EuroFire

Unit EF6: **Training: Apply Vegetation Ignition Techniques**

Introduction:

These training materials support the EuroFire Level 2 competency standard **EF6 Apply vegetation ignition techniques.**

This document is for people who are required to use hand operated ignition equipment for burning vegetation fuels. It is for situations where: the ignition operation is simple, the level of risk, complexity and fire behaviour is low and the operator is under direct supervision.

Ignition techniques are likely to be a regulated activity. All national and local laws relating to ignition techniques must be followed. In addition local landowners may need to be consulted or give their approval before ignition takes place.

The training for this unit may be delivered through a combination of formal training, mentoring and coaching. Self-learning should be restricted to knowledge and understanding of the material and not practical application, which must only be carried out under direct supervision.

The nominal/notional/guided learning hours for this unit is 20 - 30 hours.

Eurofire is a pilot project. The training material will be evaluated as part of an on- going process. A feedback form is included on the website www.euro-fire.eu

The target audience for this material are the people who work in fire services, farming, forestry, game management, conservation, range land and recreation management who have a role assisting with the management of vegetation fires, either on a full or part-time basis.

Relationship with EuroFire competency standards and risk management

Reference to the EuroFire competency standards should be made to understand the full range of expected learning outcomes. The sections of the standards are: unit title, element title(s), about this unit, key words and phrases, what you must be able to do, this element covers, and what you must know and understand.

The support materials for all the EuroFire competency standards are designed to support a flexible approach to training delivery. They can be adapted or modified to suit a particular target audience. The learning material for this unit should be used with the support materials for other units to ensure all learning outcomes in the standards are covered.

There are various European Union Safety Directives which have been enacted as specific Health and Safety legislation in each country in the EU. This legislation is designed to improve workplace safety and health and reduce work related accidents and diseases. All necessary safety legislation, risk management policies and procedures, for your location, agency or organisation must be followed.

Preparatory (pre-requisite) learning:

EF 1 - Ensure that your actions in the vegetation fire workplace reduce the risks to yourself and others
EF 2 - Apply techniques and tactics to control vegetation fire

Complimentary (co-requisite) learning:

EF 3 - Communicate within a team and with supervisors at vegetation fires
EF 4 - Apply hand tools to control vegetation fires
EF 5 - Control vegetation fires using pumped water

Learning objectives:

On completion of learning you should be able to:

1. Prepare ignition devices and ancillary equipment for use at vegetation fires
2. Apply ignition devices following specified firing plans

Keywords and phrases:

Anchor Point, Burning Out, Backburning, Backfiring, Control Line (Fire Line), Driptorch, Fire Environment, Fire Behaviour, Fuel Moisture Content, Fuel Load, Fuel Type, Ignition Patterns, Prescribed Burning.

Application:

Vegetation ignition techniques are used in the following fire management operations:

- Burning out
- Backburning
- Backfiring
- Prescribed burning

Ignition is a dry fire fighting technique. It extinguishes a fire by burning and removing fuels. Fires lit for this purpose must be maintained within the threshold of control. i.e. the fire behaviour in terms of flame length, rate of spread and fire intensity must be low enough for suppression teams to cope with.

The pattern of ignition, the firing plan, can be designed to achieve the desired fire behaviour. Often these are categorised into either low intensity fires or high intensity fires. This is often by reducing or increasing the influence of: fuels, wind, slope or aspect on fire intensity and rate of spread.

1. Prepare ignition devices and ancillary equipment for use at vegetation fires

Ignition Devices:

These are tools that are used to light fire, either for burning out, backburning, backfiring or prescribed burning. Each tool has advantages and disadvantages.

Diesel Burner

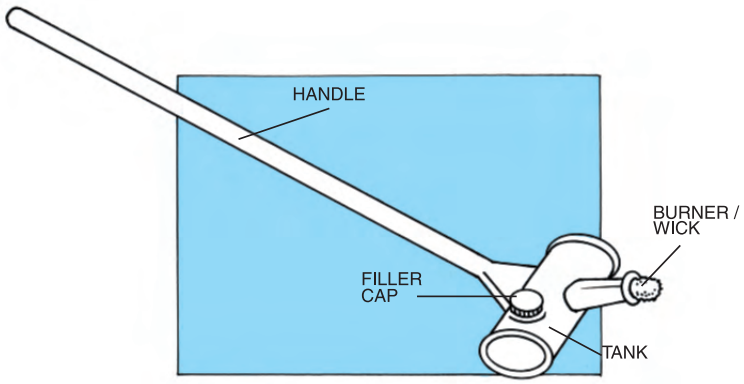

Illustration 1.1 Diesel burner

The diesel wick device is a simple tool. It consists of two main parts:

Burner	Where diesel fuel flows through a wick and burns at the tip
Tank	A metal cylinder with handle and filler cap

The fuel that this device uses is diesel. The device produces a low flame that is suitable for spot ignition in dry fuels. The device should be fuelled in an upright position with a funnel or spout and any spillage wiped off before use. Direct heat on the tank or spare diesel container should be avoided.

Drip Torch

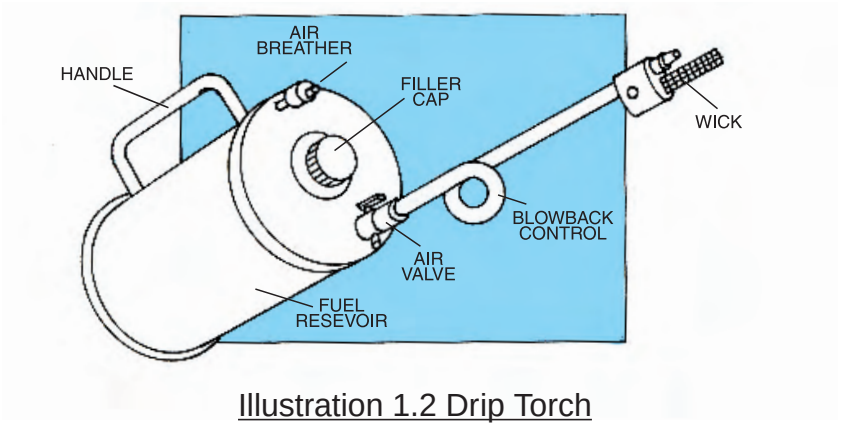

Illustration 1.2 Drip Torch

The drip torch is one of the most commonly used ignition devices. It consists of three main parts:

Burner	Where fuel comes out of a nozzle onto material that allows it to burn on some form of wick
Spout	A section of metal tube with a coiled section that prevents a flashback of flame back up the spout from the burning fuel at the tip of the spout
Tank	A metal cylinder with a handle, filler cap and air vent

The drip torch uses a mix of diesel and petrol fuels. Kerosene can be used instead of diesel. The drip torch can light wetter fuels either as spot or line ignition. It is a flexible tool that can create most ignition patterns.

The preferred mixing ratios of diesel to petrol are:

Dry fuels	4:1 (normal ratio)
Damp fuels	3:1

Fuelling / Re-fuelling of drip torch:

1. If necessary allow device to cool before refuelling.

2. Vapours from petrol are invisible and can travel considerable distances from spillage or fuelling sites. Maintain a safe distance from the fire and other ignition sources at all times.

3. Pre-mix the fuel in required ratio and store in an appropriately marked container.

4. Fill the drip torch to about ¾ full using the pre-mixed fuel through a funnel or spout to minimise spillage. Wipe off any spillage before use.

