Alabama
PRESCRIBED BURNING GUIDE

Kent Hanby, RF, CF, and the Alabama Forestry Commission
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Preface

This guide has been developed to help the Alabama prescribed burn manager plan and conduct burns safely in today's fuels and political environment. The information has been gleaned from numerous publications and internet resources, most importantly *A Guide for Prescribed Fire in Southern Forests* (NFES 2108), and *Smoke Management Guide for Prescribed and Wildland Fire 2001 Edition*, (NFES 1279). Hugh Mobley's work and Alabama Forestry Commission publications have been drawn on substantially.

Particular attention has been paid to including new concerns and techniques that have come into practice since the publication of NFES 2108. Air quality is a primary consideration. The litigious nature of society demands special attention to detail. The Alabama Prescribed Burn Act has created an opportunity for burn managers. The basic science of fire has not changed. How the burn manager plans, conducts, and evaluates the burn and the related record keeping have changed.

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Several individuals with substantial prescribed burning experience have reviewed the information in this publication, including David Frederick, Lou Hyman, Hugh Mobley, Dale Wade, and Kent Davenport. They have made substantial contributions to the final document through their suggestions. Lou Hyman served as principal editor for the material. The author is solely responsible for any and all errors and omissions.

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Prescribed Burner's Proverb

My fire
My smoke
My problem
Wherever they go

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Chapter 1

Fire History

A brief history of wildland fire in Alabama

“The fire is Tess, the rain is Jo, and they call the wind Moriah.” Each of the three is an elemental reaction to conditions in the environment. They have existed since the beginning of time. When humans first came on the North American landscape, they no doubt brought knowledge of fire, both its uses and its power to change, and a healthy respect for its potential disruptive force.

The plants and animals that existed at the time of human arrival in the southeastern part of the North American continent were arguably adapted to fire on a relatively frequent interval. Fire occurrences were no doubt more frequent on dryer sites and less frequent on wetter sites. The wetter sites tended to grow greater quantities of fuel, which probably resulted in more intense fires, but on a lesser frequency. Those plants which could not survive the passage of a flame front were relegated to exist in very moist soil conditions. Some plants evolved with a reproductive strategy that allowed them to survive fire, such as serotinous cones.

Humans learned much about the use of fire to mold their environment. Fire was apparently used in pre-recorded times to clear the landscape along travel corridors and around villages to prevent ambush. Fire was also used to “freshen” up portions of the landscape, to provide forage for stock, or to attract wild animals to “yards.”

Early settlers used fire to clear land. They swept the area around their buildings to reduce the risk of fire burning into their building. In the spring of the year when fire was prevalent, they set fire to the area around their “yard” and allowed the fire to burn away from their buildings, forming a safe “black” area. The neighbor had to beware.

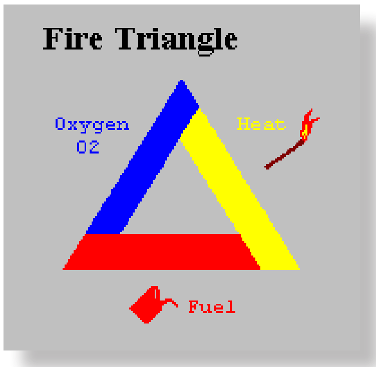
Today, foresters, wildlife biologists, and other land managers use fire as a tool to manipulate vegetation to achieve management objectives similar to their ancestors. While the application of fire is relatively inexpensive, the related liability risk, primarily related to smoke, is significant, and can be an impediment to the use of fire.

Stephen Pyne’s book *Fire in America: A Cultural History of Wildland and Rural Fire* is probably the most comprehensive historical coverage of wildland fire in North America.

Chapter 2

Fire Science

2.1. The Fire Triangle



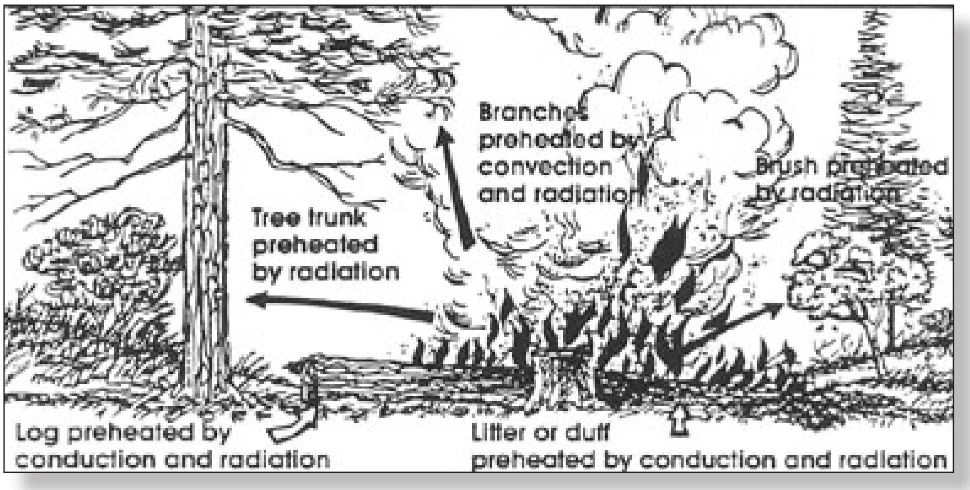
Fire is a rapid exothermic chemical reaction, a form of oxidation, which results in the rapid release of energy. Fire can be represented as a triangle with fuel, oxygen, and ignition temperature as the legs of the triangle. All three components must be in the right relationship for fire to occur.

In order for fire to continue, conditions must continue to support the reaction.

One of the elements or legs of the triangle must be broken to stop fire. Fuel may be removed. Oxygen may be removed. Or, the temperature may be reduced below the level necessary for combustion.

2.2. Heat Energy Transfer

Heat energy is transferred in three ways: **convection, conduction**, and **radiation**. Each of these processes comes into play in wildland fire behavior.



Conduction is the process of heat transfer though a solid: when one end of a steel rod is placed in a fire, the other end, which is ***not*** in the fire, gets hot.

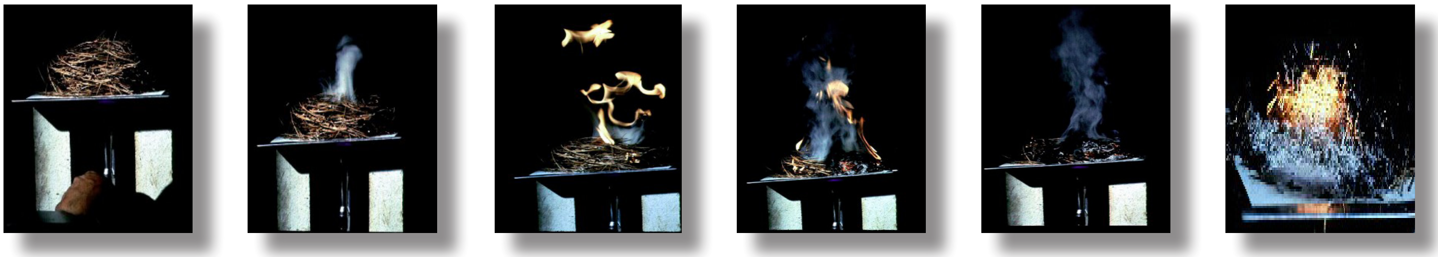
Convection is the process of heat transfer due to the rising of the heated air as it warms: the sun's energy warms the earth's surface, which warms the air adjacent to the surface, and that air begins to rise because it is warmer than the air in shaded areas around it.

Radiation is the transfer of heat through energy waves: the sun's warmth can be felt through a glass window.

2.3. Combustion

Fire in organic, woody fuels burns in several stages. The amount of energy, heat, required to raise the temperature of woody fuels to the ignition temperature varies with the moisture content of the fuel and the atmosphere.

As a fire advances, it pre-heats the adjacent fuel, driving off moisture and raising the temperature to the ignition point, normally 400-800 degrees Fahrenheit in woody fuels such as pine litter, hardwood leaves, logging debris, or brush. Combustion of woody fuels can be divided into five stages: pre-heating, pre-ignition, flaming, flaming and smoldering, and smoldering glowing.



pre-heating pre-ignition flaming transition smoldering glowing

During **pre-heating** of the fuel, moisture is driven off. Typically in woodland settings, the sun is the primary source of pre-heating. As a flame front advances, it can accelerate the pre-heating process.

During the **pre-ignition** stage, the fuel temperature rises toward the ignition temperature, and compounds in the fuel begin to volatize. Some other source of energy would be required to cause ignition such as lightning, an advancing flame front, or a match. On rare occasions, spontaneous combustion can occur. In even rarer cases, the reflection/magnification of the sun's rays through a piece of glass may cause ignition.

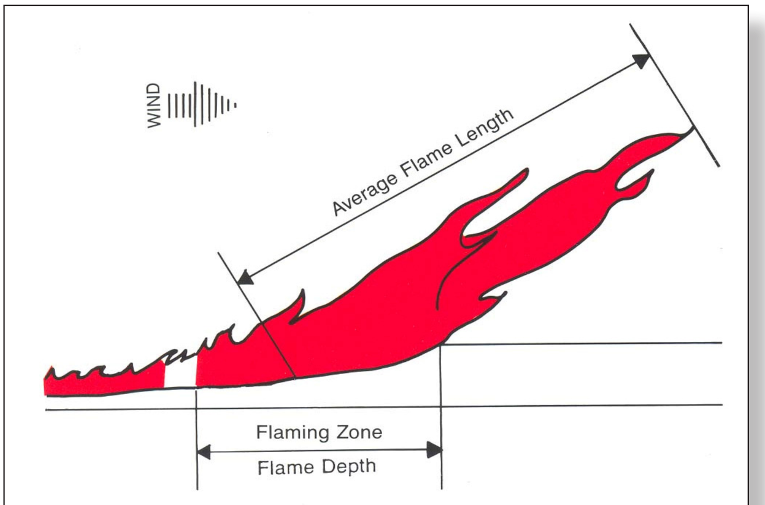
The **flaming** stage results when the oxidation rate and resulting heat energy release reaches a temperature level high enough to sustain combustion. In the flaming stage, most of the organic matter is broken down into varied compounds and a minimum amount of organic material is left in particulate matter, the visible part of smoke from woody fuel. During the flaming stage, fuel combustion and consumption is most rapid. Smoke production during the flaming stage depends on the fuel being consumed and the direction the fire is burning in relation to the wind.

The **smoldering** stage results as the flame front passes. In some cases, such as piles, fuels may smolder and sometimes never reach the flaming stage. As the temperature cools down and consumption is not as complete, more smoke may result. Typically there is a **transition stage** between flaming and smoldering as the combustion process begins to cool off.

The **glowing** stage occurs as general smoldering subsides and pockets of unconsumed fuels continue to oxidize at a reduced rate, resulting in a glow rather than a flame.

2.4. Flame Length

Flame length can be used as a prescription parameter to predict fire effects. Flame length in a given fuel, under given weather conditions, differs depending on the direction of ignition, heading or backing. A backing fire may have a flame length of one foot, while a heading fire under the same conditions may have a six-foot flame length. Similarly, the effect of flame length is different in dormant-versus-growing tissue. A six-foot flame length may not cause unacceptable scorch during the dormant season while the same flame length may result in severe scorch in the growing season. Note in the diagram that flame length may be different from flame height.



Flame dimensions for a wind-driven fire.

Chapter 3

Fire Behavior Factors

There are three major factors that impact fire behavior that the burn manager and burn planner must be thoroughly familiar with before attempting to plan or conduct a prescribed burn. They are **weather, fuels**, and **topography**. In addition, ignition techniques – both method and pattern – influence the effects of fire on vegetation, soils, and smoke production *(see Chapter 4, Ignition Systems)*. Areas where smoke may be a nuisance or annoyance are also critical considerations and will be discussed in Chapter 7, Smoke Management.

3.1. Weather

> *"Knowledge of weather is the key to successful prescribed burning, and is mandatory for proper management of smoke produced by burning."*
> *— Wade*

The individual weather element ranges presented are not a prescription. Recommended weather conditions are presented in boxes under each section. The burn planner and manager must prescribe specific weather criteria to accomplish the burn objectives.

Temperature

Ambient air temperature is probably the single most important factor affecting fuel moisture. The instantaneous lethal temperature for growing plant tissue, including the cambium under the bark and buds, is approximately 145°F. However, the dwell time around the root collar or in the crown may result in live tissue mortality at lesser temperatures, depending on whether the tissue is dormant or actively growing. Plant tissue is more susceptible to mortality when it is actively growing rather than dormant. Hot growing season fires tend to be lethal to live tissue. Less intense fires in the dormant season tend **not** to be lethal to live tissue.

> CAUTION! Temperatures of 80°F+ may result in a Probability of Ignition of 70%+ which may be very risky and not a good prescribed burning condition if control is a problem *(see page 28)*.

Relative Humidity

Relative humidity is the amount of moisture in the air or atmosphere, related to the amount of moisture that the air can hold at a given temperature and atmospheric pressure. The dew point, a related factor, is the air temperature at which water droplets would begin to form (100% RH) if the air temperature drops one more degree. Relative humidity is strongly affected by the daily temperature cycle.

["Relative Humidity doubles with each 20° drop in temperature – and halves with each 20° increase in temperature."]

Relative humidity is a critical factor affecting fire behavior and probability of ignition. Normally wildland fire will not carry adequately in hardwood fuels if the relative humidity rises above 55 percent, and above 65 percent in pine fuels in most fuel beds in Alabama. If the relative humidity drops below 30 percent, wildland fire can be difficult to control and the probability of fire brand ignition, "jumps," rises.

The relative humidity is impacted by the diurnal cycle (*see page* 22). Early in the morning the relative humidity is high. As the temperature rises, the relative humidity drops. Fire may not carry at 8 a.m. but may carry readily at 10 a.m. and may become difficult to control at 2 p.m. Similarly, fire may fizzle out at dusk as temperature falls and relative humidity rises. Light fuel (1 hour fuels) moisture drops as temperature rises, and increases as temperature falls.

[Suggested Range:
Relative humidity 30-55%]

[Burning is risky when the relative humidity drops (or is forecast to drop) to 25% or below.]

Pressure or Gradient Winds

Air moves as a result of temperature and air pressure differences. It moves from high pressure areas to low pressure areas in an attempt to balance out the differences in temperature and pressure. Due to the movement of the earth, this is not a straight line. Wind from a "high" will spiral outward in a clockwise direction. The winds flowing toward a "low" will spiral in a counter clockwise direction toward the center. These highs and lows are generally shown on weather maps.

Knowing where pressure centers are helps the burn manager understand wind and smoke behavior at the fire and helps to predict wind shifts as the pressure center passes.

Frontal Winds

A weather front is the boundary layer between two air masses of different temperatures. Fronts start from an area of low pressure. Winds will be the strongest at the frontal boundaries. Wind direction will also shift in a clockwise direction as the front passes.

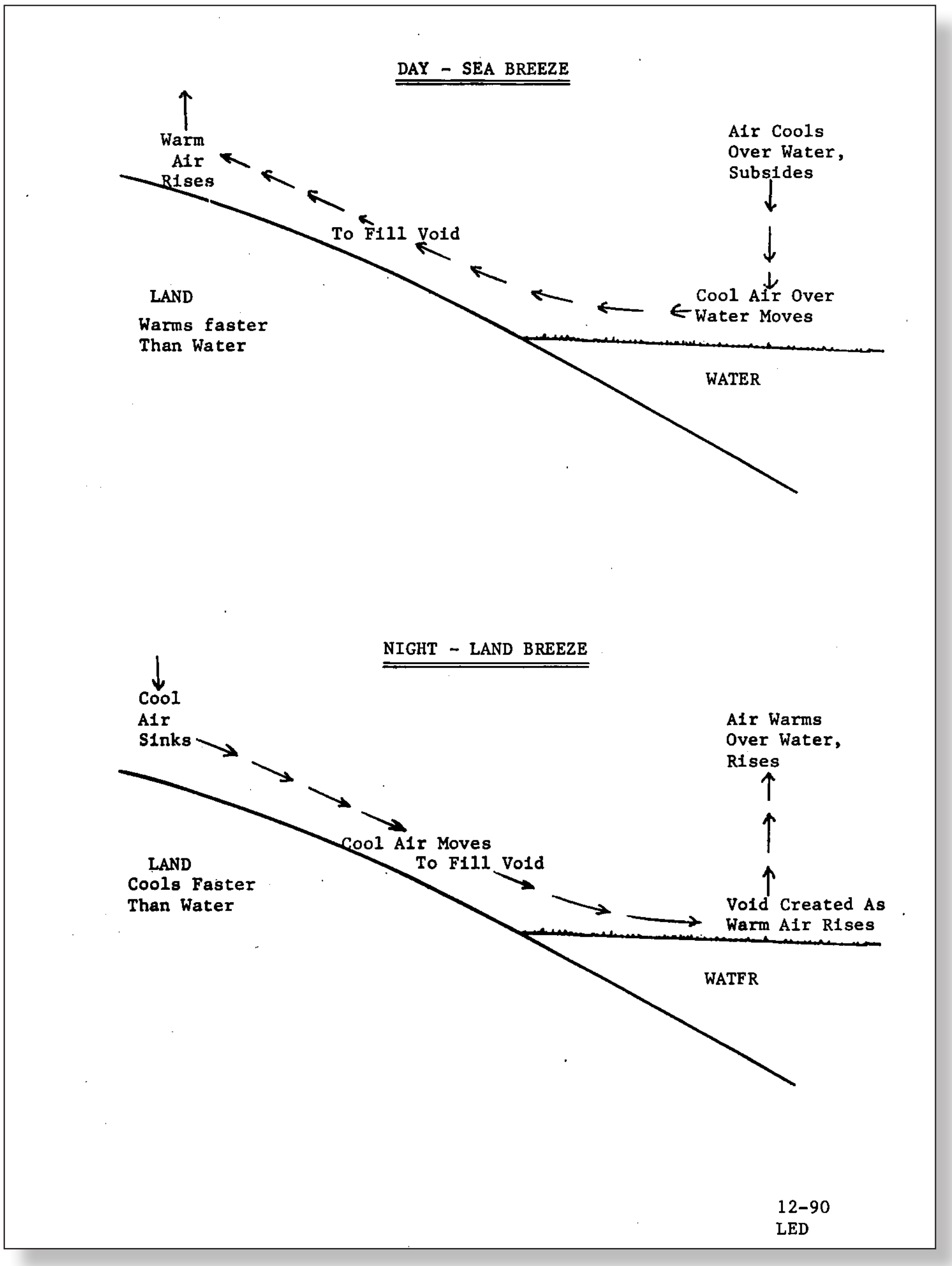
Local Winds

General winds are winds that are included in the weather forecast. Local factors will also affect the wind in an area that is too small to be included in the forecast. These are known as "local winds." There are three types of local winds that are important to fire behavior in the southeast: land and sea breezes, eddies, and slope winds.

Land and Sea Breezes

As discussed earlier, land surfaces become warmer than water surfaces during the day. As a result, the air adjacent to the land surface, being warmer, begins to rise and the cooler air (heaver) flows inland to take its place. This local wind begins around 2 to 3 hours after sunrise and ends around sunset.

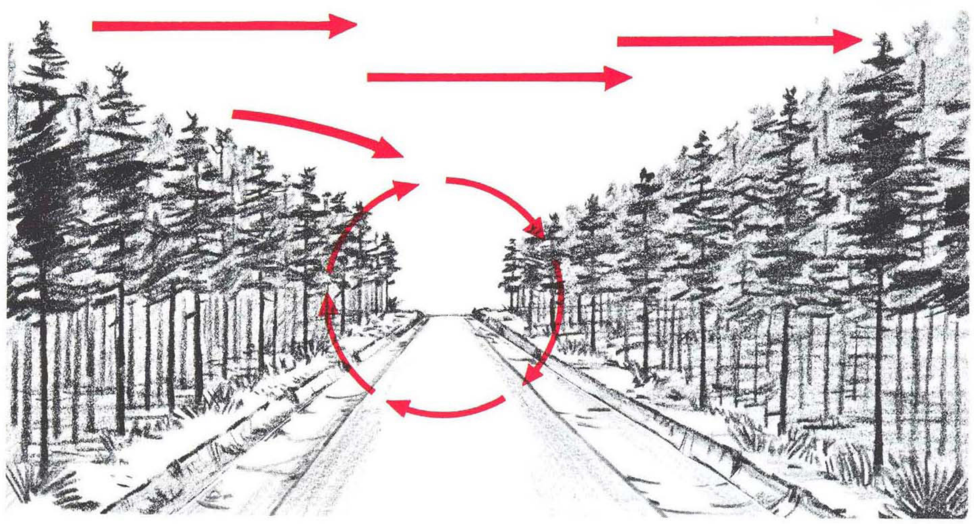
At night, the reverse is true because the land surface cools more quickly than the water surface causing airflow from land to the water.



