



FOREST PROTECTION



S- 235 (BC)

Ignition Operations

STUDENT MANUAL



BRITISH
COLUMBIA
Ministry of Forests



BC Suppression
Training Series
Fire Suppression Training

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Acknowledgements

This course is based primarily on material from the (U.S.) S 234 Ignition Operations course. Thank you to the National Interagency Fire Center and the National Wildfire Coordinating Group for generously allowing us to use this material

A sincere thanks to the B.C. Forest Service employees and forest industry personnel who reviewed and revised subsequent drafts of the Ignition Operations course.

Course content developed by:

- Kelly Johnston, Wildland Solutions

Comments on the S-235 course please direct to:

- Team Leader, Training & Safety, Protection Program

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1. OVERVIEW

Course Learning Objective

Upon completion of this course, the participant will demonstrate a working knowledge of the duties and responsibilities, ignition devices, fire behaviour, ignition techniques and sequences and ignition operations safety requirements to ensure that they can operate safely and effectively as part of the ignition team

Course Outline

The British Columbia Forest Service S-235 Ignition Operations course is a 4 hour training session.

Target Audience

This course was designed for delivery to the following individuals involved in wildland fire ignition operations:

- Province of British Columbia staff
- Local government staff
- First nations groups
- Industry personnel
- Contractors

Recognition of Training

This course is recognized by the British Columbia Ministry of Forests as the minimum recommended training standard for fire fighters involved in wildland fire ignition operations.

Evaluation

Individuals will be evaluated on this course using the following criteria:

- | | |
|--------------------------------|-----|
| • Written exam | 70% |
| • Ignition Operations Exercise | 30% |

2. DUTIES AND RESPONSIBILITIES

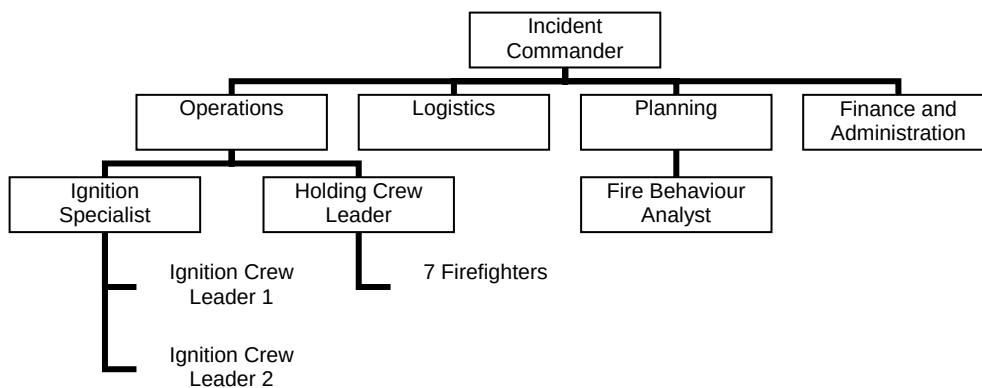
Section Learning Objectives

Upon completion of this section the participant will demonstrate an understanding of the duties and responsibilities in an ignition operation through knowledge of:

1. The relationship of crew leader and the ignition specialist within the fire organization
2. The Ignition Plan
3. The topics to be discussed in an ignition crew briefing
4. The personnel resources required to execute the ignition plan

Organizational Structure

There are several positions that may be filled during a burning operation, depending on the complexity. The organizational structure (Incident Command System) must remain flexible to ensure efficient and safe ignition operations. As with all other fireline activities, the Incident Commander (Prescribed Fire Burn Boss) has overall responsibility for ignition operations. During low complexity operations the qualified IC or Crew Leader may directly supervise the ignition crews; as the operation grows in complexity, the Incident Commander will fill additional positions, such as the Operations Section Chief and Ignition Specialist positions to maintain optimum span of control.



Suppression Ignition Operations

During suppression operations, low complexity Burn Out and Burn Off activities are conducted and supervised by the Crew Leader (Incident Commander). Higher complexity, or large Burn Out or Backfire operations are the responsibility of the Division/Group Supervisor, or the Operations Section Chief.

Prescribed Fire Ignition Operations

During prescribed fire operations, all ignition activities are directly supervised by the Prescribed Fire Burn Boss or the Ignition Specialist.

The ignition specialist reports to the Prescribed Fire Burn Boss, or on high complexity operations, the qualified Operations Section Chief.

General Duties and Responsibilities***Incident Commander***

- Responsible to the fire centre
- Oversees all fire operations activities on wildfire operations

Prescribed Fire Burn Boss

- Incident Commander qualified and equivalent
- Oversees all fire operations activities on prescribed fire operations
- Responsible to land agency (crown, private, licensee)
- Terminates operations if the fire behaviour or effects are not meeting objectives
- Directs overall burn operations
- Supervises and evaluates subordinates including
 - o Ignition Specialist
 - o Fire Behaviour Analyst
- Ensures safety of personnel, observers and the public
- Coordinates with resource management specialists
- May prepare burn plan and objectives
- Determines when to start and finish ignition
- Ensures all burn plan requirements are met
- Has knowledge of resource management objectives
- Ensures all weather and fuel data are collected and interpreted
- Certifies the burn extinguished
- Ensures all burn prescriptions are met

- Briefs personnel
- Declares prescribed burn as a wildfire if burn exceeds prescription
- Directs suppression activities until relieved by appropriate wildfire suppression resources
- Evaluates the accomplishments of the burn objectives and operational procedures. This may include debriefing the crew

Ignition Specialist

Typically, the Ignition Specialist does not occupy a permanent position within the structure of the Operations Section, but instead, is placed on assignment to the Planning Section in order to carry out specific ignition objectives. During this assignment crews and resources assigned to the ignition team will be supervised directly by the Ignition Specialist.

- Supervise the ignition operation
- Participate in briefings with ground crew
- Reconnaissance of burn
- Development of ignition techniques- assist in the preparation of the prescription to meet objectives (under IC or Plans Section Chief with Fire Behaviour Specialist)
- Develop organizational plan and assign equipment
- Monitor weather and fire behaviour, and make adjustments as needed
- Provide instruction in job technique
- Assures safety of assigned personnel
- Maintains contact/communication with supervisor, assigned personnel, and adjoining resources to ensure plan is followed accordingly
- Directs and instructs personnel in ignition sequence and technique
- Advises supervisors of progress, problems and safety of assigned resources, and recommended alternative ignition sequence, if required
- Coordinates with holding resources regarding ignition/holding operations
- Record and turn in personnel time
- Evaluates subordinates and effects of ignition activities
- Responsible for firing equipment being inspected, in place, operational, refurbished and returned.

Holding Operations (Group Supervisor, Task Force Leader or Crew Leader)

- Appropriate suppression position dependent on complexity of the operation
- Responsible to the Incident Commander (wildfire) or Prescribed Fire Burn Boss (prescribed fire), depending on the complexity of the operation
- Supervises holding resources
- Ensures the safety of assigned personnel
- Maintains contact/communications with subordinates, ignition specialist, and prescribed fire burn boss
- Advises Prescribed Fire Burn Boss of conditions affecting fire behaviour and potential holding problems
- Suppresses spot fires/slop-overs and potential problem areas
- Canfers with Ignition Specialist and IC/PB Burn Boss to coordinate ignition/holding sequence
- Evaluates subordinates and success of holding plan
- Responsible for all equipment being inspected, in place, operational, refurbished and returned
- Holds burn and directs mop-up according to plan

Ground Ignition Crew Leader/Members

The Ignition Crew Leader and members can be a fire crew that is temporarily assigned to specific ignition operations during large extended attack fires. On initial attack or smaller, single crew fires, the qualified crew leader may oversee all operations including small- scale Burn Off and Burn Out tasks undertaken by the crew

- Prepares, ignites, uses and extinguishes primary ignition devices such as fusees and drip torches in a safe manner
- Serve as the basic resource used to perform on the ground duties for the ignition operation, ignition fuels according to instructions
- Monitor and adjust ignition technique or pattern to reach desired outcomes
- Crew leader position filled by qualified crew leader with training and experience in ignition

- Crew member position filled by qualified firefighter with ignition training and wildland fire suppression experience
- Number of crews determined through the planning process

Holding Crew Leader/Crew

- suppression crew operating under the direction of the holding operations supervisor or leader

Fuel Handlers

- Crew members that transport and provide fuel to the ignitors
- Holding crew (patrol and mop-up) crew may assist in this during ground ignition operations.

Mixing Crew Leader/Members

- A dedicated mixing crew is required during helitorch operations
- Maintain and operate safe and efficient mixing site
- Prepares helitorch, helitorch barrels and helitorch fuel
- Adjusts mixture as directed by the Ignition Specialist
- Hooks and unhooks helitorch and fuel barrels to and from helicopter

Lookouts

- An experienced firefighter assigned to observe the fire behaviour and identify potential problems, communicating such observations to the supervisor and other crew members
- Individual should be at a vantage point where both the objective hazards and crew members can be observed

Technical Specialist

- Aircraft Mechanical Engineer for repair, maintenance and assistance in set-up of helitorch and Aerial Ignition Device
- AID Operator

Ignition Plan

This is a plan in both prescribed and wildfire operations, that includes an explanation of the personnel, ignition tactics and devices that will be used to accomplish the burning operation task. All ignition operations must have an ignition plan. This can either be a verbal (low complexity) or written plan (higher complexity).

Ignition Crew Briefing

As with all operations, it is imperative that all personnel participating in an ignition operation, whether it is on a wildfire or prescribed fire, be briefed prior to the commencement of the operation and updated as the situation and tactics change.

Firefighters should expect the following **key information** to be included in the pre-work safety briefing:

- The Chain of Command
- Designated **Lookouts** (if any)
- **Communications** plan outlining communications between fire fighters and between firefighters and their immediate supervisor.
- At least two **Escape Routes** that lead to adequate **Safety Zones** noted in case fire fighters and equipment are threatened by sudden changes in fire behaviour.
- Known fireline hazards.
- Safe work procedures to be used
- Current and expected fire behaviour and weather
- Current fire activities and progress
- Ignition strategies, sequence and technique discussed with ignition crew and adjoining units
- Tasks the crew will be accomplishing
- Individual work assignments
- Pertinent sections of the prescribed burn plan or incident action plan
- Problems or concerns

IMPORTANT!

A crew briefing isn't a one-way process. After the briefing, ask questions on any points that weren't covered and make suggestions where needed.

- If you aren't sure about a situation, **SPEAK OUT**.
- The most important consideration when attacking a wildland fire is a "safety first" attitude.....

IF IN DOUBT – BACK OUT!

NOTES:

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3. IGNITION DEVICES

Section Learning Objectives

Upon completion of this section the participant will demonstrate an understanding of the common ignition devices used in an ignition operation through knowledge of:

1. The characteristics and operation of various devices
2. Which appropriate device would be appropriate for given fuel types and conditions
3. Maintenance problems related to various ignition devices
4. The proper procedures for transportation, handling and storage of various ignition devices

Due to the complexity of fuel, topography and weather, along with the associated safety concerns, ignition personnel must be familiar with a variety of ignition devices and the appropriate selection, use, maintenance and safety procedures of each.

GROUND IGNITION DEVICES

Fusees

Fusees are extensively used in the U.S. for ignition. They are rarely used in Canada, however they do provide compact and economical ignition capability, in the appropriate fuels, to crews on the fireline.

Characteristics

- Lightweight and portable
- Project a very hot flame
- Normally burn up in 5-10 minutes, depending on size
- Can be extinguished and re-ignited
- Come in a box of 72 each/ 38 lbs per box
- Most effectively used in dry, light and continuous fuels
- Best suited for small or short duration burning projects



- Classified as a “Flammable Solid” under the TDG regulations and Flammable material under the WHMIS

Operation

- Full PPE required
 - Fire resistant clothing
 - Long sleeves (rolled down)
 - Eye protection
 - Gloves
 - Eight inch lug sole leather boots
- Remove striker and ignite away from the body



Safety Note: Fusees are composed of phosphorous which when ignited is subject to spattering and can cause severe burns if not handled properly. The smoke from fusees can cause headaches.

