Regional Fire Management Training for South Caucasus and Western Balkans
International Fire Management Training Centre
Antalya, Turkey, 15-17 October 2014

EuroFire Competency Standards and Training Materials

and

Guidelines for the Defense of Villages, Farms and Other Rural Assets against Wildfires
Preface

Most of the destructive fires that affect fire-sensitive ecosystems in Southeast Europe and the South Caucasus, such as forests and protected areas, originate in agricultural lands. They are often consequence of the use of fire on arable lands after harvest, or use of fire to keep pastures free from brush and tree encroachment: Sometimes wildfires are caused by negligence of rural people or visitors (tourists) using campfires for cooking and warming. Such fires easily get out of control and cause very high ecological and environmental damages. The economic losses, including houses, villages, livestock and critical infrastructure, sometimes also the loss of lives or injuries of people, can be easily avoided if rural fire services and villagers are properly trained in the prevention, preparedness and control of wildfires.

Within the overall framework of fire management efforts in the South Caucasus and Western Balkans, the capacity building of rural fire fighters and inhabitants of local communities, notably farmers, shepherds and forest workers, has become a first priority. In order to achieve this goal, local communities of rural areas need to be capacitated in:

- Fundamentals of fire behaviour, as influenced by vegetation type and characteristics, topography and weather
- Safe use of fire for prescribed burning or controlling wildfire
- The tools and techniques to safely use fire and combat fire
- Basics in fire safety

To assist the South Caucasus countries in enhancing their fire management capacities, the OSCE within the framework of the Environment and Security (ENVSEC) Initiative\(^1\), launched in 2009 the project “Enhancing National Capacities on Fire Management and Wildfire Disaster Risk Reduction in the South Caucasus”. The project is conducted in partnership with the Global Fire Monitoring Center (GFMC) based in Germany.

Within the period 2009-2014, the project has facilitated

- National and cross-sectoral dialogues to identify issues and needs for action in fire management through the organization of National Round Tables on Fire Management and establishment of national inter-agency coordination mechanisms with participation of civil society
- Basic capacity building in fire management of government institutions and local communities at national and local level
- A first joint regional training in fire management aimed at exchanging expertise and facilitating transboundary fire management in South Eastern Europe and the South Caucasus (Antalya, Turkey, 2010)

\(^1\) The Environment and Security (ENVSEC) Initiative is a partnership of the OSCE, UNDP, UNEP, UNECE, REC and NATO as an associated member, established in 2003 to address environment and security challenges in South Eastern Europe, Eastern Europe, Central Asia and the South Caucasus (www.envsec.org).
This second regional fire management training in Antalya, Turkey, 15-17 October 2014, brings together trainers of schools and academies of fire and rescue services, forest and protected areas administrations from the South Caucasus and the Western Balkans for a joint training course.

The Global Fire Monitoring Center (GFMC) has developed, under the sponsorship of the EU Leonardo da Vinci programme, competency standards and basic training materials for professional and volunteer fire fighters – the EuroFire training materials – which by 2014 are available in 10 languages (www.euro-fire.eu) and have been used for training in West, East and Southeast Europe, the South Caucasus and in the Russian Federation.

The EuroFire standards are complemented by the Guidelines “Defence of Villages, Farms and Other Rural Assets against Wildfires: Guidelines for Rural Populations, Local Communities and Municipality Leaders”, which were prepared by the GFMC with the support from the European and Mediterranean Major Hazards Agreement (EUR-OPA).

The Regional Southeast Europe / Caucasus Fire Monitoring Center (Skopje) and the Eastern European Fire Monitoring Center (Kiev) as well as members of the UNECE/FAO Team of Specialists on Forest Fire and the UNISDR Regional Eurasian and South East Europe / Caucasus Wildland Fire Networks contributed to the development of the guidelines.

The EuroFire materials and the guidelines are made available to the attendees of the course. The trainees are encouraged to bring these materials to their home countries, adapt them, where deemed necessary, to the local conditions – and apply them in capacitating rural communities in the prevention and defense of harmful effects of wildfires and the safe use of fire.

GFMC Freiburg, Germany

15 October 2014

Prof. Dr. Johann Georg Goldammer
Director, GFMC, and Coordinator, UNISDR Global Wildland Fire Network
Welcome to EuroFire

EuroFire A two-years project from October 2006 to December 2008 funded by the EU Leonardo da Vinci programme. The project brought together partners with international expertise and experience in wildfire and prescribed fire research, management and training to develop, evaluate, produce and distribute new European-wide, multi-lingual on-line training resources.

The EuroFire project researched and reviewed competency based wildfire and prescribed fire training systems, including best practice examples from Europe and around the world. This research informed the production of competency based basic training resources, for use in European countries.

The EuroFire training resources have been specifically developed to support firefighting personnel, the land-based sector, sectoral organisations and education and training institutions.

The EuroFire outputs include: competency standards, training modules, illustrations and general guidance on a competency based training system. Training resources that can be used by industry practitioners to update their knowledge, to learn new skills or increase their understanding of basic wildfire and prescribed fire management techniques.

By end of 2013 the EuroFire outputs have been translated for the use in Armenia, Azerbaijan, France, Georgia, Germany, Greece, the Former Yugoslav Republic of Macedonia, Russia, Turkey and Ukraine.

This volume has been printed for the Regional Fire Management Training for the South Caucasus and Western Balkans at the International Fire Management Training Centre, Antalya, Turkey, 15-17 October 2014. This volume contains the English version of the standards and training materials addressing safety, techniques, hand tools and ignition. Please visit the EuroFire website for download of additional language versions:

http://www.euro-fire.eu/
# Unit EF1:

## Element 1.1:

Ensure that your actions in the vegetation fire workplace reduce the risks to yourself and others

### Identify the hazards and evaluate the risks that are likely to be found in the workplace

### Reduce the risks likely to be found in the workplace

### Respond to health emergencies in the workplace

## About this unit:

This Unit deals with the safety issues faced by individuals who are involved in assisting with the management of vegetation fires in rural areas, either in fire suppression or prescribed burning operations.

It has been developed so that it can be applied to any area of vegetation: forest, shrub, grass or peat.

This Unit is aimed at those who work in fire services, farming, forestry, game management, conservation, range land and recreation management and who have a role in assisting with vegetation fire management, either on a full-time, part-time or voluntary basis.

## To achieve this Unit you must show that you are able to:

- Assess hazards and risks in a vegetation fire workplace
- Follow organisational fire procedures
- Operate safely on the fireground
- Support others operating on the fireground
- React appropriately and in accordance with organisational, legislative and environmental requirements, to a fire incident.
<table>
<thead>
<tr>
<th><strong>Key words and phrases:</strong></th>
<th>For you to fully understand the content of the unit, and the activities it describes, it is important that you are able to understand the terms used within the unit. The definitions at the back of this unit should help you with this.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control line</td>
<td>All constructed or natural barriers and treated fire edges used to control a fire.</td>
</tr>
<tr>
<td>Direct attack</td>
<td>Fire control activities applied directly on the fire.</td>
</tr>
<tr>
<td>Dynamic Risk Assessment</td>
<td>The continuous process of actively identifying hazards, assessing risks and taking action to eliminate or reduce the risk. All in the rapidly changing circumstances of an incident.</td>
</tr>
<tr>
<td>Fire behaviour</td>
<td>The manner in which fire reacts to the variables of fuel, weather and topography described in terms of fire intensity and rate of spread.</td>
</tr>
<tr>
<td>Fire hazard</td>
<td>The potential exposure of people or assets to danger from the behaviour of the fire.</td>
</tr>
<tr>
<td>Fire intensity</td>
<td>The pulse or rate of energy release, that travels upwards from the fire, often linked to flame length.</td>
</tr>
<tr>
<td>Fire risk</td>
<td>The potential for a fire to start.</td>
</tr>
<tr>
<td>Fire Support Office</td>
<td>Forest District Office, Estate Office, or company office where non-fire service support for fire control effort is organised.</td>
</tr>
<tr>
<td>Fire Shed</td>
<td>Place where fire control equipment is stored.</td>
</tr>
<tr>
<td>Fire type</td>
<td>Ground fire, surface fire or crown fire, most common type is surface fire.</td>
</tr>
<tr>
<td>Fire Weather</td>
<td>Predicted climatic conditions covering period of burn, especially wind, air temperature and relative humidity.</td>
</tr>
<tr>
<td>Flame length</td>
<td>The distance between the flame tip and the middle of the base of the flame (generally the ground surface), an indicator of fire intensity.</td>
</tr>
<tr>
<td>Flank</td>
<td>The sides of the fire.</td>
</tr>
<tr>
<td>Flanking attack</td>
<td>Most common direct attack strategy, that starts control activity from an anchor point, then progresses along flanks to head.</td>
</tr>
<tr>
<td>Fuels</td>
<td>The type, quantity, arrangement, distribution, &amp; moisture content of the vegetation. Can be: ground (peat, roots), surface (plant litter, grass, shrubs) or aerial (trees) fuels.</td>
</tr>
<tr>
<td>Hazard</td>
<td>Anything that may cause harm, such as vehicles, chemicals, electricity, equipment, working from ladders, etc;</td>
</tr>
<tr>
<td>Head</td>
<td>The front of the fire showing the greatest rate of spread.</td>
</tr>
<tr>
<td>Heel</td>
<td>The rear of the fire near the origin.</td>
</tr>
<tr>
<td>Hotspot</td>
<td>A small area of smouldering or glowing combustion located on or within the fire perimeter; a term commonly used during the mop-up stage of a fire.</td>
</tr>
<tr>
<td>Indirect attack</td>
<td>Fire control activity away from the fire edge e.g, backburning.</td>
</tr>
<tr>
<td>LACES</td>
<td>Lookouts, Awareness, Communications, Escape routes &amp; Safety zones.</td>
</tr>
<tr>
<td>Origin</td>
<td>The place where the fire starts.</td>
</tr>
<tr>
<td>Rate of spread</td>
<td>The speed the fire is expanding at the head of the fire.</td>
</tr>
<tr>
<td>Risk</td>
<td>The chance, high or low, that somebody could be harmed by a hazards, together with an indication of how serious the harm could be.</td>
</tr>
<tr>
<td>Topography</td>
<td>Shape of the land, especially slope and aspect.</td>
</tr>
<tr>
<td>Wildfire</td>
<td>A fire that is not being controlled.</td>
</tr>
</tbody>
</table>
Element 1.1: Identify the hazards and evaluate the risks that are likely to be found in the workplace

What you must be able to do:

1. Correctly name and locate the person/s responsible for safety in the workplace
2. Identify the hazards that may be found in any part of your job role which could harm yourself or other persons
3. Assess and prioritise the risks that could be caused by the hazards found in your workplace
4. Report any hazards which present a high risk to team mates, supervisors and the person/s responsible for safety
5. Deal with any hazards which present a low risk in accordance with your organisations policies, legal and environmental requirements
6. Assess the fire environment logically and predict local fire behaviour
7. Apply dynamic risk assessment techniques

This element covers:

A  Identify hazards that could include:
   (i) the natural environment including topography, plants and animals
   (ii) the fire environment and fire behaviour
   (iii) non-fire hazards relating to fuels and weather, equipment, vehicles and aircraft
   (iv) operations
   (v) above ground/underground services

B  Asses and evaluate risks resulting from: -
   (i) Environmental conditions
   (ii) The use and maintenance of equipment or machinery
   (iii) Unsafe behaviour or working practices
   (iv) The use of materials and other substances
   (v) Accidental spillages
Element 1.1 cont.:  

**What you must know and understand:**

a. The basic geography and ecology of the area  
b. The fire triangle and the methods of extinguishment using a variety of vegetation fire tools  
c. Hazards indicated by heat transfer mechanisms, the types of combustion and fire types.  
d. The effect of the fire environment on fire behaviour and personal safety  
e. The use of smoke and flame length as a guide for the safe application of tools, tactics and strategies  
f. The tools, techniques, tactics and strategies used to control vegetation fires  
g. How to work safely in the vicinity of: brushcutters, chainsaws, vehicles, tractors, bulldozers, helicopters and aircraft.  
h. How to work under instruction, as part of a team, with a variety of tools, techniques and strategies in combined attack  

Element 1.2:  

**Reduce the risks likely to be found in the workplace**  

**What you must be able to do:**  

1. Carry out actions safely as instructed, in accordance with organisational policies and procedures, manufacturers and legal requirements  
2. Progress your objectives, safely and within organisational procedures  
3. Rectify safety and health risks within your capability and the scope of your job responsibilities  
4. Pass on any suggestions for reducing risks to the safety and health within your job role to the responsible persons  
5. Pro-actively monitor the effects of the activity on the health, hydration and fatigue of the people around you and yourself.  
6. Identify lookouts role, be aware of the situation at all times and use escape routes and safety zones as necessary  
7. Prepare, maintain and put on personal protective equipment correctly
**This element covers:**

Protective measures in the context of:

A  Personal issues:
   (i) Pre-existing medical issues
   (ii) Physical fitness
   (iii) Fatigue
   (iv) Stress
   (v) Heat stress, heat exhaustion or heat stroke
   (vi) Hypothermia
   (vii) Sunburn / windburn

B  Personal protective equipment (PPE):
   (i) Helmet/Face shield/Goggles
   (ii) Fire resistant clothing
   (iii) Gloves
   (iv) Heat resistant boots
   (v) Drinking Water
   (vii) Hearing Protection

C  Fire behaviour:
   (i) Radiant heat and super-heated air
   (ii) Smoke and dust
   (ii) Rapid changes in direction or speed of the fire
   (iii) Rapid changes in flame length and fire intensity

D  Equipment:
   (i) Noise and hearing protection
   (ii) Moving parts
   (iii) Moving vehicles
   (iv) Chemicals, fuel and other hazardous substances
E Workplace policies:
(i) The use of safe working methods and equipment
(ii) The safe use of hazardous substances
(iii) Smoking, eating, drinking and drugs
(iv) Rest breaks
(v) Emergency procedures

What you must know and understand:

a. Understand the hazards in the vegetation fire workplace and the ways of eliminating and minimising their effects
b. Understand the importance of physical fitness
c. The priority of firefighter and public safety, along with the values and assets that you are trying to protect
d. The role of lookouts, the importance of being aware of the fire situation and being able to communicate with team members and your supervisor at all times. Knowing where your escape routes are, as well as when to use them and how long it will take to reach your designated safety zones (LACES)
e. The efficiency and safety of different fire control tools and techniques applied in a variety of situations

Element 1.3: Respond to health emergencies in the workplace

What you must be able to do:

1 Summon assistance immediately for any health emergency and initiate action appropriate to the condition and situation
2 Give assistance with ongoing care as required
3 Provide the individual with the health emergency with suitable verbal support
4 Make the immediate vicinity as private and safe as possible once the intervention has been taken over by an appropriate person
5 Offer support to any others involved in the incident once any initial danger is passed
6 Keep records which are accurate, legible and complete
This element covers:

A  Situations where:
   (i) there is no immediate access to a person competent to deal with the situation
   (ii) there is immediate access to a person competent to deal with the situation
   (iii) the individual with the health emergency is in a dangerous place

What you must know and understand:

a. The required action to take for the health emergency concerned
b. Your own competence in dealing with the health emergency
c. The reasons for calling for assistance Immediately
d. The importance of not carrying out actions beyond your own capabilities
e. The reasons why actions beyond your level of competence may further endanger life
f. Effective ways of providing support to those suffering a health emergency and of keeping them in the best possible condition
g. The effects of shock on individual's with a health emergency and ways of dealing with this effectively
h. The type of verbal support which can be provided to the individual suffering the health emergency
i. Potential health risks to others from an emergency
j. Reasons for offering support and help to others involved in the incident and how this should be achieved
k. Relevant legislative requirements for completing records of accidents and emergencies
l. The location and use of first aid equipment according to organisational policies and procedures
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Introduction:

These training materials support the EuroFire Level 2 competency standard **EF1 Ensure that your actions in the vegetation fire workplace reduce the risks to yourself and others**

This document is for people who assist in the management of vegetation fires. It is for situations where: the fire management operation is simple, the level of risk, complexity and fire behaviour is low and the operator is under direct supervision.

All national and local laws relating to fire management techniques must be followed. In addition local landowners may need to be consulted or give their approval before operations takes place.

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

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

EuroFire is a pilot project. The training material will be evaluated as part of an on-going process. A feedback form is included on the website [www.euro-fire.eu](http://www.euro-fire.eu)

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

**Relationship with EuroFire competency standards and risk management**

Reference to the EuroFire competency standards should be made to understand the full range of expected learning outcomes. The sections of the standards are: unit title, element title(s), about this unit, key words and phrases, what you must be able to do, this element covers, and what you must know and understand.
The support materials for all the EuroFire competency standards are designed to support a flexible approach to training delivery. They can be adapted or modified to suit a particular target audience. The learning material for this unit should be used with the support materials for other units to ensure all learning outcomes in the standards are covered.

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

**Complimentary (co-requisite) learning:**

EF2 - Apply techniques and tactics to control vegetation fires

**Subsequent learning:**

EF 3 - Communicate within a team and with supervisors at vegetation fires (to be developed)
EF 4 - Apply hand tools to control vegetation fires
EF 5 - Control vegetation fires using pumped water (to be developed)
EF 6 - Apply Vegetation Ignition Techniques

**Learning objectives:**

- Assess hazards and risks in a vegetation fire workplace
- Follow organisational fire procedures
- Operate safely on the fireground
- Support others operating on the fireground
- React appropriately and in accordance with organisational, legislative and environmental requirements, to a fire incident.

**Keywords and phrases:**


**Application:**

- Basic risk management

A wildfire or prescribed fire environment has many potential hazards, some of which may cause an accident to occur. The aim of risk management is to avoid accidents and minimise the harm that might occur. Risk management is not just an activity for leaders and managers but involves everyone. Everyone is responsible for safety and communication on safety issues should be a two-way process between personnel and supervisors.
Sometimes the terms hazard and risk are confused. The definition of a hazard is anything that may cause harm and the risk is the chance, high or low, that somebody could be harmed by these and other hazards, together with an indication of how serious the harm could be.

A good way to create safe working practices is for an organisation to follow the 5 steps to risk assessment. Individuals may be involved in all these steps.

Step 1 Identify the hazards
Step 2 Decide who might be harmed and how
Step 3 Evaluate the risks and decide on precautions
Step 4 Record your findings and implement them
Step 5 Review your assessment and update if necessary

Individuals involved in prescribed burning or fire suppression operations often work in the open for long periods of time. During such operations risk management should be a continuous and dynamic process. Risk assessment and control need to become ingrained into working practices so that they become safe. The concept of dynamic risk assessment helps this process.

**Dynamic Risk Assessment:**

The continuous process of actively identifying hazards, assessing risks and taking action to eliminate or reduce the risk; all in the rapidly changing circumstances of an incident.

The approach whether written down or carried out mentally should be the same. For each hazard be clear about who might be harmed because it will help you identify the best way of managing the risk.

For each hazard ask yourself:

- Can I get rid of the hazard altogether?
- If not, how can I control the risks so that harm is unlikely?

When controlling risks, apply the principles below, if possible in the following order:

- Try a less risky option
- Prevent access to the hazard
- Organise your work to reduce exposure to the hazard
- Use personal protective equipment
- Use welfare facilities provided
The risks include hazards that are part of the workplace environment as well as those that are specifically fire related, for example vehicle accidents are a significant hazard.

Accidents occur as a result of an unsafe condition or an unsafe act. Often it is the unsafe act, the human factor, which is the cause of an accident.

A fireground environment holds many potential hazards so the first question to be asked is “why am I here at all?” or “what is my purpose here?” For people carrying out prescribed burning operations following a plan this may be to create a firebreak or improve a habitat. For firefighters tackling a wildfire the normal purpose is to protect something, usually in the following order:

- Human life, firstly of the firefighter
- Communities
- Property
- Natural resources

We all rely on our senses of sight, hearing, touch and smell to identify threats. However in the fire environment there are factors that can mislead or confuse our senses, such as noise, smoke and carbon monoxide. There is a need to develop and use safe working practices to control hazards and risks that are not obvious as well as the ones that are obvious.

Also if people operate in extreme conditions for long periods of time they start to think hazards as normal and just accept them. However they are working in unsafe conditions where any unsafe act is very dangerous. A disciplined approach, following instructions, job procedures and safe working practices is essential in these circumstances. Safety is everyone’s responsibility.

Over the years, in various countries, firefighters have lost their lives tackling wildfires. These fatalities have been due to a range of factors from aircraft accidents to the behaviour of the fire itself. Fatal and near-fatal fires have four major common denominators, in that they occur:

- On relatively small fires or deceptively quiet areas of large fires.
- In relatively light fuels, such as grass and shrubs.
- When there is an unexpected shift in wind direction or in wind speed.
- When fire responds to topographic conditions and runs uphill.

Common factors that have lead to these unfortunate situations have been identified and systems of safe working to control these types of hazards and risks have been developed. Particular attention should be paid to the memory aids such as: LACES, Watchout, Fireorders and the 18 Watch Out Situations. These are described Appendix A.
Safety responsibility in teams

The responsibility for safety is held by individuals, supervisors, managers and organisational procedures. The first responsibility is for individuals to look after the safety and health of themselves, co-workers, the team and the people around them. The use of the “buddy system” where personnel work in pairs, checking each other's safety and general condition is especially useful.

Individual's relationship with their supervisor and the team is extremely important. Individuals need to:

• Make sure that the supervisor knows where they are at all times
• Stay in contact with their supervisor
• Know their task(s) and the task(s) of their team
• Know where other team members are and what they are doing
• Know their emergency escape plans to leave the area

After the individual the immediate supervisor is the next person responsible for safety. It is important to develop a relationship with him or her that allows the open discussion of safety issues. At times individual firefighters may see hazards or risks before anyone else and they need to be able to communicate information on safety issues without undermining their supervisor role.

Some organisations have dedicated safety managers both on and off the fireground but the primary responsibility for safety will rest with either the Fire Boss on a prescribed fire or the Incident Commander at a wildfire.

To tackle fires safely depends on individuals working together as a team. Continuous communication is essential. Everyone should always be in contact either verbally, by sight or on a radio with someone else. The paired worker “buddy system” should be used so that individuals are always in contact with a colleague. There is a tendency when working in the open of people gradually becoming separated, don’t allow this to happen.

A safety briefing must be given to everyone attending fires. Personnel should make sure they have extracted the following general safety points before they go to the fireline. If anyone is unsure about any safety issue, ask questions at the briefing.

• Understand the communications and command system
• Understand and follow instructions
• Check that assigned task(s) are within your own and your teams capabilities
• Know the hazards, especially fire behaviour and the terrain
• Know your escape routes and safety zones
• Know where your anchor point is located
1. Risk management: hazard identification and control measures

Situational Awareness

Often accidents are the result of human error. Individuals need to be continually aware of the situation around them. It’s too easy to lose this situational awareness by focusing too much on the task. Constantly check for hazards, do simple checks like “look up, look down and look around” the area.

Natural environment

For many people the first change to take account of for prescribed burning and wildfire suppression work is that these activities take place in open country, in farmland, forests, or rangeland. It’s only when fires reach the interface with villages and towns that buildings and infrastructure become involved.

So the first issue is to be able to operate safely in rural areas.

