Forestry Commission
231 Corstorphine Road
Edinburgh
EH12 7AT
www.forestry.gov.uk

Planning Controlled Burning Operations in Forestry

TECHNICAL NOTE

BY IAN R MURGATROYD OF FOREST RESEARCH SEPTEMBER 2002

SUMMARY

Controlled (or prescribed) burning is the planned use of fire within a defined area. The relevant legislation and the organisations responsible for administration are identified. The importance of careful planning is emphasised including site-specific risk assessment and a checklist. Other important factors to consider, including wind, fuel type and load, personal protective equipment and site visitors, are listed and described. Environmental impacts and operational control are discussed. Conclusions and recommendations are provided, and references include sources of reading which explain fire behaviour and control measures in detail.

This Technical Note is produced as a guide to the planning of controlled burning operations in forests and is the first in a series of three on forest fire control. The others are: *Forest and moorland fire suppression* and *Burning forest residues*.

INTRODUCTION

This Technical Note aims to assist managers in the planning of controlled (or prescribed) burning operations in forestry. Prescribed burning is an alternative term used in some countries. Controlled or prescribed burning can be defined as the planned use of fire within a specified area.

The main type of controlled burning operation (Figure 1) undertaken in the UK is to remove uncut heather and moorland vegetation which may act as a fuel source in the event of an uncontrolled fire.

Controlled burning can be split into three stages:

- Setting objectives/prescription for burn.
- Planning and liaison.
- Burning under control and extinguishing fire.

All burning operations carried out within forests and woodlands, including open moor and heathland, should be planned and controlled, and alternative methods to burning should be fully explored. The following points should always be considered:

- Health and safety of operators and public.
- Environmental protection.
- Prevention of damage to property and equipment.

When using fire in silvicultural and management systems, health and safety, environmental and operational issues should all be considered.

Before drawing up a plan, it is essential to be aware of, and comply with, the legislation relevant to controlled burning operations.

Figure 1 Controlled burning using a foam trace

LEGISLATION

The legislation relevant to controlled burning and the organisations responsible for its administration are listed in Table 1. It is recommended that the appropriate organisation should be contacted prior to burning if there is any doubt on the applicability of any of the legislation. Although not exhaustive, the list in Table 1 should help managers to appreciate the wide range of factors that have to be considered when carrying out controlled burning.

All parties involved in controlled burning have responsibilities under the various Acts and Regulations concerning Health and Safety at Work.

Table 1 Legislation to be considered when burning

Name and enactment date of legislation	Organisations with statutory responsibility	Potential relevance to burning operations	Comments
Heather and Grass Burning (England and Wales) Regulations 1986 and Hill Farming Acts 1946 (Scotland)	DEFRA, England and Wales The Scottish Executive	Clearly defined periods when burning is lawful, and when neighbour notification is required	Burning periods in England and Wales are 1 November–31 March and 1 October–15 April in upland areas. Outside these periods a licence is required. Burning periods in Scotland are 1 October–15 April; this can be extended to 30 April or 15 May on land over 450 m above sea level with the proprietor's written consent.
Roads (Scotland) Act 1984	Police	Burning within 30 m of a road without lawful authority	Creating a danger to road traffic or damaging road.
Highways Acts 1980 (Amended 1986)	Police	Roadside burning	Creating a danger to road traffic.
Clean Air (Emission of Dark Smoke) (Exemption) Regulations 1969 and Scotland Regulations 1969	Scottish Environment Protection Agency, Environment Agency, Local Authority Environmental Health Departments	Creation of dark smoke from all fires other than training fires	Burning tyres to start fires and possibly burning material with high soil content. Both are forms of bad practice.
Clean Air Act 1993, amended by Environment Act 1995	Scottish Environment Protection Agency, Environment Agency, Local Authority Environmental Health Departments	Creation of dark smoke from fires	Burning tyres to start fires and possibly burning material with high soil content. Both are forms of bad practice.
Civil Government Act (Scotland) 1982	Scottish Environment Protection Agency, Environment Agency, Local Authority Environmental Health Departments	Burning in public areas	Creating danger, alarm or annoyance to persons.
Environmental Protection Act 1990 (Statutory Nuisances and Clean Air)	Scottish Environment Protection Agency, Environment Agency, Local Authority Environmental Health Departments	All burning operations	Emission of smoke so as to be prejudicial to health or a nuisance constitutes a statutory nuisance under this Act.
Public Health (Scotland) Act 1987	Scottish Environment Protection Agency, Environment Agency, Local Authority Environmental Health Departments	All burning operations	Emission of fumes and gases, vapours or dust that would be a nuisance, injurious of dangerous to health.
Wildlife and Countryside Act 1981	Scottish Environment Protection Agency, Environment Agency, Local Authority Environmental Health Departments	Burning operation in sensitive areas	Consultation is recommended with the organisations with statutory responsibility.