- Use a stick or other fusees for extension handle
- Extinguish by sticking fire in mineral soil
- Clean-up and dispose of all fusee caps

Maintenance Problems

- If fusees are wet or have been previously exposed to moisture they will not function
- Fusees will deteriorate, if not stored properly
- Fusees can break if they are hit hard, dropped or crushed and therefore not function properly

Transportation and Handling

- Fusees are a Class 4 (4.1 Combustible Solid) Dangerous Good under the Transportation of Dangerous Goods (TDG) regulations and a Class B- Flammable Material under the Workplace Hazardous Material Information System (WHMIS)
 - The container they are packaged in must display the appropriate WHMIS and TDG marks and labeling
 - The appropriate WHMIS Material Safety Data Sheets must be readily available
 - When being transported by helicopter, they must be in a package, box or pack and transported in the baggage compartment.

- o Broken fusees and those with the protective ignitercaps removed will not be transported by aircraft

Drip Torch

The drip torch is the most common hand ignition device used in Canada

Characteristics

- Fuel oil, diesel (gasoline/diesel mixture the most common) or other flammable-combustible fuel mixtures; dripped from the canister onto fuels to be ignited.
- Can last up to one hour if properly used, depending on fuel types
- Works well on almost all fuel types
- Normally used when ignition operation is of longer duration
- Fuel is classified a Flammable Liquid under the TDG regulations and a Flammable Substance under WHMIS

Operation

- Full PPE required
- Mix fuel and fill torch
 - o All fuel containers with mixed fuel must be labeled with mixture ratios and dates
 - o Do not open or fill near hot embers, sparks, or while smoking, as the tank may contain dangerous vapour
 - o Open by removing lock ring and spout
 - o Mixing and fueling personnel should wear an organic vapour respirator to protect from harmful vapours
 - o Fuel mixtures are usually a ratio of diesel fuel to gasoline. The best fuel mixture ratio should be selected for each job
 - The gasoline lowers the mixture flash point. Flash point is the temperature that liquid fuel gives off sufficient vapours to be ignited
 - The diesel raises the mixture flash point and increases residual burning



- Recommended mixtures:
 - 1 part gasoline to 3 parts diesel (volatile)
 - 1 part gasoline to 4 parts diesel (less volatile)
 - 1 part gasoline to 5 parts diesel (least volatile)

Safety Note: Do not confuse the ratios. For example, 3 parts of gasoline to 1 part of diesel produces a very volatile mixture and can result in serious burn injuries

- o To prevent leakage around the lid, leave at least one inch of air space at the top of the container for expansion of fuel
- Remove discharge sealing plug and re-screw plug into blind threaded socket
- Position spout so wick and loop are pointing away from the handle. Slide lock ring over spout and screw lock ring down securely
- Open breather valve
- Tip drip torch forward and flow fuel onto wick
- Ignite drip torch wick by using:
 - o Matches/lighter
 - o Small ground fire
- Carry the torch away from your body with the wick forward
- Extinguish by:
 - o Setting upright
 - o **Preferred Method:** Letting the wick burn dry after closing the breather valve (minimizes exposure to fuel; but is time consuming), or:
 - o **Alternate Method:** Extinguishing with a gloved hand (most successful method; ensure gloves do not have any holes)

Safety Note: Do not blow the wick out. This may result in burns to the head and face. Firefighters have been burned in the face using this technique.

- To store torch:
 - o Remove lock ring
 - o Reverse spout and stow inside tank
 - o Replace lock ring securely
 - o Remove discharge sealing plug from blind threaded socket and screw tightly into spout opening. Close breather valve.

Maintenance Problems

Ensure there is a maintenance kit with spare gaskets and parts on hand

- Wick
 - o The wick will not light if it is wet
 - o Extensive use will burn the wick up requiring replacement
 - o If the wick is missing there will not be an ignition source for the mixture
 - o A bent or broken wick will affect it's ability to ignite the mixture
- Gasket
 - o If the gaskets are missing, damaged or the wrong size, the unit will not seal properly and will leak
- If the check valve is not seating, fuel will not flow
- A cross threaded air valve will result in flow adjustment problems and fuel leaks
- Dirty, contaminated fuel or improper fuel mixture will result in fuel ignition problems
- A Plugged fuel line will restrict or stop the flow of fuel
- A smashed nozzle may result in fuel leaks and uncontrolled fuel flow

Transportation

- Full or partially full drip torches should always be transported in their upright position to eliminate leakage
- Whenever transporting personnel and fuel on the same vehicle, all fuel containers must be separated from the passengers, and in ventilated compartments
- Keep all excess fuel at least 150 meters away (upwind/downslope) from burn area, except that being used by the drip torch
- "Flammable Liquid" placards must be displayed on vehicle if transporting fuel weighing more than 1100 lbs (500kg) .

Helicopter/Fixed Wing

- All approved fuel containers, including the drip torches, may be transported only in:
 - o Sling loads
 - o External baskets
 - o Well ventilated compartments

- Containers must be secured in an upright position by tie-down straps or placed in such a manner that they cannot be overturned
- Containers must not be filled beyond their rate of capacity
- Fuel will not be transported with passengers during commercial air operations

When large quantities of fuel are required

- Consider using burn trailers
- Arrange to have 45 gallon drums of pre-mix fuel with a barrel pump transported by vehicle or in a sling load to pre-determined points or helispots

Matches/Lighters

Always ensure that you are carrying matches or a lighter. In dry, light fuel In the absence of a fusee or drip torch, matches can be used to simply and effectively Burn Off islands of light fuel or Burn Out small strips of light fuel inside of the control line

Natural Fire

Hot coals or flaming fuels can shoveled or raked into fine fuels to Burn Off islands or Burn Out small strips inside the control line.

**Power Flame
Thrower/Terra-Torch**

The power flame thrower/Terra Torch is a good option, and cost effective alternative to a helitorch in the right conditions. It is most effective for the ignition of large areas of moderate to heavy fuels, directly adjacent to roads or vehicle accessible control lines (dozer lines), and in marginal burning conditions

**Characteristics**

- Produces a hot, high volume flame approximately 100 feet in length, depending on pump pressure and flame production

Safety Note: This device is dangerous to personnel within 200 ft of the nozzle (while in operation) due to the high level of radiant heat and or direct flame production

- Uses a positive displacement pump and propane igniter for ignition
- The device uses a mixture of gasoline and a gelling agent(surefire, alumagel petrogel)
 - The alumagel/petrogel solidifies the gasoline into a jelly like substance
 - The mixture is very flammable with the consistency of applesauce
 - The mixture produces hazardous fumes
- The fuel is classified as a Flammable Liquid under the TDG Regulations and a Flammable Material under WHMIS.
- Capable of igniting fires under conditions that make other devices ineffective
- When firing along roads and dozer lines, will set more fire faster than fire crews using simpler devices. More cost effective than the helitorch in this setting
- Operators must be aware that this device can easily create more fire than desired, in short time, if it is not used properly.
- May be installed in the back of a pick-up truck, trailer or boat
- May be pulled by a bulldozer or skidder

Operation

- Specific operational training under the direction of an experienced operator will be required
- An organic vapour respirator should be worn when mixing gelled fuel
- Requires a three person crew for operation, in addition to the ignition crew leader
 - One person at the nozzle
 - One person to guide the hose over obstacles
 - One person to drive the vehicle/monitor radio
- Ensure crew is rotated to prevent nozzle person from becoming fatigued due to radiant heat

Safety Note: The nozzle operator must use caution not to drip flaming material onto or around the feet.

- The nozzle operator must use caution not to drip flaming material onto or around the feet.
- Special PPE is required for mixing operations
 - Chemical resistant Rubber Boots
 - Fire resistant clothing

- o Chemical resistant apron
- o Chemical resistant gloves
- o Eye protection
- o Organic vapour respirator
- o Burn Kit
- o Class B rated fire extinguishers

Maintenance

- May require occasional skilled maintenance to keep operating properly
- Batteries on older model terra-torches will need recharging after extended use. Newer models have a built in recharging system

Transportation

- “Flammable Liquid” TDG placarding is required when transporting burn mix weighing more than 1100 lbs.

AERIAL IGNITION DEVICES**Helitorch**

The helitorch is the most common high intensity fire producing device in Canada. It is readily available through most helicopter companies and is used extensively in forest operations block preparation. It is best suited for ignition of large areas of moderate to heavy fuels, where ground access, topography or fire behaviour potential is a safety concern for ground crews. This device also works well under marginal burning conditions.

**Characteristics**

- Produces large amounts of fire in a short period of time. This may:
 - o Aid the burn
 - o Produce more fire than the operation can handle
- The device uses a mixture of gasoline and gelling agent or jet fuel and gelling agent (Surefire, Alumagel, Petrogel)
 - o The gelling agent solidifies the gasoline into a jelly like substance
 - o The mixture is very flammable with the consistency of applesauce
 - o The mixture produces hazardous fumes
- This is an external load (sling/longline) with the helicopter

- Capable of burning standing brush and fuel types with little or no ground fuels
- Ignites fuels with higher moisture contents, that may not be ignited successfully by other devices.
 - o This will expand the prescription window for prescribed fire operations
 - o Will not, however burn wet fuels
- Prone to frequent equipment failures, So:
 - o Arrange for at least one back-up torch
 - o Specialized parts and supplies may be difficult to obtain, so have lots of spares
 - o Best to have an aircraft engineer (from the helicopter company supplying the helicopter and torch) on site.
- Mixing of fuel and gelling agent requires:
 - o Specialized equipment and trained people to accomplish
 - o A large organization
 - o Environmental precautions due to the higher risk of environmental site damage (fuel spills)
 - o Specialized PPE
- The mixing crew must be familiar with servicing, maintenance and stowing of the equipment, including stripping and assembly
- Will require a separate helibase for helitorch
- The operator must also be familiar with servicing, maintenance and stowing of the equipment, including stripping and assembly
- May be on the same field
- Requires a separate air organization with designated frequencies
- May require second helicopter as observation platform for Ignition Specialist/Ignition Leader
- Limited to daylight hours (1/2 hour before sunrise, 1/2 after sunset)

Operation

- Full fireline PPE required for all ignition personnel
- Special PPE is required for mixing operations
 - o Chemical resistant Rubber Boots, gloves and apron
 - o Fire resistant clothing
 - o Eye protection
 - o Organic vapour respirator

- o Burn Kit
 - o Class B rated fire extinguishers
- Ignition specialist, Ignition Leader, technicians and mixing crew require specialized training under the direction of experienced personnel
- Helitorch helibase requires 5 or more personnel for mixing and general air operations procedures
- Ignition Specialist cannot be aboard the helicopter carrying helitorch
- Aerial observation aircraft, if used should be a minimum of 1000 feet above the altitude of the ignition aircraft
- Requires isolated radio frequency for helitorch pilot and ignition specialist/ignition leader to operate on during operation
- From an altitude of 200 feet AGL and at an airspeed of 64km/hr (40 mph), the unit produces burning golf ball –sized particles that burn approximately 8 to 10 minutes
- From an altitude of 150 feet AGL and an airspeed of 48km/h (30 mph), the unit delivers baseball-sized particles that burn on the ground for 12 to 17 minutes
- The mixing crew must be familiar with emergency procedures for:
 - o Fuel fire at mixing site
 - o Fuel spill
 - o Aircraft Accident
 - o Mixing crew burn or chemical exposure injury



Transportation

- “Flammable Liquid” TDG placarding is required when transporting burn mix weighing more than 1100 lbs.

Premo Mark III Plastic Sphere Dispenser

Commonly known as:

- Ping pong ball machine
- **A.I.D.S. (Aerial Ignition Device System) used most often**
- D.A.I.D.S.(Delayed Aerial Ignition Device System)
- C.I.D.S.(Chemical Ignition Device System)

This device is quick to deploy and requires a much smaller ignition organization. It is best suited for dry, light and open canopy fuels, however, if the fuel structure is adequate, can generate a crown fire in the higher ISI and BUI ranges. These attributes make this device a good choice for initial attack ignition operations under extreme conditions (backfiring, steering, and ring firing around values immediately threatened during Rank 5 and Rank 6 fires).