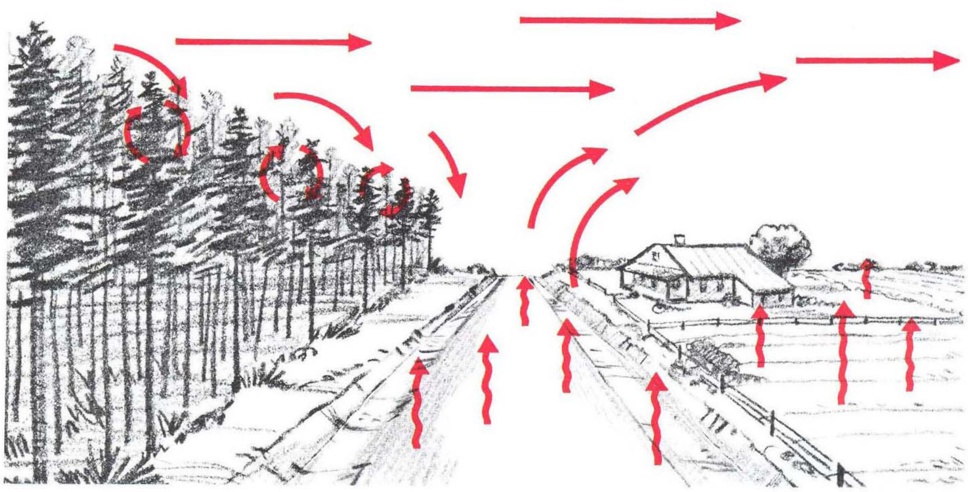
Eddies

Eddies are winds that in effect wrap around a topographic, vegetative, or other obstruction. They may be horizontal eddies or vertical. They can dramatically impact fire behavior either on a small scale or large scale. The prescribed burn manager and ignition person should be sensitive to the potential of eddy winds to influence the fire.

In some cases, wind may be channeled or funneled trough gaps, buildings, and tree stand openings.



Eddies caused by forest openings



Convection and eddies for open areas

Slope Winds

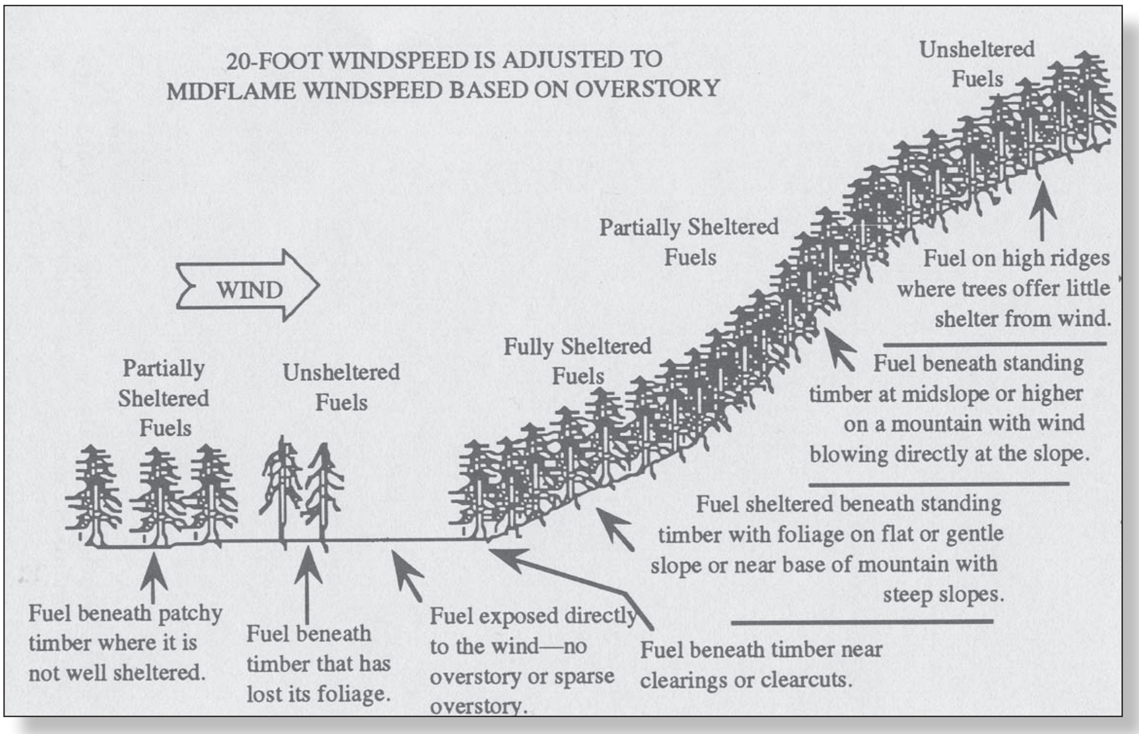
Warmer lighter air can rise along a slope with cooler air filling in from below. Local winds will flow upslope during the day and down-slope at night. This is true even on the slightest slope unless the general wind is strong enough to overcome this phenomenon.

Surface Wind Speed

Surface wind is the air movement that drives a fire. Surface wind speed is measured at six feet. Fire behavior is best managed when the surface wind speed is between one and five miles per hour. Wind speeds may be measured on the fire ground with an anemometer *(see page 23)*. Wind speeds less than one do not push the fire and may result in unacceptable crown scorch in short trees. Wind speeds in excess of five miles per hour may make the fire difficult to control and may result in flame lengths that cause unacceptable scorch.

[Suggested Range:
Mid-flame wind speed 1-5 mph
NWS 20' wind speed 3-10 mph]

Wind speed as reported by the National Weather Service (NWS) is measured at 20 feet above the ground in the open, for instance at an airport. The best option is to have an anemometer on site and read wind speeds directly. But, in the absence of an anemometer or when planning the burn, mid-flame wind speed may be estimated in the following way:



NWS Surface to in Stand Wind Speed Adjustment Method

Determine the 20' wind speed from the NWS fire weather forecast from the AFC web page connection or by calling the AFC dispatch center. Then determine the fuel model for the proposed burn site using the 13 fuel models for fire behavior *(see the section 3.4. Fuel Models)*. If conditions vary on the site multiple estimates may be called for. Always be conservative and on the safe side. The following is an example for a loblolly plantation thinned one year previously:

20' wind speed	18
fuel model #	11
wind sheltering	partial
see diagram on previous page	
1 unsheltered	
2 partially sheltered	
3 fully sheltered, open	
4 fully sheltered, closed	
wind adjustment factor	0.3
(Wind adjustment Table below)	
mid-flame wind speed, mph	5.4
(20' wind speed x wind adjustment factor)	

Wind Adjustment Table (NFES 2165)

Fuel Exposure	Fuel Model	Adjustment Factor
UNSHELTERED FUELS	4	0.6
	13	0.5
	1,3,5,6,11,12	0.4
	(2,7)[1]	0.4
	(8,9,10)[2]	0.4
PARTIALLY SHELTERED FUELS	all Fuel Models	0.3
FULLY SHELTERED FUELS	all Fuel Models	
	Open stands	0.2
	Dense stands	0.1

UNSHELTERED FUELS: Fuel exposed directly to the wind. Sparse to no overstory. Fuel beneath timber that has lost its foliage; fuel beneath timber near a clearing or clear cut; fuel on high ridges where trees offer little shelter from the wind.

PARTIALLY SHELTERED FUELS: Fuel beneath patchy timber where it is not well sheltered; fuels beneath standing timber at mid-slope or higher on a mountain with wind blowing directly at slope.

FULLY SHELTERED FUELS: Fuel sheltered beneath standing timber on flat or gentle slope or near base of mountain with steep slopes.

[1] Fuels usually partially sheltered [2] Fuels usually fully sheltered

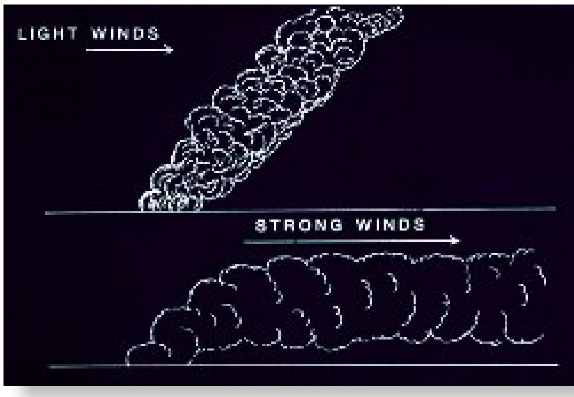
Surface Wind Direction

Surface wind direction should always be away from areas where smoke might be a nuisance to the public or result in damage *(see chapter 6)*. The burn manager must be aware of approaching fronts and possible wind shifts *(see page 13)*. It is helpful to tie strips of flagging to limbs near the ignition area or the boundary of the fire to indicate the local wind direction. The flagging picks up eddies and local wind shifts. They help the fire line personnel stay tuned to the wind condition.

Transport Wind Speed

Transport wind speed is the average wind speed from the ground to the mixing height. Transport wind determines the direction of smoke dispersal. Fire behavior and smoke dispersal are best managed when the transport wind speed is between 9 and 20 miles per hour. Transport wind speeds of less than 9 miles per hour may result in smoke not dispersing satisfactorily while transport wind speeds in excess of 20 miles per hour may result in erratic fire behavior which is difficult to control.

[Suggested Range:
Transport wind speed 9–20 mph]



Transport Wind Direction

Transport wind direction, like surface wind direction, should be away from smoke sensitive areas. But, since transport winds can carry smoke long distance, up to 50 miles or more) special attention must be given to the air shed drainage area. Transport wind direction is influenced by the jet stream and may be different from surface wind direction. Transport winds have a strong influence on plume rise and dispersal. In the following pictures you can see the plume on the horizon looking east just to the right of the barn. Then in the second picture looking 90° to the left, north, of the first picture the plume can still be seen at approximately the same elevation and relatively in tact.


Looking east


Same plume & photo point looking north

Smoke generally disperses horizontally and vertically. Smoke does not disperse consistently. Sometimes it seems to form a "glob" and drift away. Other times it appears to dissolve into the air.

Atmospheric Stability

Atmospheric stability is an indication of the atmosphere's resistance to turbulence and vertical motion. In prescribed fire activities the atmosphere is usually described as stable, neutral, or unstable. For prescribed fire, the air mass should be neutral to slightly unstable. Unstable air carries smoke up. If smoke is hotter than the ambient air it will rise. An air mass that is substantially unstable could result in an uncontrollable fire while a stable air mass might result in smoke problems in the vicinity of the burn. During some stable air situations an inversion occurs and smoke settles to the ground.

Atmospheric stability is reported by the NWS. Watching sources of smoke such as from a chimney or a fire gives an indication of stability. If the air mass is unstable smoke rises straight up from the chimney. If the air mass is stable or there is an inversion in the area smoke from the chimney may drop down to the ground level.

The Dispersion Index is a good indicator of stability, the higher the index the more unstable the air.

slightly unstable / neutral

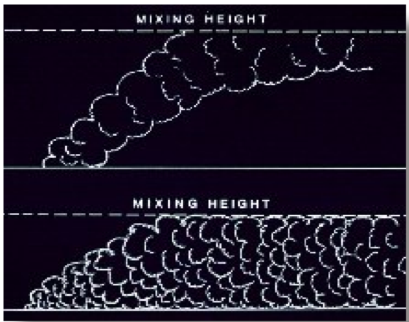
unstable

stable

Mixing Height

Mixing height is defined as the height to which relatively vigorous mixing of the atmosphere occurs or the depth of the unstable air in the boundary layer and is used for forecasting smoke or pollutant trajectories. The mixing height varies throughout the day and night. Air begins to rise as the temperature of the earth's surface rises after sunrise in a zone of active convection. When the mixing height is less than 1,650 feet above the earth's surface smoke does not usually disperse adequately for prescribed burning. When the mixing height is above 6,500 feet above the earth's surface smoke dispersion will not be a problem but fire may be difficult to control. The mixing height reported by the NWS is calculated based on the average elevation for the reporting area. In mountainous areas the mixing height may be closer to the earth's surface than reported by the NWS. In mountain and valley areas care needs to be taken to ensure that smoke is not trapped in a valley.

[Suggested Range:
Mixing height 1,650' to 6,500']



Ventilation Factor

The ventilation factor may help the burn manager intuitively visualize the ability of the air column to disperse smoke. The Dispersion Index calculation includes the ventilation factor and is a better planning tool for smoke screening and management. The ventilation factor may be calculated by multiplying the mixing height by the transport wind speed. Normally transport wind speed would be in miles per hour and mixing height would be in feet which results in a large number with units that are difficult to grasp. In order to simplify the concept the actual number may be divided by the minimum number to give a relative factor.

Ventilation factor = Transport wind speed x Mixing height
Minimum ventilation factor = 9 MPH x 1,650 feet = 14,850 or 1
Maximum ventilation factor = 20 MPH x 6,500 feet = 130,000 or 130,000/14,850 = 8.7

The ventilation factor may be thought of as a sensitivity indicator where a factor of 1 indicates weak ventilation and a factor of 8 indicates strong ventilation.

Sky Cover

The degree of cloud cover affects the drying rate of fuels *(see section 3.3 Fuels)*. The more extensive the cloud cover the slower the drying rate will be. Prescribed burning may be possible with extensive cloud cover if the mixing height, transport wind, and Dispersion Index are appropriate. Cloud cover may delay the effect of the diurnal cycle and necessitate a later start time in order to allow one hour fuel moisture to drop to a workable level.

Dispersion Index

The Dispersion Index is the most reliable predictor of prescribed burn smoke behavior. The ventilation index is incorporated into the Dispersion Index calculation. The Dispersion Index is a numerical index developed by Lee Lavdas that estimates the capacity of the atmosphere to dissolve and disperse prescribed fire smoke. The Dispersion Index is not a perfect predictor and should be used conservatively based on personal experience. In Alabama the Dispersion Index is reported by the National Weather Service in the forestry weather forecast. It is reported as a whole number of one or greater.

Dispersion Index (DI)	
1 – 6	very poor dispersion
7 – 12	poor dispersion
13 – 20	generally poor dispersion
21 – 40	fair dispersion
41 – 60	generally good dispersion
61 – 100	good dispersion
100 +	excellent dispersion

Preferred prescribed burning daytime Dispersion Index is 40–100+. However, the experienced burn manager may elect to burn under lower Dispersion Index where conditions warrant.

[Suggested Range:
Dispersion index (daytime) 41+]

The Dispersion Index drops substantially at night due to atmospheric conditions and is interpreted differently. Nighttime prescribed burning should be done only with substantial experience and knowledge of air mass and smoke dispersion behavior in the area. The minimum recommended Dispersion Index for night burning is 3.

Keetch-Byram Drought Index

The moisture conditions of the litter, duff, humus, and soil are critical to fire behavior, fire effects, and the ability to control prescribed fire. The burn planner must prescribe an acceptable KBDI range to accomplish the burn objectives. This will vary by season and burn objective.

The following discussion of the drought index is taken from the Virginia Department of Forestry web site, **www.dof.virginia.gov/fire/kbdi.htm.**

The **Cumulative Severity Index (CSI)** or **Keetch-Byram Drought Index (KBDI)** is a continuous reference scale for estimating the dryness of the soil and duff layers. This system was originally developed for the southeastern United States and is based primarily on recent rainfall patterns.

The KBDI, specifically developed to equate the effects of drought with potential fire activities, is the most widely used system by fire managers in the south. This mathematical system for relating current and recent weather conditions to potential or expected fire behavior results in a **drought index number** ranging from 0 to 800. This number accurately describes the amount of moisture that is missing; a rating of 0 defines a point of no moisture deficiency (soil saturation where the next drop of water will run off over the surface) and 800 defines the maximum drought possible (oven dry).

Prolonged droughts (high KBDI) influence fire intensity since more fuel is available for combustion (i.e. fuels have a lower moisture content). In addition, dry organic material in the soil can lead to increased difficulty in fire suppression. High values of the KBDI are an indication that conditions are favorable for the occurrence and spread of wildfires, but drought is not by itself a prerequisite for wildfires. Other weather factors, such as wind, temperature, relative humidity and atmospheric stability, play a major role in determining the actual fire danger.

These KBDI numbers correlate with potential fire behavior as follows:

0 - 200	Soil and fuel moisture are high. Most fuels will not readily ignite or burn. However, with sufficient sunlight and wind, cured grasses and some light surface fuels will burn in spots and patches.
200 - 400	Fires more readily burn and will carry across an area with no “gaps”. Heavier fuels will still not readily ignite and burn. Also, expect smoldering and the resulting smoke to carry into and possibly through the night.
400 - 600	Fire intensity begins to significantly increase. Fires will readily burn in all directions exposing mineral soils in some locations. Larger fuels may burn or smolder for several days creating possible smoke and control problems.
600 - 800	Fires will burn to mineral soil. Stumps will burn to the end of underground roots and spotting will be a major problem. Fires will burn thorough the night and heavier fuels will actively burn and contribute to fire intensity.

KBDI may be tabulated for a given site by monitoring the temperature and rainfall over time. The AFC Dispatch Center and the USFS ranger district offices maintain local KBDI records for Alabama.

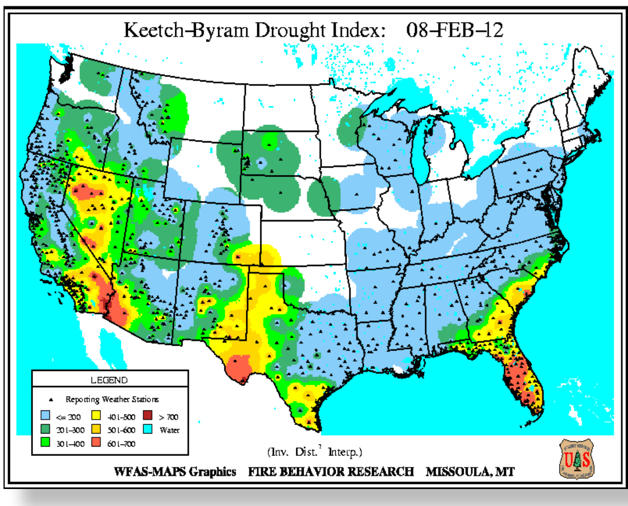
The current KBDI for Alabama, as well as other information such as the last 24-hour rainfall amounts, can be found at **www.forestry.alabama.gov/weather.aspx**.

A regional KBDI map may be obtained from the website **www.wfas.net/index.php/keetch-byram-index-moisture--drought-49**

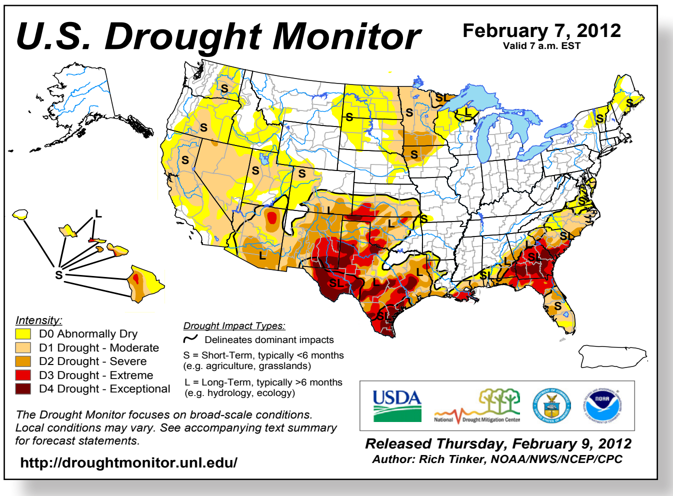
Placing a copy of the current KBDI map with the burn plan report serves as good documentation of the regional drought conditions at the time of the burn.