PLANNING

Careful overall planning is required to ensure that:

- A burn plan or map and checklist are compiled (see Main checklist).
- Employee and public safety is maintained (methods, site access, roads etc.).
- Sensitive areas such as Sites of Special Scientific Interest (SSSIs), Scheduled Ancient Monuments or utilities are not affected by burning operations.
- Climatic and fuel conditions are known and assessed for the period of the operation and conditions are known in adjacent areas. Where the hazard is high in adjacent areas, burning should only take place in suitable weather conditions and where control measures are satisfactory. It should be remembered that wind and thermals can transport embers and burning vegetation.
- Legislation (as described in the previous section) has been complied with.
- The ability to control the burning operation is assessed and full requirements for control have been decided.
- Equipment and labour requirements are understood and available.
- Liaison with relevant parties has occurred.

Before burning commences a thorough *risk assessment* should be undertaken to ensure that all pertinent factors have been taken into consideration. The main points shown in Table 2 should be included and managers should also ensure that other site-specific factors are taken into consideration.

Regulation 3 of the Management of Health and Safety at Work Regulations requires all employers, employees and self-employed persons to assess the risks to themselves and any others who may be affected by their activities.

Table 2 Risk assessment

Hazard	Factors to consider
Driving and personnel transport	Driving to burning site Off-road driving on site with road vehicles Using ATVs and associated equipment on site Night time driving Machine recovery/debogging
Smoke inhalation	Safe working methods, wind direction
Hot weather and fire intensity	Heat stress, fuel load, weather conditions, Personal Protective Equipment (PPE) issue, fitness, training, water and food, number of fire fighters
Disorientation/lone working	Work as teams, buddy systems, night-time working, smoke
Equipment use	Adequate training and information, pressurised hoses, foam concentrates, petrol storage, moving equipment and water/foam laying, PPE, fire risk to machinery
Rough terrain	Smoke and heat conditions, darkness, heat stress
Helicopter	Landing sites, fuel handling, water bombing, other underslung loads
Manual handling	Ergonomic handling systems
Injury	Injuries to fire fighters, third parties, public, Fire Brigade Injuries associated with fire suppression, equipment use, crossing terrain

Employers with five or more employees must also have a written record of the significant findings and conclusions of that assessment.

Main checklist

The following main points should be checked and managers should also ensure that other site-specific factors are taken into consideration.

- **Legislation** In some situations controlled burning may be covered by specific legislation. For instance, there are specific periods of the year where burning can take place in upland areas and these are legislated for in different Regulation/Acts depending on the country of Britain. Other legislation can be used to prosecute parties who create a hazard or danger to health, such as burning within 30 m of a public road without lawful authority. Persons involved in controlled burning should ensure that the operation complies with current legislation.

- **Health and safety** The creation of smoke is recognised as a hazard under the Control of Substances Hazardous to Health (COSHH) Regulations. When burning, operators should avoid inhalation of and exposure to smoke (Figure 2). The Health and Safety at Work Act 1974 should be complied with to ensure that no persons are put at risk. The Supply of Machinery (Safety) Regulations 1992 requires employers to ensure that machinery supplied after 1 January 1993 meets essential Health and Safety requirements, carries a declaration of conformity and is CE marked. The Provision and Use of Workplace Equipment Regulations are explained in the publication *Safe use of work equipment* (Health and Safety Executive, 1998).

- **Resources** Adequate resources are required to control burning in the correct conditions. Mechanised controlled burning of cut residues requires a different type of resource deployment compared with heathland controlled burning. An assessment of tool and equipment requirements and machine cleaning should be made. Equipment should be adequately maintained and tested before use. Some conditions may require water and pump standby or pump use.

- **Training** Persons involved with controlled burning should be trained and have access to information on the safe use of appropriate equipment and safe working conditions. A person experienced in fire control should be in charge of the burning operation. Where external training is unavailable managers should review 'in house' training to ensure that it is adequate. External training should be sought from the local Fire Service and equipment suppliers where required.