Characterisitics

- Components
 - o Polystyrene spheres partially filled with potassium permanganate crystals
 - o Ethylene glycol (antifreeze)
 - o 24 volt power source
 - o Internally mounted (passenger compartment) of the helicopter sphere dispensing machine
- Eliminates:
 - o Handling of raw fuel
 - o External helicopter loads
- Reduces hazards on the ground by :
 - o Increasing accuracy in deployment
 - o Decreasing possibility of hang fires
- Low operating costs (approximately 1/3 cost of the helitorch)
- Most effective in :
 - o Dry, light and open canopy fuels
 - o Aquatic areas, marshes and swamps. (This is the best device for these areas)

- Produce relatively low intensity fire from each ignition source. Simulates dot firing technique
- Allows for better control of flame production due to slow fire/ intensity development
- Patience is required to allow time for fire to develop
- Can burn extremely large areas without additional support (smaller organization required)
- Limited availability. One manufacturer in the world.
- Limited to daylight hours (1/2 hour before sunrise, 1/2 after sunset)
- Spheres classified as a Class 5 Oxidizer Dangerous Good under the TDG regulations and Class 5 Oxidizing Material under WHMIS

Operation

- Full PPE required for operator navigator (usually Ignition Leader or Ignition Specialist) and pilot of ignition aircraft
- Requires specialized training under the direction of an experienced operator to operate AIDS
- Ignition Leader/Specialist should have experience in large scale ignition operations
- Ignition Leader/Specialist can remain on board the helicopter during ignition operations providing for :
 - o Better communications with the pilot
 - o Better control and direction of ignition
- Smaller organization required typically ignition team consists of:
 - o Pilot
 - o Ignition Leader/Specialist
 - o AIDS Operator or Technician
- Aerial observation aircraft, if used should be a minimum of 1000 feet above the altitude of the ignition aircraft
- 1 cc of ethylene glycol induces an exothermic reaction (heat producing) which causes the sphere to ignite. This flaming reaction takes 20 to 30 seconds
- The ball is dispensed down the chute and falls to the ground where it ignites



- Each device has 4 chutes which is controlled, along with the airspeed to achieve the desired ignition spacing:

GROUND SPEED km/h					
	16	32	48	64	80
1 CHUTE	5	9	13	18	22
2 CHUTES	2	5	7	9	11
3 CHUTES	2	3	5	6	7
4 CHUTES	1	2	3	4	5



**Approximate
ignition spacing in
metres**
Canadian Forest Service

- The AIDS operator must be familiar with emergency operations for:
 - o A jammed dispenser
 - o AID fire
 - o Premature ignition of sphere in the AID
 - o Electrical system fault
 - o Aircraft crash procedures (load jettison)
- The operator must also be familiar with servicing, maintenance and stowing of the equipment, including stripping and assembly

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4. FIRE BEHAVIOUR REVIEW

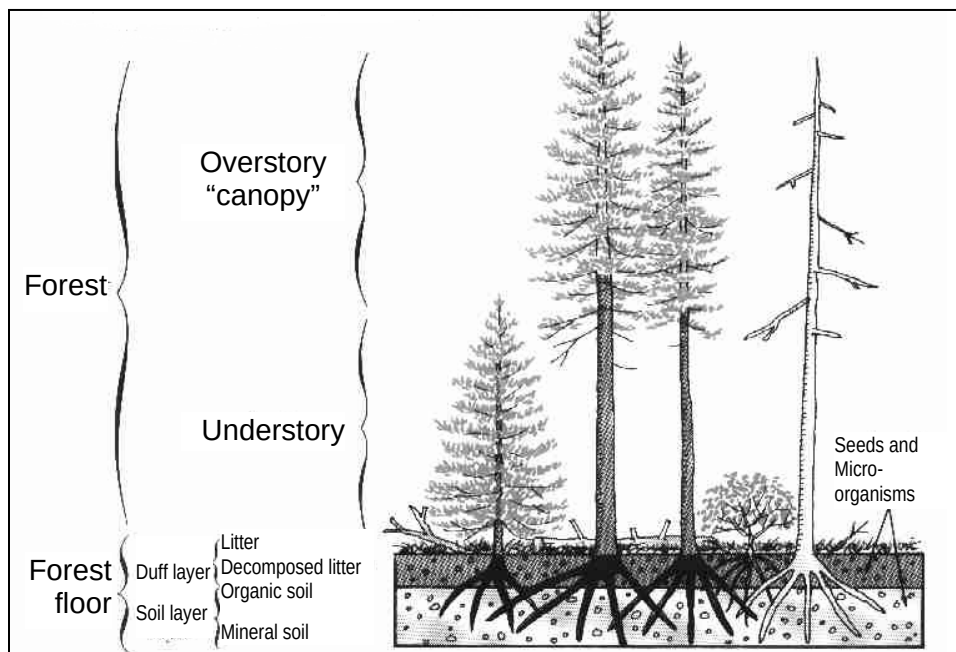
Section Learning Objectives:

Upon review of this section, the participant will demonstrate a basic understanding of wildland fire behaviour through knowledge of:

1. The basic structure of forests and fuels in the wildland fire environment
2. The three elements of the fire triangle
3. The three key factors that influence fire behaviour; the 30/30 Cross concept
4. The main components of the Canadian Forest Fire Danger Rating System
5. The three fire types; candling and spotting
6. The Fire Intensity Ranking System
7. The parts of a fire

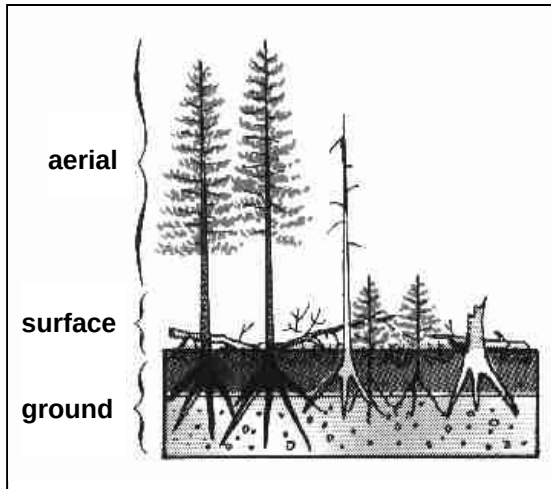
Forest Layers

A wildland forest consists of a plant community dominated by trees growing on a forest floor.



The duff layer rests on top of the soil layer. Duff evolves from each year's dead and decomposed plants and animals. Mineral soil evolves from decomposition of rocks.

Forest Fuels



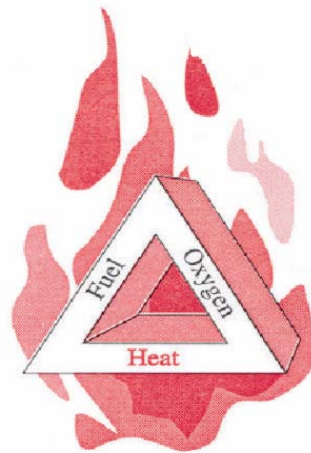
Any substance that will ignite and combust (burn) is a fuel. There are three types of fuel:

- **aerial** fuel: combustible material higher than one metre (39 inches) above ground level;
- **surface** fuel: includes all combustibles less than one metre above ground level and one year's litter accumulation; and
- **ground** fuel: includes all combustible substances below the surface litter of the duff.

The Fire Triangle

In order to control and successfully fight forest fires, we must first understand what makes fire spread.

Three elements: *fuel, oxygen* and *heat* must be present to start and maintain a fire.

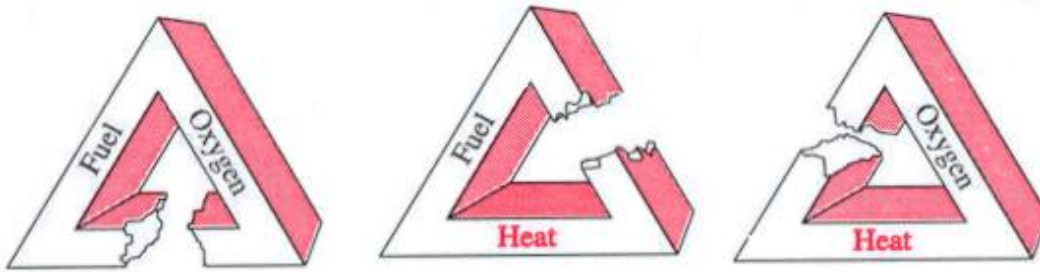


Fuel + Oxygen + Heat

In a forest fire:

- Forests provide the fuel;
- oxygen is in the air and;
- heat results either naturally (lightning strike) or is introduced by people.

These three elements (fuel, oxygen, heat) are related to a triangle with each side representing one element. If any one of these elements is altered, the fire will behave differently; if one side of a triangle is removed, the fire extinguishes.



The Heat Transfer Process

The process by which heat travels from one body or object to another is known as heat transfer. There are three processes.

Radiation: Transfer of heat through the air from warm surfaces to cooler surroundings (the heat you feel when you are sitting next to a campfire)

Convection: Transfer of heat by the movement of a hot air mass; usually upwards (burning objects below heat objects above)

Conduction: Transfer of heat through solid matter (objects touching each other).

Factors Influencing Fire Behaviour

There are three key factors that influence fire behaviour. They are:

Key Factors		
1. Fuel	2. Weather	3. Topography
Moisture	Wind	Slope
Size	Precipitation	Aspect
Spacing (continuity)	Relative Humidity	Terrain
Fuel Loading	Temperature	Elevation

Fuel

Fuel Moisture

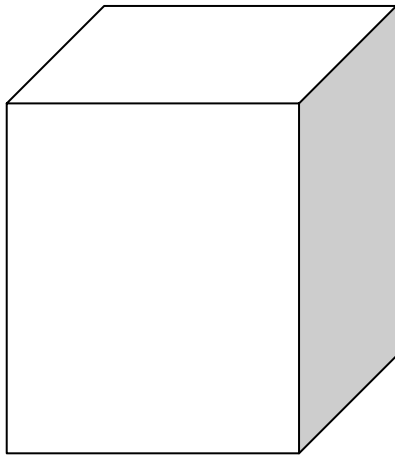
Fuel moisture content is the single most important fuel-related factor affecting fire behaviour.

Fire will ignite easier and spread faster in fuels with lower fuel moisture.

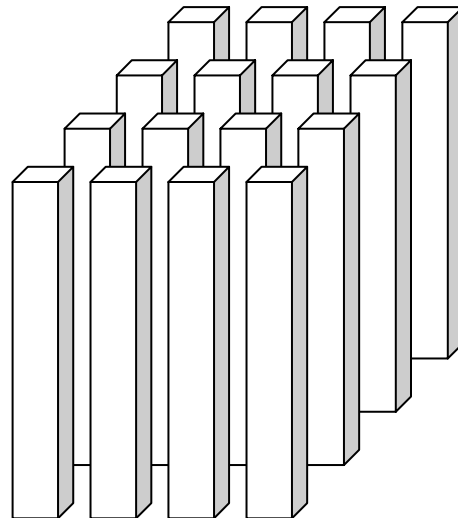
Fuel moisture in wildland fuels is determined by :

- Weather related factors affecting the amount of moisture in the fuel. For example, the amount and type of precipitation (rain, snow)
- Percentage of live or dead (cured) fuel. For example green grass will not burn as well as brown grass.

Fuel Size



Surface Area = 6 m²



Surface Area = 18 m²

Heavy, slow-burning fuels include logs, stumps, large branch wood, trees and deep duff. Taking longer to ignite (due to moisture content) fires spread slowly but burn longer with greater intensity. The moisture content change is slower due to a low surface area to volume ratio.

Light, fast-burning fuels include grass, dead leaves, tree needles, brush and small trees. They ignite quickly, result in fast spreading fires and act as kindling to light heavier fuels. The moisture content change is faster due to a high surface area to volume ratio.

Fuel Spacing (Continuity)

Fuel spacing refers to the arrangement of fuel on the landscape and can be considered as the fuel distribution in the horizontal and vertical directions. Fuel closer together increases the ability of fire to spread, while fuel spaced further apart decreases the ability of fire to spread

Horizontal Fuel Spacing- is usually described as “continuous” or “patchy”.

Vertical Fuel Spacing- refers to the distance between surface fuels and aerial fuels. Fuels present between these two fuels are called **ladder fuels**.

Fuel Loading

Fuel loading refers to the weight or mass of fuels in a given area, usually measured in tonnes per hectare. Fuel loads may vary across the landscape. Higher density fuel loads will burn at higher intensities if fuel moisture conditions make all the fuel available for combustion.

Weather***Wind***

Wind is the single most important weather factor affecting fire behaviour and influences fire behaviour by:

- Increasing or decreasing fuel moisture
- Bending the flames ahead, heating, drying and igniting new fuels
- Carrying sparks and embers into new fuel sources (spotting)
- Feeding more oxygen to a fire
- Driving the direction of a fire

Precipitation

Precipitation influences fire behaviour by affecting fuel moisture. The effect of precipitation on fuel moisture is mostly dependant on fuel size:

- Less precipitation is required to raise the fuel moisture content in fine fuels than in heavy fuels
- Fine fuels will dry out faster heavy fuels
- Precipitation may not wet ground fuels if they are located under a dense canopy
- Duration of precipitation, not quantity, is the most important factor determining the effect of precipitation on fuel moisture.

