Use of Water and Additives
Status of this Document

This document is issued by the National Rural Fire Authority.

What This Means
It is written to comply with:
- other National Training material
- National Rural Fire Authority best practice
- Forest and Rural Fires Act 1977
- Fire Service Act 1975
- Health and Safety and other relevant legislation
- New Zealand Qualifications Authority requirements
- Fire and Rescue Services Industry Training Organisation (FRSITO) requirements.

The document, its content and specified processes are not to be altered, except through National Rural Fire Authority processes.

Recommendations for Change
National Rural Fire Authority encourages and welcomes feedback on all its products and processes to ensure currency and continuous improvement.

Recommendations for changes to this material should be sent to National Rural Fire Authority.
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The National Rural Fire Authority (NRFA), New Zealand Fire Service (NZFS) and the Fire and Rescue Services Industry Training Organisation acknowledge the help of the many subject matter experts in preparing this course.
## Study Guide Introduction

### Overview

Welcome to Use of Water and Additives. The course is made up of this study guide, a workbook, a theory assessment and a practical training session which includes a practical assessment.

During the course, you will learn about:

1. Types of waterway equipment.
2. Use of waterway equipment and additives.
3. Operating a fire hose in vegetation fire settings.
4. Relocating hose lines.
5. Mopping up of vegetation fires using water.

Read through this study guide and complete the workbook before your practical training date. This will ensure you are familiar with the subject and can highlight any questions at the training session.

### Course Objectives

The general objective for this course is to demonstrate knowledge of wet firefighting techniques. After studying this material, you should be able to demonstrate knowledge of:

- wet firefighting techniques
- explain and demonstrate use of waterway equipment
- roles of water and additives in wet firefighting
- outline and demonstrate using water for mop-up.

This course provides evidence towards the achievement of unit standard 3287 Suppress vegetation fires with water and with water with additives.

### Theory

There are three theory sections in this course: Once you have completed all three sections complete the workbook and make notes of any questions you want to ask during the practical training.

1. Firefighting Fundamentals
2. Delivery

### Assessment and Evidence

Because each trainee’s practical experience differs you will need to check with an approved assessor and discuss the requirements for you to achieve the unit standard. This could include attestation of previous practical experience and/or practical assessment.

A properly maintained work record will support your portfolio of evidence for use as evidence for assessment against unit standards. You’ll need to maintain a record of relevant work experience, together with an evaluation of tasks completed at an incident by the relevant supervisor.
The practical training session is made up of three parts:

1. The instructor demonstrates the use of the wet firefighting equipment and the trainees practise using each item.
2. Trainees work in a crew to set up and use wet firefighting equipment and practising using these skills.
3. Trainees complete the supervised assessment.

At the practical training, you will be asked to:

- watch the instructor demonstrate wet firefighting equipment
- use the tools yourself.

There is also a theory assessment for this course. This is usually completed after the practical training session. This will be given to you by the assessor for the course. You will need to have an approved assessor assess you against the practical and theory assessment to be awarded this unit standard.
Introduction

To control and successfully fight vegetation fires, we must know:

- why a fire burns
- what makes it spread.

Fire Triangle

The aim of fire suppression is to extinguish the fire by eliminating oxygen, heat and fuel, the three required components of combustion:

- oxygen is essential for burning
- heat is the energy causing flammable material to emit vapours, which mix with oxygen and burn
- fuel is combustible materials such as dead and live vegetation.

![Fire Triangle Diagram]

Figure 1.1 – Fire Triangle
<table>
<thead>
<tr>
<th>Fire Behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fire Development</strong></td>
</tr>
<tr>
<td><strong>Fire Spread</strong></td>
</tr>
<tr>
<td><strong>Fire Intensity</strong></td>
</tr>
<tr>
<td><strong>Flame Length</strong></td>
</tr>
<tr>
<td><strong>Suppression Effort</strong></td>
</tr>
</tbody>
</table>

**Remember, fire intensity may limit fire suppression efforts.**
Flame Lengths and Fire Intensity

The following chart shows estimated flame height in relation to frontal fire intensity and Fire Danger Class Interpretation.

<table>
<thead>
<tr>
<th>Fire Danger Class</th>
<th>Description of Probable Fire Potential and Implications for Fire Suppression</th>
<th>Nominal Max Flame Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXTREME</td>
<td>This situation is explosive. The only effective and safe control action warranted until the fire run expires is at the back and along the flanks.</td>
<td>3.6 metres</td>
</tr>
<tr>
<td>VERY HIGH</td>
<td>Any attempt to attack the fire’s head should be limited to helicopters with buckets or the use of fixed-wing aircraft.</td>
<td>2.6 to 3.5 metres</td>
</tr>
<tr>
<td>HIGH</td>
<td>Use water under pressure (from ground tankers or fire pumps with hose lays) and bulldozers for effective action at the fire’s head.</td>
<td>4 to 2.5 metres</td>
</tr>
<tr>
<td>MODERATE</td>
<td>Direct manual attack around the entire fire perimeter by firefighters with only hand tools and backpack pumps is possible.</td>
<td>Up to 1.3 metres</td>
</tr>
<tr>
<td>LOW</td>
<td>Resulting fires generally do not spread much beyond their point of origin. If they do, they are easy to control.</td>
<td>No visible flame</td>
</tr>
</tbody>
</table>

Figure 1.2 – Flame lengths and fire intensity

Safety Note
Do not use the above notes as a guide for firefighter safety. Fires can be potentially dangerous or life threatening at any level of fire danger!
Fire Extinguishing Methods

Methods

There are three methods of extinguishing a fire and each breaks the fire triangle.