5. Position the drip torch spout so that the loop faces outwards away from the handle.

6. Replace the fuel caps securely after filling. Make sure that the seal or ’O’ ring is securely in place. Wipe off any fuel that has been spilt before ignition.

7. Keep fuel from contacting the skin. If fuel gets into the eyes wash out with sterile water immediately and seek medical advice as soon as possible.

Gas Burner

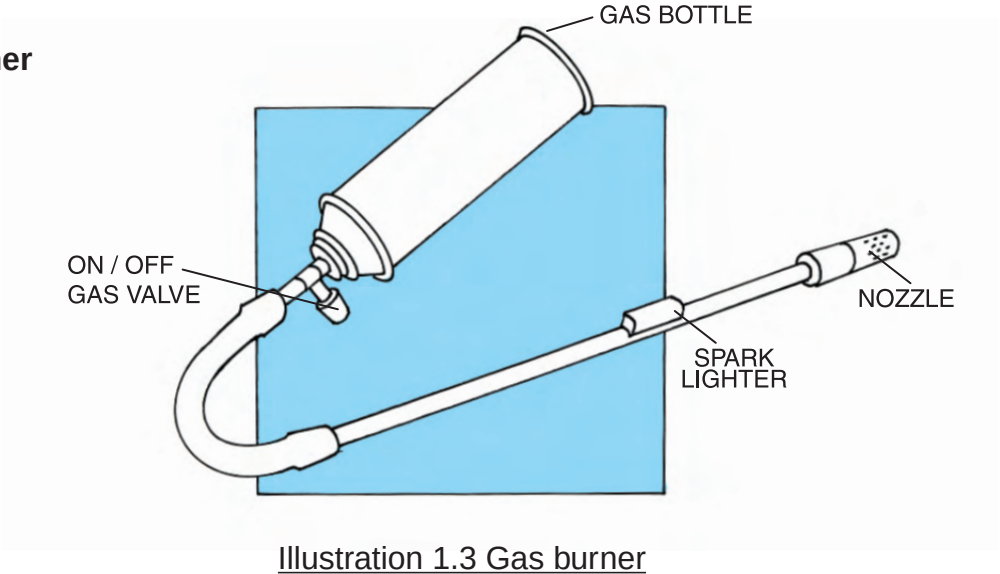

Illustration 1.3 Gas burner

The LPG pressurised gas burner consists of three main parts:

Spout Metal tube with ring at end to direct burning gases

Sparker Ignition device

Gas bottle Container of pressurised LPG gas

The gas burner is considered to be a clean device that is useful for spot ignition. However care is required not to allow the container to be damaged, punctured or heated and manufacturer's instructions must be followed at all times.

Transport and storage of ignition devices and spare fuel:

1. Drip torchs must have all vents and fuel valves turned off and ignition wick extinguished.

2. Drip torchs and diesel wick devices should be stored and transported in an upright position to avoid spillage.

3. Gas burners and gas bottles should be secured in a safe position before transport and empty gas containers should be disposed of safely and according to manufacturer's instructions.

4. Fuel containers must be designed and approved for use with petrol or diesel. They should be in sound condition, clearly labelled and have securely fitting caps.

5. Store fuel some distance away from the fire to avoid vapour ignition. Select a site shaded from direct sunlight and away from watercourses and drains.

Personal Protective Equipment (PPE)

The Personal Protective Equipment that a person carrying out ignition requires is described in the training module **EF1 Ensure that your actions in the vegetation fire workplace reduce the risks to yourself and others.**

The equipment includes:

- Helmet
- Goggles / visor
- Fire retardant clothing
- Strong boots
- Gloves
- Water bottle

Illustration 1.4 Personal Protective Equipment

2. Apply ignition devices following specified firing plans

Ignition and extinguishment process for drip torch and diesel burner:

1. Point the wick towards the ground where initial ignition is to take place. This may be at an anchor point or on the fuels to be burnt.

2. Allow the fuel to seep on to the wick, with a drip torch the air vent and any taps should be opened sufficiently to provide fuel.

3. Ignite the soaked wick with a match or lighter. The wick should now be kept alight as a pilot light.

4. Control the flow of diesel/petrol mixture onto the wick and onto the vegetation to be ignited. Adjust the flow of the mixture using valves, taps or air vents as necessary.

5. Choose the fuels specified in the firing plan and ignite them, while making sure that other fuels are not ignited.

6. After ignition is completed carefully place the device upright, close any taps or air vents and allow the fuel to burn low, then extinguish the pilot light, either with a sharp breath or by “clapping” the wick with gloved hands.

7. Do not push the wick into soil to extinguish as this will damage the burner.

Ignition and extinguishment of a gas burner

1. Point the spout towards the ground where initial ignition is to take place. This may be at an anchor point or on the fuels to be burnt.

2. Open the gas valve.

3. Press the sparking device.

4. Adjust the flow of gas as necessary.

5. Choose the fuels specified in the firing plan and ignite them, while making sure that other fuels are not ignited.

6. After ignition is completed hold the device firmly with the spout pointing away from fuels, people or equipment, close the gas valve and allow the gas to burn out.

Application of ignition

The successful application of ignition as a technique to suppress fires or when used in prescribed burning is largely dependent on achieving the desired fire behaviour.

The desired fire behaviour will be a combination of igniting and maintaining a fire within the threshold that available fire suppression resources can control.

As described in the **EF 2 Apply techniques and tactics to control vegetation fire** training material fire behaviour is largely determined by the combined influence of many factors including those related to fuel, weather and topography. These influences on fire behaviour apply to small local areas as much as they apply to larger areas.

Fire behaviour in this context relates to:

- Rate of spread
- Flame length and fire intensity
- Spotting activity
- Total burn-out time

Table 1: Influence of the fire environment on ignition techniques.

Fire Behaviour Factor	Description	Influence
Fuel factors:		
Type	Grass, crops, shrubs, trees, peat & roots	Potential for ground, surface & crown fire
Quantity	Tonnes / hectare	Fire intensity
Arrangement	Aerated & elevated or solid and on the ground	Rate of spread and fire intensity, potential for smouldering
Fuel Moisture	Where, what and how to ignite	Fuel moisture controls ignition, available fuel and rate of energy release
Weather factors:		
Wind	Strength & direction	Where to ignite, what to avoid.
Temperature & relative humidity	Dryness of fuels	Time of day/night most suitable for ignition
Atmospheric stability	Variable winds	Potential for blow-ups
Topographic factors:		
Slope	Potential ignition points	Lee slope, top of slope, mid-slope and bottom of slope issues
Aspect	Dryness and heating of fuels	Time of day

The phases of fire suppression that ignition is often used in are knockdown and containment. The main fire suppression strategies where ignition is used to achieve knockdown are parallel and indirect attack.

The flame lengths that different fire suppression tools and techniques can normally cope with are:

Table 2. Relationship between fire danger, flame length and tactical significance.

Flame Length (m)	Significance
0 – 0.5	Fires generally self extinguish
0.5 – 1.5	Fire intensity low Hand tools can be used in direct attack to control the fire
1.5 – 2.5	Fire too intense for direct attack with hand tools Pumped water or bulldozers may be needed Flanking / parallel attack recommended
2.5 – 3.5	Fire too intense for direct attack from control line Helicopters & fixed wing aircraft drops may be needed Flanking / parallel attack depending on local flame length
3.5 – 8	Very intense fire Backburning and backfiring may knockdown the head fire Flanking / parallel and indirect attack recommended depending on local flame length
8m+	Extreme fire behaviour Defensive strategies recommended

*NB the highlighted section indicates the range of fire danger that ignition techniques are sometimes used in.