Relative Humidity

Relative Humidity influences fire behaviour by affecting fuel moisture.

Relative Humidity is the percentage of water vapour present in the air. When the air is dry (low Relative Humidity), fuels are likely to dry out; when the air is damp (high Relative Humidity), fuels are likely to absorb moisture (fuel moisture increases). Typically, the relative humidity will increase overnight and decrease during the day.

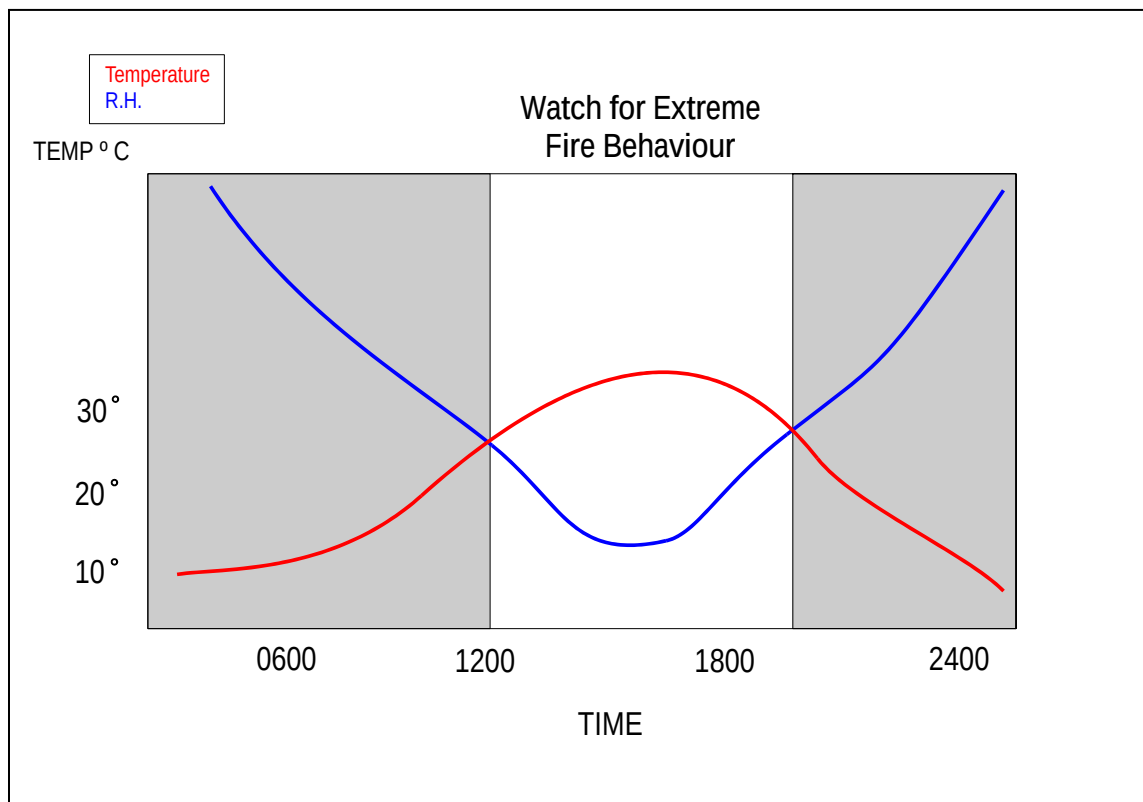
Temperature

Temperature fluctuations affect relative humidity, thereby affecting fuel moisture content. To a lesser degree, temperatures also influence the amount of preheating required to bring fuel to its ignition temperature.

The 30/30 Cross (Black Cross)

Watch for Extreme Fire Weather

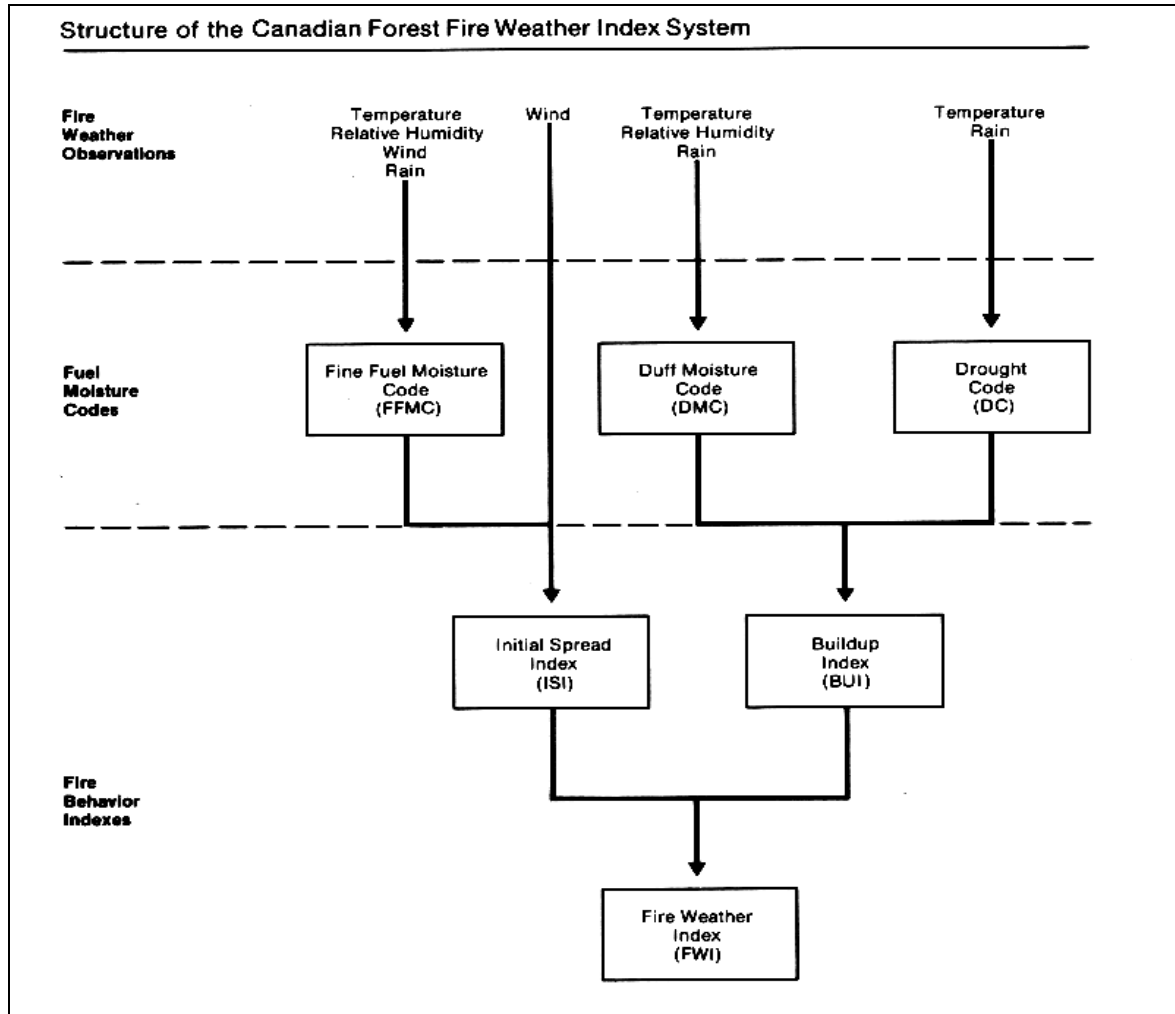
The 30/30 Cross describes the condition where the RH drops below 30% and temperature rises about 30°C. If this occurs on the fireline, this is a useful rule of thumb to potentially expect extreme fire behaviour – precautions must be taken accordingly.



The Canadian Forest Fire Danger Rating System (CFFDRS)

The Canadian Forest Fire Danger Rating System (CFFDRS) is a standard national system of rating fire danger in Canada. Fire potential and fire spread rates are used to determine day-to-day fire preparedness and suppression requirements for fire centre operations.

Fire fighters should have a general understanding of the CFFDRS and the importance of the various codes and indexes to understand ease of ignition, rate of spread and difficulty of control.



The CFFDRS has two sub-systems:

1. The Fire Weather Index (FWI) system
2. The Fire Behaviour Prediction (FBP) system.

The Fire Weather Index (FWI) system

The Fire Weather Index (FWI) system uses four weather readings (taken each day at 1300 hours PDT). These inputs are:

- Temperature (wet and dry bulb)
- Relative Humidity
- Wind speed and direction
- Rainfall (cumulative – past 24 hours)

The weather readings are entered into standard tables which provide fire fighters with three Fuel Moisture Codes and three Fire Behaviour Indexes.

Fuel Moisture Codes

Fuel Moisture Codes are numerical ratings that express daily changes in moisture content of three classes or layers of forest fuel (each class has a different drying rate). Fuel Moisture Code values increase with lower fuel moistures.

Code	Represents	Time Lag*	Amount of 24 hr rainfall required to lower value
FFMC Fine Fuel Moisture Code	Surface litter	2/3 day	0.6 mm
DMC Duff Moisture Code	5 – 10 cm duff	12 days	1.5 mm
DC Drought Code	10 – 20 cm duff	52 days	2.9 mm

*Time lag refers to the time required for fuel to lose 2/3 of its moisture under standard drying conditions

Fine Fuel Moisture Code (FFMC)- The FFMC represents the moisture content in litter (needles, twigs) and other cured fuels on the surface. This fuel group is extremely sensitive to all daily weather changes. The FFMC expresses ease of ignition and fuel flammability.

CODE / INDEX	INTERPRETATION
FFMC Less than 77	Generally a fire will not start without a concerted effort.
77 – 86	Approximately 50% of ignition sources will start fires.
More than 86	Easy ignition of fuels.
Greater than 94	Almost 100% of ignition sources will ignite forest fuels.
ISI Less than 10 Above 10	When FFMC is less than 86, fire spread is generally not great. Expect rapid spread rates which escalate rapidly as the FFMC increases.

Duff Moisture Code (DMC)- The DMC represents the moisture content of duff layers 5 – 10 cm (2 – 4 inches) deep. This fuel group is affected by rainfall, temperature and humidity. The DMC expresses fuel consumption in medium-depth duff layers and medium-sized woody material.

CODE / INDEX	INTERPRETATION
DMC Less than 35	Do not expect a great deal of involvement of fire in this layer. Above this level one can expect more intense fires.

Drought Code (DC)- The DC represents the moisture content of deep duff layers 10 – 20 cm (5 – 10 inches) deep. This fuel group is affected by rainfall and temperature. The DC expresses seasonal drought effects on forest fuels and the amount of smoldering that will occur in deep duff layers and large logs.

CODE / INDEX	INTERPRETATION
DC 0-300	Very little involvement of this fuel in most areas.
300-450	Increased involvement with fires becoming more intense and mop-up problems increasing.
500+	Extensive involvement of the fuel layer. Fires are intense with difficult mop-up problems, due to the depth of the fires.

Fire Behaviour Indexes

ISI Initial Spread Index

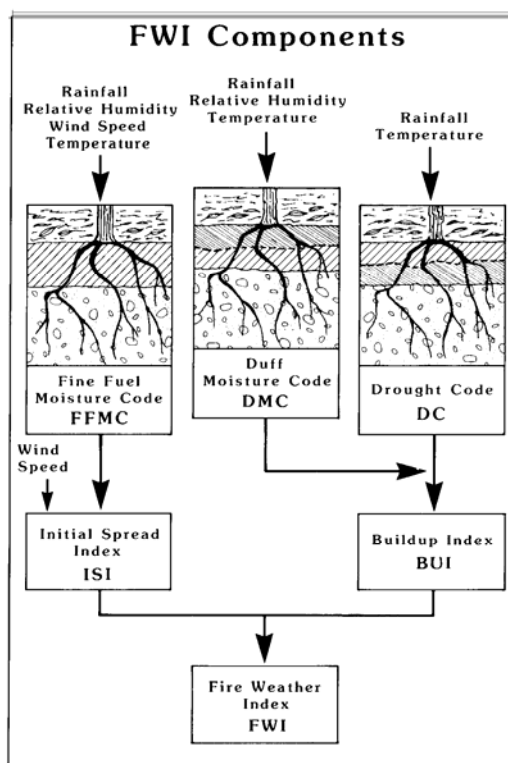
Represents the relative fire spread expected immediately after ignition.