You can use one or a combination of the following three methods to extinguish a fire:

1. Cut off the oxygen supply to SMOTHER the fire.
2. Reduce the temperature to COOL the fire.
3. Remove the fuel from the path of the fire to STARVE the fire.

Smother

This can be the quickest and most efficient form of attack when dealing with small fires. Cutting off the oxygen supply of a large fire in the open is usually impractical.

To smother, lay firefighting foam over burning fuels.

Cool

Using water when fighting fires cools the fuel to the point where combustion stops. This is the most effective way of extinguishing a vegetation fire. The ignition temperature of a fuel is the temperature at which it starts to burn.

Using water:

• absorbs heat energy and removes heat as the water turns to steam
• cools the fuel to a temperature below its ignition temperature.

Always apply water to the base of the flames. If applied to the flames, water will not stop the process. The fuel will continue to give off flammable vapours.

Starve

Removing fuel effectively stops a fire by:

• using water with a suppressant to create a fire line
• using foam or retardant to create a wider fire line or widen a firebreak.
Fire Suppression Strategy – the Basic Rules

Fire suppression strategy has three basic rules:

1. Fast initial attack.
2. Aggressive methodical action.
3. Prompt and complete mop-up.

The Strategy to Extinguish Fire

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knock-down</td>
<td>Perform a concentrated attack on flames on the fire perimeter to reduce the heat.</td>
</tr>
<tr>
<td>Control Spread</td>
<td>When the heat is reduced, contain and control fire spread.</td>
</tr>
<tr>
<td>Extinguish Completely</td>
<td>Completely extinguish the fire and then mop-up and patrol the area until there is no possibility of fire restarting.</td>
</tr>
</tbody>
</table>

To Extinguish Fire with Water

<table>
<thead>
<tr>
<th>Task</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remove the Fuel</td>
<td>Wet a path between the fire and fuel.</td>
</tr>
<tr>
<td>Remove the Air</td>
<td>Use Class A foam over the fire.</td>
</tr>
<tr>
<td>Remove the Heat</td>
<td>Apply water directly to the burning fuel.</td>
</tr>
</tbody>
</table>
### Aerial Support

Aircraft drop water to knock down the surface flame so that ground crews can work at the fire edge. Aircraft operating alone are not effective firefighting tools.

If an aircraft arrives during firefighting and starts dropping water, firefighters must continue their task and not rely on the aircraft to take over. The aircraft supports the work of the firefighters.

### Environmental Impact

**Steps to minimise impacts to land and environment**

Action should be taken to minimise, soil and vegetation disturbances. Key issues are:

- avoid getting class A foam into waterways
- if you find a gate open then leave it open. If the gate is closed then you need to close it behind you
- take care with fuel dumps and machinery areas
- take care with land owners property – report any damage
- ensure that appliances will not get stuck in paddocks
- fire line construction
- burning-out operations
- pick up trash and remove it.
Use of Water in a Direct Attack

Direct Attack Strategy
A direct attack is when the initial effort is to contain the spread of fire by extinguishing a narrow strip around the perimeter.
When the fire has been contained, the remaining area can be extinguished.

Direct Attack on a Small Fire
You can work on and around the perimeter to contain fire spread.

Direct Attack on a Moving Fire
Use this method for direct attack on a moving fire:
1. Approach the fire from the base, starting suppression effort along the perimeter at the base of the fire, which has the lowest spread rate and heat output.
2. Then work along the flanks of the fire towards the head, which has the fastest-moving and hottest part.
3. Remain just inside the burnt area as progress is made along the flanks.

This method, ‘chasing the fire head’, is a pincer movement along the flanks, aiming to close the two flanks together and cut off the advancing fire.
It ensures that the main dangers of a fire are ahead of, and moving away from the firefighters.
Speed and effectiveness of suppression is essential. If the suppression rate is slower than the fire growth rate, the fire will continue to spread.

Direct attack is the safest and preferred method of attack on vegetation fires in New Zealand.

Figure 1.3 – Direct attack
Indirect Attack

This is used when the fire is in extreme fire behaviour and too dangerous to approach, or is in inaccessible terrain.

Containing the fire is done by using favourable terrain such as natural barriers and/or constructed firebreaks well away from the fire perimeter. Also by applying Class A foam or fire retardant to the vegetation on the side of the firebreak away from the approaching fire. This can be reinforced by burning out the fuels between the fire barriers and the fire.

The Incident Controller (IC) directs any indirect attack and/or burning out operations.

Safety Note

Only use indirect attack under strict supervision and only when it is safe!

Review Dangerous Situations to Watch Out For! on your LACES pink card.

The first priority is protecting life, including the safety of firefighters.

Protecting property or vegetation is secondary.