The USFS in Alabama uses the following KBDI guidelines:

Growing season MAX KBDI = 450
Dormant season MAX KBDI = 300
Site preparation MAX KBDI = 500

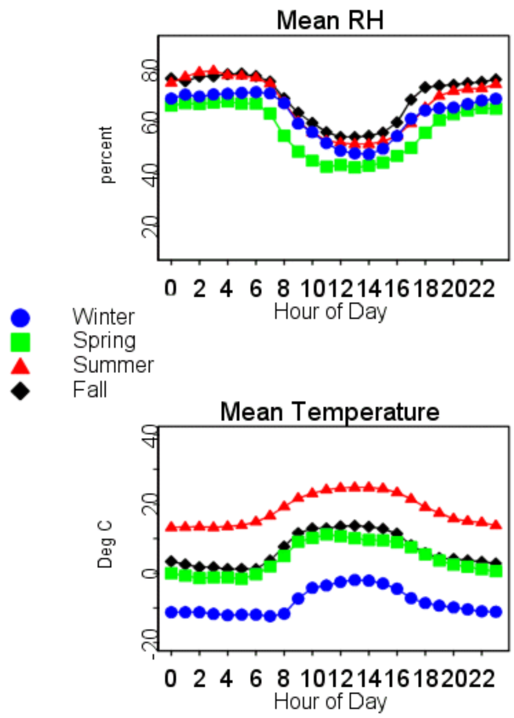


The Drought Monitor



Another online source of drought information is the Drought Monitor, which is based on the Palmer Drought Index. References to both KBDI and Palmer Drought Index may be found on the Alabama Forestry Commission website at **www.forestry.alabama.gov/weather.aspx**

Diurnal Cycle



The diurnal cycle is the cycle of weather factors in a 24-hour period from sunrise to sunset to sunrise. As the sun rises the air temperature rises. As the sun sets the air temperature decreases. Conversely as the sun rises the relative humidity decreases and as the sun sets the relative humidity increases. Mixing height tends to rise from sunrise and declines as dusk approaches. After sunrise the air mass tends to become unstable. As the sun begins to set the air mass tends toward stability. Prescribed burn managers must be sensitive to the diurnal cycle and its effect on fire and smoke behavior. The graph represents a ten-year average by season. Note how consistent the pattern is for the 24-hour cycle.

Sources of Fire Weather Information

Forecasts

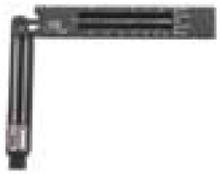
The National Weather Service, NWS, publishes fire weather forecasts in Alabama daily throughout the 24-hour period. This information is constantly available via weather radio and the internet. A fire weather forecast is published each morning around 7:30 a.m. and may be obtained at the Alabama Forestry Commission website, **www.forestry.alabama.gov/weather.aspx,** or by contacting the AFC Dispatch Center at 1-800-392-5679. This is a forecast, not the actual weather. The fire weather forecast in Alabama is provided for four separate NWS regions. Additionally, the National Weather Service fire weather forecast for Alabama my be found at **http://radar.srh.noaa.gov/fire**.

[Note: Fire weather reported by the NWS is a *forecast,* NOT the actual weather or a prescription!]

Actual Fire Weather Direct Measurements

Ambient temperature, relative humidity, and wind speed and direction should be measured on site just prior to the burn, during the burn, and following the burn. There are several types of devices that may be used. An anemometer measures wind speed, a thermometer measures ambient temperature, and a sling psychrometer can be used to measure relative humidity. A Kestral or similar device may be used to measure all three. When using special devices, care must be taken to ensure that they are accurately calibrated. A belt weather kit contains several useful devices including a sling psychrometer, an anemometer, and a compass. When using a belt weather kit it is important to keep the anemometer orifices clean and clear of obstruction. Distilled water should be used for the wet bulb on the sling psychrometer. Total recording weather stations are effective on large operations or when lots of fires are conducted.


anemometer


sling psychrometer


Kestral


belt weather kit


weather station

Current local weather may be obtained on some personal cell phones from various sources such as **WeatherBug**. Care must be taken to ensure that the weather recording station is close enough to the burn site to be relevant.

Weather Observations

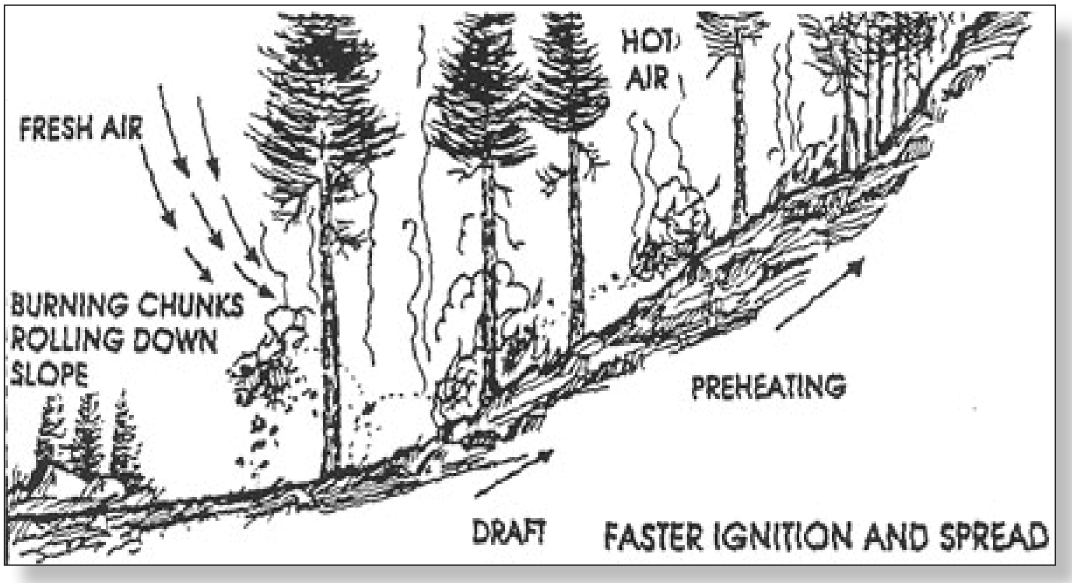
Certain weather elements can be observed but not readily measured at the burn site. Atmospheric stability, transport wind direction, and sky cover may be observed on site but not measured. Each of these should be observed and documented during a burn.

Documentation

All actual fire weather elements should be observed and recorded on site throughout the burn.

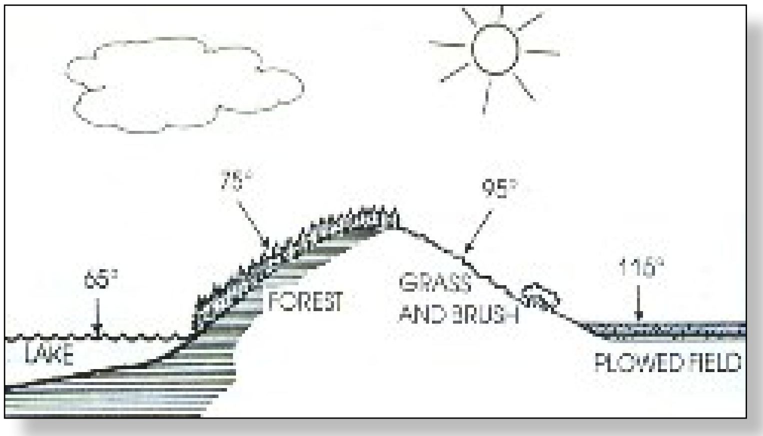
[Weather conditions change continuously:
stay updated — stay alert — keep the burn crew informed.]

3.2. Topography



Because heat rises, fuels on a **slope** tend to be affected by convective heat causing them to dry faster than those on a flat surface. As a flame front approaches on a slope, the fuels upslope from the flame are heated by the flame's convective energy. Fire tends to burn more rapidly upslope than on a flat surface or downslope. The steeper the **gradient** (angle) of the slope, the stronger the influence of convective energy.

Aspect: In the northern hemisphere slopes that face south and west tend to dry faster due to the incident angle of the sun, while north facing slopes tend to be cooler and moister.



Natural boundaries in the topography, such as rivers, open fields, highways, swamps, and creek bottoms may serve as passive fuel breaks. Open edges may have faster fuel drying rates due to direct exposure to the sun.

Gaps, chimneys, chutes, draws, ridge lines, and other landforms can funnel air flows that result in updraft winds. Fires burning in these types of land forms can be affected by these updraft winds. Winds may curl around hills and bluffs causing erratic fire behavior.

3.3. Fuels

Physical Characteristics

Woodland fuels have several different characteristics that affect the way they burn.

Fuel Shape

The important aspect of fuel shape is the surface area compared to the mass of the individual piece. In other words, fuels such as pine needles have a higher fuel-to-oxygen ratio than logs. Pine needles have a high surface-area ratio and may ignite rapidly and burn quickly. Oak leaves have a high surface-area ratio but due to their flatness, may be matted down and not support combustion. On the other hand, logs have a low surface-area ratio which causes them to ignite slowly and in some cases not burn. Some of the shapes of fuels are needles, leaves, limbs, logs, palmetto fronds, and peat.

Fuel Size

Fuel size affects fuel moisture and the rate of drying. The drying time lag in hours can be related to thickness or diameter:

Time lag	Diameter
1 hour	<1/4 inch
10 hour	¼ to 1 inch
100 hour	1 to 3 inches
1,000 hour	>3 inches

One-hour fuels (normally grasses or pine straw) reach equilibrium with the moisture in the atmosphere rapidly. As relative humidity drops during the diurnal cycle, one-hour fuels dry and become more flammable. As the relative humidity rises during the diurnal cycle, one-hour fuels pick up moisture from the atmosphere and become less volatile. Since one-hour fuels dry faster, they tend to be the primary fuel that carries fire in the fuel bed.

Ten-hour fuels (small litter and dead brush) may be part of the flammable fuel bed.

In some cases, 100- and 1,000-hour fuels may be harvested or removed from the site in some other way and thus would not be part of the fuel bed. When 100- and 1,000-hour fuels are part of the fuel bed and when their moisture content has dropped to the point that they are flammable, very intense fires may occur.

Fuel Arrangement

Fuels are arranged through the forest in different ways. Whether fuels are **matted** tightly or **lofted** affects the oxygen surface area and thus the flammability. In some cases fuel may be **suspended** vertically in limbs and vines. This type of arrangement is referred to as a **fuel ladder** that can support flames from the ground up into the canopy.

Fuel ladder

Mixed fuels

Fuel Distribution

Fuels may be distributed in different ways. They may be evenly **broadcast**, in **piles**, **clumped**, or **patchy**. Fuel distribution affects flame spread and may affect ember pitching.

Pile

Broadcast and clumpy

Fuel Volume

The volume of fuel in the burn area will affect fire behavior and smoke production. A great deal of research has been put into estimating the fuel volume for each of the 13 fuel models for predicting prescribed burn fire behavior *(see page 29)*. Actually measuring fuel volume can be time consuming and is typically not done for an individual burn. In order to adjust for fuel moisture content, fuel volumes are reported in oven dry weight.

Fuel Moisture and Probability of Ignition

Fuel can vary in moisture content from saturated (holding the maximum amount of water possible) to oven dry (no moisture). Saturated fuels will not burn without a substantial pre-drying energy input. Oven dry fuels are readily combustible. Ambient air temperature is the driving force for relative humidity, fuel moisture, and fuel drying. The hotter it is the faster fuel dries. Relative humidity, shading, fuel arrangement, aspect, wind speed and fuel size are all factors that the prescribed burn planner and manager must be knowledgeable about. In southern fuels it is typically the fine fuels that form the fuel bed and carry the fire. The prescribed burn planner and manager should be able to prescribe a desired fine fuel moisture content to accomplish a burn objective and then to determine fine fuel moisture at the burn site on the day of the burn. Likewise the burn manager should be able to predict the fine fuel moisture content at the peak of the diurnal cycle based on the actual weather conditions on site at the time fire is first ignited.

The fine fuel moisture content and probability of ignition can be determined from tables. The tables included in this publication have been extracted from the *NWCG Fireline Handbook* (NFES 2156), Appendix B, Fire Behavior. The prescribed burn planner should set parameters in the prescription for fuel moisture and probability of ignition.

Fine Dead Fuel Moisture Content Estimation

Fine dead fuel moisture content is an important fire behavior factor. Fuel moisture predictions are difficult to make in the field; however, estimates can be made from measured or predicted values of dry bulb temperature and relative humidity.

The data used here was develop for "worst case" conditions during the diurnal cycle (2 p.m., SW aspect, open conditions). These predictions are for fine dead forest fuels. In Alabama, in order to be conservative, a south aspect is used and altitudinal variation within a burn site is not typically a factor. In some cases in northeast Alabama, altitudinal variation may be a factor.

Temperature and relative humidity can be measured using instruments. Fine fuel moisture can be predicted for a forecast relative humidity and temperature. This makes it possible earlier in the day to predict fine fuel moisture at the peak of the diurnal cycle.

Determine the dry bulb temperature and the relative humidity, and then consult the data in the boxes that follow to find the Fine Dead Fuel Moisture and Probability of Ignition.

WORKSHEET: Fine dead fuel moisture content estimation (example)

INPUT (daytime calculation)	
Dry Bulb °F	55°F
Wet Bulb °F	45°
Relative Humidity %	43%
Reference Fuel Moisture % (RFM) (see following charts)	6%
Month	February
Shaded/Un-shaded	Shaded
Time	2 p.m.
Aspect	S
Slope %	0%
Fuel Moisture Correct. % (FMC) (see following charts)	4%
OUTPUT	
Fine Dead Fuel Moisture %	
RFM % + FMC % (above)	6 % + 4% = 10%
Probability of Ignition % (see page 28)	30%

Note: In this example, fire may not carry very well in pine straw due to the fine dead fuel moisture content.

Reference Fuel Moisture (RFM)
Day (0800 – 1959 hours)

Dry Bulb Temp °F	Relative Humidity % 25/29	30/34	35/39	40/44	45/49	50/54	55/59	60/64	65/69
10-29	5	5	6	7	8	8	8	9	9
30-49	5	5	6	7	7	7	8	9	9
50-69	5	5	6	6	7	7	8	8	9
70-89	4	5	5	6	7	7	8	8	8
90-109	4	4	5	6	7	7	8	8	8
109+	4	4	5	6	7	7	8	8	8

Dead Fine Fuel Moisture Corrections (FMC)
Day (0800–1959 hours)

	8 a.m.>	10 a.m.>	12 p.m.>	2 p.m.>	4 p.m.>	6 p.m.>
May, June, July						
Un-shaded	3	1	0	0	1	3
Shaded	4	4	3	3	4	5
February, March, April / August, September, October						
Un-shaded	4	2	1	1	2	4
Shaded	5	4	4	4	4	5
November, December, January						
Un-shaded	5	4	3	2	4	5
Shaded	5	5	5	5	5	5

Unshaded: less than 50% of surface fuels in shade
Shaded: more than 50% of surface fuels in shade

Probability of ignition is an indicator of how readily a fuel bed will ignite when an ignition source is present, or conversely, whether a fuel bed will burn at all. A probability of 70+ indicates very flashy conditions where control would be difficult and jumps or escape very likely. A probability of ignition of 30 or less indicates a moist fuel bed that probably will not carry fire.

Probability of Ignition

	Dry-Bulb Temp. °F	Fine Dead Fuel Moisture % 2	3	4	5	6	7	8	9	10
	100-109	100	100	80	70	60	60	50	40	40
	90-99	100	90	80	70	60	50	40	40	30
	80-89	100	90	80	70	60	50	40	40	30
Unshaded	70-79	100	80	70	60	60	50	40	40	30
	60-69	90	80	70	60	50	50	40	30	30
	50-59	90	80	70	60	50	40	40	30	30
	40-49	90	80	70	60	50	40	40	30	30
	30-39	80	70	60	50	50	40	30	30	20
	100-109	100	90	80	70	60	50	50	40	40
	90-99	100	90	80	70	60	50	50	40	30
	80-89	100	80	70	60	60	50	40	40	30
Shaded	70-79	90	80	70	60	50	50	40	30	30
	60-69	90	80	70	60	50	40	40	30	30
	50-59	90	80	70	60	50	40	40	30	30
	40-49	90	80	60	50	50	40	30	30	30
	30-39	80	80	60	50	50	40	30	30	20

3.4. Fuel Models

For planning purposes it is useful to divide fuels into different categories. This helps the planner to estimate fire and smoke behavior and to plan for the effects of fire. Fire behavior fuel models describe the fuel bed, the fuel that will carry a fire. Other materials in the stand may be flammable under some conditions but do not typically carry a fire. The planner should consider the fuels that will carry the fire under the conditions the planner prescribes, in order to achieve the burn objective. In turn these fuel models are an important part of computer modeling of fire behavior.

In *A Guide for Prescribed Fire in Southern Forests*, fuels and fuel conditions were divided into six broad types, 1) grass (with pine overstory), 2) light brush, 3) pine needle litter, 4) palemetto/gallberry, 5) windrowed logging debris, and 6) scattered logging debris or small dry piles. These types along with the size of the burn allow the planner to predict the distance smoke will travel under a given Dispersion Index.

Two other systems of dividing fuels into types or models are in popular use.

The *Aids to Determining Fuel Models for Estimating Fire Behavior* describes 13 fuel models which are divided into four categories:

FIRE BEHAVIOR

Fuel Model	Fuel Loading 1 hr	10 hr	100 hr	Live	Moisture of Extinction Dead Fuels
	(tons per acre)				%
Grasses and grass dominated					
1. Short grass (1 foot)	0.74	0.00	0.00	0.00	12
2. Timber (grass and understory)	2.00	12.00	0.50	1.00	15
3. Tall grass (2.5 feet)	3.01	0.00	0.00	0.00	25
Chaparral and shrub fields					
4. Chaparral (6 feet)	5.01	4.01	2.00	5.01	20
5. Brush (2 feet)	1.00	0.50	0.00	2.00	20
6. Dormant brush, hardwood slash	1.50	2.50	2.00	0.00	25
7. Southern rough	1.13	1.87	1.50	0.37	40
Timber litter					
8. Closed timber litter	1.50	1.00	2.50	0.00	30
9. Hardwood (& pine) litter	2.92	0.41	0.15	0.00	25
10. Timber litter (& understory)	3.01	2.00	5.01	2.00	25
Slash					
11. Light logging slash	1.50	4.51	5.51	0.00	15
12. Medium logging slash	4.01	14.03	16.53	0.00	20
13. Heavy logging slash	7.01	23.04	28.05	0.00	25

These fuel models are for the entire United States. In the South, fuel model 2 is typical for grasses, fuel model 9 is typical for pine and hardwood understories, fuel model 7 is specific to the lower coastal plain of the Southeast, and fuel model 11 is typical of logging slash fuel loads. Fire tends to burn more aggressively the lighter the fuel and the heavier the fuel load. Thus a fuel model 2 would not generate as much heat or smoke as a fuel model 3, all other conditions being the same. Likewise a fuel model 2 will burn more aggressively in terms of spread rate than a fuel model 9.

The fuel loading data in the table above is also for the entire U.S. Typically in the South, fuel loads are not as heavy as some in the Northwest. In order to more accurately predict spread rate, the burn planner may choose to use a fuel model 2 when the conditions appear to be more similar to a fuel model 9, based on substantial experience.

Fuel model 2 - grass

Use **fuel model 3** table values for estimating fire behavior in kudzu or cogongrass.

Fuel model 4
(not typical of the Southeast) Note backing fire, downslope, and quantity of smoke. This fire is burning in very dry conditions in resinous fuels. The only condition in Alabama that might be similar to this would be a ty-ty swamp during a very dry period with very low green fuel moisture content or a lower coastal plain upland site with heavy loading of wax myrtle, yaupon, and/or gallberry.

Fuel model 7
(Southern rough) palmetto, gallberry

Fuel model 9
hardwood & pine understory litter, light brush, and blackberries

Fuel model 11
typical clearcut

The third fuel classification system in common use is the National Fire Danger Rating System (NFDRS) which is used for fire suppression planning. It includes models A through O. These models should not be confused with the fire behavior models and should not be used for planning prescribed burns.

More recently an extensive amount of research is being done to develop fuel classification systems and computer models to predict fire emissions information pertaining to public health.

Piles

Piles are not a natural distribution of fuels on the forest floor and thus are not a part of any of the fuel models listed above. Windrows are piles typically containing 100 and 1000 hour fuels. Special problems for burn managers result when piles are present. The convective energy of burning piles can loft burning embers that may result in jumps or escapes.

Chapter 4

Ignition

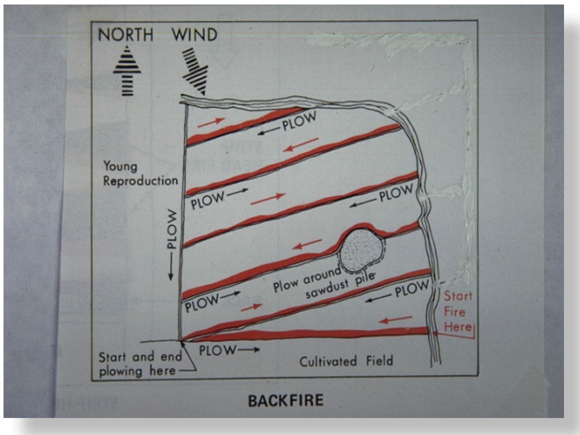
The **device** used to set a prescribed burn and the **pattern** in which the fire is ignited affect fire behavior and smoke production. The prescribed burn planner must prescribe the device and pattern required to achieve the burn objective.