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Control Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changes in the weather</td>
<td>• Develop knowledge of the effect of time of day, season and topography on local weather conditions</td>
</tr>
<tr>
<td></td>
<td>• Get advice on local weather influences from local people</td>
</tr>
<tr>
<td>Poor work location due to change in wind speed or direction</td>
<td>• Watch out for flare ups</td>
</tr>
<tr>
<td></td>
<td>• Check escape routes</td>
</tr>
<tr>
<td>Weather getting hotter and drier through the day creating high fire intensities</td>
<td>• Different tools, techniques and strategies may be required</td>
</tr>
<tr>
<td></td>
<td>• Withdrawal of teams and reassessment may be a safer option</td>
</tr>
<tr>
<td>Slips, trips and falls</td>
<td>• Wear heat resistant boots with ankle support and a good tread.</td>
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<tr>
<td></td>
<td>• Walk carefully over difficult terrain</td>
</tr>
<tr>
<td>Dense vegetation, losing sight of the fire and difficult to escape</td>
<td>• Maintain a lookout</td>
</tr>
<tr>
<td></td>
<td>• Find alternative route or cut a path through it.</td>
</tr>
<tr>
<td></td>
<td>• Make sure you have escape routes that are easy to use</td>
</tr>
<tr>
<td>Unburned fuel between you and the fire</td>
<td>• Maintain a lookout</td>
</tr>
<tr>
<td></td>
<td>• Establish an escape route</td>
</tr>
<tr>
<td>Rugged / difficult terrain</td>
<td>• Avoid difficult areas if possible and use a different approach to the fire</td>
</tr>
<tr>
<td></td>
<td>• Avoid uphill escape routes</td>
</tr>
<tr>
<td></td>
<td>• Scout escape routes to avoid obstacles</td>
</tr>
<tr>
<td>Venomous snake &amp; insect bites</td>
<td>• Wear Personal Protective Equipment, be watchful and avoid</td>
</tr>
<tr>
<td></td>
<td>• If bitten apply pressure bandage, immobilise and seek medical attention immediately</td>
</tr>
</tbody>
</table>
| Falling branches and trees, especially dead trees or fire affected trees | • Have a lookout  
• Avoid  
• If unstable keep 2 tree lengths away |
| Being lost or disoriented:  
- Unfamiliar area  
- Heavy smoke  
- Darkness | • Before leaving get a map and briefing on your area from local people  
• If lost, remain where you are, if it is safe to do so.  
• Seek contact with local people or other firefighters to establish your location  
• Use map and compass to orientate the map and relate land marks to the map  
• Seek urgent assistance if threatened by the fire. |
| Water borne pathogen (e.g. bacteria) | • Drink safe / clean drinking water  
• Treat water |
| Poor hygiene | • Maintain good personal hygiene, especially before eating or drinking  
• Establish appropriate welfare facilities at feeding stations and campsites |
Fire environment & fire behaviour

As described in training module **EF2 Apply Techniques and Tactics to Control Vegetation Fire** the fire environment is a combination of the fire triangle (heat, oxygen and fuel) with weather, topography and fuel. The most important influences on fire behaviour as it crosses a landscape are: wind, slope, fuels and aspect. A vegetation fire is constantly reacting and changing, because of these underlying influences, especially if two or more of these factors are working together. If two or more factors are re-inforcing each other they are said to be *in alignment*.

When approaching a fire first assess fire behaviour.

- Look at what fuels are burning and the flame lengths on the different parts of the fire (head, flanks & heel).
- Work out what is driving the fire at those points. Are the factors that support fire behaviour (wind, slope, fuels & aspect) in alignment or not?
- Will the fire move to places where those factors will be more/less in alignment?

This information should allow an individual to predict local fire behaviour.

Also assess the fire for safety purposes. Work out which parts of the fire are hazardous and should be avoided.

Illustration 1 below shows the key area to avoid, being at the head of the fire. Unless the flames are small don’t put yourself in front of a fire. Even if they are small think twice as this is where the fire behaviour can change very quickly. The safest areas to work are usually on the flanks and heel of a fire where the flames are lower.

![Illustration 1.1.Typical fire shape with associated hazards.](image)

<table>
<thead>
<tr>
<th>Heel</th>
<th>Flanks</th>
<th>Head</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low flames</td>
<td>Moderate flames</td>
<td>Large flames</td>
</tr>
<tr>
<td>Slow rate of spread</td>
<td>Moderate rate of spread</td>
<td>Fast rate of spread</td>
</tr>
<tr>
<td>Little smoke</td>
<td>Little smoke</td>
<td>Lots of smoke</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Very hot air</td>
</tr>
</tbody>
</table>
The key question is whether the behaviour of the fire is going to get more intense with bigger flames or less intense with smaller flames. This implies first, a need to constantly be aware of what the fire is doing, either directly or by communication with a lookout and second to have an understanding of what the fire is likely to do now, or in the next 5 or 10 minutes, hours and days. Anticipation of changes in fire behaviour due to changes in the alignment of wind, slope, fuel and aspect is extremely important. Fire behaviour can change very quickly and your thinking should always be ahead of the situation.

Some key questions:

• Where and when will fire behaviour change?
• Will the situation become worse or better?
• How long will your location be safe?
• When should you move?

**Illustration EF2.1.9 Effect of wind change on a fire**

This change, where a relatively quiet flank of a fire rapidly becomes the head of the fire can occur for a variety of reasons, or a combination of reasons:

• A shift in the wind direction, the most common reason for a change in fire behaviour, for example as it curls round a hill,
• Where a fire reaches the bottom of a steep slope,
• The fire moves into an area with a lot of fine fuels,
• The fire moves out of the shadows on a cold, north facing slope onto a hot, south facing aspect
Illustration EF2.3. The chimney effect

In narrow steep valleys heat convection, slope and wind can combine to produce extreme fire behaviour, often known as the chimney effect, with very fast rates of spread and significant spot fire activity. Firefighters can become trapped between the fast developing fire and the slopes, unable to access safe areas fast enough.

When carrying out the assessment of the fire environment there are a number of natural indicators of dangerous conditions. These should be assessed continuously as part of a “**look up, look down and look around**” process.

Table 1. Look up, look down and look around fire behaviour indicators.

<table>
<thead>
<tr>
<th>Fire Environment Factors</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Characteristics (Assess)</td>
<td>Continuous fine fuels</td>
</tr>
<tr>
<td></td>
<td>Heavy loading of dead and down</td>
</tr>
<tr>
<td></td>
<td>Ladder fuels</td>
</tr>
<tr>
<td></td>
<td>Tight crown spacing (&lt;6m) (&lt;20 ft.)</td>
</tr>
<tr>
<td></td>
<td>High dead to live ratio</td>
</tr>
<tr>
<td>Fuel Moisture (Feel and Measure)</td>
<td>Low Relative Humidity (&lt;25%)</td>
</tr>
<tr>
<td></td>
<td>Low 10 hr Fuel Moisture Content (&lt;6%)</td>
</tr>
<tr>
<td></td>
<td>Drought conditions</td>
</tr>
<tr>
<td></td>
<td>Seasonal drying</td>
</tr>
<tr>
<td>Fuel Temperature (Feel and Measure)</td>
<td>High temps (&gt;30°C) (&gt;85°F)</td>
</tr>
<tr>
<td></td>
<td>High % of fuels with direct sun</td>
</tr>
<tr>
<td></td>
<td>Aspect changing &amp; fuel temp. increasing</td>
</tr>
</tbody>
</table>
| Terrain (Scout) | Steep slopes (>50%)  
|               | Narrow valleys  
|               | Saddles       |
| Wind (Observe) | Surface winds above 15 kph (10mph)  
|               | High, fast-moving clouds  
|               | Sudden calm  
|               | Battling or shifting winds       |
| Stability (Observe) | Good visibility  
|                    | Gusty winds and dust whirls  
|                    | Cumulus clouds  
|                    | Smoke rises straight up         |
| Fire Behaviour (Watch) | Leaning smoke column  
|                        | Sheared smoke column  
|                        | Well-developed smoke column  
|                        | Changing smoke column  
|                        | Trees torching  
|                        | Smouldering fires picking up  
|                        | Small fire-whirls beginning  
|                        | Frequent spot fires          |

The type of hazards and control measures for fire behaviour can be seen in Table 2 below.

Table 2. Fire behaviour hazards and control measures.

<table>
<thead>
<tr>
<th>Fire behaviour hazards</th>
<th>Control measures</th>
</tr>
</thead>
</table>
| Radiant heat           | • Move away, radiant heat effect drops rapidly with distance  
|                        | • Use physical barriers if necessary (logs, walls, ditches) these block radiant heat  
|                        | • Use appropriate Personal protective equipment (see also metabolic heat load) |
| Entrapment / burn-over | • Maintain awareness of fire behaviour and spread at all times  
|                        | • Avoid dangerous situations by complying with LACES, Watchout, and Fireorders guidelines and the 18 Watchout situations |
| Exposure to excessive radiant heat | • Avoid high fire intensities, most likely at the head of the fire  
|                                      | • Shield yourself from the heat source  
|                                      | • On foot:  
|                                      |   o Evacuate to a safe area using scouted escape routes  
|                                      |   o Look after your buddy  
|                                      |   o Use the “black” if flames are low e.g. areas of less fuel  
|                                      |   o Use Personal Protective Equipment, clear a survival area, find a ditch, wall, log, that you can use for protection  
<p>|                                      |   o Lie down as low as possible |</p>
<table>
<thead>
<tr>
<th>In a vehicle:</th>
<th>Smoke and carbon monoxide</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Park in open away from fuels and approaching fire</td>
<td>- Avoid working in smoke unnecessarily, especially for long periods</td>
</tr>
<tr>
<td>- Remove any fuel containers</td>
<td>- Where there is heavy smoke – relocate</td>
</tr>
<tr>
<td>- Clear area of elevated fuels</td>
<td>- Use approved Personal protective equipment e.g. goggles and filters when supplied</td>
</tr>
<tr>
<td>- Leave engine and lights on, prepare protection hose lines</td>
<td>- Make sure you rest in smoke free areas to clear carbon monoxide from your body.</td>
</tr>
<tr>
<td>- Close windows, doors and vents</td>
<td></td>
</tr>
<tr>
<td>- Advise supervisor / Head Quarters of actions and location</td>
<td></td>
</tr>
<tr>
<td>- Wait outside vehicle for as long as possible</td>
<td></td>
</tr>
<tr>
<td>- When too hot enter vehicle from side away from fire</td>
<td></td>
</tr>
<tr>
<td>- Remain in vehicle for as long as possible</td>
<td></td>
</tr>
</tbody>
</table>

| Being physically fit                                                        |                                                                                           |
| Put on lights on machinery and use hand held lights to carry out tasks safely |                                                                                           |

| Extreme fire behaviour:                                                     |                                                                                           |
| - Flare ups                                                                  |                                                                                           |
| - Increasing numbers of spot fires                                           |                                                                                           |
| - Rapid fire runs                                                            |                                                                                           |
| Briefings on weather, topography and fuels                                  |                                                                                           |
| Avoiding 18 “Watchout Situations”                                            |                                                                                           |
| Early detection by a lookout                                                 |                                                                                           |
| Maintaining awareness of the situation                                      |                                                                                           |
| Maintaining communications with buddy, team and supervisor(s)               |                                                                                           |
| Evacuate using scouted escape routes                                        |                                                                                           |
| Use appropriate safety zones                                                 |                                                                                           |

| Burns to hands, feet and ankles, particularly in mop-up                     |                                                                                           |
|皮革手套                                                                |                                                                                           |
| Feel for heat with the back of the hand                                    |                                                                                           |
| Appropriate footwear as issued                                              |                                                                                           |
| Avoid contact with burned out stumps, hot coals, embers                    |                                                                                           |

| Being outflanked by the fire                                                |                                                                                           |
| - Round the end of the fireline                                              |                                                                                           |
| - Re-ignition                                                                |                                                                                           |
| - Spotting                                                                   |                                                                                           |
| Make sure you start from a secure anchor point                              |                                                                                           |
| Make sure that your fireline is dug down to mineral soil so that smouldering or creeping fire cannot cross it. |                                                                                           |
| Maintain a lookout to watch for re-ignition upwind of your position         |                                                                                           |
| Maintain a lookout to watch for fires crossing the fireline. Lookouts should look outside the perimeter for spot fires. |
Equipment and vehicle hazards.

The fire is not the only threat. Situational awareness needs to cover other hazards as well. This includes hazards stemming from equipment and vehicles used as part of the overall management of the fire.

Use of powered equipment and vehicles usually requires specialist skills. Each organisation and country will have its own methods of ensuring the relevant people have these skills with a combination of training and certification. Each piece of equipment will also need to be assessed for appropriate Personal protective equipment. For example a tractor or bulldozer operator may require hearing protection, in addition to other items.

For individuals who are not given specific training avoiding a hazard is a key control measure to minimise risk. The typical danger zones for different types of equipment can be seen in Table 3 below.

Table 3. Equipment and vehicle hazards and control measures.

<table>
<thead>
<tr>
<th>Equipment / vehicle hazards</th>
<th>Control measures</th>
</tr>
</thead>
</table>
| Hand tools                  | • Keep tools cutting edges sharp & handles smooth  
                               • Keep 3 metres apart  
                               • When walking hold tools parallel to the ground at waist height with the sharp edge facing forwards |
| Brushcutter                 | • Keep 3 metres away  
                               • Specific Personal Protective Equipment and training required for operators |
| Chainsaw                    | • Stay at least 2 tree lengths away from a chainsaw in operation  
                               • Specific Personal Protective Equipment and training required for operators |
| Foam concentrate & fire retardents | • Avoid splashing in eyes or contact with skin  
                                        • Wear Personal Protective Equipment (goggles & gloves)  
                                        • Wash out immediately if contact is made |
| Hose lines                  | • Avoid flames until water is on  
                               • Avoid excessive pressure build up (jet reaction) that can push an operator off balance |
| Vehicles                    | • Drive defensively not aggressively  
                               • Use headlights  
                               • Park away from the fire with the vehicle positioned and ready to leave the area |
| Tractor with implements     | • Avoid working parts, which may extend beyond the tractor  
                               • Avoid area behind cutters where debris goes |
<p>| Bulldozer                   | • Keep a safe distance away (minimum 2 tree lengths) |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintain a lookout when heavy machinery is working in the area</td>
<td></td>
</tr>
<tr>
<td>Only approach with the drivers approval</td>
<td></td>
</tr>
<tr>
<td>Don’t work downhill of machinery</td>
<td></td>
</tr>
<tr>
<td>Helicopter, especially rotor blades and aircraft</td>
<td>Follow pilots instructions at all times</td>
</tr>
<tr>
<td></td>
<td>Specific safety training required</td>
</tr>
<tr>
<td></td>
<td>Keep away from landing and take-off areas</td>
</tr>
<tr>
<td>Water drops</td>
<td>Step a short distance away from target area</td>
</tr>
<tr>
<td></td>
<td>If caught in target area lie face down towards helicopter/aircraft and hold hand tools on ground away from the body</td>
</tr>
<tr>
<td>Dust</td>
<td>Avoid excessive dust</td>
</tr>
<tr>
<td></td>
<td>Use goggles, masks or cloths to protect eyes and airways</td>
</tr>
<tr>
<td>Noise</td>
<td>Avoid areas with excessive noise</td>
</tr>
<tr>
<td></td>
<td>Use hearing protection provided</td>
</tr>
</tbody>
</table>

The range of equipment and vehicles that may present a hazard to you can be seen in Illustration 1.2 below:
# Operational hazards

Situational awareness needs to be maintained during operations. Situations that may be safe one moment can become unsafe the next moment due to a change in fire behaviour or a change in the location of the teams on the ground.

Specific additional control measures may need to be built in to working practices to avoid the human factor in creating accidents.

### Table 4: Operational hazards and control measures

<table>
<thead>
<tr>
<th>Operational Hazards</th>
<th>Control Measures</th>
</tr>
</thead>
</table>
| Metabolic heat load (body heat from hard work) | • Use appropriate Personal Protective Equipment e.g. cotton with fire retardant and not heavy turn-out kit  
• Supervised rests  
• Rotate tasks and share heavy loads  
• Drink plenty of water  
• Good level of physical fitness |
| Dehydration                                   | • Drink lots of safe / clean drinking water (at least 1 litre per hour)                                |
| Heat illness caused by combination of:  
  • High body temperature from hard work  
  • High air temperature  
  • Radiant heat | • Pre-hydrate before starting work  
• Pace and share work, take rests  
• Use appropriate Personal Protective Equipment  
• Reduce exposure to radiant heat  
• Loose clothing  
• Drink water at frequent intervals |
| Located above a fire on a hill  
  • Smoke, heat, rapid rate of fire spread, spot fires | • Avoid locations uphill of a fire  
• Apply LACES |
| Located below a fire on a hill  
  • Rocks, burning logs  
  • Rolling downhill creating spot fires below you | • Keep a lookout for fires below and materials rolling downhill  
• Build properly trenched fireline to catch rolling material |
| Poor communications:  
  • Tasks / instructions not understood  
  • Lines of communication busy / lost  
  • Information not passed on to all people | • Communicate with buddy, team & supervisors.  
• Make sure you understand tasks, query and clarify  
• Make sure you understand the communications plan: channels/frequencies  
• Maintain radios and make sure sufficient batteries  
• Don’t work in isolation |
| Human factors:  
  • Medical conditions  
  • Capabilities  
  • Stress | • Inform supervisors of any medical or physical condition that will affect your performance  
• Physical fitness  
• Training and preparation |
2. Risk management: risk evaluation and implementation of control measures

Earlier the 5 steps to risk assessment were described.

Step 1 Identify the hazards
Step 2 Decide who might be harmed and how
Step 3 Evaluate the risks and decide on precautions
Step 4 Record your findings and implement them
Step 5 Review your assessment and update if necessary.

Once the first 2 steps have been done there are various processes for establishing the level of risk. It is important that organisational procedures are followed as some organisations have sophisticated risk evaluation procedures. However an example of a simple risk evaluation process is given below:

For each hazard:

1. Identify how likely it is to occur: Low, Medium or High
2. Establish how serious its effects could be: Low, Medium or High

Then combine the likelihood and the seriousness as either a Low, Medium or High risk. Some examples are given below.

• A high likelihood and a high seriousness will create a high risk that should receive immediate attention.
• A low likelihood with a medium seriousness could be a medium risk.
• A low likelihood with a low seriousness could be a low risk.

This process gives an immediate prioritisation of the risks that need to be addressed.
The precautions or control measures can then be applied and the risk re-evaluated. If the risk is now acceptable the task can go ahead. If not then the task should not be carried out until a safer way of approaching the task can be identified.

Another way of describing this process, which in a dynamic risk assessment process may also be appropriate is:

Step 1 Gather information
Step 2 Risk assessment
Step 3 Risk control
Step 4 Decision point
Step 5 Evaluate

The actual process used should be decided by the organisation that at the time has jurisdiction. It should also relate to the laws that are applicable in the work location.

**Tools, tactics and fire behaviour**

Flame length can be used as a useful proxy for fire intensity. This means that one of the ways of reducing risks is to have an understanding of the appropriate tools and tactics to use with different flame lengths. See Table 5 below:

Table 5. Tools, tactics and fire behaviour

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

The safety issue is to recognise the significance of different flame lengths and apply the appropriate tools and tactics. The hazards that are being reduced through this approach include entrapment and exposure to radiant heat. Radiant travels in straight lines and drops significantly with distance so it is often safer to work further away from the fire and the bigger the flames the further away people need to be.
Personal Protective Equipment (PPE)

Across the European Union it is a legal requirement on employers to provide suitable personal protective equipment for the risks that present hazards to workers. All team members need to be adequately equipped with personal protective equipment. No one should attend a fire unless they are suitably and safely clad.

Illustration 2.1. Personal protective equipment

Personal protective equipment must protect from:

- Physical injury - scratches, abrasions and direct burns
- Exposure to radiant heat
- Build up of metabolic heat

This requires a balance of the type of protection, for example, a full fire resistant suit gives very good protection from direct heat and burns, but could very quickly cause heat stress by not allowing body heat to escape. Additional Personal Protective Equipment for ear/eye protection should be provided as needed.

At the other extreme, shorts and a singlet minimise the build up of body heat but the wearer risks burns and abrasions.
Recommended Clothing

Clothing for firefighting should include:

- Safety helmet and neck-protecting cloth (also protects from radiant heat)
- Long sleeve thick shirt and long trousers of thick fabric, or fire resistant overalls
- Leather or other suitable boots with woollen socks
- Woollen or plain cotton underclothes
- Trouser legs, and shirt or overall cuffs and necks should be left open. This allows air to circulate and sweat to evaporate reducing the risk of a dangerous build up of body heat

Fabrics

Wool, fire-resistant cotton or specific fire-resistant material, are the best for firefighter clothing.

Most synthetic fabrics do not allow body heat to escape and may ignite or melt when exposed to heat.

The thickness of material is the main factor in reducing the amount of radiated heat transmitted to the body. Layers of clothing and the air pockets between the layers can create a similar barrier.

Loosely woven fabrics (e.g. wool) provide good insulation from radiant heat and allow body heat ventilation.

Tightly woven fabric (e.g. denim) is a poor insulator from radiant heat and a poor ventilator of body heat, though it has good resistance to wear and tear.

Additional items should be considered:

- Hearing protection is needed when working in a noisy environment (e.g. in the vicinity of pumps, power equipment, heavy machinery and aircraft)
- Dust goggles and dust masks reduce discomfort when firefighters are in smoky, ash and dusty conditions particularly during mop up operations
- Gloves may be needed when working with handtools and/or when mopping up

Note: The face and backs of the hands are important heat sensors.

- Firefighters should retreat immediately when the temperature is too hot for the face or the backs of the hands
- Covering these parts can take that important sensor away from the firefighter
- Additional warm clothing (e.g. woollen bunker coat, balaclavas and gloves) may be necessary when working in cooler environments (e.g. high country or overnight)
- Bottles of treated water should be considered especially where firefighters are working in remote areas to avoid biological pathogens
• A small back pack with extra clothing and high energy food should be considered for crews in remote areas who may be there for some considerable time
• A kit bag may be required for your personal protective equipment

Clothing that is not recommended includes:

• Nylon or non fire resistant synthetic clothing
• Shorts and short sleeve shirts
• Plain cotton overalls without an underlayer of clothing
• Tight fitting garments that soak up sweat and prevent it from evaporating from the skin
• Clothing that restricts normal movement
• Clothing that increases metabolic heat

**Balancing the protection**

A balance between the level of protective items worn and the level of exposure enables the firefighter to operate safely and effectively.

In situations where there are excessive levels of radiant heat, withdraw to a safer distance.

Increasing the level of protective clothing is likely to lead to metabolic overheating and place the person at greater risk.

• Increasing the distance away from the flame reduces the effects of radiant heat
• Job rotation and regular cooling breaks reduce the build up of metabolic heat
• Potential hazards at a wildfire are different from those of structural firefighting, only use appropriate Personal Protective Equipment

**Fitness**

The risks from various hazards are reduced by personnel having an appropriate level of physical fitness. The level of fitness that will be required will be determined by the employing organisation. However as constructing fireline with hand tools is hard physical work, and as operations are often conducted in rough hilly terrain generally a high level of fitness is required.

The level of physical fitness also affects individual’s ability to cope with other fire related hazards, including smoke, carbon monoxide, stress, and heat illnesses. A person that is in good physical condition is also less likely to suffer fatigue and injuries from lifting loads.

The ability to escape from a rapidly approaching fire to a safety zone is also related to fitness.
Entrapment / burn-over survival actions

When all attempts to avoid entrapment or burn-over situations have failed and when an escape to a safety zone is not possible there are some emergency survival techniques. These techniques should only be used as a last resort.

Radiant heat in entrapment and burn-over situations is the greatest threat. Radiant heat travels in straight lines. The fire intensity that you are exposed to is less close to the ground. Pockets of fresh air can also be found close to the ground.