These thresholds of control, along with the total resources available, need to be considered before permission to ignite is given.

To consider the locations that ignition is used a look at the shape of a typical fire is useful:

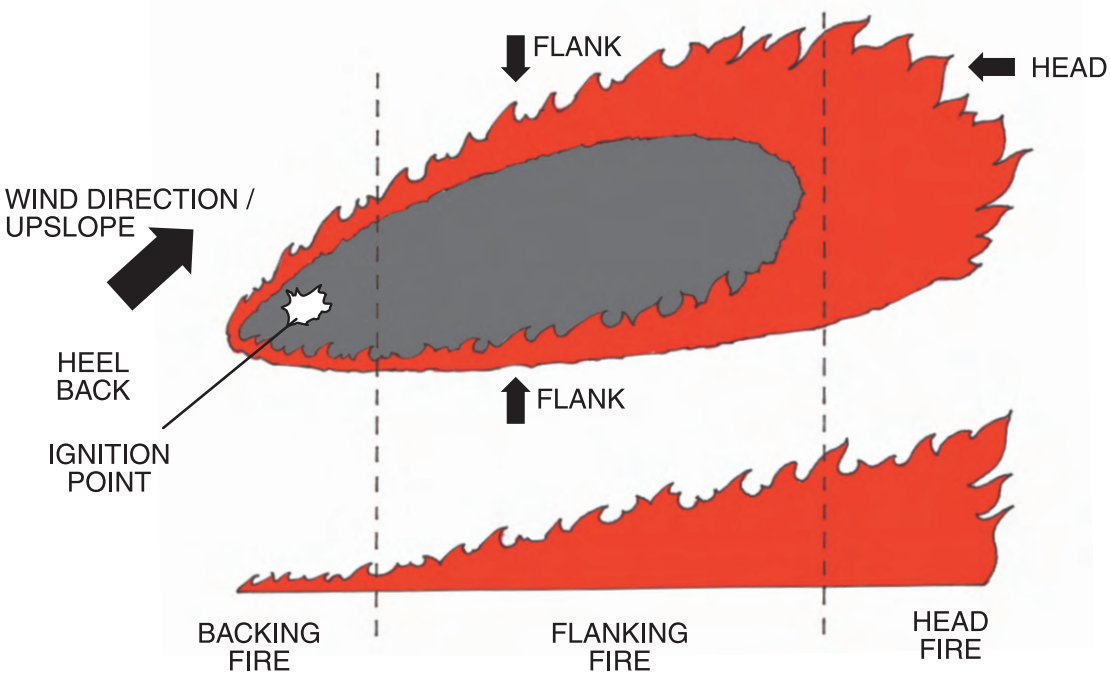

Illustration 2.1 Vegetation fire shape

The diagram shows a typical fire from above and from the side, where the length of flames varies around the perimeter of the fire. This fire shape is typical of a fire that is driven by either a moderate wind or slope. These are often the main factors affecting fire behaviour. To make sure that the fire stays within the desired threshold of control one or more of the factors controlling fire behaviour may need to be avoided or removed.

To keep fires small and within the threshold of control they can be lit: against the wind, downhill, across the wind or slope, or kept small. Fires can also be lit at different times of day on different slopes to catch or avoid the sun (aspect), or at night when it is cool. Different fuel types and fuel loads can also be burnt at different times and in different ways.

Control lines and anchor points

Detailed information on control lines can be found in **EF4 Apply hand tools to control vegetation fires.**

An anchor point is somewhere that has little or no fuels that cannot be outflanked by the fire. Anchor points are used to secure control lines. Anchor points are often the place where a road or river joins with a control line or fireline. It can also be a rocky area, pond or some other feature with no fuels.

The width of a control line that needs to be constructed varies. This can be due to the height of the surrounding vegetation, the angle that a fire approaches the line, the size of the flames or the amount of spotting that is occurring.

To stop a flanking or backing fire a control line needs to be 1 ½ times wider than the height of the surrounding vegetation. Another way of looking at it is that firebreaks should be 2 ½ times wider than the length of the flames.

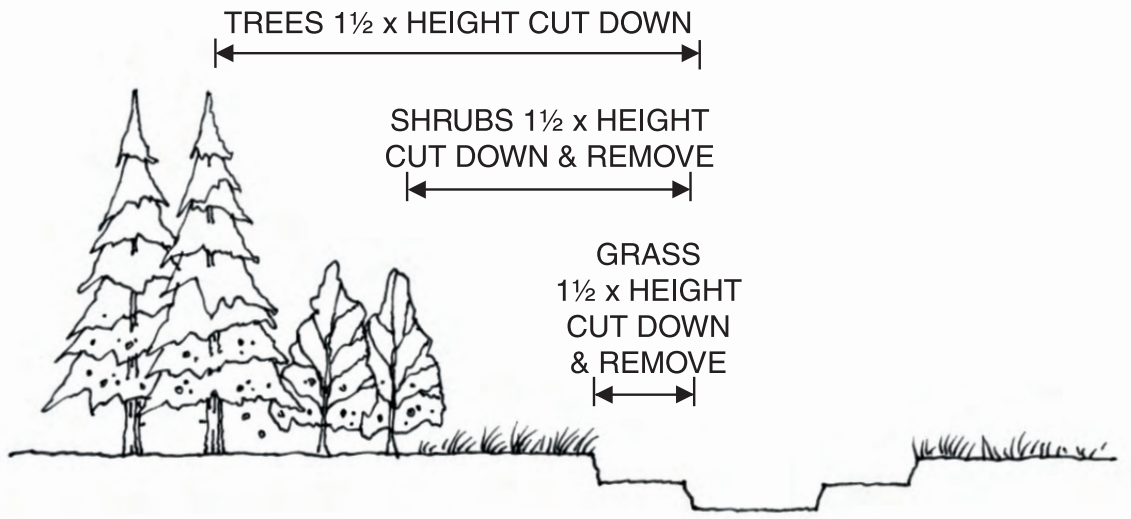

Illustration EF4 3.4 Fireline width in different vegetation types

Care should always be taken to watch for embers jumping control lines and starting new spot fires. It is essential to have lookouts observing the fire and people patrolling control lines.

Ignition techniques

The types of ignition techniques that are used to achieve the desired fire behaviour include: backing, flanking, point, strip, and strip head fire. Ignition techniques operate at two levels. First is the application of the technique on its own and second as part of a team or implementing an ignition pattern.

The start of the process and throughout any ignition operation is a continuous evaluation of the factors that are going to affect fire behaviour on a site, especially wind, slope, fuels and aspect. Are these factors supporting likely fire behaviour, sometimes known as being in alignment, or are they reducing fire behaviour? Are these factors going to change as the fire progresses or are they going to stay the same?

Each ignition needs to create and maintain the desired fire behaviour in terms of fire intensity and fire severity. In other words the acceptable rate of spread, flame length and fuel consumption. Each ignition can influence this by either:

- Lighting down or up the slope
- Lighting against or with the wind
- Lighting many small fires or fewer larger fires
- Lighting on a cool aspect or on a hotter aspect.

The ignition tools that are chosen in each case and the pattern of ignition used will influence how long it takes to burn-out the area chosen and what fire intensity will occur.

Backing Fire

Backing fire's are lit either against the wind, downslope or a combination of both. In this way rate of spread and flame lengths are reduced. With the removal of the influences of wind and slope the fire can be said to be out of alignment with the main factors that support fire behaviour. Low intensity fires can be expected.