4.1. Pattern of Ignition

Fire is pushed by the wind. The direction fire burns in relation to the wind determines the pattern. All patterns other than head and back are some combination of heading, backing, or flanking.

Backing

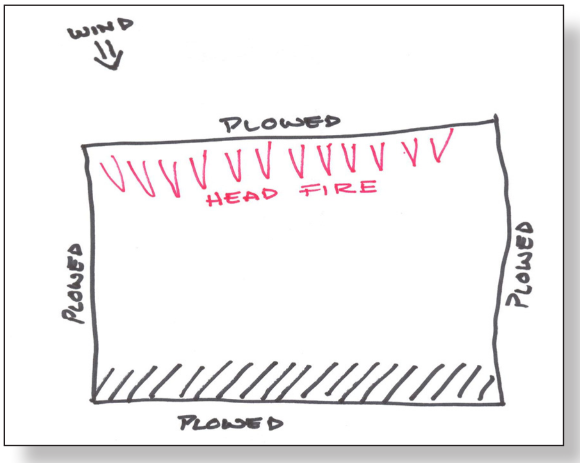
Backing fires burn against the wind into the fuel. Backing fires have relatively short flame lengths and slow spread rates compared to the other ignition patterns. Backing fires take longer to pass a point and thus dwell at a point for an extended period of time. Because of the dwell time, the time required for the flame front to pass a point or stem, backing fires can raise the temperature of the growing tissue under the bark and may have a girdling effect on stems at or near the ground line. Backing fires generally result in more complete combustion of the fuel during the flaming stage and thus tend to produce less smoke. Most prescribed burns are started with a backing fire on the downwind side of the area to be burned. Once a substantial "black" area is established using the backing technique, other ignition patterns may be employed to accomplish the burn objective.



Heading

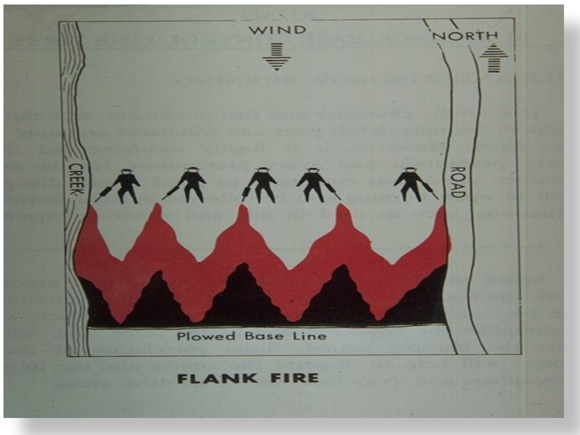
A head fire burns with the wind, being pushed by the wind. Head fires fanned by the wind are more intense and the flame front passes a point rapidly. Head fires have longer flame lengths and faster spread rates than backing fires. Because of the rapid and incomplete fuel consumption as the flame front passes, head fires produce more smoke. Due to the longer flame length, head fires tend to damage or kill plant tissue higher off the ground. However, head fires may not have long dwell times and may not girdle stems.

Usually a back fire is backed off the downwind side of a tract until a safe "black" area exists before a head fire is set.



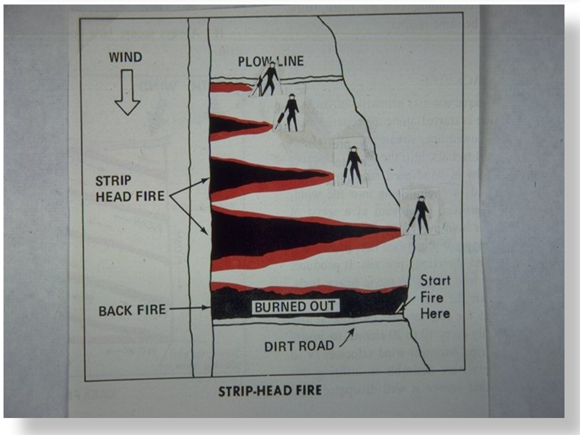
Flanking

Lighting fire directly into the wind is refered to as the flanking technique. The flame front is neither moving into or with the wind but rather across the wind. Flanking fires tend to be less intense than a head fire but more intense than a backing fire. Any shift in the wind direction may turn a flanking fire into a head fire and a backing fire. The convective energy at the bases of the flank "v" tend to swirl and may cause more heat at a higher level.



Strip Head

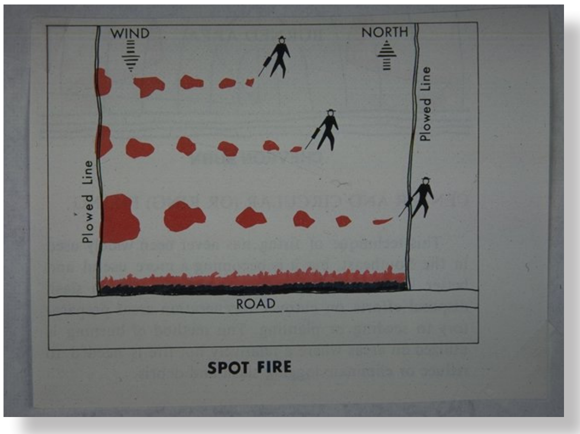
Strip head firing consists of lighting a series of fires across the wind typically progressing from the downwind side of the burn area. Strips are typically only ignited after a safe "black" area has been established by backfiring along the downwind side of the burn area. Strip head firing is probably the most commonly employed ignition technique employed to extend or spread fire across the burn area. The heat convection along the line where the heading fire and the backing fire meet can result in elevated temperatures in the tree crowns and may result in unacceptable scorch. In young stand such as pine plantations spot ignition may be more effective than strip head fires to accomplish the burn objective.



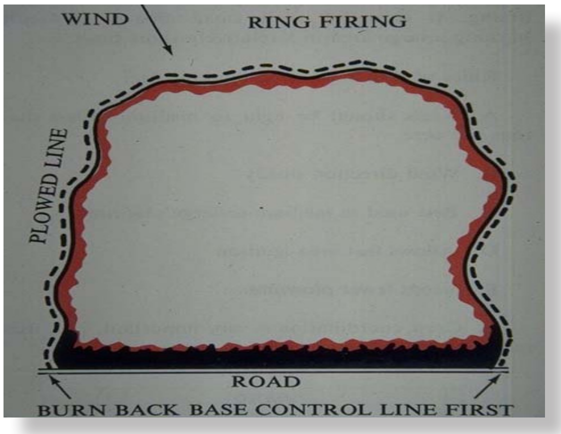
Care must be taken when using multiple ignition people to ensure that the upwind ignition person does not get ahead of the downwind ignition person, trapping the downwind ignition person between two ignition line.

Spot

Igniting fire in spots rather than in lines is the spot or point source technique. Each spot consists of heading, backing, and flank behavior. Spots may create a mosaic in the fuel bed. Spot ignition results in a fire that is less intense than a head fire but more intense than a backing fire. Wind shifts are not a problem with spot ignition the way a wind shift can be a problem with flank ignition. When a helicopter equipped with the delayed aerial ignition device (DAID) system is employed, the result may be spot ignition. A safe "black" area should be established using a backing fire on the downwind side of the burn area prior to setting spots.

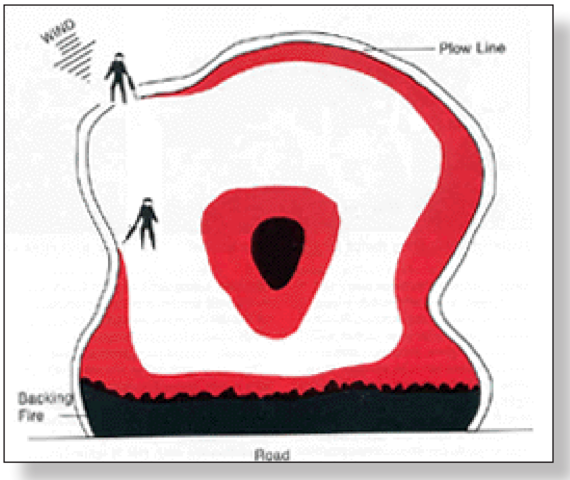


Ring



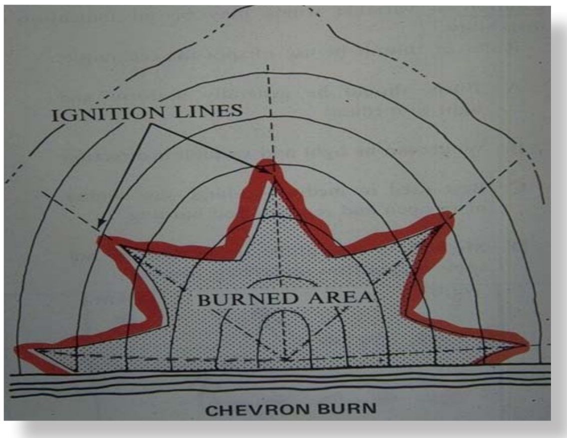
Lighting the entire perimeter of the burn area is called ring firing. A substantial "black" safe area should be established before proceeding with ring firing. After the "black" is established the flanks should be ignited and finally the upwind side should be ignited. Under certain weather and fuel conditions ring firing can result in a convection column over the fire which causes the fire to draw air from the entire burn perimeter resulting in an intense fire. Ring firing is typically used with site preparation burning where an intense fire is desired to consume most of the fuels in the fuel bed to facilitate tree planting.

Center



Center firing consists of putting a single spot ignition in the center of the burn area. Center firing is typically employed in combination with ring firing to initiate the desired convection column. In combination the technique is referred to as **center-ring firing**. Under dry fuel and weather conditions, dramatic convection columns capable of lofting substantial amounts and sizes of burning embers may result. Center-ring firing should only be employed with substantial experience and when adequate man power and equipment is available to hold the fire in the planned burn area.

Chevron



Lighting fire in a series of Vs with the bases of the Vs, or chevrons, connected at the interior ends is referred to as the chevron ignition technique. Because of the convection effect at the bases of the Vs the chevron ignition technique tends to burn more intensely than a backing fire. The chevron technique may be used to "hurry-up" a fire along a line where it is prudent to get the fire away from the line as quickly as possible. Igniting the fuels along the edge of a highway in some cases may be an example. The chevron techniques may be used along slopes and ridge lines to prevent the fire from burning too intensely up the slope. The chevron technique may be effective but should only be used based on substantial experience.

Hurry-up techniques may be used to complete the planned burn within the planned time frame. Several of the ignition techniques listed above may be considered hurry-up, strip-head, flank, spot, and chevron. In some cases where fire is not burning as intensely as anticipated or planned, head firing may be used as a hurry-up technique to accomplish the burn plan objective. Rounding the corners of a burn area may also be employed as a hurry-up technique in some cases.

Keeping firing lines as straight as possible will reduce the likelihood of jumps. The exception is the chevron technique. In corners of the flame front, the two opposing sides of a corner may work together resulting in convection that can cause flaming embers to cross the fire line.

4.2. Techniques Of Ignition

Drip torch

The hand held drip torch is the most commonly used ignition technique for prescribed burning. All drip torches are similar. They consist of a manually vented canister, a looped tube, and a wick. The loop in the tube prevents flame from flashing back from the wick into the canister.

The drip torch **fuel mixture** is a mix of gasoline and diesel fuel. The ratio of gas to diesel fuel varies from 1/3 gas in 2/3 diesel to ½ gas in ½ diesel. The richer the gas in the mixture the flashier the mixture and the more readily it will ignite. If the mixture is too rich it will tend to make the torch sputter. The greater the ratio of diesel fuel in the mixture the longer it will sustain flame after dripping from the torch. The mixture may need to be adjusted slightly depending on the vegetative fuel moisture, the relative humidity, the wind speed, and the air temperature. Torches should never be stored or filled with a pure gas mixture. Gasoline is extremely volatile.

[CAUTION
Never use a drip torch without a loop in the wick tube !!]

[Suggested drip torch fuel mix:
1/3 gas to 2/3 diesel fuel]

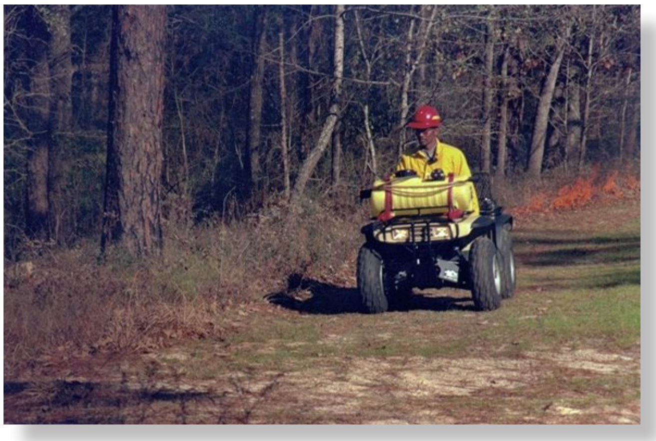
Caution should be used while using a drip torch to ensure that the fuel mix does not get on clothing or boots in order to prevent the torch person from becoming inflamed. In the event the fuel mix does get on the torch person, the torch person should stop work, get away form the fire, and change clothing or drench the clothing in water.

Drip torch

Drip torch alternative, fusee

ATV Torch

Burners can mount a modified drip torch on an ATV in order to speed up the ignition process. ATV torches can negotiate rough terrain, thick grass, and small brush. However, ATV torches are subject to tip over or may fall into stumps holes and become trapped. The torch and fuel tank should be mounted with a quick disconnect device to allow jettisoning in the event of an emergency. A water tank with pressure spray capability can be mounted on the front for dealing with unwanted ignitions. The ATV torch should be equipped with a fire extinguisher that is mounted away from the torch preferably on the front of the ATV.



Tractor Torch (for piles and windrows)

A tractor torch may be used for igniting piles and wind rows. The tractor torch is similar to an ATV torch with a greater fuel capacity and a higher reach.

Aerial Ignition

Aerial ignition can be employed to ignite fires in any one of the patterns discussed above with the possible exception of the chevron. The advantage of aerial ignition is speed. A large area can be ignited quickly with an aerial torch, resulting in quick burn out and securing personnel from the burn. Aerial burning requires a substantial commitment of fire crew personnel and fire suppression units to ensure that the fire can be held.

Heli-torch

The fuel for a heli-torch is a mix of gasoline and a gelling agent similar to napalm. The torch should be attached to the helicopter with a quick disconnect device so that the torch can be dropped in the event of an emergency such as a helicopter engine failure. A heli-torch operation is probably cheaper than the DAID system.

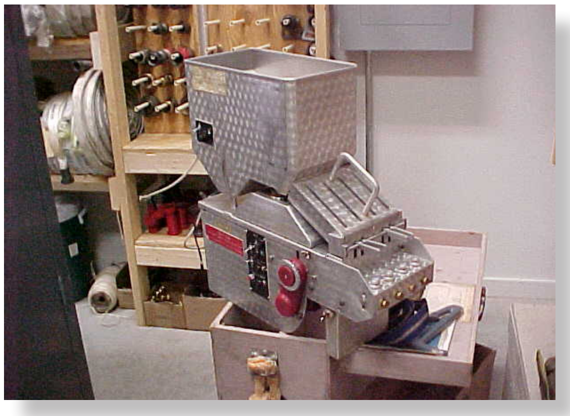
Helicopter Delayed Aerial Ignition Device (DAID)

DAID dispenser mounted in helicopter

DAID machine hopper with “ping-pong balls”
Photo by Dan O’Conner

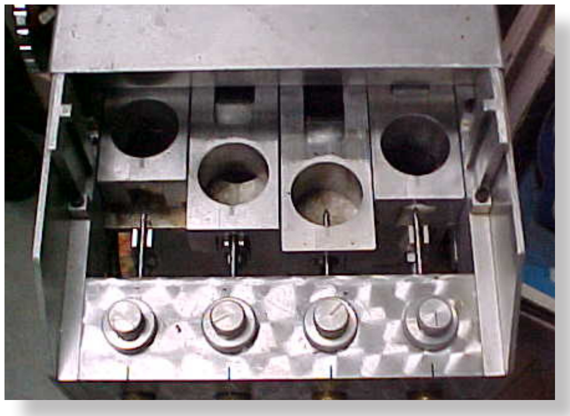
CAUTION
Due to the uncertainty of where helicopter ignition system fuels may fall, it is necessary to have substantial equipment and personnel on site to hold the fire within the planned burn area!

Spot ignition with "ping-pong balls"
Photo by Dan O'Conner

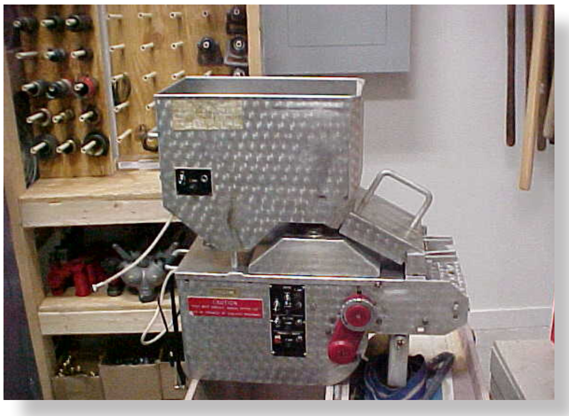


DAID machine with drop chute
at bottom right

Cam mechanism that allows balls to fall



Pockets where balls are injected



DAID machine: side view

The DAID ball

The DAID is sometimes referred to as the "ping-pong ball" system. On board a helicopter, a trained fire specialist operates a device packed with small plastic spheres filled with a precise amount of potassium permanganate, an inorganic chemical oxidant. The little plastic spheres are about the size and shape of ping-pong balls, thus the name. An arm of the machine holds each ball and injects it with a measured quantity of ethylene glycol, and the ball is rolled down a chute and immediately jettisoned from the helicopter. Within 30 seconds, the chemicals in the ball react thermally to produce a small fire. As the ball hits the forest floor and the exothermic reaction causes the plastic to burn it ignites the forest fuel. The plastic ball and its contents are completely consumed by the fire. The end result is a spot of fire that, when multiplied by the number of balls dropped, enables ignition quickly and safely. Efficiency is gained due to the speed with which ignition of the burn area can be completed.

Chapter 5

Fire as a Tool

Resource managers have used fire as a tool for many purposes. The better the burn planner understands fire effects, the better job the he/she can do prescribing fire to accomplish an objective.

The U.S Forest Service website, Fire Effects Information System (FEIS), located at **www.fs.fed.us/database/feis/**, contains information about fire effects on many forest plants and animals. The prescribed burn planner can use information from this website to help develop a burn objective.

The season of the burn, the return interval (number of years between burns in a sequence) of fire in a stand, and the intensity of the burn must be understood in order to use fire effectively.

Prescribed burn objectives may include site preparation, fuels management/reduction, wildlife habitat, timber stand improvement, ecological manipulation/restoration, agro-forestry, disease control, and aesthetics.

The prescribed burn planner should be as specific as possible when defining the burn objective, and avoid trying to include too many objectives. In order to be effective, the resource objective must be specific so that the fire objective can be tailored to accomplish the resource objective. In a burn area there may be sub-areas with different burn objectives. A burn area map delineating areas with different resource and fire objectives is essential to the burn manager.

The information in the following matrix is general in nature. With experience, the FEIS home page, and by calling on the experience of neighboring prescribed burn managers, the burn planner can become proficient in prescribing resource and fire objectives.

