Carry Out Ignition at Prescribed Vegetation Burning Operations

Student Notes

Unit Standard 3289

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Acknowledgments

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Update Summary

A summary of all updates made to this material from date of first publication is recorded below:

Changes to Pages 9, 10 Exercises moved to separate Workbook.

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Staff having recommendations for change to contents or layout should notify:

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Table of Contents

What do I need to know?

Welcome

Welcome to this course on how to *Carry out Ignition at Prescribed Vegetation Burning Operations*, supporting Unit Standard 3289. This material is for light up crews and support personnel for the burning of vegetation fuels.

Background

Prescribed burning operations have been used in the NZ rural sector for many years. This training package is one of 3 learning resources for the skills required in prescribed burns over the following three different levels:

Crew	1. Carry out ignition at prescribed vegetation burning operations
Crew leaders	2. Lead prescribed vegetation burning operations
Operations Managers	3. Manage prescribed vegetation burning operations

What will we cover?

This learning resource focuses on the first level – the knowledge and skills required to safely *carry out ignition* at prescribed vegetation burning operations. We'll cover:

- What's involved in a prescribed burning operation
- Some of the methods and tools used to *ignite*, or light-up, a prescribed burn
- How to use and maintain the *ignition*, or lighting-up equipment
- The way burn patterns influence fire behaviour - the choice of burn pattern and tools depends upon the prevailing fire environment conditions
- A review of how to keep yourself safe on the fireground

What are the entry requirements?

You will need to have competency in Unit 3285, *Demonstrate knowledge of protection of personal safety at vegetation fires*, or demonstrate equivalent knowledge and skills. And we strongly recommend competency in Unit 14564, *Demonstrate knowledge of the fire environment on vegetation fire behaviour, or demonstrate equivalent knowledge and skills.*
Where possible, complete these notes in conjunction with a prescribed burn – and complete the FRSITO Task Book record of learning.

How do I use the material?

What now?

Read through these notes and complete the questions in the Workbook. Update and correct your answers as you discover more information.

- They will be part of your formal course evaluation and your course director will use them to assess your understanding - you won't be able to attend the course unless the course director has received your completed Workbook
- Return your completed Workbook to the course director for checking at least one week before the course

What next?

Your course director will check your Workbook before returning them to you at the beginning of the course.

Continued on next page

What do I need to know?, Continued

Support

If you have any study problems, ask your course director for advice.

Requirements

Participants must at least complete the following satisfactorily:

1 The Workbook completed and submitted for approval.

2 Attendance and participation in the training session.

Assessment

There are specific assessment guidelines compiled by FRSITO for this unit standard.

Because each participant's practical experience differs, your next step will be to contact an approved Assessor:

- Discuss any other requirements you may need to fulfill
- This could include attestation of previous practical experience and/or practical assessment

Work record

You'll need to maintain Taskbooks (from FRSITO) or notebook record of relevant work experience completed, together with an evaluation of tasks completed at an incident by the relevant supervisor to support portfolio of evidence towards unit standard assessment.

Course

Bring your Student Notes and pink cards to the course.

Terminology

Terminology used in these guidelines is in accordance with the *Rural Fire Management Glossary of Terms* issued by the NRFA. The following provides an explanation of key terms that are used in these Student Notes. Direct quotes from the Glossary are in italics. See www.nrfa.org.nz then Glossary of Terms.

Anchor Point	*An advantageous location from which a fire-line can be constructed. It is used to minimise the possibility of being outflanked by a fire while the line is being constructed.*
Backing fire	*The part of a fire which is burning back against the wind, where the flame height and rate of spread is minimal.*
Buddy system	A practice involving people working in pairs, maintaining constant contact and looking out for one another's safety
Briefing	*A general overview of an operation (CIMS)*
Burnout time	The time required for the fire to fully burn itself out. (No Glossary definition)
Burn Plan	*A prescription defining the location, sequence, method, and precautions to be observed in carrying out a prescribed burn.*
Burning Conditions	*The state of the combined components of the fire environment that influence fire behaviour and fire impact in a given fuel type. Usually specified in terms of such factors as fire weather elements, fire danger indices, fuel load, and slope.*
Burning Off	*Generally, setting fire – with more or less regard to areas carrying unwanted vegetation such as rough grass, slash, and other fuels.*
Burnout	*A counter-fire commenced from a natural or previously constructed firebreak for the purpose of fighting a fire.*
CIMS	*Coordinated Incident Management System. A structure to systematically manage emergency incidents*
Clean Burn	*Any fire, whether deliberately set or accidental, that destroys most above ground vegetation and litter along with the lighter slash thus exposing the mineral soil.*
Command	*The internal direction of members and resources of an agency (or organisation) in the performance of that agency's role and tasks. Command relates to single agencies and operates vertically within an agency.*
Convection column	*The rising column of heated air, smoke, ash, burning embers and other matter generated by a fire.*
Drip torch	*A canister of flammable fuel fitted with a wand, a burner head and a fuel flow control device. It is used for lighting fires.*
Firebreak	*A natural or artificial physical barrier against the spread of fire from or into any area of continuous flammable material.*
Fire edge	*Any part of the boundary of a fire at a given moment. Note: The entire boundary is termed the fire perimeter.*
Fire line	*That portion of the fire perimeter upon which resources are deployed and are actively engaged in fire suppression action.*
Flank/Flanks Of A Fire	*Those parts of a fire's perimeter that are roughly parallel to the main direction of spread. Referenced to as left or right flank from the base of the fire.*

Continued on next page

Terminology, Continued

Frontal Fire Intensity	*The rate of heat energy release per unit time per unit length of fire front. Frontal fire intensity is a major determinant of certain fire effects and difficulty of control. Numerically, it is equal to the product of the heat of combustion, quantity of fuel consumed in the flaming front, and linear rate of spread. Measured in kilowatts per metre (kW/m).*
Head = Fire Front (Heading Fire)	*That portion of a fire edge showing the greatest rate of spread and fire intensity (i.e. generally to downwind or upslope).*
Ignition	*The beginning of flame production or smouldering combustion; the starting of a fire.*
Ignition pattern	*The manner in which a prescribed burn, backfire, or burnout is set, determined by weather, fuel, ignition system, topographic and other factors having an influence on fire behaviour and the objective of the burn.*
Junction zone effect	An increase in fire intensity when two or more fire edges merge
Mopping-up (Mop up)	*Making a fire safe after it has been controlled, by extinguishing or removing burning material along or near the control line, felling snags, trenching logs to prevent rolling, and the like.*
Prescribed burning	*The controlled application of fire under specified environmental conditions to a predetermined area and at the time, intensity, and rate of spread required to attain planned...objectives.*
Ring burning	Ring burning involves lighting the outside edge of the burn area in a prescribed sequence so that the fire burns towards the centre of the area creating a convection column and a high intensity burn.
Spot Burning	*The setting of a number of individual fires throughout an area so spaced that they will spread independently over most of the rest of the area before finally meeting at the junction zone*[1]*. (In Ontario referred to as spot ignition)*
Strip burning	*Setting fire to a narrow strip of fuel adjacent to a fire-line and then burning successively adjacent strips in parallel lines.*
Windrow	*A line of piled slash or debris resulting from forest or scrub clearing.*

[1] **Glossary of Fire Management terms NRIC No 20516**

Crew Responsibilities

Overview

What's a prescribed burn?