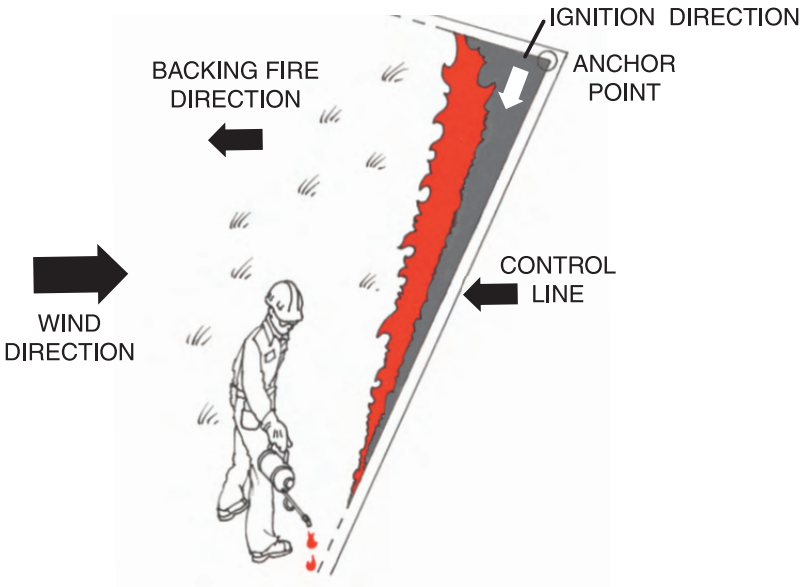

Illustration 2.2 Single ignition backing fire

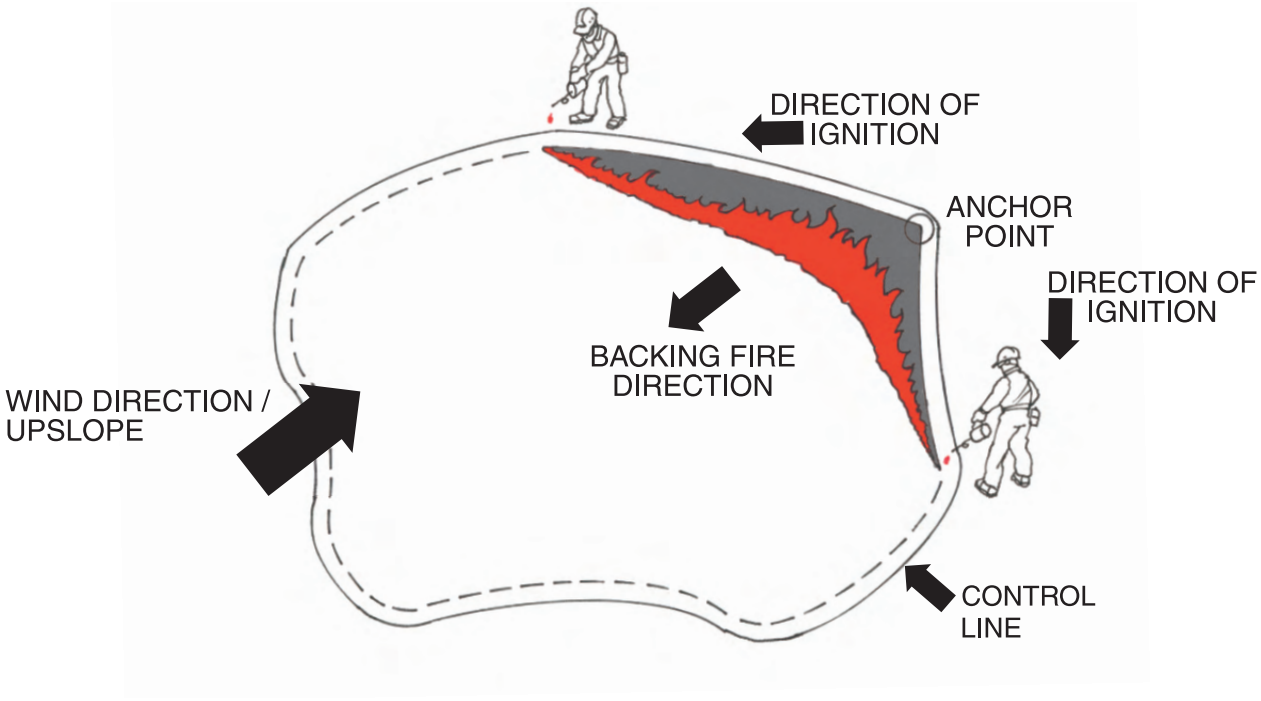

Illustration 2.3 Team ignition backing fire

Flanking fire

Flanking fires are either lit upwind or against the slope allowing the fire to spread laterally, or across the slope. Rate of spread and flame length will be slightly higher than with a backing fire in a similar situation as the factors that support fire behaviour are more in alignment. Low to moderate fire intensity can be expected.