Property can be rebuilt; do not risk lives.
Communication

**Hand Signals for Hose Lines**

When portable radios are not available, clear, commonly understood hand signals are less likely to be misunderstood than shouted instructions.

![Hose hand signals](image)

*Figure 1.5 – Hose hand signals*

**Emergency Message**

At vegetation fires, the call to clear the radio channel and/or gain the attention of other radio users in an emergency is:

```
EMERGENCY – EMERGENCY – EMERGENCY
```

When a reply is received, the caller must give their:

- identity
- location
- nature of emergency.

Stay in contact, since they may need further information.
## Delivery Hoses and Couplings

<table>
<thead>
<tr>
<th>Hose Sizes</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mm</td>
<td>Light to handle, but provides limited water flow</td>
</tr>
<tr>
<td></td>
<td>Useful in steep, difficult and remote areas</td>
</tr>
<tr>
<td></td>
<td>Ideal for short hose lines to mop-up</td>
</tr>
<tr>
<td></td>
<td>Comes in 30 m lengths with 3/4 lengths/pack (extruded/rubber lined)</td>
</tr>
<tr>
<td></td>
<td>Available in non-percolating only</td>
</tr>
<tr>
<td>41 mm</td>
<td>The most commonly used hose for forest and rural firefighting</td>
</tr>
<tr>
<td></td>
<td>Easy to handle and supplies sufficient water over distances</td>
</tr>
<tr>
<td></td>
<td>Conserves water</td>
</tr>
<tr>
<td></td>
<td>Comes in 30 m lengths with 3 lengths/pack</td>
</tr>
<tr>
<td></td>
<td>Available in non-percolating and percolating</td>
</tr>
<tr>
<td>45 mm</td>
<td>Used as firefighting length</td>
</tr>
<tr>
<td></td>
<td>Conserves water</td>
</tr>
<tr>
<td></td>
<td>Easy to handle and supplies sufficient water over distances</td>
</tr>
<tr>
<td></td>
<td>Used as a working length for firefighting at the end of 70 mm hose line</td>
</tr>
<tr>
<td></td>
<td>Coiled in 25 m lengths</td>
</tr>
<tr>
<td></td>
<td>Non-percolating</td>
</tr>
<tr>
<td>70 mm</td>
<td>Used mainly for bulk water supply from high-volume pumps for dam, tanker and helicopter filling</td>
</tr>
<tr>
<td></td>
<td>Coiled in 25 m lengths</td>
</tr>
<tr>
<td></td>
<td>Non-percolating</td>
</tr>
<tr>
<td>90 mm</td>
<td>Feeder base used from hydrants to water tanks or mobile pumps</td>
</tr>
<tr>
<td></td>
<td>Comes in 25 m lengths</td>
</tr>
<tr>
<td></td>
<td>Used for bulk water supply from high volume pumps from dams, tanker and helicopter bucket filling</td>
</tr>
<tr>
<td></td>
<td>Non-percolating</td>
</tr>
</tbody>
</table>
**Couplings**

25 mm and 41 mm

Hoses and associated waterway equipment use 25 mm and 41 mm screw coupling.

*Male to the fire and female to the pump.*

45 mm, 70 mm and 90 mm

Hoses and associated waterway equipment use 45, 70, and 90 mm instantaneous couplings.

*Female to the fire and male to the pump.*
**Percolating Hose**

This allows water under pressure to weep through the lining, giving some protection to the hose from burning. It may not protect the hose in very hot areas.

Generally, percolating hose has a red line marked down the length of the hose (the second left examples in figure 2.3).

**Non-percolating Hose**

This is non-porous and has less burn protection. This needs to be used where there is no risk of the hose line burning. The smooth interior lining has less friction loss, which is helpful when pumping long distances and useful with Class A foam. Extruded hose is a new form of non-percolating hose made of all synthetic material.

Non percolating hose can be of the extruded type (all red plastic type jacket or have a blue line marked down its length).

*Figure 2.3 – Percolating and non-percolating hose*
Packed Hose

Hose is flaked crosswise in a hose pack, with the three lengths of 41 mm or four lengths of 25 mm coupled and stacked on top of each other. The male coupling goes in first, allowing the hose to be run out when carrying the pack from the pump to the fire.

Pack Colour Codes

<table>
<thead>
<tr>
<th>Colour</th>
<th>Hose Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>41 mm percolating hose</td>
</tr>
<tr>
<td>Blue</td>
<td>41 mm non-percolating hose (and extruded hose)</td>
</tr>
<tr>
<td>Red</td>
<td>25 mm non-percolating hose</td>
</tr>
</tbody>
</table>

Figure 2.4 – Packed hose
**Hose Rolled on Bight**

This is a rolled hose that is ready for use. The hose is folded in half, and then rolled up with both couplings on the outside of the roll. Three rolls of 41 mm can be stored in a hose pack.

![Hose Rolled on Bight](image)

*Figure 2.5 – Hose rolled on bight*
**Waterway Equipment**

**Straight Nozzle**

The nozzle size is pre-set (optimum 4 mm to 8 mm) to provide a straight jet of water.

It is ideal for conserving water, reaching distant hot spots and penetrating deep-seated burning material.