COMMON PRESCRIBED BURNING OBJECTIVES

Purpose	Time of Burn	Size of Burn	Type of Fire	Frequency	Remarks
Reduce fuels	Winter	Large enough to break fuel continuity	Not critical (Do not ring fire)	2-4 years	Use line-backing fire, or spot fires under moist conditions for initial burn. Grid-firing technique excellent for maintenance burns.
Improve wildlife habitat					General – Protect transitional or fringe areas. Do not burn stream bottoms.
Deer habitat	Winter preferred	Small or leave unburned areas in a mosaic	Backing fire or spot fires	2-4 years	Want to promote sprouting and keep browse within reach. Repeat summer fires may kill some rootstocks.
Turkey habitat	Winter preferred; summer burns in July–August	Small or leave unburned areas in a mosaic	Backing fire or spot fires	2-4 year	Avoid April through June nesting season.
Quail habitat	Later winter	25+ acres	Not critical (Do not ring fire)	1-2 years	Avoid April through June nesting season. Leave unburned patches and thickets.
Dove habitat	Winter	Not critical	Not critical (Do not ring fire)	Not critical	Leave unburned patches and thickets.
Waterfowl habitat	Late fall or winter	Not critical	Heading fire	2+ years	Marshland only. Do not burn in hardwood swamps.
Control competing vegetation	Heavy roughs in winter, otherwise not critical	Not critical	Not critical (Do not ring fire)	2-8 years	Summer burns result in higher rootstock kill and affect larger stems. Exclude fire from desirable hardwoods in pine-hardwood type.
Improve forage for grazing	Winter through late spring for most situations	Not critical but will be damaged by overuse if too small for herd	Not critical (Do not ring fire)	3 years	Split range and burn one-third each year. Individual herbs and grasses respond differently to fire and season of burn. Consult expert.
Improve accessibility	Will vary with understory and desired use	Varies with individual situation	Depends on amount of fuel present	As needed	Coordinate with other resource objectives. They will dictate size, timing and frequency of burn.

Control disease	Brownspot, winter	Depends on size of infected area. Include a buffer strip	Strip-heading or heading fire	2-3 years	Burn when humidity is above 50%. Avoid leaving unburned pockets of infected seedlings within or adjacent to burn.
Enhance appearance	Late fall through late winter	Varies with each situation	Backing fire or spot fires	1+ years	Requires precise prescription to protect vegetative type changes. Know effect of fire frequency and season of burn on both annual and biennial flowering plants. Provide pleasing visual lines.
Perpetuate fire-dependent species	Will vary with species	Will vary but usually fairly small	Will vary with fuel conditions and species requirements	Will vary with species	Fire intensity, timing and frequency all dictated by species requirements.
Young pine stands	Winter	Varies with size of stand	Backing fire	2-4 years	Pine diameter 3 inches or more at ground. Pine height above 10 ft. Burn only after a strong cold front with rain.
Dispose of logging debris	Not critical	Small areas mean fewer nighttime smoke problems	Center firing with heli-torch preferred		Smoke management is a must! Take care not to damage soil or water resources with these hot fires. If a broadcast burn will not meet objectives, pile – do not windrow debris.
Prepare sites for seeding	Natural seeding, summer to early fall prior to seed fall	Large enough to prevent concentrations of birds and rodents (usually 10 acres or more)	Not critical (Do not ring fire)		Be careful not to kill seed trees. If logging debris is present, manage your smoke.
	Direct seeding, fall to late winter for spring sowing; previous winter for fall sowing of longleaf	Large enough to prevent concentrations of birds and rodents (usually 10 acres or more)	Not critical (Center firing with heli-torch preferred if slash present)		If logging debris present, smoke management is a must! Take care not to damage soil or water resources with these hot fires.

Note: To eliminate sweetgum from a pine stand in the Piedmont region of Alabama it is necessary to start when the sweetgum has a ground diameter of less than 6 inches. The return interval must be annual until the sweetgum is satisfactorily controlled. Some species of plants do not produce seed every year. Blackberry is an example. If soft mast is an important part of the resource management objective the return interval should be at least 2 years.

Chapter 6

Alabama Prescribed Burn Laws

Prescribed Burn Law at a Glance:
Must have permit to burn.
Must stay with burn until extinguished.
Must have sufficient fire break.
Must notify neighbors under certain circumstances.
Alabama Forestry Commission (AFC) has authority to ban burns.
AFC has police power related to prescribed burning.
ADEM has authority to stop all burning under certain air quality situations.
Certified Prescribed Burn Manager free from liability in absence of gross negligence subject to certain requirements.

There are several Alabama laws and several federal laws that pertain to prescribed burning. The prescribed burn manager and planner should have a basic understanding of these laws and their intent to avoid problems and to take advantage of the protection provided by the law. Laws pertaining to prescribed burning in Alabama may be outlined in layman's terms as follows:

- Prescribed Burn Law
    - Practitioner certification
    - Landowner's right to burn
- AFC enabling legislation
    - Police power
    - Permitting / Burn bans
    - ADEM connection
- ADEM/EPA
    - EPA connection
    - Public health
    - NAAQS
    - Non-attainment
- EPA
    - Clean Air Act
    - Endangered Species Act
    - Class One air sheds

6.1. AFC Enabling Legislation

The section of Alabama law that is the "enabling" legislation for the Alabama Forestry Commission is:

§ 9-13-10. Powers of state forestry commission employees as to enforcement of laws, prevention and suppression of forest fires, etc,

All employees of the State Forestry Commission appointed as forest law enforcement officers by the State Forester are hereby constituted peace officers of the State of Alabama with full police power and may exercise such powers anywhere within the state. They are hereby authorized to carry firearms or other weapons when they are actually in the discharge of their duties as such officers as provided by law. They shall be clothed with the power to arrest with or without warrant any person who shall violate any of the laws of the State of Alabama or any rule or regulation of the Alabama Forestry Commission and take him before a proper court for trial. All employees of the State Forestry Commission and all duly appointed officers of the United States whose duty it is to prevent and suppress forest fires are empowered to enter any lands and to construct thereon fire lines, fire lanes or firebreaks, to set back fires thereon if necessary to prevent the further spread of fire then actually burning and to do all other work necessary in the performance of their duties, including the right to enter any lands for the purpose of making investigations for the cause or causes of fires, without liability for trespass or damage therefrom.

(Acts 1939, No. 492, p. 711, § 3; Code 1940, T. 8, §206; Acts 1967, No. 724, p. 1560, § 1; Acts 1980, No. 80-507, p. 786, § 1.)

§9-13-10.1. Assistance of state forestry commission in control and suppression of wildfires by other state agencies.

All state agencies, in the performance of their duties and responsibilities to the people of Alabama, are authorized to aid and assist the State Forestry Commission in the control and suppression of wildfires, on request of the Governor of Alabama, with such requested resources that are reasonably available and needed to cope with the specific situation.

(Acts 1976, No. 102, p. 98.)

§9-13-11. Willful, malicious or intentional setting on fire, etc., of woodlands, grasslands, etc., burning permits: fire alerts: placement of areas under organized fire protection: disposition of fines, etc.

(a) It shall be a Class C felony for every person, firm, association, or corporation to do either of the following:

(1) Willfully, maliciously or intentionally burns, sets fire to, attempts to set fire to, or causes to be burned or any fire to be set to any forest, grass, woodlands, or other inflammable vegetation on any lands not owned, leased, controlled, or in the lawful possession of the person, firm, association, or corporation setting the fire or burning such lands or causing the fire to be set or lands to be burned.

(2) Shall have in his or her possession or shall set, throw or place any device, instrument, or other incendiary paraphernalia, including any time-delay incendiary device, in or adjacent to any forest, grass, woodlands, or other inflammable vegetation, which forest, grass, woodland or other inflammable vegetation is not owned, leased, controlled, or in the lawful possession of the person possessing such device, instrument, or paraphernalia.

(b) It shall be a Class B misdemeanor for any person, firm, association, or corporation:

(1) Who recklessly or with wanton disregard for the safety of persons or property allows a fire to escape from land owned, leased, or controlled by him or her, whereby any property of another is injured or destroyed;

(2) Who shall burn any brush, stumps, logs, rubbish, fallen timber, grass, stubble, or debris of any sort, whether on one's own land or that of another, without taking reasonably necessary precautions, both before lighting the fire and all times thereafter to prevent the escape thereof;

(3) Who shall set fire to any brush, stumps, logs, rubbish, fallen timber, grass, stubble, or debris of any sort within or near any forest or woodland, unless the area surrounding said material to be burned shall be cleared of all inflammable material for a reasonably safe distance in all directions and maintained free of all inflammable material so long as such fire shall continue to burn;

(4) Who shall set a fire within or near any forest, woodland, or grassland without clearing the ground immediately around it free from material which will carry fire, or shall leave such fire before it is totally extinguished or start a fire in any forest, woodland, or grassland by throwing away a lighted cigar, cigarette, match or by the use of firearms or in any other manner and leave the same unextinguished;

(5) Who shall destroy, remove, injure, or deface any fire warning or notices or deface any inscription or devices comprising such notices;

(6) Who shall burn any new ground, field, grasslands, or woodlands, or adjoining woodlands or grasslands of another within any area which has been placed under organized forest fire protection by the State Forestry Commission without first obtaining verbal authorization from the State Forestry Commission by obtaining a burning permit number.

(c) It shall be a Class A misdemeanor for any person to recklessly or with wanton disregard for the safety of persons or property burn, set fire to, attempt to set fire to, or cause to be burned or any fire to be set to any forest, grass, woodlands, or other inflammable vegetation on any lands not owned, leased, controlled, or in the lawful possession of the person setting the fire or burning such lands or causing the fire to be set or lands to be burned without the permission of the lawful owner.

(d) (1) Burning permits may be obtained from the district operations center when the center is in active operation. The following criteria must be met:

a. The person requesting the permit must have adequate tools, equipment, and manpower to stay with and control the fire during the entire burning period.

b. The person requesting the permit is responsible to keep the fire confined.

c. In no case will the person requesting the permit allow the fire to be unattended until it is dead out.

(2) Burning permits will be issued if the individual requesting the permit states that the above criteria will be met unless the State Forester shall declare a fire alert. Under fire alert conditions the State Forester may allow issuance of permits at his or her discretion, taking into account the number of fires burning in the district, current and projected weather conditions, the ability of the person seeking the permit to contain the fire and that individual's knowledge of fire behavior, and other factors which may affect fires and fire behavior. A fire alert will be issued by the State Forester for any district or portion of a district that in the opinion of the State Forester, has existing conditions which produce extraordinary danger from fire or smoke.

(3) If subsequent to issuance of a permit a lawfully authorized fire escapes to the lands of another and an investigation reveals that the permit holder did not meet all the criteria as set forth above, the fire will be treated as if no legal authorization had been obtained.

(4) A burning permit once issued may be revoked if the person requesting the permit fails to comply with proper burning procedures or if weather conditions develop which may result in erratic fire or smoke behavior.

(e) An area shall be deemed legally placed under organized forest fire protection by the State Forestry Commission of the State of Alabama upon proclamation of the State Forester. Such proclamation shall describe the lands placed in said area and shall be published once a week for two consecutive weeks in a newspaper published in the county where the lands composing said area are located. If there are no newspapers published in the county where said lands are located, then said proclamation shall be published in a newspaper of an adjoining county. In the event the lands composing said area are located in more than one county, such proclamation shall be so published in a newspaper in each county where said lands are located. Beginning with the twelfth day after the first publication of said proclamation in said newspaper or newspapers, the lands described in the proclamation shall be deemed in an area under organized forest fire protection. Upon the trial of any person, firm, or corporation for the violation of any provision of this section, a certified copy of said proclamation executed by the State Forester shall be admissible in evidence and shall be conclusive evidence of the fact that the lands described in said proclamation constitute an area under organized forest fire protection within the meaning of this section.

(f) All moneys collected for any violation of this section as fines, forfeitures, etc., shall go to the Alabama Forestry Commission Fund and shall be used in defraying the expense of the administration of such State Forestry Commission.

(Acts 1939, No. 492, p. 711, §1; Code 1940, T. 8, §204; Acts 1943, No. 464, p. 426, §1; Acts 1980, No. 80-743, p. 1512, §1; Act 98-603, p. 1321, §1; Act 2010-603, p. 1471, §1.))

§9-13-12. Uncontrolled fires declared public nuisances: liability for refusal or neglect to control or extinguish same,

Any fire burning uncontrolled on any forested, cutover, brushland or grassland area is hereby declared to be a public nuisance by reason of its menace to life and property. Any person, firm, association or corporation responsible either for the starting or the existence of such fire is hereby required to make a reasonable effort to control or extinguish it as soon as he has knowledge thereof, and if such person, firm, association or corporation shall refuse or neglect to do so, any organized fire suppression force may suppress the nuisance thus constituted by controlling and extinguishing the fire, and the cost thereof may be recovered from said person, firm, association or corporation responsible for the starting or existence of such fire.

(Acts 1939, No. 429, p. 711, § 2; Code 1940, T. 8, §205.)

§9-13-13. Setting on fire, etc., of woods, etc., without written notice to adjacent landowners

Any person or corporation who shall set fire to or procure another to set fire to any woods, logs, brush, weeds, grass or clearing upon his or its own land without giving adjacent landowners five days' written notice of such intention to do so, unless he or it shall have taken all possible care and precaution against the spread of such fire, shall be guilty of a misdemeanor.

(Acts 1923, No. 486, p. 638, § 12; Code 1923, §4114; Code 1940, T. 8, §207.)

6.2. Alabama Prescribed Burning Act

Requirements of the Act: For protection under this act, the following requirements must be met.

1. The burn is to be accomplished only when at least one certified prescribed burn manager is supervising the burn or burns that are being conducted.
2. A written prescription is prepared and witnessed or notarized prior to prescribed burning.
3. A burning permit is obtained from the Alabama Forestry Commission.
4. It is conducted pursuant to state law and rules applicable to prescribed burning.

§ 9-13-270. Short title.

This article may be cited as the "Alabama Prescribed Burning Act."

(Acts 1995, No. 95-609, p. 1304, §1.)

§ 9-13-271. Legislative findings.

(a) The Legislature hereby finds and declares that the application of prescribed burning is a landowner property right and a land management tool that benefits the safety of the public, the environment, the natural resources, and the economy of Alabama. Therefore, the Legislature finds that:

(1) Prescribed burning reduces naturally occurring vegetative fuels within wildland areas. The reduction of the fuel load reduces the risk and severity of major catastrophic wildfire, thereby reducing the threat of loss of life and property, particularly in urbanizing areas.

(2) Many of Alabama's natural communities require periodic fire for maintenance of their ecological integrity. Prescribed burning is essential to the perpetuation, restoration, and management of many plant and animal communities. Significant loss of the state's biological diversity will occur if fire is excluded from fire-dependent ecosystems.

(3) Forest lands constitute significant economic, biological, and aesthetic resources of statewide importance. Prescribed burning on forest land prepares sites for reforestation, removes undesirable competing vegetation, improves wildlife habitat, expedites nutrient cycling, and controls or eliminates certain forest pathogens.

(4) The state manages hundreds of thousands of acres of land for parks, wildlife management areas, forests and other public purposes. The use of prescribed burning for management of public lands is essential to maintain the specific resource values for which these lands were acquired.

(5) Proper training in the use of prescribed burning is necessary to ensure maximum benefits and protection for the public.

(6) As the population of Alabama continues to grow, pressures from liability issues and nuisance complaints inhibit the use of prescribed burning.

(b) The purpose of this article is to authorize and promote the continued use of prescribed burning for ecological, silvicultural, agricultural and wildlife management purposes.

(Acts 1995, No. 95-609, p. 1304, §2.)

§ 9-13-272. Definitions.

As used in this article, the following words have the following meanings:

(1) Certified Prescribed Burn Manager. An individual who successfully completes a certification program approved by the Alabama Forestry Commission.

(2) Prescribed Burning. The controlled application of fire to naturally occurring vegetative fuels for ecological, silvicultural, agricultural and wildlife management purposes under the specified environmental conditions and the following of appropriate precautionary measures which cause the fire to be confined to a predetermined area and accomplishes the planned land management objectives.

(3) Prescription. A written plan for starting and controlling a prescribed burn to accomplish the ecological, silvicultural, and wildlife management objectives.

(Acts 1995, No. 95-609, p. 1304, §3.)

§ 9-13-273. Liability for damage caused by fire; requirements; rules and guidelines; fees for certification or training.

(a) No property owner or his or her agent, conducting a prescribed burn in compliance with this article, shall be liable for damage or injury caused by fire or resulting smoke unless it is shown that the property owner or his or her agent failed to act within that degree of care required of others similarly situated.

(b) Prescribed burning conducted in compliance with this article shall be considered in the public interest if it meets all of the following requirements:

(1) It is accomplished only when at least one certified prescribed burn manager is supervising the burn or burns that are being conducted.

(2) A written prescription is prepared and witnessed or notarized prior to prescribed burning.

(3) A burning permit is obtained from the Alabama Forestry Commission.

(4) It is conducted pursuant to state law and rules applicable to prescribed burning.

(c) The Alabama Forestry Commission may promulgate rules for the certification of prescribed burn managers and guidelines for a prescribed burn prescription.

(d) The Alabama Forestry Commission may charge and collect fees and other payments from persons applying for certification or training as a prescribed burn manager as may be necessary to provide training required for certification as a prescribed burn manager and to carry out other administrative aspects of this article; however the expenditure of any fees charged by the Forestry Commission under this subsection shall be budgeted and allotted pursuant to the Budget Management Act and Article 4 of Chapter 4 of Title 41.

(Acts 1995, No. 95-609, p. 1304, §4.)

§ 9-13-274. No certification as prescribed burn manager required in certain circumstances.

Nothing in this article shall be construed as requiring certification as a prescribed burn manager in order to conduct burning operations on one's own property or on the lands of another with the landowner's permission as long as applicable state laws and rules relating to prescribed burning are complied with.

(Acts 1995, No. 95-609, p. 1304, §5.)

6.3. Certified Burn Manager Continuing Education Requirement

In 2003 the Alabama Forestry Commission instituted a regulation that requires all Alabama Certified Prescribed Burn Managers to complete six hours of approved continuing education every five years in order to maintain certification. The Commission took this step to ensure that prescribed burn manager stayed abreast of current evolving technology particularly with regards to air quality.

6.4. Minimum Standards For Prescribed Burning Plans

1. **Personal information to include:**
   a. Name of property owner
   b. Owner's mailing address
   c. Owner's phone number
   d. Same information on individual preparing the plan and/or executing the burn
   e. Prescribed burn manager certification number.

2. **Description of area to be burned:**
   a. County
   b. Section, Township, Range
   c. Acres to be burned
   d. Type and size of overstory
   e. Type and size of understory
   f. Fuel type and amount
   g. Topography

3. **Purpose of burn**

4. **Pre-burn information to include:**
   a. Needed manpower and equipment
   b. Firing techniques to be used
   c. List of areas around site that could be adversely impacted by smoke from burn*
   d. Special precautions taken

**As determined by A Smoke Screening System for Prescribed Fires in Alabama.*

5. **Range of desired weather information to include:**
    e. Surface wind speed and direction
    f. Minimum and maximum relative humidity
    g. Maximum temperature
    h. Transport wind speed and direction
    i. Minimum mixing height
    j. Dispersion index

6. **Starting time and completion of ignition**

7. **Sketch of area to be burned**

6.5. ADEM AND EPA

Under the authority of the Clean Air Act the U.S. Environmental Protection Agency (EPA) and the Alabama Department of Environmental Management (ADEM) are charged with the responsibility for public safety. Standards have been set for certain compounds that occur in the atmosphere that may be detrimental to human health. The agencies have established standards, NAQQS *(see chapter 7, Smoke Management)*. While it is not necessary for the burn manager to know all the compounds and their critical levels it is essential that the burn manager be sensitive to air quality, stagnation, and the potential public health risks. In Alabama there are several areas that seasonally tend to be in *non-attainment*, not meeting the standard.

Under the authority of the EPA, ADEM restricts all outdoor burning, except for prescribed burns for silvicultural, agricultural and wildlife management purposes. Under ADEM regulations, "open burning" is not allowed during the months of May through October. Counties include Baldwin, Dekalb, Etowah, Lawrence, Jefferson, Madison, Mobile, Montgomery, Morgan, Russell, Shelby, and Talladega. Although this regulation does not apply to prescribed burns, it does apply to the burning of piled debris for land clearing or any "miscellaneous" burns. The AFC will not issue Burn Permits for these restricted counties.

You must also consider the impact on Atlanta and Chattanooga when burning near the state line. Burn managers must be sensitive to the air shed of their burn and take precautions to prevent nuisance problems for the public.

Type One Air Sheds (*see chapter 7, Smoke Management*) are defined and listed in the Clean Air Act. They are scenic areas and the primary concern is visibility. The Sipsey Wilderness Area of the Bankhead National Forest in Alabama is an example.

ADEM works closely with the AFC to implement programs designed to protect public health in Alabama. All permitting and burn bans are handled by the AFC.

Chapter 7

Smoke Management

7.1. Smoke Management Strategies

Smoke management includes planning, screening, and emissions reduction.

