Guide to Assist in Basic Wildland Fire Instruction

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This content of this guide has been edited from materials provided by Tom Wordell that he prepared in previous trips to Sub-Saharan Africa.

Module 1- Introduction to Fire and Fire Behavior

Parts of the Fire and Basic Terminology

PARTS OF THE FIRE

Origin – the location where the fire started.
Head – shows the direction in which the fire is burning. This is the hottest and most active part of the fire.
Flank (right and left) – Sides of the fire, parallel to the main direction of spread. May have active fire, but not as hot as the head of the fire.
Rear/Heel – Opposite the head of the fire and burning less vigorously, if at all. Often near the fire origin.
Perimeter – Boundary line of the fire or fire edge. May not have active fire on some portions.
Finger – An area, usually a narrow strip, that burns away from the main part of the fire. Could be dangerous if personnel working the fire are flanked by a finger.
Pocket – Unburned area between the main fire and any fingers.
Island – Area of unburned fuel inside the fire perimeter.
Spot Fire – Burning area outside the main fire perimeter, often caused by wind blown embers or rolling debris.

FIRE BEHAVIOR TERMS

Spread – Movement of the fire. ROS is Rate of Spread and given in chains per hour. A chain is a surveying term and equals 66 feet. A good rule of thumb is to watch the fire spread for a minute as there are 60 minutes in an hour and just over 60 feet in a chain so this will give a fairly quick, relatively accurate measurement of the fire's forward progress (ex. 1 foot/minute = 1 chain/hour).
Smoldering – Fire burning without flame and barely spreading.
Creeping – Fire burning with a low flame and spreading slowly.
Running – Fire spreading rapidly with a well-defined head.
Backing – Fire moving away from the head, downhill, or against the wind.
Spotting – Sparks or embers produced by the main fire are carried by winds or convection column.
Torching – Fire burning on the surface, but periodically igniting the crown of a single or small group of trees or shrubs before returning to the surface. Although sometimes confused with crowning this behavior is not as serious as a crown fire.
Crowning – Fire that advances across tops of trees or shrubs more or less independent of surface fire. High fire intensity and high forward rate of spread. Use crown fire or crowning with care because it describes a very serious fire situation.
Blowup – Sudden increase in fire intensity or rate of spread of a fire sufficient to preclude direct control or to upset existing suppression plans.

OTHER USEFUL FIREFIGHTING TERMS

Control Line – A comprehensive term used for all the constructed or natural fire barriers and treated fire edges used to contain the fire.
Fireline – Any cleared strip or portion of a control line from which flammable material has been removed by scraping or digging down to mineral soil.
Anchor Point – An advantageous location, generally a fire barrier, from which to start constructing a fireline. Used to minimize the chance of being outflanked by the fire while the line is being constructed.
Mopup – Final extinguishment of a fire after it is lined.
Class of Fire – This classifies the size of the fire with class "A" being the smallest and class "G" being the largest.

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Fire Behavior

FIRE BEHAVIOR (DEFINITION): The manner in which a fire reacts to the influences of fuel, weather, and topography. The combined effects of the fire's environment on how the fire acts or behaves.

- A basic understanding of fire behavior is necessary for each firefighter. This knowledge is a necessary aid in safe and effective control of wildland fires.
- A firefighter must know what the fire is doing at all times. A firefighter must base his actions on what the fire is doing now and what he expects it to do. he can do neither of these unless he understands something about fire behavior.
- After completion of this lesson, you will be able to identify the influences that fuel, weather, and topography have on fire behavior.

HOW A FIRE BURNS

To understand how a fire behaves, you must have some understanding of how a fire burns. The act of burning is called combustion.

Fuel, Oxygen, and heat must be present to support combustion or burning. In our situation, the wildland fire, fuels are the forest vegetation, oxygen is the air around us, and heat comes from lightning or man. All these things in combination create fire combustion.

FUEL + AIR + HEAT = FIRE

If you alter or change any of these elements, the fire will behave differently. If you remove any one of these elements from the triangle, the fire will go out.

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HOW A FIRE SPREADS

A fire spreads because of the following three methods of heat transfer:

1. Conduction
2. Radiation
3. Convection
4. Mass Transfer

How do these methods of heat transfer work?

1. **Conduction** - The transfer of heat through an object. This method has the least effect on the spread of a wildland fire because wood is a poor conductor of heat.

2. **Radiation** - Heat is transferred through the air from one object to another. In radiation, the heating surface does not have to be in contact with the heated surface.

Examples in wildland fire situation:
-Burning fuels radiating heat to fuels adjacent to the fire line or across narrow streams or roads.
-The radiation method of heat transfer is important to the firefighter. It is a main factor he is combating in the proper location and construction of fire lines.

3. **Convection** - Heat is transferred by the movement of hot air and smoke rising and heating the fuel above.

Examples in a wildland fire situation:
-Preheating fuels upslope from a fire. (This is one reason why fires burn faster upslope than downslope).
-Convection columns such as heated air or rising smoke

4. **Mass Transfer** - Heat transported in the form of firebrands.

Examples include:
-Embers carried by convective columns or wind
-Rolling burning debris on steep slopes

NOTES

FACTORS THAT INFLUENCE IGNITION AND FIRE SPREAD

The likelihood of a fire starting is dependent upon the ignition temperature of a fuel. This is the temperature at which it will ignite and continue to burn without any heat from an outside source. Different fuels have different ignition temperatures. Most wildland fuels have ignition temperatures in excess of 232 degrees Celsius.

FUELS

Fuels are made up of the various components of vegetation, live and dead, that occur in a particular area.

1. Fuel Type

Fuels are broken into 4 main categories.

1. Grass 2. Shrubs
3. Timber 4. Slash

They are also broken down by what "stratum" of the vegetative profile they occur in:

- Ground fuels; Combustible materials beneath the surface: (duff, roots, rotten material, etc)
- Surface fuels: Combustible materials on or immediately above the ground (leaves, needles, branches and limbs, logs, etc).
- Aerial fuels: Combustible materials above the ground (ladder fuels, canopy fuels, snags, etc)

2. Fuel Moisture

- Fuel moisture is a primary factor that influences the ease of ignition (how easy a fire will start) and the rate of combustion (how fast they will burn). The more moisture a fuel contains, the more heat is required to ignite it. Moisture within the fuel must first be vaporized and driven from the fuel before it can be raised to its ignition point (fire start).
- Therefore, fuels with low moisture content ignite more easily and fire spreads in them more rapidly than in fuels with higher moisture content.
- When fuel moisture is low, you can expect rapid fire spread. You can also expect spot fires and high intensity burning.
- Live fuels (live trees - green grass) have a higher moisture content than dead fuels (dead trees - dry grass).
- The amount of moisture in the air also determines the amount in the fuel. Spot fires are most likely to occur in dead fuels with low moisture content. If you are getting frequent spot fires, you know you may have a dangerous situation.

3. Fuel Size.

- The ease of ignition and the rate-of-combustion are influenced by another factor....that is size of fuels.
- Small (or light) fuels ignite quickly. In small fuels, fires spread more rapidly and burn out faster than they do in large fuels.
- Large (or heavy) fuels take longer to ignite and fires spread slower and burn longer, but usually with greater intensity.
- Examples of small fuels are grass, leaves, tree needles, and light brush.
- Examples of large fuels are stumps, logs, branch wood, and large trees.

4. Fuel Loading

- The amount of fuel by size class present per hectare, usually expressed in weight per hectare.
- The more fuel there is to burn, the more intense the fire can be

5. Fuel Continuity

Another factor which influences the spread of a fire is continuity of fuels. This is thought of as horizontal spacing and vertical spacing.

Horizontal Continuity is the spacing of the fuel, or the distance between burnable fuel as it lies on the ground.

- When fuels are close together, the fire will spread faster because of the effects of heat transfer.
- The most commonly used method of fire suppression is to break the continuity of the fuel by separating burning fuels from unburned fuels. This is the fire line.

Vertical Position and Spacing:

- When fuels are closely spaced vertically, fire will spread rapidly as convected heat preheats and ignites the fuels above.
- When fuels are spaced far apart vertically, convected heat is not usually sufficient to ignite the fuels above.

6. Fuel Compactness:

- Fuel compactness refers to the spacing between fuel particles.
- This is a very important characteristic of fire spread. Compact fuels have less oxygen available and combust slower than fuels that have an "optimum" packing ratio.

7. Chemical content

- Some fuels have a high volatile oil or wax content and will combust more robustly than other fuels with the same moisture content.
- It is imperative local knowledge of fuel characteristics are known and understood

NOTES

WEATHER

One of the most important factors affecting the behavior of a fire is weather. In fire control, we usually break weather into three parts. These are:

1. Temperature
2. Relative humidity
3. Precipitation
4. Wind
5. Atmospheric Stability

1. Temperature.

- The effect of temperature is important because fuels that are preheated by the sun burn more rapidly than do cool fuels.
- Preheating also drives off moisture in the fuels and less heat is required to ignite them. Once ignited, preheated fuels will burn more rapidly than cool fuels.

2. Relative Humidity (RH)

- Moisture in the form of water vapor is always present in the air. The measurement of this moisture in the air is relative humidity. Relative humidity is expressed in per cent. It is the amount of moisture present in a parcel of air compared to the total amount the air could hold at that temperature.
- RH is determined by measuring the difference between wet and dry bulb temperatures (we will teach you how to do this using a belt weather kit and psychrometer)
- The amount of moisture in the air affects the amount of moisture in the fuel.
- Air is usually drier during the day than it is at night because temperatures are usually cooler at night. Fuels, then, are also drier during the day than at night. The result is that fires will normally burn more rapidly during the day.
- You should remember this because anytime you feel the weather getting hotter and drier, the behavior of your fire is likely to change.

3. Precipitation

- Precipitation is the amount of moisture in liquid or solid form which reaches the earth's surface.
- Precipitation has an obvious effect on fuel moisture.
- Light rain over a long period will have a significantly greater effect than a short, heavy rain.

4. Wind

- The most important weather factor is wind.
- Of all influences on a fire's behavior, wind has the greatest influence on both the rate and direction of spread. It does this by increasing the oxygen supply causing more intense burning. The wind bends the flames closer to the unburned fuels and moves heat in advance of the fire, preheating the fuels. It carries burning embers beyond the fire, causing spot fires.
- Winds generally blow upslope during the day due to warmed air rising. At night, the winds generally blow downslope due to the cooler air sinking. Night winds are generally

not as strong as day winds.

- Another visible indicator of a possible change in wind speed and direction is the presence of thunderstorms (cumulus clouds). Gusty winds usually flow out from the edge of a thunderstorm and can reach speeds over 100 kilometers per hour. When this happens, it may cause the fire to suddenly change both direction and rate-of-spread.

5. Stability

- A stable atmosphere is resistant to vertical movement of air, i.e., the normal convective processes. Stable conditions are usually associated with high pressure systems and relatively calm winds.
- An unstable air allows good mixing and lift high into the atmosphere. Unstable conditions can be associated with low pressure systems, frontal passages and wind. Unstable air promotes convective heat transfer, column development and atmospheric conditions that tend to facilitate fire intensities.

NOTES

TOPOGRAPHY

Where the fire is burning, whether it is in steep terrain or on level ground, the lay of the land is an important factor in the rate and direction of fire spread.

This lay of the land (or configuration of the land surface) is called topography.

Topography is usually broken into three parts. These are:

1. Slope - How steep it is.
2. Aspect (or exposure) - The direction it faces.
3. Elevation
4. Landform or Terrain - The local features of the land.
5. Fire Position

Of these three, slope has the greater influence on fire behavior.

