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ACADEMIA GALEGA
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ΠΕΡΙΦΕΡΕΙΑ ΗΠΕΙΡΟΥ
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List of Abbreviations and Acronyms

| | |
|-----------|--|
| AFAC | Australasian Fire and Emergency Service Authorities Council |
| AH | Absolute Humidity |
| AIIMS | Australasian Inter-service Incident Management System |
| ALSM | Airborne Laser Swath Mapping |
| ATC | Air Traffic Control |
| ATV | All-Terrain Vehicle |
| ATVEA | All-Terrain Vehicle Industry European Association |
| CDF | Centro para la Defensa contra el Fuego (Spain) |
| CIFFC | Canadian Interagency Forest Fire Center Inc. |
| DAID | Delayed Action Incendiary Device/Delayed Aerial Incendiary Device |
| DEFRA | Department for Environment, Food and Rural Affairs |
| DEM | Digital Elevation Model |
| DTM | Digital Terrain Models |
| DSM | Digital Surface Models |
| ETA | Estimated Time of Arrival |
| EUFOFINET | European Forest Fire Networks Project |
| FAO | Food and Agriculture Organisation |
| FEMA | Federal Emergency Management Agency (USA) |
| FTA | Fire Traffic Area |
| GFMC | Global Fire Monitoring Center |
| GIS | Geographic Information System |
| GPS | Global Positioning System |
| ICS | Incident Command System |
| IR | Infrared |
| LACES | Safety protocol. Acronym stands for: L = Lookouts; A = Awareness or Anchor Point; C = Communication; E = Escape Routes; S = Safety Zones |
| LIDAR | Light Detection and Ranging |
| NFPA | National Fire Protection Association (USA) |
| NFRS | Northumberland Fire and Rescue Service (UK) |
| NWCG | National Wildfire Coordinating Group (USA) |
| PEDA | Local, Union of Municipalities and Town Councils of Attica (Greece) |
| PPE | Personal Protection Equipment |
| RH | Relative Humidity |
| RUI | Rural-Urban Interface |
| SOP | Standard Operating Procedures |
| TFR | Temporary Flight Restriction |
| TOLC | Take Off and Landing Coordinator |
| UK | United Kingdom |
| USA | United States of America |
| USDA | United States Department of Agriculture |
| USDHS | United States Department of Homeland Security |
| WUI | Wildland-Urban Interface |

Chapter 1:

Introduction

1.1 Preamble

For effective collaboration across national borders on any technical or emergency issue, the establishment of a common language is crucial. Prior to the commencement of the European Forest Fire Networks Project (EUFOFINET), there was no single accepted glossary of terminology in use in Europe for wildfires and forest fires and, therefore, no common language for the partners to use. This situation posed a difficulty to the partnership in terms of establishing a common understanding around technical and practical issues. The EUFOFINET partners subsequently decided to set themselves the ambitious but very important task of creating a European glossary of terminology that could be used by all European countries both during and after the completion of the project.

The development and compilation of the glossary has been led by Northumberland Fire and Rescue Service (UK) as lead partner on the EUFOFINET “Theme GP1 – Intervention Strategies/Wildfire and Forest Fire Suppression Tactics”. NFRS was assisted in this substantial task by all of the EUFOFINET partners and a number of external experts around the World, as verified by the substantial list of contributors included within the Acknowledgements. The end result is an impressive English language glossary of more than 800 terms and associated definitions arranged within thirteen thematic chapters. The document is named the “*European Glossary for Wildfires and Forest Fires*” and has been colour-coded and designed in a user-friendly format to enable its use as both a reference document and training resource.

The EUFOFINET partners are currently working to implement the glossary within their own countries. NFRS and other members of the partnership are also working to promote the adoption of the glossary across Europe to countries not represented within the EUFOFINET partnership. A number of partners will translate the entire glossary document into their native language (including French, Italian, Greek, Slovak and Gallego) during late 2012 and early 2013, which will further improve its accessibility and usability.

Northumberland Fire and Rescue Service and the EUFOFINET partners believe that the glossary has significant potential to improve cross-border work before, during and after wildfire and forest fire incidents and that it will be a very useful tool for maintaining and improving health and safety for suppression teams composed of individuals from multiple countries.

1.2 Structure of this document

This glossary is divided into a number of chapters, thirteen of which present terms and definitions related to specific themes concerning wildfires and forest fires. For information and convenience, a list of abbreviations and acronyms used throughout this document is included on page 6. This first chapter has presented a summary about the purpose of the glossary and the follow-on translation and dissemination work that will be completed by the EUFOFINET partners during 2013. Chapter 2 then presents some background information regarding the EUFOFINET Project, including a

summary of the project aims, themes and deliverables. This is then followed by Section 1, which is named “*The Wildfire Environment*”. This is the first of three thematic sections that divides the sub-thematic chapters of terms and definitions. Section 1 has been designed to provide practitioners with the terms and definitions that are required to develop a basic understanding of the key factors that influence fire behaviour and development within the wildfire environment. This section includes four chapters: *Chapter 3 - Fire behaviour*; *Chapter 4 – Fuel*; *Chapter 5 – Topography*; and, *Chapter 6 – Weather*.

Chapter 6 is then followed by Section 2. This Section includes six chapters on the theme of “*Wildfire Suppression Operations*”. This section has been designed and developed to provide terminology that is essential for practitioners to know and understand in order to be able to work safely and effectively within a suppression team at a wildfire or forest fire incident. It is suggested by the EUFOFINET partners that a knowledge and understanding of Sections 1 and 2 is of key importance for maintaining safety and effectiveness of suppression teams, particularly if those teams are composed of personnel from multiple countries. Section 2 includes the following specific chapters: *Chapter 7 – Safety*; *Chapter 8 – Incident Command*; *Chapter 9 – Tactics*; *Chapter 10 – Cartography and Map Reading*; *Chapter 11 – Equipment*; and, *Chapter 12 – Aerial Operations*.

The final section, Section 3, addresses the multitude of different types of work completed both before and after wildfire and forest fire incidents occur. This section is named “*Wildfire Preparation, Prevention and Recovery*” and includes three chapters: *Chapter 13 – Prevention and Detection*; *Chapter 14 – Fire Investigation*; and, *Chapter 15 – Restoration*.

The glossary culminates with two bibliography chapters: the first chapter provides a list of books and reports that were reviewed and consulted during the development process and which have informed the end-product; and, the second chapter provides a list of online only reference resources which have been consulted. Finally, a full index of terms is included at the back of the document to aid usability and cross-referencing.

1.3 Contact details for further information

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Chapter 2:

The EUFOFINET Project

2.1 Project summary

The EUFOFINET (European Forest Fire Network) Project is being delivered as part the INTERREG IVC programme. The project is being delivered over a 26-month period, between October 2010 and December 2012. Of the total project budget of €2 million, approximately 75% was co-financed by the European Regional Development Fund (ERDF).

The principal aim of the EUFOFINET Project was to improve and enhance regional and local approaches to wildfire prevention and suppression through European cooperation, collaboration and the exchange of good practice.



2.2 Five themes of the EUFOFINET Project

In order to achieve the principal aim of the project, the EUFOFINET partnership structured the project around five key thematic areas:

- ❖ ***Intervention strategies***
 - 1 - Wildfire suppression - intervention techniques and tactics
- ❖ ***Technological innovation***
 - 2 - Training using simulation tools
 - 3 - Territorial surveillance, detection and prevention strategies
 - 4 - Mapping hazards and fire risks
- ❖ ***Restoring fire-damaged terrain***
 - 5 - Techniques and procedures

2.3 The EUFOFINET Partnership

The Lead Partner on the EUFOFINET Project was the Association of Municipalities of Attica in Greece (PEDA). The entire partnership included:

- The Association of Municipalities of Attica (PEDA) (Greece)
- The Region of Tuscany (Italy)
- Office National des Forêts (France)
- ENTENTE pour la Forêt Méditerranéenne (France)
- The National Forest Center (Slovakia)
- The Centre for Servicing Woods and Forests of Castilla y León (CESAFOR) (Spain)
- The Region of the North Aegean (Greece)
- The Region of Epirus (Greece)
- The Region of Thessaly (Greece)
- The Galician Academy of Public Security (Spain)
- Frederikssund-Halsnæs Fire and Rescue Service (Denmark)
- The Forest Research Institute (Poland)
- Northumberland Fire and Rescue Service (United Kingdom)

The involvement of a number of northern European partners reflects the growing concerns about wildfire across the continent as a whole, and the accepted need for practitioners working in all regions of Europe to share good practice and collaborate across national borders.

2.4 Activities and deliverables completed during the project

A number of important activities and deliverables have been organised and developed during the course of the EUFOFINET Project.

- Delivery of eight Technical Workshops:
 - “*Restoration of land burned by wildfires*” in Valabre (France), 16th-20th May 2011
 - “*Prevention of wildfires*” in Frederikssund-Halsnæs (Denmark), 19th-23rd September 2011
 - “*Training and simulation*” in Valabre (France), 1st-5th November 2011
 - “*Action planning*” in Athens (Greece), 17th-19th January 2012
 - “*Cartography of risks and hazards*” in Leon (Spain), 20th-24th February 2012
 - “*Wildfire suppression tactics*” in Northumberland (U), 19th – 23rd March 2012
 - “*Detection of wildfires*” in Zvolen (Slovak Republic), 20th-25th May 2012
 - “*Action planning*” in Firenze (Italy), 1st-5th October 2012.
- Delivery of 9 Steering Committee Meetings.
- Compilation and publication of the “*European Glossary of Wildfire Terminology*”.
- Publication of two informative newsletters concerning the project.
- Publication of numerous technical articles and press releases detailing the project activities.
- Delivery of a staff exchange workshop on “*Wildfire Incident Command Training*”, hosted by ENTENTE in Valabre (France), 9th-14th September 2012.
- Delivery of a staff exchange workshop on “*Training in Forest Fires*”, hosted by AGASP in Pontevedra, Galicia (Spain), 27th-28th September 2012.

- Delivery of a staff exchange workshop on “*Training in Forest Fires*”, hosted by Regione Toscana in October 2012.
- Publication of 5 technical guides (one per project theme) documenting best practice exchanged during the project.
- Organisation of a final project conference for wildfire stakeholders in Europe –held at the Committee of the Regions in Brussels (Belgium) on 12th November 2012.

2.5 Final results of the project

In summary, the final key results of the EUFOFINET Project are:

- The exchange of models of good practice between the project partners;
- The updating and improvement of the good practice matrix created by the "INCENDI" project, a Regional Framework Operation co-funded by INTERREG IIIC;
- The identification and promotion of common intervention procedures for forest fires and wildfires;
- The creation of a regional institutional network for forest fire/wildfire;
- The production of an operational Action Plan by each partner documenting the planned implementation of one or more good practices.
- The collaborative production of a “*European Glossary of Terminology for Wildfire*” and, subsequently, the establishment of platform for developing a common language and understanding among wildfire practitioners in Europe.

The EUFOFINET Partners are now exploring ways to collaborate further in the future. In particular, a number of EUFOFINET Partners are assisting one another with the implementation of individual Action Plans and some of the partners are also actively developing new collaborative projects on topics related to wildfires/forest fires.

Section 1:

The Wildfire Environment



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Including the following Chapters:

3. Fire Behaviour

4. Fuel

5. Topography

6. Weather

Chapter 3 - Fire behaviour

Fire behaviour: “The reaction of a fire to the influences of fuel, weather, and topography.”



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Chapter 3 - Fire Behaviour

| Term | Definition |
|---------------------------|---|
| Accelerant | Material used to initiate or increase the spread of a fire. This will often be a flammable liquid. |
| Advancing fire | This is fire progression associated with the head (front) of the fire. Fire behaviour in this area is usually characterized by more intense burning, increased flame height and length and more rapid rates of spread. It will usually occur when a fire burns with the support of one or more forces of alignment (for instance, wind or slope). |
| Area of origin | General geographical location within a fire scene where the point of ignition is believed to be located. |
| Aspect | The direction a slope faces in relation to the sun or the alignment or non-alignment of the landscape to solar radiation. |
| Backing fire | A lower intensity fire or part of a fire which burns against the wind and/or down slope. |
| Barrier | Any natural or artificial obstruction to fire spread. This is normally an area devoid of fuel which is large enough in size to prevent a fire passing through or over it. |
| Breakout | The escape of a fire from an area of containment. |
| Build up | a) A sustained increase in fire intensity; or, b) An accumulation of fuel available to burn |
| Burn | a) To be on fire. b) An area of fuel consumed or partly consumed by a fire. c) An injury to flesh caused by a cauterizing agent, heat from a fire, or a heated object. d) A managed fire (i.e. an operational burn or prescribed burn) |
| Burning conditions | The state of the combined components of the fire environment that influence fire behaviour within available fuels. Burning conditions are usually specified according to the factors of aspect, weather, slope/topography, and fuel type and load. |
| Burn severity | A qualitative assessment of the heat pulse directed toward the ground during a fire. Burn severity relates to soil heating, large fuel and duff consumption, consumption of the litter and organic layer beneath trees and isolated shrubs, and mortality of buried plant parts ³ . |
| Cause of fire | The sequence of events and actions that brings an ignition source into contact with materials first ignited which leads to sustained combustion. ⁴ For statistical purposes, causes of fire are usually grouped within a standard classification. ⁵ |
| Clean burn | A fire that consumes all vegetation and litter above the ground exposing the mineral soil. |
| Combustibility | Relative ease of fire spread within a fire environment. |
| Combustion | The rapid oxidation of fuel in which heat and usually flame are produced. |

³ Source: National Wildfire Coordinating Group (2008) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.39.

⁴ Source: Paul Steensland, Paul Steensland and Associates LLC (USA).and Richard Woods, Australian Capital Territory Rural Fire Service (Australia).

⁵ Classifications vary between countries and sometimes also between States, regions or localities within the same country.

Chapter 3 - Fire Behaviour

| Term | Definition |
|--------------------------------|--|
| Combustion efficiency | A measure of the efficiency with which a fire consumes fuel. ⁶ |
| Compactness | The density of fuel particles. Compactness can influence ignition and fire behaviour. |
| Condition of Vegetation | Stage of growth or degree of flammability of vegetation that forms part of a fuel complex. This will be dependent upon time of year, amount of curing and weather conditions. |
| Conduction | The transfer of thermal energy by direct contact. |
| Convection | The transfer of heat by the movement of a gas or liquid. In meteorology, convection is the predominantly vertical movement of warmed air. |
| Convection column | A rising column of pre-heated smoke, ash, particles and other debris produced by a fire. |
| Convection-driven fire | A fire that is spread predominantly by the intensity of the convection column. |
| Cool fire | A low intensity fire or part of a fire. |
| Creeping fire | A slow burning fire with low flame activity. This type of fire may occur due to the condition of vegetation, fuel type or because a fire is burning out of alignment. |
| Critical point | This is a point in time or space when/where there will be a significant influence on fire spread, rate of spread and/or fire intensity. |
| Crown Fire/Crowning | When a fire burns freely in the upper foliage of trees and shrubs. There are three different types of crown fires: <ul style="list-style-type: none"> • Active Crown Fire – A fire that advances as a wall of flame engulfing all surface and aerial fuels. • Independent Crown Fire - A fire that advances through aerial fuels only. • Intermittent Crown Fire - A surface= fire involving torching behaviour but without sustained crowning activity. Rate of spread is controlled by the surface fire. |
| Curing | A process that leads to the reduction in moisture content of dead vegetation ⁷ . This usually causes the vegetation to turn brown in appearance. |
| Deep-seated fire | An established ground fire burning 0.5 metres or more below the surface. This type of ground fire is particularly challenging to extinguish. |
| Depth of burn | The vertical reduction in surface and ground fuels due to consumption by fire. |
| Extinction | The ceasing of the combustion process, either naturally or as a result of suppression activities. |
| Extreme fire behaviour | Fire behaviour that becomes erratic or difficult to predict due to its rate of spread and/or flame length. This type of fire behaviour often influences its environment. |
| Fingers of fire | An elongated burned area projecting from the main body of the fire resulting in an irregular fire perimeter. The pattern on the ground may resemble fingers on a hand, hence the name. ⁸ |

⁶ The smouldering phase of combustion is less efficient at consuming fuel and producing carbon dioxide and water than the flaming phase. As a result, a smouldering fire will emit more smoke particles than a flaming fire.

⁷ Including dead parts of living vegetation.

⁸ This term should not be confused with the term “fingers of fire ignition”, which is defined within this glossary as “a low intensity back burn which is achieved by lighting lines of at right angles to a control line and parallel to the wind”.

Chapter 3 - Fire Behaviour

| Term | Definition |
|--------------------------------|---|
| Fire | Fire is the product of the chemical reaction of combustion. The three factors of fuel, oxygen and heat must all be present in the correct proportions for combustion to occur. When the combustion process is initiated, heat and light are emitted and a fire occurs. |
| Fire activity | Description of a fire based on an assessment of visible evidence, including the speed of the fire, flame length, flame height, fire severity, and fire behaviour. |
| Fire analysis | The process of reviewing the behaviour and effects of a specific fire or group of fires and/or the actions that have been taken or which might be needed to suppress it/them. |
| Fire behaviour | The reaction of a fire to the influences of fuel, weather, and topography. Different types of fire behaviour include: <ul style="list-style-type: none"> • Smouldering fire - A fire burning without flame and with minimal rate of spread. • Creeping fire - A fire with a low rate of spread and generally with a low flame length. • Running fire - A fire with a high rate of spread. • Torching - A fire that burns from the ground through the surface and aerial fuels and into the crown of a single tree or small parcel of trees. • Spotting - fire behaviour where sparks and hot burning embers are transported by the wind or convection column to land beyond the fire perimeter resulting in spot fires. • Crowning – When a fire burns freely in the upper foliage of trees and shrubs. |
| Fire behaviour forecast | A prediction of probable fire behaviour to be used to inform fire suppression operations. |
| Firebrand | Particles of ignited fuels that are carried by the wind or the air currents of a convection column. |
| Firebreak | An area on the landscape where there is a discontinuity in fuel which will reduce the likelihood of combustion or reduce the likely rate of fire spread. |
| Fire concentration | The number of fires per unit area during a specified time period. |
| Fire damage | The loss that is caused by the fire. This loss will normally include financial costs, but will also include other direct and indirect costs to the environment and society. |
| Fire danger | A general term used to express an assessment of both fixed and variable factors of the fire environment that determine the ease of ignition, rate of spread, difficulty of control, and impact. Fire danger is often expressed as an index. ⁹ |
| Fire danger index | A quantitative indicator of fire danger, expressed either in a relative sense or as an absolute measure. Fire danger indexes are often used to guide fire management activities. |
| Fire dynamics | The detailed study of how chemistry, fire science, and the engineering disciplines of fluid mechanics and heat transfer interact to influence fire behaviour. ¹⁰ |

⁹ Source: Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology* (Global Fire Monitoring Center, Freiburg), p.121.

¹⁰Source: NFPA (2011) NFPA 921 – Guide for Fire and Explosion Investigations (NFPA, Quincy, Massachusetts), p.14.

Chapter 3 - Fire Behaviour

| Term | Definition |
|-------------------------------|---|
| Fire ecology | The study of the relationships and interactions between fire, living organisms and the environment. |
| Fire edge | Any section of the fire perimeter. |
| Fire effects | The physical, biological, and ecological impacts of fire on the environment. ¹¹ |
| Fire environment | The surrounding conditions, influences, and modifying forces of topography, fuel, and weather that determine fire behaviour, fire effects and impact. |
| Fire footprint | The resulting impression created by a fire burning within an area of fuel. |
| Fire front | Any part of the fire perimeter that displays continuous flaming combustion. |
| Fire growth | The evolution of a fire from ignition to self-sustaining propagation and its movement through available fuels. |
| Fire hazard | Any situation, process, material or condition that can cause a wildfire or that can provide a ready fuel supply to augment the spread or intensity of a wildfire, all of which pose a threat to life, property or the environment. ¹² |
| Fire history | The reconstruction and interpretation of the chronology of wildfire occurrence and the causes and impacts of wildfires within a specified area. |
| Fire intensity | The rate at which a fire releases energy in the form of heat at a given location and at a specific point in time, expressed as kilowatts per metre (kW/m) or kilojoules per meter per second (kJ/m/s). |
| Fire model | A computer program which will predict or reconstruct fire behaviour and rate of spread of a fire from a point of ignition or area of origin. |
| Fire perimeter | The entire outer boundary of a fire. |
| Fire prediction system | A method or tool used to forecast future behaviour of a fire. |
| Fire regime | The pattern of fire occurrence, fire frequency, fire seasons, fire size, fire intensity, and fire type that is characteristic of a particular geographical area and/or vegetation type. |
| Fire risk | The probability of a wildfire occurring and its potential impact on a particular location at a particular time. Wildfire risk is calculated using the following equation: $\text{Fire risk} = \text{probability of occurrence} \times \text{potential impact}$ |
| Fire season | The period or periods within a year when wildfires are likely or most likely to occur. |
| Fire spread | The movement of a fire through available fuels arranged across the landscape. |
| Fire storm | Violent convection caused by a large continuous area of intense fire. |

¹¹Source: National Wildfire Coordinating Group (2011) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.74.

¹² Amended from the definition provided by: NFPA (2011) NFPA 921 – Guide for Fire and Explosion Investigations (NFPA, Quincy, Massachusetts), p.14.

Chapter 3 - Fire Behaviour

| Term | Definition |
|---------------------------|--|
| Fire severity | <p>Fire severity can be defined in two ways:</p> <ul style="list-style-type: none"> • The degree to which a site has been altered or disrupted by fire.¹³ • The capacity of a fire to cause damage.¹⁴ <p>Fire intensity and the amount of time a fire burned within a particular area, among other possible factors, will influence fire severity.</p> |
| Fire triangle | Diagram which presents the three factors that are necessary for combustion and flame production: FUEL-HEAT-OXYGEN. |
| Fire types | <p>There are three different schemes for classifying fire type:</p> <ol style="list-style-type: none"> 1. Classification of a fire or section of fire according to the fuel level within which it occurs. For example, aerial, crown, understory, surface and ground fires. 2. Classification of a section of fire according to its position along the fire perimeter. For example, head, tail and flank fires. 3. Classification of a fire or section of fire according to the visual characteristics it displays. For example, smouldering, creeping, backing, running, torching, spotting, crowning, fire whirl, convection driven fire etc. |
| Fire whirl | Spinning vortex column of ascending hot air and gases rising from a fire and carrying aloft smoke, debris, and flame. ¹⁵ |
| Fire wind | The inflow of air close to a fire caused by the action of convection. ¹⁶ Fire winds influence fire spread. |
| Flame angle | The angle of a flame measured in relation to the ground surface. Flame angle is expressed in degrees. |
| Flame depth | The distance from the rearmost to the foremost parts of the fire front, usually expressed in metres. |
| Flame height | The vertical extension of a flame. Measurement of flame height is calculated perpendicular from ground level to the tip of the flame. Flame height will be less than flame length if flames are tilted due to wind or slope. |
| Flame length | The total length of a flame measured from its base at ground level to the flame tip. Flame length will be greater than flame height if flames are titled due to wind or slope. |
| Flammability | Relative ease with which a fuel will ignite and burn with a flame. |
| Flaming combustion | The production of flames as part of the combustion process. |
| Flaming front | The area of a moving fire where combustion is primarily flaming. The flaming front normally consists of the fire front and the flaming zone. |

¹³Based on the definition of “Fire Severity” within National Wildfire Coordinating Group (2011) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.78.

¹⁴British Standards Institution (2010) *BS EN ISO 13943:2010 Fire Safety – Vocabulary (ISO 13943:2008)* (Milton Keynes: BSI), 4.130, p.15.

¹⁵Source: National Wildfire Coordinating Group (2011) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.80.

¹⁶ Source: Australasian Fire and Emergency Service Authorities Council (2009) *Wildfire Glossary* (Australasian Fire and Emergency Service Authorities Council, Melbourne), p.13.

Chapter 3 - Fire Behaviour

| Term | Definition |
|----------------------------|---|
| Flaming zone | The flaming zone is located behind the fire front and is primarily characterised by flaming combustion. The flaming zone is where coarser fuels are consumed and where fire behaviour is typically less dynamic and more static. Depending on the fuels present, the fire can burn for a considerable length of time within this zone. |
| Flame risk | An assessment of risk to fire suppression personnel which is calculated using flame length. |
| Flank fire | A fire spreading or predicted to spread parallel (approximately at a right angle) to the prevailing wind direction or a slope. ¹⁷ |
| Flanks | The parts of a fire's perimeter that are roughly parallel to the main direction of fire spread. ¹⁸ The flanks usually have less fire intensity than the head fire because they have a weaker alignment with wind or slope. |
| Flare up | A short and sudden increase in fire activity. |
| Flashing | Rapid ignition of unburned gases released into the atmosphere as a result of heat generated by a wildfire. Normally observed during high intensity fires. |
| Forces of alignment | A collective term for the forces that have a significant impact on wildfire behaviour. These forces can support or hinder fire development and can be used to predict likely fire behaviour, including fire spread and fire intensity. Wind, slope and aspect are considered to be key forces of alignment. |
| Fuel | Any material that can support combustion within a wildfire environment. Fuel is usually measured in tonnes per hectare. |
| Fuel-driven fire | A fire or part of a fire that is spread predominantly by the arrangement, condition, and/or other characteristics of the fuel within which it is burning. This situation occurs in the absence of a significant effect from the forces of alignment, such as wind, slope and aspect. Fuel-driven fires can produce erratic fire behaviour. |
| Glowing combustion | Low intensity combustion, when there is little or no flame and little or no fire spread. Glowing combustion will usually occur shortly before extinction, during the final stages of a fire. |
| Ground fire | A fire burning below the surface fuel layer. |
| Head fire | The leading part of an advancing wildfire at a particular point in time. The head fire will usually exhibit the highest level of fire activity of any part of the fire. |
| Heat transfer | The process by which heat is imparted from one body or object to another. In wildfires and forest fires, heat energy is transmitted from burning to unburned fuels by: <ul style="list-style-type: none"> • Convection – Transfer of heat by the movement of masses of hot air; the natural direction is upwards in the absence of any appreciable wind speed and/or slope. Convection can include spotting behaviour. • Radiation – Transfer of heat in straight lines from warm surfaces to cooler surroundings. • Conduction – Transfer of heat through solid matter.¹⁹ |
| Hot fire | A high intensity fire or part of a fire. |

¹⁷ Source: Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology*(Global Fire Monitoring Center, Freiburg), p.153.

¹⁸Source: National Wildfire Coordinating Group (2011) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.84.

¹⁹ Source: Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology*(Global Fire Monitoring Center, Freiburg), p.188.

Chapter 3 - Fire Behaviour

| Term | Definition |
|-----------------------------|--|
| Hot spot | A small burning area within a fire perimeter which requires suppression action as part of the mop-up phase of suppression. |
| Ignition | The initiation of combustion. |
| Ignition method | The means by which a fire is ignited. |
| Ignition temperature | The minimum temperature at which ignition can take place and sustained combustion can occur. ²⁰ |
| Islands | Areas of unburned fuel within the fire perimeter. |
| Junction zone | The area where two separate fires move together. The junction zone is usually characterised by increased fire activity. |
| Junction zone effect | This is the term used to describe the increased fire activity that occurs when two separate fires move together. |
| Lateral confinement | Restriction of fire spread caused by topographical features. When wildfires are confined by topographical features such as gullies, ravines, or narrow valleys, convective heating by confined gases and radiation feedback from flames and burning vegetation increases the heat release rate of the burning fuels. Rapid fire spread is also enhanced by the acceleration and channelling of wind through these topographical features. These factors may result in a more rapid combustion and spread than that of an unconfined vegetation fire. ²¹ |
| Mega fire | A wildfire demonstrating abnormally extreme fire behaviour. Mega fires will usually represent a significant challenge to suppression agencies because they are very resource intensive to suppress and can pose a significant risk to the safety of suppression personnel. |
| Point of ignition | The precise physical location where the source of ignition came into contact with materials first ignited. |
| Preheating | Preliminary phase of combustion where fuels ahead of an advancing fire are heated and dried. Fuel temperatures can be raised either by the advancing fire and/or by weather (i.e. solar radiation, aspect). |
| Rate of spread | A measurement of the speed at which a fire moves across a landscape. Rate of spread is usually expressed in metres per hour. |
| Running fire | A fire that is rapidly spreading with a well-defined head. |
| Sleeper fire | A fire that remains dormant for a period of time. |
| Slope-driven fire | A fire or part of a fire that is spread predominantly by the direction and angle of a slope. |

²⁰ Source: Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology*(Global Fire Monitoring Center, Freiburg), p.203.

²¹Based on the definition provided in NFPA (2011) *NFPA 921 – Guide for Fire and Explosion Investigations* (NFPA, Quincy, Massachusetts), p.262.

Chapter 3 - Fire Behaviour

| Term | Definition |
|------------------------------------|---|
| Slope effect | <p>Variations in fire behaviour induced by slope. Slope can both support and hinder fire spread and development and the angle of the slope will have an important influence on the degree of effect.</p> <p>The following descriptions explain the general slope effect that would be expected from a fire spreading upslope and a fire spreading down slope:</p> <ul style="list-style-type: none"> • Fires spreading upslope –The flames of a fire spreading upslope will be angled towards the unburned fuel above it which will pre-heat the fuel in front of the advancing fire. This pre-heating increases combustibility and rate of spread for fires travelling upslope. • Fires spreading down slope - The flames of fires burning down slope will be angled away from the fuel and will, therefore, lead to less preheating of the fuel in front of the fire. Consequently, the effect of slope on a fire burning down slope is a reduction in combustibility and rate of spread. |
| Smouldering combustion | Low intensity combustion with no flame and little or no fire spread. |
| Smouldering fire | A fire burning without flame and barely spreading. |
| Spark | An ignited particle thrown from burning material. |
| Spot Fire | A fire outside the main fire perimeter which is caused by flying embers transported by the wind or convection column. |
| Spotting | Fire behaviour characterised by sparks and embers that are transported through the air by the wind or convection column. Spotting can be classified as short range or long range. |
| Surface fire | A fire that burns within the surface fuel layer. |
| Tail fire²² | The rear most part of a wildfire/forest fire, it is normally out of alignment with wind and slope, and consequently will usually demonstrate less fire activity than the head fire because it usually has less support from wind or slope. |
| Topographical wind | When the direction and/or speed of a meteorological wind is altered by the topography of the landscape ²³ . Importantly, topographical winds are a general wind adaptation and they occur on a larger scale than more localised slope winds. |
| Topographically-driven fire | A fire that is spread predominantly by the shape of the landscape, such as the steepness of slopes and gullies. |
| Torching | A fire that burns from the ground through the surface and aerial fuels and into the crown of a single tree or small parcel of trees. |
| Transition zone | An area where the spread of a fire changes direction. Transition zones can be identified by changes in the appearance of indicators. |
| Understory fire | A fire that burns beneath a canopy of trees. It can occur during the course of a wildfire or may be a tactic for a prescribed burn. |
| Vegetation | A term used to describe all forms of plant life. |

²² Also commonly referred to as the “heel of a fire” or a “heel fire”.