Figure 2 Operator avoiding exposure to smoke by wearing correct protection

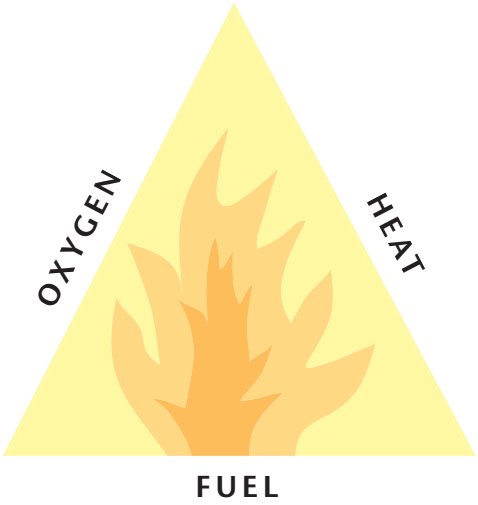
- **Liaison** Persons undertaking controlled burning in Scotland, outwith the standard statutory period, have a legal obligation to inform neighbours of the operation. The local Fire Brigade should also be informed of burning operations in case concerned people report the fire. All burning operations should be controlled to prevent the spread of fire onto neighbouring lands. This requires a continual assessment of burning conditions (fuel type, wind speed and wind direction) and if conditions rapidly change, leading to loss of control, contingency plans should be available. Contingency plans can identify suitable fire breaks and the call up of extra resources.

- **First aid** Adequate provision must be made for possible first aid requirements. The provision of vehicles, first aid kits, communications (for example, mobile phones and relevant emergency phone numbers) and drinking water should be considered.

- **Fire lighting** A safe and efficient method of ignition must be identified; this can improve productivity and control.

- **Fire and fuel moisture** Fire is a chemical reaction that requires a combination of fuel, oxygen and heat, and can be represented in a simplified form by a fire triangle (Figure 3). When a fuel has been ignited the moisture of the fuel load influences the heat side or rate of burn of the fire triangle. To control or extinguish fire, one or more of the three components must be managed. This can be done by burning in low wind speeds to reduce available oxygen, reducing the amount of fuel available by burning regularly or mechanically, treating prior to burning or reducing heat by applying water or foam.

Figure 3 Fire triangle



OTHER IMPORTANT FACTORS TO CONSIDER

Fuel moisture level

The Australasian Fire Authorities Council has identified fuel moisture levels that are suitable and unsuitable for controlled burning. Fuel moisture is affected by conditions such as vegetation type, terrain and wind, and managers should ensure that they understand the relationships involved. Heather burning has been observed where the upper heather foliage has been dry enough to burn and the ground layer of vegetation was damp and did not burn. This reduced damage to the heather roots and assisted with controlled burning, because some of the surface fuel was moist. Where all the fuel (plants, top and bottom litter layers) and organic soil horizons are dry enough to readily burn, burning must not take place.

Wind

Increasing wind strength exponentially increases the rate of burn in dry fuels (oxygen side of the fire triangle, Figure 3). It is easier to control a fire in a dry fuel in light wind conditions than in strong wind. Wind speed varies and can be affected by conditions such as slope, convection updraughts, obstacles and height. General forecasts may not be accurate for the burning site where the final decisions must be made. To improve 'on site' forecasting, hand-held anemometers are recommended. Dramatic increases in the rate of fire burn can be experienced on slopes especially with wind and the effect of convectional updraughts. Burning fuel such as *Molinia* grass blades can be blown in front of the fire, over fire breaks and cause spot fires in stronger winds.

Fuel type and load

Fuel is the base of the fire triangle. In Australian conditions fine fuels less than 6 mm in thickness have the greatest effect on fire behaviour. Well-aerated fuels such as uncompacted grass and heather burn more readily than more compacted fuels such as larger branches in dense heaps. Larger fuel elements such as logs continue to burn after the fire front has passed and have a lesser and indirect effect on fire behaviour. Smaller fires are more sensitive to changes in the average fuel bed, such as areas of bare ground or larger fuel elements. Variations in the average fuel bed have less effect on larger fires. The types of fuel to be burnt should be assessed.

Personal protective equipment

Clothing with a low flammability should be worn. Synthetic materials should be avoided. Research from Australia has identified that loose fitting, Proban-treated cotton overalls with a weight of 300 to 350 g/m^2 are suitable for bush fire fighting. Some treated cotton welding overalls have a similar specification. Leather gloves should be used with most items of equipment. Waterproof gloves (and jackets and trousers in some conditions) should be worn when handling foam concentrate and foam laying equipment. The use of heat resistant face shields and goggles is strongly recommended for heather and grass fire suppression and when handling foam concentrate. Suitable steel toe-capped boots or wellingtons are recommended. Helmets should be worn where there is a risk of falling objects and secured with a chinstrap when working with helicopters.