1. Slope

The steepness of the slope affects both the rate and direction of the spread. Usually fires will move faster uphill than downhill. The steeper the slope, the faster the fire will move. This is due to several things:

- On the uphill side, the flames are closer to the fuel. The fuels become drier and ignite more quickly than if on level ground.
- Wind currents are normally uphill and this tends to push heat and flames into new fuels.
- Convected heat rising along the slope causes a draft which further increases the rate-of-spread.
- Burning embers and chunks of fuel may roll down-hill into unburned fuels increasing spread and starting new fires.

2. Aspect

A second factor is aspect or exposure. This refers to the direction a slope is facing whether north, south, east or west. The aspect of a slope has several influences on a fire's behavior.

In the northern hemisphere, east and west aspects receive more direct radiation from the sun, drying both the soil and vegetation. The more intense heating by the sun also causes earlier and stronger slope winds.

3. Elevation

- Temperatures generally cool with increases in elevation, so higher elevations tend to have greater moisture levels than lowlands.
- Vegetation changes with elevation and so will fire behavior.

4. Terrain (Special land features)

Local terrain or land features have a direct effect and influence on air movements. These land features are obstructions, and may control wind flow in a relatively large area. Winds flow much like water in a stream, and will try to follow the path of least resistance.

Obstructions, such as ridges, trees, rocks, etc., may alter its flow and cause turbulence or eddies to form on lee side of obstructions. Does everyone know what the lee side is?

- Saddles and Ridgetops:
  - Saddles constrict and speed up airflow, increasing winds and fire rate of spread.
  - Ridgetops are the dividing line between distinct airflows, and so turbulence is greatest at the ridgetops.

- Narrow Canyons: When wind flows through a restriction such as a saddle or a narrow canyon, it will increase in velocity through that restriction. This, in fact, funnels the wind through the restriction.

- Chutes or Box Canyons: Wind movement can be critical in chutes or steep "V" drainages. These terrain features create a chimney effect, causing a forced draft, as in a stove chimney. Fires in these chutes or drainages spread at an extremely fast rate and are very dangerous.

- Barriers: Barriers are any vegetation free area, natural or man-made, such as rivers, rock outcroppings, roads, etc.

NOTES

Intermediate Fire Weather

An Introduction to Atmospheric Influences on the Fire Environment

Major Factors of Fire Weather

- Atmospheric Stability & Instability
- Dry, Cold Fronts
- Subsidence and Foehn Winds
- Thunderstorms

STABILITY AND INSTABILITY

- STABLE CONDITIONS: A stable atmosphere is resistant to vertical movement of air, i.e., the normal convective processes.
- UNSTABLE CONDITIONS: An unstable air allows good mixing and lift high into the atmosphere. Remember that convective processes facilitate fire intensities.

Visual Indicators of Instability

- Vertical cloud development.
- Smoke rises to great heights.
- Gusty winds.
- Clear air.
- Dust devils, fire whirls.

Visual Indicators of Stability

- Stratified clouds.
- Little upward or even downward movement in smoke columns.
- Hazy air.
- Fog layers.
- Steady winds.

Inversions: Stable Air

- An atmospheric layer where temperature increases with altitude (Reverse adiabatic lapse rate).
- Smoke only rises to the level where their temperature equals the surrounding air.
- Often occurs at night.
- Smoke rises and then spreads at a specific level where temperatures equal.

When Inversions Break

- Air becomes unstable, vertical air movement begins and fire behavior increases.
- This can be a VERY dangerous situation since stagnant air is "flushed" out with fresh air, increasing the oxygen to the fire, and often causing a marked, rapid, increase in fire activity.

Thermal Belts

- In complex terrain, the top of inversions can be below the highest ridgetops.
- The earth radiates absorbed heat which is trapped by cooler air above.
- Surface air is cooled by the earth, leaving a band of warm air above.
- A band of warm air, the "thermal belt", maintains a higher temperature and lower RH than areas above and below.
- Wildland fires often remain active within these areas.
- Look for them at mid-slope regions.

SIGNIFICANT FIRE WEATHER EVENTS

Subsiding Winds (*Foehn Winds)*

- Subsiding air is large scale sinking of air caused by persistent high pressure.
- This is a very stable condition, with a warm and dry air mass.
- Under certain conditions, high pressure will "squeeze" air out from underneath the air mass.
- Subsiding air pushes over a range of mountains, losing what little moisture it had.
- Gravity carries the air downslope on the lee side.
- Air flow gains speed and temperature as it loses elevation, decreasing RH's and fuel moistures.
- Winds often reach 40 to 50 mph and can be as high as 90 mph
- How will this affect fire behavior? Do these occur in the Mt. Kenya area?

NOTES

The Lifting Process

Lifting of air can occur four ways

- **Thermal –** Occurs when strong thermal heating of the earth's surface occurs. This can trigger instability and formation of cumulous clouds
- **Orographic –** Occurs in mountainous areas when air is forced to rise due to slope. Air usually cools at dry adiabatic lapse rates. Often occurs in conjunction with thermal lifing. Clouds will form if saturation point is reached.
- **Frontal -** Frontal lifting occurs when an air mass pushes its way under an existing air mass causing it to lift. A cold front will produce cumulous clouds while a warm front will cause stratus clouds.
- **Convergence –** Occurs when more air moves into an area than moves out. Can occur independently or in conjunction with Thermal, Orographic or Frontal lifting. Always occurs in low pressure areas with opposing winds.

Dry Cold Fronts: Indicators

- Line of cumulus clouds approaching.
- Large dust clouds precede front.
- Winds are strong, gusty and erratic as the front arrives.
- After passage, expect cooler winds**.**

Thunderstorms: Indicators

- Strong, variable and gusty winds.
- Tall, building cumulus clouds with flat base and anvil heads.

NOTES

Extreme Fire Behavior

INTRODUCTION

Extreme Fire Behavior: Indicates the level of behavior of the fire which ordinarily ***prevents*** direct attack. These fires often exhibit rapid growth and spot fires are frequent. These characteristics make them dangerous to all personnel in the fire area.

In general, the following fire behavior conditions are observed during extreme conditions:

1. Very high rates of fire spread.
2. Very intense burning with extra-ordinary flame lengths
3. Individual tree torching, crown fires, and/or profuse spotting.
4. A well-developed column of smoke.

VISUAL INDICATORS OF EXTREME BEHAVIOR

A well developed convective column is one of the more notable characteristics of an explosive fire or "blow up". The column can reach thousands of meters in height. Other indicators include:

1. Unstable atmosphere
2. Great quantities of dry fuels.
3. Strong winds
4. Steep slopes.

EXTREME FIRE BEHAVIOR INDICATORS

- Rapid Rates of Spread.
- Intense Burning Conditions.
- Frequent and Extensive Crowning.
- High, strong smoke column.
- Numerous small fires gaining intensity simultaneously.
- Frequent spot fires.
- Frequent torching and crowning.
- Developing fire whirls.

SPOT FIRES

Spot fires normally are the result of the movement of sparks and embers lifted by the convection column and taken by wind to unburned fuel in front or behind the fire line. The velocity of the wind has a direct affect on the distance at which "spotting" occurs. Spot fires can also occur from rolling material on steep slopes.

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INDIVIDUAL TREE TORCHING AND CROWN FIRES

It is important to differentiate between individual tree torching and "Crowning".

Passive Crowning: When the foliage of a single or a group of trees ignite. This will cause the intensity of a fire to increase temporarily.

Active Crowning: A "running" crown fire when multiple trees ignite and fire spreads from crown to crown. This causes a major change in the rate of spread, ember production, spotting frequency and distance.

SUPPRESSION GUIDLELINES BASED ON FIRE BEHAVIOR OBSERVATONS

Height of the flames (meters)

- **Less than 1 meter.**
  - Direct attack on the head and sides of the fire can be effective with the use of hand tools.
- **From 1 to 3 meters.**
  - The heat intensity of the fire is high enough to impede direct attack with hand tools.
- **From 3 to 4 meters.**
  - Heat intensity of the fire is high and starting the phenomena of crown and spot fires.
  - The heat intensity is so high that it presents serious dangers to personnel who work within a 10 meter distance to the fire.
- **More than 4 meters.**
  - Fires of this intensity will spread rapidly and be of great danger to both fire suppression personnel and the public. Spotting will be frequent and may occur several kilometers away from the fire.

NOTES

Module 2 - Organizing, Supervising, and Managing Fires

Overview of the Incident Command System

What is an Incident?

The word "incident" refers to an emergency response situation such as a:

- Wildfire
- Typhoon response
- Earthquake Response
- Building fire
- Vehicle Accident
- National Emergency

What is the Incident Command System (ICS)?

The Incident Command System is used to manage an emergency or even a non-emergency event. It can be used equally well for both small and large situations. ICS has been implemented by emergency managers in many parts of the world including the United States, Australia, New Zealand, Canada, and India. Features of ICS:

- Single standardized organization and system for responding to emergency situations.
- Adaptable to many types of incidents
- Used on incidents of all sizes: large, small, or changing. It can grow or shrink the meet the needs of the incident.
- Provides accurate information, strict accountability, planning, and cost effective operations and logistical support for any incident

US Model and Use of ICS

Virtually all emergency management agencies in the US have adopted ICS.

- Multiple agencies and jurisdictions at the local, state, and federal levels
- Decentralized decision making authority for emergency response – local levels
- Recognized need for resource sharing

NOTES

OVERVIEW OF BASIC ICS CONCEPTS

Chain of Command & Span of Control

A key part of ICS is **Chain of Command**, which means the line of authority through which decisions are made, recommendations offered, and work assignments are given. In ICS, the chain of command is clearly defined and understood, with the intent of getting in getting direction and information from the Incident Commander to the firefighter in a clear and efficient manner.

Span of Control is also a very important concept, with no individual directly supervising more than 3-7 people. In a small fire organization, the Incident Commander directly supervises the firefighters, and can maintain span of control.

- On a larger incident, steps need to be taken to ensure span of control is maintained.
- For example, for a large workforce a crew supervisor and subordinate supervisors may need to be assigned
- Some large fires need big organizations - ICS is designed to MAINTAIN span of control

Other Key ICS Concepts

- **Delegation of Authority** is when the official in charge delegates responsibility to a skilled Emergency Manager to manage the incident.
- **Positions are based on expertise and qualifications**, not positional rank, seniority, or status.
- **Focus is on management functions**, not specific technical skills. These skills are integrated into the ICS organization when and where needed.
- **Non-Permanent Organization**; ICS is activated in response to an emergency and is NOT a permanent organizational structure
    - During an emergency, ICS qualified personnel leave "regular" positions to assume the ICS positions for which they are trained and qualified. Their ICS position may be very different from their regular job. ICS personnel devote 100% of their time during the incident. In many cases, ICS personnel travel away from their regular work station for the duration of the ICS assignment.

Incident Command System Capabilities

- A single management system for multi-jurisdictional incidents.
- Provision for Unified Command, where multgi-jurisdictional fires can be more efficiently managed under one command structure
- Modular: ICS allows for expansion and contraction depending on size and complexity of incident.
- ICS is structured to integrate any type of resource including local community resources, police, military, technical experts, and NGOs.
- ICS can be used to manage any incident: e.g. disasters, long-term relief efforts (i.e. food distribution after a typhoon), or non-emergency events (festivals, Olympic Games).

Other ICS Features:

- Clearly established objectives and priorities are communicated to all key people assigned to an incident.
- Incident Action Plans are developed each day of incident - range from simple verbal plans to fairly complex documents.
- Common terminology: Allows any agency or entity to interface and communicate with others who know the Incident Command System
- Resources are "typed" based on their capability. Typing refers to common experience and standards for each position or equipment.