²³ This contrasts with more relatively more localised wind adaptations that occur, such as slope winds, land and sea breezes, and valley and mountain breezes.

Chapter 3 - Fire Behaviour

| Term | Definition |
|-------------------------------|--|
| Wildfire ²⁴ | Any uncontrolled vegetation fire which requires a decision or action regarding suppression. Wildfires are commonly classified according to size and/or impact upon suppression resources. ²⁵ |
| Wind | The horizontal movement of air relative to the surface of the earth. ²⁶ Wind direction, wind speed and wind shift can all influence fire behaviour, fire intensity, direction of travel and rate of spread. |
| Wind-driven fire | A fire or part of a fire that is spread predominantly by the speed and direction of the wind. |

²⁴ Within some parts of the world, alternative terms are used in place of the term *wildfire*. Some of the more common examples include: *bushfire*, *wildland fire*, *forest fire* and *grass fire*.

²⁵ The term *wildfire* is used to describe any uncontrolled forest fire, grass fire, peat fire or scrub fire.

²⁶Source: National Wildfire Coordinating Group (2011) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.186.

Chapter 4 - Fuel

Fuel: “Any material that can support combustion within a wildfire environment.”



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Chapter 4 - Fuel

| Term | Definition |
|--------------------------------|--|
| Aerial fuels | Any fuel found at a height of more than 3.5 metres above the ground surface. |
| Arable crops | Cultivated grassland. Arable crops can have a much higher fuel loading than natural grassland and are commonly characterised by uniformity in both vertical and horizontal fuel arrangement. |
| Available fuels | The proportion of the total fuel that would burn under specified burning and fuel conditions. |
| Black area | An area of fuel that is black in appearance because some or all of the fuel has been burnt. |
| Broadleaved trees | Trees that are characterised by their wide leaves, most of which are deciduous. |
| Burn | e) To be on fire. f) An area of fuel consumed or partly consumed by a fire. g) An injury to flesh caused by a cauterizing agent, heat from a fire, or a heated object. h) A managed fire (i.e. an operational burn or prescribed burn) |
| Canopy | The upper layer of aerial fuels which will contain the crowns of the tallest vegetation present (living or dead). |
| Clean burn | A fire that consumes all vegetation and litter above the ground exposing the mineral soil. |
| Coarse fuels | Fuels that are more than 6mm in diameter. Due to their size and shape they burn more slowly and ignite less readily than finer fuels. Examples of coarse fuels include thick stems, logs, and branches. Coarse fuels can either be living or dead. |
| Combustibility | Relative ease of fire spread within a fire environment. |
| Combustion rate | Measurement of heat release per unit of burning area per unit of time. |
| Compactness | The density of fuel particles. Compactness can influence ignition and fire behaviour. |
| Condition of vegetation | Stage of growth or degree of flammability of vegetation that forms part of a fuel complex. This will be dependent upon time of year, amount of curing and weather conditions. |
| Coniferous trees | Coniferous trees are characterised by their needle- or scale-like leaves. Most conifers are evergreen. |
| Cool fire | A low intensity fire or part of a fire. |
| Crown scorch | Browning of needles or leaves in the crown of a tree or shrub due to burning which has killed but not consumed the vegetation. Crown scorch may not be visible immediately and it may take several days or weeks after the fire for it to become apparent. |
| Crown kill | The proportion of limbs, buds, and foliage within the canopy vegetation that has been killed and consumed by a wildfire. |
| Curing | A process that leads to the reduction in moisture content of dead vegetation ²⁷ . This usually causes the vegetation to turn brown in appearance. |
| Dead fuels | Fuels with no living tissue. The moisture content of dead fuels is mostly controlled by external weather conditions, for instance, relative humidity, precipitation, temperature, and solar radiation. |
| Debris | Dead and dying fuel, consisting of both fine and coarse fuels, and inclusive of twigs and any vegetation. Debris is usually found lying on the ground but can also be found at various levels within the vertical arrangement of fuels. |

²⁷ Including dead parts of living vegetation.

Chapter 4 - Fuel

| Term | Definition |
|---------------------------|---|
| Deciduous trees | Trees with broad, flat leaves which are shed annually during the autumn. These trees will usually remain bare during the winter months, with leaf growth restarting in the Spring. |
| Deep-seated fire | An established ground fire burning 0.5 metres or more below the surface. This type of ground fire is particularly challenging to extinguish. |
| Depth of burn | The vertical reduction in surface and ground fuels due to consumption by fire. |
| Desorption | The process by which dead plant material loses moisture to the atmosphere. |
| Duff | A surface fuel consisting of partly or fully decomposed organic material lying on the mineral soil. |
| Elevated fuels | Any fuel found at a height of 1.5-3.5 metres. The presence of elevated fuels will increase the risk of vertical fire spread into aerial fuels and the canopy. |
| Fine Fuels | Fast-drying dead fuels which are less than 6mm in diameter. Fine fuels ignite readily and are rapidly consumed by fire when dry. Examples of fine fuels include: grass, leaves, ferns, mosses, pine needles and small twigs. When dried, fine fuels are referred to as flash fuels. |
| Fine fuel moisture | The moisture content of fast-drying fuels. Measurement of moisture content will indicate the relative ease of ignition and flammability of a fine fuel. |
| Fire environment | The surrounding conditions, influences, and modifying forces of topography, fuel, and weather that determine fire behaviour, fire effects and fire impact. |
| Fire hazard | Any situation, process, material or condition that can cause a wildfire or that can provide a ready fuel supply to augment the spread or intensity of a wildfire, all of which pose a threat to life, property or the environment. ²⁸ |
| Fire scar | a) The overall shape and size of the area burned by a wildfire ²⁹ ; or, b) A healing or healed injury or wound to woody vegetation which has been caused or accentuated by fire. |
| Fire spread | The movement of a fire through available fuels arranged across the landscape. |
| Firebreak | An area on the landscape where there is a discontinuity in fuel which will reduce the likelihood of combustion or reduce the likely rate of fire spread. |
| Flash fuels | Fine fuels that have been dried and which will ignite very readily and rapidly. |
| Flammability | Relative ease with which a fuel will ignite and burn with a flame. |
| Forest | An area of woodland with a minimum percentage of canopy cover, as prescribed within national or international guidelines/stipulations. |
| Fragmentation | The process of transforming large continuous areas of vegetation and fuel into smaller discontinuous areas. Fragmentation leads to a change in fire regimes through the alteration and discontinuity of fuels. |
| Fuel | Any material that can support combustion within a wildfire environment. Fuel is usually measured in tonnes per hectare. |

²⁸ Amended from the definition provided by: NFPA (2011) NFPA 921 – Guide for Fire and Explosion Investigations (NFPA, Quincy, Massachusetts), p.14.

²⁹ Source: Julia McMorrow, University of Manchester, United Kingdom.

Chapter 4 - Fuel

| Term | Definition |
|-------------------------|---|
| Fuel arrangement | The horizontal and vertical distribution of all combustible materials within a particular fuel type. ³⁰ <ul style="list-style-type: none"> • Horizontal fuel arrangement - A description of the distribution of fuels on the horizontal plane. The horizontal arrangement of fuels will influence the relative ease with which fire can spread horizontally across an area of land. • Vertical fuel arrangement – A description of the distribution of fuels on the vertical plane, from the ground up to the canopy levels of vegetation. The vertical arrangement of fuels will influence the relative ease with which fire can spread vertically through the fuel layers. |
| Fuel assessment | The estimation or calculation of total and available fuel that is present within a specific area. |
| Fuel boundary | A dividing line between two distinctly different fuel types. |
| Fuel complex | The type, quantity, condition, arrangement and continuity of fuel available to burn. |
| Fuel condition | Relative flammability of a fuel, as determined by fuel type and environmental conditions. ³¹ |
| Fuel continuity | The extent to which fuel arrangement will support fire spread. |
| Fuel consumption | The amount of a fuel that is removed by a fire, often expressed as a percentage of the fuel load. |
| Fuel-driven fire | A fire or part of a fire that is spread predominantly by the arrangement, condition, and/or other characteristics of the fuel within which it is burning. This situation occurs in the absence of a significant effect from the forces of alignment, such as wind, slope and aspect. Fuel-driven fires can produce erratic fire behaviour. |
| Fuel hazard | A fuel complex defined by type, alignment, arrangement, volume, continuity, condition etc. that forms a special risk. |
| Fuel layers | The classification of fuels according to their height relative to the ground surface. There are five general fuel layers: <ul style="list-style-type: none"> • Aerial fuels • Elevated fuels • Near surface fuels • Surface fuels • Ground fuels |
| Fuel load | The amount of fuel present within a particular area. Fuel load is measured in weight per area measured (usually in kilograms per square metre). Fuel loading is expressed in relative terms as either “heavy fuel loading” or “light fuel loading”. |
| Fuel management | The process of managing fuel or fuel arrangement. The aim of fuel management is usually to create a discontinuity in fuels to achieve fragmentation. |
| Fuel model | A mathematical representation of fuel properties within a specified location, often used to predict and plot likely fire spread and intensity. |

³⁰ Source: Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology* (Global Fire Monitoring Center, Freiburg), p.166.

³¹ Source: National Wildfire Coordinating Group (2011) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.88.

Chapter 4 - Fuel

| Term | Definition |
|------------------------------------|--|
| Fuel moisture content | Water content of a fuel expressed as a percentage of fuel weight when oven dried. |
| Fuel properties | The physical characteristics of a fuel; for example, volume, size, shape, compactness and arrangement. |
| Fuel separation | The distance between fuel layers or fuel particles. |
| Fuel treatment | The deliberate manipulation or removal of fuels using one or more of a variety of different means ³² to: <ul style="list-style-type: none"> • reduce the likelihood of ignition; and/or, • reduce potential fire intensity; and/or, • reduce potential damage; and/or, • assist suppression activities. |
| Fuel type | A group of fuels that will respond to fires in a similar way. |
| Fuel type pattern | A mosaic of distinct fuel types within a particular area. |
| Grassland | An area predominantly covered in one or more species of grass. |
| Ground fuels | Any fuel below the surface fuel layer, normally within the soil. Examples of ground fuels include: duff, tree roots, shrub roots, rotting wood, peat etc. |
| Heathland | An area of open uncultivated land which is dominated by dwarf shrubs and which is usually characterised by poor acidic sandy soil. Heathland is similar in appearance to moorland, although heath is normally found on well-drained sandy soils at lower altitudes. |
| Horizontal fuel arrangement | A description of the distribution of fuels on the horizontal plane. The horizontal arrangement of fuels will influence the relative ease with which fire can spread horizontally across an area of land. |
| Horticultural crops | Intensively cultivated plants used by people for food, medicinal purposes or for ornamental/aesthetic purposes. Horticultural crops are usually less susceptible to wildfires than other types of vegetation, but post-harvesting residues can create fine fuels and increase the risk of wildfires (particularly during warm and dry conditions). |
| Hot fire | A high intensity fire or part of a fire. |
| Islands | Isolated areas of unburned fuel within a fire perimeter. |
| Ladder fuel | Fuels that provide vertical continuity which allow fire to move through the vertical fuel arrangement. |
| Land management | The process of managing the use and development of an area of land for: wildfire prevention; conservation, restoration or protection of the environment; commerce; and/or for other reasons. |
| Land use planning | A decision-making process involving the allocation of areas of land to different uses and/or vegetation types. |
| Litter | The top layer of debris fuels consisting of twigs, sticks and branches, it can also include recently fallen leaves and needles. The structure of the material within the litter layer has not been altered significantly by the process of decomposition. |
| Live fuels | Fuels with living tissue. The moisture content of live fuels is controlled largely by internal physiological mechanisms. |
| Mineral earth/soil | A soil layer that does not contain organic material which could support combustion. |
| Mixed woodland | Woodland containing a mixture of deciduous and coniferous tree species. |

³² Inclusive of the following means: manual, mechanical, chemical, or using fire.

Chapter 4 - Fuel

| Term | Definition |
|---------------------------|---|
| Moorland | An area of open uncultivated land which is dominated by dwarf shrubs and other low-lying vegetation. Moorland is similar in appearance to heathland; although moorland is found in wetter areas where mosses help retain water content. |
| Natural fuel | Fuels created and developed through natural processes and which have not been directly generated or altered by land management practices. |
| Natural woodland | Trees that have germinated and grown in their natural state without the influence of human actions. Natural woodland is likely to contain multiple species of trees which leads to less continuity of fuels than is found in planted woodland. |
| Near surface fuels | Any fuels found at a height of 0.5-1.5 metres above the ground surface. Near surface fuels are found above surface fuels and have a vertical component to their structure. |
| Peat | An organic fuel layer consisting of a light, spongy material formed in temperate humid environments through the accumulation and partial decomposition of vegetation debris. Peat is formed by decomposition in the absence of oxygen (anaerobic decomposition). Peat forms in areas that are seasonally or permanently inundated with water. Fires in peat burn by smouldering combustion and generate high levels of heat energy per unit area. |
| Planted woodland | An area of managed woodland (often artificially established) where trees are grown for sale as timber and/or for the commercial production of other forest products. |
| Scrubland | Area of mixed vegetation predominantly consisting of shrubs, bushes and grasses. Scrubland may be found on the fringes of other fuel types, but it may also be found in isolated pockets within other fuel types. |
| Shrub | A woody perennial plant characterised by its low stature and habit of branching from the base. Shrubs normally contain a high quantity of fine fuels. |
| Slash | Debris left lying on the ground after logging, pruning or thinning operations within woodland. Slash may consist of both coarse and fine fuels and sometimes forms a significant surface fuel. |
| Stand | Trees of one type or species grouped together within woodland. |
| Standing Fuel | Part of vegetation, living or dead, that is supported by a stem, branch or trunk. |
| Surface fuel | Any fuels found at a height of 0-0.5 metres above the ground surface. |
| Tree | A tree is a perennial woody plant with a single main stem or trunk which supports branches above the ground. Trees usually have a distinctive crown. |
| Understory | Vegetation found beneath the canopy. Understory vegetation is normally found growing or lying on the ground. |
| Uniform fuels | Identical or consistent fuels distributed continuously across an area or landscape. It is usually easier to predict fire behaviour for fires burning in uniform fuels than it is for fire in mixed vegetation types. |

Chapter 4 - Fuel

| Term | Definition |
|-----------------|--|
| Woodland | <p>A generic term for any area of land which is predominantly characterised by trees, whether in large tracts or smaller units.³³</p> <p>Woodland can be categorized according to the types of species it contains, for instance:</p> <ul style="list-style-type: none">• –containing predominantly coniferous tree species.• Deciduous woodland – containing predominantly deciduous tree species.• Mixed woodland – Woodland containing a mixture of coniferous and deciduous tree species. <p>Woodland can also be categorized according to the degree to which humans manage the area, which has an influence on the type of fire behaviour that may be observed:</p> <ul style="list-style-type: none">• Planted woodland – An area of managed woodland (often artificially established) where trees are grown for sale as timber and/or for the commercial production of other forest products. Planted woodland is often characterised by a single species and continuity in both the horizontal and vertical fuel arrangements.• Natural woodland – Trees that have germinated and grown in their natural state without the influence of human actions. Natural woodland is likely to contain multiple species of trees which leads to less continuity of fuels than is found in planted woodland. |

³³ Woodland can be classified as “forest” if the minimum percentage of canopy cover, as stipulated within national or international guidelines/stipulations, is exceeded.

Chapter 5 - Topography

Topography: “The description and study of the shape and features of the land surface.”



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Chapter 5 - Topography

| Term | Definition |
|----------------------------|---|
| Aspect | The direction a slope faces in relation to the sun. |
| Barrier | Any natural or artificial obstruction to fire spread. This is normally an area devoid of fuel which is large enough in size to prevent a fire passing through or over it. |
| Blind area | An area in which neither the ground nor its vegetation can be seen from an observation point. |
| Bog | A permanently saturated area of spongy ground with poor drainage. Bogs are usually found in upland areas experiencing cool temperatures and high rainfall. Slow decomposition of the plants found within bogs leads to the formation of peat. |
| Catchment area | The area from which rainfall flows into a river, lake, or reservoir. |
| Confluence | The location where two streams or rivers meet. |
| Cliff | A vertical or near vertical rock face. |
| Drainage system | A naturally occurring or human-made network of channels which moves water across an area of land using the force of gravity. |
| Elevation | Height above sea-level. |
| Fire environment | The surrounding conditions, influences, and modifying forces of topography, fuel, and weather that determine fire behaviour, fire effects and impact. |
| Firebreak | An area on the landscape where there is a discontinuity in fuel which will reduce the likelihood of combustion or reduce the likely rate of fire spread. |
| Floodplain | A relatively flat area of land found alongside a water channel that is prone to flooding. |
| Forces of Alignment | A collective term for the forces that have a significant impact on wildfire behaviour. These forces can support or hinder fire development and can be used to predict likely fire behaviour, including fire spread and fire intensity. Wind, slope and aspect are considered to be key forces of alignment. |
| Gorge | A deep, narrow and extremely steep-sided valley which usually has a river occupying its entire floor. Gorges are very dangerous topographical features because they can support extreme fire behaviour. |
| Gradient | The angle or steepness of a slope. |
| Gully | A relatively steep-sided water channel formed on a hillside. A gully might only contain water during periods of heavy rain. Gullies are dangerous topographical features because they can support extreme fire behaviour. ³⁴ |
| Groundwater | Water found beneath the land surface. Groundwater is found in fractures of rock formations and as soil moisture. |
| Hill | An area of high ground with slopes falling down in all directions. Hills will often, but not always, have distinct summits. |
| Lake | A large natural body of water that is usually fed and drained by a stream or river. |
| Landscape | The physical appearance of the land comprising of the features of the terrain, the indigenous vegetation and the human impact caused by variations in land use. |
| Latitude | The angular distance north or south between a point on the earth's surface and the equator ³⁵ . Latitude is usually measured in degrees, minutes and seconds. |
| Lee slope | A slope that faces away from the direction of the wind. A lee slope is therefore sheltered from the wind. A lee slope is the opposite of a stoss slope. |

³⁴ Also commonly referred to as a "re-entrant".

³⁵ Source: <http://www.ordnancesurvey.co.uk/oswebsite/aboutus/reports/misc/glossary.html>

Chapter 5 - Topography

| Term | Definition |
|--|---|
| Longitude | The angular distance of a point east or west of an arbitrarily defined meridian, usually taken to be the Greenwich meridian ³⁶ . Longitude is usually measured in degrees, minutes and seconds. |
| Marsh | An area of soft, wet, low-lying land, characterized by grassy vegetation. Marshland may often form a transition zone between water and land. |
| Military training area | A section of land used by a military organisation to experiment, test and/or train with weapons and other military technology. The unexploded ordnance found within some military training areas may pose a significant risk to suppression personnel responding to wildfire incidents. |
| Mountain | An area of very high ground with steep slopes falling down from a sharp peak at the top. Mountains are larger landforms than hills and generally have steeper slopes. |
| Mountain breeze | A localised down slope wind which occurs at night when cool mountain air sinks down slope to replace warmer air found at lower elevations. A reversal of this process may occur during the day leading to a valley breeze. ³⁷ |
| Peak | The pointed top of a mountain or ridge. |
| Peat | An organic fuel layer consisting of a light, spongy material formed in temperate humid environments through the accumulation and partial decomposition of vegetation debris. Peat is formed by decomposition in the absence of oxygen (anaerobic decomposition). Peat forms in areas that are seasonally or permanently inundated with water. Fires in peat burn by smouldering combustion and generate high levels of heat energy per unit area. |
| Peninsula | A relatively narrow strip of land projecting from a land mass into a sea or lake. |
| Plateau | An elevated area of land which has an extensive and relatively level surface. |
| Pond | A small body of still water which is not fed by a stream or river. Ponds may be constructed or form naturally within undulations of the land surface. |
| Protected area | An area that has special status and which has been given specific legal protection. |
| Reservoir | A large constructed body of water that is usually fed and drained by a stream or river. |
| Ridge | A narrow, pointed crest formed by two opposing slopes. |
| Ridgeline | A long, narrow chain of hills or mountains. |
| River | A body of flowing water with a clearly defined valley. Rivers empty into a sea, ocean, lake, or other body of water and are usually fed along their course by converging tributaries. |
| Rural-Urban Interface (RUI) environment | The zone of transition between rural land and human settlements. |
| Saddle | A depression between two hills or mountains, so-called because of its similarity to the shape of a horse riding saddle. Wind is often funnelled and intensified between the two hills of a saddle. Saddles are therefore dangerous topographical features because they can support extreme fire behaviour. |
| Sand dunes | Accumulations of sand forming undulating hills along coastal shores. They are formed by sand deposited by the wind and are predominantly populated by grasses shrubs. |

³⁶ Source: <http://www.ordnancesurvey.co.uk/oswebsite/aboutus/reports/misc/glossary.html>

³⁷ The daily transitions between valley and mountain breezes follow a similar process to that observed for sea and land breezes.

Chapter 5 - Topography

| Term | Definition |
|---------------------------|---|
| Scree | An unstable mound of angular pieces of rock found at or near the base of a cliff or steep slope. |
| Slope | An incline of the ground. |
| Slope-driven fire | A fire or part of a fire that is spread predominantly by the direction and angle of a slope. |
| Slope effect | <p>Variations in fire behaviour induced by slope. Slope can both support and hinder fire spread and development and the angle of the slope will have an important influence on the degree of effect.</p> <p>The following descriptions explain the general slope effect that would be expected from a fire spreading upslope and a fire spreading down slope:</p> <ul style="list-style-type: none"> • Fires spreading upslope –The flames of a fire spreading upslope will be angled towards the unburned fuel above it which will pre-heat the fuel in front of the advancing fire. This pre-heating increases combustibility and rate of spread for fires travelling upslope. • Fires spreading down slope - The flames of fires burning down slope will be angled away from the fuel and will, therefore, lead to less preheating of the fuel in front of the fire. Consequently, the effect of slope on a fire burning down slope is a reduction in combustibility and rate of spread. |
| Slope wind | <p>Highly localised convective winds that occur due to local heating and cooling of a natural incline of the ground.³⁸ They can be classified in two ways:</p> <ul style="list-style-type: none"> • Anabatic winds – Upslope winds. Anabatic winds occur when daytime solar radiation heats air at lower elevations causing it to flow upslope. • Katabatic winds – Down slope winds. Katabatic winds occur when air at higher elevations is cooled (often at night) and is subsequently pulled down slope by the force of gravity. |
| Spring | A point at which water emerges from the ground. Springs often lead to the formation of water channels. |
| Stoss slope | A slope that faces the direction of the general wind. A stoss slope is the opposite of a lee slope. |
| Stream | A smaller body of flowing water which is normally a tributary to a larger body of flowing water. |
| Stump | The woody base of a tree that remains in the ground after felling. Stumps are common slip, trip and fall hazards at wildfire incidents. |
| Summit | The top or highest point of a hill or mountain. |
| Swamp | A vegetated area that is permanently flooded. Unlike most other areas of land which are temporarily or permanently flooded by water, swamps may contain dense woody vegetation. |
| Terrace | An area of flat ground which is set into or onto a steep slope. |
| Topographical Wind | When the direction and/or speed of a meteorological wind is altered by the topography of the landscape ³⁹ . Importantly, topographical winds are a general wind adaptation and they occur on a larger scale than more localised slope winds. |

³⁸ Source: National Wildfire Coordinating Group (2011) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.159.

³⁹ This contrasts with more relatively more localised wind adaptations that occur, such as slope winds, land and sea breezes, and valley and mountain breezes.

Chapter 5 - Topography

| Term | Definition |
|---|--|
| Topographically-driven fire | A fire that is spread predominantly by the shape of the landscape, such as the steepness of slopes and gullies. |
| Topography | The description and study of the shape and features of the land surface. |
| Tributary | A stream or river that flows into another larger stream, river or lake. Tributaries do not flow directly into a sea or ocean. |
| Valley | An elongated depression between hills or mountains that usually follows the course of a channel of water or ice. The cross-section of a valley will usually resemble one of two shapes: <ul style="list-style-type: none"> • V-shaped valley – a valley that usually has shallow sides and a cross-section that resembles the letter “V”. V-shaped valleys are usually formed by the erosion of a channel of flowing water. • U-shaped valley – a type of valley with steep walls and a broad floor, with a cross-section resembling the letter “U”. U-shaped valleys are usually formed by glacial erosion. |
| Valley breeze | A localised upslope wind which occurs when the sun rapidly heats the air within a valley causing it to rise upslope. A reversal of this process may occur at night leading to a mountain breeze. ⁴⁰ |
| Vegetation | A term used to describe all forms of plant life. |
| Water channel | Natural or human constructed drainage features that normally contain flowing water. Some common examples of water channels include streams, rivers, dykes and canals. |
| Water source | Any natural or artificial body of water which can provide water to support of fire suppression operations. Common examples of water sources include lakes, reservoirs, ponds, rivers and streams. |
| Water table | The upper level of groundwater. Soil below the water table will be saturated. The level of the water table will vary due to changing conditions. |
| Wetland | An area of land that is permanently saturated up to or very near to the land surface. |
| Wilderness | <ol style="list-style-type: none"> 1) A wild, uncultivated, and largely uninhabited region, which may be vegetated or non-vegetated; and/or, 2) An area of remarkable natural beauty and ecological diversity. |
| Wildland | An area in which development is essentially non-existent, except for the presence of basic infrastructure such as roads, railroads and power lines. Any buildings and structures will be widely scattered. |
| Wildland-Urban Interface (WUI) environment | The zone of transition between wildland and human settlements and/or development. |

⁴⁰ The daily transitions between valley and mountain breezes follows a similar process to that observed for sea and land breezes.

Chapter 6 – Weather

Weather: “The state of the atmosphere at a given time and place with respect to atmospheric stability, temperature, relative humidity, wind speed, cloud cover and precipitation.”



© Enrico Marchi (Italy)

Chapter 6 - Weather

| Term | Definition |
|-------------------------------|---|
| Absolute humidity (AH) | The mass of water contained in a unit volume of moist air. ⁴¹ |
| Advection | The transfer of atmospheric properties by the horizontal movement of air. Advection will usually involve the transfer of warmer or cooler air, but it may also involve the transfer of moisture. |
| Air mass | An extensive body of air with relatively uniform horizontal levels of temperature, humidity, and pressure. |
| Anemometer | An instrument that measures wind speed. |
| Aspect | The direction a slope faces in relation to the sun. ⁴² Aspect is a force of alignment. |
| Atmosphere | The air surrounding the earth. The atmosphere is divided into a series of layers with different characteristics. ⁴³ |
| Atmospheric inversion | An atmospheric condition that occurs when temperature within a vertical layer of air increases with altitude, resulting in a very stable atmosphere. ⁴⁴ The inhibition of vertical motion in the atmosphere can allow the build-up of fire-generated smoke pollution. ⁴⁵ |
| Atmospheric pressure | The force exerted by the weight of the atmosphere per unit area. ⁴⁶ |
| Atmospheric saturation | An atmospheric condition which is reached when air at a specific temperature contains all the water vapour it can potentially hold. When saturation occurs, the process of evaporation ceases. Saturated air can also be referred to as 100% relative humidity. |
| Atmospheric stability | The degree to which the vertical movement of air within the atmosphere is enhanced or suppressed. The stability of the atmosphere can be classified in one of three ways: <ul style="list-style-type: none"> • Stable atmosphere – An atmospheric condition that occurs when the potential temperature within a vertical layer of air increases with altitude⁴⁷. A stable atmosphere will suppress the vertical movement of air (i.e. convection) and is likely to produce predictable fire behaviour. The inhibition of vertical motion in the atmosphere can also cause a build-up of fire-generated smoke pollution. • Neutral atmosphere – A neutral atmosphere will neither enhance nor suppress the vertical movement of air. • Unstable atmosphere – An atmospheric condition that occurs when the potential temperature within a vertical layer of air decreases with altitude⁴⁸. An unstable atmosphere will enhance and support the vertical movement of air and is more likely to produce erratic, unpredictable and extreme fire behaviour. |

⁴¹ Source: www.nsidc.org/arcticmet/glossary/absolute_humidity.html

⁴² A slope receiving direct sunlight at a particular point in time is described as being *in aspect*, while a slope not receiving direct sunlight at a particular point in time is described as being *out of aspect*.

⁴³ The layers of the atmosphere, in order as they extend away from the earth, are: troposphere, stratosphere, mesosphere, thermosphere and exosphere.

⁴⁴ This is contrary to the usual situation in which potential temperature decreases with increasing altitude.

⁴⁵ Based on the definition provided by the Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology* (Global Fire Monitoring Center, Freiburg), pp.212-3.

⁴⁶ Source: www.firenotes.com/wild3rd/redwild3terms/redwild3ch1terms.php

⁴⁷ With thanks to Karl Kitchen of the MET Office for his contribution.

⁴⁸ With thanks to Karl Kitchen of the MET Office for his contribution.