![Figure 2.6 – Straight nozzle](image_url)
Adjustable Nozzle

The nozzle can be adjusted from a straight jet (used to knockdown flame from a distance) to a spray (used to take heat out close up or as a shield against radiant heat).

Caution:

Some models of adjustable nozzles use excessive amounts of water; use these on a fine jet to conserve water.

Controlled Dividing Breeching

This is used to divide a single hose line into two lines, control water flow direction, and close off supply when adding hose to a line.
Short hoses are used as a bypass hose from pump back into water supply or to couple in the hydroblender close to the pump (8 m and 2 m lengths).

Figure 2.9 – Short hose
Hydroblenders hold two soap capsules. Soap improves the water’s ability to spread over and penetrate the fuels.

Figure 2.10 – Hydroblender
Hose Adaptor

Hose adaptors are used to link 70 mm hose to 41 mm hose or equipment.

![Hose Adaptor Image](image1.png)

Figure 2.11 – Hose adaptor

Relay Adaptor

A relay adaptor is used to connect 41 mm delivery hose to the inlet of a relay pump.

![Relay Adaptor Image](image2.png)

Figure 2.12 – Relay adaptor
Foam Inductor

Foam inductors are available in a variety of types and models and can connect into a suction or delivery hose. Check the operator manual for correct use and appropriate operating range of pressure and flow rates.

Hose Strangler

This is a clamp device that compresses the hose to stop water flow. It may be used instead of a controlled divider at long distance from the pump.

Caution: If not used correctly, it can damage the hose.
**Hose Coupling Spanners**  This is used for uncoupling 41 mm couplings that have been over-tightened. They are not to be used for tightening couplings.

![Figure 2.15 – Hose coupling spanners](image)
**Relay Dams**

A portable dam can be set up before the upper end of the first pump’s flow limit.

When the dam is filled, it provides a water source for the second pump.

Practice will ensure effective use of multiple pump systems.

In some cases, a combination of relay dams and relay adaptors is required to achieve efficient water movement.

**Gravity Systems**

Gravity can be used to increase water pressure. Nozzle pressure increases considerably when a pump is above the level of the fire. Be careful not to supply too great a pressure.

It is also possible to work without a pump.

If hose can be laid out downhill, gravity will provide pressure for mop-up work. Gravity increases pressure by 10 kPa per metre in fall.

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**Safety Note**

Check against- Dangerous Situations to watch out for! on the LACES card
Hose Laying

Hose should be laid in as straight a line as possible. This reduces the length of hose needed and avoids kinks that reduce water flow.

Communication between nozzle operator, controlled divider operator and/or pump operator is essential when extending a hose line.

Hang empty hose packs on a branch or over a rock so they are not lost or burnt.

Burnt Area

Outside of the burnt area:
- avoid laying out hose in unburnt fuels where the fire may spread
- use hose ramps on roads to allow vehicles to cross over
- lay hose under bottom of wire fences
- lay through culvert pipes
- lay hose under a bridge to cross a road
- lay under railway tracks and between sleepers.

Inside the burnt area:
- always charge the hose before extending over burnt ground
- damp down a strip and then lay hose along it
- take care to avoid hot spots, like the base of vegetation clumps or stumps, when extending into burnt area.
Controlling Hose

There is a tendency to use excessive pressure; this makes unnecessary hard work for the nozzle operator. Ideal nozzle pressure is 500 kPa.

Close down the nozzle when climbing over obstacles.

Place a firefighter just behind the nozzle operator to help handle the hose.

On steep hillside, secure hose to avoid the hose sliding downhill while in use.

Figure 2.17 – Controlling the hose

Extending Hose Line

To extend the hose line:

- always lay uncharged hose onto dampened ground
- have extra hose just behind the nozzle operator
- establish communications between the nozzle and pump operators to ensure quick change-over when adding hose lengths
- do not extend new lengths of hose ahead of the nozzle.
Nozzle Pressure

Pressure at the nozzle decreases as more hose is used and/or height above the pump increases.

500 kPa is sufficient nozzle pressure for firefighting and 350 kPa for general mop-up work. Higher pressures may be required to mop up deep-seated fire.

For adequate pressure when using 41 mm hose from a Wajax pump, use:
- up to 18 lengths over flat ground
- up to nine lengths up very steep terrain.

Terrain is never uniform. Assess the pressure at the nozzle as the hose is extended. Consider the need for a relay pump in advance.

Care of Hose and Water Equipment

<table>
<thead>
<tr>
<th>During use</th>
<th>After use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avoid dragging kinked hose over rough ground.</td>
<td>Check that hose won’t get burnt before leaving it unattended on the fire line.</td>
</tr>
<tr>
<td>Do not bend hose at a sharp angle.</td>
<td>Check condition of hose and couplings.</td>
</tr>
<tr>
<td>Protect first length of hose from the pump from chafing against the ground.</td>
<td>Check washer is in female coupling.</td>
</tr>
<tr>
<td>Check that hose is not pulled onto hot spots.</td>
<td>Store wet hose separately from dry hose on the fire appliance.</td>
</tr>
<tr>
<td>Do not walk on or drive over hose.</td>
<td></td>
</tr>
<tr>
<td>Do not drop couplings.</td>
<td></td>
</tr>
<tr>
<td>Take care with cutting tools near hose lines.</td>
<td></td>
</tr>
</tbody>
</table>