BUI Build Up Index

Represents the total amount of fuel available for combustion – useful in determining mop-up requirements – used in calculating fire rate of spread.

FWI Fire Weather Index

Represents the potential fire intensity. Fire danger levels (classified as very low, low, moderate, high or extreme) summarize wildland fire conditions for a specific area.



Fire danger class ratings are calculated for three danger regions in the province of BC and are used to determine the need for open fire bans and public travel restrictions or road closures in forested areas. Industrial activities use the fire danger classes to determine restrictions on industrial operations such as the need for early shutdown, 'fire-watch' following early shutdown or complete shutdown of industrial activity.

The Fire Behaviour Prediction (FBP) System

The FBP system predicts fire rate of spread in a given fuel type with a known ISI. The FBP system evaluates:

- FWI indices on site or from the nearest weather station
- Fuel type (17 different fuel types)
- Topography (slope and aspect)
- Time of day / time of year

Primary outputs of the FBP system are:

- Rate of Spread (meters per minute)
- Fire Type (surface, intermittent crown, crown)
- Fire Intensity (kilowatts per meter)

Fire Types



Topography

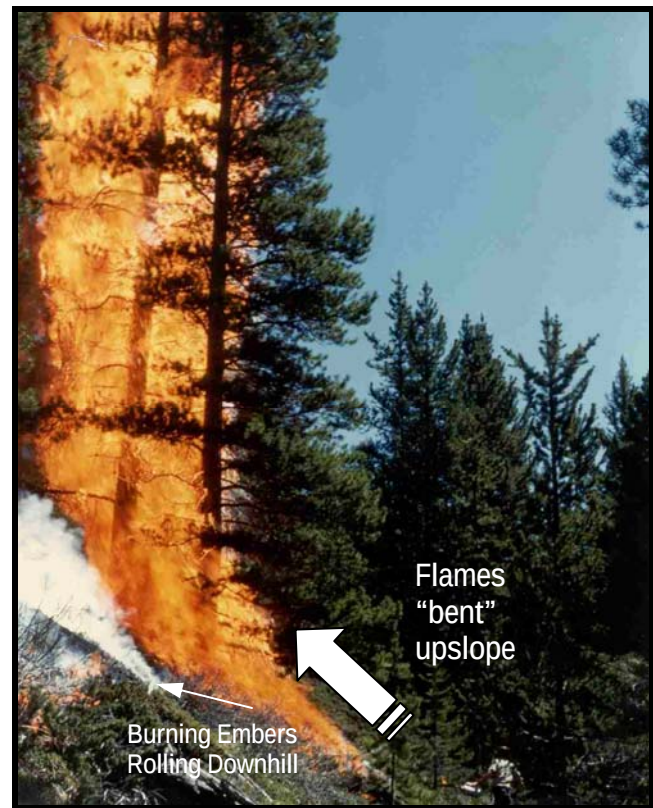
There are three topographical factors that influence fire behaviour:

- Slope
- Aspect
- Terrain
- Elevation

Slope

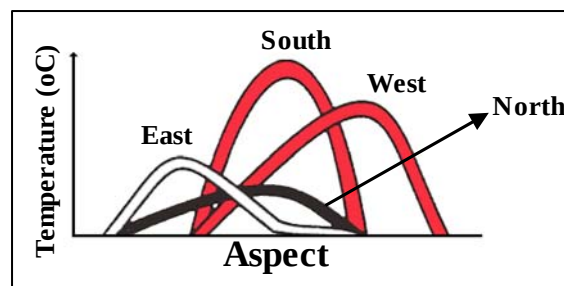
Slope is the single most important topographical factor affecting fire behaviour. Slope affects fire behaviour in the following ways:

- Flames are closer to fuels on the uphill side, heating and igniting these new fuels
- Convective heat (rising heat) from the fire travels up the slope, heating and drying new fuels
- The convective air may carry firebrands, which can ignite spot fires above the main fire
- Burning embers and large burning material may roll downhill igniting new, unburned materials below the fire
- Firefighting efforts are hampered and slowed on slopes
- Cooling at night and weather changes can cause winds to blow down slope.



Aspect

Aspect refers to the direction the slope faces. For example, a southwest aspect is a slope that faces southwest.



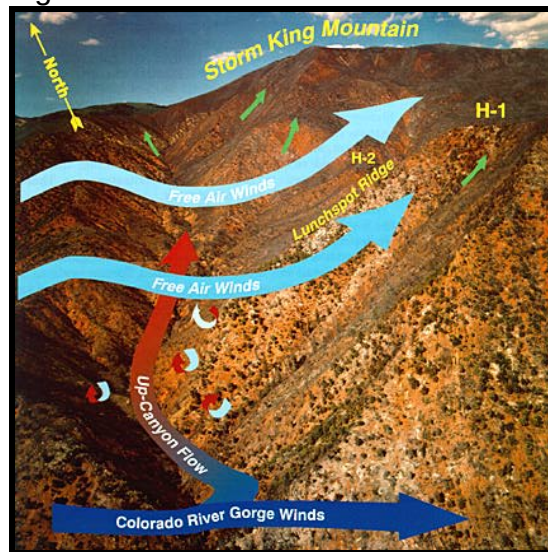
The following aspect factors affect fire behavior directly:

- Southern slopes receive the most direct heat from the sun and therefore have higher temperatures
- Fuels on south facing slopes typically have the lowest fuel moisture

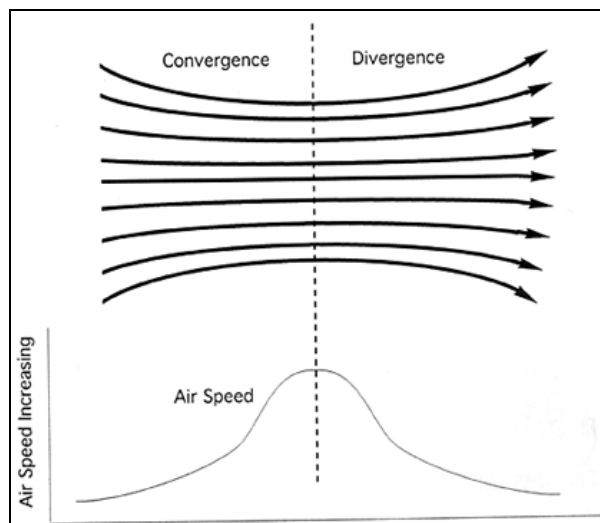
Terrain

Terrain is the variation in land features, which primarily affects fire behaviour by altering wind direction and speed at a local level. It is useful to think of the wind patterns over terrain as water flowing in a river. Terrain affects wind patterns in the following ways:

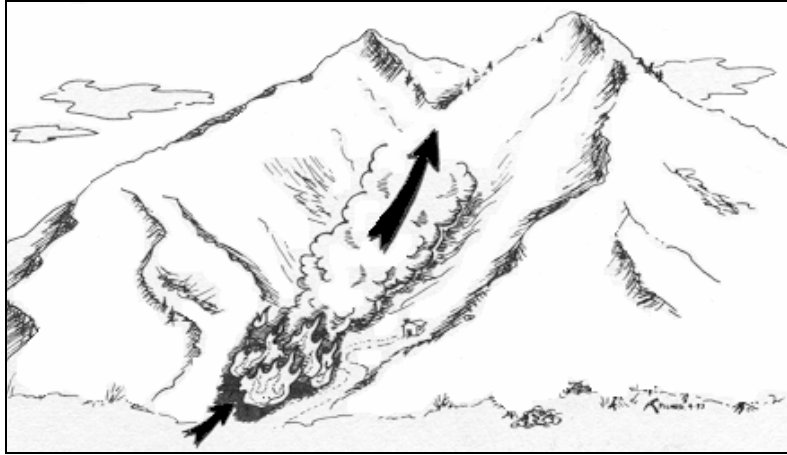
- Turbulence or “eddies” can be generated on the leeward side when wind blows across ridges



- Terrain restrictions, such as narrow portions of valleys, or knolls, can increase wind speed as the wind passes through, or around these restrictions.

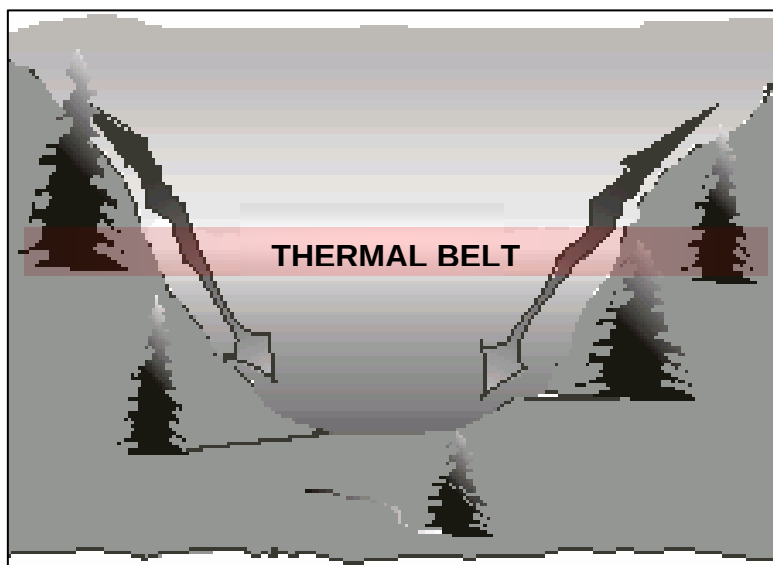


- Steep-sided gullies or canyons running uphill can create a “chimney effect” dramatically increasing uphill spread rates and intensity. In many cases these terrain features will also have heavy fuel loadings, increasing fire behaviour.



Elevation

Typically, air temperatures follow an elevation gradient with temperatures being warmer at lower elevations and cooler at higher elevations. Quite often, atmospheric conditions will cause a band of warm air to be trapped at mid-elevation between cool air at lower elevations and cool air above. In mountainous terrain this is a temperature inversion known as a **thermal belt**. Within the thermal belt, temperature will be higher and relative humidity will be lower than the elevations above and below, possibly creating extreme fire conditions when unexpected



Fire Intensity Ranking System

Fire ranking is a very convenient way of quickly assessing the fire.

It is important to understand the Fire Intensity Ranking System which enables fire fighters to communicate a summarized assessment of fire behaviour. Numbers from 1 (low) to 6 (extreme) are based on the FWI values.



Rank 1

- No open flame, white smoke, smouldering ground fire

Rank 2

- Visible open flame, surface fire only
- Unorganized flame front, little or no spread

Rank 3

- Organized surface flame front
- Moderate rate of spread
- Vigorous surface fire

Rank 4

- Organized surface flame front, disorganized crown involvement
- Moderate to fast rate of spread on the ground
- Short range spotting
- Grey to black smoke

Rank 5

- Organized crown fire front
- Moderate to long range spotting
- Independent spot fire growth
- Copper to black smoke

Rank 6

- Organized crown fire front
- Moderate to long range spotting
- Independent spot fire growth
- Presence of fire balls and fire whirls

Definitions

Candling - A single tree or a small clump of trees is said to candle when its foliage ignites and flares up, usually from bottom to top.

Spotting - A fire producing firebrands carried by the surface wind, a fire whirl and/or convection column that fall beyond the main fire perimeter and result in spot fires

Parts of the fire

It is very important that you are able to describe the anatomy of a wildfire. You will need this to describe your position on the fire or the position of an observation you are making from afar. The following anatomical descriptors are important to remember and understand:

Head -The head or front of the fire is the portion of the fire that has the greatest rate of spread. The head is the direction in which the fire is growing. The head is usually on the downwind or upslope part of the fire.

Back- The back or rear of the fire is opposite the head and usually has the slowest rate of spread. It is also known as the heel or the base.

Flank-The flanks are any areas between the head and the back. The flanks are often referred to in relation to a geographic feature such as the 'north flank'.