ICS ORGANIZATION AND FUNCTIONS

A key feature of the ICS organization is that it can be designed to meet the needs of the incident. Only the positions and functions required for the incident are filled. About 90% of all wildland fires are suppressed during the initial attack phase, with a small organization.

The Incident Command organization is divided into 5 major components: command, operations, planning, logistics, and finance/administration. The next section will discuss each of the components.

Command has overall responsibility and decision making for the Incident. Responsibility and positions, depending on size of the incident, include:

- Incident Commander (always)
- Information (Officer)
- Safety (Officer)
- Liaison (Officer)

The **Operations** Section develops and implements the strategy and tactics.

The **Planning** Section documents and displays the approved strategy and tactics for the incident.

The **Logistics** Section provides support and service for all incident personnel.

The **Finance/Administration** Section processes payments, purchasing, contracts, and provides cost estimates.

NOTES

USE AND APPLICATION OF THE INCIDENT COMMAND SYSTEM

ICS works best if used as standard operating procedure on all incidents, even a small grass fire. This provides a consistent approach each and every time you respond and helps get the system adopted by others.

There is always an Incident Commander assigned, even at the smallest incident. All other position needs are dictated by the complexity of the incident.

On larger incidents, to maintain span of control, operations may be divided geographically, or functionally.

Small Incident 3 Divisions: the graphic illustrates how a fairly small wildfire is divided geographically into 3 divisions, each supervised by a Division Supervisor. Each Division Supervisor may have 3-7 resources working under them such as crews or equipment strike teams.

Larger Incident Example - Branches & Divisions: On a larger incident, the area may be geographically divided into branches, under the supervision of a Branch Director. Each Branch may have several Divisions, under the management of a division supervisor.

Organization Summary

- There is no one best way to organize an incident.
- Organization should develop to meet the functions required
- Characteristics of Incident and management needs of IC will determine what organization should be established.
- Organization may change over time, as the incident changes.

FACILITIES

The following is a list of facilities that may be designated under the Incident Command System. Facilities are established as the need arises:

- Incident Command Post: The location from which the IC oversees all incident operations. There is only one ICP for each incident. Every Incident will have some kind of ICP.
- Staging Areas: Locations where resources are kept while awaiting incident assignment. Staging areas will be managed by a staging area manager who reports to the Operations Section chief.
- Base: The location at the incident at which primary service and support activities are performed. Not all incidents will have a base. There will be only one base for each incident.
- Camps: Locations where resources are kept to support incident operations. Camps have essential support operations such as food and sleeping areas for firefighters. Not all incidents need a camp.

INCIDENT ACTION PLAN

Every Incident has a plan. This can range from a very basic verbal plan, for an initial attack incident, to a complex written plan for an incident with many branches. The Incident action plan provides direction to personnel, to achieve stated objectives. Incident Action Plans are prepared for a designated "Operational Period." On wildfires in the US, and Operational Period is generally 12 hours. The Incident Action Plan includes tactical operational objectives that are to be achieved during that operational period. Incident Action Plans are prepared in advance of the operational period to ensure that resources are available when the operational period begins.

Plan Elements

- Objectives- What is to be achieved?
- What organization is assigned and available to meet the objective?
- Assignments for each division or group
- Supporting elements, such as maps, transportation plans, medical evacuation plans

The key to a successful plan is that it is known and understood by all supervisory personnel so that all personnel are working towards common objectives. A good way to communicate the plan is a briefing of all supervisory personnel at the beginning of the Operational period. If possible, written copies are helpful.

NOTES

LEADERSHIP AND SUPERVISION

Providing strong, effective leadership for the operations and effort on a fire is essential in order to have a coordinated, successful, and safe outcome. These principles apply to all work situations, but are especially important during the supervision of fire control operations.

Why is leadership important?

- A fire can be chaotic, confusing and complex.
- A successful fireline leader is able to make sense of the chaos and develop a credible plan and then communicate that plan.
- In this way, a fireline leader will win support from others and have the ability to control the situation and implement a strategy.
- Leadership is needed to influence people by providing purpose, direction and motivation in order to accomplish the mission and improve the organization.

One of the key factors in directing and communicating any plan is to conduct a Briefing.

- Briefings are required when a change in the incident environment, assignment or personnel occurs.
- At the heart of every briefing is Leader's Intent, or what the goal is.
    - Provide an overview of the SITUATION
    - Describe the MISSION and EXECUTION of the plan
    - Provide COMMUNICATION information – how to contact you and each other
    - Discuss who else is one (or will be arriving at the fire) and any other SERVICE/SUPPORT issues that need to be covers
    - Discuss potential hazards and other RISK MANAGEMENT issues
    - Provide an opportunity for your workers to ask QUESTIONS or express CONCERNS

In addition to providing a good briefing, you should:

- Make sure people CLEARLY understand what is expected of them.
- Handle problems in a timely manner.
- Provide a safe and healthful work environment.

NOTES

Supervision Skills for Fire Control Work

- Know ICS or the "chain of command" (who do you report to, who reports to you, who is in charge of work on the entire fire?)
- Don't attempt to supervise too many people or things (Span of Control concept, 1:5 guideline).
- Delegate people (squad bosses) to assist you and maintain contact with all the people you are responsible for.
- Assign people to specialized duties if necessary (Lookouts, fireline patrol, burnout operations, relay messages, etc.).
- REGULARLY review L.C.E.S., the "10 Standard Firefighting Orders" and the "18 Situations (or any others) That Shout Watch Out.“ – to be covered in Safety section

Leadership Traits

- Leaders Communicate Clearly
- Leaders Respect Others and Their Opinions
- Leaders Make Difficult Decisions
- Leaders Build Highly Reliable Organizations
- Leaders Reflect and Learn from Their Mistakes

Accident Prevention

- A primary task of the fireline supervisor is to take direct action to reduce or eliminate unsafe acts and hazards that cause accidents.
- The supervisor must motivate people to work safely by:
  - Establishing control
  - Teaching and integrating safety into the job.
  - Be consistent; Establish a “procedural” approach for every job duty
  - Be alert to safety hazards and work to eliminate causes of accidents.
  - Stress simplicity.

Crew Welfare

- A successful supervisor takes a genuine interest in his crew's welfare. If your people are reasonably comfortable, have water, and have food, they will be more likely to stay with a difficult job or work under severe conditions. The following list covers the basic items about which the supervisor needs to be concerned.
  - Water
  - Food
  - First Aid

- **NOTES**

After Action Reviews

In order to improve your leadership and supervisory skills, you should take the time to perform a quick After Action Review (AAR). After Action Reviews:

- Help incorporate incident events into the learning cycle.
- Provide a forum for determining the roots of success and failure.
- Are instrumental for developing strategies to mitigate causal factors in the future.
- Assist in establishing a common perception of the events of the day.
- Provide a mechanism to resolve conflict between team members.
- Provide a place to establish, emphasize, and reinforce group standards.

"The ultimate measure of a man is not where he stands in moments of comfort and convenience, but where he stands at times of challenge and controversy."
- Dr. Martin Luther King, Jr., Minister

NOTES

Common Denominators of Fire Behavior on Fatal and Near-Fatal Fires

Such fires often occur:

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

WATCH OUT SITUATIONS

1. FIRE NOT SCOUTED AND SIZED UP.
Why is this important?

2. IN COUNTRY NOT SEEN IN DAYLIGHT
Why is this important?
What can you do if you cannot wait to see the country in daylight?

3. SAFETY ZONES AND ESCAPE ROUTES NOT IDENTIFIED.
Why is this important?

4. UNFAMILIAR WITH WEATHER AND LOCAL FACTORS INFLUENCING FIRE BEHAVIOR.
Why is it important?
Weather patterns - Do all fires have them?
How do you obtain this local information?

5. UNINFORMED ON STRATEGY, TACTICS AND HAZARDS.
What does strategy mean?
What are tactics?
What hazards need to be identified?
What questions can be asked to reduce the risks?

6. INSTRUCTIONS AND ASSIGNMENT NOT CLEAR.
What should your instructions include?

7. NO COMMUNICATION LINK WITH CREW MEMBERS/SUPERVISOR.
Why must you be in communication?

8. CONSTRUCTING FIRELINE WITHOUT SAFE ANCHOR POINT.
What is a safe anchor point?

9. BUILDING FIRELINE DOWNHILL WITH FIRE BELOW.
What is the danger in building line downhill?
Can you ever build line downhill?

10. ATTEMPTING FRONTAL ASSAULT ON FIRE.
What are the dangers involved with a frontal assault?

11. UNBURNED FUEL BETWEEN YOU AND THE FIRE.
Why is this a "watch out situation?"
How can you prevent this potential problem?

12. CANNOT SEE MAIN FIRE, NOT IN CONTACT WITH ANYONE WHO CAN.
Why is this important?

13. ON A HILLSIDE WHERE ROLLING MATERIAL CAN IGNITE FUEL BELOW.
What are the consequences?

14. WEATHER IS GETTING HOTTER AND DRIER.
Why is this a "watch out situation?"
How can you tell if it is getting hotter and drier?

15. WIND INCREASES AND/OR CHANGES DIRECTION.
Why is this a "watch out situation?"

16. GETTING FREQUENT SPOT FIRES ACROSS LINE.
What are the consequences of spot fires?

17. TERRAIN AND FUELS MAKE ESCAPE TO SAFETY ZONES DIFFICULT.
Why is this a "watch out situation?"

18. TAKING A NAP NEAR FIRELINE.
Although this is a convenient place what danger might there be?

NOTES

STANDARD FIREFIGHTING ORDERS

1 - Keep informed on fire weather conditions and forecasts.
Weather will most often dictate where and how your fire will move.
What weather factors are most important to know?
What personal observations can you make?
Where might you obtain "off-site" weather information?

2 - Know what your fire is doing at all times.
Observe, use lookouts and scouts. This is the basic order that all orders fall back on.
What current information on the fire's status do you need to know?
How do you obtain this information?

3 - Base all actions on current and expected behavior of the fire.
Fire is not static. It will constantly move and grow until it is controlled. Once you have sized up the fire, begin to anticipate its movements. Current and expected fire behavior will help you do this.
When applying this Standard Firefighting Order, what fire behavior elements are considered?
What time of the day are burning conditions most active and why?
Where would most active burning take place for any operational period?

4 - Identify escape routes and safety zones, and make them known.
This order must be in place before firefighters can become engaged. If the fire situation deteriorates, you can always move to a safety zone until the situation becomes clear to you.
What would you consider when identifying escape routes and safety zones?

5 - Post lookouts when there is possible danger.
*A lookout will be able to tell you **what your fire is doing**. The lookout can also take weather readings to help you predict future fire behavior.*
What things would you consider when assigning a lookout?

6 - Be alert. Keep calm. Think clearly. Act decisively.
You must first be clear and calm in your own mind to be safe and effective. If you are confused then move to a safety zone until the situation is clear again. Remember all of us, no matter what our experience level, will be confused and unsure of ourselves at times on the line. There are often just too many variables changing too fast for our minds to process. If you are confused, then move to your safety zone to watch and learn.
What factors in the fire environment might adversely affect our alertness, thinking, judgment, and decision making ability?
What can you do to prevent or reduce the effect of the following factors?
Fatigue and heat stress?
Carbon Monoxide?
Stress?
What should you do to increase your decision making ability?

7 - Maintain prompt communications with your forces, your supervisor and adjoining forces.
If your communication lines are broken then stop and take time to re-evaluate until the lines are open again.

Who do you need to stay in communication with?
What information do you need?