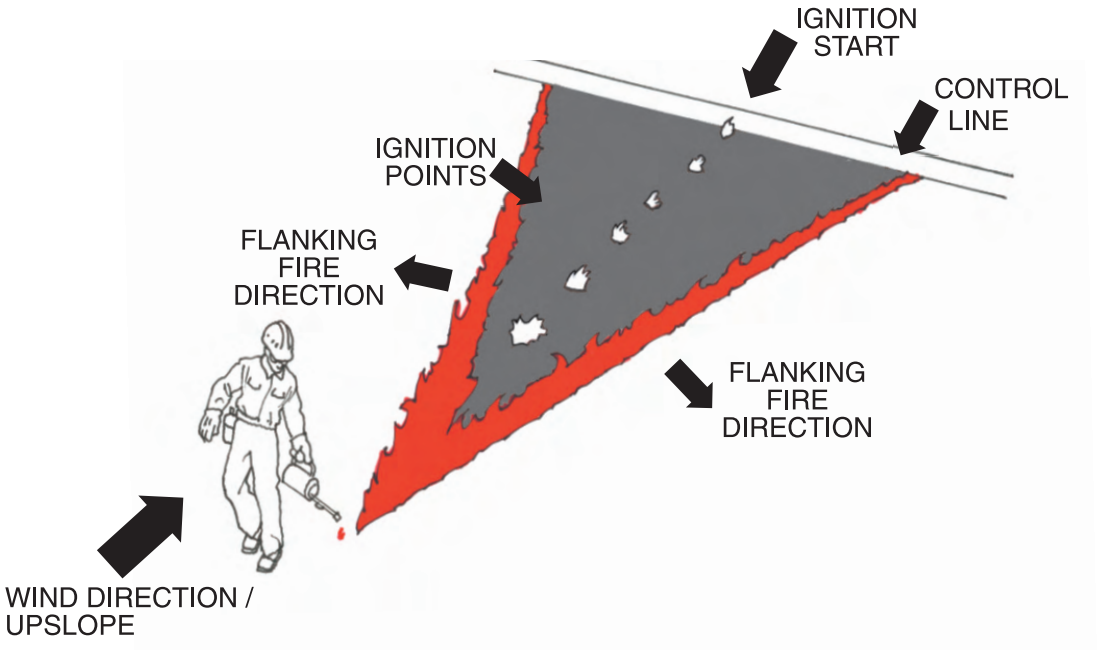

Illustration 2.4 Single ignition flanking fire

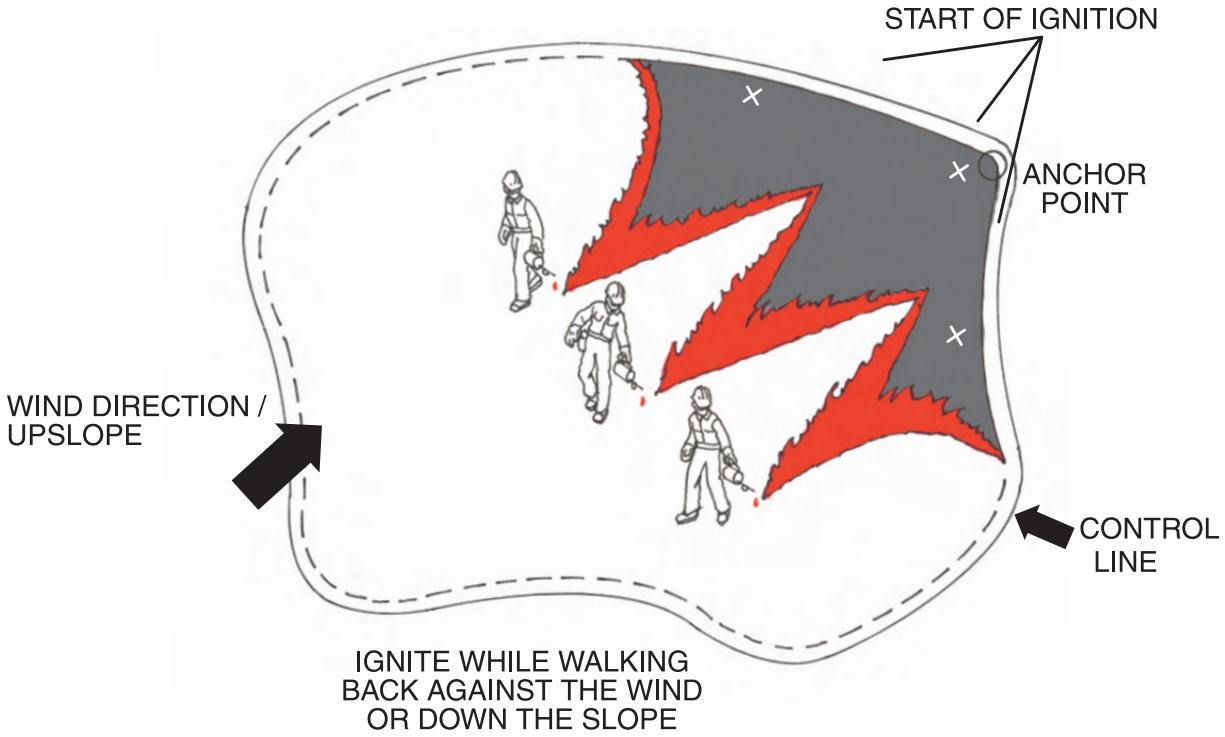

Illustration 2.5 Team ignition flanking fire

Point Ignition

In the initial period of fire spread, from an ignition point, fire intensities tend to be low. Multiple point ignition in a grid pattern can be used to reduce fire intensities.

However, where two fires join the combined convection columns reinforce each other and increase fire intensity, including the generation of embers and potentially spot fires. This is known as the junction effect. Care over spacing is required to avoid excessive fire intensities and spotting from the junction effect. It is best to ignite fewer points than too many.

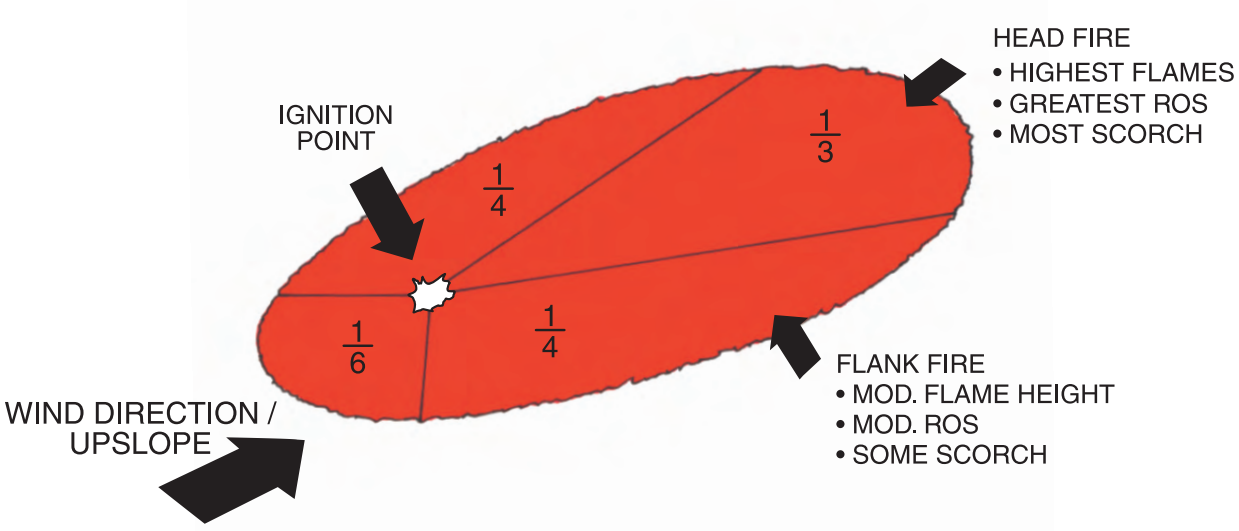

Illustration 2.6 Ignition from a single point

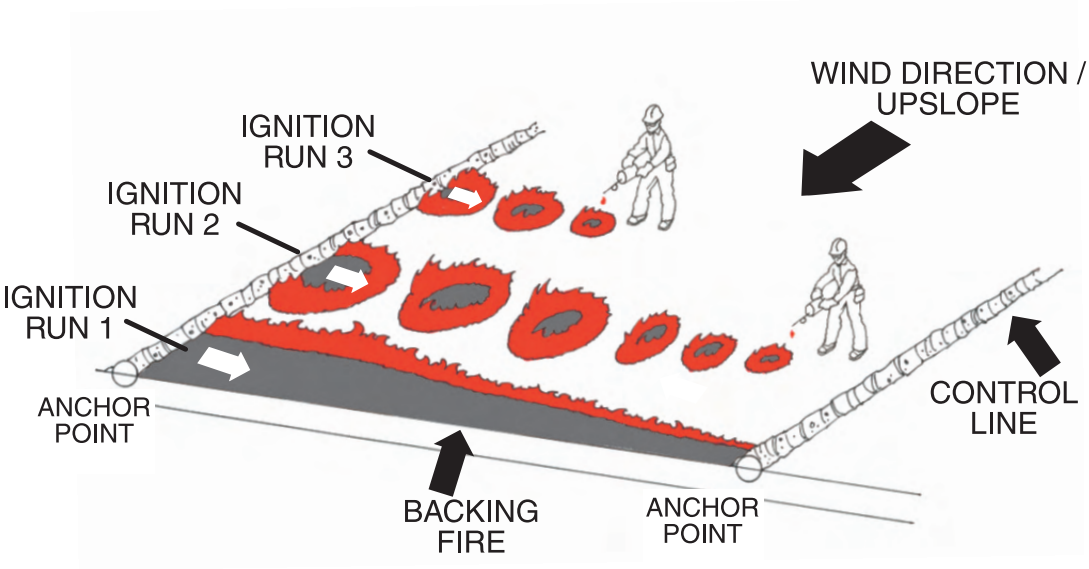

Illustration 2.7 Grid pattern ignition

Strip Ignition

Strip ignition is where narrow strips of fuel are ignited across the wind or slope allowing short fire runs, as headfires. As a headfire gets wider, especially if supported by wind or slope, flame length and rate of spread become greater. Fire intensity is also controlled by the width of the strip being lit. The wider the ignition line is the quicker the fire will speed up.