The action to take is therefore to seek shelter as low as possible, behind a solid barrier, where there is no fuel. Airways and exposed skin should also be protected as much as possible. Locations such as a ditch or behind the trunk of a large fallen tree, or in water of reasonable depth, may be suitable. Once in a survival location it is necessary to stay there until the fire has moved away completely, to minimise exposure to heat.

Emergency survival actions where individuals are directly threatened by a fire when on foot or in a vehicle are shown below:

Illustration 2.2. Personal safety on foot - emergency situation

Illustration 2.3. Personal safety in a vehicle - emergency situation
3. First Aid Awareness

European Union legislation puts a duty on employers to make an assessment of the first aid needs of their employees and to make efficient provision of first aid.

First aid is the application of accepted principles of treatment to an injury or sudden illness using the facilities and materials available. It is the approved method of treating an injured or sick person until qualified medical aid is able to render further assessment and treatment.

First aid treatment is given to a casualty to:

- Preserve life
- Prevent the condition worsening
- Promote recovery

Accidents and illness requiring first aid can occur during rural fire fighting. First aid skills and training, to the level of a current certificate from a recognised first aid authority are essential.

In managing a casualty, the responsibilities are to:

- Assess the situation
- Identify the cause of the suffering
- Give immediate first aid treatment
- Arrange for further medical attention if necessary

The particular aspects of first aid that are likely to be needed during rural fire fighting are:

- Scene assessment
- Patient assessment
- Resuscitation

And treatment for...

<table>
<thead>
<tr>
<th>Burns</th>
<th>Bleeding</th>
<th>Foreign bodies in the eye</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fractures</td>
<td>Heat exhaustion</td>
<td>Heat stroke</td>
</tr>
<tr>
<td>Hypothermia</td>
<td>Smoke inhalation</td>
<td>Soft tissue injuries</td>
</tr>
</tbody>
</table>

Medical attention should be sought for all injuries at fires

- Unwell firefighters must be removed from the fireground
- Fire management must be informed of all injuries or situations where firefighters become ill at fires
- Names of the injured must not be given over the radio

Many of the medical conditions above are covered in normal first aid training. Some examples of the more specialist needs of people involved in fire management are given below. These conditions are often due to the combination of hot air
temperatures, exposure to radiant heat and especially the internal body heat generated from working hard.

**Heat Illness**

Heat illness has three stages - heat stress, heat exhaustion and heat stroke. These are the most common conditions to affect firefighters. They affect not only their physical welfare, but also their judgment and competence on the job.

- Watch for signs of heat stress and treat early on the fireground.
- Cooling a person affected by heat is a priority

**Heat Stress (1st stage)**

Heat stress undetected or untreated will quickly lower the performance of a firefighter.

The body controls its temperature by blood circulation and sweating. The heart rate increases and pumps the blood near to the skin (the face may become flushed) and the body sweats. The sweat evaporates drawing heat from the body - evaporation requires heat - so the body is cooled.

People differ in their response to the same heat stress because each person has a different ability to regulate heat.

Firefighters who are physically fit generally have a greater tolerance to heat stress.

Firefighters need to watch for the warning signs of heat stress.

Heat stress is recognised by:

- Flushed face
- Tiredness
- Sweating
- Dizziness
- Weakness
- Nausea

If heat stress is recognised early enough and appropriate action is taken, the person will recover quickly.

- If heat stress is not recognised, the firefighter will move into a state of heat exhaustion
- Loosen clothing, cool with water, fan person to increase evaporation cooling

**Heat Exhaustion (2nd stage)**

If heat stress is not remedied and hard work continues, the condition can deteriorate into heat exhaustion.

When the brain recognises that the body is overheating it slows down body functions and the symptoms change.
The patient will now have:

- Weak pulse (blood pressure is lowered)
- Clammy skin (sweating)
- Shallow breathing (breathing rate increases)
- Pale face (result of lowered blood pressure)
- Slow reactions

This person is unwell and must be removed from the fireground to rest and recover, and get medical attention. Loosen clothing, cool with water, fan person to increase evaporation cooling.

**Heat Stroke (3rd stage)**

If heat exhaustion is not recognised and treated the person will go into a state of heat stroke.

The regulatory system can no longer cope with the over-heating body, the brain has become affected and ceases to instruct the body to cool down.

The body’s regulatory system has failed and the following symptoms result:

- Rapid and strong pulse (increased heart rate)
- Hot, dry skin (dehydration - no sweating)
- High temperature (body heat not controlled)
- flushed face (increased circulation and temperature)
- Headaches and dizziness
- The person is likely to be irritable, confused, disinterested and may lose consciousness

**URGENT MEDICAL ATTENTION IS ESSENTIAL**

- This person is hot, dry and in a serious state
- Initial treatment is to loosen clothing, cool with water, fan person to increase evaporation cooling
- URGENT medical assistance is required
- Evacuation should not be attempted before medical treatment has been started because the body must be cooled immediately

**Burns**

Burns vary in depth, size and severity and may damage the underlying tissues as well as the skin.

Burns can result from direct contact with a heat source or from exposure to radiant heat. The immediate dangers after a burn injury are continuation of burning within the skin and tissues, and shock.

The burnt area must be cooled immediately and the patient monitored for the effects of shock.
• Firefighters must wear approved Personal protective equipment (PPE)
• All burns require immediate cooling with water for a minimum of 10 minutes and seek medical attention

Dehydration

The body’s cooling system involves perspiring.

People differ in their response to the same hydration because each person has a different ability to regulate heat.

Firefighters who are physically fit generally have a greater tolerance to heat stress.

Dehydration will occur if fluids lost through perspiration are not replaced regularly. The importance of this when working on the fireground is clear.

• Consume water regularly - always drink more water than you need in order to prevent dehydration - failure to do this leads to the body overheating and the onset of heat illness
• On days of extreme fire danger, increase your hydration in case you get called out
• Drink to prevent thirst

Your thirst is not a true indication of how much water your body needs - there’s a time lag between the onset of dehydration and feeling the need for water.

• You may begin to suffer the effects of dehydration before you realise it You know when you are perspiring - use this as an indication that your body needs appropriate fluids.

On the fireground you need to replace fluids frequently.

• You may require up to 150-200 ml every 15 minutes (individual metabolism varies)
• If using hand tools you may need to increase this to 300 ml every 15 minutes
• Re-hydrate with water
Appendix A. Safety procedures

Another key safety response to potentially dangerous situations is to embed the LACES process in working practices. LACES stands for:

**Lookouts** placed where they can see the fireline, the fire and the teams that are working. They should be experienced and able to keep the team constantly up-to-date on the progress of the fire and its potential to change, as well as recognise and anticipate dangerous fire situations.

**Awareness** of what is happening with the fire and other activities, must be maintained at all times. Be aware of changes in the weather, where the fire is in relation to different slopes, aspects and fuels. Be aware of the danger zones around machinery and equipment. Be aware of the condition of your buddy and team mates.

**Communications** by word of mouth, hand signals, radios, between team members, supervisors and incident commanders are all important. Have a back-up plan should radios fail or are out of range and check the radio frequencies to be used. It can be very noisy on the fireline. The distance between personnel may need to be reduced to maintain good communications among the team, especially in difficult situations.

**Escape routes** Have 2 routes planned and scouted out before commencing operations. Time how long the evacuation will take at a walking pace. Evaluate rate of spread and make sure there is enough time to walk to the safety zone. Work out the trigger point for leaving the fireline and going to the safety zone. Give alarm early not late. The escape routes should avoid going uphill. Everyone on the fireline must know the plan and what is expected of them. Everyone must know what the trigger to evacuate is. Mark routes for access during the day and night.

**Safety zones** identified, assessed and prepared as necessary. Area should be big enough that you can survive without a fire shelter. You can use previously burned ground and work keeping “one foot on the black”. Use natural features: lee slopes, rocky areas, places with low fuel loads, lakes and ponds, recently felled and cleared areas in forests, roads and helicopter landing sites. Clear these sites of vegetation as much as possible bearing in mind the location of the fire and the speed that the fire is moving towards the location.

Take account of fire behaviour when working out the acceptable size and location of the safety zone. On flat ground with no wind the minimum distance between each person and the fire is four times flame height. This distance should be maintained all around the safety zone. Larger safety zones are required if the location is upslope or upwind of the fire or if it is in an area with heavy fuel loads. Avoid locations in steep narrow valleys, or ones that need an uphill escape route.

In an emergency, while on the escape route, all non-essential equipment should be discarded. Essential equipment to keep includes your hand-tool, some water, radio and fire shelter if provided. Keep as low as possible and protect airways and exposed skin.
The appropriate size of safety zone varies with flame length of the fire to allow people sufficient distance for the radiant heat to dissipate. If the convection column of a fire is pointed at an area, because of wind or slope influences, then the separation distances are greater. See Table 5 below showing minimum distances in the absence of wind and slope influences.

Table 5: Flame length and safety zone sizes

<table>
<thead>
<tr>
<th>Flame Length (metres)</th>
<th>Separation Distance (metres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>15</td>
<td>60</td>
</tr>
<tr>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>30</td>
<td>120</td>
</tr>
<tr>
<td>60</td>
<td>240</td>
</tr>
</tbody>
</table>

Some other examples of standard safety procedures are given below:

“Watchout - Australian”

| W | Weather dominates fire behaviour so keep informed |
| A | All actions should be based on current and expected fire behaviour |
| T | Try out at least 2 safe escape routes |
| C | Communications maintained with your crew, boss and adjoining crews |
| H | Hazards to watch out for are heavy fine fuels and steep slopes |
| O | Observe changes in wind speed and direction, humidity, cloud |
| U | Understand your instructions and make sure you are understood |
| T | Think clearly, be alert and act decisively before your situation becomes critical |

“10 Standard Fireorders - USA”

| F | Fight fire aggressively but provide for safety first |
| I | Initiate all actions based on current ad expected fire behaviour |
| R | Recognise current weather conditions and obtain forecasts |
| E | Ensure instructions are given and understood |
| O | Obtain current information on fire status |
| R | Remain in communication with crew members, your supervisor and adjoining forces |
| D | Determine safety zones and escape routes |
| E | Establish lookouts in potentially hazardous situations |
| R | Remain in control at all times |
| S | Stay calm, think clearly and act decisively |

From analysis of situations some 18 common issues relating to the development of hazards have been identified:
18 Situations that you should “Watchout” for (USA)

1. You are on a fire that has not been scouted or sized up (assessed)
2. You are in country you have not seen in daylight
3. Safety zones and escape routes have not been identified
4. You are unfamiliar with the local weather and other factors that may influence fire behaviour
5. You are uninformed regarding strategy, tactics and hazards
6. You are not clear on your instructions and assignment
7. You have no communications with your crew members, your supervisor or adjoining forces
8. You are constructing fireline without a safe anchor point
9. You are building fireline downhill and there is fire below you
10. You are attempting frontal attack on the fire
11. There is unburned fuel between you and the fire
12. You cannot see the main fire and you are not in contact with anyone who can
13. You are on a hillside where rolling material can ignite fuel below you
14. You notice the weather is getting hotter and drier
15. You feel an increase in the wind or a change in direction
16. You are getting frequent spot fires across the fireline
17. You notice that the terrain and fuels will make escape to a safety zone difficult
18. You notice firefighters are sleeping on the fireline

Each of these watch-out situations needs you to implement appropriate control measures.

References:


Teie W.C. (1997), Fire officers handbook on wildland firefighting, Rescue, California, United States of America: Deer Valley Press
Unit EF2: Apply techniques and tactics to control vegetation fire.

Element 1.1: Prepare for vegetation fire control activities
Element 1.2: Control vegetation fires

About this unit:

This unit deals with the techniques and tactics used by individuals who are involved in managing vegetation fires in rural areas, either in fire suppression or prescribed burning operations.

It has been developed so that it can be applied to any area of vegetation: forest, shrub, grass or peat.

This unit is aimed at those who work in fire services, farming, forestry, game management, conservation, range land and recreation management who have a role managing vegetation fires, either on a full or part-time basis.

To achieve it you must show that you are able to:

• Interpret fire behaviour and apply appropriate techniques and tactics in a local area
• Follow organisational fire procedures
• Operate safely on the fireground
• Support others operating on the fireground
• React appropriately, within organisational procedures, to a fire incident.
<table>
<thead>
<tr>
<th>Key words and phrases:</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bay(s)</td>
<td>The areas in front of the headfire, between fingers of fire, where you may have fire on three sides.</td>
</tr>
<tr>
<td>Control line</td>
<td>All constructed or natural barriers and treated fire edges used to control a fire.</td>
</tr>
<tr>
<td>Crown fire</td>
<td>A fire that advances through the tree crown fuel layer, usually in conjunction with a surface fire.</td>
</tr>
<tr>
<td>Direct attack</td>
<td>Fire control activity applied directly on the fire.</td>
</tr>
<tr>
<td>Flank</td>
<td>The sides of the fire.</td>
</tr>
<tr>
<td>Fingers</td>
<td>Narrow slivers of advancing fire that extend beyond the head or flanks.</td>
</tr>
<tr>
<td>Fire behaviour</td>
<td>The manner in which fire reacts to the variables of fuel, weather and topography described in terms of fire intensity and rate of spread.</td>
</tr>
<tr>
<td>Fire hazard</td>
<td>The potential exposure of people or assets to danger from the behaviour of the fire.</td>
</tr>
<tr>
<td>Fire Weather</td>
<td>Predicted climatic conditions covering period of burn, especially wind, air temperature and relative humidity.</td>
</tr>
<tr>
<td>Fire Perimeter</td>
<td>The outside edge of the fire.</td>
</tr>
<tr>
<td>Fire risk</td>
<td>The potential for a fire to start.</td>
</tr>
<tr>
<td>Fuels</td>
<td>The type, quantity, arrangement, distribution, &amp; moisture content of the vegetation. Can be: ground (peat, roots), surface (plant litter, grass, shrubs) or aerial (trees) fuels.</td>
</tr>
<tr>
<td>Fire intensity</td>
<td>The pulse or rate of energy release, that travels upwards from the fire, often linked to flame length.</td>
</tr>
<tr>
<td>Fire Support Office</td>
<td>Forest District Office, Estate Office, or company office where non-fire service support for fire control effort is organised.</td>
</tr>
<tr>
<td>Fire type</td>
<td>Ground fire, surface fire or crown fire, most common type is surface fire.</td>
</tr>
<tr>
<td>Flame length</td>
<td>The distance form the base to the tip of the flames.</td>
</tr>
<tr>
<td>Flanking attack</td>
<td>Most common direct attack strategy, that starts control activity from an anchor point, then progresses along flanks to head.</td>
</tr>
<tr>
<td>Ground fire</td>
<td>A fire that burns in the ground fuel layer often associated with smouldering fire.</td>
</tr>
<tr>
<td>Head</td>
<td>The front of the fire showing the greatest rate of spread.</td>
</tr>
<tr>
<td>Heel</td>
<td>The rear of the fire near the origin.</td>
</tr>
<tr>
<td>Indirect attack</td>
<td>Fire control activity away from the fire edge e.g. backburning.</td>
</tr>
<tr>
<td>LACES</td>
<td>Lookouts, Awareness, Communications, Escape routes and Safety Zones.</td>
</tr>
<tr>
<td>Origin</td>
<td>The place where the fire starts.</td>
</tr>
<tr>
<td>Rate of spread</td>
<td>The speed the fire is expanding at the head of the fire.</td>
</tr>
<tr>
<td>Smouldering fire</td>
<td>A fire burning without flame through solid material that spreads slowly, eg peat fire.</td>
</tr>
<tr>
<td>Spot fires</td>
<td>New fires ignited ahead or away from the main fire by embers or a burning object.</td>
</tr>
<tr>
<td>Surface fire</td>
<td>Fire that burns surface litter, other loose debris on the forest floor and small vegetation such as grass and low shrubs.</td>
</tr>
<tr>
<td>Topography</td>
<td>Shape of the land, especially slope and aspect.</td>
</tr>
<tr>
<td>Wildfire</td>
<td>A fire that is not being controlled.</td>
</tr>
</tbody>
</table>
Element 1.1: Prepare for vegetation fire control

What you must be able to do:

1. The location of the fire and the most effective route to the fire are obtained taking into account local conditions
2. Protective clothing and equipment, food and fluid requirements are identified and prepared before departure
3. Predict fire behaviour in your local area based on the combined influences of the fire environment
4. Assess the fire environment and provide a report with key vegetation fire information to your supervisor
5. Identify your role within your organisations fire procedures
6. Identify the role of your organisation, the fire group, fire service, and other agencies within fire procedures
7. Approach the fire in a safe manner
8. Return and secure resources on completion of activity, carry out immediate maintenance and report any defects or deficiencies

This element covers:

A. The types of fire:
   (i) Ground
   (ii) Surface
   (iii) Crown

B. Key vegetation fire information:
   (i) Location of fire (site, map reference)
   (ii) Size of fire (small, medium, large)
   (iii) Type of fuels burning (grass, crop, shrub, forest, peat/roots)
   (iv) Type of fire (ground, surface, crown)
   (v) Fire behaviour (rate of spread, flame length)
   (vi) Access to fire
   (vii) Water sources
   (viii) People or property threatened by the fire
Element 1.1 cont.:

C  The key factors affecting fire behaviour:
   (i)  Wind
   (ii)  Slopes
   (iii)  Fuels
   (iv)  Aspect

What you must know and understand:

a.  The information that can be gathered on fire behaviour from observation of the fire and the fire environment, including: flame lengths, smoke, wind, fuels, aspect and topography
b.  How to assess and analyse the information on observed fire behaviour logically

c.  The influence that types of fuel: peat/roots, grass, crops, shrub/scrub and forests have on fire behaviour
d.  The influence of different fuel features on fire behaviour including: type, size, arrangement/distribution, quantity and moisture content
e.  The influence of weather on fire behaviour including: wind speed and direction, air temperature, relative humidity, rain, and day/night variations.

f.  The influence of topography including: slopes, altitude, aspect, shape of the ground, gullies, and barriers to fire spread
g.  Your organisations fire plan and fire map, including symbols used and operating procedures
h.  The implications for your activities of the relevant legislation
i.  The role of the primary fire service and how to identify the incident commander

Element 1.2:  Control vegetation fires

What you must be able to do:

1  Extinguish fires using the tools made available, within the accepted range of fire behaviour for each tool, according to your organisations procedures

2  Progress your objectives using dynamic risk assessment to minimise risks to yourself, team members and the public

3  Observe and report the development of the fire and changes in fire behaviour, weather, fuels or topography to your supervisor

4  Be aware of the location of the fire, fire behaviour and your team members at all times
Element 1.2 cont.:

5. Be aware of your route to a safe area(s) at all times.
6. Maintain communication with team members and your supervisor through the whole operation.
7. Contribute to de-briefs after the activity has ended.

This element covers:

A. The stages in controlling a vegetation fire:
   (i) Knockdown
   (ii) Containment
   (iii) Mop up and patrol

B. Fire control strategies:
   (i) Offensive and defensive
   (ii) Direct and flanking attack
   (iii) Parallel and Indirect attack
   (iv) Combination attack

C. The methods of extinguishment:
   (i) Remove oxygen
   (ii) Remove heat
   (iii) Remove fuel

D. Control line construction:
   (i) Anchor points
   (ii) Line types

What you must know and understand:

a. The priority of personnel safety and the values and assets that you are trying to protect.

b. The role of lookouts, the importance of being aware of the fire situation and being able to communicate with team members and your supervisor at all times. Knowing where your escape routes are, as well as when to use them and how long it will take to reach your designated safety zones (LACES)
c. The fire triangle and the methods of extinguishment using a variety of vegetation fire tools

d. The ranges of flame lengths that different tools, tactics and strategies can cope with.

e. The efficiency and safety of different fire control tools and techniques applied in a variety of situations

f. How to work safely in the vicinity of: vehicles, tractors, bulldozers, helicopters and aircraft.

g. The basic principles and methods of control line construction and placement in varied terrain

h. How to work as part of a team with a variety of tools, techniques and strategies in combined attack
Unit EF2: Training: Apply Techniques and Tactics to Control Vegetation Fire

Introduction:

These training materials support the EuroFire Level 2 competency standard EF2 Apply Techniques and Tactics to Control Vegetation Fire.

This document is an introduction to wildfire behaviour and the techniques and tactics that may be applied to suppress a wildfire or perform a prescribed burn, for people who assist in the management of vegetation fires.

It is for situations where: the fire management operation is simple, the level of risk, complexity and fire behaviour is low and the operator is under direct supervision.

All national and local laws relating to fire management techniques must be followed. In addition local landowners may need to be consulted or give their approval before operations takes place.

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

The nominal/notional/guided learning hours for this unit is 40-50 hours.

EuroFire is a pilot project. The training material will be evaluated as part of an on-going process. A feedback form can be found at www.euro-fire.eu

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

Relationship with EuroFire competency standards and risk management

Reference to the EuroFire competency standards should be made to understand the full range of expected learning outcomes. The sections of the standards are: unit title, element title(s), about this unit, key words and phrases, what you must be able to do, this element covers, and what you must know and understand.
The support materials for all the EuroFire competency standards are designed to support a flexible approach to training delivery. They can be adapted or modified to suit a particular target audience. The learning material for this unit should be used with the support materials for other units to ensure all learning outcomes in the standards are covered.

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

**Complimentary (co-requisite) learning:**

EF 1 - Ensure that your actions in the vegetation fire workplace reduce the risks to yourself and others

**Subsequent learning:**

EF 3 - Communicate within a team and with supervisors at vegetation fires (to be developed)
EF 4 - Apply hand tools to control vegetation fires
EF 5 - Control vegetation fires using pumped water (to be developed)
EF 6 - Apply Vegetation Ignition Techniques

**Learning objectives:**

On completion of learning you should be able to:

1. Understand wildfire behaviour

2. Apply suppression techniques to control vegetation fires

**Keywords and phrases:**

I. Understanding Wildfire Behaviour

Wildfire

Wildfire is an uncontrolled fire that occurs in both rural and urban areas that burns vegetation, agricultural resources and human structures. It includes peat, grass, shrub (scrub) and forest fires.

Before undertaking wildfire suppression activities, it is important to have an understanding of the basic physical processes that cause fire to occur and the environmental factors that influence fire behaviour.

The Fire Triangle

The Fire Triangle illustrates the three elements that must be present for a fire to occur. If one of these elements is removed a fire will go out.

- Oxygen is a component of air which is necessary for fuel to burn and is readily available in a wildfire environment. Air, in the form of wind, plays a critical role in shaping wildfire behaviour.

- Heat is the energy needed to make flammable material give off vapours that mix with the oxygen in the air to cause fire. Fuel can be heated in numerous ways to reach an ignition point.

- Fuel is any flammable material or vegetation that is readily available to burn. The type, quantity, arrangement, distribution and moisture content of the fuel will influence fire behaviour.

Illustration 1.1 The fire triangle
Heat Transfer

A fire’s heat can be transferred to other fuel through convection, radiation and conduction.

- **Convection** is the movement of heat through air. In wildfire terms, convection is the heat that is both rising and moving sideways with the air in front of the flames. Convection is the most important form of heat transfer for wild land fire fighters because the superheated gases preheat fuels in front of the fire which can cause the rapid expansion of wildfire.

Illustration 1.2 Convection

- **Radiation** is heat that moves from a single source in all directions in the form of waves or rays. Burning fuels will radiate heat in all directions and contribute to the preheating of un-burnt fuels. The sun is another source of radiant heat.

Illustration 1.3 Radiation
• **Conduction** is the transfer of heat through a solid object from a region of higher temperature to a region of lower temperature. It is transferred by direct contact from one object to another. The makeup of the receiving object will determine the speed of heat transfer. Conduction plays a minor role in wildfire because wood, like many other forms of vegetation, is a relatively poor conductor of heat.