8- Give clear instructions and ensure they are understood.
When in doubt, ask for clarification of instructions.
Whose responsibility is it to ensure instructions are given and understood?
How do you "ensure understanding?"

9 - Maintain control of your forces at all times.
How do you "maintain control?"

10 - Fight fire aggressively, having provided for safety first.
What safety considerations need to be taken into account prior to fighting fire aggressively?

LCES
Lookouts
Communication
Escape Routes
Safety Zones

It would be impossible to fight fire without exposing ourselves to some hazardous situations, but that doesn't mean we must experience personal injuries.

The safety rules and equipment are designed to help protect us. Personal injuries can be avoided if these guidelines are properly applied in conjunction with skill and common sense.

Personal Protective Equipment

1. Gloves
2. Trousers (Flame resistant)
3. Shirts (Flame resistant)
4. Boots
5. Canteens (for drinking fluids only)

NOTES

Module 4 - Wildfire Size Up and Initial Attack

I. INTRODUCTION

Size up -- the beginning and continuing appraisal of the overall fire situation for purposes of determining appropriate control actions.

The first thing to do at the scene of the fire is to size up the entire situation to determine how best to attack the blaze. This may require walking or scouting entirely around the edge of a fire. Or, if you are fortunate, you will be able to see the entire fire when arrive. However you accomplish it, sizing up the fire is of great importance, for it will provide you with essential information about the fire and the territory in which it is burning. Without such knowledge in the beginning, your attack may be completely ineffective.

II. INFORMATION, OBSERVATIONS, AND ACTIONS NEEDED FOR SIZE-UP AND INITIAL ATTACK

A. Prior to fire report

1. Weather Observations.

2. Resource Preparedness.
    a. Personnel
    b. Equipment

DOUBLE CHECK EQUIPMENT!! DON'T WAIT UNTIL A FIRE IS REPORTED.

B. Gather all information available on the fire

C. En Route to Fire

1. Think about your knowledge of fire area:
    a. Fuels and Topography
    b. Access Roads
    c. Fire Barriers
    d. History of Fires in Area and Causes
    e. Backup Forces
    f. Water Sources
    g. Recent fire behavior in this area

Relative to today's weather, how do you expect this fire to burn?

2. Look for local current weather indicators.
    a. Wind - is it faster or slower than you anticipated? Is it from the same direction or changing?
    b. Any dust devils or gusty winds that would indicate erratic fire behavior?

3. After Sighting Smoke Column.

a. Check size, height, color, direction, and shape. (These are indicators of fire behavior).

b. Verify your expected behavior of fire, relative to the forecast and the resulting smoke column.

4. Approaching Fire Area.

a. Look for alternate routes. Approach from bottom of fire when possible.

b. Look for people or cars coming from fire area.

D. Arrival on Scene.

Take a minute and calmly look at the total fire picture. The next few minutes are critical to the success of your initial attack. The first thing to do at the scene of the fire is to size up the entire situation and determine the best method of attack. If you "GO OFF IN ALL DIRECTIONS", little will be accomplished.

1. Factors to consider for fire size-up:

FIRE BEHAVIOR – What is this fire going to do? Standard Orders 1-3

a. Date/ Time of day

b. Size of fire

c. Location of head - be sure you know what's in path of fire.

d. Current/expected weather at fire - wind speed and direction, variable or steady?
Get current weather observations.

e. Current/expected fire behavior:
- rate of spread
- flame lengths
- spotting distance

f. Fuels burning:
- type and arrangement of fuel
- fuel consumption. How clean is the fire burning?
- crown fire. Any aerial fuels burning?

g. Fuels in path of the fire:
-Do they change and if so, how will they affect the fire?

h. Terrain or topography - slope and aspect, natural barriers, access roads.

NOTES

SAFETY CONSIDERATIONS – Standard Orders 4-6

i. Identify potential Safety hazards

- snags
- wildlife
- rolling rocks
- access
- lack of safety zones and escape routes
- public in area
- livestock

SAFETY SAFETY SAFETY

d. Where to attack - head, flank, rear. ANCHOR, FLANK, and PINCH

e. Method of attack - direct/indirect. Don't try the impossible.

f. Location of control lines - take advantage of barriers.

g. Estimate completion time of line construction. Make allowances for physical limitation of crew.

h. Estimate probable spread and behavior of fire.

i. Determine possible danger spots - fuel, buildup, snags, bogs, etc.

BRIEF YOUR CREW

ORGANIZATIONAL CONTROL- Standard Orders 7-10

Remember: The situation is constantly changing!!
Continue to gain situational awareness and re-evaluate operational plan.

NOTES

Module 5 - Wildfire Suppression Methods and Tactics

INTRODUCTION

Suppression of wildland fires presents both a challenge and hazard to personnel and equipment. It is our intention during the development of this lesson to help you master the challenges and point out the hazards that may be involved. There are many ways to suppress a wildland fire.

THE FIRE TRIANGLE

All of the methods and tactics discussed in this section are based on breaking the Fire Triangle. Remove one of the three legs; Fuel, Oxygen, or Heat and the fire will go out.

There are three basic ways to achieve this:

1. Digging a line or trench to separate the fire from the surrounding fuel
2. Spraying water or using dirt to "smother" the fire in order to remove the oxygen.
    a. Note: Its very important not to bury the fire or burning material since it can continue to smolder under the ground.
3. Cooling with water or dirt to remove the heat.

HAND TOOLS

Hand tools are the main resource used to suppress wildland fires world wide. In some countries there are pumpers and aircraft used for specific tasks and to support personnel on the fireline, but it is the hard work of individuals with hand tools that is the most common technique used through out the world.

General Inspection before Use:

- Make sure the tool head and handle are well attached and secure
- Check for proper sharpness and condition of cutting edge
- Inspect the handle for smoothness, cracks, or other defaults

Principle Hand Tools

1. **Pulaski** – a combination axe and grubbing tool on an axe handle. Used to cut/chop small trees, roots, and logs; dig fire line, and scrape burning debris.
2. **Panga** – a machete type cutting tool used for clearing undergrowth and chopping.
3. **Shovel** – an excellent tool for digging, throwing dirt, scraping/clearing line, and chopping fine roots. Used extensively in mop-up.
4. **Fire flapper** (swatter) - used to smother fire with a rubbing motion. (Beating will only serve to spread fire). Best used in lighter fuels.
5. **McCloud or Council Rake** – a combination rake and scraping tool used to clear leaves and duff, drag burning material back into the fire and clearing other material from the fire line.
6. **Backpack Pump** – a rigid or collapsible 20 liter container equipped with a short hose and trombone pump used to squirt water on hot spots and cool the fire.
7. **Burlap bag** – excellent tool when wetted in light fuels to beat the fire down and cool the flaming edge.
8. **Branches**- Branches or other field expedient tools can be very useful.

THREE METHODS OF ATTACK

1. **Direct Attack** – Working close or at the flaming edge of the fire to wet, smother, or separate the fire from the unburned fuels. Use when:
   - Fire is small or low intensity (surface or ground) and firefighters can safely work the fire edge directly.
     - Throw all unburned material to the outside of the fire perimeter.
     - Lines are constructed directly on the edge of the fire.

2. **Flanking/Parallel Attack** - Method of fire suppression in which fireline is constructed approximately parallel to, and just far enough from the fire edge to enable workers and equipment to work effectively, though the fireline may be shortened by cutting across unburned fingers. The intervening strip of unburned fuel is normally burned out as the control line proceeds but may be allowed to burn out unassisted where this occurs without undue delay or threat to the fireline. Use parallel attack when:
   - The fire is too intense for firefighters to work close to the flames
   - There are many fingers and its more efficient to cut them off and burn out
   - You can straighten fire lines (across pockets) and reduce the time or work needed to complete the fireline.

3. **Indirect Attack** - A method of suppression in which the control line is located a considerable distance away from the fire's active edge along natural firebreaks. This tactic is generally done in the case of a fast-spreading or high-intensity fire in order to keep fire fighters safe and to utilize natural or constructed fuel breaks. The fuel between the indirect line and the active fire edge needs to be burned out in order to control the fire. Use indirect attack when:
   - The fire is very intense or spreading very rapidly
   - There are natural barriers or other opportunities to establish a line and burn it out before the fire arrives.
   - There are insufficient personnel.

   The indirect method uses existing natural and artificial barriers to impede the fire. These barriers are called firebreaks, e.g.: mineral firebreaks (ample strips deprived of vegetation to the mineral ground); green firebreaks (zones of vegetation resistant to the fire); fuel break (vegetation has been removed), etc.

NOTES

FIRE LINE CONSTRUCTION

Factors that influence the location and size of the fire line include:

- **Fuel type** (grass, brush, forest, slash): What will be the characteristic fire behavior given the predominant fuels? Will the fire burn fast or slow? Will it burn for a long time or go out quickly?
- **Fuel moisture:** How dry are the fuels? How hot will the fire burn? Can direct line be used? Are the fuels likely to generate embers and spot fires? How receptive are the fuels outside the fire perimeter to spots?
- **Vertical and horizontal continuity and arrangement of fuel:** Are the fuels uniform or broken? How tall is the fuel? Are there ladder fuels? Will the fire torch or crown? How wide will the fire line need to be to stop the fire? How wide of a cleared area will be needed?
- **Temperatures:** Are the fuels burning in the sun or shade? Is it early in the day and getting warmer or late in the day and starting to cool off?
- **Wind:** Are the fuels sheltered from the wind or exposed? Are the winds expected to increase or change direction? Will the wind push the flames over the fireline?
- **Slope:** How steep is it? Will there be rolling material? Is it safe to build control line above or below the fire? Is direct line appropriate or will indirect line be needed?

Control Line Location: Utilize opportunities present when locating fire control line. Consider;

- Cold fire edge as an anchor point
- Natural breaks in the fuel
- Previously constructed barriers

Control Line Basics

- Make sure line is dug to mineral soil so the fire cannot burn through duff or ground fuels
- Fell snags or trees adjacent to the control line that may catch on fire to prevent embers from crossing the line
- Use dirt to cover exposed stumps

Under Slung Line

- Constructing line on a steep slope beneath a fire is called “Under Slung Line”.
- Under slung line is dangerous since rolling rock or debris may be a safety hazard to firefighters and because it is difficult to stop or catch debris on fire rolling downhill.
- If you must use this tactic:
    - Construct a “cup trench” to catch as much rolling material as possible
    - Post a lookout while working beneath the fire to warn workers of hazards
    - Patrol this section of line often to check for spot fires beneath the control line

Threats to Existing Control Line include:

- Embers starting spot fires across the line
- Rolling material that is burning crossing the line and igniting fuels below
- Creeping fire under the control line (through roots or rotten material)
- Radiant heat igniting fire across the line (especially dangerous at corners)

ACTIONS FOR FIRE LINE CONSTRUCTION

The location of the line is marked with cuts made by axes or machetes in the vegetation, flagged with brightly colored ribbon (surveyor's tape), or is indicated verbally to the fire fighters where to cut.

The Line Locator - not only marks the path of the line, also:

a. Continually evaluates the situation.
b. Keeps the safety of personnel in mind at all times.
c. Locates a path which saves time and energy.
d. Maintains an adequate distance between the line and the border of the fire.

Fireline Construction

Construction of the fireline consists of the following actions:

- Cut and clear both aerial and surface fuels with tools such as axe, machete, Pulaski, sickle and chainsaw.
- Eliminate the lower branches, shrubs, small trees and other light materials. The material extracted is deposited on the exterior side of the line, or the side away from the fire.
- The cut and clearing does not consider the removal of heavy combustibles and those of great size. The Line Locater should mark the line circling the dense accumulations of fuels to reduce the cut to the minimum.
- Nevertheless, logs, branches, and other materials which cannot be avoided, should be removed from the line and be dispersed as far as reasonable away from the fire line.
- The amount of the clearance depends on the size of the combustibles. It can be from 1/2 to 4 meters.