Relocating a Charged Hose Line

Take care to avoid damage when dragging across the ground and road surface. Allow for the additional weight of the hose. Moving it requires greater effort. Avoid dragging when the hose is kinked.
**Safety on Hose Lines**

To maintain safety on hose lines:

- knock down the flame ahead with a water jet to reduce exposure to heat
- then reduce the flow through the nozzle and apply water to and into the ground fuels
- use water sparingly when working from a tanker or limited water supply; careful use of available water may be sufficient to contain the fire and secure a fire line without running dry
- be careful directing the water jet at the ground because this can return mud and debris into the face
- watch behind for fire flare-up and check that the hose has not moved onto hot spots or become kinked
- to know about any water supply problems, maintain communications with the pump operator
- use a back-up person
- don’t open or shut the nozzle or breeching too quickly
- don’t straddle a pressurised hose.

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**Safety Note**

Do not advance to and along the fire edge without water pressure at the nozzle.
Collection after Use and Relocation

You may take used hose to another place and use it again. Carry hose a short distance by either laying in short folds over your shoulder or folding into a figure eight pattern, i.e. rolling and twisting the hose between your arms. It’s difficult to roll up used small-diameter hose into coils. So, after draining, roll hose into a pineapple shape for more secure carrying.

Making a Pineapple

To pineapple 25 mm and 41 mm hose:

1. Uncouple hoses.
2. Start at the uphill end and drain the hose by walking with the hose over a shoulder.
3. Pull the hose out straight and remove any twists.
4. Start at the male end, fold the hose over about 300 mm from the end, and continue folding about six times to form a solid core (or backbone).

5. As the core is rotated, twist it a quarter turn so the hose crosses on each end.

6. Continue rolling and twisting in a pineapple shape (working the ball of hose along on the ground and keeping it firmly bound will help).

7. Tuck the female end under one of the folds to secure.

The hose can be carried using one of the inner folds as a handle. Two pineapples hoses fit into a hose pack.
**Damaged Hose or Couplings**

Tie a knot in the hose end after it has been rolled up to identify that it is damaged. If possible, also label and note the damage.

![Damaged hose](image)

*Figure 2.19 – Damaged hose*
Use of Water

Water is the most effective and efficient means of extinguishing a fire if applied correctly.

In rural areas, water can be a scarce resource, so thrifty application is required. The major constraint is getting water to the fire quickly. Unless an adequate source is very close to the fire, water used in the initial attack should knock down the fire to create tolerable conditions for crews to construct the fire line. When fire spread is held, use water to support the fire line.

Figure 3.1 – Using water
Use water sparingly!

Water is often scarce, so it is critical to use it carefully.

The initial attack on a fire edge is with a straight jet to knock down flame and reduce radiant heat. This allows the nozzle operator to move in closer. The nozzle is turned to spray to extinguish the edge.

To practise water conservation, use:

- a straight jet to reach and knock down flame
- a spray to remove heat from surface fuels
- a closed-down flow at the nozzle when not firefighting
- a spray pattern as a shield from a flare up
- a straight jet to penetrate into deep-seated fire (watch out for blow back) or to reach hot spots in trees/spars
- spray along the fire edge, not into unburnt fuels
- just enough pressure to apply water and handle the hose with ease
- spray along the fire edge for maximum effect.

A Wajax pump at half-throttle supplies sufficient water at the nozzle when pumping over a short, flat distance

Safety Note

Direct water at the burning material, not at the flames!
Spraying across the fire edge may spread embers into unburnt fuels.
Use of Water and Additives Study Guide

Water Additive

Always use a water additive!

The properties of water can be changed to reduce the surface tension (suppressant) or retard fire development (retardant) and make it more effective in extinguishing fire.

High surface tension prevents water from penetrating into organic fuels, especially deep duff (dead organic ground litter) layers.

If the ground is extremely dry, plain water will just run off and not soak into the dead fuels.

Suppressants

Adding a suppressant, wetting agent or soap reduces surface tension, allowing the water to penetrate fuels.

Hydroblender capsules or Class A foam increase penetration. The use of hydroblender capsules reduces the surface tension of water to the same level as using 0.1% Class A foam.

Figure 3.2 – Foam inductor
**Retardants**

A fire retardant is chemicals mixed with water and sprayed onto organic fuels to prevent them burning.

![Retardant inductor](image)

**Figure 3.3 – Retardant inductor**

**How Retardant Works**

When the mixture is applied to organic fuels and then exposed to heat, the water will evaporate after absorbing heat from the flame. The remaining chemical reacts with the fuel breakdown phase of combustion, inhibiting oxygen supply and the release of combustible gases. This retards fire development.

**What's in a Retardant**

Retardants are generally a fertiliser-based product containing ammonium sulphate or ammonium phosphate, a thickener, anti-corrosives and a colouring agent.

**Application of Retardants**

For best results, apply retardant by aerial/hose line and ensure the mixed product covers the vegetation ahead or the edge of the fireline in a fine spray.
Application Rates

Depending on the requirements, retardants may be applied (as with foam) in varying concentrations and application rates.