Chapter 6 - Weather

| Term | Definition |
|-------------------------------|--|
| Average wind direction | The most frequent direction from which a wind blows at a particular location over a specified period of time, usually 10 minutes as specified by the World Meteorological Organisation. ⁴⁹ |
| Average wind speed | The mean average wind speed at a particular location over a specified period of time, usually 10 minutes as specified by the World Meteorological Organisation. ⁵⁰ |
| Barometer | An instrument used for measuring atmospheric pressure. |
| Beaufort Scale | A system for estimating wind speeds based on observation of visible wind effects. A series of descriptions of visible wind effects upon land objects or sea surfaces is matched with a corresponding series of wind speed ranges, each being allocated a Beaufort number. ⁵¹ |
| Breeze | A gentle constant wind. The Beaufort Scale defines a breeze as any wind with a speed of between 7 and 50 kilometres per hour. ⁵² |
| Cloud | A visible body of fine water droplets or ice particles suspended within the atmosphere. |
| Cloud cover | The amount of sky obscured by cloud at a particular location. Cloud cover is expressed in eighths (usually called octas), where eight eighths is used to describe complete cloud cover. |
| Cloud types | <p>A visible body of fine water droplets or ice particles suspended within the atmosphere. There are a significant number of different types of clouds; however, there are three key cloud types that are particularly important for wildfire suppression activities because they can be used as a visual indicator of atmospheric stability:</p> <ul style="list-style-type: none"> • Stratus clouds – low altitude clouds (below 6,000 feet) with a flat or sheet-like appearance which develop within a stable layer of the atmosphere. • Cumulus clouds – clouds with strong vertical development (below 6,000 feet) which develop within an unstable layer of the atmosphere. Cumulus clouds often have a lumpy or piled up appearance. • Cumulonimbus clouds – clouds with very strong vertical development which develop within an unstable layer of the atmosphere. The base of cumulonimbus clouds is near to ground level and they can extend vertically beyond 50,000 feet. Cumulonimbus clouds sometimes have a characteristic anvil shape. • Fog – A cloud with its base on the ground surface. |
| Condensation | The process by which a gas is transformed to a liquid. |
| Convection | The transfer of heat by the movement of a gas or liquid. In meteorology, convection is the predominantly vertical movement of warmed air. Convection at a wildfire incident can lead to spotting. |
| Convection column | A rising column of pre-heated smoke, ash, particles and other debris produced by a fire. |
| Convection-driven fire | A fire that is spread predominantly by the intensity of the convection column. |

⁴⁹ With thanks to Karl Kitchen of the MET Office for his contribution.

⁵⁰ With thanks to Karl Kitchen of the MET Office for his contribution.

⁵¹ Source: Australasian Fire and Emergency Service Authorities Council (2009) *Wildfire Glossary* (Australasian Fire and Emergency Service Authorities Council, Melbourne), p.3.

⁵² Which is equivalent to: 5 to 31 miles per hour, or 4 to 27 knots.

Chapter 6 - Weather

| Term | Definition |
|--------------------------------|---|
| Desorption | The process by which dead plant material loses moisture to the atmosphere. |
| Dew | Moisture which collects in small droplets on the surface of vegetation through the process of condensation. Dew predominantly forms at night. |
| Dew point | The temperature at which air must be cooled in order for atmospheric saturation to occur and, subsequently, for dew to form. Dew point can therefore be used as a measure of the moisture content of the air. |
| Drought | A prolonged period of abnormally low precipitation within a particular area. |
| Evaporation | The process by which a liquid or solid is transformed to a gas/vapour. |
| Fire environment | The surrounding conditions, influences, and modifying forces of topography, fuel, and weather that determine fire behaviour, fire effects and impact. |
| Fire storm | Violent convection caused by a large continuous area of intense fire. |
| Fire whirl | Spinning vortex column of ascending hot air and gases rising from a fire and carrying aloft smoke, debris, and flame. ⁵³ |
| Fire wind | The inflow of air close to a fire caused by the action of convection. ⁵⁴ Fire winds influence fire spread. |
| Forces of Alignment | A collective term for the forces that have a significant impact on wildfire behaviour. These forces can support or hinder fire development and can be used to predict likely fire behaviour, including fire spread and fire intensity. Wind, slope and aspect are considered to be key forces of alignment. |
| Humidity | A generic term used to describe the amount of water vapour in the air. |
| Hygrometer⁵⁵ | An instrument used for measuring the relative humidity of the air. |
| Isobar | A line on a weather map which connects points of equal atmospheric pressure. |
| Isotherm | A line on a weather map which connects points of equal temperature. |
| Land breeze | A local night time breeze which occurs when cooler, higher pressure air above the land surface moves offshore to replace warmer air rising above coastal waters. |
| Meteorological winds | The movement of air within the upper air level masses as a result of atmospheric pressure variations. Meteorological winds generate regional weather patterns. |
| Mountain breeze | A localised downslope wind which occurs at night when cool mountain air sinks downslope to replace warmer air found at lower elevations. A reversal of this process may occur during the day leading to a valley breeze. ⁵⁶ |
| Potential temperature | The temperature a parcel of air would have if moved vertically to some other reference height. |
| Precipitation | All forms of water, whether liquid (e.g. rain) or solid (e.g. snow or hail), that fall from the atmosphere and reach the ground. |
| Prevailing wind | The predominant wind direction. |
| Radiometer | An instrument that measures electromagnetic radiation. Radiometers mounted on satellites measure the characteristics of fires, vegetation and clouds and are used to detect and monitor wildfires and their impact. |

⁵³ Source: National Wildfire Coordinating Group (2008) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.79.

⁵⁴ Source: Australasian Fire and Emergency Service Authorities Council (2009) *Wildfire Glossary* (Australasian Fire and Emergency Service Authorities Council, Melbourne), p.13.

⁵⁵ An alternative term for a hygrometer is a *psychrometer*.

⁵⁶ The daily transitions between valley and mountain breezes follow a similar process to that observed for sea and land breezes.

Chapter 6 - Weather

| Term | Definition |
|-------------------------------|---|
| Relative humidity (RH) | The amount of water vapour present in the air expressed as a percentage of the amount of vapour needed for saturation to occur at the same temperature. Saturated air is referred to as 100% relative humidity. |
| Sea breeze | A daytime breeze in which cooler, higher pressure air from over coastal waters moves on shore to replace heated air rising off the warmer land mass. ⁵⁷ |
| Slope wind | Highly localised convective winds that are caused by local heating and cooling of a natural incline of the ground. ⁵⁸ There are two types of slope winds: <ul style="list-style-type: none"> • Anabatic winds – Upslope winds. Anabatic winds occur when daytime solar radiation heats air at lower elevations causing it to flow upslope. • Katabatic winds – Down slope winds. Katabatic winds occur when air at higher elevations is cooled (often at night) and is subsequently pulled down slope by the force of gravity. |
| Smoke | The atmospheric suspension of small particles of solids and liquids produced by combustion. |
| Solar radiation | Energy emitted by the sun which indirectly heats the earth's surface. Solar radiation has a significant influence on weather. |
| Temperature | The degree or intensity of heat present in a substance or object. Temperature is expressed using a comparative scale (usually degrees Celsius or degrees Fahrenheit). |
| Thermograph | A thermometer that automatically and continuously records air temperature on a chart. |
| Thermometer | An instrument used to measure air temperature. |
| Topographical wind | When the direction and/or speed of a meteorological wind is altered by the topography of the landscape ⁵⁹ . Importantly, topographical winds are a general wind adaptation and they occur on a larger scale than more localised slope winds. |
| Valley breeze | A localised upslope wind which occurs when the sun rapidly heats the air within a valley causing it to rise upslope. A reversal of this process may occur at night leading to a mountain breeze. ⁶⁰ |
| Weather | The state of the atmosphere at a given time and place with respect to atmospheric stability, temperature, relative humidity, wind speed, cloud cover and precipitation. ⁶¹ |
| Weather history | A description of the state of the atmosphere during the hours, days or weeks preceding a wildfire. ⁶² |
| Wind | The horizontal movement of air within the atmosphere. Wind has a strong influence on fire behaviour and is one of the forces of alignment. |

⁵⁷ Source: Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology* (Global Fire Monitoring Center, Freiburg), p.296.

⁵⁸ Source: National Wildfire Coordinating Group (2011) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.159.

⁵⁹ This contrasts with more relatively more localised wind adaptations that occur, such as slope winds, land and sea breezes, and valley and mountain breezes.

⁶⁰ The daily transitions between valley and mountain breezes follows a similar process to that observed for sea and land breezes.

⁶¹ Based on the definition provided for "Weather" within NFPA (2011) *NFPA 921 – Guide for Fire and Explosion Investigations* (NFPA, Quincy, Massachusetts), p.260

⁶² Based on the definition provided for "Weather History" within NFPA (2011) *NFPA 921 – Guide for Fire and Explosion Investigations* (NFPA, Quincy, Massachusetts), p.261.

Chapter 6 - Weather

| Term | Definition |
|-------------------------|---|
| Wind direction | The direction from which the wind is blowing. A change in average wind direction is termed a "wind shift". |
| Wind drift | The effect of the wind on water and retardant drops. For precise drops, pilots need to make a correction for wind drift. Generally speaking, the higher the drop the greater the potential drift. |
| Wind-driven fire | A fire or part of a fire that is spread predominantly by the speed and direction of the wind. |
| Wind gust | A short burst of high speed wind. |
| Wind shift | A change in average wind direction. |
| Wind speed | The rate at which air moves horizontally past a particular location at a particular point in time. |

Section 2:

Wildfire Suppression Operations



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Including the following Chapters:

7. Safety

8. Incident Command

9. Tactics

10. Cartography and Map Reading

11. Equipment

12. Aerial Operations

Chapter 7 – Safety

Safety: “When exposure to hazards has been controlled to an acceptable level.”



A lookout monitoring a wildfire to ensure the safety of wildfire suppression personnel

© José Antonio Grandas Arias (Galicia, Spain)

Chapter 7 - Safety

| Term | Definition |
|----------------------------------|--|
| Access | A point of entry, exit and/or route to an incident location. |
| Accident | An unexpected and undesirable event that causes injury or illness to a person or persons and/or damage to property or the environment. |
| Accident investigation | The process of determining the circumstances and cause(s) of an accident or near miss incident. The seriousness of the accident or near miss incident will usually dictate the level of investigation required. |
| Accident report | A document which records the circumstances and causes of an accident or near miss incident. The primary purpose of accident reporting is to identify measures that can be taken to reduce the likelihood of recurrence. In some circumstances an organisation may have a legal obligation to complete and submit an accident report to a relevant authority. |
| Advancing fire | This is fire progression associated with the head (front) of the fire. Fire behaviour in this area is usually characterized by more intense burning, increased flame height and length and more rapid rates of spread. It will usually occur when a fire burns with the support of one or more forces of alignment (for instance, wind, slope or aspect). ⁶³ |
| Anaphylaxis ⁶⁴ | A severe and potentially life threatening allergic reaction that can affect many systems within the body, including: <ul style="list-style-type: none"> • Airways • Breathing • Circulation of the blood <p>The most common triggers of anaphylaxis are insect stings, certain types of food and certain types of medication.⁶⁵ Anaphylaxis should always be treated as a medical emergency.</p> |
| Anchor point | An advantageous location, usually a barrier to fire spread, from which to begin constructing a control line. An anchor point is essential when constructing a control line because it will ensure that the control line is completely closed and that the fire cannot breakout of the area of containment. The creation of an anchor point is sometimes a key element included within the LACES safety protocol. |
| Asphyxia | A serious medical condition which leads to loss of consciousness or death. It is caused by an extreme decrease in the concentration of oxygen and an associated increase in the concentration of carbon dioxide within the body. Some common causes of asphyxia include: inhalation of toxic gases; choking; drowning; and, electric shock. |
| Audible warning device | A signalling device which generates a loud siren to provide a warning. Audible warning devices are sometimes mounted to aircraft and are sounded by pilots to warn ground teams that an aircraft is approaching to make a drop. |
| Black area | An area of fuel that is black in appearance because some or all of the fuel has been burnt. A black area may support a second burn if some fuel remains and this could represent a safety risk to suppression personnel. |
| Blind area | An area in which neither the ground nor its vegetation can be seen from an observation point. |
| Breakout | The escape of a fire from an area of containment. |
| Briefing | A meeting during which relevant information is exchanged. |

⁶³ This is an amendment from the definition of “advancing fire” provided within the National Wildfire Coordinating Group (2005) *Wildfire Origin and Cause Determination Handbook* (National Wildfire Coordinating Group Fire Investigation Working Team; USA), p.7.

⁶⁴ Also referred to as “anaphylactic shock”.

⁶⁵ Website: <http://www.nhs.uk/Conditions/Anaphylaxis/Pages/Introduction.aspx>

Chapter 7 - Safety

| Term | Definition |
|--------------------------------|--|
| Burn | <ul style="list-style-type: none"> i) To be on fire. j) An area of fuel consumed or partly consumed by a fire. k) An injury to flesh caused by a cauterizing agent, heat from a fire, or a heated object. l) A managed fire (i.e. an operational burn or prescribed burn) |
| Burnover | A situation where personnel or equipment are caught in an advancing flame front. |
| Burn supervisor | A person who manages the actions, assignments and safety of a burn team. |
| Chain of command | The line of authority and responsibility along which operational orders are passed. Also commonly referred to as “line of command”. |
| Command | The authority of an agency to direct and control resources. Command is delegated to an individual. |
| Competency | When a person has the authority and sufficient technical knowledge, training and experience to carry out their assigned tasks safely and effectively. |
| Dehydration | A medical condition resulting from the loss of excessive amounts of water/fluid from a person’s body. This excessive loss of fluid can upset the delicate fluid-salt balance which is required to maintain healthy cells and tissue. Strenuous activity, excessive sweating and prolonged exposure to heat are common causes of dehydration at wildfire incidents. |
| Dynamic risk assessment | The continuous process of identifying hazards, assessing risk, taking action to eliminate or reduce risk, monitoring and reviewing, in the rapidly changing circumstances of an operational incident. ⁶⁶ |
| Escape plan | Predetermined actions to be enacted in the event of unforeseen hazardous circumstances (for instance, an unexpected change in fire behaviour). An escape plan must include an escape route. The development of an escape plan is a key element of the LACES Safety Protocol. |
| Escape route | A pre-planned route to be taken in the event of unforeseen hazardous circumstances (for instance, an unexpected change in fire behaviour). An escape route is an important part of an escape plan and is a key element of the LACES Safety Protocol. |
| Evacuation | The removal of people from dangerous or potentially dangerous areas and their subsequent relocation to safe areas. |
| Extreme fire behaviour | Fire behaviour that becomes erratic or difficult to predict due to its rate of spread and/or flame length. This type of fire behaviour often influences its environment and can represent a significant risk to suppression personnel. |
| Fire behaviour forecast | A prediction of probable fire behaviour to be used to inform fire suppression operations. Fire behaviour forecasts can be used to maintain safety, as well as for other purposes. |
| Fire danger | A general term used to express an assessment of both fixed and variable factors of the fire environment that determine the ease of ignition, rate of spread, difficulty of control, and impact. Fire danger is often expressed as an index. ⁶⁷ |
| Fire prediction system | A method or tool used to forecast future behaviour of a fire. Fire prediction systems are an important tool that can be used to maintain safety. |

⁶⁶ HM Government (2008) *The Fire Service Manual Volume 2, Fire Service Operations: Incident Command*, Third Edition (London: TSO), available at:

<http://www.communities.gov.uk/documents/fire/pdf/incidentcommand.pdf>

⁶⁷ Source: Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology* (Global Fire Monitoring Center, Freiburg), p.121.

Chapter 7 - Safety

| Term | Definition |
|--------------------------------------|--|
| Fire risk | The probability of a wildfire occurring and its potential impact on a particular location at a particular time. Wildfire risk is calculated using the following equation: $\text{Fire risk} = \text{probability of occurrence} \times \text{potential impact}$ |
| Fire shelter | A small single person aluminized cover that can provide an individual with some protection from the effects of fire in a fire entrapment situation. |
| Flame risk | An assessment of risk to fire suppression personnel which is calculated using flame length. |
| Flare up | A short and sudden increase in fire activity. |
| Flashing | Rapid ignition of unburned gases released into the atmosphere as a result of heat generated by a wildfire. Normally observed during high intensity fires. Flashing can represent a significant risk to the safety of suppression personnel. |
| Fuel-driven fire | A fire or part of a fire that is spread predominantly by the arrangement, condition, and/or other characteristics of the fuel within which it is burning. This situation occurs in the absence of a significant effect from the forces of alignment, such as wind, slope and aspect. Fuel-driven fires can produce erratic fire behaviour, which can represent a significant risk to suppression personnel. |
| Gorge | A deep, narrow and extremely steep-sided valley which usually has a river occupying its entire floor. Gorges are very dangerous topographical features because they can support extreme fire behaviour. |
| Gully ⁶⁸ | A relatively steep-sided water channel formed on a hillside. A gully might only contain water during periods of heavy rain. Gullies are dangerous topographical features because they can support extreme fire behaviour. |
| Hazard | Anything which has the potential to cause harm. |
| Hyperthermia | A condition in which a person's core body temperature becomes elevated. It occurs when the body produces or absorbs more heat than it can dissipate. The most common cause of hyperthermia at a wildfire incident is prolonged exposure to excessive heat or heat and humidity. When a person's body temperature is elevated sufficiently high, hyperthermia becomes a medical emergency requiring immediate treatment to prevent disability or death. |
| Hypothermia | A condition in which a person's core body temperature drops below the temperature required for normal metabolism and body functions. The condition is usually the result of prolonged exposure to cold temperatures, although there may be other influencing factors. Any person suffering from hypothermia should be treated as a medical emergency and immediate treatment should be sought to prevent disability or death. |
| Incident | An occurrence or event that requires action to prevent or minimise loss of life, damage to property or damage to the environment. |
| Incident Command | The authority of an agency to direct and control resources at an event/occurrence which requires action to prevent loss of life or damage. |
| Incident Command System (ICS) | A standardized emergency management system which is specifically designed to allow its users to adopt an integrated organisational structure equal to the complexity and demands of single or multiple wildfire incidents. An ICS provides a standard framework within which individuals and teams present at an incident can work together safely and effectively. |

⁶⁸ May also be called a "re-entrant".

Chapter 7 - Safety

| Term | Definition |
|-------------------------------|---|
| Incident Commander | The nominated competent officer who has overall responsibility for safety, tactics and management of resources at a wildfire incident. |
| LACES | <p>An essential safety protocol which should be implemented at wildfire incidents to address risks and hazards. The correct implementation of LACES helps to ensure that suppression personnel are appropriately supervised, informed and warned of risks and potential hazards and that they are aware of how and where to escape should a high risk situation occur.</p> <p>LACES is an acronym for:</p> <ul style="list-style-type: none"> • L = Lookouts • A = Awareness or Anchor Point • C = Communication • E = Escape route and plan • S = Safe area |
| Lateral confinement | Restriction of fire spread caused by topographical features. When wildfires are confined by topographical features such as gullies, ravines, or narrow valleys, convective heating by confined gases and radiation feedback from flames and burning vegetation increases the heat release rate of the burning fuels. Rapid fire spread is also enhanced by the acceleration and channelling of wind through these topographical features. These factors may result in a more rapid combustion and spread than that of an unconfined vegetation fire. ⁶⁹ Lateral confinement can produce fire behaviour which poses a significant risk to the health and safety of suppression personnel. |
| Line of communication | The means by which messages are sent between suppression personnel within the chain of command. ⁷⁰ |
| Lookout | A person responsible for supervising safety. Lookouts are a key element of the LACES safety protocol. |
| Medical emergency | An injury or illness that poses an immediate risk to a person's life or long term health. |
| Mega fire | A wildfire demonstrating abnormally extreme fire behaviour. Mega fires will usually represent a significant challenge to suppression agencies because they are very resource intensive to suppress and can pose a significant risk to the safety of suppression personnel. |
| Near miss incident | An unexpected and undesirable event where injuries or illness and/or damage to property or the environment are narrowly avoided. Under slightly different circumstances, the same event could have caused an accident. |
| Military training area | A section of land used by a military organisation to experiment, test and/or train with weapons and other military technology. The unexploded ordnance found within some military training areas may pose a significant risk to suppression personnel responding to wildfire incidents. |
| Patrol | The act of supervising a specified area in order to prevent, detect and/or control a wildfire. |

⁶⁹The first part of this definition is based on the definition provided within: NFPA (2011) *NFPA 921 – Guide for Fire and Explosion Investigations* (NFPA, Quincy, Massachusetts), p.262.

⁷⁰ Importantly, a *line of communication* operates on a two-way system with information flowing from both the higher to the lower levels and the lower to the higher levels of the *chain of command*.

Chapter 7 - Safety

| Term | Definition |
|--|--|
| Personal Protection Equipment (PPE) | Any equipment or clothing required to maintain the safety of suppression personnel at a particular wildfire incident. While some PPE will most likely be required at all wildfire incidents, the need for some types of PPE will vary according to the particular conditions experienced at an incident. To provide an example, suppression personnel operating at a wildfire incident at night will require lighting. |
| Reconnaissance | The act of gathering information about a wildfire incident in order to monitor fire behaviour and suppression activities. The primary reasons for completing reconnaissance should be to maintain safety and to assess the effectiveness of a fire suppression plan. |
| Report | <ul style="list-style-type: none"> • The process whereby resources first register their arrival at a wildfire incident; or, • A formal statement of the results of an activity or of an investigation. Reports may analyse situations, provide progress updates on current assignments, draw conclusions and/or make recommendations. A report can be either verbal or written. |
| Responsibility | The duty or obligation to satisfactorily perform or complete an assignment. |
| Restricted area | An area in which specified activities or entry are temporarily or permanently restricted in order to mitigate risk to human health or safety by potential or on-going wildfires. A restricted area may also be temporarily or permanently established in order to reduce the risk of a wildfire igniting within a specified location. |
| Risk | The probability of a hazardous event occurring and the potential outcome/consequences of that hazardous event. Risk is calculated using the following equation: $\text{Risk} = \text{probability of occurrence} \times \text{potential impact}$ |
| Risk assessment | The process of establishing information regarding acceptable levels of risk and actual levels of risk posed to an individual, group, society or the environment. The process involves the identification of risk, an assessment of probability and an assessment of potential impact. |
| Risk management | A process involving the systematic application of policies, procedures and practices to identify, analyse, evaluate, manage, control, communicate and monitor risks. ⁷¹ |
| Role regression | When an individual reverts back to behaviour and actions that are characteristic of a past role they once held. For instance, this could be a team leader reverting back to the behaviour and actions required of a fire fighter. |
| Role rotation | The act or process of periodically changing the assignments provided to individuals working at a wildfire incident to ensure adequate rest breaks and appropriate variety in the physical and mental intensity of tasks completed by all team members. |
| Saddle | A depression between two hills or mountains, so-called because of its similarity to the shape of a horse riding saddle. Wind is often funnelled and intensified between the two hills of a saddle. Saddles are therefore dangerous topographical features because they can support extreme fire behaviour. |

⁷¹ Based on the definition presented within the final report of the ANSFR Project: *The ANSFR Project Final Report: Recommendations for Improving Fire Risk Assessment and Management in Europe* (2010), p.9 - http://www.fire-risk.eu/resources/documents/document_display.htm?pk=88

Chapter 7 - Safety

| Term | Definition |
|------------------------------|--|
| Safe area | An identified area of safety where people can find refuge. The identification of a safe area is a key element of the LACES safety protocol. |
| Safe systems of work | A formal procedure which results from systematic examination of a task in order to identify potential hazards and risks. The resulting document produced will describe the safest way(s) of completing a task to ensure hazards are eliminated or that risks are controlled as far as possible. |
| Safety | When exposure to hazards has been controlled to an acceptable level. |
| Safety officer | An officer appointed to manage risk. |
| Safety release | A release of water or retardant over a vehicle or group of individuals in difficulty on the ground for the purpose of reducing the intensity of the fire to enable the personnel to escape. |
| Shock | A life threatening condition that occurs when the body's vital organs, such as the brain and heart, are deprived of oxygen due to a problem affecting the circulatory system. The most common cause of shock is blood loss but it can also be caused by other fluid loss such as vomiting or severe burns. ⁷² |
| Situational awareness | The perception of the surrounding environment within the context of both time and space. It includes the comprehension of meaning of observed phenomena and patterns and the provision of information relevant to a team or individual's situation. It also includes the projection and prediction of what will happen within the surrounding environment in the future. |
| Snag | A standing dead tree or part of a dead tree. Unstable snags can pose serious safety hazards to suppression personnel. |
| Spotting | Fire behaviour characterised by sparks and embers that are transported through the air by the wind or convection column. Spotting can be classified as short range or long range and can represent a significant risk to fire suppression personnel. |
| Stress | The harmful physical or psychological reactions that occur when people are subject to excessive demands, unrealistic expectations and/or threatening situations. Signs of stress may be cognitive, emotional, physical and/or behavioural. |
| Stressor | An event or stimulus that induces stress. |
| Stump | The woody base of a tree that remains in the ground after felling. Stumps are common slip, trip and fall hazards at wildfire incidents. |
| Stump hole | A hole in the ground, sometimes containing smouldering embers, which is formed when the woody base of a tree is burned. Stump holes are common burn and slip, trip and fall hazards at wildfire incidents. |
| Tactics | The deployment of resources at a wildfire incident to achieve the aims of a fire suppression plan. |
| Tactical lookout | A person with an advanced understanding of wildfire behaviour who acts as a safety officer at a wildfire incident. He/she will observe the fire and the action of teams involved in fire suppression. He/she will maintain close communication with suppression teams and supervisors and will be responsible for ensuring the safety of all individuals present at the incident. Lookouts are a key element of the LACES safety protocol. |
| Team supervisor | A person who manages the actions, assignments and safety of a team. |

⁷² Website: <http://www.sja.org.uk/sja/first-aid-advice/shock.aspx>

Chapter 7 - Safety

| Term | Definition |
|--------------------------|---|
| Water Safety Plan | <p>A plan that is created to assure the safety of water bombing aircraft and other users of a body of water used for water filling. A water safety plan will commonly document the following types of arrangements:</p> <ul style="list-style-type: none">• Measures to be implemented to inform users of a body of water about its use by water bombing aircraft.• Systems and protocols for towing and salvage of water bombing aircraft that breaks down on the water.• Systems and protocols for providing aid and assistance to the crew of a water bombing aircraft which has broken down on the water. |

Chapter 8 – Incident Command

Incident Command: “The authority of an agency to direct and control resources at an event/occurrence which requires action to prevent loss of life or damage.”



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Chapter 8 – Incident Command

| Term | Definition |
|----------------------------|---|
| Access | A point of entry, exit and/or route to an incident location. |
| Accountability | The obligation of an individual or organization to justify its actions and to accept responsibility concerning the decisions that were made which determined the actions taken. Accountability cannot be delegated. |
| Assigned resources | Resources that have been allocated work tasks at a wildfire incident. |
| Assignment | A task allocated to an individual or team to complete. |
| Authority | The legal right to attend and complete actions and assignments at a wildfire incident. |
| Available resources | Resources which are present and ready for assignments at a wildfire incident. |
| Bearing | The horizontal direction to or from any point, usually measured clockwise from true north, or some other reference point, through 360 degrees. ⁷³ |
| Blind area | An area in which neither the ground nor its vegetation can be seen from an observation point. |
| Breakout | The escape of a fire from an area of containment. |
| Briefing | A meeting during which relevant information is exchanged. |
| Burn plan | A pre-determined scheme or programme of activities which is formulated in order to safely and effectively accomplish the objectives of a managed burn. A burn plan will outline the selection of tactics, selection of resources, resource assignments and how performance will be monitored during a managed burn. It should be noted that a burn plan may need to be dynamic to take into account any changes in conditions or circumstances. |
| Burn team | A group of individuals with the collective competencies to safely and effectively carry out an operational burn. |
| Burn supervisor | A person who manages the actions, assignments and safety of a burn team. |
| Chain of command | The line of authority and responsibility along which operational orders are passed. Also commonly referred to as “line of command”. |
| Command | The authority of an agency to direct and control resources. Command is delegated to an individual. |
| Communications Plan | A pre-determined scheme which details the methods and systems to be used by suppression personnel (within one or multiple agencies) to communicate with each other during a wildfire incident. |
| Competency | When a person has the authority and sufficient technical knowledge, training and experience to carry out their assigned tasks safely and effectively. |
| Containment | An area of a fire where control has been established and no breakout is anticipated. |
| Contingency Plan | A pre-prepared alternative plan which can be implemented if circumstances change. |
| Controlled Fire | A fire with a secure perimeter, where no breakouts are anticipated. |
| Control room | An emergency centre which receives emergency telephone calls and which coordinates the mobilization and demobilization of appropriate available resources to/from incidents. |
| Cooperating agency | Any organisation supplying resources to assist with the implementation of a fire suppression plan. A cooperating agency differs from a partnership agency in the sense that it only comes to the assistance of a suppression agency when a wildfire occurs. |

⁷³ Source: Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology* (Global Fire Monitoring Center, Freiburg), p.29.

Chapter 8 – Incident Command

| Term | Definition |
|--|--|
| Coordinates | Alphanumeric characters that are used to describe the precise geographic location of a point on the earth's surface. |
| Critical point | A point in time or space when/where there will be a significant influence on fire spread, rate of spread and/or fire intensity. |
| Delegation | To give responsibility to competent persons to complete assignments and/or to make decisions. |
| Demobilize | To direct resources to return to their normal base. |
| Estimated Time of Arrival (ETA) | The predicted time that a resource will reach a specified destination. |
| Fire fighter | Any competent person deployed at a wildfire incident to undertake assignments that contribute to fire suppression operations. |
| Fire investigation | The process of determining the origin, cause, and development of a fire. ⁷⁴ |
| Fire Management Plan | A plan detailing predetermined fire suppression strategies and tactics to be implemented following the occurrence of a wildfire within a particular area. |
| Fire perimeter | The entire outer boundary of a fire. |
| Fire risk | The calculation of the probability of a wildfire occurring and its potential impact on a particular location at a particular time. Wildfire risk is calculated using the following equation: $\text{Fire risk} = \text{probability of occurrence} \times \text{potential impact}$ |
| Fire Suppression Plan | A pre-determined scheme or programme of activities which is formulated in order to safely and effectively accomplish fire suppression objectives. A fire suppression plan will outline the selection of tactics, selection of resources, resource assignments and how performance and safety will be monitored and maintained at a particular incident. Fire suppression plans need to be dynamic to take into account any changes in conditions or circumstances. |
| Geographic Information System (GIS) (GIS) | A system designed to capture, store, manipulate, analyze, and present geographically referenced data. |
| Global Positioning System (GPS) (GPS) | A global navigation system that provides very precise positioning information about the location of any point on or near the Earth's surface. |
| Ground team | Any supervised group of individuals operating on the ground at a wildfire incident. This term is usually only required if an incident involves aerial operations. |
| Hand team | A supervised group of individuals tasked with carrying out an assignment (s) at a wildfire incident using hand tools. |
| Hand line | A control line constructed using hand tools. |
| Holding area | Location established at an incident where resources can be placed while awaiting assignment. |
| Incident | An occurrence or event that requires action to prevent or minimise loss of life, damage to property or damage to the environment. |
| Incident Command | The authority of an agency to direct and control resources at an event/occurrence which requires action to prevent loss of life or damage. |
| Incident Commander | The nominated competent officer who has overall responsibility for safety, tactics and management of resources at a wildfire incident. |

⁷⁴ Source: NFPA (2011) NFPA 921 – Guide for Fire and Explosion Investigations (NFPA, Quincy, Massachusetts), p.14.