Cut and rake the surface fuels to mineral soil:

- With raking tools, such as the rake, Pulaski and shovel, you should cut and rake the combustible to the soil. This last aspect is very important to avoid spread by humus or roots. The material is deposited outside the line.
- The width of the area cleaned varies from 50 cm to 1 m. or more depending on the situation.
- The lines in brush should be wider than the lines in the open forest.
- The lines on the slope above the fire should be wider than the lines below the fire.
- The greater the wind velocity the greater the width of fire line!
- In slopes and with lines which cross from side to side, you should cut a cup trench and structure a high border with dirt to stop rolling burning material.

ORGANIZATION OF PERSONNEL FOR LINE CONSTRUCTION

There are two basic methods of organizing people for working as a team:

Progressive Line Method: Each firefighter advances without changing his location in relation to other firefighters.

- Each firefighter uses a technique which corresponds to the tool he is assigned. The last person in the progression is responsible for ensuring the fireline is complete.
- The personnel are organized in the following way:
    - Line locater marking.
    - Cutting tools - cutting or clearing.
    - Raking tools - finishing till the mineral ground.
    - Burning out.
    - Mop-up tools -controlling the fire after burning out.

Alternative Advance (Squad method; passing; leap frogging.) This is where the crewboss assigns the crew sections or particular portions of the line. As the tasks require distinct tools, the crew is divided into two groups with the cutting tools in front. In each group the personnel are placed far enough apart to work safely and complete a short segment of fireline.

- When the fastest person arrives at a completed portion of line, he or she passes the rest of the firefighters and begins working on a new portion of the fireline as assigned.

NOTES

OTHER SUPPRESSION METHODS

- **Scratch lining** - Scratch line is an unfinished, *preliminary* control line hastily established to check or slow the spread of a fire
- **Wet Lines** - A temporary fire control line prepared by treating the fuels with water to slow or stop the spread of fire. Works best in light, flashy fuels
- **Hot Spotting** – Some fires practically burn themselves out and only need to be suppressed in the areas still actively burning or hot. Hot Spotting is a term used when firefighters go after the remaining hotspots to stop the fire spread and cool the fire down. A fireline is still needed to ensure the fire won't rekindle and start spreading at a later time.
- **Burning Out -** Burning the vegetation between the control line and the fire edge. Burning out is done to increase the area of fuels burned without the additional work of the crew or machinery. The line is not secure until the burning out is done. It starts from the fire side of the control line, utilizes elements and techniques of firing similar to those utilized in prescribed burnings.

  Burning out is considered good practice. It should occur as the control line is being constructed in order to bring the "black" or safe burned area with the fireline crew as they dig line. Remember the following:

  1. Do not burn out without obtaining approval.
  2. Coordinate firing operations with those around you.
  3. Don't burn unless you have favorable conditions.
  4. Make sure you have adequate holding forces.

  Several methods of ignition can be used to accomplish burnout. Some suggestions:

  -Dragging with a tool made of bundled grass, needles or leaves.
  -Use of matches.
  -Oil soakes rag on stick.
  -Corn cobs.
  -Fusee
  -Drip Torch
  -Other.

- **Cold Trailing** - Cold trailing is using your sense of sight, smell, and touch to search and check for hot spots or any remaining heat. This is done after the fire is lined, controlled and the perimeter is mopped up
- **Bone Yarding** - To "bone yard" a fire means to systematically work the entire area, scraping embers off remaining fuel, feeling for heat with the hands, and scattering unburned materials in areas cleared to mineral soil. A bone yard can also be an area cleared to mineral soil for placing unburned fuels.

Firing Tactics

- Firing should be against the wind and/or slope.
- Favorable weather conditions should always be in place before firing operations begin.
- Fuels outside control line can be wet down ahead of firing to prevent spotting.
- Do not advance firing faster than holding forces can keep up with.
- Always have safety zones and escape routes identified prior to initiating firing operations.

Strip Firing Method

- Involves setting fire to one or more strips of fuel and allowing the strips to burn together.
- Width and location of strips in relation to slope or wind direction regulates firing intensity.

Ring Firing Method

- Generally used for indirect attack and backfiring operation or to burn out around structures.
- Involves circling the perimeter of an area with a control line and firing the entire perimeter.
- Generally doesn't provide a good anchor point to commence firing.
- Escape routes and safety zones must be established.

NOTES

MOP UP AND PATROL

Mop-up and patrol is the process of making a controlled fire safe by checking, removing or extinguishing all burning material along or near the perimeter edge of the burned area. The thoroughness of mop-up operations may be the factor that determines whether the fire will re-kindle or break out again, requiring additional control work.

Mop-up is the last step in fire suppression.

Here are a few key pointers to remember about mop-up:

1. Small fires - mop-up the entire burn.
2. Larger fires - mop-up within a specified distance of the fire perimeter (e.g. 30 meters of fire line) The distance to "mop –in" is variable with weather and fuel conditions.
3. Use dirt to cool and scrape stumps, logs, and debris, scraping the burning material away from unburned fuel, and mixing with soil to extinguish.
4. When available, use water.
5. Cut down burning snags adjacent to fire lines and extinguish.
6. If personnel are scarce, extinguish hot spots first!
7. Try cold trailing (using your hands to locate hot spots on stumps, logs, snags, etc.)

Patrol the Fire

- Patrol the fire to ensure it is out
- Cover your entire assigned area
- Work in pairs using a systematic approach

Check for Spot Fires outside the fire line especially where you know the following to be true:

Standards for Declaring the Fire "OUT"

The fire should only be declared "OUT" after the following are true:

1. The fire has been thoroughly patrolled and checked inside and outside the fire perimeter for spot fires and:
    a. No unburned patches of fuel are left.
    b. All fire is out of logs, stumps, roots, etc.
    c. All rotten material and duff pockets have been re-check to ensure they are dead out.
    d. Fires mopped up at night have been checked the following morning.
    e. The entire fire edge -- on the head, rear, and flanks--- has been checked

AFTER ACTION REVIEWS (AAR)

An After Action Review can be a formal or informal process to help critique the complete fire problem - from beginning to end - while it's fresh on your mind. Ask yourself the following questions --

Prevention:

a. What caused the fire?
b. What could I/the department have done to prevent it? Make a list.

Detection and Response.

a. What can I/the department do to improve notification time?
b. What can I/the department do to improve response time?

Size up

a. What did we do right?
b. What information wasn't collected or reported that would've been helpful.
c. Were sufficient resources available? Ordered?
d. What did we do that can be improved upon?

Suppression

a. What did we do right? Were the right decisions made? Right tactics used?
b. What did we do wrong?
c. Was anyone injured? Why?

Demobilization-

Don't get hurt leaving the fire.
Ensure all personnel and equipment are off the fire.
Refurbish all equipment after the fire so that it is ready to go next time.

NOTES

Appendix I

Glossary of Wildfire Terminology

ACTIVE FIRE: Any wildfire on which suppression action has not reached an extensive mop-up stage.

ADIABATIC LAPSE RATE: The rate at which a parcel of air changes temperature as it rises in altitude (this rate varies with the amount of water vapor in the parcel and the stability of the atmosphere).

AERIAL FUELS: Standing and supported live and dead combustible material not in direct contact with the ground and consisting mainly of foliage, twigs, branches, stems, cones, bark, and vines.

AERIAL RECONNAISSANCE: Use of aircraft for detecting and observing fire behavior, values-at-risk, suppression activity, and other critical factors to facilitate command decisions on strategy and tactics needed for fire suppression.

ANCHOR POINT: An advantageous location, usually a barrier to fire spread, from which to start constructing a fireline. The anchor point is used to minimize the chance of being flanked by the fire while the line is being constructed.

ARSON FIRE: A wildfire willfully ignited by anyone to burn vegetation or property without consent of the owner.

ASPECT: The direction a slope is facing

ATMOSPHERIC STABILITY: The degree to which vertical motion in the atmosphere is enhanced or suppressed. Vertical motion is enhanced in an unstable atmosphere. Thunderstorms and active fire conditions are common in unstable atmospheric conditions. Stability suppresses vertical motion and limits smoke dispersion.

AVAILABLE FUELS: That portion of the total fuel that will burn during the passage of a flaming front under specific environmental conditions.

BACKFIRE: A fire set along the inner edge of a fireline to consume the fuel in the path of a wildfire and/or change the direction of force of the fire's convection column.

BACKFIRING: A tactic associated with indirect attack, intentionally setting fire to fuels inside the control line to slow, knock down, or contain a rapidly spreading fire. Backfiring makes possible a strategy of locating control lines at places where the fire can be fought on the firefighter's terms.

BACKING FIRE: Fire spreading, or ignited to spread, into (against) the wind or down slope. A fire spreading on level ground in the absence of wind is a backing fire.

BARRIER - Any obstruction to the spread of fire. Typically an area or strip devoid of flammable fuel.

BELT WEATHER KIT: Belt-mounted case with some basic meteorological tools used to take weather observations to provide on-site conditions to the incident commander and other fire personnel. Observations include air temperature, wind speed and direction, and relative humidity.

BERM: A ridge of soil and debris along the outside edge of a fireline, resulting from line construction.

BLACKLINE: In fire suppression, a blackline denotes a condition where there is no unburned material between the fireline and the fire edge. To achieve this, fuels are burned out to remove any unburned vegetation, reduce the heat on holding crews and lessen the chance for fires spotting across the control line. Blackline is highly recommended.

BLOWUP: Sudden increase in fire intensity or rate of spread sufficient to preclude direct control or to upset existing control plans; often accompanied by violent convection.

BONE YARD: A mopup term: (1) To "bone yard" a fire means to systematically work the entire area, scraping embers off remaining fuel, feeling for heat with the hands, and scattering unburned materials in areas cleared to mineral soil. (2) An area cleared to mineral soil for placing unburned fuels.

BOX CANYON: A steep-sided, dead end canyon.

BRUSH: A collective term that refers to stands of vegetation dominated by shrubby, woody plants, or low growing trees, usually of a type undesirable for livestock or timber management.

BURN BLOCK: In prescribed burning, an area having sufficiently uniform fuel conditions to be successfully treated given burning prescription.

BURNING OUT: The intentionally setting of a fire to fuels inside a control line in order to remove unburned fuels and strengthening the fireline. Burning out provides a wider defence perimeter. (The control line is incomplete unless there is no fuel between the fire and the line.)

BURNING CONDITIONS: The state of the combined environmental factors that affect fire behavior in a specified fuel type.

BURNING PERIOD: That part of each 24-hour period when fires spread most rapidly; typically from 10:00 AM to sundown..

CANOPY: The stratum containing the crowns of the tallest vegetation present (living or dead).

CHAIN: A measure of distance equal to 66 feet.

CLIMATE: The prevalent or characteristic meteorological conditions of any place or region and their extremes.

COLD TRAILING: A method of controlling a partly dead fire edge by carefully inspecting and feeling with the hand for heat to detect any fire, digging out every live spot, and trenching any live edge.

COMBUSTION PERIOD: Total time required for a specified fuel component to be completely burned.

COMPACTNESS - The spacing between fuel particles. This can be especially important in the surface layer of fuels where the amount of air circulation affects rate of drying, rate of combustion, etc.

CONDUCTION: Heat transfer through a solid material from a region of higher temperature to a region of lower temperature.