<table>
<thead>
<tr>
<th>General Concentrate/Water Mixtures</th>
</tr>
</thead>
<tbody>
<tr>
<td>5:1</td>
</tr>
<tr>
<td>10:1</td>
</tr>
<tr>
<td>15:1</td>
</tr>
</tbody>
</table>

Application requires full coverage of the surface of the fuels.

Advantages

The advantages of using retardants are it:

• provides a higher level of protection to treated vegetation
• once applied to vegetation, will last longer and remain more effective than foam.

Disadvantages

The disadvantages of using retardants are it:

• requires specialist supervision to ensure that the mixture is correct and the application rate is also correct for the vegetation and arrangement
• requires large volumes of concentrate to water for application
• can be very labour intensive to mix by hand when mixing equipment is not available
• can be irritating to skin and eyes because of the salt content.

Protection of the Environment

Take care when using all types of water additives to ensure that no environmental damage occurs, ie run-off into waterways.

This care includes fire suppression activities, as well as flushing/cleaning of equipment after use and disposal of empty containers.

Safety Note

Only use retardants under the supervision of a person who is familiar with retardant applications.
## Use of Class A Foam

### Class A Fires

Class A foam is used on Class A fires. Class A fires are those that involve solid materials, usually of an organic nature, such as wood, rubber or plastics.

### Advantages

The advantages of using Class A foam are that it:

- increases the effectiveness of water
- extends the useful life of water
- provides a short-term fire barrier
- is effective on fire in all types of Class A fuels
- reduces suppression and mop-up time
- is relatively easy to use (mixing and handling)
- is visible from ground and air.

### Disadvantages

The disadvantages of using Class A foam are that it:

- can be irritating to the skin and eyes
- is corrosive to some metals and may speed deterioration of some types of seal material
- may have harmful environmental effects as a result of exposure to high concentrations
- reduces the life expectancy of leather goods, such as footwear.

### Class A Foam

Class A foam solution or aspirated foam can be applied as a solution, foam concentrate and water, and sprayed directly onto the fire.
Class A Foam Solution

Class A foam solution enhances the fire-extinguishing properties of plain water. Plain water has inherent limitations in cooling and penetrating Class A fuels, because of water’s naturally high surface tension. This high surface tension causes water to form into droplets, and consequently the majority of the droplets roll off of the burning fuels, impeding the cooling ability of water.

Class A foam solution breaks the surface tension of plain water. A drop of water will then spread out across the fuel surface. The increased surface area contact increases the cooling rate through more rapid heat absorption.

The low surface tension creates very good spreading and penetrating characteristics that then absorb heat and cool the materials more quickly than plain water. The fire is extinguished more quickly.

Class A foam solutions are generally 0.1% to 1% foam concentrate. They are applied in the same manner as water.

To create aspirated Class A foam, use an aspirating foam nozzle to introduce air to a foam solution.

With aspirated Class A foam, the foam bubbles cling to fuels, allowing the majority of the water in the foam to absorb heat and evaporate.

Foam has an expanded volume and a greater surface area, allowing more water to contact more of the fuel, thus increasing heat absorption. Foam also allows for greatly improved penetration to the seat of the fire as the water runs out of the foam.

A deep-seated fire will be extinguished by the cooling effects of the water, rather than the smothering effect of the foam blanket. The foam will also create a barrier that reduces the supply of oxygen.

The foam bubbles create ‘dead air’ spaces that insulate the fuel from heat and flames, thereby slowing down heat transfer to the fuel.

Remember, it is still the water extinguishing the fire; the Class A foam enhances the water’s ability to do the job.
**Class A Foam**

With conventional Class A foam-making equipment, mix the water and foam concentrate together to create the foam solution. Then, deliver the foam solution to the nozzle for aeration to form the foam. The level of aeration depends on the branch type being used.

Low energy foam systems only use the hydraulic energy supplied by the water pump to propel the foam stream.

Conventional nozzles are a simple way to deliver foam solution with existing equipment when the objective is rapid wetting of the fuel and foam is not needed.

Aspirating nozzles are low-energy systems consisting of standard water pumping apparatus to move foam solution through the hose to a nozzle, which passes the foam solution through a venturi-like device to add air, creating foam.

There is a wide range of conventional or non-aspirated Class A foam-making equipment available. It is impossible to describe every piece in this study guide. You must familiarise yourself with the equipment available at your station.

**Compressed Air Foam System (CAFS)**

Using a mechanical compressor that is built into the appliance, a Compressed Air Foam System creates a low-expansion and high-energy foam stream.

All categories of waterway equipment, from hose reels to monitors, can be used during the creation of Class A foam.

**Foam Proportioner Equipment**

Flow-based proportioning systems measure water flow and then induct the proportional amount of foam concentrate to maintain the preset percentage.

The system will accurately deliver from 0.1% to 1.0% foam concentrate to the foam inductor fitting.

![Figure 3.4 – Foam inductor](image)
Recommissioning Equipment
Immediately after use, flush all equipment at operating pressure with clean water. During the flushing, rotate the proportioning valve.

Application Methods
When using Class A foam to suppress fire, use standard water stream application methods.

Storage
Each foam concentrate supplier includes proper storage information on the product label. Material Safety Data Sheets should be available on station for quick reference.