Warning signs

Warning signs conforming to the Safety Signs and Signals Regulations should be suitably placed to exclude members of the public from the work site. It is essential that unauthorised personnel and members of the public are kept away from burning operations. Where additional controls are considered necessary, personnel such as banksmen, may be required to exclude members of the public from the area.

Fire breaks

Fire can cross fire breaks by the burning of any fuel present in the break, by the flame length exceeding the break width and by embers blowing across the breaks. Fire break width should be related to flame length and ideally be 2.5 times flame length. It is not uncommon for heather fire flame length to exceed 2 m. For high intensity heather and *Molinia* grass fires fire breaks should be between 6 and 10 m wide and fuel free but should not be relied upon in extreme conditions.

ENVIRONMENTAL IMPACTS

Burning of any description has direct and indirect effects on the environment. Correct burning techniques and the evaluation of benefits and costs require knowledge of how fire affects wildlife, vegetation, soil, water and air. Burning techniques and timing of burns can be varied to alter the effects of fire.

Wildlife

The effects of burning on wildlife can include destruction of nesting sites and possible killing of birds, reptiles and mammals. Burning should take place at times when nests are not being used. Consultation with local organisations concerned with wildlife such as the Royal Society for the Protection of Birds, The National Trust, the Forestry Commission, English Heritage, Scottish National Heritage and local authorities is strongly advised.

Vegetation

Fire has affected the vegetation of the entire globe since time began and some species depend on fire for their well-being. From a fire viewpoint, plant species can be grouped into three categories:

- resistant to fire with practically no damage,
- regenerate rapidly after fire,
- killed outright by fire.

Shrub species may be completely destroyed by fire but survive by sprouting buds buried in the ground. The soil can act as an insulating material protecting underground regenerative organs such as rhizomes.

Soil

The effect of fire on soil will vary depending on the soil type, moisture content, intensity and duration of the fire. In mineral soils, only the surface will burn, whereas a soil with a high organic content may burn to a significant depth. To minimise the effect, burn regularly to avoid the build up of heavy vegetation layers, which can create 'hot' fires. Organic soil types such as peat can develop into 'ground fires', that is, the soil actually burns and spreads underground. In these soil conditions careful monitoring is required and a good supply of water and the means to apply it are essential.

Water

The main effect of fire on water is the potential for increased 'runoff' of rainfall when the ground is devoid of vegetation. This increase may carry suspended soil particles, dissolved inorganic nutrients and other materials into adjacent water bodies and subsequently reduce water quality. To control this effect, buffer areas such as riparian zones must be excluded from burning to preserve high quality plant and animal habitats.

Air

The amount of smoke produced is determined by fire intensity and wind velocity. Smoke consists of small particles (particulates) of ash, partly consumed fuel and liquid drops. Particulates which reach the air are of concern as they reduce visibility, and this may be of importance when burning near towns, villages and public roads. Burning during light winds and with the wind in a direction away from areas frequented by the public will allow adequate dispersal.

OPERATIONAL CONTROL

Controlled burning on heather and moorland can potentially be more difficult to control than mechanised burning of cut material in the forest situation. When

burning heather and moorland a greater surface area is usually burnt with less distinct boundaries in the available fuel. It is possible to create breaks in the fuel by using swipes or flails, foam traces or burning to tracks and to foam or swiped traces. Small fires can be repeatedly lit (2 m width) and burnt to form breaks up to 10 m wide or more. Burning back into the wind from a natural boundary such as a stream or road can be successful in light wind conditions. Previously burnt areas can also be used as breaks if they are sufficiently free from fuel. Machinery used on sites where controlled burning takes place should be regularly cleaned so that belly plates and sump guards contain minimal quantities of combustible material. Fire extinguishers should be provided on machinery and their condition and ease of access checked. Machines should be used with due regard for the risk of fire during burning operations.

In appropriate fuel and wind conditions with the correct number of suitably equipped persons, small fire fronts can be effectively controlled with hand beaters. The conditions shown in Figure 4 were good for burning. In this example the upper heather layer was dry enough to burn and the ground vegetation was damp (green) and resistant to ignition. The wind strength was Beaufort force 2 to 3. It should be noted that although the management objective was achieved in this case, insufficient material was burnt to create an adequate fire break.