Avoidance - using meteorological conditions when scheduling burning in order to avoid incursions of wildland fire smoke into smoke sensitive areas (SSAs)

Minimization - using techniques to minimize the smoke output per unit area burned and decrease the contribution to regional haze as well as intrusions into designated areas

Dilution - controlling the rate of emissions or scheduling of dispersion to assure tolerable concentrations of smoke in designated areas

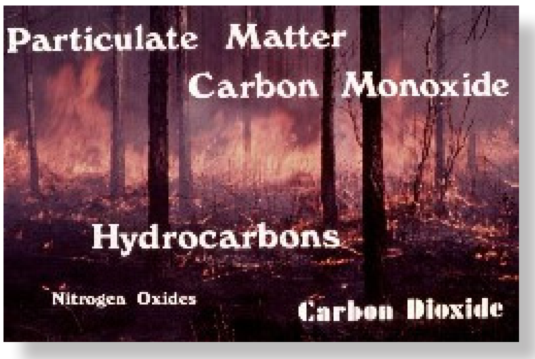
7.2. Why Plan For Smoke Dispersal?

National Ambient Air Quality Standards (NAAQS) have been established by the EPA for those compounds which exist in the atmosphere that may cause a human health problem. The standards are expressed in parts per million, PM10, PM25, etc. Historically prescribed burners have thought that particulate matter, which causes reduction in visibility, was the only problem with wildland fire smoke. While particulate matter is still an important concern, burners must be aware of NAAQS. If NAAQS become a problem, ADEM will have the Alabama Forestry Commission deny the issuance of burn permits in the area. You must also consider the impact on Altanta and Chattanooga when burning near the state line.

REGULATED POLLUTANTS (a partial list)

Wildland fire smoke is primarily water vapor. Burning wildland fuels may produce the following regulated compounds:

- **Particulate Matter** - The pollutant that can be a problem with forestry smoke. It can affect visibility and could possibly aggravate the breathing of people with respiratory problems.
- **Hydrocarbons** - Produced in very small amounts in wildland fires.
- **Carbon Monoxide** - Smoke from forestry activities (wildfire and prescribed fire) produces small quantities that are rapidly diluted in the open air.
- **Nitrogen Dioxide** - Negligible amounts produced.
- **Sulfur Dioxide** - No sulfur dioxide is found in forestry smoke except in rare cases where sulfur is in the ground.



The cumulative effect of all sources of smoke and pollutants in an area may result in problems. Prescribed burners do not operate in isolation. The smoke from a burn may seem inconsequential but may result in saturation, exceed acceptable levels, when combined with other smoke in the area.

Class I Airsheds were established by the U.S. Congress in the Clean Air Act. They are scenic areas where visibility is critical to the esthetics of an area such as Grand Canyon National Park. The Sipsey Wilderness Area on the Bankhead National Forest is a Class I Airshed.

7.3. Pre-Burn Smoke Management Planning

The planner and manager should consider smoke factors prior to the burn. Good merchandising of timber can reduce the fuel load and reduce smoke emissions. Felling or raking around snags and removal of 100- and 1,000-hour fuels from the burn area will reduce the fuel load and subsequently reduce smoke emissions. Preventing fire from getting into boggy areas and pocosins where peat and other organic soils may be ignited will prevent residual smoke production that could last for several days.

Burning immediately following a light rain, which wets the humus and part of the duff where the fuel load is heavy, may reduce the amount of fuel consumed and thus the smoke produced. Likewise planning the burn at a time when the 100- and 1,000-hour fuels are too moist to ignite can reduce smoke emission particularly residual smoke from smolder.

Who Should Use Smoke Screening?

[No Prescribed Fire Should Be Initiated Without First Performing Detailed Smoke Screening]

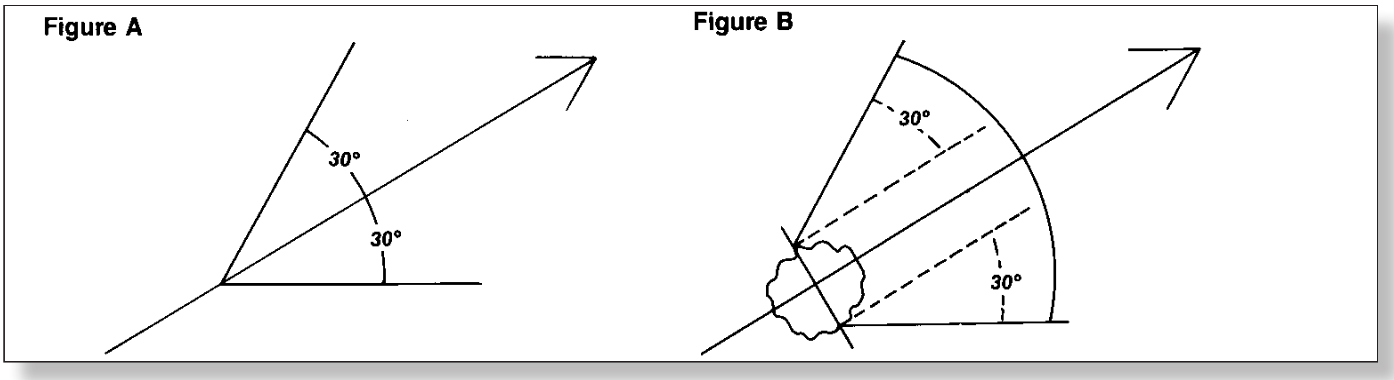
The good old days of grabbing the torch and going are gone. All prescribed burning activity must be carefully pre-planned, including planning for smoke dispersal with smoke screening.

Smoke Screening is the process of reviewing the proposed burn for any impacts that may result from smoke emissions. The burn manager and planner must be aware of the smoke sensitive areas (SSAs) in the vicinity of the burn. The planner and manager must also be familiar with the basics of smoke dispersal.

Smoke Sensitive Areas

Smoke sensitive areas (SSAs) are those places where smoke will cause problems or be a general nuisance to the public. Blocked visibility on highways may result in accidents. Smoke in chicken houses and hog parlors may cause animal fatalities. Smoke at airports can cause air traffic problems. Smoke at hospitals or nursing homes can cause problems particularly for individuals with respiratory problems. Shuts-ins who depend on supplemental oxygen or who have other respiratory problems can be adversely affected by smoke. Smoke in populated areas can be a general nuisance. Transport winds may carry smoke long distances. Special attention must be paid to critical areas downwind such as airports, hospitals, areas of non-attainment, and metropolitan areas.

Smoke Dispersal



Smoke disperses at a 30° angle to both sides of a straight line from a point source of smoke. However, wind is seldom from a fixed direction but tends to vary. Likewise we don't burn points, we burn areas, so we must consider the widest points of the source of smoke and consider the 30° drift dispersal from that point. The distance smoke will travel depends on weather factors, topography, and the volume of smoke produced. The volume of smoke produced depends on the volume of fuel that will be converted into smoke and on the speed of ignition.

Two of the strategies of smoke management can be related to each of these dispersal considerations. Avoidance can be addressed with the 30° dispersal knowledge. Dilution can be manipulated by the speed of ignition. The slower the ignition the more smoke is diluted as it enters the atmosphere.

The Southern High Resolution Modeling Consortium (SHRMC) at **http://shrmc.ggy.uga.edu** lists "Simple Smoke Screening" and "VSmoke" as useful tools for modeling daytime smoke dispersal. The use of these tools requires close on-site reconnaissance of SSAs. These tools do not address nighttime down-drainage SSAs. (*See section 7.10, Computer Smoke Screening Models*)

Topography

Where does smoke go at night? Down-drainage. Why? Because it is cool. Road bridges across drainages are critical places. Smoke on interstates and other highways and byways can result in dire consequences including fatalities and damage in the millions.

[Down-drainage smoke is a KILLER !!]

Smoke can be trapped if the surrounding mountains are higher than the mixing height.

The Burn Plan

All burn plans should include plans for smoke.

The following smoke-related questions may be addressed in the plan:

- What quantity of emissions will it take to saturate the airshed?
- Where will smoke concentrate if it settles under an inversion?
- Do special arrangements need to be made to protect populations impacted by these emissions?
- How many burning projects will it take cumulatively to exceed acceptable levels within this airshed?
- How long will this airshed remain stable and harbor the emissions?

[The person who obtains the burn permit is responsible for the decision to burn!

Likewise, the person who obtains the burn permit is responsible for where the smoke goes!]

The plan should address pre-burn smoke matters, smoke screening, monitoring smoke behavior during the burn, mop-up, and post burn, particularly in down-drainage areas at road bridges.

[Minimize Risk... Be on the safe side.]

7.4. Smoke Screening System

Because of the diurnal cycle and the effected weather factors, smoke screening must be considered for both daytime and nighttime.

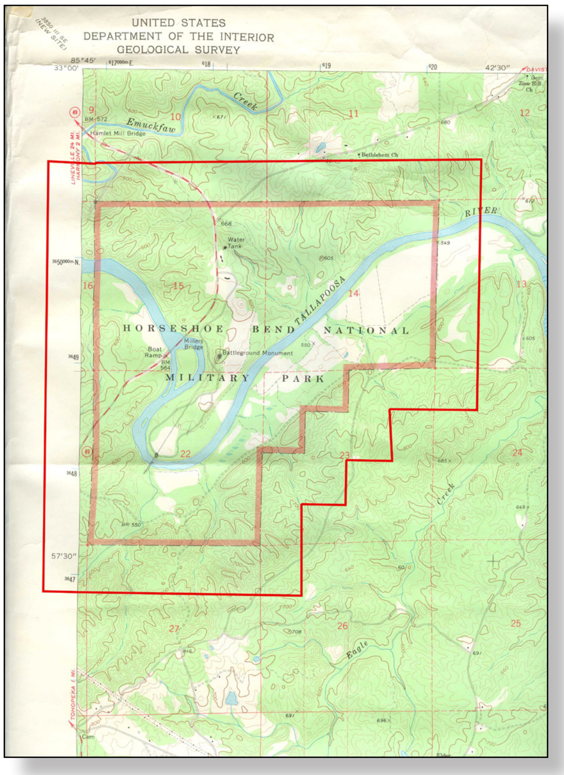
The burn planner and manager must be thoroughly familiar with all the SSAs in the vicinity of the burn. The distance of concern depends on the weather conditions, particularly the Dispersion Index, and the volume of fuel to be converted into smoke by the fire.

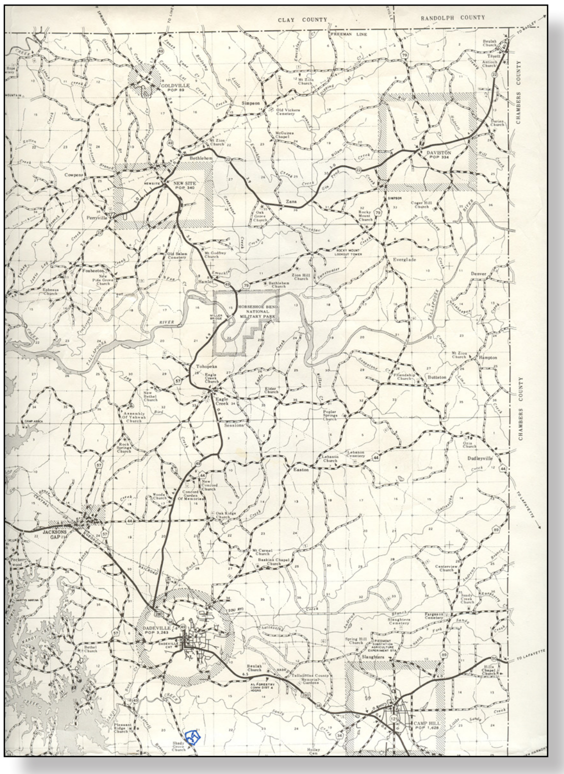
[TONS OF FUEL => TONS OF SMOKE]

The primary question answered by smoke screening is what wind directions are safe for the planned burn? The planner must know the fuel model, the burn objectives, the acres to be burned, where the SSAs are, the Dispersion Index, and the wind direction.

Wind directions that will avoid smoke problems can be identified by the following steps:

Step 1 - Plot the burn area on a map, preferably a 7.5' topographic map and/or a two-mile-per-inch Alabama Department of Transportation county road map.





Step 2 - Plot a five-chain perimeter around the burn – this is the immediate impact zone. Note in the previous example using the topographic map, the adjoining maps to the west, northwest, and north would be required to do the job properly. County mile-per-half-inch maps can be used for this purpose too. Use ten chains if the burn area is greater than 300 acres or if helicopter ignition is planned.

Step 3 (example)

Using the Dispersion Index (DI)	41-60
Burn plan objective	fuel reduction
Fuel conditions	pine thinning litter - dry with moist duff
Stand conditions	thinned 17 year old pine plantation – partially shaded
Ignition prescription	backing fire

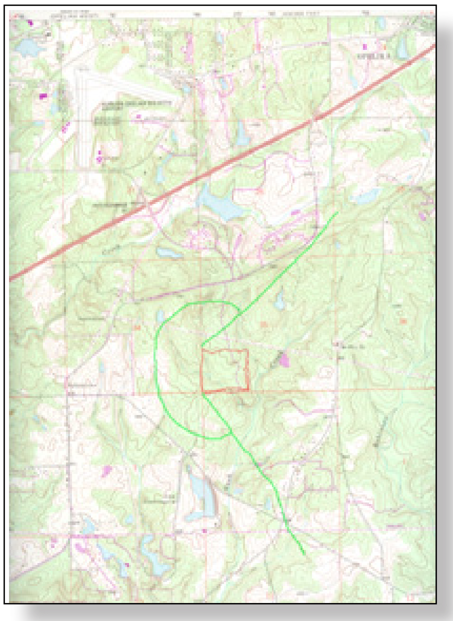
Determine the smoke impact distance for a DI of 41-60 1 mile and DI of 61-100 1/2 mile from the Distance of Possible Smoke Impact chart.

Distance of Possible Smoke Impact

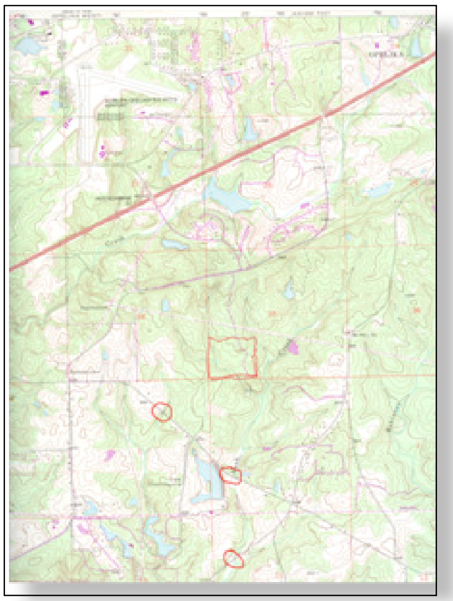
Fuel Type or Firing Technique *(Fuel Model)*		Distance in Miles by Dispersion Index+					
		7*-12 Very Poor	13-20 Poor	21-40 Fair	41-60 Good	61-100 Very Good	>100 Excellent
1.	Grass, crop residue, light understory, or using backing fire with any fuel type	8	4	2	1	1/2	1/4
2a.	Heading fire, spot fires, or <300 acres	16	12	8	4	2	1/4
@2b.	Heading or spots >300 acres	Do not burn	20	12	6	3	1/2
#3a.	Scattered logging debris <200 acres	Do not burn	16	8	4	2	1
#3b.	Scattered logging debris >200 acres	Do not burn	Do not burn	12	6	4	2
#4.	Small dry piles	Do not burn	Do not burn	12	6	4	2
#5.	Large, wet piles or windrows	Do not burn	Do not burn	Do not burn	15	10	5
*	When Dispersion Index falls below 7, **Do Not Burn!**						
@	When the fuel type is palmetto-gallberry more than 5 feet high, use 1.5 x above distances.						
#	Firing should be completed by 3:00 p.m. because dispersion will deteriorate at night, usually to "poor."						
+	Based on interstates which are most sensitive to smoke.						

Step 4 - Plot the two smoke impact distances on the maps used in Step 1, by drawing a line around the track the distance from the track perimeter determined in Step 3.

Step 5 - On the same map, identify all downwind, daytime SSAs.



Step 6 - On the same map, identify all down-drainage, nighttime SSAs.

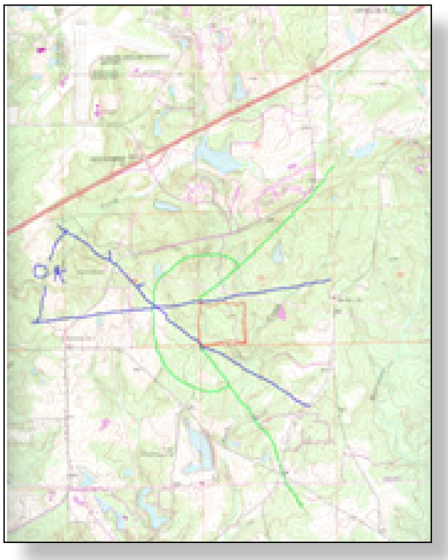


(Points where streams cross roads anywhere around the track)

Step 7 - List all the SSAs in the burn plan.

Step 8 - On the map, determine and identify/shade the downwind areas in which smoke cannot be tolerated based on the info from Steps 1 through 7.

Step 9 - Determine acceptable wind directions based on Dispersion Index and SSAs.



(Note the 30° dispersal allowance. In this example, the acceptable wind direction that will not result in smoke in an area in which it cannot be tolerated is from approximately west to northwest.)

Step 10 - List the acceptable wind directions in the planned weather section of the burn plan.

7.5. Mop-Up

Mop-up, eliminating sources of smoldering flame and residual smoke, is critical to prevent down-drainage nighttime smoke problems at road crossings. Mop-up is accomplished by working through the burned area to extinguish all sources of smoldering smoke and burning cat faces. Using a shovel and dirt is one method. Using water from a bladder pack or a mobile unit is another alternative.

Doing it the hard way: dirt on a cat face.

A mobile source of water is an efficient way to mop-up.

Caution! There may be other sources of smoke in the airshed in which you are working. Other prescribed burns, industrial smoke, construction smoke, etc. may all combine downwind to aggravate any potential problem.

Do not rely solely on tables or guidelines. Use judgment on site, based on experience! ***Remember the strategies:*** Avoidance, Dilution, Minimization. ***Certain situations deserve special attention . . .*** residual smoke/smoldering fire, windrows and large dirty piles, nighttime burning, large burns, and helicopter burns.

Residual-smoldering smoke considerations:

- The same volume of fuel consumed with a smoldering fire will produce roughly five times the amount of smoke as a flaming fire.
- Fuels containing waxes (palmetto and gallberry) produce more smoke.

To reduce the impact of smolder:

- Reduce volume of fuel (smaller block)
- Reduce the fuel size (merchandising)
- Burn only dry fuels (weather timing)
- Do not burn stumps or snags (pre-burn prep)
- Do not allow dirt in piles (use a root rake when piling, work with the logger)

7.6. Windrows And Large Piles

Windrows are the most polluting woodland fuels burned in Alabama! Don't burn windrows and large piles unless there is no other alternative, including not building them in the first place.

Piles contain a large amount of potential energy which when ignited may form a convection column that may loft fire brands to areas where they are not wanted. Wet dirty fuels in piles and windrows are a potential source of smolder smoke. Residual smoke from piles may linger for days and drift onto highways and block visibility. Piles when burning may form a convection column that lofts fire brands into neighboring fuels that were not included in the burn plan.

If conditions are not perfect for pile burning, DO NOT push the envelope! It is better to leave a pile unburned than to risk an escape or smoke problem. The few acres gained by pile burning are not worth the risk.

To reduce the impact of piles:

- Don't build them.
- Isolate piles and burn under favorable conditions.
- Break up piles and spread material.
- Require logger to spread logging slash.
- Do NOT push windrows.
- Burn with high ventilation.
- Use root rake when piling.
- Burn with low surface wind speed.
- Complete burnout one hour before sunset.

7.7. Night Burning

Smoke produced will not lift due to atmospheric stability. As smoke cools it will settle into low areas and drift down-drainage.

To reduce smoke from night burning:

- Wait until cold front moves through and wind is forecast to blow all night.
- Use backing fire.
- Burn when relative humidity is under 80 percent.
- Burn when there is no inversion.

7.8. Large Burns

300+ acres . . .1,000+ acres. Large burns produce large quantities of smoke. Consider the total volume of fuel and the potential total volume of smoke.

To reduce smoke from burning large tracks:

- Break area into smaller blocks.
- Burn scattered blocks in any given day.
- Burn when atmospheric conditions are favorable.
- Give down-drainage SSAs special attention.
- Check for nearby burns.
- Be sure smoke from different blocks does not come together down-drainage.
- Be conscious of downwind urban areas.
- Increase the Dispersion Index.