Store Class A foam concentrate in a cool, dark place in manufacturer-approved containers. It must be clearly labelled.

The viscosities of the foam concentrate increases significantly at low temperatures. This causes a slow flow of the concentrate and proportioning devices may not function accurately, if at all.

Fuel Type Concentration Percentages
When using Class A foam, different fuel types require different foam concentration percentages, as shown below.

<table>
<thead>
<tr>
<th>Fuel type/operations</th>
<th>Foam concentration percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetation fire knockdown</td>
<td>0.3% – 0.5%</td>
</tr>
<tr>
<td>Vegetation fire at mop-up</td>
<td>0.1% – 0.3%</td>
</tr>
<tr>
<td>Air operations (fixed wing and helicopter)</td>
<td>0.3% – 0.5%</td>
</tr>
<tr>
<td>Building and vegetation exposure protection/firebreaks</td>
<td>0.5% – 1.0%</td>
</tr>
<tr>
<td>Structure fires</td>
<td>0.3% – 0.5%</td>
</tr>
<tr>
<td>Vehicle fires</td>
<td>0.3% – 0.5%</td>
</tr>
</tbody>
</table>
Suppressing a Class A Fire with Foam

Initial Attack

Start with a 0.3% mix ratio for standard nozzles and CAFS, or 0.5% for aspiring nozzle systems. Make adjustments to the mix ratio to produce foam solution, wet foam or fluid foam to meet the needs of a particular situation.

Apply foam to the base of a linear flame front. This is crucial to minimise losses due to heat and updraft.

While attacking the edge, direct a portion of the foam steam onto the adjacent unburned fuels.

The highly visible foam inhibits over-application.

Work quickly! As soon as steam is visible, move on.

Leave a light covering of foam over the hot fuel to smother it; continue to wet and cool the fuel.

Proceed to coat untreated fuels along the fire perimeter.

Vegetation Fires

The four classifications for application of Class A foam allow its use in a variety of situations. Class A foam can be applied at a vegetation fire by a ground crew or by aircraft.

Class A foam is the preferred tool for extinguishing vegetation fires because it:

- gives greater knockdown ability (wet/fluid foam)
- extends water tank supply times
- can be used to pre-treat and coat a wide area to act as a firebreak (dry foam)
- reduces suppression and mop-up times (foam solution)
- reduces rekindling (fluid foam).

Structure Protection

Start with a 0.3% mix ratio for standard nozzles and CAFS or 0.5% for aspiring nozzles. Adjust the mix ratio as necessary to obtain the desired foam consistency.

Apply dry foam to outside walls, lofting it rather than directing it at the surfaces to avoid foam breakdown and run-off due to the impact of additional foam.

Depending on the fire intensity, foam can be used successfully to prevent wildland and structure fires from igniting adjacent structures.

If a structure becomes involved, foam-treated walls alone may not save it, because the water requirement for preventing combustion may be greater than the water applied as foam.
Class A Foam
Advantages
Class A foam delivered through a non-aspirating, CAFS or aspirating branch can have a number of advantages.

Structures, Vehicles and Specialised Fires
When you use Class A foam on structure, vehicle and specialised fires at timber and recycling yards, coal bunkers, and rubber or plastic storage facilities, it:

- provides greater knockdown ability than water
- reduces heat, creating a more comfortable environment for firefighters
- yields better visibility, as less steam and smoke is produced
- reduces suppression and salvage and overhaul times

It also needs less water, resulting in:

- water conservation
- reduced possibility of structural collapse due to added loading of water
- reduced water damage to the structure
- reduced environmental impact from water run-off
- reduced water shuttle activities.

Vehicle Fires Only
Using Class A foam on vehicle fires:

- provides greater knockdown ability than water
- is very effective on tyres
- reduces salvage and overhaul times

It also needs less water resulting in:

- water conservation
- reduced environmental impact from water run-off
- reduced water shuttle activities.

Mop-up
Application techniques are the same as those for plain water, but the water, aided by the wetting agents contained in the foam, does the work more efficiently.

Start with a 0.1 or 0.2% solution for nozzle systems.

Apply foam, beginning on the burn edge and progressing inward, with particular attention to hot spots.

Avoid applying dry foam during mop-up. This slow-draining foam forms a lid over deep-seated fires, trapping heat.
Class A Foam Hazards

As a general rule, Class A foam is relatively safe.
However, be aware that Class A foam concentrate can be irritating to the skin and eyes.
Take care to avoid concentrate spills.
Commonsense handling means protecting personnel, equipment and the environment.
Take care to prevent foam concentrate from entering waterways, if this occurs notify the relevant authorities immediately.

Tactical Considerations

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>Is knockdown or mop up</td>
</tr>
<tr>
<td>Two</td>
<td>Do you use wet (soap/water) or dry foam?</td>
</tr>
<tr>
<td>Three</td>
<td>What is the concentrate ratio, 0.1% to 1.0%?</td>
</tr>
<tr>
<td>Four</td>
<td>What type of equipment is needed?</td>
</tr>
<tr>
<td>Five</td>
<td>Use which application method or technique?</td>
</tr>
</tbody>
</table>

Safety Note

See Material Safety Data Sheets available with the containers of concentrate for any environmental concerns when using Class A foam.
Using Water for Mop-up

Criticality

Mop-up is the task of extinguishing a fire after containment.