![Illustration 1.4 Conduction](image)

**The Fire Environment**

The fire environment includes all of the surrounding conditions that determine fire behaviour. A fire’s rate of spread and intensity are determined by these environmental factors. The fire environment consists of three major components: fuel, weather and topography.

![Illustration 1.5 The fire environment](image)
1. Fuel

Fuel is one of the most important factors to consider when analysing a fire environment. Fuels will directly influence fire behaviour based on their:

- Class
- Type
- Size and Quantity
- Arrangement
- Moisture Content

Fuel Class

i. **Ground fuels** are organic materials below the surface litter, including duff, roots, peat, or other buried organic material. Fire behaviour in this fuel class is limited to smouldering or very low intensity burning, but can be sustained for days, weeks, or even months.

ii. **Surface fuels** are the combustible vegetation lying above the duff layer between the ground fuels and the crown fuels. Examples of this type of fuel include dead logs & branches, brush, grass, heather, young trees, etc. Surface fuels will always play a large part in determining fire intensity and rate of spread.

iii. **Crown (Aerial) fuels** are standing and supported fuels that are not in direct contact with the ground. This class will include ladder fuels and the upper levels of forest or scrub canopies. Wildfire intensity will be extreme in order for the fire to reach and spread through the crown fuels.

[Diagram: Fuel classes]

**Illustration 1.6 Fuel classes**
Size and quantity

There are two main categories of fuels:

i. Fine fuels are small fuels like twigs, grass, or leaves. These fuels are quick to dry out and ignite. They are often the main influence on fire intensity and rate of spread.

ii. Heavy or coarse fuels are large diameter logs or branches. These fuels often continue to burn long after the passing of the flame front.

The quantity of fuels readily available to burn will affect the fire intensity and rate of fire spread. A large quantity of fine fuels will result in intense fire behaviour at a flame front, while a large quantity of heavy fuels will result in a low intensity fire lasting long after the passing of the flame front.

Arrangement

Fuels can be arranged both horizontally and vertically.

i. Imagine a forest with varying types and quantities of trees and woody debris in both close and distant proximity to each other – this is horizontal arrangement. Scattered fuels will burn at a relatively low intensity, while a large amount of loosely stacked material will burn at a high intensity.

ii. Vertical arrangement refers to the quantity and distribution of fuels from the ground fuel level to the level of the crown fuels.

Fuel Moisture Content

The amount of moisture stored within a piece of vegetation will affect how easily it will burn and at what intensity it will burn. Environmental factors that influence fuel moisture are relative humidity, precipitation, air temperature, and to a lesser degree shade, aspect, slope, elevation, etc.

A fuel with a high moisture content, as a result of a recent rain, high humidity, or proximity to a water source, will require more preheating before it will burn. Fuels with low moisture contents will burn with very little preheating, at a high intensity, and with a fast rate of spread.
Table 1.1 Fuel moisture content

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Moisture Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine Fuels</td>
<td>Lose moisture and dry out easily, quickly becoming available to burn</td>
</tr>
<tr>
<td>Heavy Fuels</td>
<td>Do not lose moisture rapidly, requiring more time and heat energy to become available to burn then the finer fuels</td>
</tr>
<tr>
<td>High Moisture Content Fuels</td>
<td>Require a longer period of preheating as well as a great degree of heat energy</td>
</tr>
<tr>
<td>Low Moisture Content Fuels</td>
<td>Quickly dry out and become available to burn, burn rapidly and with a high intensity</td>
</tr>
</tbody>
</table>

2. Weather

Weather is the most variable component of the fire environment, changing rapidly over the course of a wildfire. Weather can be extremely unpredictable and its influence on fire behaviour should not be underestimated. The key weather elements are:

- Relative Humidity
- Air Temperature
- Wind
- Precipitation
- Day/Night Variation

Relative Humidity

Relative Humidity (RH) is a measure of the moisture content in the air. A number of assumptions can be made when considering the effect of RH on wildfire behaviour:

i. RH directly effects fuel moisture content in dead and fine fuels, while live fuels will not be affected to the same extent by changes in RH.

ii. If RH levels are high, then dead and fine fuels can be expected to have a higher fuel moisture content level and will not readily burn. Conversely, if RH levels are low, then dead and fine fuel can be expected to have a lower fuel moisture content level and be readily available to burn.

iii. In weather forecasts, low RH levels are a good sign that fire behaviour will be more intense, while high RH levels generally mean that fire behaviour will be less intense.
iv. RH levels will almost always rise and fall according to a known pattern (See Illustration 1.7 below). RH levels will be at their highest in the morning and evening and at their lowest in the afternoon.

v. As a general rule, a fire will burn at its greatest intensity in the afternoon when RH is at its lowest and air temperatures are at their highest.

vi. A relationship between relative humidity and air temperature can be seen in the table below.

<table>
<thead>
<tr>
<th>Air temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000</td>
</tr>
<tr>
<td>MAXIMUM FIRE INTENSITY</td>
</tr>
<tr>
<td>RELATIVE HUMIDITY</td>
</tr>
<tr>
<td>TEMPERATURE</td>
</tr>
</tbody>
</table>

Illustration 1.7 Relative humidity level/fire intensity

Air temperature

Air temperature directly affects both relative humidity and the moisture content of fuel. An increase in air temperature will have two effects:

i. Relative humidity will decrease, resulting in an increase in fire behaviour.

ii. Fuel moisture content will decrease which will allow the fuels to dry out and ignite at a quicker rate.

Therefore we can assume that higher air temperatures will cause fuels to be hotter, drier and more easily ignited.
Wind

Wind has the greatest impact on fire behaviour of all the weather factors. Wind directly affects the rate of spread and direction of the fire. A strong wind will result in an intense and fast moving fire. Wind will contribute to fire behaviour in the following ways:

i. Wind supplies more oxygen (air) to a fire which causes the fire to burn at a greater intensity.

ii. Wind will greatly influence the direction of a fire.

iii. Wind will flatten (or bend) the flames of a fire over the fuel ahead of the fire increasing the rate at which those fuels will dry out and ignite as well as increasing the intensity at which fuels will burn.

iv. Wind will lift burning embers and ash ahead of the main fire causing new fires called “spot fires”.

Illustration 1.8 Effect of wind on wildfire

There are a number of other factors to consider about wind and its relationship to wildfire:

i. Wind direction refers to the direction the wind is coming from (i.e. a southern wind is a wind that originates in the south and moves in a northerly direction across the land).

ii. Land characteristics (topography) can influence the direction and speed of wind. For example, winds could be channelled through a canyon or a valley at a slightly different direction and at a greater speed.
iii. Wind direction and speed is extremely variable and can change at any moment to a great degree. This change can be attributed to the passing of weather systems like thunderstorms or the affects of local wind characteristics.

iv. The variability of wind is an extremely important consideration for fire fighters because it can rapidly change the direction and intensity of a wildfire. This is important to consider when working anywhere on a fire ground, but especially for teams working on the flanks or head of a fire. As can be seen with the effects of the wind shift shown below in illustration 1.9.

![Wind Direction Illustration](image)

Illustration 1.9 Effect of a wind change on a fire

v. Wildfires can create their own wind. As hot air rises through the convection column of a fire, strong in-drafts of cold air will rush into the fire from all sides. The influx of wind will heighten fire behaviour.

**Precipitation**

Rainfall will have a dampening effect on a wildfire, although the degree to which rainfall will impact the fire behaviour can vary greatly depending on the amount and duration of the rainfall:

i. When there is steady, continuous rainfall over a long period of time, fuels will absorb more moisture and will not be easily ignited.

ii. Heavy rain over a short period of time will not greatly affect the fuel moisture content of surface fuels, leaving them readily available to burn.

**Day & Night Variations**

Wildfire behaviour during the night is enormously different than that of day time. Fire activity is often (but not always) relatively low throughout the night and can sometimes present excellent opportunities for wildfire suppression efforts.
3. Topography

The shape and aspect of terrain can vary significantly over the course of a wildfire. It will play a large part in determining the fire’s direction and rate of spread. Weather factors like wind can be modified depending on the shape of the landscape. The key topographic features that contribute to fire behaviour are:

- Slope
- Aspect
- Terrain

Slope

A fire burning upslope generates more convective and radiant heat that preheats the unburned fuels ahead of the fire at a faster rate than on level ground. The steeper the slope, the greater this affect. The opposite is true for a fire travelling down slope. The general rules to consider when considering the affect slope will have on fire behaviour are:

i. For every 10° increase in slope, double the rate of fire spread.

ii. For every 10° decrease in slope, halve the rate of fire spread.
Aspect

The aspect of a slope is the direction it faces – north, east, south or west. Aspect effects wildfire behaviour in two ways:

- Pre-heating effect
- Vegetation effect

i. Pre-heating effect

Fire behaviour will be affected in the short-term (over the course of a day) by the aspect of the slope terrain in which it is burning. A south facing slope will receive more sunlight over the course of the day which will increase the preheating of the fuels. In contrast, a north facing slope will receive less sunlight over the course of the day and fuels will remain cooler. As a result, fire behaviour will be more intense on the south facing slope then the north facing slope. The conditions of the east and west facing aspects will vary, but fall somewhere in between the level at which south and north facing slopes are affected.
ii. Vegetation effect

The type and amount of vegetation is partially determined by aspect. In the northern hemisphere:

- South facing slopes will generally be sunny and dry with light vegetation.
- North facing slopes will be shadier and moist with a greater quantity of heavier vegetation.
- The condition of the east and west facing slopes will fall somewhere in between the environment of the south and north facing slopes. These slopes will be greatly determined by their geographic location and local weather conditions, varying from one location to another.

Wildfire behaviour will be affected by the aspect because of the variability of sunlight, vegetation and moisture content from one aspect to another.

[Diagram showing the effect of aspect on vegetation and fire behaviour in the northern hemisphere]

Illustration 1.12 Effect of aspect on fire behaviour (northern hemisphere).

Terrain

Terrain is the physical features on the surface of an area of land. The shape of land forms will affect fire behaviour. Valleys, ridges, canyons, mountains or flat land can all have different influences on the wildfire’s direction, speed and intensity.

i. Wind & Terrain

Terrain will affect wind direction and speed. Like water, wind flows along the lowest and easiest path, following the contours of the land. Some examples of this relationship are:

- In the mountains or hills, winds tend to flow up or down valleys and gullies, irrespective of the general wind direction.
- Local winds can be generated by the terrain. An upslope wind during the day could become a down slope wind during the night.
• The leeside of a ridge (i.e. the side facing away from the wind) may have turbulent winds blowing in the reverse direction of the prevailing wind.

Illustration 1.13 Lee slope turbulence

ii. Ridges

Fire approaching a ridge top can increase in speed and intensity and behave erratically.

iii. Canyons, Gullies, & Saddles

Narrow gullies, saddles and canyons can channel the fire into a narrow, fast moving path. In this circumstance the shape of the land is funnelling both the fire and the wind into an area where the maximum effect of these factors, in terms of fire behaviour, will occur. This is also known as the chimney effect. A fire being influenced by the chimney effect will display extreme fire behaviour and move rapidly through the narrow terrain.

Illustration 1.14 The chimney effect
Wildfire Development

It is important to know the characteristics of the different types of wildfire, as well as how the different parts of a wildfire are defined. It is also critical to understand the way that fire develops from an ignition point to an active wildfire and what forces drive the fire’s development.

1. Types of Fires

Wildfires are commonly referred to by the class of fuel (ground, surface, or crown) in which they are burning. Having an understanding of the different types of wildfires is crucial because each will require different suppression methods. There are four types of wildfire:

- Ground
- Surface
- Crown (Aerial)
- Spot

i. A **Ground Fire** burns in the organic materials under the surface litter and in the root systems. Fire will burn in organic material such as peat, humus, roots, and other buried combustible material such as landfill waste. Characteristics include:

- Smouldering with no flame and little smoke
- Fires may burn unnoticed for weeks or months and could potentially re-ignite surface fuels
- Occur in any area with a deep soil layer or large amounts of organic material
- commonly occur in peat fires

ii. A **Surface Fire** involves the burning of vegetation like forest litter and undergrowth, grasses or shrubs, or other vegetation lying at or slightly above ground level. Characteristics include:

- The most common type of wildfire
- Fire behaviour can vary from very low to extreme
- Heavily influenced by the forces that drive fire behaviour (Weather, Fuel and Topography)

iii. A **Crown (Aerial) Fire** burns in the tops of trees above and ahead of an intense surface fire. Convective and radiant heat from an intense surface fire will ignite the tree tops and a crown fire will burn independently of the surface fire. Characteristics include:
Display the most extreme form of fire behaviour, fastest moving type of wildfire and highly destructive of the natural environment.

Intense surface fire will follow shortly after the passing of a crown fire.

Spot fires will appear in great numbers and some may occur well in advance of the main fire.

Normally only travel short distances supported by either a strong wind or steep slope.

iv. **Spot Fires** are new fires that have been ignited in front of the main as a result of fire brands, or burning debris that has been lifted by hot air through the smoke column and then deposited in front of the main fire. Characteristics include:

- Each spot fire is independent of the main fire and their spread and fire intensity will be vary greatly based on their location.
- Spot fires are a good indicator of the presence of, or the growing potential for extreme fire behaviour.
- Spot fires are extremely hazardous to the fire manager because of their unpredictability and potential to become a second or third rapidly growing fire independent of the main fire.

![Illustration 1.15a Types of wildfires – ground fire](image)
2. Parts of Wildfires

There is a set of common terminology used to describe the parts of a wildfire. An understanding of the basic parts of a wildfire will be essential for effective communication on a wildfire incident. Parts of wildfires include:

- Origin
- Heel
- Flanks
- Head
- Fingers
- Bays
- Perimeter
- Spot Fires
i. The **Origin** is the place where the fire starts. This may or may not be easily identifiable.

ii. The **Heel** of a fire is the rear of the fire starting at the origin.

iii. The **Flanks** are the sides of a fire, often areas of low to moderate fire behaviour.

iv. The **Head** is the front of the fire which will display the greatest fire intensity and the fastest rate of spread.

v. The **Fingers** are narrow slivers of advancing fire that extend beyond or alongside of the head or flanks.

vi. The **Bays** are the areas in front or alongside of the head fire, between fingers of fire, where you may have fire on three sides.

vii. The **Perimeter** is the outside edge of the fire.

viii. **Spot Fires** are new fires ignited ahead or away from the main fire by embers or other burning material.
3. Wildfire Spread

Wildfire spread will depend on the characteristics of the weather, topography, and fuel that determine fire behaviour. In wildfire terms, **alignment** occurs when the forces of weather, topography, and fuel are all in the fire’s favour. Wildfires that are in alignment will exhibit extreme fire behaviour and can be highly destructive.

Within the general categories of weather, topography and fuel, the forces of wind, the shape of the land, and the arrangement of the fuel will have the greatest affect on the shape or spread pattern of a wildfire. The illustrations below show the basic effects that these factors will have on wildfire spread.

i. Fire spread with little or no influence of wind or slope

![Illustration 1.17 Fire spread with little to no influence of wind or slope](image)

This type of fire spread will occur when a fire starts on flat ground, with a relatively even fuel distribution on a calm day. The fire perimeter will move out evenly from the ignition point in a circular pattern and fire spread will be slow.
ii. Fire with moderate wind and/or topographical influence

Under the influence of a moderate wind the fire's convection column is driven over the head of the fire and contributes to the heating of un-burnt fuels. A moderate slope will contribute to the increase in heating of un-burnt fuels in the same manner. The diagram shows this increase in fire behaviour and the resulting pattern of fire spread.

iii. Fire with strong wind and/or topographic influence

Under the influence of a strong wind or steep slope the pattern of fire spread will resemble an elliptical shape because the intensity of the head fire (which is most affected by the factors in alignment) will be extreme compared to those intensities seen on the flanks and at the heel. The forces at work are the same as in illustration 1.18, but to a greater degree.
II. Control Vegetation Fires

Approaching a Wildfire

The initial response to a wildfire incident is crucial to the success of wildfire suppression. An effective response depends on correctly identifying the location of the fire, understanding the fire behaviour signs that can be identified prior to arrival and choosing the most efficient route to the fire without compromising the safety of yourself or others.

When Fire is reported:

- Be sure you understand the exact location of the fire, or if only a general location is known, identify a safe vantage point in the area to obtain a more precise location
- Refer to maps or aerial photographs to identify a safe and direct route
- Collect all relevant information from the reporting party

En route to the fire ground:

- Consider weather conditions - current and expected
- Consider the indicators of fire behaviour that can be perceived on approach of the wildfire. What can you discern from the shape, colour, and size of the smoke column?

<table>
<thead>
<tr>
<th>SMOKE COLOUR</th>
<th>DENSE WHITE</th>
<th>GREY</th>
<th>BLACK</th>
<th>BLACK COPPER•BRONZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>FUEL MOISTURE</td>
<td>VERY MOIST</td>
<td>MOIST</td>
<td>DRY</td>
<td>VERY DRY</td>
</tr>
<tr>
<td>FUEL</td>
<td>FUEL</td>
<td>FUEL</td>
<td>FUEL</td>
<td>FUEL</td>
</tr>
<tr>
<td>FIRE INTENSITY</td>
<td>LOW</td>
<td>MODERATE TO HIGH</td>
<td>HIGH TO VERY HIGH</td>
<td>EXTREME</td>
</tr>
</tbody>
</table>

Illustration 2.1 Four different smoke columns

- Consider your understanding of the fire area. What are the vegetation types in the area? What are the most common topographic features? Are there any special local weather factors to consider?
Methods of Extinguishment

The removal of one of the three elements that makes up the fire triangle, or “breaking the fire triangle”, will successfully suppress a fire. There are a number of common fire fighting strategies that all aim to remove one element of the fire triangle.

1. Remove the Oxygen Supply

This can be done by throwing soil on a fire or beating out the fire along its edge using a “fire beater”. Foam also removes the oxygen supply.

Illustration 2.2 Broken fire triangle (oxygen)

2. Remove the Heat

Water absorbs heat energy through steam. The application of water is a very effective way of extinguishing a fire. Water must be directed at the base of the flames where combustion is occurring.

Illustration 2.3 Broken fire triangle (heat)
3. Removing the Fuel

Techniques which involve the removal of fuel are known as “dry fire fighting techniques”. Using hand tools to create a control line or using machinery to create “fuel breaks” are both effective dry fire fighting techniques. Backburns and other burn-out operations are also examples of removing the fuel in front of the fire.

![Illustration 2.4 Broken fire triangle (fuel)](image)

4. Combination of Methods

In many cases, it will be a combination of techniques that successfully extinguishes a wildfire. Removing the oxygen supply by adding dirt to the fire is better suited for the “mop-up” stage of the wildfire, while removing the fuels in front of fire might be used to knockdown the head of the fire and gain control of the wildfire.

Wildfire Suppression

The tools used in wildfire suppression vary greatly depending on the geographical environment. It is important to understand when and where the different types of wildfire suppression tools should be used in order to be effective.

Wildfire suppression tools may include:

- Hand tools
- Power tools
- Water equipment
- Ignition equipment
- Heavy machinery
- Air resources
1. Hand Tools

Use:
- Direct, Parallel and Indirect Attack
- Fire line and fuel break construction

Considerations:
- Some hand tools have multiple uses, while some are intended for specific tasks only.
- Depending on the geographic area or fuel type, some tools may be better suited than others for certain tasks.

Basic Hand Tool Examples:
- Axe
- Shovel
- Spade
- Hoe
- Mcleod
- Rake
- Matlock
- Gorgui
- Pulaski
- Slasher
- Brush Hook
- Knapsack
- Fire Beater
- Sprayer

*For a more in depth look at hand tools refer to training module EF4 Apply hand tools to control vegetation fires

2. Power Tools

Use:
- Create a fuel break by cutting back trees, shrubs or limbs
- Often used to create a path for the construction of hand line or to clear fuel from an existing firebreak (i.e. road or stream)

Considerations:
- Power tools must only be used by trained and qualified personnel
- Personal Protective Equipment must be worn

Power Tool Examples:
- Brush-cutter
- Chainsaw
3. Water Equipment

Use:

- Used in Direct and Parallel Attack
- Can be applied directly to the flames, used to build wet line, cool down a controlled burn line and putting out hot spots.

Considerations:

- Water Supply/Sources
- Resources are often limited so water conservation is critical
- There are multiple types, brands, styles of water fire fighting equipment (i.e. hose, hydrants, fittings, water appliances, etc) depending on the geographical area

Water Equipment Examples:

- Portable pumps
- Fire appliances/engines
- Knapsack

4. Ignition Equipment Use:

- Parallel and Indirect Attack
- Burnout operations or burning out unburned fuel within the control line perimeter Considerations:
- Using ignition equipment introduces new hazards
- Suitably qualified personnel should be in charge of all burn out operations
- Burn out operations should be carefully planned and executed

Ignition Device Examples:

- Drip torch
- Diesel burner

* Gas Burner *For a more in depth look at ignition devices & techniques refer to training module EF6 Apply vegetation ignition techniques
5. Heavy Machinery

Use:

- Direct, Parallel and Indirect Attack
- Used to build large fire lines or fuel breaks in a short amount of time
- Transport fire fighting teams

Considerations:

- Adhere to safe working practices around heavy machinery

Heavy Machinery Examples:
- Bulldozer
- Tractor & swipe
- Grader
- Transport vehicles

6. Air Resources

Use:

- Direct, Parallel and Indirect Attack
- Support ground units
- Knock down hot spots, support tactically important areas, or attack areas of intense fire behaviour

Considerations:

- Aircraft operating alone are not effective fire fighting tools.
- Fire fighters must work in conjunction with the supporting aircraft while observing safe protocol when working with aircraft on a wildfire

Aircraft Examples:

- Airplanes
- Helicopters

Control Line & Fire Line

Control line is a comprehensive term used for all of the constructed or naturally existing fire barriers used to control the fire. Some examples of existing control lines include; streams, lakes, ponds, rock slides, areas of sparse fuels, roads, canals or previously burned (cold) fireline.

Fireline refers to any cleared strips or portion of a control line from which flammable material has been removed by scraping or digging down to mineral soil.

A fireline is constructed for two purposes:
• To create a “safe strip” from which to start burning out to remove fuels between the fireline and advancing fire.

• To isolate the burned area from the unburned area.

Any control line must be commenced at an anchor point. This is an existing area of low fuel (i.e. a road or track, rocky area, substantial stream or already burnt ground) that will prevent the fire burning around the end of the constructed control line.

* For a more in depth look at control lines refer to training module **EF4 Apply hand tools to control vegetation fires**

**Wildfire Suppression Techniques**

The strategy(s) used to control a wildfire depends on a number of factors including the rate of spread, intensity, values at risk, size, location, type of available resources, and other factors. There are two broad categories of wildfire suppression techniques:

• **Offensive Strategies** are used when the fire can be safely and effectively attacked or suppressed. Wildfire suppression activities may include one or a combination of strategies.

• **Defensive Strategies** are used when the fire is too intense to be safely attacked, fire fighting resource is limited, or areas of high importance are at risk.

**Offensive Strategies**

1. Direct Attack

   i. Used mainly on low intensity wildfires that can be easily and safely reached by fire fighters.

   ii. Control efforts, including line construction, are done at the fire perimeter, which becomes the control line.

   iii. Suppression efforts should focus on the flanks of the wildfire, starting from the rear and working towards the head of the fire.

   iv. Begin fire line construction at an anchor point, (i.e. a road, stream or burned area to minimize the chance of being flanked by the fire).