In the Terminology list, we gave this definition of a prescribed burn:

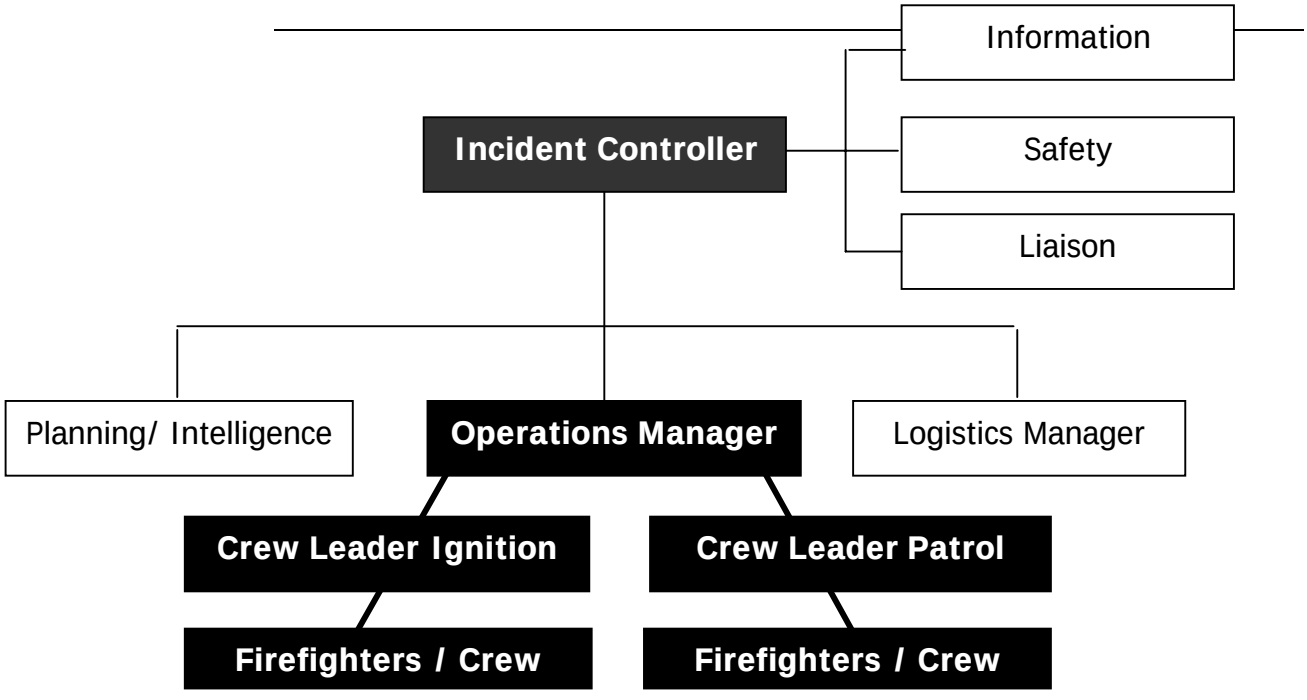
The controlled application of fire under specified environmental conditions to a predetermined area and at the time, intensity, and rate of spread required to attain planned…objectives.

- This means that to control a fire in a prescribed burn, *we vary the pattern and timing of ignition* to account for weather, fuel and topography
- We'll look at your part in carrying that out over the following pages

What's the command structure?

First, here is the command structure and a summary of your general responsibilities.

- All fire fighting, including prescribed burns, is managed under the CIMS model (*Coordinated Incident Management System*[2]*)*
- The roles and relationships described below follow this model of safety management at an emergency incident
- It is this management structure that sets the boundaries for responsibilities and reporting lines



[2] Refer to The NZ Coordinated Incident Management System (CIMS) booklet – "Teamwork in Emergency Management" for further information. See also Section 4 – Incident Management of the Rural Fire Management Handbook

Overview, Continued

Crew responsibilities

As a crew member, you are:

- Responsible to carry out the work skills and functions of this position under the direct supervision of a Crew Leader who reports through the Operations Manager to the Incident Controller (IC)
- Responsible for your personal safety and to watch out for the safety of others
- Responsible to avoid any action or lack of action that would jeopardise own safety, and as a consequence, that of any others

The ability of crew to competently and safely complete their responsibilities and tasks is key to any successful prescribed burning operation.

CL

Your Crew Leader is:

- Responsible to implement the work assignment given by the IC, by directly supervising the crew(s) and deploying crews and machinery at the local level to ensure the safety of both
- Responsible to keep the IC informed of any developments likely to be of value in re-assessing the situation (through Operations Manager)
- Accountable for the safety and welfare of the crew

IC

Crew Leaders are under the direction of the IC / Operations Manager (depending on size of burn):

- The IC has overall responsibility of an incident and must make appropriate strategic decisions based on fire environment, weather forecasts, knowledge of the fire behaviour and resources available so as not to deploy people into potentially dangerous situations

Safety first

The responsibility for safety applies at all levels in the command structure whether the fire is a prescribed burn or a wildfire, and whether affecting the safety of those carrying out the burn or an innocent passerby.

At all times in carrying out prescribed burns crews must be aware of the need to maintain their personal safety and that of others.

Fireground Safety - Individual Responsibilities

In the context of a prescribed burning operation, safety requires the following:

PPE

Personal Protective Equipment

Before entering the fireground, ensure you are wearing all your personal safety equipment and that you have adequate water.

The minimum clothing requirements for ignition crews:

- Leather or other boots appropriate to the conditions (fire resistant)
- Ankle to wrist outer clothing (wool or fire resistant)
- Cotton undergarments
- Head wear appropriate to work being done (preferably an approved safety helmet)
- Safety goggles appropriate to work being done
- Leather gloves
- Highly visible
- Trouser legs, and shirt and overalls cuffs and necks should be left open. This allows air to circulate and sweat to evaporate reducing the dangerous build up of body heat

Synthetic clothing (including synthetic undergarments) should not be worn under any circumstances – this includes any garments made from polar fleece, polyprop and microlene.

Buddy system

Constant contact

Ensure you are in constant contact with at least one other person on the fireground. You may not have a radio, but you should be within a line-of-sight of a *buddy* whenever you are within the fire ground

- The rule for the *buddy system* is that you work as a pair - entering, working and leaving the fireground together
- The purpose of the buddy system is that you look out for one another, maintain contact all the time and if that contact is lost, the buddy must take immediate action to re-establish contact, provide assistance or call for help

Communication

Briefing and Communications

- A complete briefing (including communications) is given to all those involved (see next page)

Fireground Safety - The Briefing

Who does the briefing?

- The Incident Controller (IC) will give the *overall briefing* (a complete picture of the planned prescribed burning operation)
- Your crew leader will brief you on the specific tasks you need to do
- Where possible, it's an advantage to give briefings on-site
- There will also be an opportunity to ask any questions.

If you are unsure of any of this, it is your responsibility to ask.