Chapter 8 – Incident Command

| Term | Definition |
|--------------------------------------|---|
| Incident Command Point | The geographic location where the Incident Commander is based. |
| Incident Command Support | Any person or assignment that provides direct assistance to the Incident Commander. |
| Incident Command System (ICS) | A standardized emergency management system which is specifically designed to allow its users to adopt an integrated organisational structure equal to the complexity and demands of single or multiple wildfire incidents. An ICS provides a standard framework within which individuals and teams present at an incident can work together safely and effectively. |
| Incident objectives | The desired results to be achieved at a wildfire incident. Incident objectives must be realistic, achievable and measurable, but they must also be flexible enough to allow for strategic and tactical alternatives. They must also be established within the framework of a safe and effective Incident Command System. |
| Incident support | A group or organisation responsible for providing personnel, equipment and/or welfare facilities and supplies in support of suppression operations. |
| Initial response | The first suppression resources mobilised to a wildfire incident. |
| LACES | <p>An essential safety protocol which should be implemented at wildfire incidents to address risks and hazards. The correct implementation of LACES helps to ensure that suppression personnel are appropriately supervised, informed and warned of risks and potential hazards and that they are aware of how and where to escape should a high risk situation occur.</p> <p>LACES is an acronym for:</p> <ul style="list-style-type: none"> • L = Lookouts • A = Awareness or Anchor Point • C = Communication • E = Escape route and plan • S = Safe area |
| Line of communication | The means by which messages are sent between suppression personnel within the chain of command. ⁷⁵ |
| Lookout | A person responsible for supervising safety. Lookouts are a key element of the LACES safety protocol. |
| Message | An exchange of information at an incident, either via radio or by some other means, where there is no need for a briefing to take place. |
| Mobilize | To direct resources to attend an incident. |
| Mop up | The act of extinguishing a fire after it has been brought under control. ⁷⁶ Mop up involves carrying out all necessary actions to prevent re-ignition. |
| Multi-agency incident | An incident involving more than one agency. |

⁷⁵ Importantly, a *line of communication* operates on a two-way system with information flowing from both the higher to the lower levels and the lower to the higher levels of the *chain of command*.

⁷⁶ Source: Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology* (Global Fire Monitoring Center, Freiburg), p.142 (defined within the term “Fire Suppression”).

Chapter 8 – Incident Command

| Term | Definition |
|--------------------------|---|
| Partner agencies | Any organisations that work together to prevent, investigate and/or suppress wildfires. Partnership agencies will work together on preparedness activities and plans and are likely to have formulated pre-agreed partnership agreements. |
| Preparedness plan | A pre-determined scheme or programme of activities which is formulated in order to satisfactorily prepare an organisation or a geographic area to respond effectively to wildfire incidents. |

Chapter 9 - Tactics

Tactics: “The deployment of resources at a wildfire incident to achieve the aims of a fire suppression plan.”



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Chapter 9 – Tactics

| Term | Definition |
|----------------------------|--|
| Access | A point of entry, exit and/or route to an incident location. |
| Advancing fire | This is fire progression associated with the head (front) of the fire. Fire behaviour in this area is usually characterized by more intense burning, increased flame height and length and more rapid rates of spread. It will usually occur when a fire burns with the support of one or more forces of alignment (for instance, wind or slope). ⁷⁷ |
| Aerial attack | A fire suppression operation involving the use of aircraft to release water or retardant on or near a wildfire. An aerial attack can be: <ul style="list-style-type: none"> • Direct attack (aerial) <ul style="list-style-type: none"> • Head attack (aerial) • Tail attack (aerial) • Indirect attack (aerial) <ul style="list-style-type: none"> • Flank attack (aerial) • Parallel attack (aerial) |
| Aerial coordination | The management of aerial operations at a wildfire incident. This role always has two key aims: <ul style="list-style-type: none"> • To protect the safety of all aircraft and suppression personnel on the ground. • To optimise the efficiency of all aerial resources. |
| Aerial detection | The act or process of discovering, locating and reporting wildfire incidents from aircraft. Aerial detection can be: <ul style="list-style-type: none"> • Planned – where an agency mobilizes aircraft with aerial observers for the specific purpose of detecting wildfires; • Unplanned – where an aircraft not specifically hired or mobilised to detect wildfires reports a wildfire to a responsible agency. For example, unplanned aerial detection may come from passenger airplanes or other leisure aircraft. |
| Aerial operations | Any manoeuvre completed by an aircraft in support of wildfire suppression activities, inclusive of: <ul style="list-style-type: none"> • direct attack through drops of water or retardant • indirect attack through retardant drops • cargo drops of supplies • aerial observation and reconnaissance |

⁷⁷ This is an amendment of the definition of “*advancing fire*” provided within the National Wildfire Coordinating Group (2005) *Wildfire Origin and Cause Determination Handbook* (National Wildfire Coordinating Group Fire Investigation Working Team; USA), p.7.

Chapter 9 – Tactics

| Term | Definition |
|---|--|
| Aerial reconnaissance | <p>Use of aircraft for conducting preliminary surveys of a wildfire to gather information on:</p> <ul style="list-style-type: none"> • fire behaviour • topography and fuel types • potential hazards and high risk areas • potential windows of opportunity • safety of ground personnel <p>The information gathered from aerial reconnaissance will be communicated to the Incident Commander to assist in the decision-making process.</p> |
| Aerial resources | Aircraft, including helicopters, aeroplanes and drones, which can be used to attack the fire or observe its development. It also includes supporting personnel and equipment. |
| Aerial Coordinator ⁷⁸ | The pilot or officer appointed to carry out the task of air coordination. The Aerial Coordinator will usually have authority over all aerial resources involved in aerial operations at the incident. |
| Anchor point | A location on the landscape which is strong enough to act as barrier to fire spread. The commencement of suppression operations from an anchor point ensures that a wildfire cannot escape from an area of containment which could threaten the success of the operation and/or the safety of suppression personnel. It may be necessary for anchor points to be strengthened before use or even created by hand or machine. The creation of an anchor point is sometimes a key element included within the LACES safety protocol. |
| Area ignition | Ignition of several individual fires throughout an area, either simultaneously or in rapid succession, and so spaced that they add to and influence the main body of the fire to produce a hot, fast-spreading fire condition. ⁷⁹ |
| Area of origin | General geographical location within a fire scene where the point of ignition is believed to be located. |
| Assigned resources | Resources that have been allocated work tasks at a wildfire incident. |
| Assignment | A task allocated to an individual or team to complete. |
| Attack a fire | <p>A generic term for the various methods that can be used to suppress a fire or parts of a fire, including:</p> <ul style="list-style-type: none"> • Direct attack • Indirect attack • Aerial attack • Head attack • Tail attack • Flank attack • Parallel attack |
| Authority | The legal right to attend and complete actions and assignments at a wildfire incident. |
| Available fuels | The proportion of the total fuel that would burn under specified burning and fuel conditions. |

⁷⁸ In some countries, such as the USA and Spain, the alternative term of “Aerial Tactical Group Supervisor” (ATGS) has been adopted.

⁷⁹ Source: National Wildfire Coordinating Group (2008) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.29.

Chapter 9 – Tactics

| Term | Definition |
|----------------------------|---|
| Available resources | Resources which are present and ready for assignments at a wildfire incident. |
| Backing fire | A lower intensity fire or part of a fire which burns against the wind and/or down slope. |
| Baseline | The initial line of fire ignited along a control line to contain and control subsequent burn operations. |
| Bearing | The horizontal direction to or from any point, usually measured clockwise from true north, or some other reference point, through 360 degrees. ⁸⁰ |
| Black area | An area of fuel that is black in appearance because some or all of the fuel has been burnt. |
| Breakout | The escape of a fire from an area of containment. |
| Briefing | A meeting during which relevant information is exchanged. |
| Burn | <ul style="list-style-type: none"> a) To be on fire. b) An area of fuel consumed or partly consumed by a fire. c) An injury to flesh caused by a cauterizing agent, heat from a fire, or a heated object. d) A managed fire (i.e. an operational burn or prescribed burn) |
| Burning conditions | The state of the combined components of the fire environment that influence fire behaviour within available fuels. Burning conditions are usually specified according to the factors of aspect, weather, slope/topography, and fuel type and load. |
| Burn out | The intentional burning of parcels of fuel to prevent fire spread. This is normally carried out to consume fuel between a control line and the fire edge. |
| Burning regulations | Rules and restrictions concerning the use of operational burns as a fire suppression tactic. |
| Burning period | The dates/months of the year when land management burning is legally permitted. |
| Burn plan | A pre-determined scheme or programme of activities which is formulated in order to safely and effectively accomplish the objectives of a managed burn. A burn plan will outline the selection of tactics, selection of resources, resource assignments and how performance will be monitored during a managed burn. It should be noted that a burn plan may need to be dynamic to take into account any changes in conditions or circumstances. |
| Burn team | A group of individuals with the collective competencies to safely and effectively carry out an operational burn. |
| Burn severity | A qualitative assessment of the level of heat generated by a fire/burn and the resulting impact on a fuel. |
| Burn supervisor | A person who manages the actions, assignments and safety of a burn team. |
| Catch trench | A small ditch constructed below a fire on sloping ground to catch burning material rolling down slope. |
| Centre burn | An ignition technique whereby a fire is ignited in the approximate middle of an area of unburned fuel. A ring burn is then ignited around the perimeter of the area of unburned fuel. The intention of a centre burn is to create a strong convection plume that draws the subsequent ring burn inwards and, therefore, normally away from any existing control lines. |
| Clean burn | A fire that consumes all vegetation and litter above the ground exposing the mineral soil. |

⁸⁰ Source: Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology* (Global Fire Monitoring Center, Freiburg), p.29.

Chapter 9 – Tactics

| Term | Definition |
|--------------------------------|--|
| Competency | When a person has the authority and sufficient technical knowledge, training and experience to carry out their assigned tasks safely and effectively. |
| Condition of vegetation | Stage of growth or degree of flammability of vegetation that forms part of a fuel complex. This will be dependent upon time of year, amount of curing and weather conditions. |
| Containment | An area of a fire where fire spread has been prevented and no breakout is anticipated. |
| Contingency plan | A pre-prepared alternative plan which can be implemented if circumstances change. |
| Controlled fire | A fire with a secure perimeter, where no breakouts are anticipated. |
| Control line | An inclusive term for all constructed or natural barriers and treated fire edges used to control a fire. ⁸¹ |
| Cool fire | When fuels burn and produce a low intensity fire. |
| Cooperating agency | Any organisation supplying resources to assist with the implementation of a fire suppression plan. A cooperating agency differs from a partnership agency in the sense that it only comes to the assistance of a suppression agency when a wildfire occurs. |
| Counter burn | A planned operational burn which is lit between a control line and an advancing wildfire to take advantage of in drafts towards the fire front. |
| Critical point | A point in time or space when/where there will be a significant influence on fire spread, rate of spread and/or fire intensity. |
| Demobilize | To direct resources to return to their normal base. |
| Direct attack | An offensive fire suppression tactic which involves an attack being made at or near the fires edge. This technique normally relies on the use of hand tools and or water. |
| Dynamic risk assessment | The continuous process of identifying hazards, assessing risk, taking action to eliminate or reduce risk, monitoring and reviewing, in the rapidly changing circumstances of an operational incident. ⁸² |
| Escape plan | A predetermined list of actions to be enacted in the event of unforeseen hazardous circumstances (for instance, an unexpected change in fire behaviour). An escape plan must include an escape route. The development of an escape plan is a key element of the LACES Safety Protocol. |
| Escape route | A pre-planned route to be taken in the event of unforeseen hazardous circumstances (for instance, an unexpected change in fire behaviour). An escape route is an important part of an escape plan and is a key element of the LACES Safety Protocol. |
| Evacuation | The removal of people from dangerous or potentially dangerous areas and their subsequent relocation to safe areas. |
| Extinction | When the combustion process ceases. |
| Fire activity | Description of a fire based on an assessment of visible evidence, including the rate of spread, flame length, fire severity, and fire behaviour. |

⁸¹ Source: National Wildfire Coordinating Group (2008) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.50.

⁸² HM Government (2008) *The Fire Service Manual Volume 2, Fire Service Operations: Incident Command*, Third Edition (London: TSO), available at:

<http://www.communities.gov.uk/documents/fire/pdf/incidentcommand.pdf>

Chapter 9 – Tactics

| Term | Definition |
|--------------------------------|---|
| Fire analysis | The process of reviewing the behaviour and effects of a specific fire or group of fires and/or the actions that have been taken or which might be needed to suppress it/them. |
| Fire behaviour | The reaction of a fire to the influences of fuel, weather, and topography. Different types of fire behaviour include: <ul style="list-style-type: none"> • Smouldering fire - A fire burning without flame and with minimal rate of spread. • Creeping fire - A fire with a low rate of spread and generally with a low flame length. • Running fire - A fire with a high rate of spread. • Torching - A fire that burns from the ground through the surface and aerial fuels and into the crown of a single tree or small parcel of trees. • Spotting - fire behaviour where sparks and hot burning embers are transported by the wind or convection column to land beyond the fire perimeter resulting in spot fires. • Crowning – When a fire burns freely in the upper foliage of trees and shrubs. |
| Fire behaviour forecast | A prediction of probable fire behaviour to be used to inform fire suppression operations. |
| Firebreak | An area on the landscape where there is a discontinuity in fuel which will reduce the likelihood of combustion or reduce the likely rate of fire spread. |
| Fire danger | A general term used to express an assessment of both fixed and variable factors of the fire environment that determine the ease of ignition, rate of spread, difficulty of control, and impact. Fire danger is often expressed as an index. ⁸³ |
| Fire edge | Used to refer to any section of the fire perimeter. |
| Fire environment | A generic collective term used to describe the surrounding conditions of topography, fuel, and weather. These three environmental influences collectively determine fire behaviour, fire effects and fire impact. |
| Fire investigation | The process of determining the origin, cause, and development of a fire. ⁸⁴ |
| Fire footprint | The resulting impression created by a fire burning within an area of fuel. |
| Fire perimeter | The entire outer boundary of a fire. |
| Fire Plan ⁸⁵ | A plan detailing predetermined fire suppression strategies and tactics to be implemented following the occurrence of a wildfire within a particular area. |
| Fire prediction system | A method or tool used to forecast future behaviour of a fire. |
| Fire risk | The calculation of the probability of a wildfire occurring and its potential impact on a particular location at a particular time. Wildfire risk is calculated using the following equation: <p style="text-align: center;">Fire risk = probability of occurrence x potential impact</p> |

⁸³ Source: Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology* (Global Fire Monitoring Center, Freiburg), p.121.

⁸⁴ Source: NFPA (2011) *NFPA 921 – Guide for Fire and Explosion Investigations* (NFPA, Quincy, Massachusetts), p.14.

⁸⁵ Sometimes referred to as a *Fire Management Plan*.

Chapter 9 – Tactics

| Term | Definition |
|------------------------------|--|
| Fire severity | <p>Fire severity can be defined in two ways:</p> <ul style="list-style-type: none"> • The degree to which a site has been altered or disrupted by fire.⁸⁶ • The capacity of a fire to cause damage.⁸⁷ <p>Fire intensity and the amount of time a fire burned within a particular area, among other possible factors, will influence fire severity.</p> |
| Fire spread | The movement of a fire through available fuels arranged across the landscape. |
| Fire Suppression Plan | A pre-determined scheme or programme of activities which is formulated in order to safely and effectively accomplish fire suppression objectives. A fire suppression plan will outline the selection of tactics, selection of resources, resource assignments and how performance and safety will be monitored and maintained at a particular incident. Fire suppression plans need to be dynamic to take into account any changes in conditions or circumstances. |
| Fire types | <p>There are three different schemes for classifying fire type:</p> <ol style="list-style-type: none"> 1. Classification of a fire or section of fire according to the fuel level within which it occurs. For example, aerial, crown, understory, surface and ground fires. 2. Classification of a section of fire according to its position along the fire perimeter. For example, head, tail and flank fires. 3. Classification of a fire or section of fire according to the visual characteristics it displays. For example, smouldering, creeping, backing, running, torching, spotting, crowning, fire whirl, convection driven fire etc. |
| First responders | The first person/people to arrive at the scene of a wildfire. It is often used as a generic term for all emergency service personnel who are expected to respond to emergency incidents. |
| Flame angle | The angle of a flame measured in relation to the ground surface. Flame angle is expressed in degrees. |
| Flame height | The vertical extension of a flame. Measurement of flame height is calculated perpendicular from ground level to the tip of the flame. Flame height will be less than flame length if flames are tilted due to wind or slope. |
| Flame length | The total length of a flame measured from its base at ground level to the flame tip. Flame length will be greater than flame height if flames are titled due to wind or slope. |
| Flame risk | An assessment of risk to fire suppression personnel which is calculated using flame length. |
| Flanks | The parts of a fire's perimeter that are roughly parallel to the main direction of fire spread. ⁸⁸ The flanks usually have less fire intensity than the head fire because they have a weaker alignment with wind or slope. |

⁸⁶ Based on the definition of “Fire Severity” within National Wildfire Coordinating Group (2011) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.78.

⁸⁷ British Standards Institution (2010) *Fire Safety Vocabulary* (ISO 13943: 2008; BS EN ISO 13943:2010), (BSI Standards Publication, London), 4.130, p.15.

⁸⁸ Source: National Wildfire Coordinating Group (2011) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.84.

Chapter 9 – Tactics

| Term | Definition |
|--|--|
| Flank attack | A method of fire suppression which involves attacking a wildfire along the flank or both flanks simultaneously. |
| Flank attack (aerial) | A method of fire suppression which involves dropping water or retardant along a flank or simultaneously along both flanks of a wildfire. |
| Foam | A mass of bubbles formed by mixing specific proportions of air with water and a foam concentrate. It can be applied to smother and cool parts of a fire and/or to prevent ignition within a fuel. |
| Forces of alignment | Within the complex wildfire environment, several forces have a significant impact on fire behaviour. These forces can support or hinder fire development and can be used to predict likely fire behaviour, including fire spread and fire intensity. Wind and slope are two key forces of alignment. |
| Fuel treatment | The deliberate manipulation or removal of fuels using one or more of a variety of different means ⁸⁹ to: <ul style="list-style-type: none"> • reduce the likelihood of ignition; and/or, • reduce potential fire intensity; and/or, • reduce potential damage; and/or, • assist suppression activities. |
| Gels | Chemicals which are added to water to make it thicken. When used as an extinguishing agent the mixture is able to absorb more heat than water and sticks to the surface of the fuel. |
| Geographic Information System (GIS) | A system designed to capture, store, manipulate, analyze, and present geographically referenced data. |
| Global Positioning System (GPS) | A global navigation system that provides very precise positioning information about the location of any point on or near the Earth's surface. |
| Ground team | Any supervised group of individuals operating on the ground at a wildfire incident. This term is usually only required if an incident involves aerial operations. |
| Hand team | A supervised group of individuals which is tasked with carrying out an assignment (s) at a wildfire incident. |
| Hand line | A control line constructed using hand tools. |
| Head attack | A method of fire suppression which involves an attack being made at the head of a wildfire. This tactic is not often adopted because of the increased risk to suppression personnel. |
| Head attack (aerial) | A method of fire suppression which involves the release of water or fire retardant from the air directly onto the head of a wildfire. |
| Head fire | The leading part of an advancing wildfire at a particular point in time. The head fire will usually exhibit the highest level of fire activity and fire intensity of any part of the fire. |
| Heat probe | Apparatus used to detect heat. ⁹⁰ |
| Holding area | Location established at an incident where resources can be placed while awaiting assignment. |
| Hot fire | A high intensity fire or part of a fire. |

⁸⁹ Inclusive of the following means: manual, mechanical, chemical, or using fire.

⁹⁰ Source: National Wildfire Coordinating Group (2011) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.96.

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| Term | Definition |
|--------------------------------|--|
| Hot spot | A small burning area within a fire perimeter which requires suppression action as part of the mop-up phase of suppression. |
| Ignition | The initiation of combustion. |
| Ignition method | The means by which a fire is ignited. |
| Ignition patterns | A generic term for the three key techniques for igniting a managed burn: <ul style="list-style-type: none"> • Line ignition - igniting a burn in strips along a control line and the adjacent fuel. • Points of fire ignition - igniting a number of fires within an area of fuel. The aim of this technique is for the individual fires to burn into one another. • Fingers of fire ignition⁹¹ - a low intensity back burn which is achieved by igniting lines of fire at right angles to a control line and parallel to the wind. |
| Incendiary | A device that is purposefully designed to ignite a fire. |
| Incident | An occurrence or event that requires action to prevent or minimise loss of life, damage to property or damage to the environment. |
| Incident Command Point | The geographic location where the Incident Commander is based. |
| Incident Command System | A standardized emergency management system which is specifically designed to allow its users to adopt an integrated organisational structure equal to the complexity and demands of single or multiple wildfire incidents. An ICS provides a standard framework within which individuals and teams present at an incident can work together safely and effectively. |
| Incident Commander | The nominated competent officer who has overall responsibility for safety, tactics and management of resources at a wildfire incident. |
| Incident support | A group or organisation responsible for providing personnel, equipment and/or welfare facilities and supplies in support of suppression operations. |
| Indirect attack | Any suppression methods implemented away from the fire edge. |
| Initial attack | Suppression work completed by first responders arriving at a wildfire incident. The intention of any initial attack will always be to quickly gain control of a fire. If an initial attack is unsuccessful then a prolonged attack strategy might be required. |
| Initial response | The first suppression resources mobilised to an incident following the detection of a wildfire. These resources will be available to participate in initial attack operations. |
| Knock down | To reduce the flame or heat of burning parts of a fire. |

⁹¹ This should not be confused with the term “*fingers of fire*” which is defined within this glossary as “An elongated burned area projecting from the main body of the fire resulting in an irregular fire perimeter”

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| Term | Definition |
|------------------------------|--|
| LACES | <p>LACES is an essential safety protocol which should be implemented at wildfire incidents to address risks and hazards. The correct implementation of LACES helps to ensure that suppression personnel are appropriately supervised, informed and warned of risks and potential hazards and that they are aware of how and where to escape should a high risk situation occur.</p> <p>LACES is an acronym for:</p> <ul style="list-style-type: none"> • L = Lookouts • A = Awareness or Anchor Point • C = Communication • E = Escape route and plan • S = Safe area |
| Lookout | A person responsible for supervising safety. Lookouts are a key element of the LACES safety protocol. |
| Managed burn | A planned and supervised burn carried out for the purpose of removing fuel either as part of a Fire Suppression Plan (an operational burn) or a land management exercise (a prescribed burn). |
| Marking out | The creation of a marking on the ground to identify a target area for water bombing aircraft, either by personnel on the ground or by a helicopter. |
| Massive attack | A substantial and swift attack using aerial resources which is intentionally excessive in relation to the size of the wildfire. A massive attack will be performed in order to suppress a relatively small wildfire as quickly as possible so that aerial resources can be quickly released to perform other assignments. |
| Mega fire | A wildfire demonstrating abnormally extreme fire behaviour. Mega fires will usually represent a significant challenge to suppression agencies because they are very resource intensive to suppress and can pose a significant risk to the safety of suppression personnel. |
| Mitigation | A collective term used for those activities implemented prior to, during, or after a wildfire which are designed to reduce the actual or potential consequences of the wildfire. Mitigation measures can include efforts to educate governments, businesses and the general public on appropriate actions to take to reduce loss of life and property during wildfire incidents. The development of mitigation measures is often informed by lessons learned from prior incidents. ⁹² |
| Mobilize | To direct resources to attend an incident. |
| Mop up | The act of extinguishing a fire after it has been brought under control. ⁹³ Mop up involves carrying out all necessary actions to prevent re-ignition. |
| Multi-agency incident | An incident involving more than one agency. |
| Mutual support | Coordination of the actions of multiple agencies and/or ground and aerial resources to ensure that all actions complement and support one another. |

⁹² Based on the definition provided by the NWCG: National Wildfire Coordinating Group (2011) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.121.

⁹³ Source: Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology* (Global Fire Monitoring Center, Freiburg), p.142 (defined within the term “Fire Suppression”).

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| Term | Definition |
|---------------------------------|---|
| Operational burn | A controlled supervised burn which is carried out by a burn team as part of a fire suppression plan. An operational burn can be classified as either offensive or defensive, depending upon its purpose: <ul style="list-style-type: none"> • Offensive operational burn – ignited along a control line to burn into an advancing flame front. • Defensive operational burn – ignited along a control line to strengthen/expand the control line, but will be extinguished prior to the arrival of an advancing wildfire. |
| Parallel attack | A method of fire suppression involving the construction of a control line approximately parallel to and some distance away from the fire edge. The intervening strip of unburned fuel may or may not be burned out as the control line proceeds. This decision will be influenced by an assessment of whether the unburned fuel is considered to pose a threat to the control line. |
| Parallel attack (aerial) | A method of fire suppression involving the release of water or retardant from the air to form a control line approximately parallel to and some distance away from the fire edge. |
| Partner agencies | Any organisations that work together to prevent, investigate and/or suppress wildfires. Partnership agencies will work together on preparedness activities and plans and are likely to have formulated pre-agreed partnership agreements. |
| Patrol | The act of supervising a specified area in order to prevent, detect and/or control a wildfire. |
| Pinching | The tactic of attacking a wildfire by working along the flanks either simultaneously or successively from an anchor point and endeavouring to connect the two lines at the head. ⁹⁴ |
| Point of ignition | The exact physical location within the area of origin where a wildfire was first ignited. |
| Preparedness plan | A pre-determined scheme or programme of activities which is formulated in order to satisfactorily prepare an organisation or a geographic area to respond effectively to wildfire incidents. |
| Pre-treat | The application of water, foam or retardant along a control line. |
| Prolonged attack | An extended and sustained method of attack requiring additional resources which is implemented if a wildfire is beyond the control of an initial attack. |
| Rate of spread | A measurement of the speed at which a fire moves across a landscape. Rate of spread is usually expressed in metres per hour. |
| Re-burn | Subsequent burning of an area that has already been burnt. |
| Reconnaissance | The act of gathering information about a wildfire incident in order to monitor fire behaviour and suppression activities. The primary reasons for completing reconnaissance should be to maintain safety and to assess the effectiveness of a fire suppression plan. |
| Rendezvous point | A pre-arranged location where resources arriving at a wildfire incident will report. |

⁹⁴ Source: Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology* (Global Fire Monitoring Center, Freiburg), p.153 (defined within the term “Flanking Fire Suppression”).

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| Term | Definition |
|-----------------------------|---|
| Report | <ul style="list-style-type: none"> • The process whereby resources first register their arrival at a wildfire incident; or, • A formal statement of the results of an activity or investigation. Reports may analyse situations, provide progress updates on current assignments, draw conclusions and/or make recommendations. A report can be either verbal or written. |
| Reserve resources | Resources not assigned to a specific task, but available for assignment. |
| Resources | Personnel, equipment, services and supplies which are either available or potentially available for assignment to a wildfire incident. |
| Restricted area | An area in which specified activities or entry are temporarily restricted in order to mitigate risk to human health or safety by potential or on-going wildfires. |
| Retardants | <p>A group of chemicals that are usually mixed with water which have the ability to reduce or inhibit combustion either in the long or short term:</p> <ul style="list-style-type: none"> • Long-term retardants - have the ability to reduce or inhibit combustion even after the water that they contain has evaporated. • Short-term retardants – are primarily used to inhibit combustion through the more immediate cooling and/or smothering of a fire. |
| Ring burn | A fire started by igniting the full perimeter of the intended burn area so that the ensuing fire fronts converge toward the centre of the burn. ⁹⁵ |
| Risk | <p>The probability of a hazardous event occurring and the potential outcome/consequences of that hazardous event. Risk is calculated using the following equation:</p> $\text{Risk} = \text{probability of occurrence} \times \text{potential impact}$ |
| Risk assessment | The process of establishing information regarding acceptable levels of risk and actual levels of risk posed to an individual, group, society or the environment. The process involves the identification of risk, an assessment of probability and an assessment of potential impact. |
| Risk management | A process involving the systematic application of policies, procedures and practices to identify, analyse, evaluate, manage, control, communicate and monitor risks. ⁹⁶ |
| Safe area | An identified area of safety where people can find refuge. The identification of a safe area is a key element of the LACES safety protocol. |
| Safe systems of work | A formal procedure which results from systematic examination of a task in order to identify potential hazards and risks. The resulting document produced will describe the safest way(s) of completing a task to ensure hazards are eliminated or that risks are controlled as far as possible. |
| Safety | When exposure to hazards has been controlled to an acceptable level. |
| Safety officer | An officer appointed to manage risk. |
| Scratch line | A preliminary control line that has been hastily constructed as an emergency measure to prevent fire spread. |

⁹⁵ Source: National Wildfire Coordinating Group (2011) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.150 (defined within the term “Ring Fire”).

⁹⁶ Based on the definition presented within the final report of the ANSFR Project: *The ANSFR Project Final Report: Recommendations for Improving Fire Risk Assessment and Management in Europe* (2010), p.9 - http://www.fire-risk.eu/resources/documents/document_display.htm?pk=88

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| Term | Definition |
|---|--|
| Sector | A specific area of an incident which is under the control of a Sector Commander. |
| Situational awareness | The perception of the surrounding environment within the context of both time and space. It includes the comprehension of meaning of observed phenomena and patterns and the provision of information relevant to a team or individual's situation. It also includes the projection and prediction of what will happen within the surrounding environment in the future. |
| Standard Operating Procedures (SOPs) | SOPs are written instructions that detail the necessary steps that must be taken when completing a particular process or activity. The purpose of a SOP is to ensure that a particular process or activity is always carried out safely, effectively and in the same manner. |
| Statutory responsibility | A legal obligation to satisfactorily perform or complete a particular task related to wildfire suppression or prevention. |
| Supplies | Minor items of equipment and all expendable items assigned to an incident. ⁹⁷ |
| Supply area | The location where the primary logistics functions and supplies required for a wildfire incident are temporarily stored, coordinated and administered. |
| Suppression | All work involved in controlling and extinguishing a wildfire. |
| Tactical lookout | A person with an advanced understanding of wildfire behaviour who acts as a safety officer at a wildfire incident. He/she will observe the fire and the action of teams involved in fire suppression. He/she will maintain close communication with suppression teams and supervisors and will be responsible for ensuring the safety of all individuals present at the incident. Lookouts are a key element of the LACES safety protocol. |
| Tactics | The deployment of resources at a wildfire incident to achieve the aims of a fire suppression plan. |
| Tail attack | A method of fire suppression which involves an attack being made at the tail of a wildfire. |
| Tail attack (aerial) | A method of fire suppression involving the release of water or fire retardant from the air directly onto the tail part of a wildfire. |
| Team | A group of individuals tasked with working together on an assignment. |
| Team supervisor | A person who manages the actions, assignments and safety of a team. |
| Test burn | A small burn which is ignited to observe and evaluate fire behaviour prior to igniting a larger operational or managed burn. |
| Trigger point | A pre-designated point in time or place whereby a predicted change in fire behaviour will influence tactical decision-making. For instance, if a wildfire reaches a particular trigger point on the landscape, the Incident Commander may decide it is necessary to adopt alternative tactics in order to maintain safety and effectiveness. |

⁹⁷ Source: National Wildfire Coordinating Group (2011) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.168.