   **Methods**

   • Construct hand line or beat out the fire edge using hand tools, power tools and/or heavy machinery
   • Apply water to flames using fire appliances, hose lays or knapsacks
   • Use aerial units to apply water or fire retardant on the fire edge

---
Advantages

• Safest place to work (can keep one foot in the black or burned area)
• A minimal amount of area is burned
• Immediately reduces potential for fire spread
• Eliminates the need for more complex fire suppression strategies

Disadvantages

• Firefighters can be exposed to heat and smoke because of their proximity to the fire edge
• Irregularly constructed control line
• Doesn’t take advantage of natural or existing barriers

Illustration 2.5 Direct attack (flanking)

2. Parallel Attack

i. Used on low to moderate intensity wildfires that may be too intense to attack along the edge of the fire, to make use of a natural existing barrier to act as a control line, and to easily incorporate unburned bays or pockets into the control line.

ii. Control lines are built a short distance from, but parallel to the fire edge.

iii. The distance that the control line is built from the fire edge will depend on the fire behaviour, current and expected weather conditions, terrain, and the type of fuel between the fire edge and the proposed control line.

iv. The area between the control line and the fire edge can be “burned-out” after the construction of the control line to secure it.
v. Fire must be carefully monitored for changes in direction or behaviour.

vi. Requires an experienced supervisor.

Methods

• Construct control line using hand tools, heavy machinery, or existing barriers
• Burn-out vegetation using ignition devices
• Use water to cool control line after burn-out operations

Advantages

• Direct and more secure control line
• Teams are not working within heavy smoke and intense heat
• Makes use of pre-existing natural barriers

Disadvantages

• Added complexity of burn-out operations
• Potential for new fires to escape or increase fire behaviour
• Total fire area is intentionally expanded
• Unburned fuel remains between the fire and teams

Illustration 2.6 Parallel attack
### 3. Indirect Attack

i. Used for wildfires of great intensity, large physical area, or those with limited access.

ii. This strategy often involves the use of fire (i.e. Backburning) as an offensive strategy.

iii. Uses an existing natural barrier or constructed control line that is a good distance from the fire.

iv. The distance that the control line is built from the fire edge will depend on the fire behaviour, current and expected weather conditions, terrain, and the type of fuel between the fire edge and the proposed control line.

v. Two methods of ignition can be used in an indirect attack. One, the vegetation between the main fire and the control line is “burned out”, removing the fuel from the main fire. Two, in accordance with the correct terrain and weather conditions, a “back burn” is lit to slowly burn away from the control line towards the main fire and thus removing the fuel from the main fire.

vi. Requires an experienced supervisor.

**Methods**

- Construct control line using hand tools, heavy machinery, natural barriers
- Burn-out vegetation using ignition devices
- Use water to cool control line after backburn is completed

**Advantages**

- Control line can be placed in favourable topography
- Uses natural or existing barriers
- Teams work out of the heat and smoke
- Allows time to build a control line and undertake burn out operations without responding quickly to changes in fire behaviour

**Disadvantages**

- Increases overall fire size
- A back burn could potentially get out of control due to unforeseen changes in weather conditions
- Line construction and backburning operations may not be completed before the main fire reaches the control line
- Complexity of operation is increased
- Intense fire behaviour may occur when the main fire and back fire collide, increasing the potential for spotting
4. Combination of Methods

A combination of techniques is often used to obtain control of a wildfire. Deciding on which technique to use on a wildfire, or part of a wildfire, depends on:

- Rate of fire spread
- Intensity of the fire
- Fuel ahead of the fire
- Terrain
- Available resources
- Access to the fire
- People or assets threatened

A wildfire will not burn at the same intensity on every part. A wildfire may be big enough to burn in many different vegetation types. Weather, terrain and aspect may be affecting one side of a fire in a different way than another side. As a result of this, it is common to use many a combination of offensive strategies to suppress a wildfire.

Defensive Strategies

These may be used in times where the main fire is too intense to safely attack, or the fire is remote and it is difficult to deploy sufficient resources. Examples of defensive strategies include:

- The creation of defensible space around structures, settlements, or other areas of high importance.
• An individual or a team burning out a defensible area in order to protect themselves from an encroaching wildfire.

• Only observing the movements of a major wildfire in a remote area.

Choosing a Suppression Strategy

Fire behaviour directly influences the strategy to be used in suppression operations. This relationship can be interpreted by the following table:

Table 2.2: Flame length, tools, techniques and strategies

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

*The highlighted box indicates the range of flame lengths that offensive strategies can be used to control a fire

Teamwork

Teamwork is essential to the success of wild land fire fighting. Almost every job in fire suppression is done as a part of team. As a member of a team you must stay in contact with other team members either in person or via radio during wildfire suppression operations. Some essential points to remember are:

• Assure that you understand your instructions and they relate to the instructions of other team members  
• Communicate frequently with your team members and supervisor  
• Understand the overall objective of your team’s work  
• Respect the needs of your team members  
• Assure that both you and your team members know your team’s escape plan in the case of an evacuation
Phases of Wildfire Suppression

There are four phases of fire suppression that will occur on any wildfire incident. These phases are commonly known as knockdown, containment, control, and mop up and patrol.

- **Knockdown** is the initial suppression work aimed at reducing the fire’s intensity and slowing or stopping fire spread. Implies that the foreseeable danger of the wildfire has been significantly reduced.

- **Containment** is attained when a control line has been established around the perimeter of the fire and stopped further growth.

- **Controlling** a fire means that the control lines have been improved and secured to the degree that there is no foreseeable chance of the fire escaping.

- **Mop up and Patrol** commences after the fire has been controlled and involves extinguishing the burning area until there is no possibility of re-ignition. Patrolling the perimeter of the fire will help to ensure that the fire will not escape outside of the control lines. A fire can be called “out” after the completion of this phase.

References:


Teie W.C. (1997), Fire officers handbook on wildland firefighting, Rescue, California, United States of America: Deer Valley Press
Unit EF4:

Element 1.1:

Element 1.2:

Apply hand tools to control vegetation fires.

Prepare hand tools for vegetation fire control activities

Use hand tools to control vegetation fires

About this unit:

This unit deals with the competence required by individuals who are involved in managing vegetation fires in rural areas, either in fire suppression or prescribed burning operations.

It has been developed so that it can be applied to any area of vegetation: forest, shrub, grass or peat.

This unit is aimed at those who work in fire services, farming, forestry, game management, conservation, range land and recreation management who have a role managing vegetation fires, either on a full or part-time basis.

To achieve it you must show that you are able to:

- Use hand tools in a safe and competent manner
- Follow organisational fire procedures
- Operate safely on the fireground
- Support others operating on the fireground
- React appropriately, within organisational procedures, to a fire incident.
For you to fully understand the content of the unit, and the activities it describes, it is important that you are able to understand the terms used within the unit. The definitions at the back of this unit should help you with this.

<table>
<thead>
<tr>
<th>Key words and phrases:</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anchor point</td>
<td>An advantageous location, usually a barrier to fire spread, where fireline construction can start. Used to minimise the chance of being flanked by the fire while the fireline is being constructed</td>
</tr>
<tr>
<td>Control line</td>
<td>Comprehensive term for all constructed or natural barriers and treated fire edges used to control a fire (cf. check line, firebreak, fireline, fuelbreak, scratch line, secondary line, wet line).</td>
</tr>
<tr>
<td>Hand tools</td>
<td>Shovels, spades, rakehoe, McLeod rakehoe, Pulaski, mattock, axe, slasher, beater / swatter, knapsack sprayer and combination tools</td>
</tr>
<tr>
<td>LACES</td>
<td>Lookouts, Awareness, Communications, Escape routes &amp; Safety zones</td>
</tr>
<tr>
<td>Type of combustion</td>
<td>Pre-heating, active combustion, charring/glowing and smouldering</td>
</tr>
<tr>
<td>Type of vegetation</td>
<td>Forest, shrub, grass, peat or roots</td>
</tr>
<tr>
<td>Type of fire</td>
<td>Crown, surface, and ground fire</td>
</tr>
</tbody>
</table>

**Element 1.1: Prepare hand tools for vegetation fire control activities**

**What you must be able to do:**

1. Make a safe working area for maintenance activities
2. Choose appropriate maintenance tools for the task
3. Maintain hand tools, in accordance with organisational / manufacturers requirements
4. Load and secure hand tools onto transport vehicle
5. Secure and store hand tools and maintenance tools safely
6. Prepare and check personal protective equipment
7. Maintain safety and health of self and others throughout

**This element covers:**

A. Preparing and maintaining hand tools using:
   (i) Hand files
   (ii) Other maintenance tools

B. In the following situations:
   (i) A workshop
   (ii) In the field / on operations
Element 1.1 cont.:

C  Maintaining the following types of fire control hand tools:
   (i) Digging tools
   (ii) Scraping tools
   (iii) Cutting tools
   (iv) Beating tools
   (v) Smothering tools
   (vi) Spraying tools

D  Personal Protective Equipment
   (i) Helmet/Face shield/Goggles
   (ii) Fire resistant clothing
   (iii) Gloves
   (iv) Heat resistant boots
   (v) Drinking water

E  Equipment used to secure items on transport vehicles
   (i) Ropes
   (ii) Straps

What you must know and understand:
   a. Safe use of maintenance tools
   b. How to maintain hand tools used for controlling fires
   c. Techniques for securing equipment in a variety of situations

Element 1.2:  Use hand tools to control vegetation fires

What you must be able to do:

1  Assess the fire environment logically and predict local fire behaviour
2  Use hand tools to control vegetation fire safely and within organisational procedures
3  Mop up and patrol following a vegetation fire
4  Operate as part of a team with a combination of hand tools, used in rotation, within organisational procedures
This element covers:

A  (i) Digging  
    (ii) Scraping  
    (iii) Cutting  
    (iv) Beating  
    (v) Smothering  
    (vi) Spraying

B  (i) Ground fire  
    (ii) Surface fire  
    (iii) Crown fire

C  (i) Knockdown  
    (ii) Containment  
    (iii) Mop up and patrol

D  (i) Direct attack  
    (ii) Indirect attack

What you must know and understand:

a. The information that can be gathered on fire behaviour from observation of the fire and the fire environment, including: flame lengths, smoke, wind, fuels, aspect and topography

b. How to assess and analyse the information on observed fire behaviour logically, including the identification of hazards and other safety issues

c. The role of lookouts, the importance of being aware of the fire situation and being able to communicate with team members and your supervisor at all times. Knowing where your escape routes are, as well as when to use them and how long it will take to reach your designated safety zones (LACES)

d. How to construct and place a control line correctly and efficiently in varied terrain, according to organisational procedures

e. The capabilities and limitations of hand tools used individually and in combination, with other hand tools, ignition devices, pumps and aircraft as part of a fire control team
Element 1.2 cont.:

f. How to select the correct tools for the fuel type, height and thickness of vegetation and other influences on the efficiency of the operation

g. The methods of using hand tools efficiently, safely and within organisational procedures
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Introduction:

These training materials support the EuroFire Level 2 competency standard EF4 Apply hand tools to control vegetation fires.

This document is for people who are required to use hand tools to manage vegetation fires. It is for situations where: the fire management operation is simple, the level of risk, complexity and fire behaviour is low and the operator is under direct supervision.

All national and local laws relating to fire management techniques must be followed. In addition local landowners may need to be consulted or give their approval before operations takes place.

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

The nominal/notional/guided learning hours for this unit is 10 - 20 hours.

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

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

Relationship with EuroFire competency standards

Reference to the EuroFire competency standards should be made to understand the full range of expected learning outcomes. The sections of the standards are: unit title, element title(s), about this unit, key words and phrases, what you must be able to do, this element covers, and what you must know and understand.
The support materials for all the EuroFire competency standards are designed to support a flexible approach to training delivery. They can be adapted or modified to suit a particular target audience. The learning material for this unit should be used with the support materials for other units to ensure all learning outcomes in the standards are covered.

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

Preparatory (pre-requisite) learning:

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

Complimentary (co-requisite) learning:

EF 3 - Communicate within a team and with supervisors at vegetation fires (to be developed)
EF 5 - Control vegetation fires using pumped water (to be developed)

Learning objectives:

• Prepare hand tools for vegetation fire control activities
• Carry out vegetation fire control operations using hand tools

Keywords and phrases:

Anchor Point, Control Line, Hand Tools, Type Of Combustion, Type Of Vegetation, Type Of Fire

Application:

Hand tools are used in fire management operations. For level 2 training the following activities are covered:

• Direct Attack
• Control line construction
• Mop-up

Some standard hand tools can be extremely effective in fire fighting activities. Hand tools are mainly used to construct fire line. It is very important to choose the correct tool for different fuel types. Several have multiple uses, while some are intended for specific tasks only.
There are digging, cutting, scraping, spraying and smothering, tools. Each tool has a specific application.

Table 1: Types of tools

<table>
<thead>
<tr>
<th>Digging</th>
<th>Scraping</th>
<th>Cutting</th>
<th>Spraying</th>
<th>Smothering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shovel</td>
<td>Rake</td>
<td>Axe</td>
<td>Knapsack</td>
<td>Fire Beater</td>
</tr>
<tr>
<td>Spade</td>
<td>Hoe</td>
<td>Pulaski</td>
<td></td>
<td>Spade</td>
</tr>
<tr>
<td>Mattock</td>
<td>McLeod</td>
<td>Gorguis</td>
<td></td>
<td>Shovel</td>
</tr>
<tr>
<td>Gorguis</td>
<td></td>
<td>Slasher</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brush Hook</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Methods of Extinguishment

Cutting off the oxygen supply - Reducing the temperature - Removing the fuel

There are basically three methods of extinguishing a fire, each designed to break the fire triangle. You can:

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
   or Use a **COMBINATION** of these methods to extinguish a fire.

Illustration EF2 2.4 Broken fire triangle (fuel)

The operations that involve digging, cutting, and scraping break the fire triangle by separating the heat from the fuels. Spraying works by cooling the fire and smothering by removing the oxygen.
Table 2: Flame length, tactics and techniques guidelines

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

*The highlighted box indicates the range of flame lengths that hand tools can be used to control a fire, either in direct or indirect attack.

There are four phases of fire suppression that will occur on any wildfire incident. These phases are commonly known as knockdown, containment, control, and mop up and patrol.

- **Knockdown** is the initial suppression work aimed at reducing the fire’s intensity and slowing or stopping fire spread. Implies that the foreseeable danger of the wildfire has been significantly reduced.

- **Containment** is attained when a control line has been established around the perimeter of the fire and stopped further growth.

- **Controlling** a fire means that the control lines have been improved and secured to the degree that there is no foreseeable chance of the fire escaping.

- **Mop up and Patrol** commences after the fire has been controlled and involves extinguishing the burning area until there is no possibility of re-ignition. Patrolling the perimeter of the fire will help to ensure that the fire will not escape outside of the control lines. A fire can be called “out” after the completion of this phase.

Each phase of fire suppression is equally as important as the others. The key issue is to avoid re-ignition. There are significant dangers that need to be avoided. For example re-ignition occurring in areas thought to be extinguished, a fire driven by wind could threaten crews who have moved ahead. Another example is where there are hotspots near a control line that flare-up and the fire jumps the fireline.
Fitness:

Using hand tools in fire fighting operations is likely to be a strenuous activity requiring strength, flexibility, fitness and endurance from the operator.

You need to follow your organisations guidance on the level of fitness required for manual work.

Handtools

Each hand tool is designed to achieve a particular effect in the most efficient way. Often it is best to work in a team with a variety of hand tools so that different vegetation types and ground conditions can be tackled effectively.

A number of tools can be used for more than one purpose, especially the McLeod rake hoe and the Gorgui combination tool.

The fuel types that hand tools are suitable for include: small trees, shrubs, branches, grasses, stumps, roots and peat.

Description and handling of selected hand tools in fire control:

Axe / Brush Hook:

Illustration 1.1 Brush Hook
The axe and the slasher are often used for clearing the initial path through vegetation and in mopping up operations. They can be used for:

- Cutting down small trees and removing branches
- Clearing areas of ground of short vegetation
- Removing embers and splitting logs, allowing them to cool down
- Removing stumps

Care must be taken not to abuse these tools and to sharpen them after use.

**Fire Beater / Swatter:**

Fire beaters are often used to:

- Knock down low intensity fires in direct attack on the fire edge
- Often used in flanking attack
The fire beater is a large flap of rubber, plastic or metal material attached to a long, straight handle. The user swats the flames with the flat side of the swatter, depriving the fire of oxygen.

The radiant heat from a fire reduces with distance. It is important to have a long handle to minimise heat exposure.

The fire beater is often used with light “pattings”, or by dragging it directly on and along the fire edge in a scrubbing action. Hard, vertical swatting can fan the fire causing hot embers to spring back to life, spreading the fire instead of putting it out.

If flap head fire beaters are used in a team, overlapping them and working them in a rhythm, they are extremely effective in light fuels, like grass. Alternatively working in pairs alternating strokes with hits from the mesh head or the scrubbing action can also work well.

The different types of firebeatres have evolved to suit common local vegetation and fire types. The Flap head fire beaters work well on grass. Mesh head and metal plates beaters work best on shrub fuels.
However choose your firebeater carefully because features that make one design suitable for one situation can make it unsuitable for another. For example mesh head and plate head beaters with scrubbing chains attached should not be used on grass as burning embers get caught and they can spread the fire. Flap head firebeaters made of rubber can burn up and can fan the fire rather than putting it out, in more intense shrub fires.

When the flames are above the range recommended (1.5 metres) in Table 2 for hand tools, you should stop and re-assess the tools and tactics you are applying. Other situations that may need a re-assessment are if the conditions are very dry. In these situations, using beaters and water from knapsack sprayers together, can be very effective. Often the most effective technique is to spray the water on the vegetation immediately in front of the fire beaters. This often reduces fire intensity to a level that the firebeaters can cope with.

**Digging, scraping and cutting tools.**

**Grub-Axe / Mattock / Pulaski**

The Grub Axe and Mattock are forestry tools that can be used for fire fighting. The Pulaski is a specialised firefighting tool. These tools are well suited to areas with: tussocky grass, rocks, logs, stumps, roots and peat. They are used in all 4 phases of fire suppression.

These tools are used for:

- Direct and flanking attack on low intensity fires
- Parallel and indirect attack on medium and high intensity fires
- Clearing firelines and control lines of vegetation, branches and plant litter, roots and peat.
- Containment and mopping up work breaking up hotspots and burning embers

![Illustration 1.2 Grub-Axe](image-url)
Rake Hoe - The McLeod:

These are raking, scraping and chipping tools useful for light fuels, bark and litter. The rake hoe is equipped with prongs on one side for raking and a sharpened edge for cutting, chipping and scraping down to mineral soil.
Combination Tool - Gorgui

The Gorgui combination tool is a tool exclusively designed for fighting wildfires. It combines the functions of Pulaski, McLeod, axe and pick-axe. It can therefore dig, scrape and cut.

![Illustration 1.6 Gorgui Combination Tool]

Its principal characteristic is its versatility. It combines some of the most common tools used in firefighting in a single tool and so can cope with a variety of vegetation types and ground conditions.

Knapsack:

![Illustration 1.7 Knapsack sprayer]
A knapsack is a portable spray pump containing up to 20 litres of water and fitted with shoulder straps for carrying on the back. It has a hand operated force pump which can be used to deliver water either as a jet or a spray. Most modern knapsacks have flexible rather than hard containers. On the fireground you can use a knapsack to:

- Make a direct attack on a low intensity fire
- Support hand crew who are constructing line close to the fires edge
- Assist in mop-up operations

The hand piece has a nozzle which can be adjusted to give a straight jet for distance work or a spray for close work.

Care should be taken when loading the sprayer on to your back. If possible ask a “buddy” to help you. Caution is also needed when operating in rough terrain or steep slopes where there is a danger of losing your balance by tripping or falling.

**Prepare hand tools for vegetation fire control activities**

Tool inspection, Sharpening and Handle care

Each time you pick up a hand tool, inspect it to make sure that it is in good condition and safe for you to use. Examine all the parts of the tool to make sure they are not loose, cracked or broken. Make sure the blade is sharp. Make sure the tool is properly assembled and that you have any accessories you will need to properly use the tool. Test the handle by placing the head on the ground, the handle at a 45-degree angle, and applying firm, downward pressure.

Most hand tools should be sharpened by hand with a file.

Illustration 2.1 Maintaining a shovel
• Always follow the correct procedure and use proper safety equipment when sharpening hand tools.
• Use a flat file with a safety guard to sharpen hand tools.
• Wear gloves
• Make all strokes with the file in a forward motion, holding the file at the same angle for each stroke.
• Use long, smooth strokes, applying even pressure, and releasing the pressure on the backstroke.
• When sharpening axes, Pulaski’s, and brush hooks, the filing direction should always be away from the eye toward the cutting edge to reduce the chance of injury.
• Clean the file with a wire brush or file card between uses.
• Protect the edge with masking tape. This will protect the edge from damage while in storage. You can also use boxes, old fire hose, sheaths, old inner tubes and conveyor belt to protect the tools while in storage.
• When storing the tools on a vehicle, be sure the safety guards are properly secured and placed in the proper compartment. If they are to be transported by aircraft, be sure they are properly bundled.

Many tool handles are made of wood, which is light and strong, easy to use and inexpensive. Wood handles need to be properly maintained to extend their useful life and make them safe for the user.

• Handles should be smooth and free of burs, splinters and cracks. Sand rough handles smooth, and treat with a light coat of boiled linseed oil as a preservative. Never paint or varnish the tool handle.
• Handles that are bent, cracked, splintered or otherwise damaged should be replaced before the tool is used again. Some tools may have handles made of metal, fibreglass, or other synthetic material that may require different care.
• Tool heads should be tight on the handles. Use metal wedges to tighten tool handles on heads.

When carrying hand tools:

• Carry them close to your body with handles parallel to the ground.
• Do not carry them over your shoulder. If you swing a tool around it may strike another person or if you slip it may cause you serious injury.
• You should carry tools on the downhill side when walking on steep side slopes. This way if your feet slip out from under you will fall on the hill and not on the tool.
Safety

Hand tools are simple and effective, but can be dangerous if used carelessly.

To decrease the risk of injury:

1. Preparation

- Use the right tool for the job
- Ensure handles fit tightly and are free of splinters - do not use damaged tools
- Use a file with a handle to keep cutting edges sharp - blunt tools are ineffective and dangerous
- Cover cutting edges when not in use

2. Travel to the job

- Pass tools handle first
- Keep 3 metres apart when carrying tools to the task
- Carry tools at the balance point of the handle alongside the body with the blade forward and the cutting edge facing away from the body
- Secure tools when transporting

3. Using hand tools safely

- Use tools only for their intended purpose
- Work at least 3 metres apart
- Check your backswing and impact area is clear
- Remove overhanging limbs that might interfere when swinging the tool
- Be especially careful on hillsides
- When not in use, stand the tool upright, with the blade in soil

4. Efficient use of hand tools

- Have a firm grip on the handle and secure footing
- Use a natural balanced stance with room to swing the tool
- Start the movement by bending your knees and drawing the hand tool towards your body
- Maintain a firm grip on the end of the handle with one hand
- With the other hand, hold the handle close to the head (weight) on the pick-up / up-swing movement
- Control the power of your back-swing so that you do not lose your balance and footing
- On the down-swing move your hold down the handle away from the head and grip firmly with both hands
- Focus your effort on placing the head (weight) accurately on the desired point of impact
- Use good timing and technique to minimise fatigue
- Similar actions are used for grubbing, hoeing and raking but there is less movement because the hand tool is kept in front of the body.
5. After Use

- Cover cutting edges when not in use
- Do not leave tools where they can be stepped on
- Check that the tool is in good working order before returning to storage

Control Line / Fireline Construction

Control line is a comprehensive term used for all the constructed on naturally existing fire barriers and treated fire edges used to control the fire. Some examples of existing control lines include; streams, lakes, ponds, rock slides, areas of sparse fuels, roads, canals or previously burned (cold) fireline.