The IC briefing covers:

- The objective
- View a map/plans of the area
- The types of fuel being burned
- The forecast weather conditions
- The location of the burn boundaries, firebreaks and safety zones
- Whether a low intensity fire or high intensity fire is desirable
- What the end result should look like
- What equipment and ignition pattern will be used
- What communications plan will be used
- What contingency plans are in place for escapes of fire, lost communications, accidents, etc
- What other role you might be assigned
- How fast the ignition crew should light the fire

The Crew Leader briefing covers:

- Who you report to
- What communications plan will be used
- What contingency plans are in place for escapes of fire, lost communications, accidents, safety zones etc
- What other role you might be assigned
- How to communicate with your crew leader
- Whether there are any additional site or operational hazards, including hazards that could affect fire behaviour or your ability to maintain a safe position on the fireground
- How fast the ignition crew should light the fire

In summary…

By the end of your briefing, you need to know:

- Who you report to
- What your responsibilities and tasks are before, during and after the prescribed burning operation
- What is planned, how the operation will be managed, any safety issues and LACES (refer NRFA pink card for more information on LACES)

Lookouts, Anchor points, Communications, Escape routes, Safety zones

Continued on next page

Fireground Safety - The Briefing, Continued

Remember - ask questions if things are not clear to you

As crew, you also have responsibility to carry out your own fireground reconnaissance and pre-burning checks:

Fireground reconnaissance

Check out the fireground including:

- The terrain you will be traveling
- The locations of any difficult areas that could slow you down
- Where potential hazards are located
- The locations of escape routes and safety zones
- Areas of radio "dead spots" that will affect communication
- The location of firebreaks

Pre-burning checks

- Check your safety equipment and that of your buddy (including water bottle)
- Check your ignition equipment (drip torch, etc)
- Check your communications equipment
- Check safety zones/escape routes

Careful planning is key to safety. This includes:

- A burn plan
- A well prepared area
- Meeting burn plan conditions
- Adequate people and resources
- An understanding of fire behaviour under current and forecast weather conditions

A careful burn plan assesses the need and placement of firebreaks.

The briefing checklist on the next 2 pages is an example of what can be used to support the briefing.

Fireground Safety - Briefing Checklist

Fire Management: Refer to the Green *Rural Fire Management Handbook* (Section 2) & the Orange *Air Operations Manual* (Yellow Pages) for additional briefing information.

All tasks should be preceded by a safety briefing relevant to the task being undertaken. This briefing may be delivered by a dedicated safety officer or by the person supervising the assignment, ie Crew Leader.
The **SMEACC** format should be used to deliver all briefings:

S Situation
M Mission/Objectives
E Execution
A Administration
C Command and Control
C Communications
Q Ask if there are any questions?

Consider and check off the following	✓
1. PPE - appropriate to the task	
- **Firefighters** - overalls, leather safety boots, helmet, ear muffs/plugs, goggles, leather gloves, (rubber safety boots and gloves for water additives use) - **NO SYNTHETIC CLOTHING** - **Power tool use** - chainsaw s/mark safety trousers/chaps, ear muffs, safety boots, helmet, harness for scrub bars - **Wet Weather** - wet weather coveralls, goggles and possibly rubber safety boots for those handling foam or retardant or filling aircraft with water	
2. Training	

- Firefighters are trained or experienced to FRSITO unit standard 3285 'protect personal safety at vegetation fires' or are under the direct supervision of someone who is
- People filling the position of Crew Leader and above are trained or experienced to FRSITO unit standard 3291 'command a vegetation fire crew'
- People using power tools are trained or experienced in their safe operation and hold the appropriate unit standard
- Discuss firefighter health and safety issues
  - Supervised rest breaks
  - Drinking regularly @ 0.5 - 1 (l/hr)	

3. Allocation of tasks is undertaken on physical ability, competence and training	
4. Equipment	
- Hand tools are in a safe working condition and are secure for transporting - Do not transport tools inside crew vehicles - Use the right tool for the job - Work 3 metres apart - Carry tools at the point of balance horizontally next to your body with the blade forward - Remove overhanging limbs that may interfere when swinging tools - Make sure equipment is secure in frames - Use fire retardant dispenser when applying fire retardant	

Consider and check off the following	✓
5. Vehicles and Road Signs/Barriers	
- Traffic regulations are observed - Travel at a safe speed - Must be able to stop in 1/2 the visible distance - Lights are on and flashing lights used on fireline if fitted - Windows are up - Park off road facing out of fire area - Leave keys in ignition - Don't rest or lie on roads - Road signs/barriers/cones are in place	
6. Command and Control	
- All personnel have been checked into the incident and recorded on the resource form - A safety plan is developed - All fire suppression operations are to be supervised - Dedicated personnel are appointed to supervise aerial operations - All crews are allocated a defined task - Pilots are allocated a defined task, supervision and communications prior to commencing operations - Machinery operators are allocated a defined task, supervision and communications prior to commencing operations - Reporting lines of communication are identified and known by all personnel	
7. Communications	
- A communications plan is developed and understood by everyone - There is communications with all crews, aircraft and heavy machinery - Maintain visual line of communication when visibility deteriorate	
8. Other General Hazards	
- Power lines are isolated before any work is undertaken near them - CONFIRM POWER IS OFF - Burn-offs and patrolling firebreak in steep country	

Fire Management - Briefing Checklist

Refer to the Green RFMH (Section 2) and the Orange *Air Operations Manual* (Yellow Pages) for additional briefing information.

All tasks should be preceded by a safety briefing relevant to the task being undertaken. This briefing may be delivered by a dedicated safety officer or by the person supervising the assignment, ie Crew Leader.
The **SMEACC** format should be used to deliver all briefings:

S Situation
M Mission/Objectives
E Execution
A Administration
C Command and Control
C Communications
Ask if there are any questions?

Consider and check off the following	✓
9. Working around aircraft	
- An air operations plan is developed - All Aircraft management at incidents require a dedicated controller (Aerial Operations Boss) to be appointed in the CIMS structure - Pilots have been advised of the reporting procedures - Communications are in place with all aircraft before operations commence - Pilots are allocated a defined task before commencing operations - A safety briefing is given to everyone before any flying operations commence - Remain well clear of landing/takeoff areas when aircraft are operating unless you have a task that requires you to be there - Keep the public well clear of approach and takeoff paths - Secure helmet with a chin strap - Remove any caps/hats and hold onto them - Firmly hold any other hand carried loose items - Keep crews and equipment together upwind and to one side of landing area - Make each person responsible for their own gear and equipment they carry - Plan where people will sit and the order of loading - Board on a signal from the pilot or loading supervisor - Stay in the pilots vision at all times - Only load tools or equipment with the pilots approval - Sit where instructed - Fasten seatbelt - Secure any loose objects in cabin from moving around - Uncouple the seatbelt and leave when indicated by the pilot or loading supervisor - Recouple seatbelt behind you as you exit if possible - Follow all directions or instructions from the pilot	
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Consider and check off the following	✓
10. Helicopters	
- Keep well clear of the main and tail rotors and engine exhaust at all times - Approach from the front in pilots view - Approach from the downhill side on sloping ground - Carry all tools and equipment at or below waist height - Enter and leave in a smooth steady motion - Don't make sudden movements	
11. Fixed Wings	
- Do not approach until the aircraft is stationery - Only approach from the side and stay in bodily contact with either the leading or trailing edge of the wing - NEVER APPROACH FROM THE FRONT - Establish a safe working zone with the pilot and ensure all personnel are familiar with it - Stay away from the turbine exhaust when engine is running (Cresco on the front left hand side)	
12. Working with Heavy Machinery	
- Operators have been advised of the reporting procedures - Communications are in place with all machinery before operations commence - Operators are allocated a defined task before commencing operations - Operators are fully briefed on any hazards and safety issues - Machines working at night are equipped with suitable flood lighting equipment - People working near machinery operations have high viz clothing - Keep away from the downhill side of an operating machine - Keep at least two tree lengths away from an operating machine - Attract the operators attention before approaching - Watch out for rapid and erratic movement of machine - Never mount or dismount a moving machine	
13. Identify Specific Hazards for this incident	
- For each hazard, discuss the danger signs and identify the avoidance and mitigation measures to be followed to minimise the risk	

Fireground Safety - Firebreaks

Firebreak

A natural or artificial physical barrier against the spread of fire from or into any area of continuous flammable material.