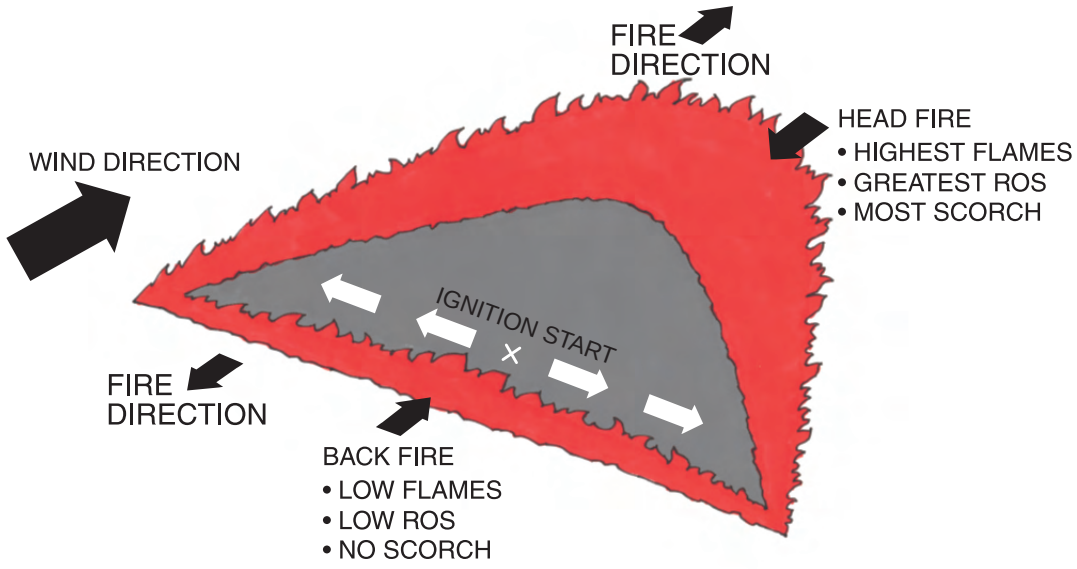

Illustration 2.8: Strip ignition

With strip ignition, even over short distances, some of the factors supporting fire behaviour will be ***in alignment*** and are likely to create higher fire intensities. Care is required with this technique.

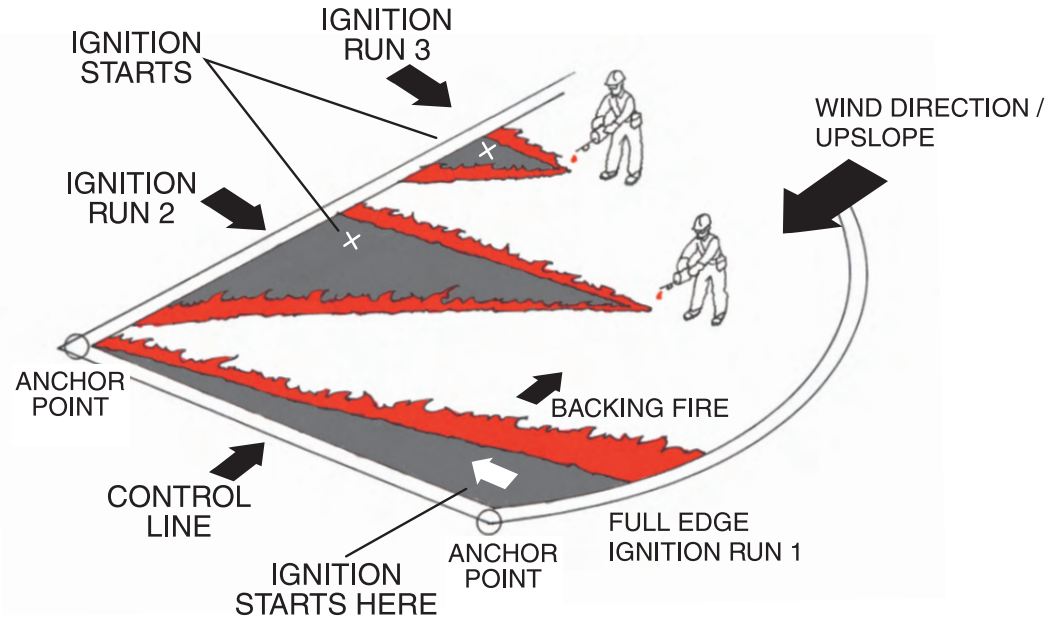

Illustration 2.9 Team strip ignition

Strip Headfire Ignition

Strip Head Fire ignition is where a line of fuels are lit and the fire is allowed to burn with the wind or slope. It is used in poor burning conditions or to get high fire intensities in good burning conditions. Operation often started with creation of a firebreak at downwind end of plot using backing fire. This technique has the highest risk of the fire escaping.

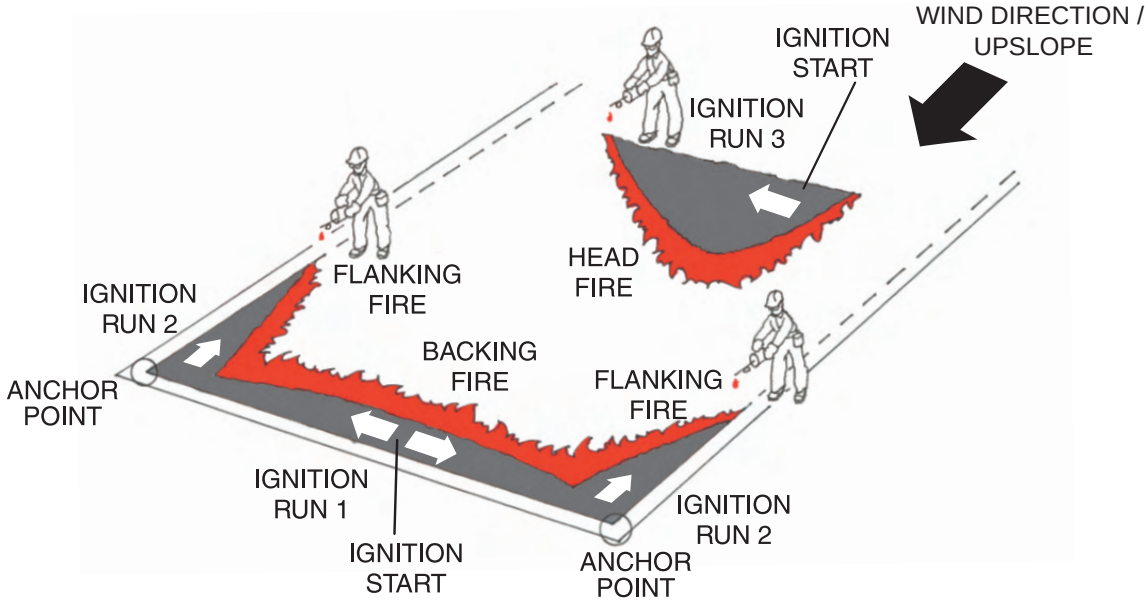

Illustration 2.10: Team strip headfire ignition

Differences between Point Ignition and Strip Headfire Ignition

Achieving the desired fire behaviour is dependent on choosing both the right place to ignite and the type and pattern of ignition.