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| Term | Definition |
|------------------------------|--|
| Water Safety Plan | A plan that is created to assure the safety of water bombing aircraft and other users of a body of water used for water filling. A water safety plan will commonly document the following types of arrangements: <ul style="list-style-type: none">• Measures to be implemented to inform users of a body of water about its use by water bombing aircraft.• Systems and protocols for towing and salvage of water bombing aircraft that breaks down on the water.• Systems and protocols for providing aid and assistance to the crew of a water bombing aircraft which has broken down on the water. |
| Wet line | A line of water, or water mixed with fire fighting chemicals, which is sprayed along the ground to serve as a temporary control line from which to ignite an operational burn or to stop a low-intensity fire. |
| Wetting agents | Chemicals which, when added to water, decrease the surface tension of the water and enable greater penetration into fuels. |
| Window of opportunity | A period of time or location on the landscape when/where it will be particularly advantageous to adopt particular suppression tactics or actions. |

Chapter 10 – Cartography and Map Reading

Cartography: “The study of maps and the practice of map making.”



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Chapter 10 – Cartography and Map Reading

| Term | Definition |
|---------------------------|---|
| Access | A point of entry, exit and/or route to an incident location. |
| Aggregation | The grouping together of individual entities with similar characteristics to form one larger entity. For example, grouping together small area units to form larger ones. |
| Aiming off | A method used by navigators to address the problem of lateral drift. Rather than take a bearing and head straight for a target, a navigator may decide to “aim off” so that they deliberately measure a bearing to take them to one side of their target. Once they have walked the measured distance, the navigator will then know whether they will need to turn 90 degrees and walk to their left or right in order to reach their target. |
| Alphanumeric | Information using both letters and numbers |
| Altitude | Height above sea-level. |
| Annotation | The addition of explanatory notes, comments or instructions to a map or image. |
| Back bearing | A navigation technique which uses a compass to locate a person’s position on a map and/or the position of a visible object or feature. |
| Base map | A map intended as a base onto which other information is added, either as manual annotations, or digitally as new map layers in a Geographic Information System (GIS). Base maps usually include the grid coordinate system, roads, settlements, rivers and any other topographic features which will help users generate new useful information. These features are used to help locate known but as yet unmapped features such as fire hydrants, or interpreted to produce new information such as relative fuel load or accessibility. ⁹⁸ |
| Baseline | A reference line that lies across a course of travel. Common examples of baselines include roads, footpaths, water channels, fences, and any other similar linear features. Baselines are helpful because they provide a large target for which to aim. Navigators may identify a baseline and then aim off when calculating their bearing. When they reach the baseline they will then know which direction they should walk along the baseline in order to reach their target destination. |
| Bearing | The horizontal direction to or from any point, usually measured clockwise from true north, or some other reference point, through 360 degrees. ⁹⁹ |
| Blind area | An area in which neither the ground nor its vegetation can be seen from an observation point. |
| Boundary | The perimeter or limit of a pre-defined area. Boundaries are usually indicated on a map by one or more lines of varying styles. |
| Boxing obstacles | A range of techniques used by navigators to move around obstacles they encounter when walking on a bearing. Boxing techniques allow the navigator to walk around an obstacle and then return to their original path and bearing. |
| Browser | A computer application which provides users with the ability and tools (such as zoom and pan) to view map data. |
| Buffer | The specification of a zone on a map around a particular point or feature. Buffers are commonly used to determine proximity of particular features to one another. |
| Cardinal direction | The four principal points of a compass: North, South, East and West. |

⁹⁸ Definition provided by Julia McMorro, University of Manchester (UK).

⁹⁹ Source: Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology* (Global Fire Monitoring Center, Freiburg), p.29.

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| Term | Definition |
|----------------------------------|--|
| Classification | A systematic arrangement of individual features into groups or classes of features with similar characteristics. For instance, designating a polygon feature on a map as a building or a hospital. |
| Cartography | The study of maps and the practice of map making. |
| Compass | An instrument used for navigation and orientation. A compass consists of a mounted or suspended magnetic needle which points to Magnetic North. |
| Compass rose | A circular symbol indicating the direction of True and/or Magnetic North which is found printed on maps and sometimes on the ground at an airport or heliport. |
| Conflation | The process of matching and merging together two maps of the same area. The process may involve matching and merging maps from different time periods or maps presenting different thematic information. |
| Contour index lines | Contour lines accompanied by a numerical value indicating elevation. Index contours are usually shown on a map as a thicker line to distinguish them from standard contour lines. |
| Contour interval | The difference in elevation between two neighbouring contour lines. |
| Contour line | A line on a map connecting points of equal elevation. |
| Contour pattern | The arrangement of contours on an area of a map. Accurate interpretation of contour patterns on a map can enable navigators to identify types of topographical features. |
| Contour spacing | The relative gap between contours indicates gradient and severity of slope. Contour lines shown relatively close together indicate the presence of steeper slopes, while the opposite is true of contours shown further apart. |
| Contour value | A height printed on or immediately next to a contour line. For ease of reference, contour values often read upslope. |
| Contouring | Planning and walking a route which follows the path of contour lines. This approach can often be safer than walking a route which intersects contour lines, particularly in rough terrain or during severe weather conditions. |
| Coordinate transformation | The process of converting a map from one coordinate system to another, often through the use of computer programmes. |
| Coordinates | Intersecting lines of reference which are used to identify specific locations on a map. |
| Copyright | A legal property right which enables the creator of an original piece of work to protect it from unauthorised use. ¹⁰⁰ |
| Data | Items of information represented in a formalised manner which are suitable for processing and interpretation. |
| Data quality | An assessment of the completeness and reliability of a dataset and its suitability for a particular purpose. |
| Data record | A set of related data fields that are grouped together for processing. ¹⁰¹ |
| Database | A management system for one or more datasets. |
| Dataset | A collection of related data records which are managed as a subset of data within a database. |

¹⁰⁰ Based on the definition provided by the Ordnance Survey at:

<http://www.ordnancesurvey.co.uk/oswebsite/aboutus/reports/misc/glossary.html>

¹⁰¹ Source: <http://www.ordnancesurvey.co.uk/oswebsite/aboutus/reports/misc/glossary.html>

Chapter 10 – Cartography and Map Reading

| Term | Definition |
|--|--|
| Datum | The term datum can be used within two different contexts and thus has two meanings: <ul style="list-style-type: none"> • Within the context of cartography and map reading, a datum is a known position from which all height information is relatively measured. • Datum is also the singular form of data. Within this context it is used to refer to a single item of information. |
| Demographic data | Statistical data on human populations. |
| Digital Elevation Model (DEM) | A digital elevation model is a 3-D representation of a terrain's surface created from terrain elevation data. It can take the form of either a 'flat' image, where the brightness or colour represents height, or a wire/block diagram which shows the terrain in 3-D. Variants of DEMs include: <ul style="list-style-type: none"> • Digital terrain models (DTM) - which show the elevation of the ground surface itself, excluding any human-made structures and vegetation. • Digital surface models (DSM) - which show the elevation of the actual surface, including human-made structures and vegetation. |
| Digitising | The conversion of paper maps into digital format. |
| Elevation | Height above sea-level. |
| Geocode | The numerical or alphanumeric element in a database which identifies the geographical location of a particular record. |
| Geographic Information System (GIS) | A system designed to capture, store, manipulate, analyze, and present geographically referenced data. |
| Global Positioning System (GPS) | A global navigation system that provides very precise positioning information about the location of any point on or near the Earth. The system is freely accessible to anyone with a GPS receiver. |
| Global Positioning System (GPS) Navigation Device¹⁰² | Any device that receives and triangulates GPS signals in order to determine its physical location on the Earth's surface. |
| Gradient | The angle or steepness of a slope. |
| Grid bearing | Measurement of a bearing using a compass placed on a map. If this bearing is to be followed to walk from one location to another, then the navigator will need to adjust it to incorporate magnetic declination. |
| Grid North | The direction north along the north-south grid lines of a map projection. ¹⁰³ |
| Grid reference | Coordinates that can be used to define and identify specific locations on a map. |
| Gridlines | Intersecting perpendicular lines drawn on a map to divide the surface into equal squares. Gridlines define the coordinate system and are labelled with numbers and/or letters to provide a unique reference to features on the map. |
| Hazard | Anything which has the potential to cause harm. |
| Index | A list of the places and/or key features that can be found on a map. The list will often include coordinates to help users identify the specific locations on the map. |

¹⁰² Also commonly known as a GPS Receiver.

¹⁰³ Source: <http://support.esri.com/en/knowledgebase/GISDictionary/search>

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| Term | Definition |
|--|---|
| Intercardinal directions | The four intermediate compass directions which are situated halfway between the cardinal directions: North East, North West, South East, South West. |
| Landscape | The physical appearance of the land comprising of the features of the terrain, the indigenous vegetation and the human impact caused by variations in land use. |
| Lateral drift | When an individual drifts from their bearing. This occurs because it is almost impossible to walk a perfect bearing. A common method of addressing the problem of lateral drift is aiming off. |
| Latitude | The angular distance north or south between a point on the Earth's surface and the equator ¹⁰⁴ . Latitude is usually measured in degrees, minutes and seconds. |
| Leading marker method | A navigational technique whereby members of a team are lined up along the course of a bearing and in so doing act as individual points of reference. The technique can be used effectively by a team of two people; however, the technique is more reliable and accurate for teams of three or more. The technique is very useful for navigating through dense woodland and/or during times of fading or limited visibility, such as at night. |
| LIDAR (Light Detection And Ranging) | An optical remote sensing technology that can measure the distance to or other properties of a target by illuminating the target with light, often using pulses from a laser. LIDAR technology has applications in geomatics, geography, geology, geomorphology, forestry, remote sensing as well as in airborne laser swath mapping (ALSM), laser altimetry and contour mapping. LIDAR data is usually used to produce Digital Elevation Models (DEMs). |
| Line of sight | A navigational technique which can be used when it is not possible to walk a bearing in a straight line because of obstacles. When using the line of sight technique, navigators walk to an obvious landmark that is situated directly on the bearing they wish to travel. When they reach this landmark, they then take another bearing and identify to the next obvious landmark. The navigator continues this process until they reach their destination. By walking to intermediate landmarks, a navigator reduces the amount of lateral drift and thereby reduces that chance of veering off of the bearing. |
| Longitude | The angular distance of a point east or west of an arbitrarily defined meridian, usually taken to be the Greenwich meridian ¹⁰⁵ . Longitude is usually measured in degrees, minutes and seconds. |
| Magnetic bearing | Measurement of a bearing using a compass to identify direction. |
| Magnetic declination | The angle between Magnetic North and True North. Magnetic declination varies from place to place and with the passage of time. Navigators need to remember to adjust bearings to take account of the magnetic declination at their particular location. |
| Magnetic North | The direction from a point on the Earth's surface following a great circle toward the magnetic north pole, as indicated by the north-arrow end of a compass. ¹⁰⁶ |
| Map | A graphical representation of an area which depicts the relative positions of features and landmarks. |

¹⁰⁴ Source: <http://www.ordnancesurvey.co.uk/oswebsite/aboutus/reports/misc/glossary.html>

¹⁰⁵ Source: <http://www.ordnancesurvey.co.uk/oswebsite/aboutus/reports/misc/glossary.html>

¹⁰⁶ Based on: <http://support.esri.com/en/knowledgebase/GISDictionary/searchh>

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| Term | Definition |
|--------------------------------|--|
| Map layer | A map of a single thematic feature, such as contours, roads, or rivers and streams. Each map layer is usually stored as a separate file in a Geographic Information System (GIS) and overlaid to produce topographic or other maps. ¹⁰⁷ |
| Map orientation | Rotating a map until recognised features on the landscape align with those shown on the map. Orientating a map with the landscape can make a map easier to read. |
| Map overlay | The combination of several map layers with the same map projection to create a new output map layer which shows the relationship between them. It is visually similar to stacking several maps of the same area. ¹⁰⁸ |
| Map projection | Any technique which represents the three-dimensional spherical surface of the Earth on a flat two-dimensional surface of a map. All map projections will lead to some distortion of shape, size, distance or direction. |
| Map legend | A table or list which explains the meanings of any symbols and colour coding used within a map. |
| Modelling | The process of creating a representation of part of the real world and subjecting it to some form of parameters and variables for the purpose of predicting, simulating or describing the real world. ¹⁰⁹ |
| Naismith's rule | Naismith's Rule ¹¹⁰ is a rule of thumb ¹¹¹ that helps navigators to calculate approximately the length of time it will take to walk a given route. The Rule stipulates that an average walker on flat terrain under normal conditions will take 1 hour to travel 5 kilometres. To account for additional time taken during ascents, one minute should be added to the time of travel for every 10 metres ascended. |
| Navigation | The process of planning, following and monitoring progress along a pre-defined route of travel. |
| Navigational techniques | A range of tools and techniques that enable skilled navigators to locate their position on the Earth's surface in relation to other known locations and landmarks. |
| Navigator | An individual with the knowledge, skills and experience that enable him/her to accurately plan, follow and monitor progress along a pre-defined route of travel. A good navigator will typically be able to use a range of navigational techniques effectively. |

¹⁰⁷ Definition provided by Julia McMorrow, University of Manchester (UK).

¹⁰⁸ With thanks to Julia McMorrow of the University of Manchester (UK) for her contributions to this definition.

¹⁰⁹ Source: <http://www.ordnancesurvey.co.uk/oswebsite/aboutus/reports/misc/glossary.html>

¹¹⁰ The rule was devised in 1892 by William W. Naismith, a Scottish mountaineer and founder member of the Scottish Mountaineering Council.

¹¹¹ A rule of thumb is a general principle with broad applicability which is not intended to be strictly accurate or reliable under all circumstances. A rule of thumb is usually very easy to learn and apply.

Chapter 10 – Cartography and Map Reading

| Term | Definition |
|-----------------------|---|
| Pacing | A technique used by navigators to estimate distance travelled. Prior to embarking on a journey, a person wishing to use pacing needs to count the number of paces taken to travel a known distance ¹¹² . Paces can then be counted during a journey to estimate distance travelled. This is a particularly useful technique for navigating at times of limited visibility (i.e. at night) and when navigating over terrain with limited features and landmarks (such as mountainous areas and open moorland). |
| Parameter | A quantity that is fixed or constant for the case in question, but which may vary in other cases. |
| Polygon | A closed line or perimeter which completely encloses a space to represent a specified area on a map. Common examples of the use of polygons on maps include the representation of buildings and field boundaries. |
| Raw data | Data that has not yet been processed for meaningful use. |
| Raster layer | A map layer made up of a grid of cells or pixels. A road map layer would be represented by pixels with, for instance, the value 1, and 0 for all other pixels. ¹¹³ |
| Remote sensing | The acquisition and interpretation of images of the Earth's surface, where images are usually acquired by cameras and scanners carried on aircraft or orbiting satellites. Optical images simultaneously record visible and invisible reflected light in several different wavelengths; when combined, these images (or 'bands') can be used to map burn scars, different types of fuel and fuel moisture. Thermal images record emitted heat from active fires and the Earth's surface. Radar remote sensing uses artificial microwave energy to produce images of burn scars through cloud and at night. ¹¹⁴ |
| Scale | The relationship between distance on a map and actual distance on the Earth's surface. Scale may be represented by words, a ratio or fraction, or a divided bar. Maps showing a small area in a high level of detail are referred to as large scale, while maps showing a large area with low level of detail are called small scale. |
| Slope | An incline of the ground. |
| Symbol | A character, letter or graphic used on a map to indicate the presence of an object or characteristic. |
| Thematic map | A map which shows data concerning one or more specific themes or subjects which is connected to a particular geographical area. Some relevant examples include maps presenting land use and maps presenting rainfall. |
| Timing | A method used by navigators to estimate distance. Prior to commencing travel between two points, a navigator will measure the ground distance and then calculate the expected time required to cover that distance. If the route to be travelled will involve an increase or decrease in elevation, further calculations should be made to account for the degree to which slope will influence time of travel (see, for instance, Naismith's Rule). |

¹¹² Most navigators use a technique called "double pacing", which is where an individual will count every second step taken (i.e. every time their right foot touches the ground). An alternative technique is "single pacing", which is when an individual counts every step taken.

¹¹³ Definition provided by Julia McMorrow, University of Manchester (UK).

¹¹⁴ Definition provided by Julia McMorrow, University of Manchester (UK).

Chapter 10 – Cartography and Map Reading

| Term | Definition |
|------------------------------|--|
| Topographical map | A map produced for the principle purpose of portraying and identifying the shape and features of the land surface. |
| Topography | The description and study of the shape and features of the land surface. |
| Triangulation | A method which uses two known coordinates to determine the coordinates of a third location. |
| Triangulation station | A permanently marked and fully documented control station whose position on the Earth's surface has been established to a high accuracy both absolutely and in relative terms to other adjacent stations by means of angular or electronic distance measurement. ¹¹⁵ Triangulation stations form the foundation on which all survey and mapping techniques are based. |
| True North | The direction from any point on the Earth's surface to the geographic north pole. ¹¹⁶ |
| Vector layer | A Geographic Information System (GIS) map layer made up of points, lines or polygons, where each point consists of an x coordinate defining its distance east of the map origin, and a y coordinates defining it distance north. A helicopter take-off and landing map layer would be stored as a series of points; a road map layer as lines connecting points; and a water body layer as polygons consisting of closed lines connecting points. ¹¹⁷ |
| Waypoint | A predefined intermediate location on a route of travel. Waypoints are used to divide a journey into shorter sections and are particularly important for long routes and for routes over difficult and rough terrain. |

¹¹⁵ Source: <http://www.ordnancesurvey.co.uk/oswebsite/aboutus/reports/misc/glossary.html>

¹¹⁶ Source <http://support.esri.com/en/knowledgebase/GISDictionary/search>

¹¹⁷ Definition provided by Julia McMorrow, University of Manchester (UK).

Chapter 11 – Equipment

Equipment: “A collective term for all hand tools, mechanized tools, supplies and vehicles used for wildfire suppression, prevention and/or restoration activities.”



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Chapter 11 – Equipment

| Term | Definition |
|----------------------------------|---|
| Aerial ignition device | Inclusive term applied to equipment designed to ignite fuels from an aircraft. Examples of aerial ignition devices include: <ul style="list-style-type: none"> • Delayed aerial ignition device (DAID) – An incendiary device dropped from an aircraft which will ignite after a predetermined amount of time. The delayed ignition is usually achieved through the production of a chemical reaction which is initiated prior to or during the drop. • Helitorch - An aerial ignition device hung from a helicopter which disperses ignited gelled gasoline. |
| Aerial resources | Aircraft, including helicopters, aeroplanes and drones, which can be used to attack the fire or observe its development. It also includes supporting personnel and equipment. |
| Alidade | A sighting device used to determine the horizontal bearing of a fire from an observation point. |
| All-Terrain Vehicle (ATV) | Any motorised vehicle designed to travel on four low pressure tires on unpaved surfaces, having a seat designed to be straddled by the operator and handlebars for steering control. ¹¹⁸ <p>ATVs can be classified into two categories:</p> <ul style="list-style-type: none"> • Type I – designed for transporting one operator. • Type II – designed for transporting one operator and one passenger. |
| Amphibious vehicle | A vehicle capable of travelling over both land and water. |
| Anemometer | An instrument that measures wind speed. |
| Audible warning device | A signalling device which generates a loud siren to provide a warning sound. Audible warning devices are sometimes mounted to aircraft and are sounded by pilots to warn suppression personnel on the ground that an aircraft is approaching to make a drop. |
| Barometer | An instrument used for measuring atmospheric pressure. |
| Beater | A hand tool consisting of a large piece of rubber attached to a long handle. Beaters are used to drag over and smother flames from burning ground fuels. |
| Bulldozer ¹¹⁹ | A heavy driver-operated vehicle which is used for clearing ground and for moving soil and debris. Dozers usually have a broad blunt hydraulic blade at the front and continuous treads for driving off-road. Dozers are used in some countries for both direct and indirect attack at wildfire incidents. |
| Cargo chute | A parachute designed and rigged for dropping equipment and supplies from an aircraft while in flight. |
| Chainsaw | A portable mechanical saw which is commonly powered by a two-stroke engine. Chainsaws are commonly used to fell trees and to remove branches and foliage. |
| Compass | An instrument used for navigation and orientation. A compass consists of a mounted or suspended magnetic needle which points to Magnetic North. |
| Coupling | An accessory used for connecting multiple hoses and pipes together. Some couplings are designed to specifically connect hoses and pipes which are incompatible with one another due to different diameters, threads or genders. Names of common types of coupling include: reducer, increaser, female, male, double female, double female, storz, wye, siamese, and distributor. |

¹¹⁸ Definition from the “All Terrain Vehicle Industry European Association” (ATVEA) at: [http://www.atvea.org/9431E/What is an ATV .aspx](http://www.atvea.org/9431E/What%20is%20an%20ATV.aspx)

¹¹⁹ Also commonly referred to as a “dozer”.

Chapter 11 – Equipment

| Term | Definition |
|--------------------------------|--|
| Drip torch | A hand tool used to drop flaming fuel onto the ground to intentionally ignite a fire as part of an operational or prescribed burn. |
| Equipment | A collective term for all hand tools, mechanized tools, supplies and vehicles used for wildfire suppression, prevention and/or restoration activities. |
| Excavator | A piece of heavy driver-operated machinery which is used for digging and moving soil and debris. Excavators are commonly used for control line construction and for digging out deep-seated ground fires during wildfire incidents. They are also commonly used during restoration work. |
| Fire extinguisher | A portable piece of equipment containing water or chemicals which can be sprayed in order to extinguish a very small fire. Fire extinguishers are not widely used at wildfire incidents because they contain a very limited supply of water/chemicals. |
| Fire fighting chemicals | <p>Substances that have the ability to prevent, reduce or inhibit combustion. They can be applied from the air or from the ground and may be applied directly onto a fire or an area of unburned fuel.</p> <p>Common types of fire fighting chemicals include:</p> <ul style="list-style-type: none"> • Foam – A mass of bubbles formed by mixing specific proportions of air with water and foam concentrate. Foam can be applied in order to smother and cool parts of a fire and/or to prevent ignition within a fuel. • Gels - Chemicals which are added to water to make it thicken. When used as an extinguishing agent the mixture is able to absorb more heat than water and sticks to the surface of the fuel. • Retardants – A group of chemicals that are usually mixed with water which have the ability to reduce or inhibit combustion either in the long or short term: <ul style="list-style-type: none"> • Long term retardants - have the ability to reduce or inhibit combustion even after the water that they contain has evaporated. • Short term retardants – are primarily used to inhibit combustion through the more immediate cooling and/or smothering of a fire. • Wetting agents – Chemicals which, when added to water, decrease the surface tension of the water and enable greater penetration into fuels. |
| Fire hydrant | An upright pipe with a nozzle or spout which is situated either above or below ground. Fire hydrants are present in many urban, suburban and rural areas and enable fire fighters to draw water from the mains water supply to assist with fire suppression activities. |
| Fire shelter | A small single person aluminized cover that can provide an individual with some protection from the effects of fire in a fire entrapment situation. |
| Foam | A mass of bubbles formed by mixing specific proportions of air with water and a foam concentrate. It can be applied to smother and cool parts of a fire and/or to prevent ignition within a fuel. |
| Fog/Fogging System | Pressurized water system which produces a fine mist or micro droplets of water to enhance the heat absorbing and steam generating capability of water. |
| Gels | Chemicals which are added to water to make it thicken. When used as an extinguishing agent the mixture is able to absorb more heat than water and sticks to the surface of the fuel. |

Chapter 11 – Equipment

| Term | Definition |
|---|--|
| Generator | A machine that converts mechanical energy into electricity to serve as a power source for other equipment and machines. Generators are particularly important pieces of equipment in remote locations where access to mains electricity may be very limited. |
| Global Positioning System (GPS) receiver | GPS is a global navigation system that provides very precise positioning information about the location of any point on or near the Earth's surface. GPS receivers are commonly available as hand-held units and receive and triangulate signals from orbiting satellites to calculate an individual's precise location on the Earth's surface. ¹²⁰ |
| Ground probe | A specialized nozzle used to penetrate deep-seated combustible fuels to extinguish ground fires. ¹²¹ |
| Hand tool | Any piece of hand-held equipment which is operated manually or with power assistance to dig, rake, scrape, chop, cut or remove fuel. |
| Heat probe | Apparatus used to detect heat. ¹²² |
| Helicopter | An aircraft capable of hovering and moving vertically and horizontally in any direction during flight. Most helicopters achieve lift and propulsion through the rotation of overhead rotor blades. |
| Helipump | A lightweight portable pump unit that has been specifically developed for transport by helicopter. |
| Helitorch | An aerial ignition device hung from a helicopter which disperses ignited gelled gasoline. |
| Hose | A flexible and collapsible tube used for transporting liquids ¹²³ under pressure. |
| Hygrometer ¹²⁴ | An instrument used for measuring the relative humidity of the air. |
| Incendiary | A device that is purposefully designed to ignite a fire. |
| Map | A graphical representation of an area which depicts the relative positions of features and landmarks. |
| Mechanised equipment | A piece of heavy equipment that is usually mechanically-driven and mounted on to or towed by a vehicle to dig, scrape, cut, move or remove vegetation or soil. |
| Nozzle | A device attached to the end of a hose that directs, shapes and regulates the flow of water and/or fire fighting chemicals. |
| Paracargo | Equipment or supplies to be dropped from an aircraft in flight by parachute, other retarding devices, or free fall. |
| Personal Protective Equipment (PPE) | Any equipment or clothing required to maintain the safety of suppression personnel at a particular wildfire incident. While some PPE will most likely be required at all wildfire incidents, the need for some types of PPE will vary according to the particular conditions experienced at an incident. To provide an example, suppression personnel operating at a wildfire incident at night will require lighting. |

¹²⁰ Currently up to an accuracy of approximately 3 metres.

¹²¹ Source: Canadian Interagency Forest Fire Centre (2003) *Glossary of Forest Fire Management Terms* (CIFFC: Winnipeg), p.25.

¹²² Source: National Wildfire Coordinating Group (2011) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.96.

¹²³ For example, water or foam.

¹²⁴ An alternative term for a hygrometer is a *psychrometer*.

Chapter 11 – Equipment

| Term | Definition |
|-------------------------------|---|
| Plough | A large implement with one or more blades fixed within a frame which is drawn over the ground to turn the soil and cut furrows, usually in preparation for planting seeds but sometimes also during the construction of control lines. |
| Pump | A device used to move liquids (i.e. water or foam) using mechanical action. |
| Radiometer | An instrument that measures electromagnetic radiation. Radiometers mounted on satellites measure the radiation characteristics of fires, vegetation and clouds. Radiometers are used to detect and monitor fires and their effects. |
| Radio receiver | A piece of communication equipment that receives incoming radio waves and converts them into sound waves. |
| Radio repeater | A piece of communication equipment that combines a radio receiver and a radio transmitter. Radio repeaters are used to receive weak radio signals and transmit them at higher power so that they can travel a longer distance without being degraded. |
| Radio transmitter | A piece of communication equipment that converts sound waves into radio waves and then transmits these radio waves. |
| Retardants | <p>A substance or chemical agent that has the ability to reduce or inhibit combustion. Retardants can be categorised as long-term or short-term:</p> <ul style="list-style-type: none"> • Long-term retardants - have the ability to reduce or inhibit combustion even after the water that they contain has evaporated. • Short-term retardants – are primarily used to inhibit combustion through the more immediate cooling and/or smothering of a fire. Short-term retardants may include chemicals added to water that alter viscosity and/or which delay evaporation. |
| Spider excavator | An excavator with articulated legs which can work on and travel over steep slopes that are inaccessible to excavators with wheels or tracks. |
| Suction hose | A semi-flexible and non-collapsible hose used to move water by means of suction from a static source, such as a pond, pool or storage tank, to a pump. |
| Supplies | Minor items of equipment and all expendable items assigned to an incident. ¹²⁵ |
| Thermograph | A thermometer that automatically and continuously records air temperature on a chart. |
| Thermometer | An instrument used to measure air temperature. |
| Water bombing aircraft | An aircraft capable of carrying and releasing a volume of water or fire retardant. Water bombing aircraft can be fixed wing aircraft (such as Canadair, Tracker and Bombardier) or helicopters (with internal or external tanks or those able to carry buckets). |
| Weather station | A collection of sensors and monitors which gathers, records and reports meteorological data. Weather stations may be permanent structures or hand-held/semi-portable/portable units. |
| Water tanker | A large vehicle with the capacity to carry substantial volumes of water. |
| Wetting agents | Chemicals which, when added to water, decrease the surface tension of the water and enable greater penetration into fuels. |
| Wye coupling | An accessory used to split one hose line into two or more hose lines. A wye coupling will often split one larger line into two or more smaller ones and may be gated with separate valves for each line. |

¹²⁵ Source: National Wildfire Coordinating Group (2011) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.168.

Chapter 12 – Aerial Operations

Aerial Operations: “Any manoeuvre completed by an aircraft in support of wildfire suppression activities”.



