The Muirburn Code 2017 – Supplementary Information 4

Fire Behaviour and Effects, Wildfire and Contingency Planning

Note: the figures in this document have been taken from the Eurofire Project Unit EF6 – *Training: Apply Vegetation Ignition Techniques* by kind permission of The Global Fire Monitoring Centre

Contents

Fire and its Impact

The way that fire works and the impacts that a fire can have are described in two ways:

- **fire behaviour** - the manner in which a fire reacts to the influences of fuel, weather, and topography and relates to the way fuels ignite, flame develops and fire spreads.
- **fire effects** - the physical, biological, and ecological impacts of fire on the environment.

Fire Behaviour and Effects

It is important to know how weather, fuel and topography interact to influence fire behaviour, before accepting the responsibility of conducting muirburn. The key influences are: wind speed, slope, the type, quantity and continuity of the fuel and fuel moisture. High wind speeds will dominate other factors.

Fire Intensity: The intensity of a fire is a measure of the rate that energy is released by a fire and is a combination of the amount of fuel that burns and the rate of spread of the fire. A good guide in the field to the intensity of a fire is the flame length. Fire intensity is used to judge how difficult a fire is to put out.

Burn Severity: A qualitative assessment of the heat pulse directed toward the ground during a fire. Burn severity relates to soil heating, large fuel and duff consumption, consumption of the litter and organic layer beneath trees and isolated shrubs, and mortality of buried plant parts.

Fire Severity: A general term most commonly used to describe the combined effects of both flaming and smouldering combustion on a fire site that creates impacts on plants, soils, and wildlife.

The impacts of fire are also linked to the frequency of its application in one location. Other impacts occur because fire should not be used in a particular location or season. There are also impacts from the land use that follows a fire, such as the level of grazing.

The Muirburn Code gives general guidance for burning. If burning in a sensitive area or a complex situation is planned, it is recommended that a more detailed prescribed burn plan is prepared.

Prescribed Burning is the planned application of fire under prescribed environmental conditions and within defined boundaries, to achieve required objectives.

Positive outcomes can be achieved and negative ones avoided by developing a general fire prescription for the moorland in the area with a more detailed prescribed burn plan for each area where burning is planned. The detailed plan should enable the land manager to burn safely to achieve the desired objectives, taking into account the factors that affect fire behaviour.

Fuels

Particular attention should be paid to the quantity of fine fuels, such as dead grass or dry heather, because these fuels have a significant impact on fire behaviour, especially fire intensity. As fuel load doubles, fire intensity quadruples.

Fuel moisture also has a significant impact on fire intensity and burn severity. The amount of moisture in dead and live fuels, including the moss and litter layer, has a major influence on fire behaviour. Dead fuels react to changes in the weather much faster than live fuels and will drive a fire when dry enough to burn. Dead fuel moisture is influenced by rainfall, humidity, sunshine and wind. Live fuels will usually have higher moisture contents than dead fuels. However, live fuel moisture in heather can become very low under particular weather conditions. This is a significant risk in the spring season.

Seasonal factors affect fuels. In the autumn deciduous vegetation dies off. Then, when the air temperature starts to warm up, at the beginning of spring, the vegetation can be at its lowest moisture level. Conversely, during the growing season from the end of spring until autumn, when the vegetation is green and full of moisture, fuels are less likely to burn.

If there are continuous fuels across a landscape, a fire will continue to spread until either it is put out, weather or topography changes, or there is a break in the fuels and it goes out.

Topography

The rate of spread and intensity of a fire increases significantly when travelling up a slope and decreases when it is travelling down a slope.

On a slope of only 10°, the rate of spread of the fire will be double that on level ground in the same conditions.

The aspect of a slope, which is its direction in relation to the sun, affects the dryness and temperature of fuels. This means that the driest and hottest slopes are the south to south-west facing ones, in mid-afternoon. These are the slopes where fires will travel fastest and burn most fiercely at this time of day.

As topography does not change, these factors can be built into a prescribed burning plan. For example, to avoid high fire intensities, the ignition pattern can be started near the top of a slope with an aspect away from the sun.

Weather

Weather conditions have a significant influence on fire behaviour. It is essential to obtain an accurate weather forecast for the area of the fire.

Wind directly affects the rate of spread and direction of the fire, so a strong wind will result in an intense and fast moving fire.

Temperature and relative humidity affect the moisture levels of the fuels. When the temperature is higher, fuels are closer to the ignition point. When humidity is lower, fuels will be drier and the fire more intense.