CONFINE A FIRE: To restrict the fire within determined boundaries established either prior to or during the fire.

CONTAIN A FIRE: To take suppression action, as needed, in order to check a fire's spread under prevailing conditions.

CONTINUITY - The horizontal distribution of fuel particles or extent of the fuel bed affecting a fire's ability to sustain combustion and spread. This applies to aerial fuels as well as surface fuels.

CONTROL A FIRE: To complete control line around a fire, any spot fires, and any interior island to be saved; burn out any unburned area adjacent to the fire side of the control lines, and cool down all hot spots that are immediate threats to the control line, until the lines can reasonably be expected to hold under foreseeable conditions.

CONTROL BURN or PRESCRIBED FIRE: A fire set by land managers to modify vegetation and achieve a management objective.

CONTROL LINE: All the constructed or natural fire barriers and treated edges used to control a fire.

CONVECTION – Vertical heat transfer or atmospheric motions that are predominantly vertical or upward.

CONVECTION COLUMN - The thermally produced ascending column of gases, smoke, and debris produced by a fire.

COOL BURN: A fire set by land managers at the end of the wet season or beginning of dry season that burns only the ground fuels. A cool fire will generally be extinguished by rising humidity in the evenings. Also known as an EARLY BURN.

COORDINATION CENTER: Term used to describe any facility that is used for the coordination of agency or jurisdictional resources in support of one or more incidents.

CREEPING: A fire burning with a low flame and spreading slowly, usually in ground fuels or the leaf and litter of the surface fuels.

CREW: An organized group of firefighters under the leadership of a crew boss or other designated official.

CREW BOSS: A supervisor in charge of usually 16 to 21 firefighters and responsible for their performance, safety, and welfare.

CROWN CLOSURE: The spacing between tree crowns; usually expressed as the percent of area covered by tree crowns in the forest canopy as viewed from above.

CROWN FIRE - A fire that advances from tree top to tree top or from tops of shrubs more or less independently of the surface fire. Crown fires are sometimes classed as running or dependent to distinguish the degree of independence from the surface fire.

CROWN SCORCH: Browning of needles or leaves in the crown of a tree or shrub caused by heating to lethal temperature during a fire. Crown scorch may not be apparent for several weeks after the fire.

CROWN SCORCH HEIGHT: The height above the surface of the ground to which a tree canopy is scorched.

CUP TRENCH: A fireline trench on the downhill side of fire burning on steep slopes that is supposed to be built deep enough to catch rolling firebrands that could otherwise start fire below

DEMOBILIZATION: Release of resources from an incident with approval by the incident commander.

DETECTION: The act or system of discovering and locating fires.

DEW POINT: The temperature to which air must be cooled, at a constant pressure and moisture content, in order for saturation to occur.

DIRECT ATTACK: A fire suppression tactic achieved by working close or at the flaming edge of the fire to wet, smother, or separate the fire from the unburned fuels.

DIURNAL - Daily, especially pertaining to daily cycles of temperature, relative humidity, and wind.

DIVISION: Divisions are used to divide an incident into geographical areas of operation. Divisions are established when the number of resources exceeds the span-of-control.

DRIP TORCH: Hand-held device for igniting fires by dripping flaming liquid fuel on the materials to be burned; consists of a fuel fount, burner arm, and igniter. Fuel used is generally a mixture of diesel and gasoline.

DRY BULB: A name given to an ordinary thermometer used to determine the temperature of the air.

DUFF: The layer of decomposing organic materials lying below the litter layer of freshly fallen twigs, needles, and leaves and immediately above the mineral soil.

EARLY BURN: Prescribed burning early in the dry season before the leaves and undergrowth are completely dry or before the leaves are shed, as an insurance against more severe fire damage later on; usually resulting in a patchy mosaic of burned and unburned areas.

ELEVATION: The height of the terrain above mean sea level, expressed in meters or feet.

ENGINE: Any ground vehicle providing specified levels of pumping, water, and hose capacity but with less than the specified level of personnel.

EQUILIBRIUM MOISTURE CONTENT (EMC): The level at which dead fuels neither gain nor lose moisture with time under constant temperature and relative humidity conditions.

ESCAPE ROUTES: Pre-planned and understood routes firefighters take to move to a safety zone or other low-risk area that should be clearly marked or flagged.

EXTREME FIRE BEHAVIOR: "Extreme" implies a level of fire behavior characteristics that ordinarily precludes methods of direct control action. One or more of the following is usually involved: high rate of spread, prolific crowning and/or spotting, presence of fire whirls, strong convection column. Predictability is difficult because such fires often exercise some degree of influence on their environment and behave erratically, sometimes dangerously.

FINE FUELS – Fast drying, small diameter, dry or dead fuels such as cured grass, leaves, draped pine needles, fern, tree moss, and some kinds of slash which ignite readily and are consumed rapidly when dry. Generally these fuels are less than ¼ inch in diameter and have a timelag of one hour or less.

FINE FUEL MOISTURE: The probable moisture content of fast-drying fuels which have a timelag constant of 1 hour or less; such as, grass, leaves, ferns, tree moss, pine needles, and small twigs (0-1/4").

FIRE BEHAVIOR: The manner in which a fire reacts to the influences of fuel, weather, and topography.

FIRE BEHAVIOR PREDICTION SYSTEM: A system that uses a set of mathematical equations to predict certain aspects of fire behavior in wildland fuels when provided with data on fuel and environmental conditions.

FIREBRAND: Any source of heat, natural or human made, capable of igniting wildland fuels. Flaming or glowing fuel particles that can be carried naturally by wind, convection currents, or by gravity into unburned fuels.

FIREBREAK or FUELBREAK: Any natural or constructed barrier or discontinuity in fuels used to check or stop the spread of fires, or to provide a control line from which to work.

FIRE DANGER RATING SYSTEM: A system designed to gauge the flammability and receptiveness of various fuels for fire ignition, spread or intensity. Outputs usually integrate selected factors into one or more qualitative or numeric index. This system is used to help determine an area's appropriate levels of preparedness, protection needs, and the need to pre-position fire fighting resources in critical areas.

FIRE FREQUENCY: The number of fires per unit time in some designated area. The size of the area must be specified (units-number/time/area).

FIRE FRONT: The part of a fire within which continuous flaming combustion is taking place. Unless otherwise specified, the fire front is assumed to be the leading edge of the fire perimeter.

FIRE GUARD: A general term for a firefighter, lookout, patrol, prevention guard, or other person directly employed for prevention, detection, or suppression of fires.

FIRE HAZARD: A fuel complex, defined by volume, type condition, arrangement, and location, that determines the degree of ease of ignition and of resistance to control.

FIRELINE: An area scraped or dug to mineral soil where all flammable materials have been removed to control a fire. Also called a fire trail.

FIRELINE INTENSITY: The product of the available heat of combustion per unit of ground and the rate of spread of the fire, interpreted as the heat released per unit of time for each unit length of fire edge. The primary unit is Btu per second per foot (Btu/sec/ft) of fire front.

FIRE MANAGEMENT: Activities required for the management and protection of burnable wildland values from fire, including the use of prescribed fire to meet land management objectives.

FIRE PRESUPPRESSION: Activities undertaken in advance of fire occurrence to help ensure effective fire suppression; includes overall planning, recruitment and training of fire personnel, procurement and maintenance of firefighting equipment and supplies, fuel treatment, and creating, maintaining, and improving a system of fuelbreaks, roads, water sources, and control lines.

FIRE PREVENTION: Activities, including education, engineering, enforcement and administration, that are directed at reducing the number of wildfires, the costs of suppression, and fire-caused damages to resources and property.

FIRE REPORT: An official record of a fire, generally including information on cause, location, action taken, damage, costs, etc., from start of the fire until completion of suppression action.

FIRE RISK: The chance of fire starting, as determined by the presence and activity of causative agents.

FIRE SEASON: (1) Period(s) of the year during which wildland fires are likely to occur, spread, and affects resources values sufficient to warrant organized fire management activities. (2) A legally enacted time during which burning activities are regulated by a government authority.

FIRE SUPPRESSION: All work and activities connected with fire-extinguishing operations, beginning with discovery and continuing until the fire is completely extinguished.

FIRE WHIRL: A spinning, vortex column of ascending hot air and gases rising from a fire and carrying smoke, debris and flame. Fire whirls range in size from less than one foot to over 500 feet in diameter.

FLAME HEIGHT: The average maximum vertical extension of flames at the leading edge of the fire front. Occasional flashes that rise above the general level of flames are not considered. This distance is less than the flame length if flames are tilted due to wind or slope.

FLAME LENGTH: The distance between the flame tip and the midpoint of the flame depth at the base of the flame (generally the ground surface), an indicator of fire intensity.

FLANKS OF FIRE: The parts of a fire's perimeter that are roughly parallel to the main direction of spread.

FLAPPER: Fire suppression tool, sometimes improvised, used in direct attack for smothering out flames along a fire edge; may consist merely of a green pine bough or wet sacking, or be a manufactured tool such as a flap of belting fabric fastened to a long handle.

FLARE-UP: Any sudden acceleration of fire spread or intensification of the fire. Unlike blowup, a flareup is of relative short duration and does not change existing control plans.

FLASHY FUELS: Fine fuels such as grass, leaves, draped needles, etc. that ignite easily and are consumed rapidly when dry.

FOEHN WINDS: A type of general wind that occurs when stable, high pressure air is forced across and then down the lee slopes of a mountain range. The descending air is warmed and dried due to compression.

FOREST FIRE: Any fire burning out of control in a forest area.

FRICTION LOSS: Pressure loss caused by the turbulent movement of water or solution against the interior surface of fire hose, pipe, or fittings; normally measured in pressure loss per length of hose or pipe.

FRONT – A term used in the forecasting of weather indicating a transition zone between two air masses of different density.

FUEL: Any burnable vegetation that can support fire initiation or spread.

FUEL ARRANGEMENT: A general term referring to the spatial distribution and orientation of fuel particles within a natural setting.

FUEL BED: Commonly used to describe the fuel composition in natural settings.

FUEL BED DEPTH: Average height of surface fuels contained in the combustion zone of a spreading fire front.

FUELBREAK: A natural or manmade change in fuel characteristics which affects fire behavior so that fires burning into them can be more readily controlled.

FUEL MODEL: Simulated fuel complex for which all fuel descriptors required for the solution of a mathematical rate of spread model have been specified.

FUEL MOISTURE CONTENT: The quantity of moisture in fuel expressed as a percent of the oven-dry weight of that fuel.

FUEL SIZE CLASS: A category used to describe the diameter of down dead woody fuels. Fuels within the same size class are assumed to have similar wetting and drying properties, and to preheat and ignite at similar rates during the combustion process.

FUSEE: A colored flare widely used to ignite backfires and other prescribed fires.

GENERAL WIND - Free air or large scale wind caused by high and low pressure systems but generally influenced and modified in the lower atmosphere by terrain.

GRADIENT WIND: (1) A wind that flows parallel to pressure isobars or contours and has a velocity such that the pressure gradient, Coriolis, and certrifugal force acting in the area are in balance. It does not occur at the earth's surface due to fractional influence, but occurs at a height of roughly 500 meters above mean terrain height. (2) Wind created by differing barometric pressures between high- and low-pressure systems. Velocity is generally five to 18.5 kilometers per hour, and wind shifts are usually gradual as systems move and shift.

GREEN FIREBREAK: A passive band of evergreen vegetation that is capable of slowing or stopping fires from spreading into protected areas. The aim of the green firebreak is to cover an area with complete canopy to prevent the growth of grass, weeds and other vegetation that would otherwise occupy the site. Local communities can be used to establish these breaks using an incentive of planting interim crops while the trees are becoming established. Typical time period for establishment is 4-6 years.