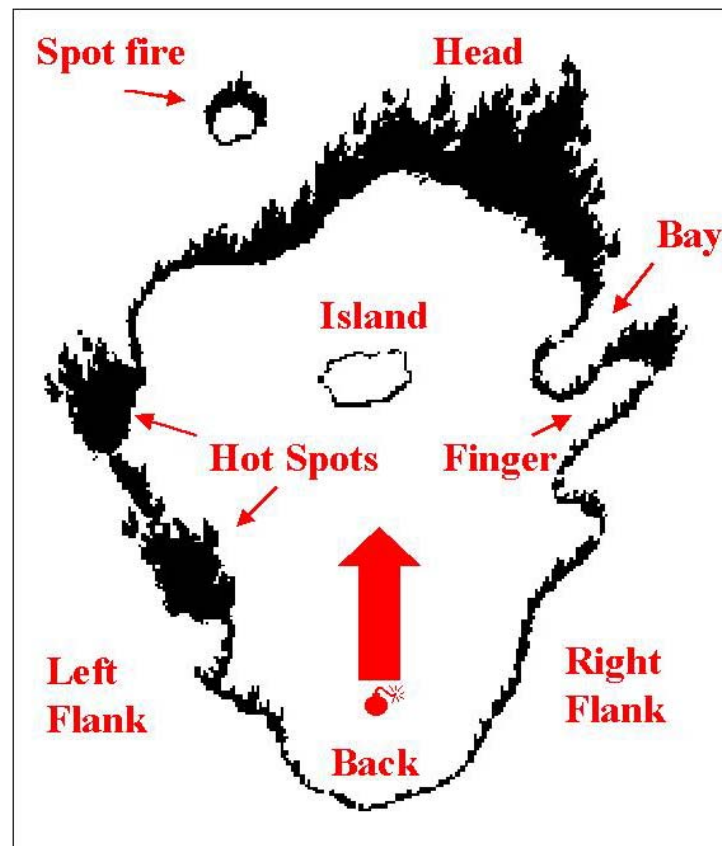
Finger-A finger is an elongated burn area projecting from the main body of the fire. Fingers often occur on wind driven fires.

Bay-A bay is a marked indentation in the fire perimeter. A bay is usually located between two fingers.

Island-An island is an area of an unburned fuel located within the fire perimeter.

Spot Fire- spot or jump fire is a fire ignited by firebrands outside the main perimeter of the fire. Spots can occur very close to the fireline or under windy conditions a great distance from the fireline.

Hot Spot- A hot spot is any part of the fire that is particularly active.



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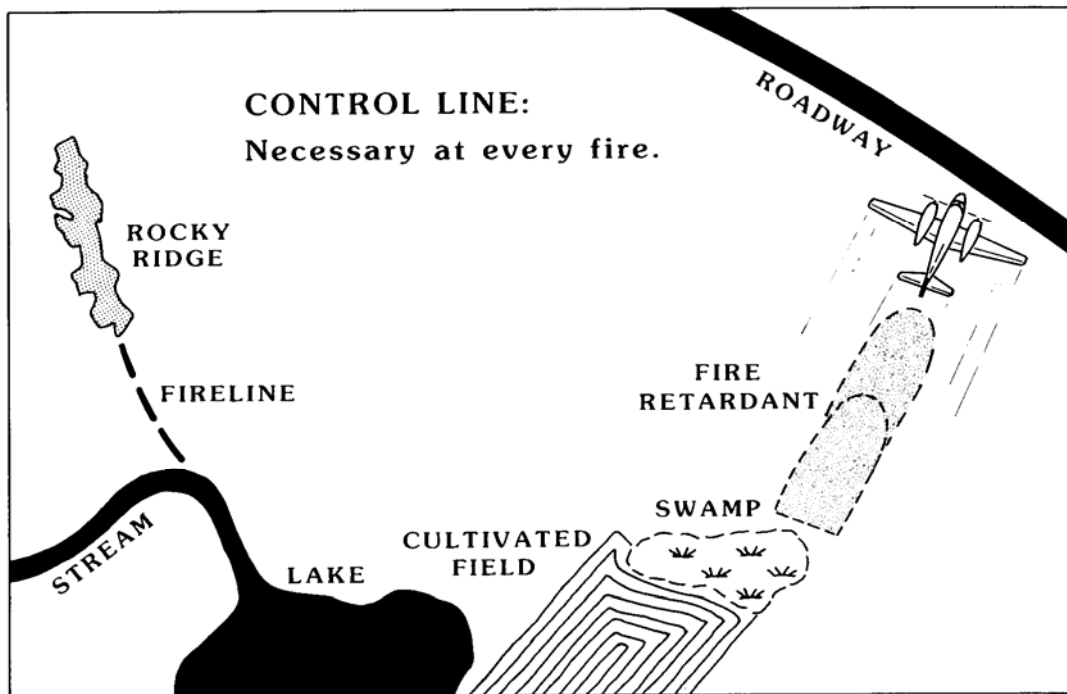
5. FIRE ATTACK METHODS REVIEW

Section Learning Objectives:

Upon completion of this section, the participant will review:

1. The control line
2. The 3 attack methods in which ignition operations may be used

Control Line

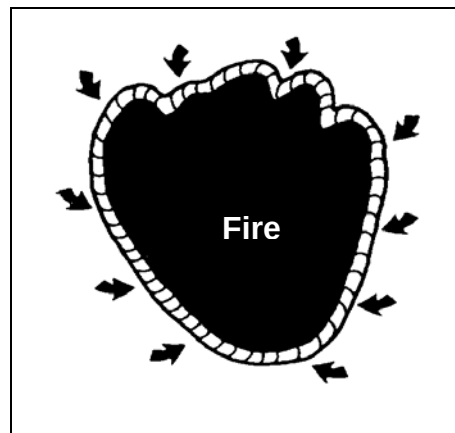


A **control line** is necessary at every fire. The control line may be a combination of man-made firelines or natural fire barriers (e.g. rivers). The term "fireguard" used historically is not accepted today. Correct terminology is 'fireline' referring to man-made lines and control line is used to describe a combination of barriers or completed firelines.

Fire Attack Methods

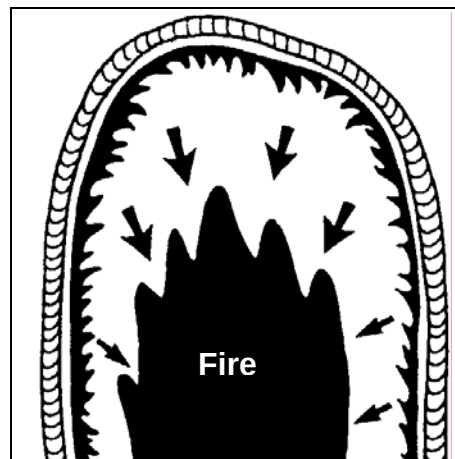
Direct Method

This attack method is normally used to suppress a slow moving fire. The fireline is constructed directly adjacent to the burning fuel. The fire is attacked and suppressed immediately. **Burning off** islands of fuel near the control line may be necessary to reduce the risk of spotting across the control line



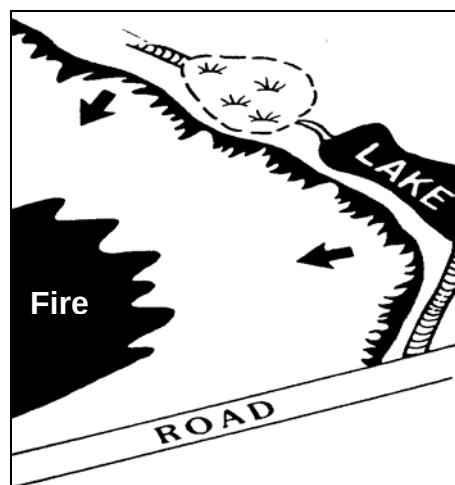
Parallel Method

This method is applied in situations where a fire is spreading at a moderate spread rate, the fire intensity is too high for fire fighters to perform direct attack, or the burnt area is highly irregular, making direct attack inefficient. The fireline is constructed as close to the fire as heat and flames permit. This technique helps to control the fire as opposed to immediately stopping it (Direct Attack). Igniting unburned fuel between the fireline and the fire reinforces the line and speeds up the control effort by consuming or **burning out** fuel between the fireline and the fire perimeter.



Indirect Method

This is a method whereby the control line is strategically located to take advantage of favourable terrain and natural barriers or breaks well in advance (several hundred metres to several kilometers) of the fire perimeter. Used under the direction of a senior, experienced Incident Commander, a **backfire** is set to stop the advancing fire.



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6. IGNITION TECHNIQUES AND SEQUENCES

Section Learning Objectives

Upon completion of this section the participant will demonstrate an understanding of ignition techniques and sequences used in an ignition operation through knowledge of:

1. The definition of ignition pattern, ignition technique, ignition method, ignition sequence, burnout, backfire and prescribed fire
2. The characteristics of commonly used ignition patterns/techniques
3. Application of ignition patterns and ignition techniques to specific situations
4. Safety hazards associated with specific ignition patterns/techniques
5. How fire environment factors (fuel, weather, topography) can affect the choice of ignition patterns/techniques, and overall ignition sequence

Understanding the ignition techniques and sequences is an integral skill set that will provide for the achievement of wildfire and prescribed fire objectives, desired fire effects and the assurance of fire personnel and public safety. We can use the dynamics of head, flank and backing fire, either on their own or in combination to achieve successful burning patterns and manageable intensities.

Definitions

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

Ignition Method: The means by which a prescribed fire, backfire or burn-out is ignited; such as handheld drip torch, helitorch or terra torch.

Ignition Sequence: The overall progression of ignition events to apply fire to a given area

Burnout: A fire set along the inner edge of a control line to consume fuel between the edge of the fire and the control line

Backfire: A fire set inside a control line, to alter the direction or lessen the intensity of the main fire

Prescribed Fire: A fire applied in a skillful manner, under exacting conditions, to fuels in a definite place to achieve management objectives

Types of Fire Spread

There are three types of fire spread:

Head Fire

A fire spreading, or set to spread with the wind or slope. Flames bending over unburned fuels

Backing Fire

A fire spreading or set to spread into the wind. Flames bending over blackened fuels

Flanking Fire

A fire spreading, or set to spread, at roughly right angles to the prevailing wind direction

Common Ignition Patterns and Ignition Techniques

Head Firing

An ignition technique using wind or slope from established control lines or anchor points to meet certain objectives

Purpose

Used for small and large area burns such as broadcast burning of large fields, harvest clear-cut blocks, overstory removal and biodiversity burns. Often used in combination with other techniques.

Advantages

Rapid, inexpensive, good mass ignition providing sufficient heat for consumption and lofting of smoke particulates

Disadvantages

High intensity leading to spotting and control problems

Backing Fire

An ignition technique that backs into the wind from an established control line

Purpose

Used alone under tree canopies, but most often used with at least one other firing technique

Advantages

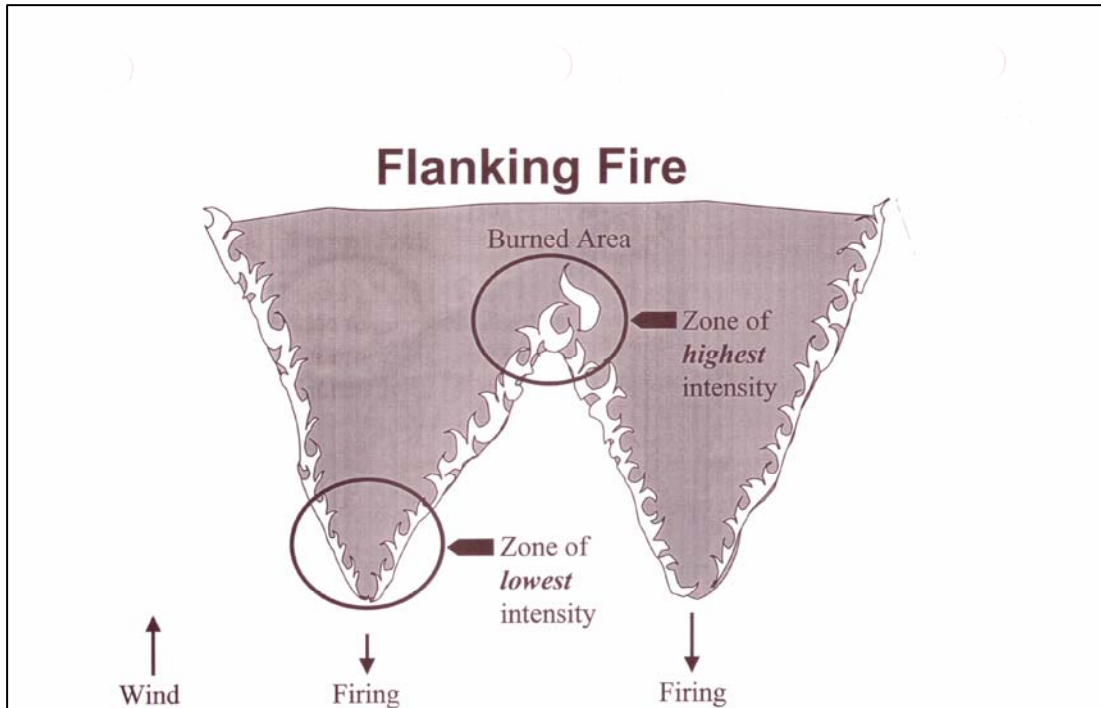
Low intensity, low scorch, low spotting potential

Disadvantages

Not readily flexible to wind changes, does not burn well at higher fuel moistures and in dry situations can produce a high severity burn (depth of burn in duff layer)

Flank Firing

An ignition technique that allows firing parallel with and into the wind or slope (fire spreads to the flanks). Has been adapted to all types of burns from broadcast to underburn



Uses

In broadcast burning it is used with a strip head fire technique lighting down along the edges. Can be used to mass ignite from the strip head

Advantage

Rate of spread and intensity is in between head and backing fires. Fire intensities and rate of spread are adjustable by proper timing of ignition sequence

Disadvantage

Wind shifts can quickly cause a loss of control. Communication and coordination with igniters can be a problem
Change in topographic features causes problems for igniters such as spotting below or in front, with possible entrapment

Chevron Firing

A variation of strip head or flank firing such that the ignition strips or burn pattern describe a chevron.