Temperatures usually reach a maximum in mid-afternoon, at the same time as the humidity reaches its minimum. Fuel moisture drops with a time-lag that is dependent on the thickness of the vegetation stems. This means that fine fuels will be driest first, then larger fuels later.

Settled, high-pressure, weather systems tend to create the most drying conditions with the potential for frosts and/or higher temperatures and low humidity levels.

Rain quickly changes the moisture of fine fuels. However, these fuels also dry out quickly. Fine fuels can dry out in less than an hour and become available to burn. This is a particular consideration for firebreaks.

Types of Fire

There are three main types of fire: ground fires, surface fires and crown fires. The most common type of fire is a surface fire burning surface vegetation such as grass and heather.

Fires spread as head fire, flanking fire or backing fire. The process of burning, as a fire front passes, occurs in three phases: pre-heating, active combustion and charring.

Each part of a fire will have different characteristics depending on what fuels burn and how much of each fuel burns. The moisture content of the fuels is the key influence on the total amount burnt at any one place.

Re-ignition commonly happens as the fuels dry out in a dry period, as the day warms up in the afternoon, or as the wind speed increases. Small smouldering patches near the perimeter should be extinguished to ensure they are safe.

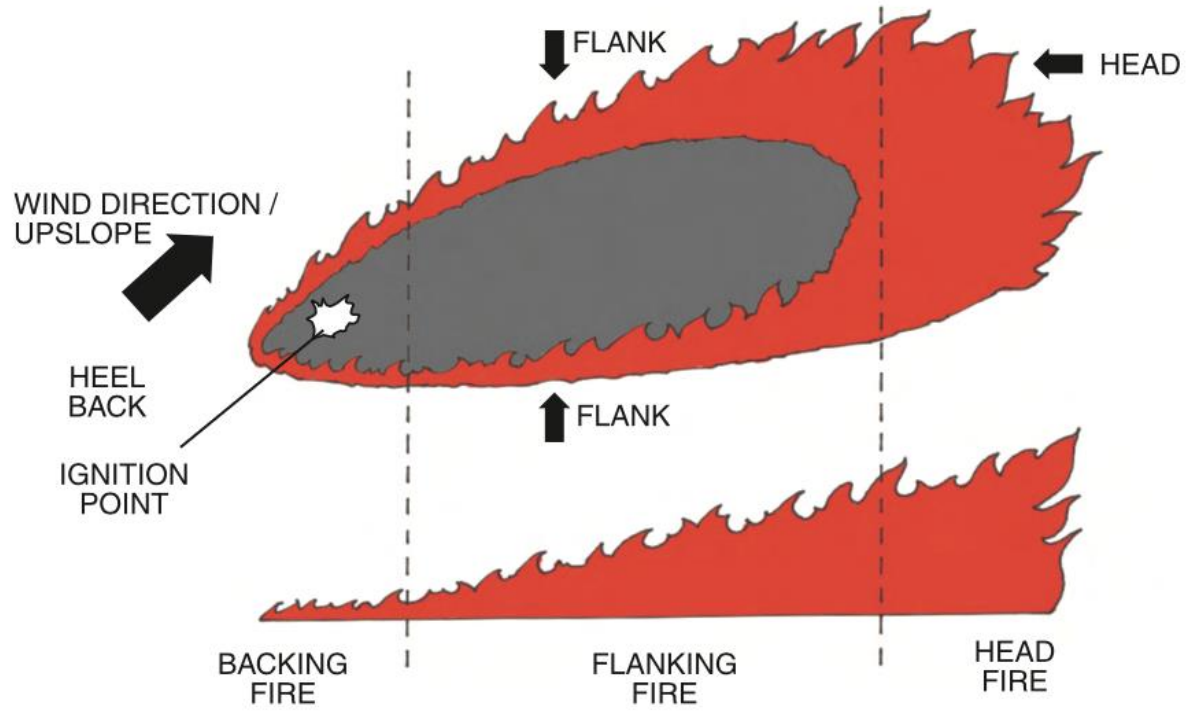

Figure 1: Parts of a Vegetation Fire

Ignition Patterns

Ignition patterns can have a big influence on fire behaviour by affecting:

- Rate of spread,
- Flame length and fire intensity, and
- Total burn-out time.

Practitioners, with experience and training, will be able to apply a range of different ignition patterns. The main choices are whether to set a fire to burn with the wind (head fire), or against the wind (back burn) or across the wind (flanking fire).

