advance.
Island	An unburnt area within the fire perimeter.
Knapsack pump	A backpack pump used to spray light fuels. Should be used with a wetting agent.
Knock-down	The initial attack on a fire using a jet of water to knock down the flames.
LPHV	Low pressure, high volume. A class of water pump based on capacity and pressure. Used to fill tankers and monsoon buckets.
McCleod tool	A rake-like tool used for scraping and grubbing into sub-surface fires.
Mattock	A hand tool used for grubbing into heavy roots, gravel, and rocky ground.
Monsoon bucket	A pilot-activated water bucket slung beneath a helicopter. Used to drop water on targeted sites.
Mop-up	The fire-fighting stage where the fire is made safe by extinguishing all evidence of burning after the main fire has been brought under control.
Non-percolating hose	Fire hose that does not allow water to weep through it. Has a smooth inner allowing greater pressure and volume. Used to transport water to fires.
Percolating hose	Fire hose that allows water to weep through it. Weeping helps protect the hose from fire damage.
Point burning	A moving fire-lighting pattern where spot fires are started in a point or grid pattern progressively upwind.
Point of origin	The location within the fire perimeter where ignition(s) first occurred.
Prime	Filling a water pump with water before starting a pumping operation. Required for centrifugal pumps (e.g., Wajax).
Pulaski	A hand tool used for chopping and grubbing.

Glossary of terms (cont...)

Radiant heat	Heat transfer directly through the air to other objects.
Relay adaptor	A fitting which allows a 41 mm fire hose to be connected to the inlet side of a portable pump.
Relay dam	A portable dam set up to provide a reservoir for another pump. Usually set up just below the maximum pumping height of the first pump.
Relay pump system	A multi-pump system where the first pump delivers water into a tank or dam. The second pump draws water from the tank or dam and pumps it further uphill.
Retardant	*see* Fire retardant
Ring burning	A fire-lighting pattern where fire is lit around the perimeter of an area to be burnt.
Reservoir	A source of water such as a stream, pond, tank, or dam.
Runners	People who deliver written or verbal instructions during a fire operation.
Shovel	Primary forestry fire hand tool.
Slasher	A hand tool used for chopping standing (light) vegetation.
Strip burning	A fire-lighting pattern where successive strips are lit up-wind of each other.
Subsurface fire	A fire that burns below-ground fuels such as roots, peat, and buried logs.
Surface fire	Fire that burns in the surface fuel layer excluding crowns of trees.
Surfactant	An additive to the water flow (such as foam or soap) which increases the ability of the water to spread and wet fuels.
Wild fire	An unplanned and uncontrolled fire.