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Chapter 12 – Aerial Operations

| Term | Definition |
|--|--|
| Aerial attack | A fire suppression operation involving the use of aircraft to release water or retardant on or near a wildfire. An aerial attack can be: <ul style="list-style-type: none"> • Direct attack (aerial) <ul style="list-style-type: none"> • Head attack (aerial) • Tail attack (aerial) • Indirect attack (aerial) <ul style="list-style-type: none"> • Flank attack (aerial) • Parallel attack (aerial attack) |
| Aerial coordination | A task dedicated to the management of aerial operations at a wildfire incident. This role always has two key aims: <ul style="list-style-type: none"> • To protect the safety of all aircraft and suppression personnel on the ground. • To optimise the efficiency of all aerial resources. |
| Aerial Coordinator ¹²⁶ | The pilot or officer appointed to carry out the task of air coordination. The Aerial Coordinator will usually have authority over all aerial resources involved in aerial operations at the incident. |
| Aerial detection | The act or process of discovering, locating and reporting wildfire incidents from aircraft. Aerial detection can be: <ul style="list-style-type: none"> • Planned – where an agency mobilizes aircraft with aerial observers for the specific purpose of detecting wildfires; • Unplanned – where an aircraft not specifically hired or mobilised to detect wildfires reports a wildfire to a responsible agency. For example, unplanned aerial detection may come from passenger airplanes or other leisure aircraft. |
| Aerial ignition | Ignition of fuels from the air. Aerial ignition is usually achieved by using an aerial ignition device. |
| Aerial ignition device | An inclusive term applied to equipment designed to ignite fuels from an aircraft. Examples of aerial ignition devices include: <ul style="list-style-type: none"> • Delayed aerial ignition device – An incendiary device dropped from an aircraft which will ignite after a predetermined amount of time. The delayed ignition is usually achieved through the production of a chemical reaction which is initiated prior to or during the release. • Helitorch - An aerial ignition device hung from a helicopter which disperses ignited gelled gasoline. |
| Aerial observer | A person flying in an aircraft who is tasked with: <ul style="list-style-type: none"> • discovering, locating, and reporting wildfires and forest fires from an aircraft; and/or, • aerial reconnaissance; |

¹²⁶ In some countries, such as the USA and Spain, the alternative term of “Aerial Tactical Group Supervisor” (ATGS) has been adopted.

Chapter 12 – Aerial Operations

| Term | Definition |
|----------------------------------|---|
| Aerial operations | Any manoeuvre completed by an aircraft in support of wildfire detection or suppression activities, inclusive of: <ul style="list-style-type: none"> • direct attack through release of water or retardant • indirect attack through release of retardant • transport of equipment and supplies • cargo drops of supplies • aerial reconnaissance • aerial coordination • aerial detection • rescue missions |
| Aerial reconnaissance | Use of aircraft for conducting preliminary surveys of a wildfire to gather information on: <ul style="list-style-type: none"> • fire behaviour • topography and fuel types • potential hazards and high risk areas • potential windows of opportunity • safety of ground personnel <p>The information gathered from aerial reconnaissance will be communicated to the Incident Commander to assist in the decision-making process.</p> |
| Aerial resources | Aircraft, including helicopters, aeroplanes and drones, which can be used to attack the fire or observe its development. This term is also inclusive of supporting personnel and equipment. |
| Aerial support group | A group or organisation responsible for providing personnel, equipment and welfare facilities and supplies in support of aerial operations. |
| Air Traffic Control (ATC) | An organization that determines the altitude, speed, and flight routes of aircraft flying within a given airspace. The primary functions of ATC are to: <ul style="list-style-type: none"> • monitor warning systems and prevent collisions; • organize flow of air traffic on the ground and through the air; • monitor radio transmissions and provide information and support to pilots. |
| Aircraft | A means of transport capable of flying around the Earth's atmosphere. Aircraft are commonly deployed at wildfire incidents to perform a number of roles, including: <ul style="list-style-type: none"> • aerial coordination • aerial observation • aerial reconnaissance • the release of water and retardant • transportation of personnel, equipment, water and retardant |
| Airspace | Any specified three-dimensional area of the atmosphere. Airspace is usually managed by the Air Traffic Control (ATC) of the country situated immediately below. |
| Altitude | Vertical distance between sea level and an aircraft in flight. |
| Approach trajectory | The trajectory that a pilot will fly in order to advance upon a destination to carry out a release, landing or other aerial manoeuvre. |
| Assignment | A specified task to be completed by an aircraft or aerial support group. |

Chapter 12 – Aerial Operations

| Term | Definition |
|------------------------------------|--|
| Audible warning device | A signalling device which generates a loud siren to provide a warning sound. Audible warning devices are sometimes mounted to aircraft and are sounded by pilots to warn suppression personnel on the ground that an aircraft is approaching to make a release or cargo drop. |
| Authorisation to release | Explicit authorisation from the aerial coordinator to the pilot of a water bombing aircraft to release over a target. The authorisation is usually expressed in the form of the following statement: “You are authorised to release”. Authorisation to release should only be given by the aerial coordinator when ground personnel are clear of the target area. ¹²⁷ |
| Bearing | The horizontal direction to or from any point, usually measured clockwise from true north, or some other reference point, through 360 degrees. ¹²⁸ |
| Body of water | Any natural or artificial body of water that can be used by aircraft to extract water for suppression purposes. Examples of sources of water that can be used by aircraft to refill aircrafts’ buckets, tanks and holds include: lakes, reservoirs, ponds, rivers and streams. |
| Bucket | Specially designed bucket carried by a helicopter and used for dropping water or retardants from the air. |
| Bucket release | The release of water or fire retardant from a specially designed bucket slung below a helicopter. |
| Cargo | Equipment or supplies that are carried by an aircraft. |
| Cargo chute | A parachute designed and used for dropping equipment and supplies from an aircraft while in flight. |
| Cargo drop | Dropping of equipment or supplies, with or without a parachute, from an aircraft in flight. ¹²⁹ |
| Cloud cover | The amount of sky obscured by cloud at a particular location. Cloud cover is expressed in eighths, where eight eighths is used to describe complete cloud cover. |
| Compass | An instrument used for navigation and orientation. A compass consists of a mounted or suspended magnetic needle which points to Magnetic North. |
| Compass rose | A circular symbol indicating the direction of True and/or Magnetic North which is found printed on maps and sometimes on the ground at an airport or heliport. |
| Control points | A predefined point in time or location when/where an aircraft will transmit a report to the Aerial Coordinator. |
| Control room ¹³⁰ | A facility from which resources are directly assigned to a wildfire incident. |
| Coordinates | Alphanumeric characters that are used to describe the precise geographic location of a point on the earth’s surface. |
| Daisy chains | A daisy chain is an informal “follow the leader” pattern for aircraft. To maintain a daisy chain, pilots need to adopt a common flight path. |

¹²⁷ For instance, in France the authorisation to release should only be given when suppression personnel are working perpendicular to and at least 50 metres away from the target area.

¹²⁸ Source: Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology* (Global Fire Monitoring Center, Freiburg), page 29.

¹²⁹ Source: National Wildfire Coordinating Group (2011) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), page 42.

¹³⁰ Also commonly referred to as a “Dispatch Centre”.

Chapter 12 – Aerial Operations

| Term | Definition |
|--|---|
| Delayed aerial ignition device (DAID) | An incendiary device dropped from an aircraft which will ignite after a predetermined amount of time. The delayed ignition is usually achieved through the production of a chemical reaction which is initiated prior to or during the drop. |
| Demobilization | To direct resources to return to their normal base. |
| Disengagement plan | <p>A predetermined list of actions to be enacted by a pilot of an aircraft in the event of unforeseen hazardous circumstances, including but not limited to:</p> <ul style="list-style-type: none"> • Engine failure • Sighting of ground personnel within a drop zone • Last minute change of tactics • Failure of a tank, bucket or door to open during a drop. <p>An escape plan should be devised for all water and retardant releases and for all personnel and equipment drops.</p> |
| Disengagement trajectory | A pre-planned flight trajectory to be flown by an aircraft in the event of unforeseen hazardous circumstances. A disengagement trajectory is an important part of a disengagement plan. |
| Divert | A change in assignment for an aircraft. |
| Drone | An aerial vehicle without a human pilot on-board. The flight of the drone is controlled by on-board computers or via a radio control operator. Drones have multiple uses, but are normally used for aerial reconnaissance at wildfires. |
| Drop zone | Specific location where personnel or equipment are to be dropped from an aircraft. |
| Dummy run | <p>A simulated run made on a target by an aircraft. A dummy run may be completed for singular or multiple purposes, including:</p> <ul style="list-style-type: none"> • Indicating the desired flight trajectory and target to other aircraft (cf. Identification run). • Identifying potential flight hazards. • Completing test releases to check for wind drift. |
| Early release | A release that lands before (or in front) of its target. In short, the pilot made the release prematurely. |
| Estimated Time of Arrival (ETA) | The predicted time that an aerial resource will reach a specified destination. |
| Exit trajectory | The trajectory that a pilot will fly after completing a release or other aerial manoeuvre. |
| Final run | The final trajectory of an aircraft towards its target. The final trajectory may be straight or curved and will not normally exceed one minute in duration. |

Chapter 12 – Aerial Operations

| Term | Definition |
|--------------------------------|---|
| Fire fighting chemicals | <p>Substances that have the ability to prevent, reduce or inhibit combustion. They can be applied from the air or from the ground and may be applied directly onto a fire or an area of unburned fuel. Common types of fire fighting chemicals include:</p> <ul style="list-style-type: none"> • Foam – A mass of bubbles formed by mixing specific proportions of air with water and foam concentrate. Foam can be applied in order to smother and cool parts of a fire and/or to prevent ignition within a fuel. • Gels - Chemicals which are added to water to make it thicken. When used as an extinguishing agent the mixture is able to absorb more heat than water and sticks to the surface of the fuel. • Retardants – A group of chemicals that are usually mixed with water which have the ability to reduce or inhibit combustion either in the long or short term: <ul style="list-style-type: none"> • Long-term retardants - have the ability to reduce or inhibit combustion even after the water that they contain has evaporated. • Short-term retardants – are primarily used to inhibit combustion through the more immediate cooling and/or smothering of a fire. • Wetting agents – Chemicals which, when added to water, decrease the surface tension of the water and enable greater penetration into fuels. |
| Fire Traffic Area (FTA) | A protected airspace around a wildfire incident where only authorised aircraft are allowed to enter. ¹³¹ |
| Flank attack (aerial) | A method of fire suppression which involved dropping water or retardant along a flank or simultaneously along both flanks of a wildfire. |
| Flight hazards | <p>Any real or potential condition that might put an aircraft at risk of damage or mechanical failure and its personnel at risk of injury or death. Some examples of common flight hazards at wildfire incidents include:</p> <ul style="list-style-type: none"> • Low level flight; • Steep terrain; • Turbulence; • Poor visibility; • Rotor downwash in burned areas from helicopter hover and landings; • Aircraft congestion in the vicinity of the fire. |
| Flight trajectory | <p>The path that a pilot will fly an aircraft through the air. Pilots should usually avoid flying over personnel or equipment at a wildfire incident and plan an escape route when setting up for a release.</p> <p>There are three additional important terms used to describe the paths to be flown by an aircraft:</p> <ul style="list-style-type: none"> • Approach trajectory – The path that a pilot will fly to advance upon a destination where a drop, landing or other aerial manoeuvre will be completed. • Exit trajectory - The path that a pilot will fly after completing a drop or other aerial manoeuvre. • Disengagement trajectory - A pre-planned route to be flown by an aircraft when a hazardous condition occurs. A disengagement trajectory is an important part of a pilot's disengagement plan. |

¹³¹ To provide some specific examples, in Catalonia (Spain) the FTA is defined as 12 nautical miles from the centre point of the wildfire incident, while in France the FTA is defined as 5,000 feet and 5 nautical miles from the incident.

Chapter 12 – Aerial Operations

| Term | Definition |
|----------------------------------|---|
| Foot | A unit for measuring distance which is commonly used in aeronautics. 1 foot (ft) is equivalent to 30.48 centimetres (cm). |
| Go-around | An order for a water bombing aircraft to disengage from its final run and delay a release until a new authorisation to release is given. |
| Head attack (aerial) | A method of fire suppression which involves the release of water or fire retardant from the air directly onto the head of a wildfire. |
| Height | Distance between the ground surface and an aircraft in flight. |
| Helicopter | An aircraft capable of hovering and moving vertically and horizontally in any direction during flight. Most helicopters achieve lift and propulsion through the rotation of overhead rotor blades. |
| Helicopter release system | A release system installed internally within or fixed by an attachment externally beneath a helicopter which is specifically designed for transporting and releasing water or retardant. |
| Helipad | A location for parking, fuelling, repairing/maintaining, and/or unloading or loading of helicopters during a wildfire incident. |
| Helipond | A small body of water which is suitable for helicopters to load helibuckets through a hover fill. Heliponds are sometimes artificially created through the damming of small water channels. |
| Helipump | A lightweight portable pump unit that has been specifically developed for transport by helicopter. |
| Helispots | Temporary or occasional landing areas for helicopters in close proximity to a fire. Helispots are usually used for cargo delivery/pick-up and sometimes for transporting suppression personnel. |
| Helitank | A specially designed tank which is fitted to the underside of a helicopter and used for transporting and dropping water or fire retardant. ¹³² |
| Helitorch | An aerial ignition device hung from a helicopter which disperses ignited gelled gasoline. |
| Hold | A tank or compartment beneath an aircraft which is capable of holding water, retardant or cargo. |
| Hover fill | When a helicopter fills a bucket or internal or external release system while in stationary flight above a water source. |
| Identification run | A flight by a lead aircraft over a target area to indicate the desired flight trajectory and target for other aircraft. |
| Jettison | To drop cargo or an unused load of water or retardant from an airplane or helicopter to lighten the aircraft and/or to improve stability. A specific location in the near vicinity of the fire may be designated for aircraft to jettison their unused loads, although a jettison in the case of an emergency may be made anywhere in order to maintain safety. |
| Knot | A unit for measuring speed which is commonly used in aeronautics. 1 knot is equivalent to a speed of 1 nautical mile per hour. |
| Late release | A release that lands after (or behind) its target. In short, the pilot made the release too late. |
| Lead aircraft | An aircraft that provides some form of leadership and/or guidance to other aircraft while in the air. Lead aircraft can have multiple assignments. |
| Load and conserve | An order given to the pilot of an aircraft to pick up and retain another load of retardant or water and to remain at a specified location until receiving further assignments. The aircraft is still committed to the fire. |

¹³² Based on the definition provided by National Wildfire Coordinating Group (2011) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), page 98.

Chapter 12 – Aerial Operations

| Term | Definition |
|------------------------------------|---|
| Load and return | An order given to the pilot of an aircraft to pick up another load of retardant or water and to return immediately to the fire. |
| Long-term retardant | Long-term retardants have the ability to reduce or inhibit combustion even after the water they contain has evaporated. |
| Low pass | A low flight over a target area. A low pass may be completed by a water bombing aircraft, lead plane, or other aircraft in order: <ul style="list-style-type: none"> • to obtain a closer look at a target; or, • to warn ground personnel in the vicinity of a target of an impending drop (normally using an audible warning device). |
| Marking out | The creation of a marking on the ground to identify a target area for water bombing aircraft, either by personnel on the ground or by a helicopter. |
| Massive attack | A substantial and swift attack using aerial resources which is intentionally excessive in relation to the size of the wildfire. A massive attack will be performed in order to suppress a relatively small wildfire as quickly as possible so that aerial resources can be quickly released to perform other assignments. |
| Mobilization ¹³³ | A command decision to move a resource or resources from one location to another. This includes moving new resources to a wildfire incident. |
| Mutual support | Coordination of the actions of ground and aerial resources to ensure that they complement and support one another. |
| Nautical mile | A unit for measuring distance which is commonly used in aeronautics. 1 nautical mile is equivalent to 1,852 metres. |
| Navigation | The process of planning, following and monitoring progress along a pre-defined route of travel. |
| One skid landing | A partial landing during which a helicopter remains in stationary flight with only one landing skid in contact with the ground. Remaining stationary in this manner allows for the loading or unloading of personnel and equipment on rocky ground or on slopes where the gradient is too steep to allow for a complete landing. |
| Paracargo | Equipment or supplies dropped from an aircraft in flight by parachute, other retarding devices, or free fall. |
| Parallel attack (aerial) | A method of fire suppression involving the release of water or retardant from the air to form a control line approximately parallel to and some distance away from the fire edge. |
| Release | When an aircraft in flight deliberately drops water or retardant over a specified target. |
| Release zone | The area surrounding a specific release target. |
| Release density | The quantity of water or retardant release per square metre. Release density is dependent upon two key variables: <ul style="list-style-type: none"> • Release height; and, • Speed of the aircraft when the drop is made. |

¹³³ Also commonly referred to as “dispatch”.

Chapter 12 – Aerial Operations

| Term | Definition |
|-----------------------------|---|
| Release height | <p>Height at which an aircraft releases water or retardant over a target. Two types of release height are of particular significance:</p> <ul style="list-style-type: none"> • High release - A release made from a higher than normal height. This type of release can be ordered for tactical or safety reasons. • Low release – A release made from a lower than normal height. A low release normally poses greater risks than a high release because flight hazards tend to be greater and because pilots have less time to take action in the case of an engine failure or other emergency with the aircraft. A low release may, however, be more effective than a high release in particular circumstances. |
| Release mode | <p>The method of release selected by the pilot of a water bombing plane in order to achieve the desired density. The mode selected will partly depend upon an aircraft's hold system. Examples of different release modes include:</p> <ul style="list-style-type: none"> • Salvo release – Release of an entire load of water or retardant carried by a water bombing plane. Generally used on fires or parts of fires requiring a high density release of water or retardant. • Single hold release – Release from only one hold of a water bombing plane. • Sequential release – The opening of multiple holds of a water bombing plane to release a continuous flow of water or retardant over a desired distance. A sequential release can be extended in length through the partial opening of holds, although this will lead to lower coverage. • Split release – Multiple releases made from one hold at a time from a water bombing plane. |
| Release over a slope | <p>Drops over a slope can be classified as:</p> <ul style="list-style-type: none"> • Cross slope release - A release of water or retardant while an aircraft flies along the contours of a slope. • Downslope release - A release of water or retardant while an aircraft flies from the top to the bottom of a slope. • Stacking pattern release - A release pattern used for steep terrain where flight trajectories of aircraft are contoured to a slope. Generally speaking, the first release is made at the top of the slope and successive releases gradually progress to the bottom of the slope. • Upslope release - A release of water or retardant while an aircraft flies from the bottom to the top of a slope. |
| Release pass | <p>When a water bombing aircraft has a target in sight and carries out a release in flight over the target.</p> |

Chapter 12 – Aerial Operations

| Term | Definition |
|------------------------|--|
| Release pattern | <p>The distribution of one or more water or retardant releases on a target area. Release patterns can be classified in six ways:</p> <ul style="list-style-type: none"> • Box pattern release - When a single bombing aircraft makes multiple releases forming a retardant line around the perimeter of a small fire. • Extended release - To make a release so that it overlaps and lengthens the coverage of a previous release. • Full coverage release – To make a release with the aim of covering the entire fire with water or retardant. Multiple releases may actually be required to obtain the desired release density. This type of release pattern is commonly used to control fire intensity and spread of small fires, such as spot fires. • Stacking pattern release - A release pattern used for steep terrain where the flight trajectory of the aircraft is contoured to a slope. Generally speaking, the first release is made at the top of the slope and successive releases gradually progress to the bottom of the slope. • “V” pattern release - Multiple releases by one or more water bombing aircraft to form a retardant line in the shape of a “V” around the head or heel of a small fire. • Safety release – A release of water or retardant over a vehicle or group of individuals in difficulty on the ground for the purpose of reducing the intensity of the fire to enable the personnel to escape. |
| Release tactics | <p>The strategic calculation of the way in which water and/or retardant should be released on a fire or parts of a fire. There are multiple ways that a pilot of an aircraft can make releases of water or retardant. Different release tactics will be more or less successful within particular situations and the choice of tactics used will vary according to a variety of factors including but not limited to: the type of aircraft deployed; the objectives and priorities of a suppression plan; current and predicted fire behaviour; fire weather; topography; and, flight visibility.</p> <p>Release tactics for water and retardant are described using four different variables:</p> <ul style="list-style-type: none"> • Release mode¹³⁴; • Release height; • Release over a slope; • Release pattern. |
| Release target | Specific location where water or retardant is to be released from an aircraft. |
| Retardant | <p>A substance or chemical agent that has the ability to reduce or inhibit combustion. Retardants can be categorised as long-term or short-term:</p> <ul style="list-style-type: none"> • Long-term retardants - have the ability to reduce or inhibit combustion even after the water that they contain has evaporated. • Short-term retardants – are primarily used to inhibit combustion through the more immediate cooling and/or smothering of a fire. Short term retardants may include chemicals added to water that alter viscosity and/or which delay evaporation. |

¹³⁴ This variable is specific to water bombing aircraft.

Chapter 12 – Aerial Operations

| Term | Definition |
|--|---|
| Rotor downwash | Movement of air caused by the rotation of the principal rotor of a helicopter during landing or take-off. When there is loose material on the ground (such as ash or sand), the rotor downwash creates an opaque cloud which surrounds the helicopter and which totally or partially reduces the visibility for the pilot. This situation also makes individuals on the ground vulnerable to the risk of flying fragments of various sizes. |
| Short-term retardants | Short term retardants are primarily used to inhibit combustion through an immediate cooling and/or smothering of a fire. Short term retardants may include chemicals added to water that alter viscosity and/or which delay evaporation. |
| Sling load | Any cargo carried beneath a helicopter which is attached by a line and swivel. |
| Snorkel tank | A tank with a pump-driven tube attached to the underside of a helicopter. To reload with water, the helicopter hovers over a water source with the end of the snorkel immersed. The pump then fills the tank. |
| Stop | An instruction to terminate a planned aerial manoeuvre. The standard instruction for terminating a water drop from a water bomber or helicopter is “Don’t release! Don’t release!” |
| Swivel | A connector which is positioned between a helicopter cargo hook and sling load to allow free turning of a load. |
| Tail attack (aerial) | A method of fire suppression involving the release of water or fire retardant from the air directly onto the tail part of a wildfire. |
| Take-off and landing coordinator (TOLC) | A TOLC is responsible for maintaining safety within helipad airspace. The TOLC coordinates all aircraft movements by issuing take-off and landing clearances and air traffic advisories. |
| Target | Specific location on which water, retardant, personnel or equipment are to be dropped by an aircraft. |
| Temporary Flight Restriction (TFR) | Temporary notices that are imposed by Air Traffic Control to limit flight activity within an area of airspace due to hazards present in the air or on the land surface (for instance, a large wildfire incident). |
| Turbulence | Irregular movement of air within the atmosphere which is characterized by rapid changes in wind speed, vertical direction and/or horizontal direction. ¹³⁵ |
| Turnaround time | The period of time separating two releases by the same water bombing aircraft. The turnaround time is given in minutes and will depend upon the distance between the wildfire and the reloading site (for retardant) or body of water. |
| Visibility | The greatest distance at which objects can be seen and identified from the cockpit of an aircraft during flight. Visibility can be reduced by cloud, smoke and darkness. |
| Water bombing aircraft | An aircraft capable of carrying and releasing a volume of water or fire retardant. Water bombing aircraft can be fixed wing aircraft (such as Canadair, Tracker and Bombardier) or helicopters (with internal or external tanks or those able to carry buckets). |

¹³⁵ Clear-air turbulence is a particularly difficult phenomenon for pilots to identify because it occurs within skies that do not exhibit any visible indicators of its presence (for example, the sky may be cloudless).

Chapter 12 – Aerial Operations

| Term | Definition |
|---|---|
| Water filling system for helicopters | A system designed to allow a helicopter to fill its internal or external tanks with water while in flight. A water filling system will usually take the form of a fixed suction pump beneath the helicopter. To fill the water tank, the helicopter pilot flies stationary over a body of water with the pump submerged. Some systems operate a hydrofoil which allows for the tank to be filled up in mid-flight at low speed. |
| Water Safety Plan | A plan that is created to assure the safety of water bombing aircraft and other users of a body of water used for water filling. A water safety plan will commonly document the following types of arrangements: <ul data-bbox="496 645 1497 846" style="list-style-type: none">• Measures to be implemented to inform users of a body of water about its use by water bombing aircraft.• Systems and protocols for towing and salvage of water bombing aircraft that breaks down on the water.• Systems and protocols for providing aid and assistance to the crew of a water bombing aircraft which has broken down on the water. |
| Wind drift | The effect of the wind on releases of water and retardant. For precise releases, pilots need to make a correction for wind drift. Generally speaking, the higher the release the greater the potential drift. |

Section 3:

Wildfire Preparation, Prevention and Recovery



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Including the following Chapters:

13. Prevention and Detection

14. Fire Investigation

15. Restoration

Chapter 13 – Prevention and Detection

Prevention: “The act or process of reducing the occurrence and/or impact of wildfires”.

Detection: “The act or process of discovering, locating and reporting wildfire incidents.”



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Chapter 13 – Prevention and Detection

| Term | Definition |
|------------------------------|--|
| Aerial detection | The act or process of discovering, locating and reporting wildfire incidents from aircraft. Aerial detection can be: <ul style="list-style-type: none"> • Planned – where an agency mobilizes aircraft with aerial observers for the specific purpose of detecting wildfires; • Unplanned – where an aircraft not specifically hired or mobilised to detect wildfires reports a wildfire to a responsible agency. For example, unplanned aerial detection may come from passenger airplanes or other leisure aircraft. |
| Aerial observer | A person flying in an aircraft who is tasked with: <ul style="list-style-type: none"> • discovering, locating, and reporting wildfires and forest fires from an aircraft; and/or, • aerial reconnaissance. |
| Aerial reconnaissance | Use of aircraft for conducting preliminary surveys of a wildfire to gather information on: <ul style="list-style-type: none"> • fire behaviour • topography and fuel types • potential hazards and high risk areas • potential windows of opportunity • safety of ground personnel <p>The information gathered from aerial reconnaissance will be communicated to the Incident Commander to assist in the decision-making process.</p> |
| Alidade | A sighting device used to determine the horizontal bearing of a fire from an observation point. |
| Altitude | Vertical distance between sea level and an aircraft in flight. |
| Annotation | The addition of explanatory notes, comments or instructions to a map or image. |
| Automatic detection | A wildfire detection device which operates by itself with little or no direct human control. |
| Base map | A map intended as a base onto which other information is added, either as manual annotations, or digitally as new map layers in a Geographic Information System (GIS). Base maps usually include the grid coordinate system, roads, settlements, rivers and any other topographic features which will help users generate new useful information. These features are used to help locate known but as yet unmapped features such as fire hydrants, or interpreted to produce new information such as relative fuel load or accessibility. ¹³⁶ |
| Blind area | An area in which neither the ground nor its vegetation can be seen from an observation point. |
| Communication channel | A medium used to send a data transmission from one or several senders (or transmitters) to one or several receivers. Common examples of communication channels include: copper wires, optical fibres and wireless communication channels. |
| Communication tower | A structure built to support equipment that transmits communication signals. |
| Control centre | A building or facility dedicated to the coordination of particular activities. |

¹³⁶ Definition provided by Julia McMorro, University of Manchester (UK).

Chapter 13 – Prevention and Detection

| Term | Definition |
|---|--|
| Conversion burning | A type of prescribed burn which involves the deliberate use of fire to eliminate unwanted species that have appeared through natural regeneration. The ultimate purpose of conversion burning is usually to prepare an area for planting or to introduce different species. |
| Coordinates | Intersecting lines of reference which are used to identify specific locations on a map. |
| Data | Items of information represented in a formalised manner which are suitable for processing and interpretation. |
| Data quality | An assessment of the completeness and reliability of a dataset and its suitability for a particular purpose. |
| Data transmission | The physical transfer of data via a communication channel. |
| Database | A management system for one or more datasets. |
| Detection | The act or process of discovering, locating and reporting wildfire incidents. |
| Digital Elevation Model | A digital elevation model is a 3-D representation of a terrain's surface created from terrain elevation data. |
| Elevation | Height above sea-level. |
| Encryption | The process of converting data into code to prevent unauthorized individuals from being able to view the data. |
| Fire danger | A general term used to express an assessment of both fixed and variable factors of the fire environment that determine the ease of ignition, rate of spread, difficulty of control, and impact. Fire danger is often expressed as an index. ¹³⁷ |
| Fire danger index ¹³⁸ | A quantitative indicator of fire danger, expressed either in a relative sense or as an absolute measure. Fire danger indexes are often used to guide fire management activities. |
| Fire hazard | Any situation, process, material or condition that can cause a wildfire or that can provide a ready fuel supply to augment the spread or intensity of a wildfire, all of which pose a threat to life, property or the environment. ¹³⁹ |
| Fire Plan ¹⁴⁰ | A plan detailing predetermined fire suppression strategies and tactics to be implemented following the occurrence of a wildfire within a particular area. |
| Fire Prevention | A collective term for all proactive activities that are implemented with the aim of reducing the occurrence, severity and spread of wildfires. |
| Fire Prevention Plan | A scheme or programme of activities which is formulated in order to prevent wildfire incidents. |
| Fire Suppression Plan | A pre-determined strategic scheme or programme of activities which is formulated in order to safely and effectively accomplish fire suppression objectives. A fire suppression plan will outline the selection of tactics, selection of resources, resource assignments and how performance and safety will be monitored and maintained at a particular incident. Fire suppression plans need to be dynamic to take into account any changes in conditions or circumstances. |

¹³⁷ Source: Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology* (Global Fire Monitoring Center, Freiburg), p.121.

¹³⁸ Also referred to as "fire index".

¹³⁹ Amended from the definition provided by: NFPA (2011) NFPA 921 – Guide for Fire and Explosion Investigations (NFPA, Quincy, Massachusetts), p.14.

¹⁴⁰ Sometimes referred to as a *Fire Management Plan*.

Chapter 13 – Prevention and Detection

| Term | Definition |
|--|--|
| Firebreak | An area on the landscape where there is a discontinuity in fuel which will reduce the likelihood of combustion or reduce the likely rate of fire spread. Firebreaks may be naturally occurring or may be deliberately created as part of a wildfire mitigation or prevention activities. |
| Fragmentation | The process of transforming large continuous areas of vegetation and fuel into smaller discontinuous areas. Fragmentation leads to a change in fire regimes through the alteration and discontinuity of fuels. |
| Fuel management | The process of managing fuel or fuel arrangement. The aim of fuel management is usually to create a discontinuity in fuels to achieve fragmentation. |
| Fuel model | A mathematical representation of fuel properties within a specified location, often used to predict and plot likely fire spread and intensity. |
| Fuel treatment | The deliberate manipulation or removal of fuels using one or more of a variety of different means ¹⁴¹ to: <ul style="list-style-type: none"> • reduce the likelihood of ignition; and/or, • reduce potential fire intensity; and/or, • reduce potential damage; and/or, • assist suppression activities. |
| Geocode | The numerical or alphanumeric element in a database which identifies the geographical location of a particular record. |
| Geographic Information System (GIS) | A system designed to capture, store, manipulate, analyse, and present geographically referenced data. |
| Global Positioning System (GPS) | A global navigation system that provides very precise positioning information about the location of any point on or near the Earth surface. The system is freely accessible to anyone with a GPS navigation device/receiver. |
| Global Positioning System (GPS) Navigation Device¹⁴² | Any device that receives and triangulates GPS signals in order to determine its physical location on the Earth's surface. |
| Grid reference | Coordinates that can be used to define and identify specific locations on a map. |
| Hardware | The physical components of a system, such as a computer monitor or CD ROM drive. The programmes that control the functioning of hardware are called software. |
| Ignition patterns | A generic term for the three key techniques for igniting a managed burn: <ul style="list-style-type: none"> • Line ignition - igniting a burn in strips along a control line and the adjacent fuel. • Points of fire ignition - igniting a number of fires within an area of fuel. The aim of this technique is for the individual fires to burn into one another. • Fingers of fire ignition - igniting lines of fire at right angles to a control line and parallel to the wind. |
| Incident | An occurrence or event that requires action to prevent or minimise loss of life, damage to property or damage to the environment. |
| Incident localization | Identification of the specific location of a wildfire following its detection. |

¹⁴¹ Inclusive of the following means: manual, mechanical, chemical, or using fire.