- A combination of these can also be used.
- A head fire covers a larger area faster.
- A back burn moves more slowly, which allows a greater degree of control.
- The rate of a flanking fire is in between these two.

Basic Ignition Techniques

- The default way to burn is with the wind, towards a firebreak, preferably downhill.
- Burning against the wind can be used to create firebreaks, but, as this is a hotter fire, great care is required.
- Burning should not take place uphill on steep slopes, as the fire will be very difficult or impossible to control.
- Control both flanks of the fire at a desired width, leaving the fire front to move with the wind. It can be useful to have one flank defined by a natural or a prepared firebreak.

More Advanced Ignition Techniques

- Different ignition patterns can be used to achieve the desired fire behaviour. Varying the influence of fuels, wind, slope or aspect can change the fire intensity and rate of spread.
- The Eurofire Project considered a variety of different ignition devices and a variety of different ignition techniques. Unit EF6 – *Training: Apply Vegetation Ignition Techniques* should be consulted for more information (https://goo.gl/NKXxmJ).

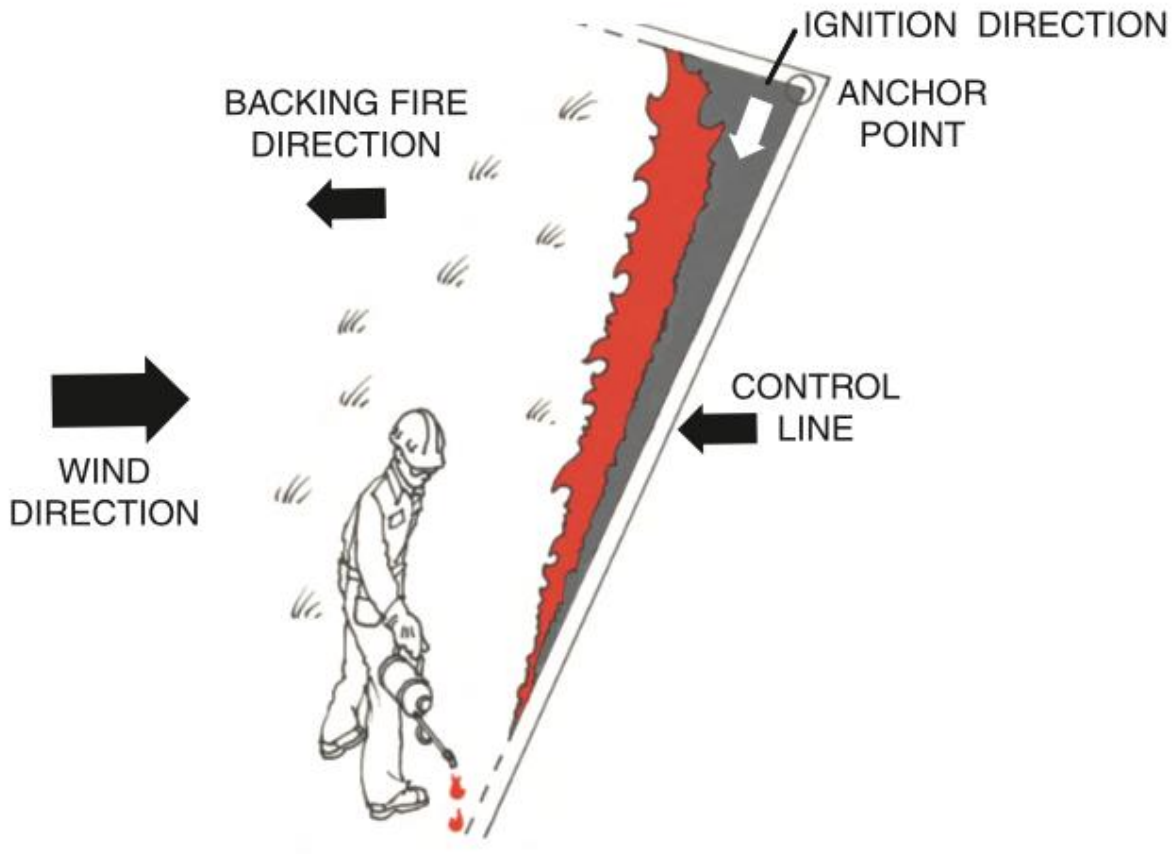

Figure 2: Back burning

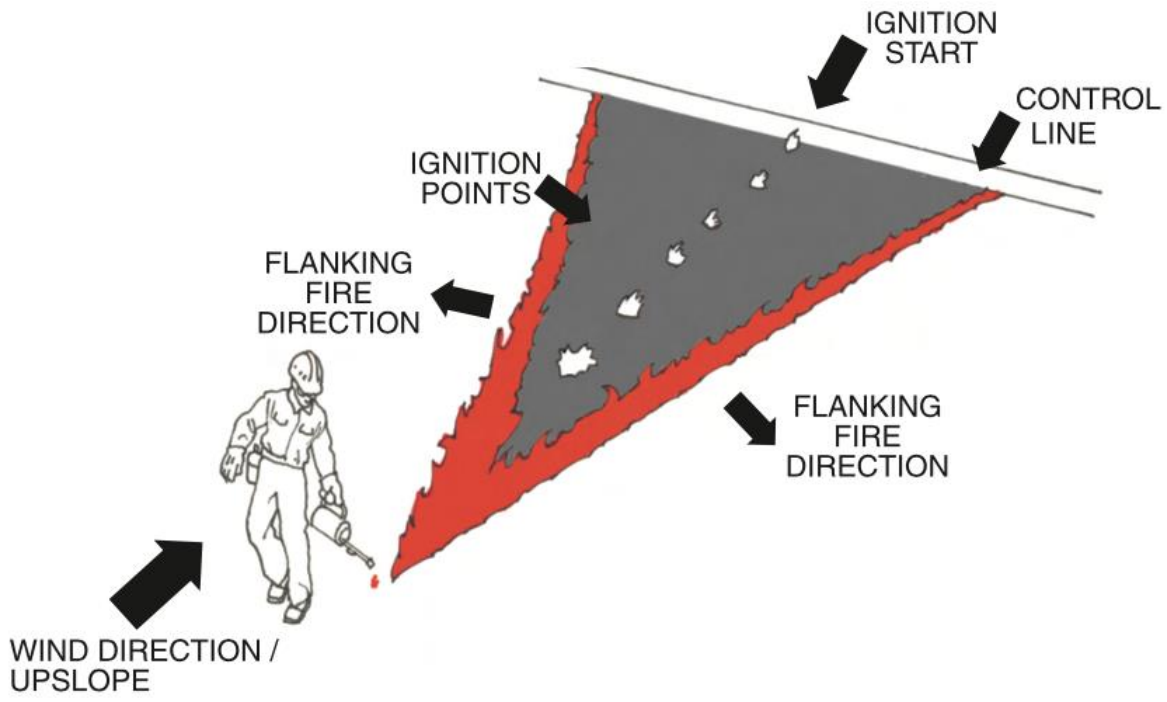

Figure 3: Flanking Fire

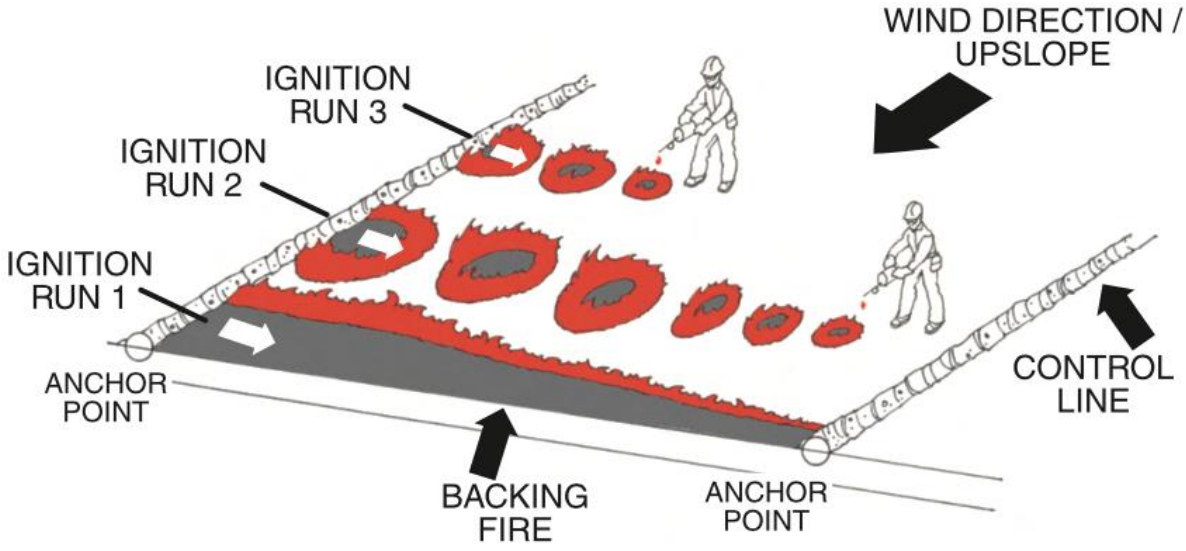

Figure 4: Grid Pattern Ignition

Firebreaks

Fire stops when it runs into something that will not burn and where it cannot jump a gap to the next area of flammable material. Firebreaks are therefore a crucial method for controlling muirburn.

A firebreak can be a track, a previously burnt area, a green grass patch, a rocky outcrop, or an area of wetter vegetation. Watercourses should not be used as a primary firebreak. Firebreaks can also be created by cutting and clearing the vegetation or by carefully conducting a back burn to remove the vegetation. In other words, it can be any feature that does not have fuel that can burn.