GROUND FIRE: Fire that consumes the organic material beneath the surface litter ground, such as a peat fire.

GROUND FUEL: All combustible materials below the surface litter, including duff, tree or shrub roots, punky wood, peat, and sawdust, that normally support a glowing combustion without flame.

GUST: A sudden, brief increase in the speed of the wind.

HEAD FIRE: A fire spreading or set to spread with the wind and/or upslope.

HEAD OF A FIRE: The most rapidly spreading portion of a fire's perimeter, usually to the leeward or up slope.

HEAT TRANSFER: Process by which heat is imparted from one body to another, through conduction, convection, and radiation.

HOT FIRE: A wildfire or prescribed fire that burns with an intensity great enough to reduce woody vegetation. This fire is generally not extinguished by nightly humidity recovery.

HOLDOVER FIRE: A fire that remains dormant for a considerable time. Also called sleeper fire.

HOT SPOT: A particularly active part of a fire.

HOT SPOTTING: (1) Checking the fire at points of more rapid spread or special threat. (2) Actively searching for and eliminating hot spots within the fire area.

INCIDENT: An occurrence, either human-caused or natural phenomenon, that requires action or support by emergency service personnel to prevent or minimize loss of life or damage to property and/or natural resources.

INCIDENT ACTION PLAN (IAP): Contains objectives reflecting the overall incident strategy and specific tactical actions along with supporting information for the next operational period. The plan may be oral or written. When written, the plan may have a number of attachments, including: incident obectives, organization assignment list, division assignment, communication plan, safety plan, and incident map.

INCIDENT COMMAND SYSTEM (ICS): A standardized on-scene emergency management concept specifically designed to allow its user(s) to adopt an integrated organizational structure equal to the complexity and demands of single or multiple incidents, without being hindered by jurisdictional boundaries.

INCIDENT COMMANDER: Individual responsible for the management of all incident operations at the incident site.

INDIRECT ATTACK: A method of suppression in which the control line is located a considerable distance away from the fire's active edge along natural firebreaks. This tactic is generally done in the case of a fast-spreading or high-intensity fire in order to keep fire fighters safe and to utilize natural or constructed fuel breaks. The fuel between the indirect line and the active fire edge needs to be burned out in order to control the fire.

INITIAL ATTACK: The actions taken by the first resources to arrive at a wildfire to protect lives and property, and prevent further extension of the fire.

INSTABILITY: A state of the atmosphere in which the vertical distribution of temperature is such that an air particle, if given an upward impulse, will tend to move vertically with increasing speed from its original level.

INVERSION: An increase in temperature with height (i.e., a departure from the usual decrease in temperature with increase of altitude).

LADDER FUELS: Fuels which provide vertical continuity between surface fuels and canopy fuels. With sufficient ladder fuels, fire is able to carry from surface fuels through convection into the crowns with relative ease.

LAPSE RATE: Decrease of an atmospheric variable (temperature unless specified otherwise) with height.

LATE BURN: A fire that usually occurs late in the fire season resulting in nearly complete consumption of grasses, most shrubs, and scorching of some trees. Also referred to as a "HOT FIRE"

LITTER: The top layer of the forest floor, composed of loose debris of dead sticks, branches, twigs and recently fallen leaves or needles, little altered in structure by decomposition.

LIVE FUELS: Living plants, such as trees, grasses, and shrubs, in which the seasonal moisture content cycle is controlled largely by internal physiological mechanisms, rather than by external weather influences.

LIVE FUEL MOISTURE CONTENT: Ratio of the amount of water to the amount of dry plant material in living plants.

LOCAL WINDS: Winds which are generated over a comparatively small area by local terrain and weather. They differ from those which would be appropriate to the general pressure pattern.

LONG-RANGE FORECAST: Fire weather forecast for a period greater than five days in advance.

LOOKOUT: A position established in a location with a wide field of view to detect and report fires, relay messages and monitor weather conditions. Lookouts can be located on the ground where topography and fuels do not obstruct the view or they can be situated in towers in order to be above surrounding vegetation or increase their field of vision.

MASS TRANSFER: Heat transported in the form of firebrands.

MID-FLAME WINDSPEED: The speed of the wind measured at the midpoint of the flames, considered to be most representative of the speed of the wind that is affecting fire behavior.

MID SEASON BURN: A fire that occurs in the middle of the dry season resulting in consumption of most of the grasses and some shrubs.

MINERAL SOIL: Soil layers below the predominantly organic horizons; soil with little combustible material.

MIXING HEIGHT: Measured from the surface upward, the height to which relatively vigorous mixing occurs due to convection. Also called mixing depth.

MOIST ADIABATIC LAPSE RATE: Rate of decrease of temperature with increasing height of an air parcel lifted at saturation via adiabatic process through an atmosphere in hydrostatic equilibrium. Rate varies according to the amount of water vapor in the parcel and is usually between 3.6 and 9.2 C per 1000 meters.

MOISTURE OF EXTINCTION: The fuel moisture content, weighed over all the fuel classes, at which the fire will not spread. Also called extinction moisture content (EMC).

MONITORING: A systematic process of sampling some feature(s) in the environment over a period of time. May include taking/comparing photographs taken of the same location taken in subsequent years.

MOPUP: The act of extinguishing hot areas and burning material inside the control lines.

NATURAL BARRIER: Any area where lack of flammable material obstructs the spread of wildfires. Includes rock outcroppings, rivers, bare ground, and other existing barriers.

ONE-HOUR TIMELAG FUELS: Fuels consisting of dead herbaceous plants and wood less than about 6.4 mm in diameter. Also included is the uppermost layer of needles or leaves on the forest floor.

ONE-HOUR TIMELAG FUEL MOISTURE (l-h TL FM): Moisture content of one-hour timelag fuels.

ONE-HUNDRED HOUR TIMELAG FUELS: Dead fuels consisting of wood in the size range of 2.5 to 7.6 cm in diameter and very roughly the layer of litter extending from approximately 1.9 cm to 10 cm below the surface.

ONE-HUNDRED HOUR TIMELAG FUEL MOISTURE (l00-h TL FM): The moisture content of the l00-hour timelag fuels.

ONE-THOUSAND-HOUR TIMELAG FUELS: Dead fuels consisting of wood 7.5 to 23 cm in diameter and the layer of the forest floor more than about 10 cm below the surface.

ONE-THOUSAND-HOUR TIMELAG FUEL MOISTURE (l,000-h TL FM): The moisture content of the l,000-hour timelag fuels.

PARALLEL ATTACK: Method of fire suppression in which fireline is constructed approximately parallel to, and just far enough from the fire edge to enable workers and equipment to work effectively, though the fireline may be shortened by cutting across unburned fingers. The intervening strip of unburned fuel is normally burned out as the control line proceeds but may be allowed to burn out unassisted where this occurs without undue delay or threat to the fireline.

PARTS OF A FIRE: On a typical fire, the spread is uneven with the main spread moving with the wind or upslope. The most rapidly moving portion is designated the *head* of the fire, the adjoining portions of the perimeter at right angles to the head are known as *flanks*, and the slowest moving portion is known as the *rear* or *heel*.

PATROL: To walk or patrol a length of control line during and/or after construction to prevent spot fires and extinguish overlooked hotspots.

PLOW LINE: A firebreak created by a road grader, dozers or drag plows.

PRE-ATTACK: A planned, systematic procedure for collecting, recording, and evaluating pre-fire and fire management intelligence data for a given planning unit. The planning phase is usually followed by a construction and development program integrated with other resources and activities.

PREPAREDNESS: (1) Condition or degree of being ready to cope with a potential fire situation. (2) Mental readiness to recognize changes in fire danger and act promptly when action is appropriate.

PRESCRIBED FIRE: A fire deliberately set by management in order to achieve a pre-determined goal.

PRESCRIPTION: A set of parameters (weather, fuel loading, fuel moisture, fire behaviour, and/or geographic area) that must be met to achieve specified objectives.

PRESUPPRESSION: Activities in advance of fire occurrence to ensure effective suppression action. Includes planning the organization, recruiting and training, procuring equipment and supplies, maintaining fire equipment and fire control improvements, and negotiating cooperative and/or mutual aid agreements.

PRESSURE GRADIENT: The change in atmospheric pressure per unit of horizontal distance.

PREVENTION: A program that informs both internal and external audiences of the ecological, social, and economic implications of unwanted fire. It includes education, communication and other activities targeted to prevent fires from occurring.

PSYCHROMETER: The general name for instruments designed to determine the moisture content of air. A psychrometer consists of dry- and wet-bulb thermometers that give the dry- and wet-bulb temperatures, which in turn are used to determine relative humidity and dew point.

RADIANT HEAT: The transfer of energy through space, in the form of light and heat

RATE OF SPREAD: The rate of forward spread of the fire front, usually expressed in meters per minute, kilometers per hour, or perimeter increase (hectares per hour).

REBURN: (1) Repeat burning of an area over which a fire has previously passed, but later ignites from unburned fuel when burning conditions are more favorable; (2) An area that has re-burned.

REHABILITATION: The activities necessary to repair damage caused by the wildfire or suppression activities. Can include re-seeding, erosion control and other activities.

RELATIVE HUMIDITY (RH): The ratio of the actual amount of water vapor in the air to the possible amount the air could hold at that temperature.

RESIDENCE TIME: The time required for the flaming front of a fire to pass a stationary point at the surface of the fuel. The total length of time that the flaming front of the fire occupies one point.

RESISTANCE TO CONTROL: The relative difficulty of constructing and holding a control line: affected by topography, fuels, and fire behavior.

SAFETY ZONE: A natural fuel break or area cleared of vegetation established for the escape of firefighters in the event the line is outflanked or in case a spot fire causes fuels outside the control line to render the line unsafe.

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SCRATCH LINE: An unfinished preliminary control line hastily established to check or slow the spread of a fire.

SCORCH HEIGHT: Average heights of foliage browning or bole blackening caused by a fire.

SIZEUP: The evaluation of the fire to determine a course of action for suppression.

SLASH: Debris left over from logging or clearing activities. It may include logs, bark, and branches.

SLOP OVER: A fire edge that crosses a control line intended to confine the fire.

SLOPE: The natural incline or steepness of the land or topography, usually measured in percent of rise (vertical rise divided by horizontal distance).

SMOLDERING FIRE: A fire that burns without flames, which is barely spreading, usually in ground fuels such as leaf litter, duff, or buried roots and debris.

SNAG - A standing dead tree or part of a dead tree from which at least the leaves and smaller branches have fallen. Often called stub, if less than 6 meters tall.

SPAN OF CONTROL: The supervisory ratio of from three-to-seven individuals, with five-to-one being established as optimum.

SPOT FIRE: A fire that gets established outside the main perimeter of the main fire by flying sparks or embers.

SPOTTING: The behaviour of a fire producing sparks or embers that could start new fires beyond the area of active combustion.

STABLE ATMOSPHERE: Condition of the atmosphere in which the temperature decrease with increasing altitude is less than the dry adiabatic lapse rate. In this condition, the atmosphere tends to suppress large-scale vertical motion. Also called stable air.

STRATEGY: An overall plan of action for managing fire that considers gives regard the use of personnel and equipment with consideration of values threatened, fire behaviour, political/legal constraints and objectives.

STRIP FIRING: Setting fires to more than one strip of fuels and providing for the strips to burn together. Frequently done in burning out against the wind.

SUBSIDENCE: An extensive sinking motion of air in the atmosphere. Subsiding air is warmed by compression and becomes more stable.

SUPPRESSION: Any action to confine, contain, control or extinguish a wildfire.