¹⁴² Also referred to as a "GPS Receiver".

Chapter 13 – Prevention and Detection

| Term | Definition |
|--|---|
| Infrared (IR) | Thermal radiation which is invisible to the human eye ¹⁴³ . A number of devices used by wildfire practitioners incorporate IR technology, including: infrared imagers; night-vision devices; and, wireless connections between computer devices. |
| Infrared imager | An instrument that converts incoming infrared radiation into a thermal image or map to show temperature variation. |
| Land management | The process of managing the use and development of an area of land for: wildfire prevention; conservation, restoration or protection of the environment; commerce; and/or for other reasons. |
| Land use planning | A decision-making process involving the allocation of areas of land to different uses and/or vegetation types. This allocation should take into account any necessary considerations regarding wildfire prevention and detection. |
| LIDAR (Light Detection And Ranging) | An optical remote sensing technology that can measure the distance to or other properties of a target by illuminating the target with light, often using pulses from a laser. LIDAR technology has applications in geomatics, geography, geology, geomorphology, forestry, remote sensing as well as in airborne laser swath mapping (ALSM), laser altimetry and contour mapping. |
| Managed burn | A planned and supervised burn carried out for the purpose of removing fuel either as part of a land management exercise (a prescribed burn) or a Fire Suppression Plan (an operational burn). |
| Manual detection system | A wildfire detection system which is operated by and requires direct control from a person. ¹⁴⁴ |
| Map | A graphical representation of an area which depicts the relative positions of features and landmarks. |
| Map layer | A map of a single thematic feature, such as contours, roads, or rivers and streams. Each map layer is usually stored as a separate file in a Geographic Information System (GIS) and overlaid to produce topographic or other maps. ¹⁴⁵ |
| Map overlay | The combination of several map layers with the same map projection to create a new output map layer which shows the relationship between them. It is visually similar to stacking several maps of the same area. ¹⁴⁶ |
| Mitigation | A collective term used for those activities implemented prior to, during, or after a wildfire which are designed to reduce the actual or potential consequences of the wildfire. Mitigation measures can include efforts to educate governments, businesses and the general public on appropriate actions to take to reduce loss of life and property during wildfire incidents. The development of mitigation measures is often informed by lessons learned from prior incidents. ¹⁴⁷ |
| Observation point | A specific location with a view of a surrounding area which is used for wildfire detection. |

¹⁴³ IR has an approximate wavelength of between 0.75 and 1,000 micrometres. IR has a frequency that is less than that of visible light (which is what makes it invisible to the human eye) and greater than that of most radio waves.

¹⁴⁴ Some detection systems are designed to allow users to switch between automatic, manual and/or semi-automatic modes.

¹⁴⁵ Definition provided by Julia McMorrow, University of Manchester (UK).

¹⁴⁶ With thanks to Julia McMorrow, University of Manchester (UK), for her contributions to this definition.

¹⁴⁷ Based on the definition provided by the NWCG: National Wildfire Coordinating Group (2011) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.121.

Chapter 13 – Prevention and Detection

| Term | Definition |
|---|---|
| Observation tower ¹⁴⁸ | A structure with a view of a surrounding area which is used for wildfire detection. |
| Observer | An individual occupying an observation tower/point or completing a patrol of a designated area that is tasked with detecting and reporting wildfires. |
| Optical sensor | A device that measures visible (light) radiation. |
| Orthophotograph | A photograph that has been geometrically corrected to adjust for topography, lens distortion and camera tilt. Unlike standard photographs, orthophotographs can be used to measure true distances. |
| Patrol | The act of supervising a specified area in order to prevent, detect and/or control a wildfire. |
| Preparedness plan | A pre-determined strategic scheme or programme of activities which is formulated in order to satisfactorily prepare an organisation or a geographic area to respond effectively to wildfire incidents. |
| Prescribed burn ¹⁴⁹ | A planned and supervised burn carried out under specified environmental conditions to remove fuel from a predetermined area of land and at the time, intensity and rate of spread required to meet land management objectives. ¹⁵⁰ |
| Prevention | The act or process of reducing the occurrence and/or impact of wildfires. |
| Remote sensing | The acquisition and interpretation of images of the Earth's surface, where images are usually acquired by cameras and scanners carried on aircraft or orbiting satellites. Optical images simultaneously record visible and invisible reflected light in several different wavelengths; when combined, these images (or 'bands') can be used to map burn scars, different types of fuel and fuel moisture. Thermal images record emitted heat from active fires and the Earth's surface. Radar remote sensing uses artificial microwave energy to produce images of burn scars through cloud and at night. ¹⁵¹ |
| Restricted area | An area in which specified activities or entry are temporarily or permanently restricted in order to mitigate risk to human health or safety by potential or on-going wildfires. A restricted area may also be temporarily or permanently established in order to reduce the risk of a wildfire igniting within a specified location. |
| Satellite detection system | A wildfire detection system which operates via a satellite. |
| Semi-automatic detection system | A detection system which is partially operated by itself and partially operated by manual control. |
| Sensor | A device that measures physical quantities and then converts them into a signal which can be interpreted by a person or instrument. Infrared and optical sensors are common components of wildfire detection systems. |

¹⁴⁸ Also sometimes referred to as "lookout towers" or "lookout points".

¹⁴⁹ Prescribed burning is not currently permitted within all EU countries. Those countries that do permit prescribed burns often have specific legal restrictions concerning when and where a prescribed burn can take place.

¹⁵⁰ Based on the definition provided by AFAC for "prescribed burning": Australasian Fire and Emergency Service Authorities Council (2009) *Wildfire Glossary* (Australasian Fire and Emergency Service Authorities Council, Melbourne), p.22.

¹⁵¹ Definition provided by Julia McMorrow, University of Manchester (UK).

Chapter 13 – Prevention and Detection

| Term | Definition |
|-------------------------------------|---|
| Server | <p>A computer or computer programme that manages access to a central service or resource within a computer network. Three examples of different servers commonly found within prevention and detection systems include:</p> <ul style="list-style-type: none"> • Database server - a computer or computer programme that provides database services to computer connected to a network. • File server – a computer or computer programme that enables the storage and retrieval of computer files by computers connected to a network. • Print server – a computer or computer programme that connects printers to computers that are connected to a network. |
| Software | <p>The programmes that control the functioning of hardware. Software can be divided into two sub-categories:</p> <ul style="list-style-type: none"> • Systems software – all software necessary for a system to function, such as a computer operating system. • Applications software – all programmes that enable the user of a system to complete a specific task, such as a word processor programme on a computer. |
| System | <p>An assembly of components connected together in an organized way to achieve a particular purpose.</p> |
| System functionality | <p>The range of operations or actions that can be run by a system.</p> |
| System integration | <p>The process of combining multiple systems into one system.</p> |
| System operator | <p>An individual who is responsible for operating and/or maintaining a computer system or communication network.</p> |
| Terrestrial detection system | <p>A wildfire detection system which is operated from the Earth's surface.</p> |
| Thermal sensors | <p>A sensor that detects variations in temperature.</p> |
| Triangulation | <p>A method which uses two known coordinates to determine the coordinates of a third location.</p> |
| Wireless communication | <p>A system that transmits data using radio waves, microwaves or other types of electromagnetic waves. In other words, a system that transmits data without the need for physical mediums such as wires, cables or fibre optics.</p> |

Chapter 14 – Fire Investigation

***Fire Investigation: “The process of determining the origin, cause, and development of a fire.”
(NFPA 921)***



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Chapter 14 – Fire Investigation

| Term | Definition | | | | | | | | | | | | | | | |
|-----------------------------------|--|--|----------------|---------------|---------|---------|--------------------------------------|-----------|---------|-------------------------------------|-----------|-----------|--|---------|-----------|--|
| Accelerant | Material used to initiate or increase the spread of a fire. This will often be an ignitable liquid. | | | | | | | | | | | | | | | |
| Access | A point of entry, exit and/or route to an incident location. | | | | | | | | | | | | | | | |
| Advancing fire | This is fire progression associated with the head (front) of the fire. Fire behaviour in this area is usually characterized by more intense burning, increased flame height and length and more rapid rates of spread. It will usually occur when a fire burns with the support of one or more forces of alignment (for instance, wind, slope, or aspect). Fire direction indicators in this area are generally large and very noticeable (i.e. macro indicators). ¹⁵² | | | | | | | | | | | | | | | |
| Angle of char indicators | <p>The angle at which standing fuels (such as trees or fence poles) are burned. Angle of char is an indicator of the direction of fire spread. The angle that the fuel is burned will depend upon whether the fire burned with or without the support of one or more factors of alignment.</p> <p>The table below provides a summary of the characteristic angles of char produced by a fire burning with or without the support of the slope and wind.¹⁵³</p> <table border="1" data-bbox="518 875 1414 1223"> <thead> <tr> <th>Direction of fire spread</th> <th>Wind direction</th> <th>Angle of Char</th> </tr> </thead> <tbody> <tr> <td>Upslope</td> <td>Upslope</td> <td>Greater than the angle of the slope.</td> </tr> <tr> <td>Downslope</td> <td>Upslope</td> <td>Parallel to the angle of the slope.</td> </tr> <tr> <td>Downslope</td> <td>Downslope</td> <td>Greater on the downslope side of the fuel.</td> </tr> <tr> <td>Upslope</td> <td>Downslope</td> <td>Parallel to the angle of the slope, with some additional damage to the fuel on the upslope side.</td> </tr> </tbody> </table> | Direction of fire spread | Wind direction | Angle of Char | Upslope | Upslope | Greater than the angle of the slope. | Downslope | Upslope | Parallel to the angle of the slope. | Downslope | Downslope | Greater on the downslope side of the fuel. | Upslope | Downslope | Parallel to the angle of the slope, with some additional damage to the fuel on the upslope side. |
| Direction of fire spread | Wind direction | Angle of Char | | | | | | | | | | | | | | |
| Upslope | Upslope | Greater than the angle of the slope. | | | | | | | | | | | | | | |
| Downslope | Upslope | Parallel to the angle of the slope. | | | | | | | | | | | | | | |
| Downslope | Downslope | Greater on the downslope side of the fuel. | | | | | | | | | | | | | | |
| Upslope | Downslope | Parallel to the angle of the slope, with some additional damage to the fuel on the upslope side. | | | | | | | | | | | | | | |
| Area of origin | <p>General geographical location within a fire perimeter where the point of ignition is believed to be located. See also:</p> <ul style="list-style-type: none"> • General Area of Origin • Specific Area of Origin • Point of Origin | | | | | | | | | | | | | | | |
| Arson | The wilful or malicious burning of a fuel with criminal intent to cause damage. ¹⁵⁴ | | | | | | | | | | | | | | | |
| Authentication of evidence | The process by which a piece of evidence is proven to be genuine. | | | | | | | | | | | | | | | |
| Authority | The legal right to attend and complete actions and assignments at a wildfire incident. Within the context of fire investigation, it is the legal right of an individual or organisation to investigate a fire. | | | | | | | | | | | | | | | |
| Backing fire | A lower intensity fire or part of a fire which burns against the wind and/or down slope. | | | | | | | | | | | | | | | |

¹⁵² This is an amendment from the definition of “advancing fire” provided within the National Wildfire Coordinating Group (2005) *Wildfire Origin and Cause Determination Handbook* (National Wildfire Coordinating Group Fire Investigation Working Team; USA), p.7.

¹⁵³ Based on information presented at <http://www.interfire.org/features/wildfires2.asp> and within NFPA (2011) *NFPA 921 – Guide for Fire and Explosion Investigations* (NFPA, Quincy, Massachusetts). Appreciation is also expressed to Prof. Vittorio Leone for his assistance in compiling this information.

¹⁵⁴ “Arson” is a legal term and as such its precise definition varies between jurisdictions/countries.

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| Term | Definition |
|--------------------------------|---|
| Burn patterns | The characteristic configuration of char and other fire direction indicators left by a fire. ¹⁵⁵ The accurate interpretation of burn patterns can assist fire investigators in identifying the origin of a fire. |
| Burn severity | A qualitative assessment of the heat pulse directed toward the ground during a fire. Burn severity relates to soil heating, large fuel and duff consumption, consumption of the litter and organic layer beneath trees and isolated shrubs, and mortality of buried plant parts ¹⁵⁶ . |
| Cause of fire | The sequence of events and actions that brings an ignition source into contact with materials first ignited which leads to sustained combustion. ¹⁵⁷ For statistical purposes, causes of fire are usually grouped within a standard classification. ¹⁵⁸ |
| Chain of custody | A document that outlines the individuals who have had possession and access to a piece of evidence from the time it was seized through any transfers and laboratory analysis to its disposition. |
| Char | Carbonaceous material formed by incomplete combustion of an organic material, such as wood or a shrub. It has a blackened appearance. |
| Char height | The vertical distance above the ground of the part of a tree or shrub that has been scorched or blackened by fire. Char height can be used as an indicator of fire intensity. |
| Circumstantial evidence | Evidence that indirectly proves a fact through inference and assumption ¹⁵⁹ . In the absence of direct evidence, an accumulation of circumstantial evidence will usually be required in order to corroborate evidence. |
| Corroborating evidence | Evidence that supports a theory which has been formulated based on the discovery and analysis of other evidence. |
| Crown kill | The proportion of limbs, buds, and foliage within the canopy vegetation that has been killed and consumed by a wildfire. |
| Crown scorch | Browning of needles or leaves in the crown of a tree or shrub due to burning which has killed but not consumed the vegetation. Crown scorch may not be visible immediately and it may take several days or weeks after the fire for it to become apparent. |
| Cupping indicators | A concave or cup-shaped char pattern found on the ends of grass stems, small stumps and the limbs of shrubs and trees. Grass stems, stumps, limbs and/or twigs that face the oncoming fire will usually be blunt or rounded, while those facing away from it will usually have sharply pointed or tapered ends. Therefore, cupping indicators can be used as a directional indicator. |
| Curling indicators | Curling occurs when green leaves curl or fold in the direction that a fire came from. Curling will usually occur during a slower moving, less intense wildfire or part of a wildfire. |

¹⁵⁵ Source: Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology* (Global Fire Monitoring Center, Freiburg), p.40.

¹⁵⁶ Source: National Wildfire Coordinating Group (2008) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.39.

¹⁵⁷ With thanks to Paul Steensland, Paul Steensland and Associates LLC (USA) and Richard Woods, Australian Capital Territory Rural Fire Service (Australia).

¹⁵⁸ Classifications vary between countries and sometimes also between States, regions or localities within the same country.

¹⁵⁹ An example of circumstantial evidence would be an eye witness who observed an individual fleeing the scene of a wildfire but who did not see the individual actually start the fire.

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| Term | Definition |
|---|---|
| Deductive reasoning | The process by which conclusions are drawn by logical inference from given premises ¹⁶⁰ . |
| Deep-seated fire | An established ground fire burning 0.5 metres or more below the surface. This type of ground fire is particularly challenging to extinguish. |
| Degree of damage | The amount of fuel that is burned and consumed by a wildfire. The degree of damage sustained by a fuel can be interpreted as an indicator of a wildfire's intensity, duration and direction. The side of a fuel that faces an oncoming wildfire will usually exhibit the greatest degree of damage. |
| Depth of burn | The vertical reduction in surface and ground fuels due to consumption by fire. |
| Depth of char indicators | When a wildfire partially burns a fuel and changes the fuel's appearance to look fissured or scaly, similar to an alligator's or crocodile's hide ¹⁶¹ . In the case of a uniform fuel, char depth will be deeper on the side of the fuel which faces an advancing wildfire. Depth of char is strictly a comparative indicator, so absolute depth is of little consequence. |
| Detonator | A device used to set off an explosive charge. |
| Die out patterns | Fingers or islands of unburned or less intensely burned fuels. Die out patterns may be observed in areas where a fire entered a more sparsely arranged fuel or a fuel with greater moisture content. Die out patterns may be used as macro scale indicators to establish general fire direction. Investigators need to be wary not to mistake die out patterns as areas of origin. ¹⁶² |
| Direct evidence | Evidence that directly proves a fact without any resort to inference or assumption. An example of direct evidence would be an eye witness who observed an individual igniting a fire. |
| Directional indicators¹⁶³ | Physical marks or clues left on partially burned fuels and non-combustible objects which can assist fire investigators in determining the movement of a wildfire across an area of land. By applying a systematic approach, fire investigators can use directional indicators to retrace the path of the fire to the point of origin. |
| Disposition of evidence | Disposal of evidence gathered from the scene of a wildfire. |
| Documentary evidence | Any evidence gathered in documentary form for the purpose of a wildfire investigation. Although the term is normally used to refer to evidence written on paper, it can also include other types of media that record or preserve evidence, such as film, photographs and tape recordings. |
| Evidence | A fact or piece of information which proves or disproves a hypothesis. |
| Expert witness | A witness that is deemed by a trial court judge to have sufficient knowledge, skill, or experience in a particular profession or area of study that allows them to draw inferences and form conclusions that an average layperson could not. |
| Factual witness | A witness who provides evidence based on factual matters that do not require the formulation of an opinion or conclusion. An example of a factual witness would be an individual who provides an account of what he/she saw, heard, smelled and/or did at a wildfire incident. |

¹⁶⁰ Source: NFPA (2011) *NFPA 921 – Guide for Fire and Explosion Investigations* (NFPA, Quincy, Massachusetts), p.13.

¹⁶¹ Hence the common alternative terms of “alligatoring” and “crocodiling”.

¹⁶² With thanks to Paul Steensland, Paul Steensland and Associates LLC (USA).

¹⁶³ In some countries the term “fire vector” is used in place of the term “directional indicator”.

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| Term | Definition |
|-------------------------------------|---|
| Fire | Fire is the product of the chemical reaction of combustion. The three factors of fuel, oxygen and heat must all be present in the correct proportions for combustion to occur. When the combustion process is initiated, heat and light are emitted and a fire occurs. |
| Fire activity | Description of a fire based on an assessment of visible evidence, including the speed of the fire, flame length, flame height, fire severity, and fire behaviour. |
| Fire analysis | Process of reviewing the behaviour and effects of a specific fire or group of fires and the actions taken to suppress it/them. |
| Fire behaviour | The reaction of a fire to the influences of fuel, weather, and topography. Different types of fire behaviour include: <ul style="list-style-type: none"> • Smouldering fire - A fire burning without flame and with minimal rate of spread. • Creeping fire - A fire with a low rate of spread and generally with a low flame length. • Running fire - A fire with a high rate of spread. • Torching - A fire that burns from the ground through the surface and aerial fuels and into the crown of a single tree or small parcel of trees. • Spotting - fire behaviour where sparks and hot burning embers are transported by the wind or convection column to land beyond the fire perimeter resulting in spot fires. • Crowning – When a fire burns freely in the upper foliage of trees and shrubs. |
| Fire concentration | The number of fires per unit area during a specified time period. |
| Fire dynamics | The detailed study of how chemistry, fire science, and the engineering disciplines of fluid mechanics and heat transfer interact to influence fire behaviour. ¹⁶⁴ |
| Fire footprint | Outer shape of the fire perimeter at a given point in time. |
| Fire growth | The evolution of a fire from ignition to self-sustaining propagation and its movement through available fuels. |
| Fire hazard | Any situation, process, material or condition that can cause a wildfire or that can provide a ready fuel supply to augment the spread or intensity of a wildfire, all of which pose a threat to life, property or the environment. ¹⁶⁵ |
| Fire history | The reconstruction and interpretation of the chronology of wildfire occurrence and the causes and impacts of wildfires within a specified area. |
| Fire intensity | The rate at which a fire releases energy in the form of heat at a given location and at a specific point in time, expressed as kilowatts per metre (kW/m) or kilojoules per meter per second (kJ/m/s). |
| Fire investigation | The process of determining the origin, cause, and development of a fire. ¹⁶⁶ |
| Fire investigation protocols | A description of the recommended procedures and methodologies that should be adopted when completing a task or tasks during a fire investigation. |
| Fire investigation team | A group of individuals from one or more organisations that has been tasked with investigating a wildfire incident. |

¹⁶⁴ Source: NFPA (2011) *NFPA 921 – Guide for Fire and Explosion Investigations* (NFPA, Quincy, Massachusetts), p.14.

¹⁶⁵ Amended from the definition provided by: NFPA (2011) *NFPA 921 – Guide for Fire and Explosion Investigations* (NFPA, Quincy, Massachusetts), p.14.

¹⁶⁶ Source: NFPA (2011) *NFPA 921 – Guide for Fire and Explosion Investigations* (NFPA, Quincy, Massachusetts), p.14.

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| Term | Definition |
|----------------------------|--|
| Fire model | A computer program which will predict or reconstruct fire behaviour and rate of spread of a fire from a point of ignition or area of origin. |
| Fire patterns | The visible or measureable physical changes and identifiable shapes left by a fire. ¹⁶⁷ |
| Fire perimeter | The entire outer boundary of a fire. |
| Fire scar | a) A healing or healed injury or wound to woody vegetation, caused or accentuated by fire; or, b) The overall shape and size of the area burned by a wildfire. |
| Fire severity | Degree to which a site has been altered or disrupted by fire. ¹⁶⁸ Fire intensity and the amount of time a fire burned within a particular area, among other possible factors, will influence fire severity. |
| Fire spread | The movement of a fire through available fuels arranged across the landscape. |
| First responders | The first person/people to arrive at the scene of a wildfire. It is often used as a generic term for all emergency service personnel who are expected to respond to emergency incidents. |
| Flame angle | The angle of a flame measured in relation to the ground surface. Flame angle is expressed in degrees. |
| Flame height | The vertical extension of a flame. Measurement of flame height is calculated perpendicular from ground level to the tip of the flame. Flame height will be less than flame length if flames are tilted due to wind or slope. |
| Flame length | The total extension of a flame measured from its base at ground level to the flame tip. Flame length will be greater than flame height if flames are titled due to wind or slope. |
| Flammability | Relative ease with which a given fuel will ignite and burn with a flame. |
| Flanks | The parts of a fire's perimeter that are roughly parallel to the main direction of fire spread. ¹⁶⁹ The flanks usually have less fire intensity than the head fire because they have a weaker alignment with wind or slope. |
| Foliage freeze | Branches, needles or leaves on green vegetation that have been dried by a fire leaving them fixed in position to point in the direction of the wind at the time of the fire's passage. Visually the vegetation takes on a windswept appearance. Foliage freeze is only an accurate indicator of wind direction; however, this will generally coincide with direction of fire spread within the areas of advancing fire progression. ¹⁷⁰ |
| Forces of alignment | A collective term for the forces that have a significant impact on wildfire behaviour. These forces can support or hinder fire development and can be used to predict likely fire behaviour, including fire spread and fire intensity. Wind, slope and aspect are considered to be key forces of alignment. |
| Fuel | Any material that can support combustion. |
| Fuel complex | The type, quantity, condition, arrangement and continuity of fuel available to burn. |
| Fuel model | A mathematical representation of fuel properties within a specified location, often used to predict and plot likely fire spread and intensity. |

¹⁶⁷ Based on the definition provided by the NFPA: NFPA (2011) *NFPA 921 – Guide for Fire and Explosion Investigations* (NFPA, Quincy, Massachusetts), p.14.

¹⁶⁸ Source: National Wildfire Coordinating Group (2011) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.78.

¹⁶⁹Source: National Wildfire Coordinating Group (2011) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.84.

¹⁷⁰ However, wind direction will often coincide with direction of fire spread.

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| Term | Definition |
|-------------------------------|---|
| Fulgurites | Natural hollow glass tubes or clumps that form in sand, silica or soil after a lightning strike or an electrical discharge from a power conductor. ¹⁷¹ Fulgurites are formed when the high temperature of an electrical discharge instantaneously melts and fuses grains of sand together to produce silica glass. The process leaves evidence of the path of the electrical discharge, sometimes many metres below the ground surface. |
| General Area of Origin | An area of the scene of a wildfire which may contain macro scale indicators indicating the origin of the fire. The General Area of Origin is usually identified through eye witness accounts of the fire perimeter during the early stages of the fire and may cover an area of 0.2 hectares or less. ¹⁷² |
| Grass stem indicators | <p>The pattern of the charred remains of grass stems. These remains will have a different appearance dependent upon the direction of fire spread and the intensity of the fire. Generally speaking:</p> <ul style="list-style-type: none"> • A fire or part of a fire which burns with the support of one or more factors of alignment will burn grass stems from the top down. Any grass stems not entirely consumed by fire may provide angle of char, cupping, degree of damage and/or protection indicators. • A backing fire which burns without the support of any factors of alignment will burn grass stems off at the base causing some to fall to the ground and into the area that has already been burned. Those grass stems remaining will generally point towards the direction that the fire came from. <p>Grass stems may form a number of recognizable patterns within the area of origin and/or within a transition zone:</p> <ul style="list-style-type: none"> • Circle pattern – when grass stems fall inwards in a circular pattern to point towards the point of ignition. This pattern occurs when a low intensity fire spreads relatively slowly away from the area of origin in all directions. • V or U pattern – when grass stems fall inward along a low intensity or transitional zone of a fire forming a V or U shape. This pattern occurs when a fire is influenced by wind or slope shortly after ignition. • Line pattern – when grass stems fall into the area of origin to form a line perpendicular to the direction of fire spread. This pattern occurs when a fire is almost immediately influenced by wind or slope, but it may be difficult to observe. |
| Ignition | The initiation of combustion. |
| Ignition method | The means by which a fire is ignited. |
| Ignition temperature | The minimum temperature at which ignition can take place and sustained combustion can occur. ¹⁷³ |

¹⁷¹ Fulgurites are sometimes referred to as “petrified lightning”.

¹⁷² This is equivalent to an area of half an acre or less. With thanks to Richard Woods of the Australian Capital Territory Rural Fire Service for providing this definition.

¹⁷³ Source: Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology* (Global Fire Monitoring Center, Freiburg), p.203.

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| Term | Definition |
|---|---|
| Incendiary | <p>A device that is purposefully designed to ignite a fire.¹⁷⁴ Incendiaries can be classified according to function and delivery method.</p> <p>The two categories for incendiary functions are:</p> <ul style="list-style-type: none"> • Hot set incendiaries – which are designed to ignite the fire immediately. • Time-delay incendiaries¹⁷⁵ – which are designed to ignite the fire after a time delay, allowing the offender time to leave the area prior to ignition. <p>The two categories for incendiary delivery method are:</p> <ul style="list-style-type: none"> • Remote delivery incendiaries – which are designed to be thrown or propelled a distance. • Hand-held and placed incendiaries – which are designed to be carried and placed at the point of ignition. |
| Indicators | <p>Physical marks, clues or patterns left on partially burned fuels and non-combustible objects which can be interpreted by a fire investigator. Accurate interpretation of indicators will enable a fire investigator to retrace the path of the fire to the point of origin.</p> <p>Indicators can be divided into two sub-categories:</p> <ul style="list-style-type: none"> • Macro indicators - These are large scale clues, marks or patterns left on partially burned fuels and non-combustible objects that are readily visible at a distance. They are usually associated with areas of higher intensity burning, where there has been an advancing head fire. • Micro indicators - Small individual clues, marks or patterns left on partially burned fuels and non-combustible objects that are often not easily visible, particularly at a distance. They often become less noticeable the closer you move towards the fire origin. |
| Lightning | <p>The discharge of electricity within the atmosphere either between two clouds or between a cloud and the ground. Lightning from cloud to ground can be a potential cause of wildfires, if conditions are suitable. Fires ignited by lightning often have multiple points of ignition.</p> |
| Macro indicators | <p>These are large scale clues, marks or patterns left on partially burned fuels and non-combustible objects that are readily visible at a distance. They are usually associated with areas of higher intensity burning, where there has been an advancing head fire.</p> |
| Material first ignited | <p>The first fuel that was set on fire.</p> |
| Memorandum of Understanding/ Agreement | <p>A documented written consensus between responsible and/or interested parties regarding the management and implementation of fire investigations.</p> |
| Micro indicators | <p>Small individual clues, marks or patterns left on partially burned fuels and non-combustible objects that are often not easily visible, particularly at a distance. They often become less noticeable the closer you move towards the fire origin.</p> |
| Motive | <p>A reason for doing something. The term is most frequently used within the context of explaining why an individual committed a crime.</p> |

¹⁷⁴ Common examples of incendiaries include: flares; fireworks; jutes; mosquito coils; twisted grass; cigarettes, matches and match boxes (independently or collectively).

¹⁷⁵ Sometimes referred to as “Delayed Action Incendiary Devices” (DAIDs).