Firebreaks need to be a minimum of either 1.5 x the height of the adjacent vegetation or 2.5 x the length of the flames. For example, a flame length of 2m would need a firebreak with a minimum width of 5m. Firebreaks can be breached by a small fire creeping across it, and for this reason firebreaks should always be monitored by a lookout. It is also a good idea for the initial test fire to be lit against a firebreak to make sure that it will hold the main fire.

Muirburn and Wildfires

The risk of damage from wildfire is linked to the intensity and severity of the fire. Wildfires can be larger, more intense, and burn more fuel, and are therefore generally more damaging than muirburn.

Fires escaping from muirburn, which has been carried out with inadequate firebreaks, staff or equipment, are a major cause of wildfire in Scotland.

Vegetation management by burning or cutting will reduce fuel loads and reduce potential fire intensity and the risk of damage from wildfire.

Grazing can also play an important role in controlling vegetation and its associated fuel load. Changes to the numbers of domestic and wild grazing animals will have an impact on the risk of damage from wildfire.

Maintaining and restoring areas of wet vegetation and soils such as bogs can help reduce the risk of wildfire spread or make control easier.

As part of developing a burning plan for the land, contingency planning for wildfire should also be carried out. Muirburn can be used to break up, or isolate, large areas of tall vegetation with a high fuel load and create firebreaks that can be used to protect important or sensitive areas in the event of a wildfire occurring. Such burning needs to be integrated with other areas where fire spread is prevented or reduced (wet areas, tops of hills, tracks) in an overall approach.

Fire Escapes and Contingency Planning

Even with the best planning and implementation sometimes things can go wrong. Fire is a complex, natural phenomenon and should at all times be used carefully. This means that it is a good idea to make plans for the occasion that a fire escapes and becomes a wildfire. The most common reasons for fires to escape are:

- Fire behaviour exceeds expectations,
- Control resources are inadequate, and
- Firebreaks are inadequate.

Another source of escapes are re-ignitions on the fire perimeter. These can be dangerous if they start behind people working near the head of the fire.

The **LACES** safety protocol, supported by a lookout, should be used to identify a potential problem, allow corrective action to be taken, and ensure operator safety:

> **LOOKOUT** - ensure that an experienced member of the burn team is assigned as a lookout.
>
> **AWARENESS** – all burn team members should be aware of any changes in conditions leading to changes in fire behaviour.
>
> **COMMUNICATIONS** – clear communications must be maintained between all members of the team.
>
> **ESCAPE** – clearly defined escape routes should be identified in advance of the fire.
>
> **SAFETY ZONES** – fuel free safety zones must be identified and agreed upon prior to the fire.

Lookouts who are not directly involved in the management of the fire can give advance warning of developing problems, for example a small fire creeping across a firebreak, in time for corrective action to be taken.

A clear policy and set of procedures is required for declaring a wildfire and seeking help. The first action when any fire escapes control should be to contact the Scottish Fire and Rescue Service by calling 999. Also see the guidance about liaison with the Scottish Fire & Rescue Service in Section 5.4 of the Muirburn Code.

In the planning stage, contact should be made with neighbours to establish what assistance can be provided in the event of a wildfire.

- Some areas have now developed fire groups that produce lists of personnel and firefighting resources and agree procedures. This can be very helpful in a difficult situation.
- It is important that the availability of the identified resources is checked on the day that burning takes place.