The differences in fire behaviour typically found in a point ignition compared to a strip headfire ignition illustrate these differences well.

The desired fire behaviour, be it low, moderate or high fire intensity, fast moving or slow moving will determine the amount of backing, flanking and headfire that is wanted.

Ignition in parallel attack – burning out

Where there is a moderate fire and flame lengths are greater than 3 metres direct attack becomes difficult. Parallel attack from a control line a short distance from the edge of the fire is required.

Most methods of creating secure control lines are relatively slow and the wider the line needs to be, the slower the rate of construction will be. However you can ignite a flanking or backing fire, with low flame lengths, against a narrow control line. This speeds up line construction. The fuel is removed between the control line and the fire. This technique is known as burning out. It is often carried out as part of a parallel attack strategy.

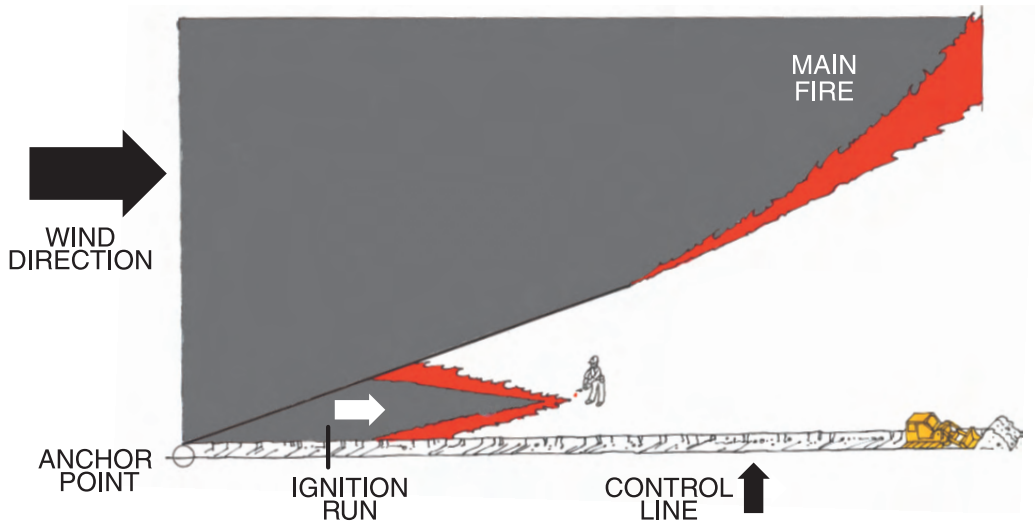

Illustration 2.11: Burning out in parallel attack

The main purpose of burning out is to remove fuels between the fire and the fireline. It can also reduce mop-up time, incorporate spot fires into the fire perimeter, and widen fireline. Burning out is sometimes used to create a safety zone.

As with other fire suppression techniques the safest way to approach a fire is from the back or from an anchor point. If either existing control lines or constructed control lines are in place then burning out operations can start to widen the line. There must a lookout to observe the fire as it approaches and people patrolling and looking out for spot fires outside the control lines.

Ignition in indirect attack – backburning and backfiring

If a fire is spreading rapidly and is burning intensely with big flames it will be too dangerous to approach directly. Also a fire in a remote area may be allowed to burn some ground while the best location is chosen to try and stop it. In these cases indirect attack, a safe distance away from the edge of the fire is often the best method.

Backburning:

The incident commander or the supervisor in charge will estimate the rate of spread of the main fire and choose a location to start from. The location chosen must give the team enough time to complete the backburning operation.

Ignition should start at the anchor point or part of the control line the fuel. The fire is then lit along the control line. The fuel between the control line and the fire is gradually burned out, usually with a low intensity backing fire. Further ignition runs may be made between the first ignition line and the fire to speed up the operation.

At all times all ignition personnel must have access to escape routes and safety zones. Also fires must not be ignited upwind or below other members of an ignition crew.

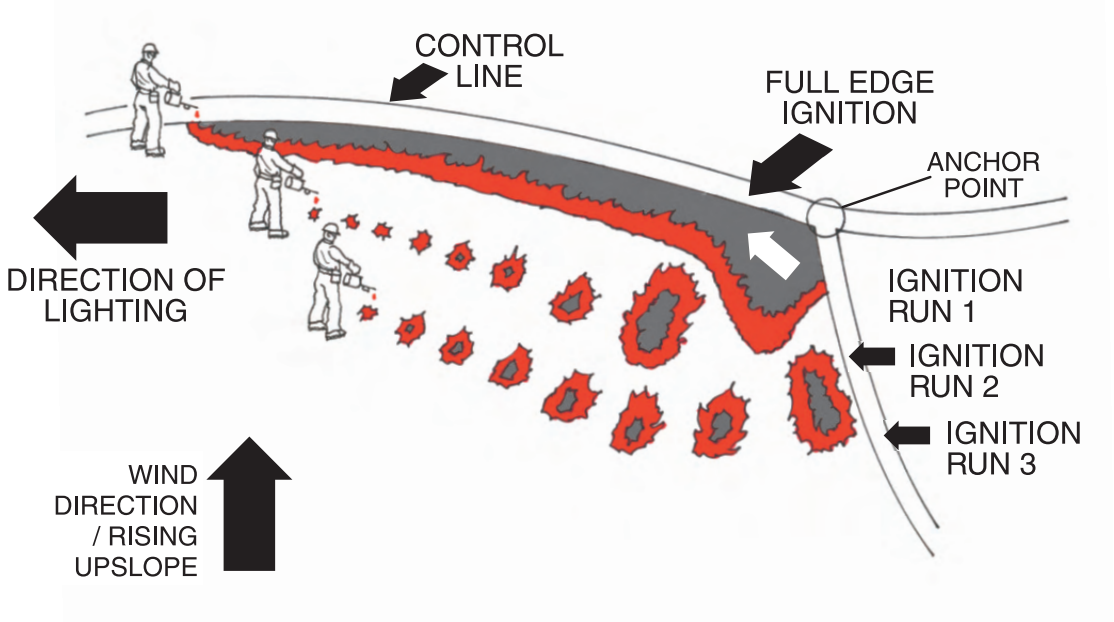

Illustration 2.12 Backburning

Backfiring:

Similar to a backburn operation except that a fire is ignited in front of the main fire so that the indrafts of air from the main fire push the backfire towards the main fire. This can reduce the fuel available to the main fire under controlled circumstances. This tactic has to be well timed and coordinated with other operations on the fire.

Backfiring is often a high risk operation. It can be dangerous if carried out in the wrong conditions and without regards for the overall fire situation. Therefore this operation can only be conducted under the supervision of a responsible person.