SURFACE FIRE: Fire that burns loose debris on the surface, which includes dead branches, leaves, and low vegetation.

SURFACE FUELS: Combustible materials on or immediately above the ground including leaves, needles, branches and limbs, logs, etc.

SURFACE WIND: The wind measured at 20 feet above the average top of the vegetation. Used as input to predict fire behavior.

TACTICS: Operational aspects of fire suppression. Determining exactly where and how to build control lines and what other suppression measures are necessary to control a fire.

TEST FIRE: A small, controlled fire set to evaluate fire behaviour and control measures before burnout or prescribed fire operations are implemented.

THERMAL BELT: An area of mountainous slope (characteristically the middle third), where the top of the radiation inversion intersects the slope. It typically experiences the least variation in diurnal temperatures and has the highest average temperatures and, thus, the lowest relative humidity. Its presence is most evident during clear weather with light wind.

TIMELAG (TL): Time needed under specified conditions for a fuel particle to lose about 63% of the difference between its initial moisture content and its equilibrium moisture content. If conditions remain unchanged, a fuel will reach 95% of its equilibrium moisture content after 4 timelag periods.

TORCHING: The burning of the foliage of a single tree or a small group of trees, from the bottom up.

UNDER SLUNG LINE: Line constructed beneath a fire that is burning on a slope

UNIFORM FUELS: Fuels distributed continuously over an area that provides a continuous path for the spread of fire.

VERTICAL FUEL ARRANGEMENT: The relative heights and continuity of fuels above the ground that influences fire reaching various levels or strata.

VOLUME - The total quantity of weight of fuels per unit area.

WATER BAR: A shallow channel or raised barrier, e.g., a ridge of packed earth or a thin pole laid diagonally across the surface of a road or trail so as to lead off water, particularly storm water. (Frequently installed in firelines on steep slopes to prevent erosion.)

WET-BULB TEMPERATURE: The lowest temperature to which air can be cooled by evaporating water into it at a constant pressure when the heat required for evaporation is supplied by the cooling of the air. It is measured by the wet bulb thermometer, which usually employs wetted wicking on the bulb as a cooling (through evaporation) device.

WET LINE: A temporary fire control line prepared by treating the fuels with water to slow or stop the spread of fire. Wet line needs to be followed up with dug fireline or cold trailed to ensure the fire will not re-kindle and burn across the area once dry.

WILDFIRE - An unplanned fire usually requiring suppression action, or a free-burning fire unaffected by fire suppression measures.

WILDFIRE: any fire that does not meet the criteria for prescribed fire or fires burning out of control.

WIND DIRECTION: Compass direction from which wind is blowing.

WIND DRIVEN FIRE: A wildfire being pushed by a strong, consistent wind: usually long and elliptical in shape.

Appendix II

FIRE MANAGEMENT AS A TOOL

FUELS MANAGEMENT

Fuels Management is the act or practice of controlling flammability and reducing resistance to control of wildland fuels through mechanical, chemical, biological, or manual means, or by fire, in support of land management objectives.

Reasons for a Fuels and Prescribed Fire Management Program

- Reduce hazardous fuel buildup
- Prepare sites for seeding or planting
- Improve Wildlife habitat
- Managing unwanted vegetation
- Improve forage for grazing
- Enhance Appearance
- Prepetuate Fire-dependent species

Program Goals must be tied to:

A. Legislation
B. Agency policy
C. Broad fire management and ecosystem objectives
D. Prescribed fire and fuels management goals need to be fully addressed in the Fire Management Plan (FMP).

The Fuels Planning Process

Delineate areas where use of fire could/should not be used for vegetation manipulation. Some factors to consider are soil and site conditions, type, slope, aspect, esthetics, fire hazards, wildlife value, watershed values, etc.

Establish a range of tolerable fuel loading, arrangement, depth and other elements critical to meet program goals. Coordinate effort with other resource managers.

Prepare fuel treatment guidelines which insure desired results.

Identify priority areas to reduce or breakup extensive concentrations of hazardous fuels.

Develop guidelines for various fuel treatment procedures based on:

1. Costs
2. Degree of Fuel Modification needed
3. Other factors

FOREST RESIDUE ANALYSIS

Forest residue is the total accumulation of vegetative materials on the forest floor that originates from human activities and from natural processes. This includes both that portion that provides vital contributions to the forest ecosystem:

1. Nutrient recycling
2. Soil protection
3. Wildlife food and cover
4. Insect and disease habitat
5. Fire hazard
6. Impediments to management

The unwanted and burnable portions of the residues are called fuels. A proposal for treatment of fuels must first describe the residues that should remain on site after the treatment. The prescription should define:

1. Residue levels and arrangement to be retained.
2. Appearance of ground surface and vegetation after completion of activity.
3. Description of fuels to be treated.

FUELS TREATMENT METHODS

Four basic types of fuels treatment include:

1. **Removal** - moving unwanted fuels offsite for use, storage, or disposal.
2. **Disposal** - onsite elimination of unwanted fuels. This includes processes needed to accomplish the disposal (for example, rearrangement by tractor for burning and construction of control lines for prescribed fire)
3. **Rearrangement** - onsite redistribution of fuels to a condition less hazardous or prone to more rapid deterioration. Rearrangement may also be accomplished in part by prescribed fire.
4. **Conversion** - either the removal of part or all of a vegetative community and replacement with another, or the maintenance of a seral stage without changing the vegetative type. (Usually this means replacing highly flammable vegetation with less flammable vegetation, or converting to vegetation that offers less resistance to suppression).

Removal from site, four basic methods:

1. Chipping with Removal - debris is gathered by machine or hand, the gathered fuel is then processed through a chipper and loaded into a truck for transport to the mill.
2. Truck Hauling - residue is loaded into trucks and hauled to offsite disposal or utilization areas.
3. Portable - Incinerator Burning - a low combustion process. Debris is loaded into a burner or burning pit. The process reduces heavy fuels to ash.
4. Advertise for Public Consumption - all material suitable for firewood is left along roads or central disposal areas and advertised for use by the public

Treating fuels on site - mechanical

1. Chipping with disposal on site - portable chippers are used and residue is dispersed over the site.
2. Crushing and Cutting - fuel treatment by vegetative crushing and cutting with tractors

and attachments. This treatment works most effectively with small stem material.
3. Tractor piling - piling of residue into piles throughout the unit.
4. Burying - involves construction of a burying pit, the tractor pushes the residues into the pit and covers them with soil.
5. Cable piling - residues are piles into large compact piles for later burning.
6. Shredding and spreading - the residue is shredded and spread by machines. The rate of decomposition is rapid in warm, moist areas.
7. Disking, plowing - for treatment of brush and rangeland residue. Residual vegetation is plowed into the soil.
8. Lopping and scattering - lopping modifies fuels by increasing their rate of decomposition. The modified fuel is then scattered over the area.

Treating fuels on site - using fire

1. Broadcast burning - accumulated fuels are burned where they lie on the ground. Broadcast burning is the most common method used for prescribed burning of clear-cut areas.
2. Hand piling and burning - debris is gathered and piled by hand, and burned during suitable weather conditions.
3. Tractor piling and burning - debris is piled by machine (causing more surface disturbance) and burned. No residual material should be left after burning. Some follow-up residue burning may be needed.
4. Progressive Burning - residues are burned progressively as they are created (along with a thinning or salvage logging operation). This method is used only in periods of low fire danger.
5. Underburn - underburning may involve back, flank, head, or striphead firing; it is a type of prescribed burning used generally with low intensity fire under the timber canopy.
6. Crush and Burn - this method involves the prescribed burning of mechanically crushed vegetation. The fire can reach high intensity and care must be taken to avoid excessive bole scorching.
7. Chemical Desiccation and Burn - used mostly for brush site conversion, this method involves the application of herbicide spray, followed later by burning of the desiccated material. This type of burn will leave the area blackened until grass or other vegetation cover is seeded on the site or until roots sprout new growth if the burn was low in intensity and the herbicides did not cause total kill. Due to the desiccated state of the fuels, this method will probably result in a high- intensity burn.
8. Open-Pit burning - debris is burned in open pits, the pits are filled in after use.

HAZARD REDUCTION

Hazard reduction means modifying the kind, arrangement, volume, condition, and location of fuels in and around facilities such as recreation areas, structural improvements, roads, fire breaks, fuelbreaks, buffer zones or greenbelts. The purpose is to reduce the threat of ignition and rate of spread of a fire and protect the facility from fire coming from an outside source.

Hazard potential or rise of costly and damaging fire varies considerably from one geographic location to another and from one microsite or climate to another.

The main variables are:

1. elevation
2. density of ground cover
3. natural barren openings
4. soil and fuel moisture
5. existing and predicted fuel loading
6. natural fire breaks (such as streams or roads)
7. weather conditions

Structures

1. The better a structure is nestled into the landscape, the higher the fire hazard is.
2. The major purpose of hazard reduction is to protect the facility from outside wildfire as well as from the spread of fire started within the structure. Clearance of flammable grass, shrubs and trees is recommended.

Roads

1. The purpose of hazard reduction along roads is usually to protect the surrounding landscape from fires.
2. Roads may also be used as fuelbreaks.

Application of hazard reduction techniques

1. Fine fuels should be removed.
2. Variety in sizes and shapes of openings.
3. Brush broken up in clumps provides low hazards.
4. Using greenbelts or buffer zones. These can reduce fire hazards and can prevent the spread of fire.

Fuelbreaks are strategically located corridors within which the vegetative cover has been modified to lower fuel volume or reduce flammability as an aid to fire control.

1. Shaded fuelbreaks occur in a woodland setting with a canopy.
2. Unshaded fuelbreaks are those in grasslands and forest community types where no canopy exists.
3. Fuelbreaks are placed strategically to divide large expanses of highly flammable vegetaion into small blocks.

NOTES

Planning for Prescribed Fire

- Program Goals
- The Decision Process
- Objectives and constraints of prescribed burning
- Elements of a Prescription

Prescribed burn planning requires:

- Advance preparation
- Objectives
  - Should clearly stated what is to be achieved and what conditions will be needed
- An Implementation Plan that includes:
  - Assessment of burn complexity/risk
  - Pre- burn notifications to other government organizations, landowners, public officials, media, etc
  - Control lines, firebreaks, natural barriers
  - Development of firing plan/sequence
  - Maps, diagrams
  - What mitigation actions will be required before the burn
  - What human and equipment resources will be required
  - A contingency plan in case the fire escapes the planned area.
  - Safety considerations
  - Mop-up/patrol plans
  - Go/No-Go checklist
- Development of a burning "prescription" that describes what conditions are needed for the burn to be conducted. The prescription may need to address:
  Fuels (fuel moisture by size class, fuel loading, etc)
  Weather (temperature, relative humidity, wind speed and direction, etc)
  Fire Behavior (rate of spread, intensity, scorch height, etc)
  Fire Effect Variables (plant response, water quality, habitat, smoke, soil exposure, etc)
- Develop a monitoring Plan
  Systematic process of collecting and recording fuels, topography, weather, fire behavior, and fire effects data to provide a basis for evaluating and adjusting prescribed fire programs through qualitative and quantitative monitoring data.

  Monitoring provides:
  - A measure of how well resource objectives have been met.
  - A basis for improving economic efficiency
  - Data that allow replication of desired results
  - Validation of fire behavior outputs
  - Opportunities to refine prescriptions based on actual experience
  - A basis for assessing long-term effects of fire and prescribed fire.

  Monitoring data should be collected during the fire and after
  While the fire is burning monitoring variables may be fire behavior, smoke and weather conditions.

NOTES