Long handled beaters (up to 3 m total length), with heads made from folded layers of rabbit mesh netting supported by wire hoops, are effective for controlling heather fires. They can be used with a beating or a scrubbing action to extinguish fires. Beaters with belt heads are recommended for *Molinia* grass fires but the belt can soften and become less effective during prolonged use, especially in heather fires. Longer handled beaters will reduce operator exposure to radiant heat.

Figure 4 Surface vegetation (in the foreground) after burning

Knapsack sprayers are useful additions for backing up fire beaters during the burn and for damping down after the burn is complete. Wetting agents are available which can give better water penetration.

Fires must always be supervised as unsupervised fires are illegal.

CONCLUSIONS AND RECOMMENDATIONS

- Controlled burning operations require careful planning with adequate knowledge of local conditions.
- A risk assessment should be made before burning operations commence.
- If conditions are misjudged fires can burn out of control with serious implications.
- Before controlled burning, managers are recommended to consider the following:

  – Alternatives to burning
  – Health and safety
  – Staff training
  – Legislation
  – Risk assessment and checklists
  – Planning checklists
  – Wind and fuel conditions
  – Resources available

ACKNOWLEDGEMENTS

I would like to thank the following for their assistance with this publication: B. Gunneberg, Technical Editor, Timber Growers Association; Association of Professional Foresters; New South Wales Bush Fire Service; M. Bruce, Glen Tanar Estate; R. Donarski, New South Wales Rural Fire Service.

REFERENCES AND FURTHER INFORMATION

UK Publications

DEFRA, formerly MAFF (1996).
Heather and grass burning code for England and Wales, PB1029.
Available from local DEFRA offices.

FORESTRY COMMISSION (1991).
Forestry practice. Handbook 6. HMSO, London.
Contains a useful chapter on fire protection. Available from Forestry Commission Publications, P.O. Box 25, Wetherby, West Yorkshire. LS23 7EW.
E-mail: forestry@twoten.press.net

FORESTRY COMMISSION (1998).
Planning forest operations.
Technical Development Branch Technical Note 15/98.
Forestry Commission, Ae.

HEALTH AND SAFETY EXECTIVE (1998).
Safe use of work equipment.
This leaflet offers practical advice on the Provision and Use of Work Equipment Regulations 1998 (PUWER).
HFE Books, Sudbury, Suffolk.

SCOTTISH EXECUTIVE ENVIRONMENT AND RURAL AFFAIRS DEPARTMENT (2001).
The Muirburn Code.
This effectively supersedes previous Muirburn codes and discusses planning, practice, effects of burning and the law. ISBN 0 7559 1004 4. SEERAD Publications, Edinburgh.

SCOTTISH EXECUTIVE ENVIRONMENT AND RURAL AFFAIRS DEPARTMENT (2001).
Prescribed burning on moorland.
A supplement to *The Muirburn Code: a guide to best practice*. ISBN 0 7559 1003 6.
SEERAD Publications, Edinburgh.

SCOTTISH OFFICE (now SEERAD) (1997).
Prevention of environmental pollution from agricultural activity.
SEERAD Publications, Edinburgh.

TGA (1997).
Risk assessment in forestry.
Information Sheet No. 5. Available from Forestry and Timber Association, 5 Dublin Street Lane South, Edinburgh, EH1 3PX. Tel: 0131 538 7111.
E-mail: info@forestryandtimber.org

Australian publications

NEW SOUTH WALES (NSW) RURAL FIRE SERVICE TRAINING SERVICES SECTION.
A series of 6 training publications. Available from Forestry & Timber Association, NSW Rural Fire Service, 3/175–179 James Ruse Drive, Rosehill, NSW, 2122.
Fax: 006129 638 7956.

THE AUSTRALASIAN FIRE AUTHORITIES COUNCIL.
A range of Learning Manuals. The Council has a combined order form and list of available publications. Available from the Australasian Fire Authorities Council, 2nd Floor, 1013 Whitehorse Road, Box Hill, Victoria, 3128. Fax: 0061 29 9899 5096.

American publications

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA).
European Catalogue with prices and summaries for each publication. The UK Agent for this American Association is ILI, Index House, Ascot, Berkshire, SL5 7EU.
Tel: 01344 636300.

Enquiries relating to this publication should be addressed to:

Forest Research
Technical Development Branch
Ae Village
Dumfries
DG1 1QB

Tel: 01387 860264
Fax: 01387 860386

E-mail: tdb.ae@forestry.gsi.gov.uk

ISSN 1470-6792
ISBN 0-85538-570-7

FCTN002/PPD(KMA)/ALLNDR:1.5K/SEP02