What is a firebreak?

A firebreak is a barrier to the spread of fire.

Generally firebreaks will not, unless very wide, stop a running fire; their main function is to break the continuity of the fuel and provide:

- A place to light up from
- Access for crew and equipment to deal with spot fires across the break
- A safety zone and escape route for fire fighters

How wide does it need to be?

The required width of a firebreak is relative to many fixed and variable factors including fuel type, fuel dryness, topography and the weather on the day of the fire.

Nevertheless, it needs to be wide enough to prevent flames, flying embers or falling or rolling burning material from crossing it.
It may consist of a dozed mineral earth firebreak, a wet line of foam or a fire retardant strip.

How do we form firebreaks?

- Where mechanical firebreaking is not an option, consider - burning in firebreaks, hand cutting or use of chemicals
- Cut firebreaks to mineral earth - a minimum of 5*m* of mineral earth or non-combustible material – pushing debris to the outer edge (away from the fire)
- Clear hand -cut breaks of all flammable material

Where do we form firebreaks?

- Site these to isolate the area to be burnt from adjacent flammable fuel, eg ridge tops, break in fuel types, immediately surrounds area to be burnt

All firebreaks must be anchored

Ignition Patterns and Techniques

Overview

Ignition pattern

The manner in which a prescribed burn, backing fire, or burnout is set, determined by weather, fuel, ignition system, topographic and other factors having an influence on fire behaviour and the objective of the burn.

Those planning the burn will have a particular objective in mind, for example:

- Crop residue removal
- Preparing an area for over sowing or planting trees, etc

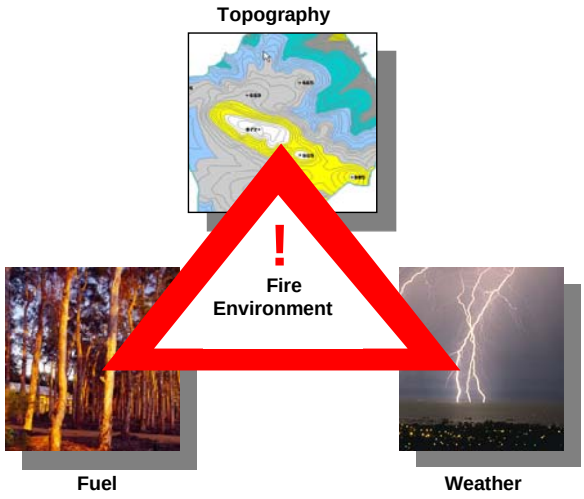
They will choose the ignition pattern and the pace of ignition to account for local weather, fuel and topography or actual fire behaviour at the time of ignition – to meet the required objective.

Adopting tactics to consider these effects requires a skilled and disciplined ignition crew and good communication with and understanding of, those leading the burn.

How are fire behaviour and the ignition pattern connected?

On a prescribed burn, the fire environment (fuel, weather and topography) together with the ignition pattern, *govern* fire behaviour.

This means the ignition pattern chosen, pace of burn and the timing of the burn cannot be separated from how they will impact these 3 components of the fire environment.



Fire environment

The surrounding conditions, influences and modifying forces of topography, fuel and fire weather that determine fire behaviour.

Fire behaviour

The manner in which fuel ignites, flame develops, and fire spreads and exhibits other related phenomena as determined by the interaction of fuels, weather, and topography.

What do Ignition Patterns influence?

What does the ignition pattern influence?

The ignition pattern influences:

- The rate of fuel ignition
- The rate of fire spread
- The fire intensity

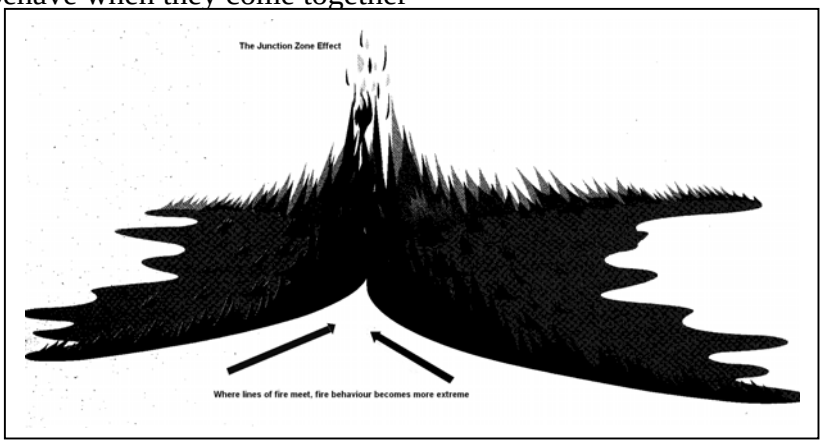
Why?

This is because the ignition pattern determines whether the fire will spread:

- Upslope, or
- Downslope, or
- Run with the wind (a *heading* fire), or
- Back against the wind (a *backing* fire); and
- The burnout time

And the ignition pattern also influences the junction zone effect

ie. How fires behave when they come together



What happens when 2 fires come together?

What is the junction zone effect?

The junction zone effect occurs where separate areas of fire come together.

- Flame height typically doubles - this creates twice the intensity and often twice the rate of spread
- Fire intensity increases abruptly, and may have consequences for spotting
- The increase is greater when fires converge along a line rather than at a point
- The result may lead to an intensity that exceeds your objectives (i.e. a fire that is simply too hot – damaging ground root structures or scorching trees etc) as well as increased ember transport, fire whirls and other unstable fire behaviour

Junction Zones can raise fire intensity by as much as 16x.

Continued on next page

What do Ignition Patterns influence?, Continued

Wind strength

Wind strength and slope have significant influence on the direction in which the fire will travel, the rate of fire spread (ROS), and fire intensity.

Your responsibility?

This means that it is important you communicate any changes in wind strength and direction to your Crew Leader

For further reading - you'll find a copy of the Beaufort Scale in Appendix 1.

Low Intensity Burning

A low intensity burn is characterised by a fire with a flame less than 1.5*m* high. Low intensity burns consume some of the fuel and have low Rate of Spread (ROS), usually less than 100*m* per hour.[3]

A low intensity burn is usually one of < 1500 – 2000 *kw/m* with flame heights < 1.5*m* high, and utilizes weather and fuel conditions to restrict fire intensity so that only target fuels are burnt and quite specific objectives are met.