7.9. Helicopter Burns

The rapid ignition of helicopter burns due to the rapidity of ignition may put large volumes of smoke into the atmosphere in a very short period of time.

To reduce potential smoke problems from helicopter ignition:

- Increase Dispersion Index by one category.
- Do not use a helicopter when RH is over 80 percent or fog is forecast for the night.
- Do not use when an inversion is forecast.
- Ignite only a few lines on one block then go to another.
- Stop ignition early in the day.
- Burn only with 3,000+ feet mixing height.
- Don't depend on forecast – **OBSERVE!!!**

Caution !!!
Smoke flows down-drainage at night!
How far is the nearest urban area? 30, 50 miles?
Be Smoke Wise

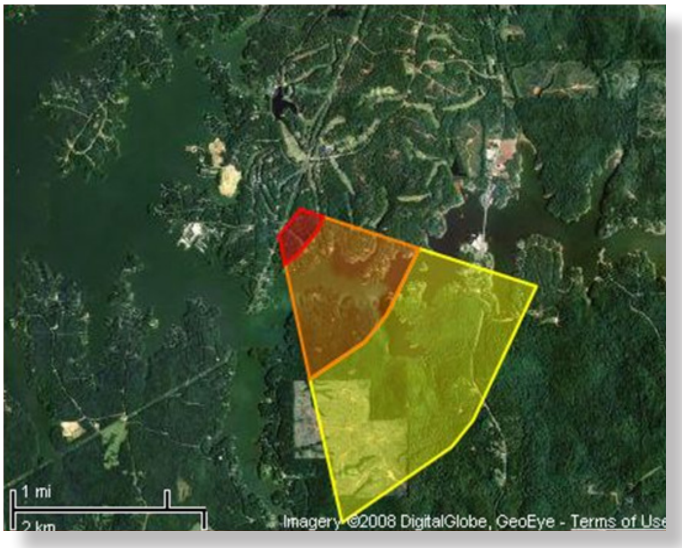
7.10. Computer Smoke Screening Models

The Southern High Resolution Modeling Consortium (SHRMC) has developed several computer smoke screening models that are very useful to prescribed burn planners and managers. These models require the understanding of the material presented in sections 7.1 through 7.9. Smoke screening requires a visit to the burn site to analyze the potential smoke production based on fuels and fuel models present and to determine the location of all problem smoke receptors and SSAs. The SHRMC models do not take the place of on-site analysis,

The models may be found at **http://shrmc.ggy.uga.edu/**. There are several smoke products, **http://shrmc.ggy.uga.edu/smoke/**.

Simple Smoke Screening employs a Google-type map that allows the desired tract of land to be located: **http://shrmc.ggy.uga.edu/maps/screen.html**. This model simulates the smoke screening techniques employed in sections 7.3 through 7.5. In addition the model requires inputs pertaining to fuels and wind direction (*chapter 3*), as well as ignition pattern (*chapter 4*). The model produces a KML file which may be exported to Google Maps for further analysis.

Example



VSmoke is a similar model that gives more information regarding compounds that may be detrimental to human health. This model, similar to Simple Smoke Screening, employs a Google-style map that allows for location of the burn project. The model provides a lot of information about various smoke-related compounds, concentrations and human health effects. VSmoke requires several inputs including acres, duration of the burn, ignition method/ pattern (see *chapter 4*), fuel type and tons per acres (see *chapter 3*), fuel moisture scenario, percent fuel consumed, PM 2.5 emissions factor (**www.epa.gov/ttn/ chief/eiip/pm25inventory/index.html**) [it is best not to modify this factor; new information based on the 2.5 standard is being developed], particulate emissions rate [not to modify], heat release rate [not to modify], mixing height and stability class (page 19), as well as transport wind speed and direction (page 18), background 2.5 factor and plume rise factor [not to modify]. The output from VSmoke probably over-predicts concentration distance. Currently, research employing on-ground monitoring stations is being conducted.

Example

Chapter 8

The Plan: Comprehensive Prescribed Burn Planning

[NO PLAN = > NO BURN]

No prescribed burn should be attempted without first preparing a detailed burn plan. The plan is more than just a plan. The plan should become a report of what is done to prepare for the burn and what happens during the burn, as well as evaluate the effects of the burn. The document, including the pre-plan, checklists, burn execution documentation, and post-burn evaluation becomes a "shield" that serves to protect the prescribed burn manager and the person who obtains the burn permit from charges of gross negligence. Adhering to a well prepared burn plan enables the prescribed burn manager to proceed with confidence that the objectives can be accomplished without problems.

There is no set form for a burn plan but there are certain groups of information that must be included in any good burn plan. The burn planner and manager should develop a plan form for each burn. No two burns are alike. Each burn has its own unique considerations.

The five steps to successful prescribed burning are analysis, prescription, preparation, execution, and evaluation. These steps may be thought of as: the pre-plan (analysis), the written plan (analysis and prescription), pre-burn (preparation), burn execution, and evaluation. All burn plans should include each of these steps.

8.1. Pre-Plan

Prescribed burning is an efficient silvicultural tool when undertaken properly. Frivolous burning can be an expensive proposition when the objectives are not met or an escape occurs. Typically the resource manager thinks about using fire in conjunction with some other resource activity: harvesting, wildlife habitat management, ecological restoration, etc. Plans for the burn should be considered when implementing other resource activities. For example timber harvesting should utilize as much of the tree as possible to limit the amount of residual material that becomes fuel for the fire.

8.2. Written Plan

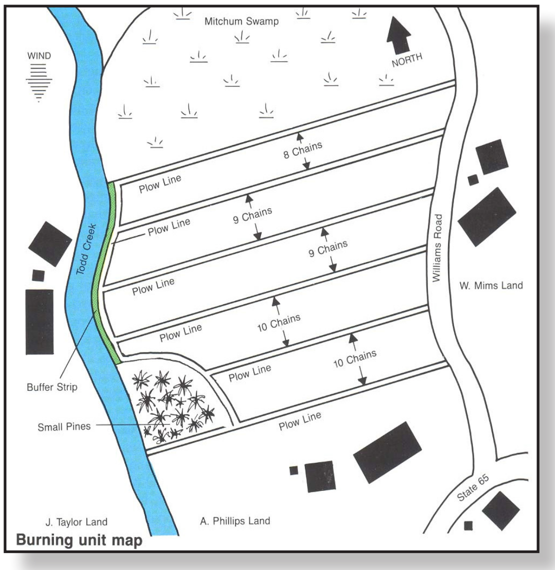
A formal written plan should be initiated once the resource manager has committed to using prescribed fire. A plan is not required by law, but a plan is required for liability protection under the Alabama Prescribed Burn Law *(see chapter* 6). The minimum standards for a burn plan are provided in AFC regulation. Additional information beyond the minimum requirements is helpful.

Basic Information

A burn plan should include certain basic information such as the landowner's name, phone number, and mailing address. Also, the name, phone number, and mailing address of the person who obtains the burn permit should be included with the permit number, date, and time. When the burn is executed, the certified burn manager's certification number should be included.

[A burn permit is NOT a license to burn !]

The legal property description of the burn area must be included: county, section, township, range, and quarter section. Additionally, a sketch of the property and burn area on a map *(example: 7.5 minute USGS topographic)* should be included. In Alabama, the 2-mile-per-inch Department of Transportation county road maps can be very helpful. The land description should include the acres within the burn perimeter and the acres expected to burn (excluding creek bottoms or other areas that are not expected to burn through). A description of the topography and soils should also be included.



Burning unit map

A detailed description of the timber stand including type and size of overstory and understory, timber volume, and the fuel conditions is an essential part of the burn plan. Tree size, fuel loading, and characteristics are important.

Objectives

The prescribed burn objectives are the basis of a prescription. Every plan should include three objectives; safety, resource, and fire.

Safety Objective - The most important objective of any prescribed burn is safety – personal safety, safety of the neighbors, and public safety – both physically and from an air quality perspective. Public safety and air quality issues are becoming a more significant concern for burn managers.

The burn manager must be cautious to protect his or her own safety while being responsible for the burn activity. The burn will probably fail to meet the resource objective if the burn manager cannot perform due to injury. Crew safety is also essential in accomplishing the resource objective. If a crew member is unable to perform, then the rest of the crew, the resources, the neighbors, and the public may be put at risk.

Neighbors must be protected by keeping the fire within the planned burn area. Neighbors must also be protected from smoke. The burn manager should contact neighbors prior to the burn and be knowledgeable of any special concerns such as a neighbor with a respiratory problem.

Public safety is a growing concern for burn managers. With a growing population that is becoming more litigious and an expanding wildland urban interface it is essential that the burn manager, when conducting the burn, take all necessary precautions to protect the public. Highway accidents resulting in bodily harm, fatalities, and property damage can result if the proper precautions are not taken. An escaped burn can cause substantial property damage to neighboring structures and natural resources and cause smoke problems. The burn manager must be aware of air quality issues in accordance with Alabama Prescribed Burning Laws *(see chapter 6)*. The burn manager must also be sensitive to National Ambient Air Quality Standards (NAAQS) and areas of non-attainment. It is important that a prescribed burn not significantly degrade the air mass.

Resource Objective - When the resource manager first conceives of using fire, a resource objective is established. It may be single in purpose or it may include a combination of objectives. Most of the prescribed burning in Alabama is done for one of three objectives; site preparation, wildlife habitat, or hazardous fuels reduction management. Other burn objectives include timber stand improvement, ecological restoration, agro-forestry, tree disease control, and esthetics *(see chapter 5, Fire as a Tool)*.

The burn plan must clearly define the burn objective in quantifiable terms. For example: if the burn is designed to clear the site to facilitate tree planting, then 100 percent of the fine fuels should be consumed, at least 50 percent of the 10-hour fuels should be consumed, and no more than 50 percent of the duff should be consumed. Or in the case of a fuel reduction burn, an example objective would be: 100 percent of the fine fuels should be consumed, 50 percent of the 10-hour fuels should be consumed, 75 percent of the duff should be consumed, and none of the humus should be consumed. The burn planner must establish the objective to accomplish the resource need.

Fire Objective - The fire objective is dictated by the resource objective. Season of burn, fire intensity, flame length, rate of spread, backing versus heading are all factors to be considered in the fire objective. The fire objective should include start time, time for completion of ignition, and burnout time. For example, the burn may start at 9 a.m., ignition completed by 3 p.m., and burn-out completed by 5 p.m.

Computer models (not included in this publication) such as BEHAVE (**www.fire.org/**) can be very helpful in predicting fire behavior.

Smoke Screening

Smoke screening is a detailed process that requires the gathering of information and analysis. Smoke screening should be completed well in advance of the burn. The SSA and the acceptable wind directions should be investigated and listed in the burn plan. A copy of the smoke screening maps should be attached to the plan and become a part of the plan.

As the burn progresses, smoke behavior should be noted in the plan. There should be a contingency plan if for some reason smoke ends up in an area where it will cause a problem. *(See chapter 7, Smoke Management)*

Weather

The burn plan should include a section defining the “desired” weather conditions necessary to accomplish all of the objectives of the burn: safety, resource, and fire. The plan should also provide a place for the predicted weather for the day of the burn from the National Weather Service and a place to record the actual weather as observed throughout the burn. The weather information included in the plan should contain:

Weather Prescription Worksheet

			Actual Weather		
	Prescribed Weather	Weather Forecast	Test Burn	During Burn	At Burnout
Season/month/ dormant or growing	_______	_______			
Temperature (max) °F	_______	_______	_______	_______	_______
Dry bulb °F			_______	_______	_______
Wet bulb °F			_______	_______	_______
Relative Humidity (min and max)	_______	_______	_______	_______	_______
Surface wind speed, 20’	_______	_______			
Surface wind speed, 6’	_______		_______	_______	_______
Surface wind direction	_______	_______	_______	_______	_______
Transport wind speed	_______	_______			
Transport wind direction	_______	_______	_______	_______	_______
Mixing height	_______	_______			
Ventilation index*	_______	_______			
Dispersion index	_______	_______			
Atmospheric stability	_______	_______	_______	_______	_______
Sky cover	_______	_______	_______	_______	_______
KBDI	_______	_______			
Probability of ignition*	_______	_______	_______	_______	_______
Fuel moisture*	_______	_______	_______	_______	_______

Not all of the items listed in the previous chart are reported by the NWS. The prescribed desired weather is established by the planner and is critical to the fire and resource objectives. The forecast weather is obtained from the NWS either via the AFC website or by contacting the AFC Central Dispatch Center at 1-800-392-5679, except for items marked with the *. These items must be calculated by the planner or the crew member responsible for observation and documentation. The "Actual" items should be observed and recorded on site prior to the burn, several times during the burn, and at burn out. The actual information during the burn can be reported on a separate worksheet.

Pre-Burn Activity

The burn plan should include all of the pre-burn activities required to accomplish the burn objective. Include a copy of the fire weather forecast for the day of the burn with the burn plan.

Firebreaks

The plan should specify the type of firebreaks for the burn *(see chapter 9)*. Firebreaks may be in different forms. Normally firebreaks are designed to contain the planned burn by establishing a fuel break where the flames can be held.

Pre-Mop-up

The burn area can be prepped following firebreak establishment to eliminate snags and other problem fuels adjacent to the break. Felling and removing snags will reduce the risk of a fire brand crossing the break and will reduce residual smoke. Moving dry tops away from the break will reduce the risk of hot spots and lofted fire brands. This prep work may reduce the amount of mop-up required following the burn.

Notify Neighbors

Neighbors should be notified of plans to burn prior to the day of the burn so that they might take precautions or burn their own property at the same time. The burn plan should include a list of the neighboring landowners with contact information so that the burn manager can notify neighbors on the day of or during the burn if necessary.

"Caution: Smoke on the Road" signs in the area of the burn on the day of the burn helps to make local people aware of potential visibility problems.

Notify Officials

Its vitally important to notify the AFC county manager, the sheriff's office, and the local volunteer fire department chief. Contact information should be included in the plan.

Equipment Preparation

Equipment needs should be determined and detailed in the plan. It is the burn planner's responsibility to specify the proper equipment for the operation.

Obtain a Burn Permit

The burn plan should include the contact information for obtaining a burn permit (which is the toll free number to the AFC Dispatch Center), the Forestry Commission county office number, and **www.forestry.alabama.gov**.

My fire
My smoke
My problem
Wherever they go

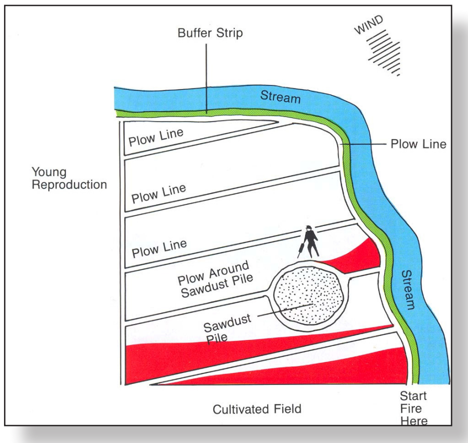
Crew Training and Briefing

The crew composition should be specified in the burn plan. All crew members should be trained and in good physical condition. Prior to the initiation of the burn, the crew should be briefed, particularly about the ignition plan, communications, their responsibilities, and their contingency duties. One crew member, other than the prescribed burn manager, should be assigned the responsibility of monitoring and recording weather conditions, fire behavior, and smoke behavior. Part of this crew member's responsibility should include keeping the entire crew informed of weather conditions and fire behavior.

Contingencies

Contingencies should be considered by the prescribed burn planner and manager. Such things as a change in the wind causing smoke on a road and heavy fuels on an adjoining property are examples of situations that need contingency planning. The burn manager should plan how to deal with each contingency and define the role of each crew member in the event a contingency situation develops. See chapters 11 and 12 for factors to consider. The contingency plans should be reviewed with the crew during the pre-burn review.

Burn Execution Plan



Ignition Plan - The burn plan should include an ignition plan which specifies the initiation of ignition and the extension of ignition. The ignition plan should include a sketch or map indicating the test burn, black lining, and ignition extension. (*See chapter 3)*.

The ignition plan consisting of a description as well as a sketch, is a part of the burn plan, and should be reviewed with the crew on the day of the burn. The sketch should point out the place to conduct the test burn as well as how "blacklining" will be conducted and how ignition will be advanced.

Test Burn - The plan should specify where the test burn should be ignited based on the prescribed wind direction. In the sketch at right, a test burn would be conducted and observed at the starting point prior to proceeding with ignition.

Blacklining - The plan should specify where backing fires should be started to back fire off of downwind lines to make them safe from jumps. The width of the "black" determines how effective it may be in reducing the risk of jumps and varies with the circumstances. The higher the wind speed, the lower the relative humidity, and the lower the fine fuel moisture content the wider the black should be.

Extending Ignition - Following the test burn and after the "black" has been established, the plan should specify how ignition is to be extended to achieve the flame objective, which in turn should accomplish the resource objective.

Ignition Devices - The plan should specify what type ignition device to use. There are several devices that may be employed. Normally burn block size is a factor to consider when planning which ignition device to use *(see chapter 4)*.

On-site Documentation Plan

On-site documentation should include weather, fire behavior, smoke behavior, and times.

The weather data form on page 61 provides only one column for "Actual – During the Burn" weather. A separate worksheet should be included with the burn plan to record hourly or more frequent observations of weather, fire behavior, and smoke behavior observed or measured on site during the burn.

Actual time of start, test burn, blacklining, ignition advancement, and completion should be recorded in the burn plan along with the actual ignition pattern and method.

Burn-Out

Burn-out should be completed prior to the down turn in the diurnal cycle or shortly thereafter. Normally this is around 5 p.m. but varies with season and daylight savings time. The burn manager should plan ignition so that it is complete at early to mid-afternoon. The burn manager may elect to modify the ignition technique and use a more aggressive technique in the event the spread rate is not sufficient to complete the burn-out by the targeted time. This can be risky and may compromise the objectives. Preferably the burn manager will have anticipated spread rate and provided adequate ignition to complete the burn. This may require plowing cross firebreaks so that more area can be ignited quicker. Strip head fires are frequently employed. However, in an understory burn, strip head fires may result in undesirable scorch where the flames merge. An alternative is spot ignition.

Spread rate may be measured on site by observing the flame front. As the diurnal cycle progresses toward mid-afternoon and burning conditions peak, the spread rate should increase. As the diurnal cycle extends past mid-afternoon, the spread rate should slow. *NWCG Fireline Handbook*, Appendix B, Fire Behavior, provides a technique for predicting spread rate using nomograms. The BEHAVE computer model also provides a technique for predicting spread rate.

Mop-up and Secure

The plan for mop-up should be included in the *Smoke Management Plan* and included with the burn plan *(see chapter 7)*. Mop-up may begin soon after the passage of the flame front when the area has cooled sufficiently for crew members to enter the area.

Mop-up is the process of working through the burned area to cool off smoldering spots that are producing smoke that may end up down-drainage later in the day. The burn manager should commit sufficient resources and manpower to this task to ensure that a minimal amount of smoke is being produced as evening approaches. Water tankers, bladder bags, shovels, and rakes are all commonly employed for mop-up activities. Mop-up may be more critical in areas close to SSAs.

In addition, all firebreaks need to be patrolled frequently following the passage of the flame front to ensure that no fire has crossed the break. Flaming cat faces and snags can present problems, both as a source of embers that might blow across the firebreak and as a source of residual smoke. They must be dealt with during mop-up. Alabama law stipulates that the burn area must be tended until the fire is dead out *(§9-13-11, (d)(1)c, "In no case will the person requesting the permit allow the fire to be unattended until it is dead out.")*. In some cases this may require that the burn area be tended for several days. The definition of "dead out" may not be clear, but it is wise to err on the safe side.

Safety Meeting

It is important to conduct a crew meeting to discuss the burn. Problems, safety situations, and accomplishment of objectives should be discussed. The burn manager may gather information from individual crew members and the crew member responsible for recording weather can make appropriate notes. In some cases the post-burn safety meeting may be the beginning of the evaluation process.

Evaluation and On-site Documentation

Evaluation of burn objective accomplishment may be included in the plan for long-range resource management plans. The burn planner can set out the special evaluation techniques to be used *(see chapter 11)*.

8.3. Piles

The burn plan should identify all piles in the burn area and prescribe how piles are to be treated *(see chapter 10)*.

8.4. Night Burning

The burn planner should keep in mind:

CAUTION!

- Night burning should only be done with substantial experience.
- Night burning should only be done in very remote areas.
- Night burning requires a uniform consistent fuel such as wire grass or pine straw.
- Night burning is useful for reducing fuels in young pine plantations.
- Night burning is very risky!