Purpose

This method established the line of fire in a crescent, or a star shaped pattern to burn off ridge points or knobs. Used with one or more other technique

Safety Note: Watch out for varying topography!

Patterns

- Multiple ridgelines/knob sequence-igniters moving down multiple ridges simultaneously where the fire backs down into draws or gullies
- Deliberate chevron pattern –igniters offsetting from a straight line with the intent to pull fire together and maintain better control: a variation of the strip head technique

Advantage

Fast implementation

Disadvantage

Requires close attention to spacing of igniters; sets out a lot of fire very quickly and therefore control could be difficult; once pattern is set out a wind change could cause the pattern to change to intense strip head fires

Circular Firing

Lighting out the perimeter of a burn area so that the ensuing fire front converges towards the centre. Usually used in combination with a dot ignition pattern in the middle so that the draw is enhanced.

Purpose

Typically used for large wildlife, range or habitat burns

Advantages

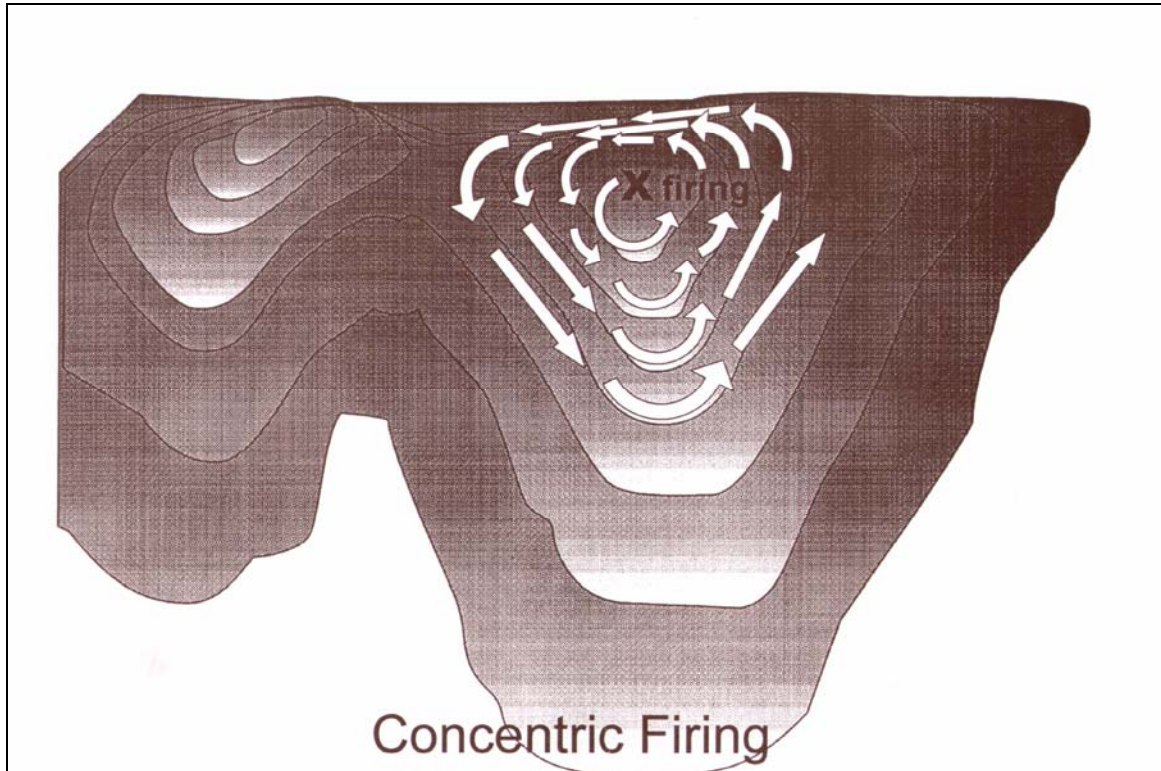
Lends itself to rapid ignition by helitorch, terra torch, or other methods; minimizes control problems along the perimeter. Can mitigate air quality problems by lofting smoke high into the air.

Disadvantages

If wind is not correct, or spotting potential is very high, spot fires could cause loss of control

Concentric or Centre Firing

Lines of fire describe circles, one within another proceeding outwards towards the control line.

**Purpose**

Used to control the amount of heat when burning off knobs or mounds

Advantage

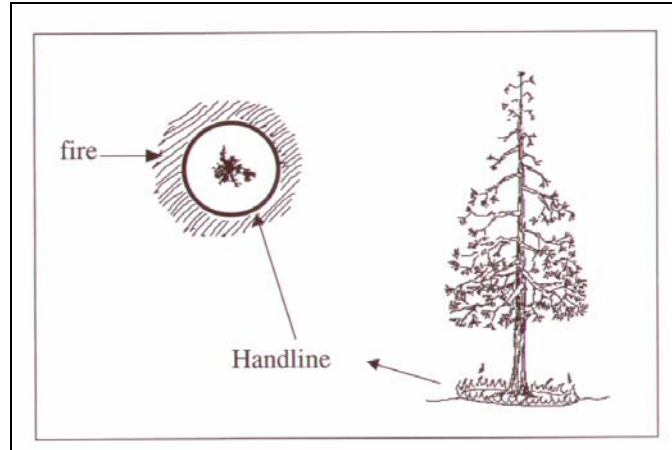
Controlled slower ignition process where heat can be more precisely managed

Disadvantage

Limited primarily to hilltops; wind can vary from one side of the hill to the other and therefore little wind tolerance; also igniter communication problems are an issue

Ring Firing

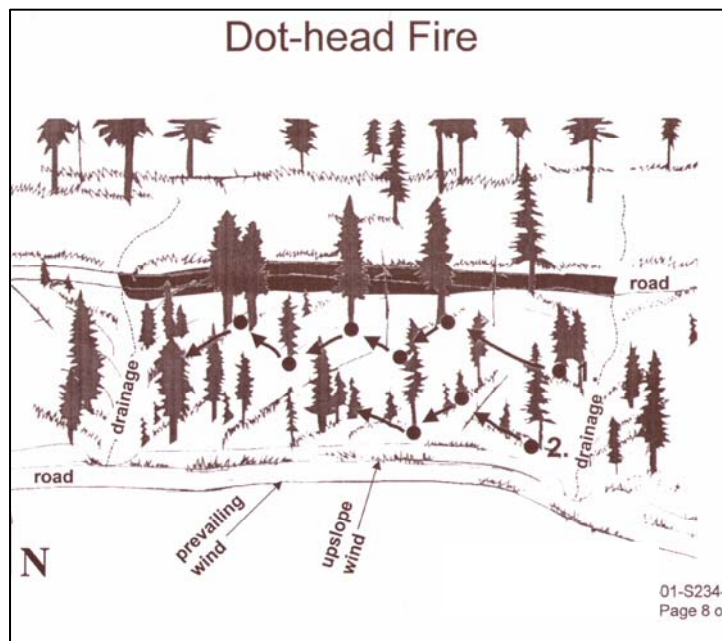
A fire set around the outer perimeter of a resource to be saved in a manner that establishes a black-line-buffer and draws heat away from the resource (Avoidance firing)



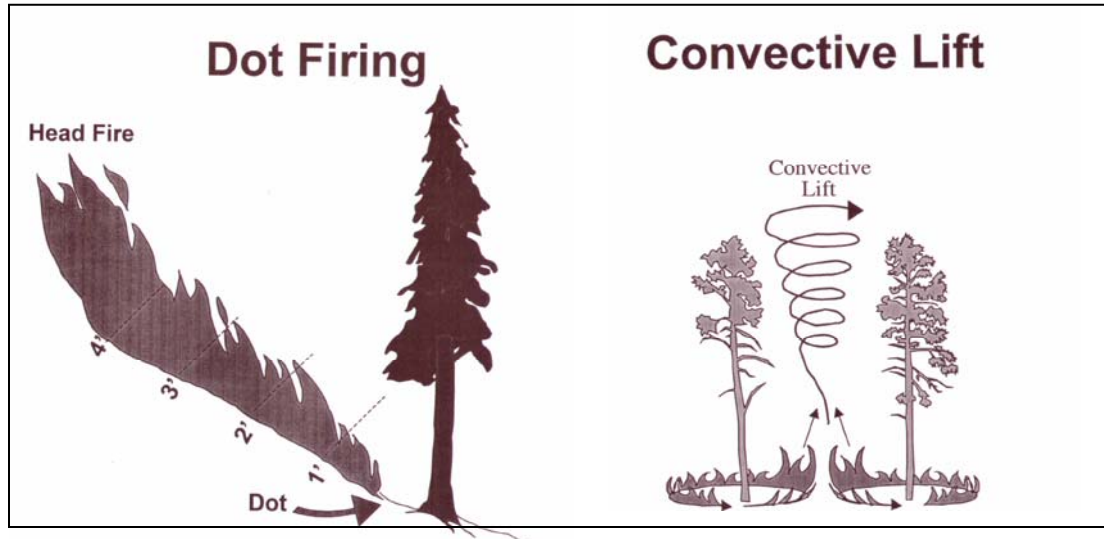
- This technique involves circling the perimeter of a resource with a control line and then firing from it
- Commonly used around structures, archeological sites and sensitive ecosystems
- This is a variation of a backing fire and usually is always used in conjunction with other techniques and patterns. Can be used alone in a natural fire strategy

Dot Firing

Individual dots of fire are set to burn together before they reach an equilibrium rate of spread and develop their own head, flank, or backing fire.