High Intensity Burning

A high intensity burn is characterised by a fire with a flame more than 2*m* high - with the principal objective being complete fuel removal. High intensity burns consume more fuel and can have extremely high ROS.

A solid strip of fire always accelerates and spreads faster and builds up intensity quicker than does a series of spot fires spaced along the same strip.

Your responsibility?

- **Keep a close eye on the fire and alert your crew leader to any changes or unexpected fire behaviour**

Pace of Ignition

If an ignition crew exceeds the required ignition pace or over-lights an area, then strip fires and junction zones can develop earlier resulting in a faster, more intense fire with extreme fire behaviour, including spotting and fire whirls.

It takes a disciplined ignition crew to recognise that some ignition patterns require considerable patience and that it is wiser not to force the fire, but to allow it to develop and to achieve the fire behaviour sought for the prescribed burn.

Continued on next page

[3] See Appendix 2 for Fire Danger Class Interpretation chart - estimated flame height in relation to frontal fire intensity.

What do Ignition Patterns influence?, Continued

Complete Questions 1 – 5 in your Workbook.

What's next? Its important you understand the different techniques available for ignition patterns, beginning with the backing fire.

Backing Fire

Backing Fire

The part of a fire which is burning back against the wind* (or downhill), *where the flame height and rate of spread is minimal.

Purpose

- A backing fire is of generally lower intensity, and will consume all fuels as it slowly makes it's way into wind or down hill
- Used in areas where very tight control of the burn is required at all times. fuel dynamics and weather are important in assessing if a backing fire will work/carry, and what intensity will be created relative to the objective
- Backing fires may be used to secure the fire perimeter within firebreaks before other ignition patterns are used

Essential for safety

- You can use a backing fire to establish a completely burned out zone just inside the firebreak – this effectively widens the firebreak
- A backing fire is the easiest and safest type of prescribed fire to use, provided wind speed and direction are constant. This is because a fire traveling against the wind or down slope should have less aggressive fire behaviour and less chance of escape
- A backing fire should be lit as a continuous strip of fire and not as a series of spot fires

Useful for different fuel types ie. Fuel reduction burns

- Under *ideal conditions*, backing fires can be used to carefully burn the *light* surface layer under some species of trees, eg. Eucalypts
  - *What do we mean by ideal conditions?* Light steady winds of 2-5 km/h at eye level help to get rid of smoke and prevent heat from rising directly into the trees

Useful for different topography

- On sloping ground, a backing fire can be started immediately down slope of a firebreak located along the ridgeline

Needs skill and discipline

- A backing fire should be lit as a continuous strip of fire and not as a series of spot fires

The Strip Burn

Strip Burn

Setting fire to a narrow strip of fuel adjacent to a fire-line and then burning successively adjacent strips in parallel lines.

Strip burning is useful when seeking a fast moving top fuel reduction burn prior to such land management activities as fertilizing and over-sowing for pasture.

Safety Watchout

Strip burning provides a high intensity burn and is ideally suited for aerial operations.

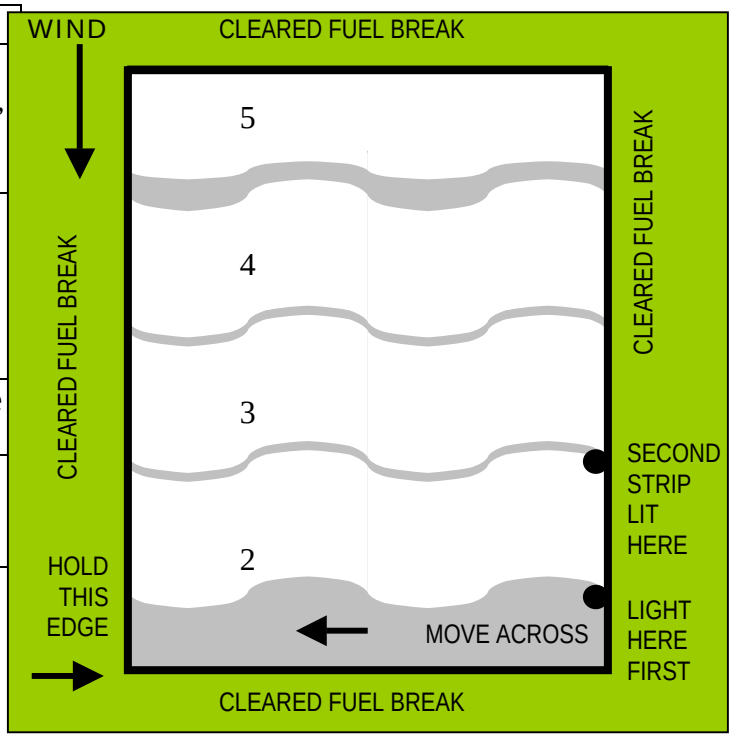
- If using this method to light fuels by hand, the fuels must be very light
- It is absolutely critical that personnel maintain watch on one another, and that they are staggered rearward of the lead person who has the strip closest the fire break, and the lighters are staged successively deeper in to the burn, so that no one person's light up threatens that person in front of them

- **Strip burning on foot is hazardous**
- **You need sound judgment, experience and close supervision to carry this method out safely**

Ignition pattern

To ignite using the strip burning pattern, follow the steps below:

Step	Action
1	Burn from the appropriate firebreak using a *backing fire*, to secure the firebreak and increase its effective width.
2	Once this strip of fire has burned back some distance, light further strips progressively upwind or down slope.
3	Continue the process until the whole block has been lit.
4	Where burn is on a slope, light from the top (upslope) and work down.



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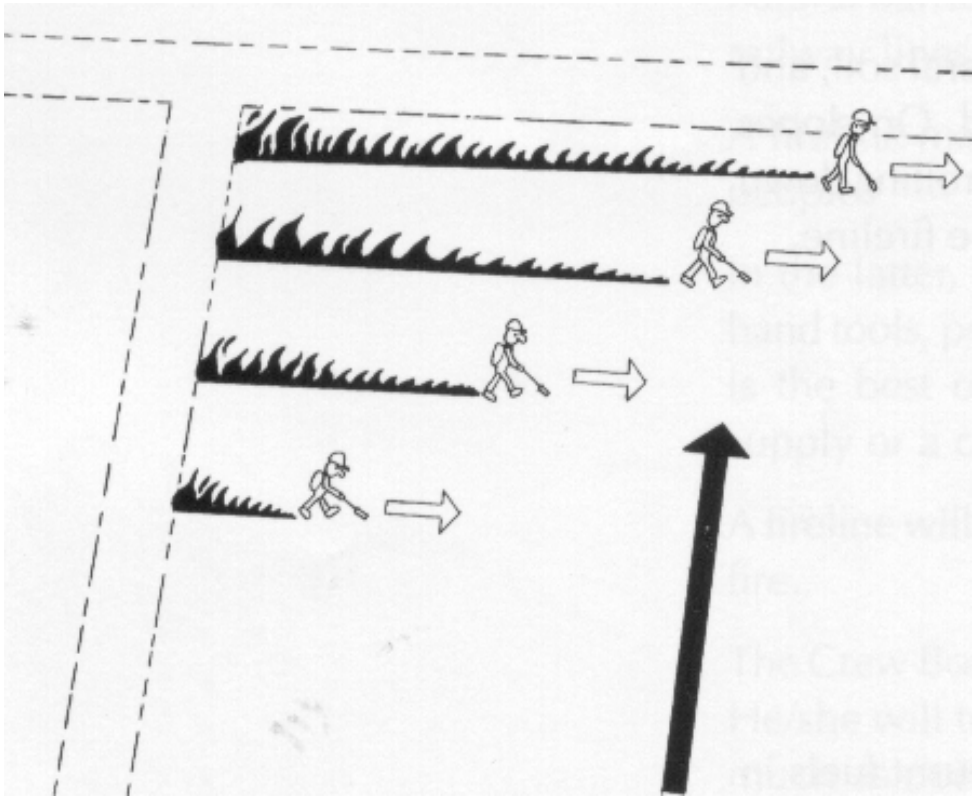
The Strip Burn, Continued

In this way the area is burned out, strip-by-strip with *heading* fires.