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| Term | Definition |
|--|---|
| Multi-agency partnership investigations | When individuals from multiple agencies work together in a structured and coordinated manner to investigate a fire. |
| Multiple ignition points | More than one point of ignition. Multiple ignitions may be lit simultaneously or successively and could be indicative of spot fires or fires set deliberately by humans. |
| Pattern clusters | Areas of a fire scene containing multiple patterns and indicators which demonstrate a particular direction of fire spread, rate of fire spread and/or level of fire intensity. |
| Photographic evidence | <p>Photographs taken at the scene of a wildfire, either during or post-fire. They may be taken by witnesses, first responders and/or fire investigators.</p> <p>There are four key different types of photographs typically taken by fire investigators¹⁷⁶:</p> <ul style="list-style-type: none"> • Orientation photographs –photographs taken at a distance to show the overall view of a fire, the area of origin or other important areas of the scene. • Relationship photographs –photographs taken at a medium range to show moderately detailed views of particular areas of the scene and to illustrate the relationship between various areas, indicators or pieces of evidence. • Identification photographs –photographs taken close-up and at short range. They are taken to show a high level of detail for specific items of evidence or indicators. • Examination photographs – photographs taken close-up and at short range with a scale. Their purpose is to clearly establish the size of a piece of evidence. |
| Physical evidence | Any material object which demonstrates a fact through its physical characteristics. |
| Point of ignition | The precise physical location where the source of ignition came into contact with materials first ignited. The physical remains of the ignition source may be present or in close proximity. |
| Preliminary scene assessment | <p>The investigation of a wildfire scene should begin with a preliminary scene assessment. The key activities for the preliminary scene assessment are observation and preservation of evidence. More specifically, investigators completing a preliminary scene assessment will:</p> <ul style="list-style-type: none"> • determine the size of the fire; • determine the necessary scope of the investigation; • approximately reconstruct the movement of the fire and determine the area of origin; • consider the health and safety implications of the investigation; • and, consider the resource implications of the entire investigation. <p>If time permits, investigators should take photographs, make sketches of the scene, gather evidence from key witnesses, and identify locations that may require more detailed examination.</p> |

¹⁷⁶ National Wildfire Coordinating Group (2005) *Wildfire Origin and Cause Determination Handbook* (National Wildfire Coordinating Group Fire Investigation Working Team; USA), p.54.

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| Term | Definition |
|---------------------------------|---|
| Preservation of evidence | Any action taken to prevent evidence from being contaminated, manipulated, lost or destroyed. |
| Protection indicators | When a non-combustible object or a fuel shields part of a fuel from heat damage. Generally speaking, fuels will be unburned or show relatively less damage on the side shielded from an advancing flame front. |
| Rate of spread | A measurement of the speed at which a fire front moves across a landscape. Rate of spread is usually expressed in metres per minute. ¹⁷⁷ |
| Remote sensing | The acquisition and interpretation of images of the Earth's surface, where images are usually acquired by cameras and scanners carried on aircraft or orbiting satellites. Optical images simultaneously record visible and invisible reflected light in several different wavelengths; when combined, these images (or 'bands') can be used to map burn scars, different types of fuel and fuel moisture. Thermal images record emitted heat from active fires and the Earth's surface. Radar remote sensing uses artificial microwave energy to produce images of burn scars through cloud and at night. ¹⁷⁸ |
| Report | <ul style="list-style-type: none"> • The process whereby resources first register their arrival at a wildfire incident; or, • A formal statement of the results of an activity or investigation. Reports may analyse situations, provide progress updates on current assignments, draw conclusions and/or make recommendations. A report can be either verbal or written. |
| Restricted area | An area in which specified activities or entry are temporarily or permanently restricted in order to mitigate risk to human health or safety by potential or on-going wildfires. A restricted area may also be temporarily or permanently established in order to reduce the risk of a wildfire igniting within a specified location. |
| Scene | The general physical location of a wildfire which is determined to be important to a fire investigation due to the potential existence of evidence. |
| Scene examination | The thorough exploration, investigation and analysis of the physical location of a wildfire. |
| Scene Investigation | Every scene investigation should begin with a preliminary scene assessment and then be followed with a detailed scene examination. <ol style="list-style-type: none"> 1. Preliminary scene assessment 2. Scene examination |
| Scene management | The process of maintaining the integrity and security of the scene of a wildfire to prevent contamination, destruction, manipulation or loss of evidence which could be important to a fire investigation. One common aspect of scene management at all wildfire incidents should be the implementation of measures to limit and record access to particular areas of the scene. |
| Scientific method | The systematic pursuit of knowledge involving the recognition and formulation of a problem, the collection of data through observation and experiment, and the formulation and testing of a hypothesis. ¹⁷⁹ |
| Scorch | Plant foliage with a "browned" appearance that has been killed but not consumed by fire. |

¹⁷⁷ The rate of spread of relatively slow fires is sometimes expressed in metres per hour.

¹⁷⁸ Definition provided by Julia McMorrow, University of Manchester (UK).

¹⁷⁹ Source: NFPA (2011) NFPA 921 – Guide for Fire and Explosion Investigations (NFPA, Quincy, Massachusetts), p.16.

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| Term | Definition |
|--------------------------------|--|
| Scorch height | The maximum vertical height, measured from the base of a tree to the tree crown, at which lethal scorching of foliage has occurred ¹⁸⁰ . Below this height, all needles/leaves are brown and dead; above this height, all needles/leaves are live and green (Albini, 1976). ¹⁸¹ |
| Search patterns | A systematic approach/technique for looking for evidence at the scene of a wildfire. |
| Seizure of evidence | The removal of evidence from the scene of a suspected crime. Each country will have specific laws regarding who is legally allowed to seize and store evidence. |
| Serial arson | When an individual sets multiple arson fires at the same or different locations with an emotional cooling-off period between the fires. ¹⁸² |
| Sleeper fire | A fire that remains dormant for a period of time. |
| Slope effect | Variations in fire behaviour induced by slope. Slope can both support and hinder fire spread and development and the angle of the slope will have an important influence on the degree of effect. The following descriptions explain the general slope effect that would be expected from a fire spreading upslope and a fire spreading down slope: <ul style="list-style-type: none"> • Fires spreading upslope –The flames of a fire spreading upslope will be angled towards the unburned fuel above it which will pre-heat the fuel in front of the advancing fire. This pre-heating increases combustibility and rate of spread for fires travelling upslope. • Fires spreading down slope - The flames of fires burning down slope will be angled away from the fuel and will, therefore, lead to less preheating of the fuel in front of the fire. Consequently, the effect of slope on a fire burning down slope is a reduction in combustibility and rate of spread. |
| Smoke | Particles of solids and liquids which are produced by the combustion process and which are suspended within the air/atmosphere. |
| Sooting indicators | Black carbon deposited on objects found in the path of a fire which is produced by incomplete combustion. Generally speaking, deposits of soot will be heavier on the side of an object which faces an oncoming fire. Soot can therefore be used to interpret the direction of fire spread. |
| Spalling indicators | Shallow craters or chips that occur on the surface of rocks that have been exposed to heat. Spalling will generally appear on the side of a rock that has been exposed to flames and can therefore be used to interpret the direction of fire spread. |
| Specific Area of Origin | An area of approximately 5' x 5' where a wildfire was first influenced by wind, slope or fuel load. The Specific Area of Origin will contain the transition zone between advancing and backing fire indicators. |
| Spree arson | When an individual sets multiple arson fires at separate locations with no emotional cooling-off period between the fires. ¹⁸³ |

¹⁸⁰ Scorch height may not be directly apparent until one or more weeks after the fire.

¹⁸¹ Source: www.firewords.net/definitions/scorch_height.htm. Full reference for citation: Albini, F. A. (1976) "Estimating wildfire behavior and effects" *General Technical Report INT-30* (Ogden, UT: USDA, Forest Service, Intermountain Forest and Range Experiment Station) p.92.

¹⁸² The precise definition of "serial arson" varies from country to country.

¹⁸³ The precise definition of "spree arson" varies from country to country.

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| Term | Definition |
|---------------------------------------|--|
| Staining indicators | Yellow to dark brown stains that are caused by the condensation of hot gases, resins and oils on the surface of non-combustible objects (for instance, rocks). The stains often feel tacky to touch and may be covered by a layer of white ash. Stains will appear on the side of the object which has been exposed to flames. Staining can therefore be used to interpret the direction of fire spread. |
| Transition zone | An area where the spread of a fire changes direction. Transition zones can be identified by changes in the appearance of indicators. |
| “V” and “U” pattern indicators | The initial perimeter of wildfires predominantly driven by the influences of wind or slope will commonly resemble a “V” or “U” shape pattern on the ground. The origin of these types of fire will usually be found towards the point of the “V” or within the cup of the “U”, dependent upon the combined influence of slope and wind. “V” and “U” pattern indicators are most easily identified from an aerial or elevated viewpoint. ¹⁸⁴ |
| Weather | The state of the atmosphere at a given time and place with respect to atmospheric stability, temperature, relative humidity, wind speed, cloud cover and precipitation. |
| Weather history | A description of the state of the atmosphere during the hours, days or weeks preceding a wildfire. ¹⁸⁵ |
| White ash indicators | A by-product produced by complete combustion. A greater amount of white ash will be created on the sides of objects exposed to greater amounts of heat and flame, i.e. on the side of a tree trunk which faced an advancing wildfire. Ash indicators can degrade and lose reliability very quickly when exposed to wind or moisture. |
| Wildfire¹⁸⁶ | Any uncontrolled vegetation fire which requires a decision or action regarding suppression. Wildfires are commonly classified according to size and/or impact upon suppression resources. ¹⁸⁷ |
| Wind | The horizontal movement of air relative to the surface of the earth. ¹⁸⁸ Wind direction, wind speed and wind shift can all influence fire behaviour, fire intensity, direction of travel and rate of spread. |
| Witness evidence | Evidence provided by a person who observed a fire, part of a fire and/or anything else of relevance to a fire investigation. |

¹⁸⁴ With thanks to Paul Steensland, Paul Steensland and Associates LLC (USA) and Prof. Vittorio Leone for their contributions to this definition.

¹⁸⁵ Based on the definition provided within NFPA (2011) *NFPA 921 – Guide for Fire and Explosion Investigations* (NFPA, Quincy, Massachusetts), p.261.

¹⁸⁶ Within some parts of the world, alternative terms are used in place of the term *wildfire*. Some of the more common examples include: *bushfire*, *wildland fire*, *forest fire* and *grass fire*.

¹⁸⁷ The term *wildfire* is used to describe any uncontrolled forest fire, grass fire, peat fire and scrub fire.

¹⁸⁸ Source: National Wildfire Coordinating Group (2011) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.186.

Chapter 15 – Restoration

Restoration: “A collective term for any actions taken to reduce and manage the impacts of wildfire incidents.”



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Chapter 15 – Restoration

| Term | Definition |
|--|---|
| Afforestation | Establishment of forest through planting and/or deliberate seeding on land that, until then, was not classified as forest ¹⁸⁹ . Afforestation may be used as an erosion control measure on land that has been effected by wildfire. |
| Anti-knot container | A shaped container with perforated base which is designed to produce plants with natural root systems that avoid root knots. |
| Artificial regeneration | Regeneration with seeds that are sown or planted by humans. |
| Bare root seedlings | Seedlings raised in the ground that are extracted and transported without soil. Bare root seedlings are less costly to produce than container seedlings and while they tend to have a lower rate of recovery they do develop more consistent root systems. |
| Bench terrace | A group of terraces constructed at vertical and/or lateral intervals across a slope, either along the contour (when they may be level or sloping slightly outward or inward) or across the contour (when they are known as graded bench terraces). |
| Bulldozer ¹⁹⁰ | A piece of heavy driver-operated machinery with tracks and a broad hydraulic blade in front. Bulldozers are predominantly used for clearing and grading land, but they may also be used as part of direct or indirect wildfire suppression tactics. |
| Burn | <ul style="list-style-type: none"> m) To be on fire. n) An area of fuel consumed or partly consumed by a fire. o) An injury to flesh caused by a cauterizing agent, heat from a fire, or a heated object. p) A managed fire (i.e. an operational burn or prescribed burn) |
| Burn severity | A qualitative assessment of the heat pulse directed toward the ground during a fire. Burn severity relates to soil heating, large fuel and duff consumption, consumption of the litter and organic layer beneath trees and isolated shrubs, and mortality of buried plant parts ¹⁹¹ . |
| Certification of Seed Origin | A legally sanctioned system for quality control of seed production. |
| Clean burn | A fire that consumes all vegetation and litter above the ground exposing the mineral soil. |
| Clearance of channels and valleys | The removal of vegetation, rocks and any other material that is or will in future restrict or prevent the flow of water through a channel or valley. Channels and valleys may be cleared for a number of reasons, but for restoration after a wildfire the main purpose is to prevent or reduce erosion. |
| Container seedling | Seedling raised in soilless rigid container that can be re-potted during the culture period. Container seedlings are usually more expensive than other types of seedlings but they tend to have better recovery rates. |
| Coppicing | A restoration technique for broadleaved woods or forests which involves cutting trees (or what is left of them) after a wildfire near to ground level to encourage new shoots and the formation of a clump of several stems. ¹⁹² |

¹⁸⁹ Source: FAO (2010) *Global Forest Resources Assessment 2010: Terms and Definitions* (Rome: FAO), p.13.

¹⁹⁰ Also referred to as a "Dozer".

¹⁹¹ Source: National Wildfire Coordinating Group (2008) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.39.

¹⁹² Coppicing is also a traditional woodland management system applied for other purposes than restoration after wildfires.

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| Term | Definition |
|-----------------------------|--|
| Crown kill | The proportion of limbs, buds, and foliage within the canopy vegetation that has been killed and consumed by a wildfire. |
| Crown scorch | Browning of needles or leaves in the crown of a tree or shrub due to burning which has killed but not consumed the vegetation. Crown scorch may not be visible immediately and it may take several weeks after the fire for it to become apparent. |
| Dam | A structure built across a valley to reduce the movement of soil to the valley below. Dams can be constructed using wood, masonry, or stones held together using wire mesh. |
| Damping-off | A plant disease which causes a lesion at or near the soil line which prevents a seedling from growing above the soil or which causes a newly emerged seedling to fall over. |
| Depth of burn | The vertical reduction in surface and ground fuels due to consumption by fire. |
| Detention pond/basin | A temporary storage basin for runoff water. |
| Direct seeding | The manual planting of seeds, wither randomly or along lines of prepared soil. |
| Dissipation area | An area of land or a water basin which is created to receive a dispersal of excess water (i.e. in times of flooding) to protect other areas of land from inundation and water erosion. |
| Drainage system | A naturally occurring or human-made network of channels which moves water across an area of land using the force of gravity. |
| Erosion | Transportation and partial or complete elimination of soil. Erosion can be caused by three main forces: <ul style="list-style-type: none"> • Water erosion – erosion caused by flowing water through surface runoff. This type of erosion is usually of most concern when restoring land after wildfires. • Wind erosion – erosion caused by the wind. • Anthropogenic erosion – erosion caused by humans repeatedly walking over an area of ground. |
| Erosion control | A collection of measures implemented to limit the loss of soil under the action of water or another erosive agent (for instance, wind or human action). |
| Excavator | A piece of heavy driver-operated machinery which is used for digging and moving soil and debris. Excavators are commonly used for control line construction and for digging out deep-seated ground fires during wildfire incidents. They are also commonly used during restoration work. |
| Fascines | An erosion control method that attempts to bind the soil by arranging tree trunks and/or branches across a slope/valley. |
| Fertiliser | Any organic or inorganic material, natural or synthetic, that is added to soil to offset a lack of elements essential to plant growth or to improve soil productivity. |
| Fire adaptation | The capacity of an ecosystem, plant or animal species to recover, react and/or evolve after the passage of a wildfire. |
| Fire damage | The loss that is caused by a fire. This loss will normally include financial costs, but will also include other direct and indirect costs to the environment and society. |

Chapter 15 – Restoration

| Term | Definition |
|---------------------------------|--|
| Fire dependent ecosystem | An ecosystem which requires periodic fires in order to maintain the character, diversity and vigour of its intrinsic plant and animal communities ¹⁹³ . A fire dependent ecosystem will often be composed of pyrophile species. |
| Fire dependent species | Plant and animal species which require regular fires in order to trigger or facilitate regeneration mechanisms, or to regulate competition from other species. Without fires, these species would become extinct. ¹⁹⁴ |
| Fire ecology | The study of the relationships and interactions between fire, living organisms and the environment. |
| Fire footprint | The outer shape of the fire perimeter at a given point in time. In the context of restoration, the fire footprint will be the final extent of the perimeter. |
| Fire resistant plant | A plant species which has morphological or seasonal growth characteristics that give it a high probability of surviving a wildfire ¹⁹⁵ . Heat-insulating bark, seasonal dormancy, and the ability to regenerate through stump sprouts or aerial re-growth (broadleaved) are specific examples of fire resistant characteristics. |
| Fire sensitive ecosystem | An ecosystem with a low resilience to fire. Fire sensitive ecosystems will struggle to recover from the passage of a wildfire. |
| Fire sensitive species | Species with a relatively high probability of being killed or scarred if a wildfire occurs. Specific examples include trees with thin bark or highly flammable foliage, or animal species that are unable to evade the heat of a wildfire. ¹⁹⁶ |
| Fire severity | <p>Fire severity can be defined in two ways:</p> <ul style="list-style-type: none"> • The degree to which a site has been altered or disrupted by fire.¹⁹⁷ • The capacity of a fire to cause damage.¹⁹⁸ <p>Fire intensity and the amount of time a fire burned within a particular area, among other possible factors, will influence fire severity.</p> |
| Flow obstruction | A mass of material that collects within a channel and acts to partially or fully block the flow of water. |
| Forest rehabilitation | A collective term for any actions required to repair damage to a forest that has been caused by a wildfire or wildfire suppression activities. ¹⁹⁹ |
| Fuel management | The process of managing fuel or fuel arrangement. The aim of fuel management is usually to create a discontinuity in fuels to achieve fragmentation. |

¹⁹³ Based on the definition provided by Canadian Interagency Forest Fire Centre (2003) *Glossary of Forest Fire Management Terms* (CIFFC: Winnipeg), p.15.

¹⁹⁴ Based on the definition provided by Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology* (Global Fire Monitoring Center, Freiburg), pp.122-3.

¹⁹⁵ Partly based on the definition provided by Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology* (Global Fire Monitoring Center, Freiburg), p.138.

¹⁹⁶ Based on the definition provided by Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology* (Global Fire Monitoring Center, Freiburg), p.139.

¹⁹⁷ Source: National Wildfire Coordinating Group (2008) *Glossary of Wildland Fire Terminology* (National Wildfire Coordinating Group, Boise), p.78.

¹⁹⁸ British Standards Institution (2010) *Fire Safety Vocabulary* (ISO 13943: 2008; BS EN ISO 13943:2010), (BSI Standards Publication, London), 4.130, p15.

¹⁹⁹ Based on the definition for “rehabilitation” provided by: Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology* (Global Fire Monitoring Center, Freiburg), p.282.

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| Term | Definition |
|-----------------------------|--|
| Fuel treatment | The deliberate manipulation or removal of fuels using one or more of a variety of different means ²⁰⁰ to: <ul style="list-style-type: none"> • reduce the likelihood of ignition; and/or, • reduce potential fire intensity; and/or, • reduce potential damage; and/or, • assist suppression activities. |
| Gabion | A wire container filled with rock, broken concrete or other similar material which is used to construct dams or artificial embankments to reduce erosion. |
| Healing in | Careful storage of bare root plants between the time of their delivery to the planting site and the actual time of planting. The primary purpose of healing in is to avoid drying of the roots. |
| Hydrology | The study of the properties, distribution, and effects of water both on and below the earth's surface and within the atmosphere. |
| Hydrophobicity | A resistance to wetting that is exhibited by some soils. Hydrophobicity, also commonly known as water repellency, may occur naturally or as the result of a fire. ²⁰¹ |
| Landslides | A mass downslope movement of soil and/or rock under the influence of gravity. Wildfires increase the risk of landslides, particularly on steep slopes, because they burn and remove vegetation which normally acts to increase slope stability and reduce the impact of erosion. Personnel working to restore land after wildfires need to assess and manage the risk of landslides to prevent injury. |
| Land management | The process of managing the use and development of an area of land for: wildfire prevention; conservation, restoration or protection of the environment; commerce; and/or for other reasons. |
| Land use planning | A decision-making process involving the allocation of areas of land to different uses and/or vegetation types. |
| Leaching | A process involving the removal of dissolved matter from the soil through the percolation of water. This process is often exacerbated by wildfires as they remove the vegetation that normally acts as a filter to prevent leaching. |
| Mulching | The application of a protective material (straw, well-rotted manure, colourless or black polyethylene plastic film) to covering the soil around plants. The purpose of mulching is to protect plants by preventing the evaporation of moisture, the freezing of roots, and/or the growth of weeds. |
| Mycorrhizal plants | Plants which have a symbiotic relationship with a fungus that improves their ability to draw nutrients from the soil. This relationship helps to improve a plant's rate of recovery and its level of adaptation to difficult environments (such as one experiencing frequent wildfires). |
| Natural regeneration | Regeneration composed of seedlings grown from the soil seed bank or from stump sprouts. |
| Nursery | A facility that raises seedlings destined for planting. |
| Plantation | An area of trees created through artificial regeneration. |
| Planting | The act of placing seeds or seedlings into soil. |
| Plough | A large implement with one or more blades fixed within a frame which is drawn over the ground to turn the soil and cut furrows, usually in preparation for planting seeds but sometimes also during the construction of control lines. |

²⁰⁰ Inclusive of the following means: manual, mechanical, chemical, or using fire.

²⁰¹ Based on the definition provided by Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology* (Global Fire Monitoring Center, Freiburg), p.198.

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| Term | Definition |
|--------------------------------------|---|
| Post-fire succession | <p>All of the different stages involving the growth of different species of plants within an area that has been affected by the passage of a wildfire. A number of different post-fire succession stages (seres) can occur, dependent upon the environment. The first and last stages of post-fire succession are always referred to as the growth of “pioneer species” and the “fire climax”:</p> <ol style="list-style-type: none"> 1. Pioneer species²⁰² - Species of plant that quickly grow and settle after the passage of a fire. The growth of pioneer species represents the first stage of post-fire succession. 2. Fire climax - The final stage of post-fire succession. The fire climax will often be a plant community at a stage of succession which is maintained by periodic fires²⁰³. |
| Prescribed Burn | <p>A planned and supervised burn carried out under specified environmental conditions to remove fuel from a predetermined area of land and at the time, intensity and rate of spread required to meet land management objectives.²⁰⁴</p> <p>There are three specific types of prescribed burn which are used for restoration activities:</p> <ul style="list-style-type: none"> • Conversion burn - The use of fire to eliminate unwanted species that have appeared through natural regeneration. The ultimate purpose of conversion burning is usually to prepare an area for planting or to introduce different species. • Regeneration burn –The use of fire to promote the natural regeneration of species which need heat/fire to release their seeds²⁰⁵ or to break a period of dormancy. • Site preparation burn – The use of fire to remove slash left after the logging of burned timber. The purpose of a site preparation burn is to prepare an area for other regeneration activities. |
| Protection against wildlife | <p>A generic term for a range of measures that may be implemented to prevent wildlife from causing damage to regeneration. Specific examples include: tubes or nets placed over individual seedlings or plants; repellent sprays applied to plants; or, the erection of a fence to prevent access to a particular plot.</p> |
| Pyrophile species (pyrophyte) | <p>Species that are able to survive wildfires and/or to regenerate after wildfires through germination stimulated by fire, stumps sprouts or aerial re-growth (i.e. broadleaved trees).</p> |
| Recovery rate | <p>The percentage of seedlings still alive one year after planting. The recovery rate is often statistically determined by counting seedlings on a sample of planting lines.</p> |
| Reforestation | <p>Re-establishment of forest through planting and/or deliberate seeding on land affected by a wildfire which was previously classified as forest.²⁰⁶</p> |

²⁰² Also sometimes referred to as “colonizing species”.

²⁰³ Source: Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology* (Global Fire Monitoring Center, Freiburg), p.119.

²⁰⁴ Based on the definition provided by AFAC for “prescribed burning”: Australasian Fire and Emergency Service Authorities Council (2009) *Wildfire Glossary* (Australasian Fire and Emergency Service Authorities Council, Melbourne), p.22.

²⁰⁵ For instance, see the term “serotinous seed container” on p.6.

²⁰⁶ Based on the definition provided by: FAO (2010) *Global Forest Resources Assessment 2010: Terms and Definitions* (Rome: FAO), p.13.

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| Term | Definition |
|-----------------------------|--|
| Regeneration | A collective term for any actions taken to attempt to reconstruct an environment that has been effected by wildfire to represent its previous state before the passage of fire. Among many examples, regeneration activities may involve the deliberate reintroduction of vegetation species that once populated the area and the removal of pioneer and other species that were not present prior to the fire. |
| Rehabilitation | A collective term for any actions taken to repair damage to an area of land that has been caused by a wildfire or wildfire suppression activities. ²⁰⁷ |
| Residue treatment | A collective term for actions taken to eliminate slash from logging operations in order to make land available for regeneration. Four different techniques are commonly used: <ul style="list-style-type: none"> • Grinding – to crush and cut woody debris into small chips for dispersion over the ground or for sale as fuel (for example to be used for heating). • Site Preparation Burning - A type of prescribed burn that is lit to remove slash left after logging burned timber. The purpose of a site preparation burn is to prepare an area for regeneration activities. • Stockpiling – the creation of a stored supply away from the site that has been logged to be used for one or more purposes in the future. • Windrowing – piling woody debris into long continuous parallel rows. |
| Resilience | The ability of an ecosystem or species to return to its original state after being affected by a wildfire. |
| Resprouter | A young shoot that emerges after a bud located on a stump remained alive after a wildfire. |
| Restoration | A collective term for any actions taken to reduce and manage the impacts of wildfire incidents. |
| Retention pond/basin | A permanent storage basin for runoff water. |
| Ridge planting | The action of planting seedlings or young trees on a long, narrow crest of excavated soil. Ridges for planting are commonly created using the slice thrown up by a plough. |
| Rock fall | Where stones or rocks fall down a slope. Wildfires increase the risk of rock falls on slopes because the fire burns and removes vegetation which enhances slope stability. Personnel working to restore land after wildfires need to assess and manage the risk of rock falls to prevent injury. |
| Root sucker | A young shoot that grows after a bud located on a root. |
| Scorch | Plant foliage with a “browned” appearance that has been killed but not consumed by fire. |
| Seed | Unitary element of dissemination of a plant embryo. This may be a seed, or seed enclosed in a fruit that does not open, or a seed adhering to a fragment of fruit. |
| Seedling | A young plant shoot of one or a few years. Seedlings may be raised in a nursery or naturally in situ. |

²⁰⁷ Based on the definition provided by: Global Fire Monitoring Center (2010) *International Multi-Lingual Fire Management Terminology* (Global Fire Monitoring Center, Freiburg), p.282.

Chapter 15 – Restoration

| Term | Definition |
|---------------------------------------|---|
| Seedling quality | An assessment of the state of the root and aerial parts of a plant. Seedling quality will depend upon the quality of the treatment and environment within the environment that the seedling grew (i.e. nursery or natural environment) and will have a direct influence on rate of recovery. |
| Seed lot | A set of seeds used in a nursery for raising seedlings. If the seeds are from the same source (same stand or same region of origin), then the lot may have a certificate of origin. |
| Serotinous seed container | A naturally occurring seed cone or hull that is coated in wax. This wax coating enables the seed cone to remain closed and dormant for several years and will only be opened after intense heat (such as that produced by a wildfire). ²⁰⁸ |
| Silviculture | The art and science of controlling the establishment, growth, composition, health, and quality of forests and woodlands to meet the multitude of purposes and values of landowners and society. ²⁰⁹ |
| Site preparation | All actions taken to prepare an area of land for regeneration activities following a wildfire. |
| Slit planting | Placing a seedling in a cut made in the soil by a spade, mattock, or planting bar, then closing the cut (often by applying pressure with a foot). |
| Soil compaction | The compression of soil due to the passage of foot traffic, equipment and vehicles. Soil compaction can occur during wildfire suppression operations and restoration, rehabilitation and regeneration activities. Soil compaction can be a severe problem because it decreases the natural porosity of the soil which reduces productivity and increases susceptibility to erosion. |
| Source identified seed (plant) | A seed lot or plant derived from a defined source that is registered by a designated authority. |
| Spider excavator | An excavator with articulated legs which can move over steep slopes. ²¹⁰ |
| Spot planting ²¹¹ | Planting within areas that have been pre-prepared by digging holes for the plants (seed spot) and then refilling the holes with loose soil to promote better root development. Holes may be created manually (for instance, using a mattock) or mechanically (for instance, using an excavator). |
| Stump removal | The deliberate extraction or destruction of tree stumps left in the ground after a wildfire and/or logging operation. Stumps are removed for multiple reasons, but two of the most common are to facilitate reforestation operations and to limit the spread of diseases present within root systems. |
| Stump sprout | A young shoot that grows from a root crown after a tree stump has remained alive following the passage of a wildfire. Stump sprouting is a specific example of a fire adaptation by some species. |
| Sub-soiling | The process of breaking down the structure of the soil to make it more favourable to plant roots. Sub-soiling is usually achieved through the use of mechanised tools. |
| Succession | The evolution of plant communities within an area of land. The process begins with the arrival of pioneer species and concludes with the establishment of a stable climax community. A gradual and progressive replacement of plant species is observed during the process of succession. |

²⁰⁸ Dehiscent cones do not require intense heat and will open as soon as they come of age.

²⁰⁹ Source: Minnesota Department of Natural Resources (USA) at:

http://www.dnr.state.mn.us/forestry/ecs_silv/index.html

²¹⁰ Spider excavators can access slopes where traditional wheeled or tracked excavators cannot.

²¹¹ Sometimes referred to as “hole planting”.

Chapter 15 – Restoration

| Term | Definition |
|--------------------------------|--|
| Terrace | An area of flat ground which is set into or onto a steep slope. |
| Treatment of vegetation | A collective term for all actions taken to limit the development of unwanted vegetation that competes with planted species being (re)introduced following a wildfire. |
| Weed growth | Woody or herbaceous plants which are undesirable within a particular location because they compete with seedlings/plants that have been planted for a specific purpose (such as regeneration, rehabilitation, afforestation, reforestation). |
| Weed removal | The action of eliminating competing vegetation around plants or seedlings. Weed removal can be achieved manually (using hand tools), mechanically (using a piece of machinery) or chemically (through localised herbicide spraying). |

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²¹² Also available online at: http://www.fs.fed.us/rm/pubs/rmrs_p041/rmrs_p041_149_162.pdf

²¹³ Also available online at: http://www.fs.fed.us/rm/pubs_int/int_gtr122.pdf

²¹⁴ Also available online at: http://knowledgeweb.afac.com.au/data/bushfire_glossary

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²¹⁶ Also available online at: http://www.naturalengland.org.uk/Images/heathergrassburningcode_tcm6-7795.pdf

²¹⁷ Also available online at: http://www.naturalengland.org.uk/Images/burningweb_tcm6-7789.pdf

²¹⁸ Also available online at: <http://www.fao.org/forestry/firemanagement/13530/en/>

²¹⁹ Also available online at: www.fao.org/forestry/site/35853/en

²²⁰ Also available online at:

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²²¹ Also available online at:

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