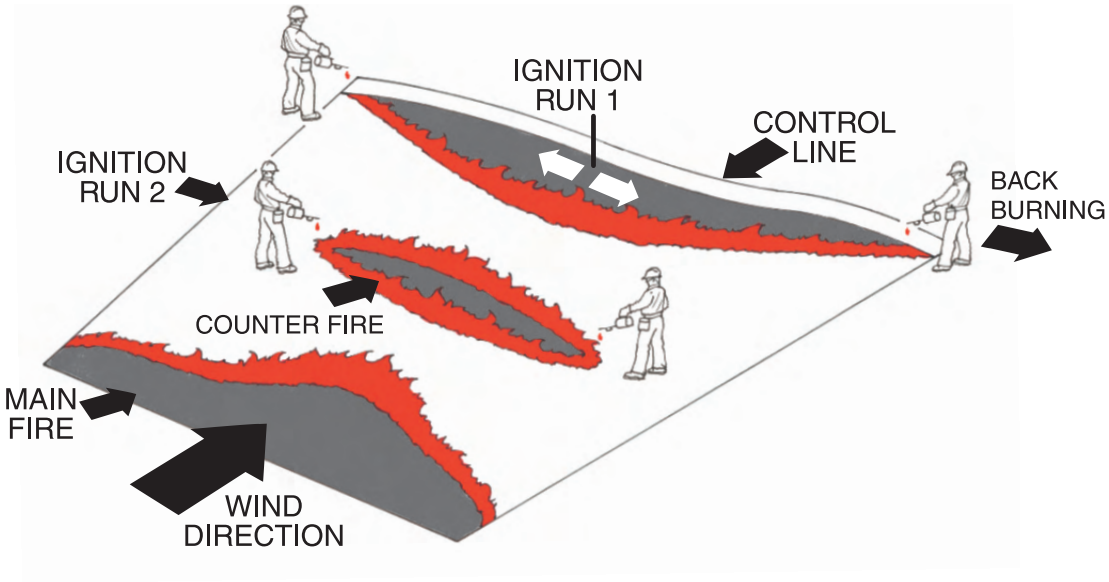

Illustration 2.13 Backfiring

The person in charge of the fire must give approval for the use of ignition techniques for all fires and the operation must be carried out under direct supervision.

Prescribed burning

Prescribed burning is the planned application of fire under prescribed environmental conditions and within defined boundaries, to achieve resource management objectives. The range of objectives includes:

- Create firebreaks
- Reduce fuel loads
- Improve habitat for wildlife
- Break-in new agricultural land
- Improve grazing
- Remove surface vegetation and the top litter layer to aid the natural regeneration of trees or shrubs.
- Remove branches and other slash, post tree-felling and prior to re-planting
- Provide a natural fertilization of the ground
- Maintain open cultural landscapes
- Preserve examples of culturally important agricultural systems
- Support fire research

Expected fire behaviour and intensity will be manipulated to meet the land management objectives. As with other ignition techniques the desired fire behaviour can be achieved by choosing to decrease or increase the factors influencing fire behaviour, as well as various fire ignition patterns. In general, this will result in following main categories of burning:

Low Intensity Burns:

Normally desirable where the objective is to consume some portion of surface fuel, and have little damage to middle and over storey vegetation. Such burns are appropriate to hazard reduction programmes and some ecological objectives where only lower level fuels and vegetation need to be modified.

High Intensity Burns:

Normally used where objectives are to:

- consume maximum fuel loads
- cause maximum death of some target species

Examples of the use of high intensity prescribed burns are:

- to control the encroachment of bushes or trees
- to burn logging slash (reduce hazard, promote regeneration)
- other ecological purposes (flora and fauna habitat benefits)

Table 3: Ignition pattern summary:

Ignition pattern	Features	Hazards
Backing	Lit upwind or downslope to create a slow moving low intensity fire.	Potential for changes in wind direction and speed, spotting
Flanking	Lit at right angles to the wind or across a slope, slightly higher fire intensity	Potential for changes in wind direction and speed, spotting
Point	Often lit as a grid pattern, distance apart will govern extent of backing, flanking or headfire, some junction effects as well. Close spacing will give higher fire intensities and spotting	Potential for high fire intensities and spotting from junction effect
Strip	Fire lit in strips parallel to control line. Width of strip controls fire intensity. Can use a team of igniters.	Failure of communication between team members. Ignition gets out of synchronisation.
Strip head fire / line ignition	Used in poor burning conditions or to get high fire intensity in good burning conditions. Often operation started with burn-out of firebreak using backing fire.	Increased risks of escape and high fire intensities

Working as a team

Working with your ignition supervisor:

The use of fire to fight fire or in prescribed burning has an inherent element of risk. These risks are substantially reduced if operations are conducted with an appropriately resourced team.

Good team working means working for each other and communicating with each other and with supervisors, in pursuit of a clear objective. Clear briefings by team leaders are a key part of success. Being able to absorb briefings quickly is an important skill for people involved in ignition operations, whether they be actually doing the lighting or as part of the suppression crews.

Table 4: A suggested layout for prescribed burn briefings:

Element	Description
1. General situation	An overview of the geography of the area involved, weather forecasts for the period especially any significant changes, current and expected fire danger rating, context of the operation.
2. Aim and objectives	Overall aim for the ignition and more detailed objectives.
3. Ignition pattern	The type and pattern of ignition required to achieve the objectives, along with a schedule of key milestones and timescales.
4. Containment Plan	Control lines, control teams, positioning of resources, smoke management etc
5. Tasks	Individual tasks and tasks for teams within the operation.
6. Command and communications	Everyone on the fireground must know who they report to and who the leaders are. They must also know what the preferred method of communications is between “Buddies”, teams and how to report information up the management chain.
7. Hazards	Highlight the hazards that are likely to be found in the area and as part of the operations
8. Safe zones & escape routes	If fire behaviour changes rapidly and becomes dangerous all personnel must know routes to safe zones
9. Contingency plans	Actions on: escape (wildfire), accidents/injury, loss of communications, fire reaching milestones etc.

Another key aspect of good team working is always working with a “buddy”, a fellow team member. Working closely with a “buddy” helps communication, safety and general efficiency at fires.

LACES

LACES is a memory aid that stands for:

L Lookouts
A Awareness
C Communications
E Escape routes
S Safety zones

When operating as part of an ignition team it is very important that these guidelines are followed to ensure safe working practises.

General environmental constraints for burning

Smoke

Smoke will be present during ignition operations. Smoke can make you disoriented and confused i.e. lost. It very is important to know where you are at all times, to know your escape routes at all times and to continually communicate with other team members and your supervisor.

The smoke from prescribed fires may sometimes affect visibility on nearby public roads. Signs should be posted on these roads to inform the traffic that a burning operation is taking place.

Smoke can also be a general public health hazard or irritant, or a hazard to individuals with certain medical conditions.

Ecological constraints

Many areas where wildfire or prescribed fire may occur have conservation designations or habitats for endangered wildlife. In these areas land managers should be consulted on burning plans and before inappropriate methods of extinguishment are used e.g. synthetic foam concentrate.

General “do’s and dont’s” for ignition operations

- Always begin firing from an anchor point or secure control line.
- Make sure you understand your instructions and are clear about the purpose of the ignition, the methods to be used, hazards, control measures and contingency plans.
- Communicate with your team, your supervisor about any changes of fire behaviour or things not working to plan
- Burn downhill when you can.
- Burn against the wind if you can.
- Begin at the head, working down the flanks to the heel if you can.
- Burn from the back side of ridges (not the top) when you can.
- Burn into saddles simultaneously from both directions.
- Adjust ignition pattern to fit the situation.
- If conditions are favourable, fire without delay; later may be too late.
- Fire short sections of line so that if you have a problem, you have the best chance of controlling it.
- The rate of ignition should be consistent with the ability to hold it, don’t introduce more fire than the control resources can handle.

All controlled burns require pre-fire site preparation like control lines and fire breaks.

Alternatively they should be planned within natural fire barriers.

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