Heading fires

Safety Watchouts

- *Heading fires* travel with the wind or upslope
- Unlike backing fires they can develop a high rate of spread and intensity
- Successful management of a heading fire requires that no individual strip of fire can develop to a high intensity before it reaches another burned out strip



Wind direction

Strip burning

Spot Burning

Definition

The setting of a number of individual fires throughout an area so spaced that they will spread independently over most of the rest of the area before finally meeting at the junction zone[4]. (In Ontario referred to as spot ignition)

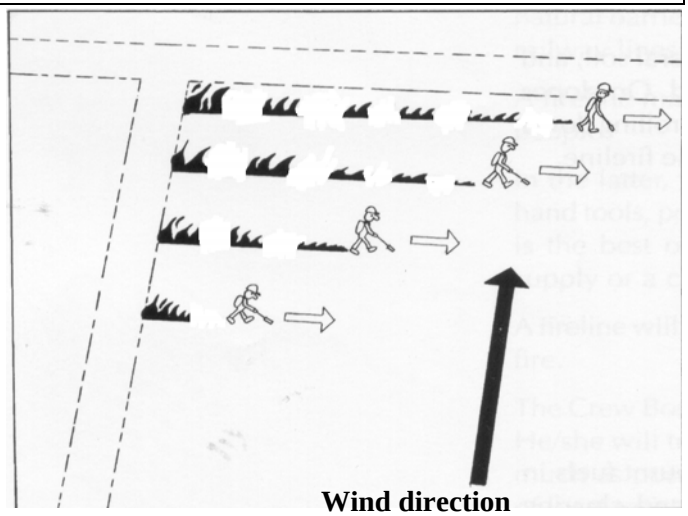
This is the standard technique for *Low Intensity Burns* where control of fire spread and intensity is paramount to achieving a certain objective. It's an effective method of reducing fire intensity compared to strip burning (which can sometimes create a fire that is too intense).

In spot burning, light a series of well-spaced, half-*metre* long spots rather than a solid strip of fire along the strip. A solid strip of fire always spreads faster and builds up intensity quicker than does a series of spot fires spaced along the same strip.

Ignition pattern

To ignite using the spot burning pattern, follow the steps below:

Step	Action
1	Burn from the appropriate firebreak using a *backing fire*, to secure the firebreak and increase its effective width.
2	Then light a series of spot fires at a specified distance upwind or downhill of the backing fire
3	Continue the process until the whole block has been lit.
4	Where burn is on a slope, light from the top (upslope) and work down.



Point or grid burning

Continued on next page

[4] **Glossary of Fire Management terms NRIC No 20516**

Spot Burning, Continued

The distance between spot fires along each line and the distance between lines will influence when the *heading fire's* potential intensity will be reached.

Safety Watchout

Be aware that a large number of small fires burning simultaneously can produce the same kind of explosive convective energy as a single large fire because too much heat energy is released too rapidly.

If the spot fires are lit too close together along the line then junction zones develop earlier resulting in a faster, more intense fire with extreme fire behaviour, including spotting and fire whirls.

Ring Burning

Ring burning

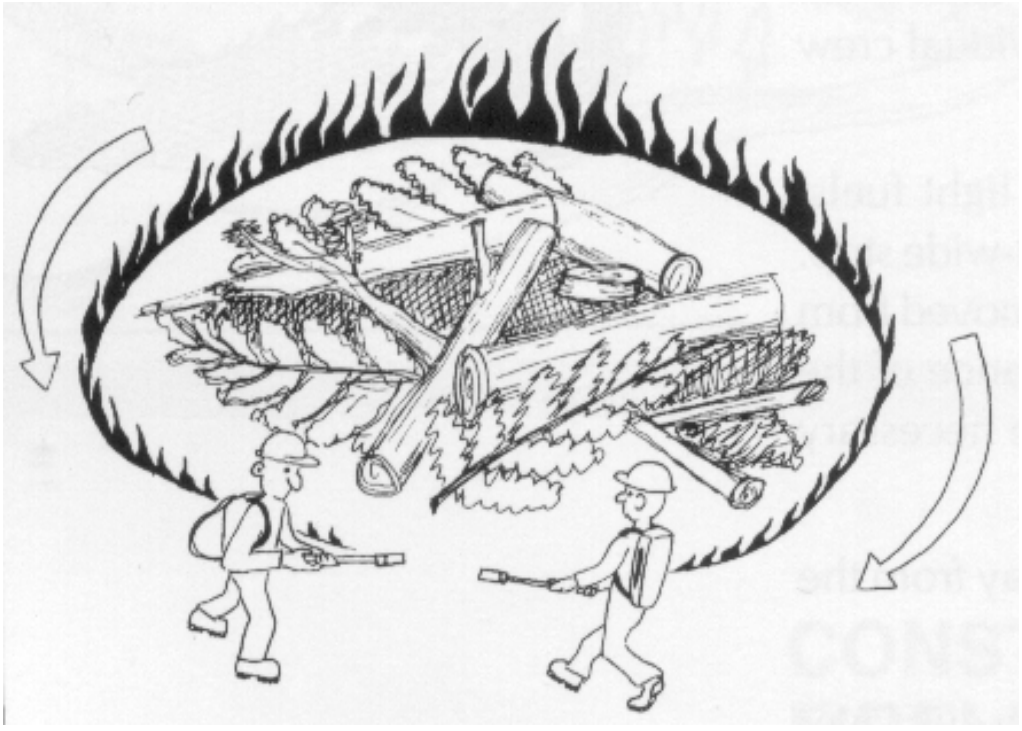
Ring burning involves lighting the outside edge of the burn area in a prescribed sequence so that the fire burns towards the centre of the area creating a convection column and a high intensity burn.

- This common practice is suitable for dense vegetation areas where the line of fire around the perimeter will be drawn into the centre from the fire on the opposite side of the prescribed area.

Ignition pattern

To ignite using the ring burning pattern, follow the steps below:

Step	Action
1	Light from the appropriate firebreak using a backing fire, to secure the firebreak and increase its effective width.
2	Once this buffer strip has been burned out sufficiently, the ignition crew proceeds as quickly as possible down the flanking firebreaks, lighting-up the flanks as they make their way to meet up in the middle of the lower slope or windward firebreak.
3	Where burn is on a slope, light from the top (upslope) and work down.