You must continue aggressive action to maintain control. This means vigorous mop-up followed by active patrols.

The fire is not out until the mop-up has been completed.

Sloppy mop-up and inadequate patrol can waste all the hard work and expense of containment.

Prompt and complete mop-up is just as important as fast initial attack.

Mop-up Task

For small fires, extinguish all smouldering fuels.

For large fires, extinguish the perimeter first.

Then, work inwards concentrating on hot spots that could send sparks out of the fire area if the wind increases.

Figure 3.5 – Mop-up task
Methods

To use water for mop-up:

- establish a fire line or wet down around the fire perimeter if the fire has burnt into the sub-surface fuels
- make sure that no roots cross under the fire line
- deal with burning spars that could spread wind-blown hot embers. Use experienced fellers to fell spars or trees. Keep other personnel at least two tree lengths away
- dig out and extinguish burning material
- use a piping (duff probe) extension on the hose line to penetrate into deep-laying burning materials
- use handtools to turn over and expose burning material to spray with water
- put fuel into position so it cannot roll downhill and cross the fire line
- remove or protect hazardous fuels just outside the fire area. Check places where spot fires can start closely
- look for spot fires outside the main fire.

Safety Note

Be extremely cautious when working around stump and root systems to avoid stepping into pits of hot ashes or embers!

Check doubtful hot spots for warmth with the back of a hand – termed ‘cold-trailing’.
**Mop-up with Water**

Water with additives such as hydroblender capsules or Class A foam at 0.1–0.2% are effective in mop-up when used properly.

To ensure a fire is out, surface fuels should be turned over and sprayed, then the sub-surface fuels dug and mixed with water.

*An effective mop-up operation is wet and dirty.*

**Use the back of the hand to feel for heat in doubtful areas.**

Sometimes, it’s necessary to bury burning material as an immediate way of stopping embers being blown into an unburnt area. These materials must be uncovered and extinguished later.

**Burning Spars**

Here are some problems:

- fire in a spar may not be detected
- the spar may weaken and fall
- wind-blown embers may spread fire into an unburnt area

Use these solutions:

- identify spars that could cause problems
- assess potential dangers
- if spar appears to be unstable, mark off the area and keep away at least twice the distance of the height of the spar
- if spar seems stable, apply water from a distance so that the spray falls like rain. Take care not to spread embers and start a new fire.

**Safety Note**

Spars or live trees with burnt-out root systems can fall at any time without warning or sound.

Spar felling is hazardous, and should only be done by skilled personnel.
The last action on a fire is to patrol the burnt and surrounding area, checking for any sign of rekindling fire.

Start patrolling immediately after the fire is contained.

Depending on the conditions, patrols may be required for a long period, minimum of 48 hours during dry periods, to ensure that any rekindling is detected and dealt with quickly. This may also be necessary several weeks later, especially during high winds.

Make sure to monitor effectiveness.

Beware of deep-seated fires.

Don’t forget to look up to ensure there are no overhead fires.

Patrolling may include:

- using all the senses to find burning embers – look, listen, smell and touch
- cold-trailing or using the back of the hand to feel for heat in the ground
- staying within calling distance of other crew members in case assistance is needed
- using hand tools to dig for hot spots
- using water to cool hot spots.
- check for smouldering spots inside and outside the fire area
- be continually moving around the area, looking for hot spots that could rekindle new fuels.

Use a thermovision scanner operated by trained personnel to help locate and detect deep-seated hot spots not apparent at the surface.

A fire that restarts after being ‘declared out’ is the result of inadequate mop-up and patrol.
**Dangerous Situations to Watch Out For**

**Dangerous Situations**  The situation is dangerous when:

- fire size and direction and speed of travel are not known
- territory is unfamiliar
- there is no escape route or safe area
- local weather influences are not known
- communication with the Crew Leader is lost
- instructions are not clear
- conditions are getting hotter and drier
- the wind changes speed or direction
- frequent spot fires occur across the fire line.

**Firefighters in Danger**  Firefighters are in danger:

- uphill or downwind of a fire
- on a hillside where rolling material can ignite fuel below
- in steep or rugged terrain
- if they cannot see the main fire and are not in contact with someone who can
- in unburnt vegetation
- walking through hot ashes
- working around burning spars
- working alone
- if feeling in need of rest or sleep
- working near power lines
- working near machinery
- moving around aircraft.
LACES pink card

Dangerous situations that you need to watch out for are listed on your pink card. As part of safe practice of fire suppression, keep the pink card in the pocket of your overalls.

Use it as a check list as you approach a fireground. Check off each listed dangerous situation to your approaching fireground.

Make sure you know what action(s) you need to take to protect yourself and those around you.

Figure 3.6– Dangerous situations
Conclusion

Now you can:

- explain wet firefighting techniques
- explain and demonstrate use of waterway equipment
- discuss the roles of water and additives in wet firefighting
- outline and demonstrate using water for mop-up.

Safety Note

Refer to your LACES pink card. Always check on local knowledge for dangerous situations that may be specific to the area you are working in, eg thermal ground, hidden mineshafts.