Fireline refers to any cleared strips or portion of a control line from which flammable material has been removed by scraping or digging down to mineral soil. A fireline is constructed for two purposes: to create a “safe strip” from which to start burning out to remove fuels between the fireline and advancing fire; and to isolate the burned area from the unburned area. The goal is to create a gap in the flammable materials which prevents the fire from continuing to spread. Fireline can be constructed using hand tools or mechanized equipment.

Any control line must be commenced at an anchor point. This is an existing area of low fuel (i.e. a road or track, rocky area, substantial stream or already burnt ground) that will prevent the fire burning around the end of the constructed control line. The anchor point should also provide a safety zone for firefighters in the event of a significant increase in fire intensity.
Basic fireline construction technique: 3 - 8 firefighters work as a team to:

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cut the vegetation at ground level.</td>
</tr>
<tr>
<td>2</td>
<td>Move cut vegetation away from the fire edge.</td>
</tr>
<tr>
<td>3</td>
<td>Scrape away surface fuels.</td>
</tr>
<tr>
<td>4</td>
<td>Cut into the duff layer.</td>
</tr>
<tr>
<td>5</td>
<td>Remove duff fuels.</td>
</tr>
<tr>
<td>6</td>
<td>Expose to mineral soil.</td>
</tr>
</tbody>
</table>

**Constructing fireline in a team**

When working as part of a team to construct fireline each person in the team either cuts, digs or scrapes vegetation or other fuel away to dig a line down to mineral soil (see illustration 3.2).

Illustration 3.2 Fireline construction using hand tools

Often different tools are used in different parts of the operation. Initially a rough path will be cleared with small trees, bushes and branches cut back. Then the actual fireline will be made down to mineral soil. Material should be scraped away from the edge of the fireline nearest the fire.

Sometimes a chainsaw is used to cut down trees and clear vegetation. Only people who have been specifically trained and achieved the necessary qualifications should use a chainsaw. When working near a chainsaw a minimum safe working distance of 2 tree lengths should be maintained when trees are being cut down and 5 metres when the chainsaw is being used to cut material close to the ground.
The last person in the team must check that the fireline has been constructed properly. The line should then be patrolled to make sure that the fire does not cross it. Good communications with your co-worker ("buddy system"), supervisor and other team members is necessary at all times.

You need to dig down and break the continuity of the sub-surface fuels. Normally the main surface fire will hit the control line first. However, you must make sure that you have dug down through any roots or other organic matter to mineral soil, preventing any smouldering ground fires crossing the control line.

![Illustration 3.3 Fireline construction - Cut / separate fuels and smouldering fire](image)

**Fireline width**

Anything that affects how a fire burns must be considered in determining the width of line needed to hold or control the fire. The hotter or faster the fire burns, the wider the control line must be. There are six factors that determine the width of the fireline:

- **Fuel** - The type of fuel, its height, density, size and condition will dictate fireline width.

- **Slope or topography** - When a fireline is to be built above a fire burning on a slope, the steeper the slope the wider the line must be. This is because the fire usually burns faster and more intensely on steeper slopes. When a fireline is to be built below a fire burning on a slope, the width of the line is not dictated by the slope, but rather by the need for trenching. The steeper the slope, the deeper and wider the trench must be. Trenching is necessary to prevent rolling burning material from crossing the fireline.

- **Weather conditions** - Weather conditions affect the intensity of the fire. The hotter the fire is burning, the wider the line should be.

- **Part of the fire to be controlled** - A fire burns hottest, with a longer flame length, on the head of the fire. The flanks generally burn with less intensity. This dictates wider fireline on the head.
• Size of fire being controlled - The amount of heat generated by a large fire has a bearing on the width of the line necessary to control the fire. The larger the fire, the wider the line.

• Possibility of cooling - The width of the fireline can be reduced if water is available for cooling the fuels.

**Table 4: Guidelines for width of fireline**

<table>
<thead>
<tr>
<th>Fuel type</th>
<th>Width of cleared area</th>
<th>Width in mineral soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass /crops</td>
<td>0.5 – 1 m</td>
<td>0.5 – 1 m</td>
</tr>
<tr>
<td>Shrubs / brush</td>
<td>1 – 3.5 m</td>
<td>0.2 – 1 m</td>
</tr>
<tr>
<td>Timber</td>
<td>6 m</td>
<td>1 m</td>
</tr>
<tr>
<td>Peat / Roots</td>
<td>0.5 m</td>
<td>0.5 m</td>
</tr>
</tbody>
</table>

Illustration 3.4: Control line width
Table 5: The effect of fuels on fireline width

<table>
<thead>
<tr>
<th>Consideration</th>
<th>Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kind of fuel</td>
<td>Some fuels burn hotter than others because of their oil content. The hotter the fuel burns, the wider the control line needs to be.</td>
</tr>
<tr>
<td>Height and density of fuels</td>
<td>The higher and denser the fuel, the higher and hotter the flame will burn, and the wider the control line needs to be.</td>
</tr>
<tr>
<td>Size of the fuels</td>
<td>Heavier fuels, such as logs, heavy limbs, and thick-stemmed brush do not ignite easily. However, once ignited, they burn very hot for a long time and may require wide control lines.</td>
</tr>
<tr>
<td>Condition of the fuels</td>
<td>The condition of fuel (whether it is dead or alive or dry) affects fire intensity. The drier the fuel, the hotter it will burn, thus increasing the fire intensity and the fireline will have to be wider to contain the fire.</td>
</tr>
</tbody>
</table>

Fire Line Location

The location of a fire line will normally be decided by the Crew Leader, who will consider:

- Where should it be placed?
- How wide does it have to be?
- What method will you use?
- Do you have the firefighting resources to construct AND hold the line?
- Rate of fire spread (ROS) and fire intensity
- What lies ahead
- The easiest path for firefighters
- Existing firebreaks
- Type of vegetation and terrain

*The success of your attack is often dependent on where the fireline is placed and how it is constructed.*

Heavy fuels and steep slopes should be avoided if possible. Where the fire edge is irregular a short, straight fireline can be cut rather than following the fire edge.
| The effectiveness of a fire line depends on its location in relation to fuel type and terrain. |
|-------------------------------------------------|-------------------------------------------------|
| **Know what lies ahead** | Being aware of the conditions in advance of the fire line reduces the chance of wasting the crew’s effort |
| | • Scouting ahead is often required |
| **Follow the path of least resistance** | Time is important and energy must be conserved |
| | • Usually the most important factor in line construction is depth to mineral soil |
| | • Seek areas of shallow organic layers |
| **Use existing breaks** | Creeks, tracks, roads or naturally sparse fuels – this saves time and increases efficiency. |
| **Avoid heavy fuels** | If possible locate the fire line between heavy fuels and the fire |
| **Avoid the steepest part of slopes** | Where trenching to stop rolling material must be deep and wide – some effort can be saved |
| **Cut across fire edge bays** | Where irregular fire growth has created bays of unburnt fuel find the easiest line from the tip of one finger of fire to the next |
| | • Unburnt fuel can be burned out and the overall fire line length reduced |

**Summary of General Rules**

- Clear vegetation to a width of at x1.5 the height of surrounding vegetation and/or x2.5 the expected flame length of the main fire.

- The trench down the centre to expose mineral earth should be from 30-60cm wide

- In dense vegetation a wider clearance may be required

- In intense fires, a greater amount of surface fuel will need to be removed to make the fire line effective

- Spread mineral soil dug from the fire line on the side opposite the fire to help increase the width

- When building a fire line on the fire edge, scatter all the unburnt cut stems and branches on the side away from the fire and all the scraped surface material into the burnt area (minimises the chance that embers are spread into the unburnt side)

- If aerial fuels are likely to ignite, cut down and remove the lower branches of trees for several metres on both side of the line
Points to remember when constructing a fire line

- **Deal first** with those **areas** from where the **fire is likely to escape** (e.g. hot spots)
- When possible keep the fireline short
- Avoid sharp angles
- Existing natural or man-made barriers such as tracks, ridges, creeks etc. should be used when available
- When possible, construct fire line **through open areas** rather than fighting through dense or heavy fuels
- **Pay attention** to daily wind shifts
- Where possible, block off the more hazardous fuels such as wind thrown trees or slash heaps by leaving them outside the fire line
- **Encircle areas of numerous spot fires** if fire line construction around each spot is impractical
- **Dig a vee-trench** to catch rolling fuels
- **Turn logs parallel** with the slope to keep them from rolling across the fire line
- Beware of spars
  - They can be highly flammable and unstable
- **Lines should be dug far from burning snags**, so when felled, the snag and any flying debris drops within the fireline perimeter
- If it is not possible to fall the snag, remove all fuel around its base
- Complete the control line by linking sections of fireline and when possible, tie **in existing barriers** to fire spread

**Mop-Up and Patrol**

Mop-up is the task of extinguishing a fire after it has been contained. It is important to make sure that a fire is fully extinguished before leaving the site.

This often involves the use of hand tools in mop-up tasks.

Once a fire is “contained” within a perimeter, patrolling should start immediately.

**Patrolling**

- Use all your senses (sight, hearing, smell and touch) to detect remaining fire, particular attention should be paid to smouldering ground fires.
- Working from the outside inwards, first check that no fires have crossed are or about to cross the fireline, then move inwards until an appropriate width of ground inside the fireline is completely extinguished.
- Use the buddy system and communicate and work as a team
- On patrol avoid stepping in “hotspots” and holes made by ground fires
- Continue patrolling for at least 48 hours in dry periods and make periodic visits over a longer period as well, especially if the wind gets up.
Mop-up

The principle behind mopping up operations is to cool and extinguish the fire as quickly as possible. This is hard, dirty but important work. All 3 methods of breaking the fire triangle are used: separating the heat from the fuel, cooling the fuels, and smothering to remove oxygen. Improvements to the fireline can also be useful.

Working inwards from the fireline using digging, scraping, cutting, spraying and smothering tools:

• Clearing any remaining fuels from the fireline: removing dead wood, partially burnt grasses and shrubs and any nearby vegetation.
• Checking the fireline to make sure it is not crossed by roots.
• Removing any fuels remaining near the fireline by allowing them to burn out or igniting them and burning them out.
• Extinguishing hotspots near the fireline.
• Cutting down high smouldering embers
• Moving smouldering material from the fireline onto burnt ground
• Digging out and breaking up smouldering embers and ground fires. Then cooling the embers down with water or smothering them with soil
• Checking logs, stumps, roots, for fire below, inside, or underneath the bark
• Digging down to mineral soil around hotspots to isolate them from other fuels
• Using hand tools and water in combination to smother and cool
• Embed material on slopes so that it does not roll down across the fireline
• Check for heat before leaving the area
Summary on line location and construction*

Fireline Location Guidelines

Locate line, after consideration of the following:

• Provide for safety of personnel.
• Locate line adequate distance from fire so it can be completed, burned out and held with predicted rate of spread and fire behaviour.
• Allow adequate time to permit forces to build lines and also do other needed work, such as snag falling and burning out, in advance of severe burning conditions.
• Make line as short and straight as practical, use topography to your advantage.
• Use easiest routes for control without sacrificing:
  - Holding practicability.
  - Too much area or resource value.
• Eliminate possible hazards from fire area and provide adequate safe distance between lines and hazards that must be left in the fire area.
• Avoid undercut lines and sharp turns in the line.
• Use existing natural and person-made barriers.
• Use heavy equipment, where appropriate, for line construction.
• Encircle area where spot fires are so numerous that they are impractical to handle as individual fires. Burn out unburned fuels, if possible.
• Consider environmental effects and agency policy.

Fireline Construction Guidelines

• Make line no wider than necessary; consider height of vegetation.
• Clean all lines to mineral soil, where practical.
• Discard unburned line construction material outside of the fireline.
• Scatter charred or burning material inside burned area.
• Below the fire on steep slope, construct trenched lines to catch rolling material.
• Increase effectiveness of line width by cooling down adjacent fire with dirt or water.
• Cover uncharred, rotten logs and stumps just outside the line with dirt or wet down.
• Fall or line snags near fireline before burnout, if time permits.
• Build fireline as close to fire edges as conditions safely permit.
• Burn out fireline as control line proceeds (if legislation allows)
• When building fireline uphill, burn out from the top down after line is tied in.
• Keep one foot in the black, where possible.

*Source: Excerpts from the USA fireline handbook 3, PMS 410-1
References:


Teie W.C. (1997), Fire officers handbook on wildland firefighting, Rescue, California,
Disclaimer

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Unit EF6:

Apply vegetation ignition techniques

Element 1.1:

Prepare ignition devices and ancillary equipment for use at vegetation fires

Element 1.2:

Apply ignition devices following specified firing plans

About this unit:

This unit deals with the competence required by individuals who are involved in managing vegetation fires in rural areas, either in fire suppression or prescribed burning operations.

It has been developed so that it can be applied to any area of vegetation: forest, shrub, grass or peat.

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

It is aimed at those who work in fire services, farming, forestry, game management, conservation, range land and recreation management who have a role managing vegetation fires, either on a full or part-time basis.

To achieve it you must show that you are able to:

- Prepare and use ignition devices to light up vegetation at burning operations
- Follow organisational fire procedures
- Operate safely on the fireground
- Support others operating on the fireground
- React appropriately, within organisational procedures, to a fire incident.
### Key words and phrases:

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anchor point</td>
<td>An advantageous location, usually a barrier to fire spread, where fireline construction can start. Used to minimise the chance of being flanked by the fire while the fireline is being constructed.</td>
</tr>
<tr>
<td>Backburning</td>
<td>A fire ignited along the inner edge of a control line to consume the fuel in the path of a wildfire.</td>
</tr>
<tr>
<td>Backfiring</td>
<td>A fire ignited along the inner edge of a control line to consume the fuel in the path of a wildfire and/or change the direction of force of the fire's convection column.</td>
</tr>
<tr>
<td>Burning out</td>
<td>Igniting a fire inside a control line to widen it or consume fuel between the edge of the fire and the control line.</td>
</tr>
<tr>
<td>Control line (fire line)</td>
<td>A natural or constructed barrier, or treated fire edge, used in fire suppression and prescribed burning to limit the spread of the fire.</td>
</tr>
<tr>
<td>Driptorch</td>
<td>A hand held canister of flammable fuel fitted with a fuel spout, fuel flow control device, wick and a burner. The fuel used is generally a mixture of diesel and petrol. It is used for lighting fires for backburning and prescribed burning.</td>
</tr>
<tr>
<td>Fire Environment</td>
<td>The complex of surrounding conditions, influences, and modifying forces of topography, fuel, and weather that determine fire behaviour and impacts.</td>
</tr>
<tr>
<td>Fire Behaviour</td>
<td>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.</td>
</tr>
<tr>
<td>Fuel Moisture Content</td>
<td>Water content of a fuel expressed as a percentage of the oven-dry weight of the fuel.</td>
</tr>
<tr>
<td>Fuel load</td>
<td>The amount of fuel present expressed quantitatively in terms of weight of fuel per unit area. This may be available fuel (consumable fuel) or total fuel, usually expressed as oven-dry weight.</td>
</tr>
<tr>
<td>Fuel type</td>
<td>The type, quantity, arrangement, distribution &amp; moisture content of the vegetation. Can be: ground (peat, roots), surface (plant litter, grass, shrubs,) or aerial (trees) fuels</td>
</tr>
<tr>
<td>Ignition patterns</td>
<td>The manner in which a prescribed burn, backfire, or burnout is lit to achieve a particular fire behaviour. Common ignition patterns used: backing, flanking, point, strip, and strip head fire.</td>
</tr>
<tr>
<td>Prescribed burning</td>
<td>The planned application of fire under prescribed environmental conditions and within defined boundaries, to achieve a resource management objective. Note: This term has replaced the earlier term “Controlled Burning”.</td>
</tr>
</tbody>
</table>

### Element 1.1:

#### Prepare ignition devices and ancillary equipment for use at vegetation fires

**What you must be able to do:**

1. Carry out daily maintenance, fuelling and pre-start checks as per manufacturers recommendations
2. Select and prepare ignition device appropriate to fuel condition
3. Load and secure ignition devices and fuel safely onto transport
4 Maintain the safety and security of equipment and supplies
5 Prepare and check personal protective equipment
6 Maintain safety and health of self and others throughout
7 Manage materials in accordance with relevant legal, organisational and environmental requirements.

**This element covers:**

A Ignition devices:
   (i) Gas torch
   (ii) Drip torch
   (iii) Diesel burner

B Preparing and maintaining ignition devices using:
   (i) Hand tools
   (ii) Other maintenance tools

C In the following situations:
   (i) A workshop
   (ii) In the field / on operations

D Personal Protective Equipment
   (i) Helmet/Face shield/Goggles
   (ii) Fire resistant clothing
   (iii) Gloves
   (iv) Heat resistant boots
   (v) Drinking water

**What you must know and understand**

a. Suppliers and manufacturers instructions for the safe use of equipment, materials and products
b. The ratios of fuels that can safely be mixed
c. The requirements and methods for the safe transport of fuels
Element 1.2: Apply ignition devices following specified firing plans

What you must be able to do:

1. Assess the fire environment logically and predict local fire behaviour
2. Confirm instructions provided in a briefing
3. Apply ignition device following specified firing plan
4. Observe fire behaviour on ignition and report variations from plan
5. Take appropriate action when fire behaviour is unsafe and/or is likely to become unsafe
6. Observe and report changes in weather conditions and fire behaviour
7. Communicate and work with fire control crews, within briefings and organisational procedures, during ignition operations
8. Extinguish ignition device safely

This element covers:

A. Ignition devices:
   (i) Gas torch
   (ii) Drip torch
   (iii) Diesel burner

B. Fuel condition:
   (i) Fuel moisture
   (ii) Fuel type
   (iii) Fuel load

C. The use of burning in fire management operations:
   (i) Parallel and Indirect attack
   (ii) Containment (burning out)

What you must know and understand:

a. The fire environment factors that influence ignition and fire behaviour
b. How to use different ignition patterns to influence fire behaviour and achieve the objectives of the firing plan, within organisational procedures
Element 1.2 cont.:

c. The influence of smoke on the safety and health of self, team members and the general public

d. The capabilities and limitations of ignition devices used individually and in combination, with other ignition devices, hand tools, pumps and aircraft as part of a fire control team

e. The role of lookouts, the importance of being aware of the fire situation and being able to communicate with team members and your supervisor at all times. Knowing where your escape routes are, as well as when to use them and how long it will take to reach your designated safety zones
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Introduction:

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

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

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

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

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

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

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

Relationship with EuroFire competency standards and risk management

Reference to the EuroFire competency standards should be made to understand the full range of expected learning outcomes. The sections of the standards are: unit title, element title(s), about this unit, key words and phrases, what you must be able to do, this element covers, and what you must know and understand.
The support materials for all the EuroFire competency standards are designed to support a flexible approach to training delivery. They can be adapted or modified to suit a particular target audience. The learning material for this unit should be used with the support materials for other units to ensure all learning outcomes in the standards are covered.

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

Preparatory (pre-requisite) learning:

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

Complimentary (co-requisite) learning:

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

Learning objectives:

On completion of learning you should be able to:

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

Keywords and phrases:

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

Application:

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

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

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

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

Ignition Devices:

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

**Diesel Burner**

Illustration 1.1 Diesel burner

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

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

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

**Drip Torch**

Illustration 1.2 Drip Torch
The drip torch is one of the most commonly used ignition devices. It consists of three main parts:

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

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

The preferred mixing ratios of diesel to petrol are:

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

**Fuelling / Re-fuelling of drip torch:**

1. If necessary allow device to cool before refuelling.

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

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

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

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

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

7. Keep fuel from contacting the skin. If fuel gets into the eyes wash out with sterile water immediately and seek medical advice as soon as possible.
The LPG pressurised gas burner consists of three main parts:

- **Spout**: Metal tube with ring at end to direct burning gases
- **Sparker**: Ignition device
- **Gas bottle**: Container of pressurised LPG gas

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

**Transport and storage of ignition devices and spare fuel:**

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

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

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

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

5. Store fuel some distance away from the fire to avoid vapour ignition. Select a site shaded from direct sunlight and away from watercourses and drains.
Personal Protective Equipment (PPE)

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

The equipment includes:

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

![Illustration of Personal Protective Equipment](image)

Illustration 1.4 Personal Protective Equipment

2. Apply ignition devices following specified firing plans

Ignition and extinguishment process for drip torch and diesel burner:

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

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

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

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

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

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

7. Do not push the wick into soil to extinguish as this will damage the burner.
Ignition and extinguishment of a gas burner

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

2. Open the gas valve.

3. Press the sparking device.

4. Adjust the flow of gas as necessary.

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

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

Application of ignition

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

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

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

Fire behaviour in this context relates to:

- Rate of spread
- Flame length and fire intensity
- Spotting activity
- Total burn-out time
Table 1: Influence of the fire environment on ignition techniques.

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

The phases of fire suppression that ignition is often used in are knockdown and containment. The main fire suppression strategies where ignition is used to achieve knockdown are parallel and indirect attack.
The flame lengths that different fire suppression tools and techniques can normally cope with are:

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

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

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

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

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

Illustration 2.1 Vegetation fire shape
The diagram shows a typical fire from above and from the side, where the length of flames varies around the perimeter of the fire. This fire shape is typical of a fire that is driven by either a moderate wind or slope. These are often the main factors affecting fire behaviour. To make sure that the fire stays within the desired threshold of control one or more of the factors controlling fire behaviour may need to be avoided or removed.

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

**Control lines and anchor points**

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

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

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

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

![Diagram of control lines](image)

**Illustration EF4 3.4 Fireline width in different vegetation types**

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

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

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

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

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

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

Backing Fire

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

Illustration 2.2 Single ignition backing fire
Illustration 2.3 Team ignition backing fire

Flanking fire

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

Illustration 2.4 Single ignition flanking fire
Point Ignition

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

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

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

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

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

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

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

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

Ignition in parallel attack – burning out

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

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

Illustration 2.11: Burning out in parallel attack

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

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

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

Backburning:

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

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

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

Illustration 2.12 Backburning

Backfiring:

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

Backfiring is often a high risk operation. It can be dangerous if carried out in the wrong conditions and without regards for the overall fire situation. Therefore this operation can only be conducted under the supervision of a responsible person.
The person in charge of the fire must give approval for the use of ignition techniques for all fires and the operation must be carried out under direct supervision.

**Prescribed burning**

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

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

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

**Low Intensity Burns:**

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

Normally used where objectives are to:

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

Examples of the use of high intensity prescribed burns are:

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

Table 3: Ignition pattern summary:

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

**Working as a team**

Working with your ignition supervisor:

The use of fire to fight fire or in prescribed burning has an inherent element of risk. These risks are substantially reduced if operations are conducted with an appropriately resourced team.
Good team working means working for each other and communicating with each other and with supervisors, in pursuit of a clear objective. Clear briefings by team leaders are a key part of success. Being able to absorb briefings quickly is an important skill for people involved in ignition operations, whether they be actually doing the lighting or as part of the suppression crews.

Table 4: A suggested layout for prescribed burn briefings:

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

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

LACES

LACES is a memory aid that stands for:

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

When operating as part of an ignition team it is very important that these guidelines are followed to ensure safe working practices.
General environmental constraints for burning

Smoke

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

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

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

Ecological constraints

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

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

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

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

Alternatively they should be planned within natural fire barriers.
References:


Teie W.C. (1997), Fire officers handbook on wildland firefighting, Rescue, California,
Disclaimer

Every effort has been made to ensure that the information above ("Information") is accurate and is based on what The Global Fire Monitoring Center, The International Association of Fire and Rescue Services and Rural Development Initiatives Ltd (together the "EuroFire Partners") believed to be current good practice as at the date it was prepared. It is not intended to be exhaustive in its content and is open to revision.