Ring burning

Windrow Burning

Windrow burning

A long line of piled slash or debris resulting from forest or scrub clearing.

The windrow burn pattern is used to burn piled debris – it is somewhat fixed because of the character and placement of fuel.

Ignition pattern

To ignite a windrow burn, follow the steps below:

Step	Action
1	Each windrow is lit along its length.
2	Where windrows are on a slope, light from the top (upslope) and work down.
3	Where windrows are on flat ground start at the downwind end.

Safety Watchout

Once started, windrow burns are difficult to extinguish.
Safe burning can be achieved if:

- The burn area is kept as small as practical
- Windrows are not close to each other or standing vegetation or fuels

Crop Residue Burning

Ignition pattern

To ignite a crop residue burn:

- Use either a ring burning or strip burning pattern
- Where crop residue is on a slope, light from the top (upslope – highest point) and work down

Complete Questions 6 – 11 in your Workbook.

Ignition Tools

Introduction

In this section we look at some hand operated ignition tools.

e.g.

Some examples of ignition devices that deposit burning substances are:

- Drip torches
- Flame throwers
- Pressurised burners/dry flamethrowers
- Igniters (aerial)

Whatever hand tools (method) you use, ensure you apply the flame to the base of the fuel.

Other necessary resources

Crews patrolling firebreaks while light up continues:

- Have hand tools
- Mobile pumps / water
- Communications

Hand-held drip torches

Hand-held drip torches are usually fuelled with a mix of diesel and kerosene.

Advantages	Disadvantages
More diesel provides more sustained burning	More diesel makes the torch difficult to light
More kerosene provides better ignition	More kerosene is more volatile

- A kerosene: diesel mix of 1:3 is commonly used and provides a good mix

Lighting the drip torch

Step	Action
1	Tighten all connections before using the torch and DO NOT use the torch if there is evidence of any leaks or escapes of fuel from any point other than the wand.
2	Select a safe, clear area and open the fuel valve (where fitted).
3	Tip the torch just enough to wet the wick and wet the small pile of grass with the fuel.
4	Place the torch upright.
5	Light the small pile with a match and dip the wick of the torch into this small fire to light the wick.
6	Place the torch upright and the wick should continue to burn, until the fuel mix is exhausted.

Using the drip torch

Step	Action
1	Hold the torch slightly away from the body, tip the torch to deposit the burning fuel and then walk away.
	If ground fuels are damp or green, progress may be relatively slow.
2	If a spot is difficult to reach, swing the torch forward and terminate with a snapping motion of the wrist.
3	To extinguish the torch, place the torch upright, close the valve and blow out the wick or allow it to burn out or smother wick.

Flamethrowers and Dry flame burners

Flamethrowers are less commonly used.

- They usually have a backpack arrangement with about 20*l* of fuel mix connected to a hand wand and incorporating a hand pump
- Their use is appropriate when fuels are difficult to light or when the fuels are discontinuous

Safety Watchout

- Take special care when using them near people

LPG torches

- Dry flame burners such as LPG torches may be slow because the operator has to apply the flame until the fuel has been raised to ignition point
- They are more useful in light and highly flammable fuel types

Drip torches - Cautions

Commercial drip torches have a fuel trap on the spout to prevent flashback and a check valve in the cover to prevent flame from reaching fuel tank as a double protection against flashback. They have a breather valve, an oil-proof gasket and sealed outlets to prevent the slopping of fuel

Fueling or Refueling

- Never fill around someone who is smoking
- Refuel well away from fire or embers
- Visually ensure that there are no flames on or near the torch when opening or refilling the torch
- Avoid fuel spills on body or clothing (preferably a second pair of gloves)
- Re-ignite away from re-fuelling area (at least 3*m*)
- Keep the torch upright when not in use for burning
- Keep escape routes in mind
- Carry a lit torch in the middle of the firebreak
- Walk carefully
- Know where others are and maintain a safe working distance
- Allow all parts to cool sufficiently prior to handling, refueling or disassembling
- Inspect the torch regularly and replace any damaged parts
- Wipe off the torch and store well away from heat when finished

Aerial Ignition

Aerial ignition involves dropping incendiary devices or burning fuel from a helicopter.

The common aerial ignition device is a drip torch slung below a helicopter that drops flaming jellied petroleum. This device will set both surface fuels and elevated coarse fuels alight.

Flow rates can be adjusted and should be monitored (by crew leaders, pilot and incident managers) to ensure correct rate.

When working with helicopters, ensure all personnel are briefed on ground safety requirements and the danger zones around the aircraft.

These NRFA publications provide some general guidelines:

- Booklet *Aircraft Safety:* Fire Management working with the Aviation Sector
- Pocket Handbook – *Air Operations* Information and Checklist
- Fire Management - Briefing Checklist (NRFA web site & in these Student Notes)

Complete Question 12 in your Workbook.

Hot Points

- The rule for the "**buddy system**" is that you work as a pair - entering, working and leaving the fireground together. The purpose of the buddy system is that you look out for one another, maintain contact all the time and if that contact is lost, the buddy must take immediate action to re-establish contact, provide assistance or call for help.

- **Before entering the fireground** ensure you are wearing all your personal safety equipment and that you have adequate drinking water

- Make sure you get a full **briefing**

- Remember - **ask questions** if things are not clear to you!

- **Fire intensity** increases abruptly when two fires burn together and the increase is greater when fires converge along a line rather than at a point

- **A solid line** of fire always spreads faster and builds up intensity quicker than does a series of spot fires spaced along the same line

- It takes a **disciplined ignition crew** to recognise that some ignition patterns require considerable patience and that it is wiser not to force the fire, but to allow it to develop and to achieve the fire behaviour sought for the prescribed burn

- **Keep a close eye** on the fire and alert your crew leader to any changes or unexpected fire behaviour

- **Successful management of a heading fire** requires that no individual strip of fire can develop to a high intensity before it reaches either a firebreak or another burned out strip

- **Be aware** that a large number of small fires burning simultaneously can produce the same kind of explosive convective energy as a single large fire because too much heat energy is released too rapidly

- When working around fire never underestimate **the effects of radiant heat**. The damaging effect of heat on your body will build up with the more time spent working in the heat

- **Know** your Dangerous Situations Watchouts and LACES

Appendices

Appendix 1 - Wind Strength, Beaufort Scale

Wind strength ***Wind strength (as with slope) has a significant influence on the direction in which the fire will travel, the rate of fire spread (ROS), and fire intensity.***

Beaufort	Average Speed kms/hr	10	20	30	40	50	60	70	80	90	100	110	120	Observable
0 = calm	<1													Calm, smoke rises vertically
1 = light air	1-5													Direction of wind indicated by smoke drift, but not by wind vanes
2 = slight breeze	6-11													Wind felt on face; leave rustle; ordinary vane moved by wind
3 = gentle breeze	12-19													Leaves and small twigs in constant motion; wind extends light flag
4 = moderate breeze	20-28													Raises dust and loose paper; small branches moved
5 = fresh breeze	29-38													Small trees in leaf begin to sway; wavelets form on inland waters
6 = strong breeze	39-49													Large branches in motion; whistling heard in telegraph wire; umbrellas used with difficulty
7 = near gale	50-61													Whole trees in motion; inconvenience felt when walking against the wind
8 = gale	62-74													Breaks twigs off trees; generally impedes progress
9 = strong gale	75-88													Slight structural damage (TV aerials and tiles removed)
10 = storm	89-102													Trees uprooted; considerable structural damage occurs
11 = violent storm	103-117													Widespread damage
12 = hurricane	118+													
Beaufort	kms/hr	10	20	30	40	50	60	70	80	90	100	110	120	