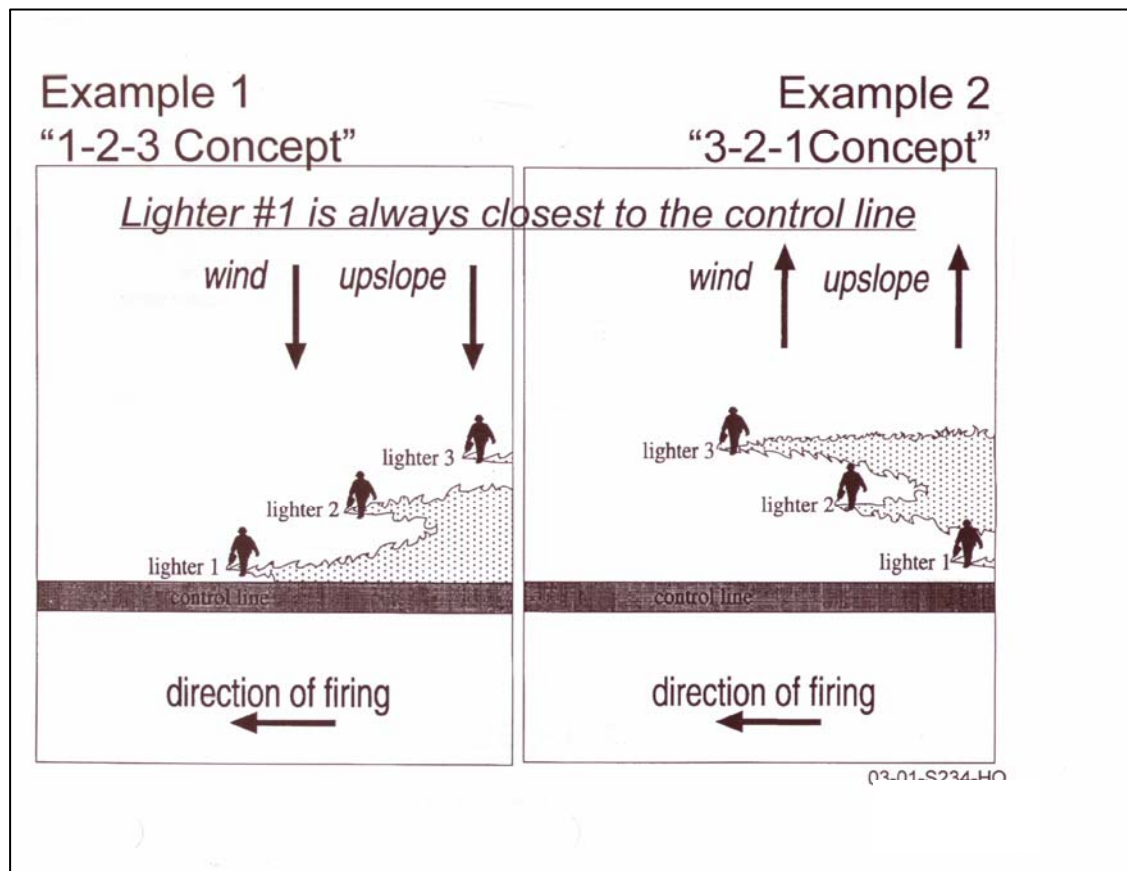


Can be used to mitigate heat production through the timing and the spacing of the dots as this offers very good control over heat production. Used when scorch height is a concern. There are several pattern variations which can be employed depending upon the objective



Strip Head Firing

Lines of fire are set perpendicular to the slope or wind.



- Most Commonly used technique.
- Versatile with good control of fire behaviour
- It can be a simple and safe technique
- Adaptable to understory burns
- Most adapted to shifting winds, changing topography or fuels and unforeseen fire behaviour
- Can adjust strips easily to affect fire intensity

Components of a Strip Head Fire

- The first strip is a combination of a head and backing fire
- Light down the fireline
- First strip becomes a black buffer line

Application of Ignition Techniques

In order to achieve objectives and ensure firefighter and public safety we must know how to successfully apply ignition techniques to on the ground situations

Heat (Intensity)

The intensity of a fire must be regulated so that there is control at all times regardless of the ignition pattern used, or the speed at which it is carried out

Order of Firing

- Firing is always started at an anchor point to ensure safety. The most common anchor points are:
 - o Roads
 - o Dozer and handlines
 - o Burned out areas
 - o Natural barriers
 - o Wet/retardant lines

Adjust firing order to fit the situation when the main fire is uneven and approaches the line at different points

- Whenever possible:
 - o Commence firing in steep terrain from the top down
 - o Commence at a down wind anchor point and fire into the wind

Firing Under Adverse Conditions

Severe Winds

- When firing against the wind, embers may be carried across or flames may lay over the control line
- Ensure adequate line preparation is accomplished and sufficient holding forces are available before firing operations commence
- Use strip/spot firing techniques to regulate the degree of intensity along the control line by:
 - Controlling the width of the strips or amount of spots within a given strip
 - Incorporating temporary check lines at right angles to the control line
 - As successful strip/dot firing reinforces control lines, progressively more depth can be obtained, creating in-darfts to draw the backing fire away from the control line
- Monitor upper level winds and surface winds. Observe the convection column. Upper level winds may sink to the surface and over ride the surface winds
- When strong, downslope winds overcome the effects of the terrain and the main fire is spreading downhill
 - Fire the lower elevations first, then proceed up slope towards the main fire
 - Use extreme caution and always anticipate an unpredicted wind change
 - Wind direction may shift, changing your operation from a backing fire/flanking fire to a head fire
 - Provide **Lookouts, Communications** with adjoining forces, **Escape Routes** and **Safety Zones**

Steep and/or Midslope Conditions

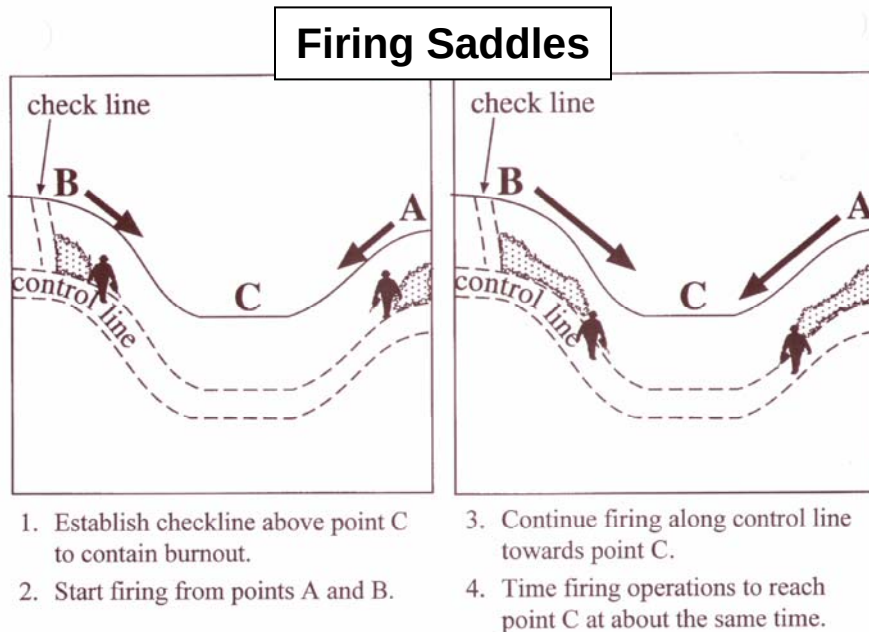
- Midslope locations are the most dangerous from the standpoint of personnel safety.
- Skilled ignition teams with a good understanding of fire behaviour should be used
- Guard against rolling material starting spot fires that could cause intense uphill runs against the control line
- Limit both length and width of the strips so that the volume of heat and flame length next to the control line can be handled by the holding forces available

- As successful ignition period reinforces control lines; more depth can be progressively obtained.

V-shaped Canyons

- When the main fire is progressing down one slope of a V-shaped canyon the following should be done
 - Start firing above the control lines as high as terrain, fuel and winds will allow, using an aerial ignition device
- Bring firing down to control lines incorporating the use of Drip torches/ Fusees
- By insuring the spread of fire, both up into the main fire (head fire) and down to the control line (backing fire) will reduce the threat of spot fires and radiant heat adjacent to control lines and across canyons

Saddles and Deep Ravines



- A saddle or the crossing of a deep ravine should be reviewed very cautiously, since it is a natural chimney
- Always burn into saddles and ravines, rather than away from them, starting from the highest point and firing downhill
- Establish a check line at the opposite end of the saddle/ravine to contain the burnout or backfire until firing is complete
- Commence firing using the strip fire technique
- Proceed cautiously across the ravine/saddle, since temporary adverse wind conditions may develop by the burnout or backfire

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7. IGNITION SAFETY

Section Learning Objectives

Upon completion of this section the participant will demonstrate an understanding of ignition safety through knowledge of:

1. The common hazards to ignition techniques
2. Preparation for firing considerations
3. Problems that may seriously affect a firing operation
4. General ignition operations safety, including ignition crew briefing and safe work practices

Hazards Common to Ignition Techniques

- Changes in wind speed or direction
- Spotting across the control line
- Possible entrapment of fire personnel due to the following:
 - o Incorrect timing
 - o Lack of visual contact
 - o Poor communications
 - o Incorrectly staggering strips or dots
- Rolling material on slopes
- Uncontrolled fire intensity after ignition

Preparation For Firing Considerations

- Firing must not:
 - o Jeopardize the safety of personnel or equipment
 - o Adversely affect the suppression action on adjacent divisions
- Most successful firing is conducted from completed control lines, which are best located at breaks in the terrain such as:
 - o Lee side or tops of ridges
 - o Wide canyon bottoms
 - o Roads or benches

- Concentrations of fuels adjacent to and inside the control lines should be removed, scattered or treated prior to firing
 - o Fuels inside the control line
 - Dangerous trees should be felled, protect desirable wildlife trees
 - Ladder fuels should be removed and scattered to reduce the possibility of torching or crowning
 - Other fuels existing inside the control line may require rearrangement
 - o Fuels outside the control line
 - Fell dangerous trees, protect desirable wildlife trees
 - Pre-treat with mineral soil, water, foam or retardant
 - Remove or scatter fuels
- Successful firing can be accomplished with minimal preparation when firing under the following conditions:
 - o Burning in light fuels
 - o Favourable wind, weather and topography
 - o Adequate resources for holding and line construction
 - o Firing from pre-existing control lines i.e., natural barriers, fuel breaks, road systems

Problems that may seriously affect a firing operation

- Adverse line location
 - o Mid-slope
 - o Underslung
 - o Hooks or dog legs in the line
- Topographic features
 - o Narrow canyon bottoms
 - Heavy fuel concentrations
 - Increased radiant heat
 - Increased spotting potential
 - Limited access for personnel and equipment
- Saddles
 - o Wind shifts and eddies
 - o Increased spotting potential

- o Increased radiant heat
 - o Access may be limited due to fuel loading and terrain features
- Excessive slopes
 - o Accessibility may be limited due to steepness
 - o Rolling material
 - o Potential head fire build-up
 - o May require additional time during backing fir operations
- Fuel variations
 - o Heavy fuels may produce heat build-up near the control line
 - o Poor accessibility for the igniters
 - o Limited ladder fuels for heat generation
 - o Heavy concentrations of dead dangerous or wildlife trees near the control line may lessen control capability
- Weather changes
 - o Wind shifts across the control line
 - o Increased wind speed
 - o Thunderstorms with downdrafts
 - o Humidity changes
- Structures and improvements within the area may require additional:
 - o Line construction
 - o Fuel preparation
 - o Resources
 - o Reconnaissance
- Additional problems to consider
 - o Poor coordination or communication
 - o Equipment failures
 - o Lack of suitable and/or sufficient resources

General Ignition Operations Safety

Ignition Crew Briefing

Remember, as with all operations, it is imperative that all personnel participating in an ignition operation, whether it is on a wildfire or prescribed fire, be briefed prior to the commencement of the operation and updated as the situation and tactics change.

Firefighters should expect the following **key information** to be included in the pre-work safety briefing:

- The Chain of Command
- Designated **Lookouts** (if any)
- **Communications** plan outlining communications between fire fighters and between firefighters and their immediate supervisor.
- At least two **Escape Routes** that lead to adequate **Safety Zones** noted in case fire fighters and equipment are threatened by sudden changes in fire behaviour.
- Known fireline hazards.
- Safe work procedures to be used
- Current and expected fire behaviour and weather
- Current fire activities and progress
- Ignition strategies, sequence and technique discussed with ignition crew and adjoining units
- Tasks the crew will be accomplishing
- Individual work assignments
- Pertinent sections of the prescribed burn plan or incident action plan
- Problems or concerns

IMPORTANT!

A crew briefing isn't a one-way process. After the briefing, ask questions on any points that weren't covered and make suggestions where needed.

- If you aren't sure about a situation, **SPEAK OUT**.
- The most important consideration when attacking a wildland fire is a "**safety first**" attitude.....

IF IN DOUBT – BACK OUT!

General Safe Work Procedures

- Always maintain awareness of your **Look Outs, Communications** and **Escape Routes** and **Safety Zones**
- Always use a Lookout for firing operations
- Always fire from an Anchor Point
- Follow the chain of command
- Maintain span of control at all times
- Minimum 500 metre separation between ground crews and aerial ignition operation
- Appropriate PPE for all personnel; specialized PPE is required for mixing crews
- Ensure all excess fuels and combustibles are stored a minimum of 150 metres away from the ignition area up wind and down hill
- Appropriate spill berms should be used for storing and mixing ignition fuel. Emergency spill kits and procedures should be in place
- Do not open or fill fuel containers near hot embers, sparks, or while smoking, as the tank may contain dangerous vapour
- Ensure all hazardous materials are labeled to WHMIS standards and that all Material Safety Data Sheets are readily available
- When handling and transporting Dangerous Goods, ensure that they are appropriately packaged, labeled, placards are in place, and drivers have the paperwork.

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