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Defence of Villages, Farms and Other Rural Assets against Wildfires

Guidelines for Rural Populations, Local Communities and Municipality Leaders in the Balkan Region

Published by the Global Fire Monitoring Center (GFMC) on behalf of the European and Mediterranean Major Hazards Agreement (EUR-OPA) Council of Europe

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Defence of Villages, Farms and Other Rural Assets against Wildfires

Guidelines for Rural Populations, Local Communities and Municipality Leaders in the Balkan Region

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Preface

In some regions of Europe rural settlements (villages, towns, scattered farmsteads) and other rural assets (agricultural fields / crops, infrastructures and other values at risk) are increasingly endangered by wildfires. This trend is driven by the consequences of land-use change, regional climate change and particularly by the rural exodus, which has resulted in the weakening of rural work force and self-protection ability, and increasing wildfire hazard on abandoned lands.

Vice-versa, increasing industrialization and concentration of populations in some areas exert a high pressure on natural resources for land use change, which is reflected by the high frequency of arson and ‘unknown’-cause fires in the wildlands. The intermix of human settlements with natural ecosystems and the fires burning at the interface between wildlands and rural settlements in many places create severe problems, which have become a major issue of political debate and confrontation.

Recent major wildfire disasters in Europe reveal that government authorities and civil society, notably rural communities, are not sufficiently prepared to prevent and reduce the risk of wildfires, to defend rural communities and rural assets at risk, and to protect human health and altogether human security against the adverse direct and indirect impacts and consequences of wildfires.

Guidelines are needed that will provide information to local inhabitants (farmers, community leaders, local fire service units, volunteer firefighters and village defence committees) with state-of-the-art information on wildfire damage prevention measures, and pragmatic measures for the defence of settlements and rural assets threatened by wildfires. With such guidelines local communities will be capacitated to apply all fire safety regulations for protecting the structures of the community (clearing vegetation, provide extra sources of water, application of appropriate building codes and use of appropriate materials, etc.) and for the protection of rural populations against the adverse effects of vegetation fire smoke pollution on human health and security. Also, the problem of fires burning on terrain altered by human activities, such as fires affecting dispersed, sometimes abandoned structures, waste deposits / garbage dumps and otherwise contaminated lands, needs to be addressed due to the highly toxic emissions generated by co-burning of natural vegetation and technical / chemical produce.

In addition, the threats arising from fires burning on territories contaminated by unexploded ordnance (UXO) need to be addressed since some forest and non-forest lands in Balkan region are contaminated by land mines and unexploded ordnance (UXO) stemming from recent conflicts.
In order to enhance the capabilities of local rural communities to defend themselves against wildfires a set of guidelines was developed in order to:

- Provide a practical technical document designed as a support tool for the protection of people and local rural communities in the Balkan region from wildfires
- Serve as a starting point and basis for the exchange of expertise and concepts within the Council of Europe / UNECE member states to continuously expand capacities in rural fire management.

The guidelines were prepared with the support from the European and Mediterranean Major Hazards Agreement (EUR-OPA) set up by the Committee of Ministers of the Council of Europe. The collaborating centers are the European Forest Fire Center (Athens), the Global Fire Monitoring Center (Germany), the Regional Southeast Europe / Caucasus Fire Monitoring Center (Skopje) and the Eastern European Fire Monitoring Center (Kiev). Members of the UNECE/FAO Team of Specialists on Forest Fire and the UNISDR Regional Eurasian and SE Europe / Caucasus Wildland Fire Networks contributed to the development of the guidelines.

The guidelines are divided into three sections:

- Part 1: Guidelines for Municipality Leaders
- Part 2: Guidelines for Local Community and Population
- Part 3: Fire Management Training Materials for Rural Fire Services and Local Communities based on the EuroFire Standards

In February 2013 the concept of the guidelines was tested in a field campaign on Chios Island, Greece, organized by GFMC and Maria Tsakos Foundation. The aim of the field campaign was to investigate the exposure, experiences and views of local population before, during and after wildfires. The investigation involved interviews with 118 local residents in areas affected by the large wildfire of August 2012. The results of the field campaign can be obtained upon request directed to GFMC.
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Useful References and Further Reading

Web Sources

FireSmart Canada: https://www.firesmartcanada.ca

FireWise Communities: http://www.firewise.org


National Fire Protection Association: http://www.nfpa.org


EuroFire Standards: http://www.fire.uni-freiburg.de/eurofire/about_intro_en.html

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Defense of Villages, Farms and Other Rural Assets Against Wildfires:

Guidelines for Local Community and Municipality Authorities in the Balkan Region

PART 1

GUIDELINES FOR LOCAL AUTHORITIES
SECTION 1 - Background and Rationale

All over the Balkan Peninsula and the surrounding islands of the Aegean, Ionian and Adriatic Seas, rural settlements (villages, towns, agricultural and livestock farms) and other rural assets (agricultural fields and crops, infrastructures and other values at risk) are increasingly endangered by wildfires. This increasing wildfire threat is a consequence of:

- Internal immigration of rural population to urban centers, which resulted in the decrease of the rural work force and, consequently, self-protection ability against wildfires
- Land use changes from the abandonment of agricultural and grazing lands which resulted to the encroachment of natural vegetation (shrubs, trees, etc) and high natural fuel accumulation
- Less intensive forest management practices (logging, resin collection, road construction, etc) and decreased firewood collection from forested lands, as a result of rural population reduction and economic decisions
- Regional climate change characterized by higher summer temperatures, prolonged drought episodes and rainfall reduction throughout the year.

The urbanization of large parts of the rural populations and the industry concentration around urban centers created a keen demand for housing and industrial development sites and, consequently, increased pressure for land use change of areas covered with natural vegetation at the rural – urban interface. This trend was reflected by an increased frequency of arson fires in these areas.

The intermix of human settlements with natural ecosystems and the fires burning at the interface between wildlands and rural settlements and, in some cases, also in the peri-urban zone of larger cities in many places create severe problems, which have become a major issue of political debate and confrontation.

Recent major wildfire disasters in the Balkan Region reveal that government authorities and civil society, notably rural communities, are not sufficiently prepared to prevent and reduce the risk of wildfires, to defend rural communities and rural assets at risk, and to protect human health and altogether human security against the adverse direct and indirect impacts and consequences of wildfires.

These Guidelines provide information to local community leaders, local fire service units, volunteer firefighters and village defense committees about the necessity of collaboration with local inhabitants to develop efficient measures in

- Wildfire prevention
- Preparedness for a wildfire emergency situation, including a large wildfire incidents
- Protection of settlements and rural assets threatened by wildfires.

Heads of Local Communities (Mayors or Heads of Local Administrations) and the Heads of Public Services at Municipality or County levels, need to promptly inform the inhabitants of local communities, living in villages and dispersed agricultural farms, about the threats of wildfires and how to protect themselves and their property.

These guidelines aim to inform and enable local community members to put in effect basic fire safety regulations for protecting their properties and, most importantly, their families against direct and indirect effects (e.g., consequences of fire smoke pollution on the health and security of people and firefighters) of wildfires.
The problem of wildfires burning on natural lands that are used as waste disposal sites or they are contaminated by industrial waste needs to be addressed due to the highly toxic emissions that are produced by the simultaneous burning of natural vegetation and chemical by-products.

In addition, the threats arising from fires burning on territories contaminated by unexploded ordnance (UXO) need to be addressed since some forest and non-forest lands in the Balkan Region are still contaminated by land mines and UXO stemming from historic and recent armed conflicts.

Along with these Guidelines a second set of illustrated materials is provided to be distributed to the individual owners of houses or farms and to rural businesses. With these illustrated materials local inhabitants will be made aware of the threats of wildfires to the security and health of their families, threats to private property and to public infrastructures, and will learn how to reduce or mitigate these potential threats.
SECTION 2 – Some Facts about Wildfire Threats

2.1 Wildfire Threats to Society

Many homes, structures and other rural assets, such as machinery and crops, are interspersed within forests, natural rangelands, agricultural lands and pastures. Thus, there are many different zones of interaction between potentially flammable landscapes and the assets of rural society. This zone of contact between natural landscapes and human structures and assets increases the risks of catastrophic wildfires threatening life, property and infrastructure in thousands of communities across the Balkans. Fighting wildfires within this zone can be complicated, costly and dangerous due to the perplexity of the situations that are faced by the firefighters and civilians. Apart from the effects of wildfires on the natural environment, the main wildfire threats to rural communities are:

- Loss of life and adverse health effects due to heat and smoke
- Loss of private and public property and assets
- Damage and loss of agricultural products, productivity, and livestock
- Destruction of forests
- Negative impact on the tourism sector.

Apart from rural communities, wildfires are also threatening the fringes of towns and even large cities.

Altogether direct and indirect impacts of wildfires on life and property of society and the financial losses involved may be higher and highly disproportionate to the damages caused to natural ecosystems, especially considering that many ecosystems in the Eastern Mediterranean and Southeast European will naturally recover after fire.

Human casualties

Death or injury caused by wildfire is a risk for both firefighting personnel and citizens

- The spread of wildfires is often very fast and unpredictable
- People may become entrapped by the flames and suffer from direct burns
- Fire smoke inhalation directly affects the human respiratory system. Thus, many people could suffocate from smoke when they are fighting or trying to flee from a fire
- Fires can lead to casualties among professional and volunteer firefighters because of heat exhaustion, smoke inhalation and body stress during a wildfire situation
- Heat exhaustion and stress, combined with the operation of firefighting vehicles and other firefighting equipment can lead to accidents
- Even minor injuries under these circumstances may result in loss of life.

The impacts of smoke pollution on human health effects may affect firefighters and people nearby the fires, but also people living in areas far away from the fires. Smoke inhalation has dangerous consequences to human health:

- Smoke from wildfires is a complex mixture of gases and particles which are dangerous to human health
- Fire smoke inhalation can cause a number of acute, short-term or long-term health effects
- Symptoms range from headaches and stinging eyes and throat as a consequence of short-term exposure to smoke, up to exhaustion accompanied by respiratory and cardiac problems
• The negative effect of smoke inhalation is deteriorated if the victim is already suffering from asthma, allergies or heart disease. In these cases smoke inhalation can be fatal.

Special attention has to be given to fires burning on terrain where unexploded ammunition (unexploded ordnance – UXO) and landmines stemming from previous armed conflicts still exist. Such fires have repeatedly resulted in human fatalities and injuries (see Section 2.4).

**Loss of property**

Homes, farms and whole rural communities are threatened by wildfires in two ways:

• Direct damage can occur when the flames or the radiant heat from the fire preheat and ignite an adjacent structure

• Flying embers can be transported by wind over great distances and be deposited on rooftops or even inside houses, igniting a flammable part of the structure such as furniture, curtains, etc.

An important factor significantly affecting the loss of property is the flammability of materials from which the buildings are constructed:

• In countries where countryside homes and farms are typically made of wood or makeshift materials, the losses during wildfires often reach hundreds of structures burned in a single fire event

• In contrast, where the houses are made of non-flammable materials such as natural rock, brick or concrete, the losses are much smaller.
Economic impacts

Economic loss from wildfires includes both damage to private assets and public property. Apart from the profound destruction of houses and infrastructures, the following major losses have been recorded in the Balkan region:

- The loss of annual agricultural crops due to wildfire can be very extensive, especially when wildfires occur just before the harvesting period. As a matter of fact, sparks produced from the harvesting machinery have been reported to ignite fires.

- The destruction of perennial cultivations such as olive groves, fruit tree plantations or orchards with mastic trees are economically of greater importance because of the time needed to recreate these orchards, a process that often requires several years.

- Smoke from large fires deposited to vineyards affects wine quality since it results to a ‘smoked flavour’ of the wine produced, thus reducing its quality and commercial value. Furthermore, the effect of deposited ash on the soil maintains the problem for a number of years.

- A special case is the destruction of greenhouses and other infrastructure (e.g., irrigation networks) that involve significant capital loss that is not easily recovered by farmers; other losses include fences and agricultural outbuildings.

- Livestock losses may occur on open grazing lands, paddocks, corrals and stables.

- Telephone and electricity poles and wires can be damaged by wildfires, thus causing failure of communications and energy supply. They are also costly to repair.
**Forest products losses**

Significant economic damages in forests include the loss of forest products, e.g.:

- Timber: The extent of damage depends on the type (surface, crown, mixed) and the severity of the fire, the stand and tree characteristics of the burned forest areas and their intended uses (poles, lumber, chips for particleboard production, etc)
- Firewood or raw materials for renewable energy (pellets)
- Non-wood forest products such as resin, seeds, herbal / medicinal plants.
Tourism
Wildfires often have detrimental and costly effects on local tourism. Evacuations of tourists from camping grounds or other accommodations are dangerous and costly. The negative image broadcasted from tourism areas affected or visibly endangered by fire usually result in cancellation of short term reservations. The effects of wildfires on scenic recreation areas are often detrimental and may last for several years. Thus, it is in the highest interest of local authorities to take all precautionary measures to secure the safety of visitors and to avoid long-term losses of income in the fire-affected touristic areas.
**Losses of non-market forest values**

Local communities and municipalities have an important ethical obligation to contribute to the protection of common global assets such as biodiversity and carbon sequestration:

- **Biodiversity**: Wildfires often cause serious loss of biodiversity, especially in fire-sensitive ecosystems

- **Loss of carbon**: Current international policies foster carbon sequestration by forests in an effort to combat the greenhouse effect. They provide motives for countries to increase their forest area cover, including monetary subsidy according to the Kyoto Protocol. Forest fires release carbon in the atmosphere primarily in the form of carbon dioxide and this translates directly into monetary losses.

**Other secondary impacts**

Significant secondary impacts of wildfires are caused by the destruction of the surface vegetation cover and duff layer, which are important for soil protection against erosion, especially in mountain regions. Severe wildfires which deplete the soil from protecting vegetation cover may result in:

- Increased erosion and thus loss of fertile and productive soil

- Landslides or mudslides which threaten structures and infrastructures (including roads) and even human lives

- Development of rapid floods (flash floods), which are most dangerous for settlements and human safety.

Other secondary impacts result from the burning of structures, infrastructures and “heritages of industrialization”, i.e. garbage dumps and other uncontrolled disposal of industrial waste disposal sites. Structures, businesses and garbage dumps contain household waste, electric appliances, synthetic and industrial fabricated materials, including batteries, and eventually radioactive materials. The combustion of these materials generates substantial amounts of air pollutants that are extremely hazardous to human health.
2.2 Wildfires Causes

According to statistical data more than 98 percent of all wildfires in the Balkan region are caused by human activities. Most wildfires result from negligence and the use of fire as a tool in agricultural practices. Very often agricultural burning practices are considered as tradition, but nowadays in most countries of the region such burning is against the law. The examples of wildfire causes below include other fire uses and sources, which are also very common in the region.

In the following, advice is given to local community administrations on how to reduce the occurrence or consequences of fires caused by people.

Agricultural burning

The use of fire in the agricultural sector is common practice all over Southeast and East Europe. Fire is mainly used for:

- Clearing agricultural cultivations from harvest or pruning residues and stubble burning
- Improving the quality of pasture lands.

Very often these fires are not properly attended. Despite agricultural burning in most countries is illegal, nonetheless many farmers start fires and immediately leave the scene in order not to be arrested by the police. This is one of the main reasons why these intentional burnings often get out of control and spread to forests and settlements.

Local round-table discussions should be regularly held at community level in order to inform local land users and property owners about the legal situation of fire use; the risks involved when burning illegally, or when not obeying laws and regulations; Guidelines should be proposed to replace traditional burning by other methods that will reach the same goals (clearing agricultural fields, improving pasture) in a more safe manner.

Garbage dumps and other waste disposal sites

Garbage dumps constitute a significant source of wildfires spreading from:

- Spontaneous combustion of fermenting waste that produces methane
- Garbage is often set afire to reduce its volume and extent of the waste disposal sites
- Household waste and garden waste burned in communities where there is no communal waste disposal service, due to lack of alternatives.

The management or closure of open garbage dumps and landfills must receive high priority in order to meet legal and environmental regulations, including the prevention of self-ignition or ignition by local people.

Local round-table discussions should be regularly held at community level to inform local residents that garbage burning on private property is illegal because it involves a high risk of wildfires and also produces toxic air pollutants.

Road and railway traffic, agricultural and forestry machinery

Road and railway traffic are significant sources of wildfire ignitions. Sparks from the brakes of trains, or the heat of vehicle exhaust systems and catalytic converters can ignite dry fuel. Agricultural and forest machinery are in close contact with the combustible materials and constitute an important ignition source. Discarded cigarette butts are a very common source of ignitions along roads.

Local authorities in cooperation with government agencies or private companies should collaborate to reduce combustible materials along roads and railroad tracks in order to decrease the ignition potential. This would require regular employment of local workers to clear dry vegetation, prune trees and create open, accessible buffer zones with fewer trees, shrubs or grass layers. Railroad companies should be held responsible if they do not apply
technically adequate measures such as spark arrestors at the exhaust pipes of engines, or appropriate materials for the brakes, in order to minimize the production of sparks.

Electric power lines

Electric power lines are a common cause of wildfires. Strong winds can cause electric arcs and short circuits between swaying electric lines, thus causing the creation of sparks that may ignite fine, dry fuels when they fall on the ground. Inadequately cleaned and maintained insulators may also cause the production of arcs on humid days. Power lines fallen by strong winds or due to poor maintenance of poles may also produce sparks. Fires under such windy conditions can spread and become large very quickly.

- It is absolutely necessary to clear the vegetation immediately underneath and at a strip of at least 10 m across the electric power lines. Although this task is an obligation of the Electric company, nevertheless local authorities should seek cooperation with the company in order regularly check and maintain the power line strips free of vegetation.

Arson

Arson is a major cause of wildfires in the Balkans. Fires are sometimes set to hide illegal forest logging, to conceal illegal cultivation of drug crops, or to create burned forests in which normally trees cannot be harvested, but post-fire salvage logging would be permitted. In some cases wildfires are set on purpose in order to clear forests and other natural vegetation, thus enhancing encroachment on burned public forest areas for subsequent land-use change (housing development, agriculture, etc).

- Local round-table discussions at community level should be conducted to inform land owners that encroachment and subsequent land use change of public burned forest lands is illegal even though the forest vegetation has been destroyed in these areas.

2.3 Factors that affect Wildfire Behaviour

There are three main factors that influence fire behaviour: The amount and characteristics of combustible vegetation materials, weather and topography.

Combustible vegetation materials

Organic fuels – live (green) or dead – are flammable and carry wildfires:

- **Forests**: Leaves, needles, twigs of trees and herbaceous vegetation and duff and litter on the forest floor
- **Agricultural and pasture areas**: Agricultural residue, stubble, dry and unpalatable grass, and encroaching shrubs and trees.

There are certain parameters of combustible organic materials that determine how fire behaves:

- **Size of fuel particles**: Small leaves, twigs and grass burning more easily
- **Moisture content**: The moisture content or dryness of the combustible organic materials is determined by
  - **Air temperature**: High temperatures speed up the drying and flammability of organic materials. Less energy is required to bring these materials to ignition temperature
  - **Air relative humidity**: Decreasing relative humidity contributes to drying and increased flammability of dead organic materials
  - **Time since last rainfall and the amount of rain received**: This determines the moisture content and the drying rate of the fuel.
Weather
Weather is perhaps the dominant factor that affects forest fire behaviour. Besides air temperature and relative humidity, wind is the most important factor influencing the spread of a wildfire:

- **Wind speed** has a strong influence on the intensity of a fire, the speed at which it spreads and its shape. Wind may also lift burning embers, such as bark, and carry them in front of the main fire, resulting in spot fires. The stronger the wind the faster a fire will spread.

- **Wind direction /change in direction** is very critical for assessing the behaviour of a wildfire and deciding the appropriate fire suppression method or evacuation procedure. Human lives and property losses to wildfire mainly result from sudden and unexpected changes in wind direction. Changes in wind direction will cause shifts of the fire front. These shifts are dangerous if they occur suddenly and unexpectedly, and can convert relatively sedated fire flanks to active fire fronts, suddenly. Firefighters and community leaders therefore need a constant update of reliable weather forecasts regarding wind shifts.

Topography
The third major factor that influences the risk and spread of wildfires is topography, especially in mountain regions:

- **Slope**: Wildfires spreading uphill will move faster than fires spreading downhill. While fires advancing downhill are spreading slowly and can be controlled easily, fires advancing uphill are burning very fast and are usually difficult to control. Uphill burning fires are the most important cause of accidents and fatalities.

- **Aspect**: Southerly and westerly aspects receive more sun and are warmer and drier than northerly and easterly aspects. Fires burning on these sunny slopes will advance much faster than on northern and eastern slopes because the fuels are drier.

In conjunction with the preparation of a development of a “Community Fire Protection Plan” (see Section 3.2), local authorities in mountain regions with buildings or villages on mountain ridges, slopes and valleys, should be aware of the danger to human lives and property in such locations.

2.4 **Special Concerns: Fires burning on Contaminated Lands**
In many countries of the Balkan Region there are areas of forests and other lands that are contaminated by various types of industrial, chemical and radioactive pollutants or by the remnants of armed conflicts such as unexploded ammunition (UCO) and land mines. Wildfires occurring in such areas may result in collateral damages such as chemical and radioactive air pollution and explosions.

Fire prevention or suppression activities in such terrain are highly hazardous and require specialized expertise and equipment. Local people living inside or at the fringes of such contaminated areas must receive special instructions on how to deal with these risks.

Areas contaminated by UXO and land mines should be mapped as *Red Zones* in which mechanical fire prevention measures and firefighting on the ground must be restricted and can be conducted only by specifically trained personnel with appropriate equipment. Community administrations and local fire services are responsible to mark these dangerous areas with visible, unambiguous marks.
SECTION 3 – Wildfire Preparedness

Guidance is necessary for rural communities in order to be prepared for defending their homes, farmsteads and villages against wildfires. Good preparedness will enhance the resistance of a community to wildfire and will also facilitate the work of firefighters when they are called for fire suppression. Wildfire preparedness includes:

- Consultation with local experts and authorities responsible for fire management in forests, agricultural lands, nature reserves, national parks and natural / cultural heritage sites
- Development of a Community Fire Management Plan
- Efforts by individuals to reduce the fire risk in their own properties.

3.1 Convene stakeholders and decision makers

In the beginning of the planning process a core team should be formed made up of

- Representatives from the local government and administration, local fire authority, and state agencies responsible for forest management and agriculture
- Local representatives of the villages (to be identified and actively engaged)
- Other interested organizations and stakeholders (to be encouraged to participate).

3.2 Community Fire Protection Plan

Considering the factors influencing fire behaviour, as described in Section 2, it is important to first identify the wildfire risk that the community may be exposed to. Development of a “Community Fire Protection Plan” involves several steps with different objectives:

- Direct participation of local residents: Involvement of the local population in the development of a Community Fire Protection Plan will create awareness about the wildfire risk, will stimulate active participation and is likely to lead house and land owners to assume responsibility and prepare and defend their property against wildfires
- Analysis of past fire history: Study of past fire occurrence, causes and damages in the community and surrounding areas will lead to useful conclusions of what to do and what to avoid in advance and during a wildfire
- Risk assessment: Identification of local areas of high wildfire risk within the community will allow to prioritize measures to be taken for fire prevention and preparedness.

Fire history and fire season

Consulting historical records and narratives of past fires can allow a broad evaluation of

- How often and at what time of the year have fires occurred in the region
- Typical size of fires
- Main types of vegetation burned
- Causes of past fires.