Appendix 2 - Fire Danger Class Interpretations

This chart shows estimated flame height in relation to frontal fire intensity and Fire Danger Class Interpretation.		
FireDanger Class	**Description of Probable Fire Potential and Implications for Fire Suppression**	**Nominal Max. Flame Height**
EXTREME	The situation should be considered "explosive". The characteristics associated with the violent physical behaviour of conflagrations or firestorms is a certainty (e.g. rapid spread rates, crowning in forests, medium to long range mass spotting, firewhirls, towering convection columns, great walls of flame). As a result, fires pose an especially grave threat to persons and their property. Breaching or roads and firebreaks occurs with regularity as fires sweep across the landscape. Direct attack is rarely possible given the fire's ferocity – except immediately after ignition and should only be attempted with the utmost caution. The only effective and safe control action that can be taken until the fire run expires is at the back and along the flanks.	**3.6+metres**
VERY HIGH	Burning conditions have become critical, as the likelihood of intense surface fires is a distinct possibility; torching and intermittent crowning in forests can take place. Direct attack on the head of a fire by ground forces is feasible for only the first few minutes after ignition has occurred. Otherwise, any attempt to attack the fire's head should be limited to helicopters with buckets, or to the use of fixed wing aircraft – preferably dropping long-term chemical fire retardants. Until the fire weather severity abates, resulting in a subsidence of the fire run, the uncertainty of successful control exists.	**2.6 to 3.5 metres**
HIGH	Running or vigorous surface fires are most likely to occur. Any fire outbreak constitutes a serious problem. Control becomes gradually more difficult if it is not completed during the early stages of fire growth following ignition. Water under pressure (from ground tankers or fire pumps with hose lays) and bulldozers are required for effective action at the fire's head.	**1.4 to 2.5 metres**
MODERATE	From the standpoint of moisture content, fuels are considered to be sufficiently receptive to sustain ignition and combustion from both flaming and most non-flaming (e.g. glowing) firebrands. Creeping or gentle surface fire activity is commonplace. Control of such fires is comparatively easy but can become troublesome as fire damages can still result and fires can become costly to suppress if they are not attended to immediately. Direct manual attack around the entire fire perimeter by firefighters with only hand tools and back-pack pumps is possible.	**Up to 1.3 metres**
LOW	New fire starts are unlikely to sustain themselves due to surface moisture fuel conditions. However, ignitions may take place near large and prolonged or intense heat sources (e.g. camp fires, windrowed slash piles) but the resulting fires generally do not spread much beyond their point of origin, and if they do, control is easily achieved. Mop-up or complete extinguishment of fires that are already burning may still be required provided there is sufficient dry fuel to support smouldering combustion.	**No visible flame**

NB The above notes should not be used as a guide for Firefighter safety. Fires can be potentially dangerous or life threatening at any level of fire danger!

General rule(s) of thumb When Drought Code (DC) exceeds about 300 and/or Buildup Index (BUI) is greater than around 40, one can generally expect ground or subsurface fires. Please note, however, these benchmark values are for moderately well-drained sites, but in actual fact will vary according to soil type and drainage conditions and should be determined locally on the basis of past wildfire suppression and/or prescribed burning experience.

Appendix 3 - Smoke from burn-off may have caused fatal crash

We can be aware that safety comes first, and yet act without thinking through consequences. Even a simple burn-off can have fatal consequences.

This report of a tragic accident is a wake up call to anyone considering a prescribed burn.

03 August 2004

By ANNA CLARIDGE and SEAN SCANLON

Thick smoke from a farm burn-off in North Canterbury may have caused a horrific crash that killed a Nelson mother and left her three-year-old daughter and 17-year-old son in a critical condition.

Police had been warned of the smoke hazard just minutes earlier after another motorist reported it at a service station. Wendy Keenan, 41, of Nelson, was killed on Sunday afternoon after the car she was a passenger in was shunted off the road by a truck and trailer unit.

Her family was yesterday struggling to come to terms with the accident. Keenan, her two teenage sons and her three-year-old daughter had been driving south on State Highway 7 near Waikari in North Canterbury when they slowed to navigate through the thick smoke. Police said it appeared the car had almost left the smoke when the truck hit them from behind and pushed them off the road, through a fence and into a paddock.

Keenan's three-year-old daughter and 17-year-old son were flown to Christchurch Hospital. The young girl was taken off a respirator yesterday afternoon but both remained in a critical condition. Keenan's second son and the truck driver both received moderate injuries and remain in hospital.

Wendy Keenan's father-in-law, Henry Keenan, told The Press from Te Puke last night that the family was struggling with its loss. "She was a lovely girl, good mother, lovely kid. I am so very sorry that she got killed."

Wendy Keenan's husband, Whitu, was "pretty cut up" about the accident, Henry Keenan said.

...Police are now investigating the crash and hope to speak to other motorists who noticed the smoke. Just 10 minutes before the crash happened, staff at the Waikari service station had phoned police to alert them to the dangerous smoke drifts after concerns were raised by a passing motorist.

Senior Constable Ian Price, of the Culverden police, said the farmer who lit the fire was trying to clear long grass from the roadside to avoid potential fire risk in the summer. "The roadside is unfenced and it's about a 20m wide road verge. The fire was lit to take down the long grass to avoid fire danger when the summer comes."

Price said police were investigating whether the roadside land belonged to Transit New Zealand or to the farmer. "The farmer believes that the land he was burning was his own. We are investigating whether it was his or Transit's." Price said that if the land was owned by the farmer, a fire permit would not have been needed because it is an open fire season. No charges had been laid.

Review Questions

Use these questions to review your knowledge. Check your answers against the SN content. **Answer as a crew member in a prescribed burn you have taken (or will be) taking part in.**

1. In the space below, draw a diagram of the command structure at this burn.
- Who do you report to?

2. a. If you were a member of the **Lightup Crew**, what tasks would you need to complete?

b. If you were a member of the **Patrol Crew**, what tasks would you need to complete?

Continued on next page

Review Questions, Continued

3. **Map Legend**

Draw a sketch map, identify each of the following by writing the matching letter.		
a. hazards b. access points c. assembly point	d. danger areas e. escape routes f. ICP	g. Water points h. Safety zones i. Wind direction for burning

Continued on next page

Review Questions, Continued

4. List what equipment you need.

5. What lighting patterns you would use at this burn?

6. Explain why ignition point spacing is important.

Continued on next page

Review Questions, Continued

7. What safety issues do you need to consider when carrying out ignitions for a crop residue burn?

8. When would you use strip lighting?

9. **Explain the operation of:**

a. Drip torches

b. Pressurised burners

c. Backpack flame-throwers