This information will help to plan targeted hazard-reduction measures both geographically and seasonally.
**Preparation of a Community Fire Protection Plan**

The preparation of a fire management plan at community level should involve active participation of land owners / land users concerned, and the people living at the fringes of villages or settlements at the interface with the surrounding forest, brush lands and agricultural lands. Other interested organizations and stakeholders should also be encouraged to participate.

The basis for a Community Fire Protection Plan is the development of a Fire Management Map. One methodology to develop such a map is a Transect Walk during which a fire management specialist, the local community leaders and residents will collect information in the field. At the Transect Walk the fire hazards and fire sensitive zones along with the topography of the terrain will be assessed.

The following information should be included in the map:

- **Description of vegetation characteristics:** The map should describe the type of combustible materials during the fire season, e.g., grass and bush on open pastures, agricultural residues, forests, but also the flammable materials within or at the edge of tree orchards. Visiting the forests and rangelands that surround the community during a Transect Walk will give an idea about the kind of vegetation that is prevalent. Consultation with local land managers such as local foresters and landscape planners will help to understand the vegetation patterns of the region, such as how quickly the fine vegetation grows and dies off and in which period this process takes place.

- **Community-Vegetation Interface:** An assessment of houses, stables, barns, paddocks and other assets at fire risk should consider their proximity to flammable vegetation. Individual property and land owners should be made aware that they are responsible for protecting their own individual properties by taking fire prevention measures. The local government or administration will determine the scale of the wildfire risk of the whole community and will also identify the risks and possible limitations of future development in vegetated landscapes.

- **Terrain:** If the village or individual farmsteads or summer houses are located in an area of steep terrain, the threats arising from wildfire are much higher. This is particularly the case for structures built on ridges, steep slopes or in steep gullies. These areas may be particularly hazardous because of the high intensity of fires burning uphill. Furthermore, in such terrain there may be limited access for fire services, or limited to no escape routes.

- **Road Conditions:** Areas with few, narrow roads may be considered as being at higher risk in the event of a wildfire because a simple fallen tree may seriously hinder the ability of residents to escape or the ability of firefighting forces to access the fire for suppression purposes. Also, rarely used roads may become vital transport routes in the case of wildfire. The condition of such roads should be considered, particularly during the period just before the fire season.

This baseline map will then display the wildfire risk of:

- The type of vegetation cover
- Forest and agricultural areas at risk for large-scale fire damage
- Individual houses / farmsteads scattered within the rural landscape
- Residential areas at the community's interface with rural vegetation
- Other critical infrastructure
- Areas contaminated by unexploded ordnance, land mines, or landfills.
While the development of this map through an active participatory process with local residents will be the base for prevention and preparedness planning, the map may also be used by the fire services during fire suppression. The map could help the firefighters to identify the risks during firefighting.

**Evaluation with all stakeholders: Development of agreement on priorities**

- Community leaders should use the Community Fire Protection Plan to facilitate a collaborative community discussion that leads to the identification of local priorities for reducing combustible materials, the ignitability of structures, and other issues of interest, such as improving fire response capability.

- After the finalization of the protection plan, the results will be communicated to the community and other involved parties and interested organizations. The firefighting organization must have a copy of the current Community Fire Protection Plan in advance of the fire season. It is even better if a representative of the organization participates in the development of the Plan.

### 3.3 Realization of Wildfire Prevention and Preparedness at Community Level

When implementing the Community Fire Protection Plan some of the actions for Wildfire Prevention and Preparedness at Community Level need to be coordinated by the local government. Local government is also responsible to provide advice and guidance to local individual residents and facilitate measures for the protection of private property by the owners. Such work should be done at times of the year when wildfire risk is low.

The detailed technical instructions for private property owners are provided in a separate Guidelines booklet. Thus, the following technical and organizational measures in fire prevention and preparedness for a wildfire situation are those that the local community administration has to take responsibility.

**Creation of Fire Buffer Zones**

Increasing the distance between flammable vegetation and property assets will result in decreasing the risk of their ignition during wildfires. Creation of Fire Buffer Zones in which vegetation and easily ignitable combustible materials are reduced or removed, reduces the intensity of an approaching wildfire (reduction of flame length and radiant heat) and, eventually, slows down or even stops the spread of the fire. On such cleared buffer zones is easier to fight fires and also to facilitate access to people in distress (e.g. for rescue and evacuation).

- Therefore, the following action must be considered, dependent on the type of vegetation surrounding a village or an individual house or farm:
  - **Perimeters of villages** should be cleared of fine vegetation to a distance of 25 meters to create Fire Buffer Zones on which flammable vegetation is largely removed or reduced. Some trees may remain, but they should be widely spaced and pruned. All dead plant material on the ground should be removed regularly
  - **Isolated houses and structures** should also be protected by a similar buffer zone, but this is in the responsibility of the resident or owner
  - **Gardens or vegetated spaces** within the boundary of a residence or other asset should be kept similarly clear by the resident or owner
  - **Vacant plots** within residential developments, in which often wild vegetation is growing, must be cleared by the owner or by local government
  - **Roads** can be integrated and utilized as buffer zones by clearing combustible vegetation to a distance of 5-10 meters on each side.
Access roads

Access roads are necessary for firefighting and evacuation of local residents. In new developments, it is advisable to plan for all homes or assets to be accessed from two directions. This reduces the chance of residents becoming trapped by road barriers. Furthermore, the following measures will improve the safety of firefighters and local people:

- **Roads of all sizes** should be maintained to remain drivable and kept clear of obstacles, such as fallen trees at all times. This will allow better access for firefighters and more escape options for civilians in the event of a wildfire.

- **Street names** should be clearly and consistently signposted in order to reduce confusion in potential fire suppression activities.

- **House numbers** should be clearly visible and consistently displayed for the same reason.

- **Parking** should be forbidden on roundabouts or in narrow streets so that emergency vehicles can get through.

- **Trees growing alongside streets** should not hinder the passage of emergency vehicles in any way. This means they should be sufficiently set back from the road and the branches should be pruned up to a height of 3-4 meters from the ground.

- **Turn-around points** should be constructed at regular intervals on narrow roads to allow two fire engines to pass. This is in order to avoid the need for long and complicated reversing maneuvers – an operation that can be dangerous in the case of wildfire.

- **Fire hydrants** should be designed into new developments and extend as far as possible along major roads beyond village boundaries. This will allow for faster filling of fire engines by avoiding the need for engines to travel long distances for water.

Emergency equipment and other non-specialized firefighting tools

Besides the specialized firefighting equipment used by professional and volunteer firefighters, the local administration may be able to assist fire suppression operations by supporting the acquisition and maintenance of other fire emergency equipment such as water pumps, electricity generators, tractors and water tanks.

While the local fire brigade may be well prepared for suppressing structural and / or vegetation fires, almost all fire prevention work can be done with tools not specifically designed for firefighting.

The main aim of almost all vegetation fire preparedness work is to reduce the amount and continuity of easily combustible vegetation in the vicinity of assets, as explained above.

This can be achieved by tools that range from simple hand-tools to heavy machinery – tools generally used for day-to-day work in agriculture, road maintenance or construction work – both private and public.

- **Hand-tools** that can be used for this purpose include rakes, hoes and shovels. Individual households and farms as well as local agencies managing forests and parks are highly likely to possess these items. In order to construct fuel breaks, it may be possible to collaborate with such parties in order to avoid the need of purchasing equipment specifically for this purpose.

- **Power tools** including chainsaws and brush-cutters are similarly likely to be owned by farmers and land management agencies.

- **Heavy machinery** regularly used for farming, such as tractor-towed ploughs and slashers, or machinery normally used for road construction such as graders and bulldozers, can be used to construct fire strips.
Cooperation and coordination between local authorities, land management agencies and landowners on the use of equipment may allow fire preparedness measures to be taken at relatively low cost for all involved parties.

**Preparedness for limiting the impact of a burning wildfire**

Despite the best preparation possible, it remains highly likely that a region that has in the past experienced wildfire will continue to do so. In this case, the measures above will go a long way towards limiting the damage caused by wildfire.

However, there are further measures that can be taken that will limit the exposure of the community to a wildfire by improving wildfire preparedness at an organizational level.

- **Communication plan**: All technical means that are nowadays available should be used to prepare an alert / warning system to inform residents about a dangerous wildfire situation. Since mobile phones are becoming common, even in remote rural areas, it should be considered to create a community-wide emergency alert system (by SMS)

- **Hotline**: Besides national emergency telephone numbers (e.g., 112) community members should also be able to call the local administration to actively provide information about a fire situation, or to receive instructions on what to do in the case of a fire emergency

- **Emergency Plan**: An emergency plan in the case of a large fire disaster should be developed and should include preparedness measures concerning evacuation and safe shelters.

**Special attention to people with disabilities:**

People with disabilities and many of those individuals unable to evacuate themselves, see approaching danger, or hear announcements to evacuate, they are especially vulnerable to wildfires. People who are blind and/or deaf are unable to hear local radio announcements and would be unlikely to be watching (or listening to) television. Additionally, they are usually unable to drive themselves and to evacuate properly.

Preparedness at community level should also include:

- Emergency plans with updated press releases and brochures relating to steps to be taken by individuals with disabilities in preparation for wildfires and/or evacuation

- Enhanced hotline and alert systems that allow public safety entities to access a list of individuals who may need specialized assistance of some type in an emergency or evacuation

- Volunteer programs that can assist individuals during evacuation when they are unable to do so themselves

- Public safety programs able to assist individuals with disabilities in completing a home assessment regarding safety

- A recommended list of critical items to be evacuated in the event of wildfire emergency so that people with disabilities can have these items readily available

- Television media with caption emergency announcements whenever a real-time emergency announcement is made.
Defense of Villages, Farms and Other Rural Assets Against Wildfires:

Guidelines for Local Community and Municipality Leaders in the Balkan Region

PART 2
GUIDELINES FOR LOCAL POPULATION
Introduction

Most wildfires in the Balkan region occur during normal summer weather. During moderate weather conditions most fires can be controlled by the personnel and equipment of the fire services. However, wildfires that break out on very hot, dry and windy days can spread rapidly and may be difficult or impossible for firefighters to control. These fires can burn large areas of forest and farmland, destroy homes and livestock, and sometimes injure or even kill people. In recent years you have seen that many forests, agricultural fields and villages in your vicinity have been damaged or destroyed by wildfires. For example, in Greece, in 2007, the fires resulted in many deaths and left thousands of people homeless and unemployed. Additionally, thousands of hectares of agricultural land, together with significant areas of human settlements and other cultural lands have been destroyed by wildfire events throughout the Balkan Region during the last years.

During wildfires, firefighters are usually over occupied with slowing down and controlling the fire, however fire size and intensity could be such that fire suppression resources may not be sufficient to protect you and your home. Wildfires can start suddenly and you may not get any warning from the authorities because they may be overwhelmed with many fires occurring at the same time. Therefore it is your responsibility to be prepared to defend your property and the lives of your family. A properly prepared home is more likely to survive a wildfire, and the chances increase significantly if people with adequate knowledge in fire safety, including yourself, are there to protect your home. The knowledge of simple fire safety principles will help you to minimize the risk of getting caught by fire in your car or suffering from smoke inhalation or extreme heat.

This guideline booklet helps you to take important and necessary preventive measures that can help you survive and protect your property from wildfires.

Are your house and your family at risk?

It is in your own interest to be prepared and protect your property, your family and neighbours until assistance arrives. It is important to make a plan for what you will do if a wildfire threatens your area. You should practice your plan regularly with your family. Your plan and your awareness could be the difference in saving your life and the lives of your loved ones.

Please familiarize yourself with the following facts and questions. This will help you to understand the fire risk in your area:

- **Wildfire History – Where and how often in the past?** Some places have a history of wildfires. The more often fires have occurred in the past, the higher the risk they will occur again.
• **Vegetation – How much?** If you have a heavy coverage of tall grass, forest and flammable shrubs nearby, you are in high risk area. A low risk area would have less or no such fuels

• **Vegetation – How dry?** The drier the vegetation, the greater the fire hazard. Vegetation dries out throughout summer, but also gains and loses moisture on a daily basis. Generally, air humidity and dead vegetation moisture content is the highest in the morning (low fire risk) while they are at their lowest in mid-afternoon (high fire risk)

• **Roads – how good?** Areas with few, narrow roads could pose a problem during wildfires, because a simple barrier (e.g., a fallen tree) may block the escape or the ability of the firefighting forces to fight the fire or help you.

**Preparing your property**

*How to keep your home and its surroundings safe from wildfires*

The fire season is the time of year when small fire ignitions are likely to cause wildfires. This happens usually during the summer when hot and dry weather conditions cure grass and other fine vegetation material. However, it is important to remember that fires can start at any time of the year when dry fuel is present.

During the months that wildfires are more likely to occur, the risk of damage or loss of life from a wildfire can be reduced by maintaining buildings and surrounding property in a condition that will mitigate the impact of wildfires. Much of this work should be carried out in spring, before the wildfire season begins, in order to avoid doing all the work at once or leaving until it is too late.
Your family should plan the preparation of the season of high wildfire risk

Home fire safety check list

OUTSIDE

1. Layout / Construction

- Be aware that ridge tops, canyons and areas between high points of a ridge pose higher risk in case of fire

- Use ignition resistant construction materials for roofs (metal, tile, cement), gutters (metal), vents (cover vents with fine weaving metal mesh), exterior walls (cement, brick, reinforced concrete), windows (metal frame) and doors (metal based). Double-paned windows generally pose greater fire resistance. In addition, specialized fire resistant window shutters can be used although they are considered cost effective.

- Cover the underside of eaves, balconies and above ground decks with fire resistant materials, such as cement board, or fire proof plasterboard. Fire resistant varnish or paint may be used for wooden surfaces.

- Avoid using flammable materials e.g. tar paper under the roof, plastic furniture, wooden floor or wooden frame windows, particle boards, e.t.c.

- Store firewood away from the house, preferably protected so that it will not ignite in case of fire
• Store liquid fuels in ventilated and protected enclosures, preferably in a separate cement shed no less than 5 meters from the house

• Construct barbecue places with bricks, and clear vegetation in a 2 meter zone around it. Yellow grasses may catch on fire from sparks even at longer distances

• Notify the power line company if trees and branches are growing less than 3 meters away from electric power lines.

2. Roof and yard

• Clear your roof and gutters from all dead fuels (leaves, needles etc.)

• Remove anything overhanging your roof and keep trees and branches at least 5 meters from your chimney

• Remove lower dead tree branches up to 3 meters from the ground and regularly cut back grass and shrubs

• Maintain all plants by watering them regularly, and by removing dead branches, leaves and needles as needed.

![Image of roof and yard maintenance](image)

Remove living and dead vegetation and firewood storage nearby houses and outbuildings

3. Emergency Water Supply

• Have a hose long enough to cover the perimeter of your property in order to extinguish fire embers, water vegetation around house and keep the roof moist if needed
• Keep a water tank filled at all times

• If your water comes from a well, an emergency generator would be extremely useful to operate the pump during a power failure.

Collect rain water or water from wells and creeks in a storage tank or reservoir for the use in protecting your house and garden against wildfire

4. Accessibility

• Identify at least two exit routes from your neighborhood

• Make sure that your street name sign is clearly visible at each street intersection

• Post the number of your house address so it is easily visible from the street, even at night

• Clear flammable vegetation at least 3-4 meters from roads and driveways

• Cut back overhanging tree branches above access roads

• Make sure power lines are clean of trees and branches. If possible use insulated electric wires.
Keep access roads and electric power lines free of overhanging trees and branches
Make sure that traffic signs and house numbers are posted and maintained properly

INSIDE

1. Living Room
   - Install a metal screen in front of fireplace or wood stove
   - Store the ashes from your fireplace in a metal container and dispose of only when cold
   - Clean fireplace chimneys at least once a year. Cover chimney with fine weaving metal mesh
   - Fire resistant varnish or paint can be used for wood surfaces inside the house.

2. Protective clothing
   - Maintain a supply of protective clothing that will be sufficient for all family members. Advisable choices include; thick, cotton clothes that cover from head to toe; leather boots with laces; leather work gloves; protective masks.

3. Garage and farm buildings
   - Mount at least one dry powder fire extinguishers in the garage, check their condition regularly and learn how to use them
• Have such tools as shovel, hoe, rake and bucket available for use in a wildfire emergency. A manual backpack pump, such as those used by firefighters, or even an agricultural sprayer, filled with water and ready to use, are also extremely useful.

• Store all combustibles away from ignition sources such as water heaters.

• Disconnect electrical tools and appliances when not in use.

Your workshop or garage often contains electric appliances, heating systems and machines. Make sure that all technical infrastructure is safely installed. Have fire extinguishers and hand tools ready for use.

Farm assets and fire protection

Farm machinery and operations

Good planning, maintenance and housekeeping are the keys to protecting your farm property and to preventing your farm machinery from igniting fires that could get out of control.

• Fit suitable fire extinguishers on machinery.

• Check that all machinery is free of mechanical defects that could start a fire and has an approved exhaust system and spark arrester.
- Clean all machinery regularly to ensure belly pans and spaces around motors are free of oil, dust, grease, grass and straw

- Fires can start when driving through or near flammable vegetation as a result of hot exhaust, moving machine parts or when stones or wire are struck by tractor blades. Machinery operators need to be aware of what is happening outside the cab and always check behind them for possible ignitions

- Keep paddocks around farm buildings and yards well grazed or mown to reduce the fire hazard

- Bale and stack hay when it’s dry, not damp, to prevent spontaneous ignition

- Do welding and angle grinding only in clear areas. Wet down the surrounding area and have fire extinguishing equipment nearby. These activities should not be carried out in high fire danger weather.
Repair your agricultural tractors and machines and a piece of land cleared from vegetation
Be careful using welding equipment and avoid smoking
Wildfire Emergency

When a forest fire is approaching your house or the village, warnings and information may be given by different means:

- Mobile loudspeaker systems on police and emergency vehicles, especially in housing developments
- Local radio stations, especially public ones, and local and regional television stations
- In person, door-to-door, or by phone in the case of farms and isolated houses
- Other systems may be brought in such as warning sirens. Modern information system will send SMS messages to the subscribers.

Listen to radio and TV broadcasts for getting information about wildfires in your vicinity. Call the police and the fire service if you have detected a fire, or if you need information about a fire.
Preparing a structure for wildfire

In a wildfire situation, a house or similar structure can provide adequate shelter from sparks, embers, radiant heat, hot gases and flames. Such a building might eventually burn after some time, but it can protect you during the most critical time until the severe fire danger passes.

If there are warnings about fires in the area and you decide to remain in your property

The following actions should only be taken by adults who can tackle the fire:

- Place water hoses so that you can reach any part of the house
- Preferably use pumps powered by combustion engines
- Protect yourself with long-sleeved cotton clothing, closed shoes and a mask to prevent smoke inhalation. Scarves or handkerchiefs could be used as an alternative but they offer minimum protection
- Remove any flammable objects from outside the house
- Fill the bath and sinks with water and soak towels for extinguishing small fires
- If time permits, clear fine vegetation from directly around the house using rakes and hoes, etc.
- Remain outside as long as possible in order to extinguish small fires starting from falling embers.

Small flying embers from bush and forest fires are an important cause of house fires. They will not ignite your garden and house if the flammable materials are removed before the fire. Burning embers can be extinguished easily when landing on your garden or house roof.
If the fire is approaching very close to your house

- Go into the house with the whole family. It is important to stay together as a group

- Stay inside the house if the fire has already reached it or is moving very quickly nearby. In these cases, if the authorities do not give you other instructions, it is always safer to remain inside the house

- Close all doors and windows, close window shutters

- Shut off gas, gasoil and other fuel stopcocks and turn off the electric power

- Thoroughly wet all areas threatened by the flames

- Watch for and extinguish any fire spots, especially on the roof, ceiling, window shields and verandas or timber decks.

Stone houses in the middle of villages offer a good protection against wildfires

When a wildfire is approaching give first priority to bring elderly people, children and disabled people to a safe building

Evacuation

Major considerations during evacuation:

- Walk in the opposite direction of the fire until you reach a safe place designated by the authorities, which may be a clearing, parking place or near the sea

- If you use a car, avoid panic, drive as calmly as possible and be prepared for panicky behaviour from other drivers. Be extra careful when there is smoke, as emergency vehicles and cars of other evacuating people may appear suddenly in your view.
Turn on the headlights and the rear fog light. Use the car's air-condition and set it to recirculation of internal air

- First evacuate children, people with disabilities, the elderly and people with breathing difficulties and anxiety problems
- Allow free passage for emergency vehicles so they can operate
- Help the emergency services to enter your home and premises
- Always follow the advice above, but also seriously consider the instructions of the authorities
- However, do not leave your property if you judge that your house (stone made etc.) is safe enough and/or you will have to pass close or through flames to evacuate.
Late decision often results in chaos and uncoordinated or incomplete evacuation

**Wildfire Survival**

Sometimes there may be no chance to escape easily an approaching wildfire. In the case of being directly threatened by wildfire, injuries can be minimized or avoided and possible death averted by adhering to certain fundamental principles and procedures. There are four simple concepts that one must try to adhere to at all times:

- Select an area with little or no vegetation fuel and keep as close as possible to the ground preferable in a gully or depression
- Protect yourself from heat by sheltering behind solid objects such as boulders, rock outcrops, large downed logs, trees etc.
- Protect your airways from heat at all costs and try to minimize smoke exposure with a handkerchief, scarf or similar
- Try to remain as calm as possible.

**How to protect yourself from fire in open country**

- Walk in the opposite direction of the fire and try to get to an area that has already been burnt or is clear of vegetation
- Do not run through flames unless you are able to see the ground on the other side and they are low enough for you to safely cross (breaks may occur where there is less fuel)
• Use a scarf or handkerchief and cover your face to avoid inhaling smoke
• Avoid slopes and narrow valleys and do not take shelter inside wells or caves
• If you are near the sea or a river, keep close to the water, and if necessary get into it.

If a wildfire approaches – immediately leave the forest or bushland
A beach or a place free of vegetation is safe

If you and your family is trapped by a wildfire:
Look for a non-flammable place such as a river or underneath a stone bridge
How to protect yourself if fire catches you by surprise in your car

- Stop in a protected place with as little vegetation around as possible. If possible pull to the side of road on the opposite side of the approaching flames
- Close doors and windows and switch off the car’s ventilation
- If you have an air-conditioning system in your car, switch it on to keep the interior of the car as cool as possible. Make sure you have set it to recirculation of the interior air to avoid that smoke enters your car
- Turn on the headlights so that your car can be seen more easily in the smoke
- Sound horn to attract the attention of emergency services.

If your car is trapped by fire and smoke:
Make sure that you can be seen and heard by the fire and rescue service

Protection from fire smoke pollution

Even if the flames are not a direct threat, smoke from a wildfire can be highly hazardous. If there is smoke from wildfire:

- If you do not have a smoke mask, breath through a handkerchief to help filter smoke
- Stay inside with windows and doors shut and use wet towels to prevent smoke insertion from outside through the openings
Use the recycle or recirculation mode on the air conditioner in your home or car, so that no smoke can enter from outside

Avoid cooking and vacuuming. They can increase pollutants indoors

People with health problems should be especially careful, avoid intense physical activity and should use handkerchiefs for breathing all the time

Consult your doctor if you have chest pain, chest tightness, shortness of breath, or severe fatigue. This is important for people with chronic lung or heart disease and for people who have been previously diagnosed with such diseases. Smoke can "unmask" or produce symptoms of illness

Keep airways moist by drinking lots of water. Breathe through a warm, wet washcloth to help relieve dryness.

Keep the windows and doors closed when wildfire smoke is covering your area

Prepare breathing protection and call your doctor and ambulance if you feel pain and suffer breathing problems