[Dispersion Index and weather change dramatically at night]

Experienced night burners watch for the passage of a cold front. Typically in Alabama the air mass behind a cold front is dry and the wind will be steady from the northwest. Night burners in coastal regions must be particularly sensitive to land and sea breezes *(see chapter 3)*.

8.5 Contingencies: Potential Problems

The burn plan must anticipate anything that might go wrong such as jumps, wind shifts, and smoke on the road. The plan should provide direction and contact information for the burn manager to deal with contingencies *(see chapters 12 and 13)*.

8.6. Signatures, Dates, Witness

The burn plan must be signed and dated prior to the burn in order to be complete. The prescribed burn planner should sign the burn plan and have the signature witnessed and dated at the time the original plan is made. If for some reason the plan is witnessed on the day the burn is conducted, the time should be noted to verify that the plan was made prior to the burn.

The evaluation portion of the burn should be signed and dated by the prescribed burn manager or the person doing the evaluation following each evaluation.

Chapter 9

Pre-Burn

Prior to initiating any burn the following things must be done:

9.1. Develop The Plan

No burn should be conducted without a comprehensive plan *(see chapter 8, The Plan)* that includes smoke screening *(see chapter 7, Smoke Management)*. The plan should be developed at a minimum of several weeks prior to the burn to allow sufficient time to gather the necessary information and attend to essential details.

9.2. Notify Neighbors

Alabama law *(see chapter 6 and chapter 8)* specifies that anyone conducting a prescribed burn must notify the neighboring landowners in writing at least five days in advance of the burn. In addition to being required by law, it is the considerate "neighborly" thing to do even if due care has been exercised. It is beneficial to notify local information "sources" such as the clerk at the corner convenience store.

9.3. Notify Officials

Communications are extremely important. In addition to notifying neighbors, it is wise to notify all local officials; sheriff, volunteer fire departments, Forestry Commission personnel (county AFC personnel do not always get notification of issued burn permits), etc. It is good to visit with the AFC county manager a day or so before the burn and fill the manager in on the burn plans. In the event assistance is needed, the manager will be aware of the burn. This is a common courtesy and may pay off substantially if a problem develops.

Likewise, a call to the sheriff's office will inform them about the burn so that dispatchers can answer questions that will undoubtedly be received as the burn starts putting up smoke. In the event smoke gets on the road and blocks visibility, assistance with traffic control may be needed.

Volunteer fire departments tend to be very conscientious and respond to smoke and phone calls. It is wise to inform the volunteer fire department a day or so in advance of the burn. In some situations the volunteer fire department may be able to provide resources, particularly a water tanker.

9.4. Firebreaks

Sufficient firebreaks and control lines must be established around the burn area prior to initiation of the burn in accordance with the plan. This can be done months in advance, but a final cleaning and inspection of the breaks to determine adequacy must be done on the day of the burn just prior to ignition.

The straighter the firebreak the better. Nooks and bends in the line may result in fire swirls that can loft fire brands across the break. Best Management Practices should be followed to prevent sedimentation in water courses when constructing and maintaining firebreaks. The burn plan should specify where the firebreaks for the planned burn are to be constructed and the character of the breaks.

Established firebreaks
- Temporary
  - Plowed
  - Wet lines
- Permanent
  - Pushed

Passive firebreaks
- Streams
- Poorly drained areas
- Fields
- Roads

Breaks designed to hold a backing fire may be smaller than breaks required to hold a heading fire. When a helicopter ignition is used, breaks should be substantial, possibly fifty feet or more in width, to protect against wayward ignition material. If the control lines for helicopter burning are hand- or ATV-ignited and the black area is adequate, no additional plowed firebreak clearing is required.

Breaks may be natural barriers such as roads or streams. These are referred to as passive breaks. Normally firebreaks are constructed by plowing with a fire plow or pushing with a bull dozer. Plowed breaks are not permanent and may result in water channels that affect hydrology and/or result in erosion. Plowed breaks may be rehabilitated with a bush and bog harrow set to pull the soil back to the center. Plowed breaks have the advantage of being cheaper and faster than permanent pushed breaks.

Pushed firebreaks may be maintained as access roads for other activities. Permanent firebreaks may be maintained with a farm tractor and a disk harrow.

Disked break

Road-side break

Firebreaks may be established by hand raking. Hand raking is slow and labor intensive but may be necessary if equipment access is limited or the area is sensitive. Using the “one lick and go” method with a crew makes the work go faster.

Plowed, pushed, and disked breaks may be seeded with a mix of grasses beneficial to wildlife following the burn. Re-vegetating the breaks minimizes erosion.

In some cases, wet lines may be used by spraying water or foam. This may be risky in the event of a change of wind direction. A substantial mobile source of water and personnel are required for this type firebreak.

Wet lines are useful where low impact burning is called for in parks, preserves, golf courses, and ecologically sensitive areas. They are also useful for burning in the wildland urban interface where it is necessary to burn close to buildings. Wet lines are very temporary and cannot be depended on to hold fire for a long period after application.

Class A foam can be used as a wet line to form a more substantial firebreak than plain water.

9.5. Equipment

All personnel and crew equipment should be in place and ready in accordance with the burn plan prior to the initiation of the burn. Equipment should be serviced, fueled, sharpened, etc. prior to the day of the burn and staged for the burn. Everything should be in place on the morning of the burn.

Prescribed burning equipment comes in various and assorted styles. It is not only the burn planner's responsibility to specify the proper equipment for the operation, but also to see that all equipment is adequate, functioning properly, and in place.

Loaded and ready to go

Tractor-mounted plow

ATV and "mini-engine" standing by

Nurse tanker

Trailer plow

Disk harrow

Communications

Hand tools and drip torch

Nomex clothing, which is designed and manufactured so that it will not burn, is effective protection for crew members. Some organizations specify the personal protective gear a crew member must wear (i.e. NFPA-certified as "Fire Resistant" or "Fire Retardant"), while others leave the decision to the individual.




[Clothing that will melt such as synthetic fibers and plastic-soled boots should never be worn when working on a burn.]

9.6. Crew

The crew must be trained, equipped, and ready for duty. In most cases the crew should assemble their gear the day before the burn.

9.7. Obtain A Permit

Anyone who burns over one-quarter acre or burns contiguous to continuous fuels must obtain a burn permit from the Alabama Forestry Commission. Information about obtaining a burn permit may be obtained via the internet at **www.forestry.alabama.gov** or by contacting the AFC Dispatch Center at 1-800-392-5679. The phone number may be found along with other emergency numbers inside the front cover or the first page of any phone book.

9.8. Evaluation

Prior to the day of the burn any evaluation methods planned for the burn should be established. There are numerous evaluation techniques. Photo points may be established. Wires can be placed around 100- and 1,000-hour fuels to indicate consumption. Steel rods can be placed in the duff and marked for duff consumption observations. The duff height on tree butts can be marked for "duff donut" consumption observations. Any heat sensing gadgets may be placed. The type and amount of evaluation will vary based on the landowner objections and the resources *(see chapter 7 and 10)*.

Chapter 10

Executing the Burn

The burn manager is responsible for the decision to put fire on the ground!

10.1. Burner's Check List

A checklist developed during planning can serve as an excellent tool for the prescribed burn manager on the day of the burn. The following might serve as the structure of a detailed checklist in which all the specifics are spelled out.

- Obtain burn permit *(see chapter 9)*
- Obtain current fire weather forecast *(see chapters 3 and 8)*
- Monitor actual weather before Test Burn
- Inspect firebreaks
- Pre-ignition crew review
- Ensure all equipment and personnel are in place and ready
- A communications check of all gear and procedures should be conducted
- Test Burn *(see chapter 8)*
- Proceed with ignition plan *(see chapter 8)*
- Blacklining
- Ignition extension

- Complete ignition by 3 p.m. or at a time so that burn-out will be complete no later than 5 p.m.
- Monitor actual weather during the burn
- Check smoke drift and any impacts to downwind SSAs
- Burn-out by 5 p.m.
- Mop-up may be initiated as the flame front passes, if sufficient crew members are available. The sooner smolder can be knocked down, the sooner latent smoke production will cease. Alabama law specifies that the burn must be attended until it is "dead out."
- Follow up crew review, tailgate safety meeting, and evaluation *(see chapters 10 and 11)*
- Monitor smoke at critical down-drainage SSAs

10.2 Piles

Special attention needs to be paid to any piles in the burn area during execution of the burn, due to the potential pile burning problems. If the plan calls for burning the piles, a careful review of the conditions should be conducted.

Pile alternatives include: scatter, break-up, isolate, or burn at another time under different conditions.

[If conditions are not perfect for pile burning, **DO NOT** push the envelope!
It is better to leave a pile unburned than to risk an escape or smoke problem.
The few acres gained by pile burning are not worth the risk.]

The burn manager should consider all piles carefully and make an informed decision whether to proceed.

10.3. Contingencies

If a potential smoke or fire problem is observed, stop burning and plow out.

What to do if a problem develops:

- Call 911 to notify all emergency responders including the sheriff's office, volunteer fire departments, and the Alabama Forestry Commission. Stay on the line with the 911 operator to ensure that your location is properly identified.
- If there are injuries, call for an EMT via 911.
- Post road guards if there is smoke on a road.
- Take precautions to prevent further accidents.
- Notify potentially affected people.
- Investigate and document immediately.
- Secure witness information.
- If at night, check for fog.
- Take pictures.
- Secure detailed weather records.
- Seek expert independent advice.
- DOCUMENT! DOCUMENT! DOCUMENT!

Chapter 11

Evaluation

[The job is not finished until the paper work is complete!]

11.1. Evaluation

The extent of evaluation varies with the landowner's objectives. Evaluation can be helpful in developing long-range resource management plans. In some cases evaluation may consist of a drive by; in other cases evaluation may be detailed, sophisticated, and complex.

Evaluation of the burn is essential to determine if the objectives have been met. Evaluations may be done on the day of the burn, the day after the burn, the week after the burn, the month after the burn, the season after the burn, and the year after the burn, depending on what is to be evaluated. At the time of evaluation, many things may be reviewed such as smoke behavior, fuel consumption and load reduction, scorch, mortality of various components of the stand, the need for subsequent burns to accomplish a long-term resource objective, insect infestation, etc.

Each evaluation may require a specific form. There are no standard forms. Each burn and each organization may develop forms that are appropriate for their needs. The burn manager should ensure that adequate documentation is completed and that the information is attached as part of the completed plan.

There are many techniques of evaluation: photo points, wires around logs, rods in the duff, paint marks on tree butts, and heat-sensing gadgets that record temperature levels – both thermocouple and chemical types. These types of evaluation must be initiated prior to the burn *(see chapter 9)*.

Post-burn evaluation may be initiated by the burn manager during a wrap-up tailgate session prior to securing the crew from the burn. A crew member, possibly the individual who maintained the weather data during the burn, may make notes for inclusion in the burn plan. Observation should be made relating to the accomplishment of the burn objectives, resource, flame, and safety.

A tailgate safety meeting immediately after the burn can determine any potential risks that may need to be avoided in future burns. Evening or next-day early morning checks can determine the extent of residual smoke and potential problems. Checking down-drainage SSAs can be very important and informative. Follow-up evaluations can determine fuel consumption, scorch, and mortality. Late winter or early growing season burns in pine stands can be followed by pine beetle inspection several times during the growing season.

11.2. Optional Evaluation Techniques

100- and 1,000-hour fuels: Wires can be placed around 100- and 1000-hour fuels to indicate consumption.

Heat sensors: More sophisticated techniques can be employed to measure temperatures on stems and at varying duff and soil depths by using heat-sensitive devices.

Photo Points: Photo points may be established prior to the burn so that a post-burn sequence of pictures can be made with the exact same location, camera height, horizontal angle, and vertical angle. A compass and clineometer can be helpful in this process. If a picture is worth a thousand words, a sequence of pictures must be worth ten thousand words.

photos by John McGuire

Longleaf pine release from loblolly pine

Light burning under young stand

11.3. Scorch

Trees may be scorched in several places . . . the roots, the root collar, the stem or bole, and the crown. Scorch estimates are subjective. The evaluator must make estimates based on what can be observed and the evaluator's experience.

Root collar and bowl scorch - Duff tends to build up around the base of older pine trees. This ring of duff may be referred to as a "duff doughnut." Intense burning of the "duff doughnut" may result in damaging the tree cambium in the area of the root collar and possible mortality of the tree.

photos by John McGuire

Monitoring the "duff doughnut" around a large pine

Checking a "duff doughnut" following a burn


Scorch *LSU Cooperative Extension Service photos*

Crown scorch - Crown scorch is typically estimated as a percent of the length of the live crown. Southern pines normally survive severe crown scorch, but a growth loss does occur. Follow-up visits to the stand during the following growing season can be made to determine if pine beetles have invaded the stand when crown scorch occurs. Crown scorch and pine beetles can wipe out any positive gains from a burn.

Scorched soil *LSU Cooperative Extension Service*


Site prep burns

Soil scorch - Scorched soil can reduce the site index and have substantial ecological impact. Soil scorch is evident when all of the organic matter is burned out of the soil and nothing remains but grit and sand, which may result in soil erosion. Site restoration may be required. In extreme cases the heat may be so intense it causes the sand to form glass beads.

Chapter 12

Rules of Thumb

1. Don't burn on organic soils unless the water table is very close to the surface.
2. Heading fires produce about three times more particulates than backing fires.
3. Burn when fuels are dry, but not too dry. Wet fuels produce substantially more particulate than do dry fuels.
4. Start burning logging debris by mid-morning.
5. Site prep burning behind chopping or other mechanical treatment gives best results if done 10 to 15 days after treatment.
6. Windrows are the most polluting of all southern fuel types.
7. Broadcast burn-scattered debris if possible.
8. Do not pile when either ground or debris is wet.
9. Dirt in piled debris will increase the amount of smoke produced by up to four times. Shake out dirt while piling; "bump' piles while burning, and re-pile as necessary.
10. Use a smoke management plan. Consider smoke sensitive areas. Look several miles downwind and down-drainage for potential targets.
11. If nighttime Dispersion Index forecast is poor or very poor [less than 13], stop burning by 3 p.m.
12. Doubling the Dispersion Index implies a doubling of the atmospheric capacity to disperse smoke within a 1,000 square mile area.
13. Assuming one ton of fuel per acre is being consumed by smoldering combustion during poor nighttime dispersion conditions, within a 1-1/2 mile radius of the fire expect visibility in the smoke to be less than 1/2 mile.
14. Obtain and use latest weather and smoke management forecasts.
15. Relative humidity will roughly halve with each 20° F rise in temperature and double with each 20° F drop in temperature in a given air mass.
16. Expect increased spotting when relative humidity drops below 30 percent. Be EXTREMELY careful when the relative humidity is below 25 percent.
17. Burn when mixing height is above 1,650 feet [500 meters].
18. Do not burn under temperature inversions.
19. Burn areas with low fuel loading and large-sized trees on marginal days at the high end of the prescription window.
20. Never under burn during a drought. Soil moisture is needed to protect tree roots and lower litter.
21. Decrease smoke concentration by: increasing transport wind, mixing height, or plume rise.

Other rules:

- Expect control problems when the probability of ignition is 70 percent or higher.
- Expect control problems if the burn area has cured cogongrass or kudzu near the fire lines, unless otherwise mitigated.
- Consider the fuel model(s) outside and adjacent to the planned burn area with regard to rate of spread and the flame length in the event of spotting.
- Consider KBDI indices in relation to seasonal averages for the area.

Chapter 13

Red Flag Situations

If any of the following conditions exist, analyze further before burning.

Understory burning:

- No written plan
- No map
- No safety briefing
- Heavy fuels
- Dry duff and soil
- Gusty and or swirling wind
- Extended drought
- Inadequate control lines
- No updated weather forecast for area
- Forecast does not agree with prescription
- Poor visibility
- Personnel or equipment stretched thin
- Burning large area using ground ignition
- Communications for all people not available
- No backup plan or forces available
- No one notified of plans to burn
- Behavior of test fire not as prescribed
- A smoke management system has not been used
- Smoke-sensitive area downwind or down-drainage
- Organic soil present
- Daytime Dispersion Index below 40
- Not enough personnel or equipment available to control an escaped fire
- Personnel on fire not qualified to take action on escaped fire

Debris burning – in addition to the above:

- Gusty and or swirling wind
- Temperature in excess of 80°
- Area contains windrows
- A lot of dirt in piles
- Poor nighttime smoke dispersion forecast
- Have not looked down-drainage
- Mixing height is below 1,650 feet (500 meters)
- Debris was piled when wet
- Pile exteriors are wet

If any of the following conditions exist, stop burning and plow out existing fire:

- Erratic fire behavior
- Spot fire or slop-over occurs and is difficult to control
- Probability of ignition is 70 or higher, wind shifting, or other unforeseen change in weather
- Smoke not dispersing as predicted
- Public road or other sensitive area smoked in
- Burn does not comply with all laws, regulations, and standards
- Large fuels igniting, not enough personnel to mop-up, likely to smoke in a smoke-sensitive area

Chapter 14

Burning Young Stands

The information included here is based in part on an unpublished paper, *Prescribed Burning in Young Stands; Opportunity Overlooked?*, by John R. Stivers, RF, CF *(rxburning@aol.com)* and the personal experience of the author. The information is primarily anecdotal.

14.1. Objectives

Some of the uses of fire for managing timber stands were presented in chapter 5 – Fire as a Tool. Fire can be used to manage young pine stands for several objectives:

Fuels management: Young stands of pine are particularly vulnerable to damage from fire. Under certain conditions a substantial investment in stand establishment can be wiped out by fire. A prescribed burn under proper conditions can reduce the fuel load in a young stand and reduce the risk of an unplanned fire. Properly timed fire is particularly effective in longleaf pine stands. Fire can reduce the fuel load and control brown spot needle blight when longleaf is still in the grass stage. The key is to burn in such a way as to not scorch the longleaf terminal buds.

Wildlife habitat: Fire in young stands where adequate sunlight reaches the ground can stimulate succulent browse growth and stimulate seed production, both of which provide a food source for a wide variety of wildlife. Recently burned areas can also serve as good "bugging" areas for young turkey poults or quail biddies.

Thermal thinning: Fire can thermally thin overstocked pine stands when applied under precise conditions. A fire in a young stand may kill the smaller shorter stems without lethally scorching the bigger stems. Fire can be used to thin out natural reproduction in a young planted loblolly stand by keeping the temperature in the crowns low and by allowing the dwell/residence time at the root collar to linger. This works well in young longleaf stands that have been invaded by volunteer loblolly seedlings.

Timber stand improvement: Fire can eliminate undesired species from young pine stands. Young undesirable hardwoods are particularly susceptible to fire where the growing tissue can be raised to the lethal range. The required temperature and stem size, bark thickness, varies by species. Typically a first burn will only kill stems that are 3 inches or less at the root collar. Sweet gums are often a target species. However, multiple burns are typically required to displace sweet gum from a stand.

Agro-forestry: Fire can stimulate browse for domestic livestock in agro-forestry management regimes. New shoot sprouts, especially in grasses and legumes, are nutritious for animals.

Pruning: Young pine stands that are burned properly tend to self prune readily, and the form class in stands where fire has been used tends to be higher. Fire scorches the lower limbs without scorching the upper limbs.

14.2. Conditions

Several things must be right for fire to be used in young stands:

Continuous readily-burnable fuel: Conditions must be just right for burning in young stands. Continuous light fuels, one-hour fuels, with the fuel moisture at approximately 5 or 6 percent, must be in the stand. Wiregrass, pine needles, or broom sedge serve as good fuel beds for burning in young stands. If the fuels are too moist, the fire will not carry. If the fuel is too dry, the flame length may be too long and result in crop tree scorch. If good burnable fuels are not present, the fire may finger around and then burn with the wind in spots resulting in unacceptable scorch.

Steady wind: A steady ground-level wind of one-to-three miles per hour is required in young pine stand burns to push the heat up and out of the stand. If there is no wind, the heat may rise straight up and result in unacceptable scorch. If the wind is greater than three miles per hour, the flame length may be too long and again result in unacceptable scorch.

Cool air: Ambient air temperature of 50° or less is required to prevent excessive crown scorch.

Dormant season: Young pine stand burning should only be done in the dormant season when buds are hardened off and not as susceptible to scorch. Normally in Alabama, the weather and fuel conditions for burning young pine stands occur in late winter prior to bud break. During this season, cold fronts pass through the state from the northwest. Immediately following the passage of a cold front, the relative humidity tends to drop and wind direction remains steady. At the same time one hour fuels dry out quickly while heavier fuels and the deeper duff remain moist and will not burn. It is important to monitor weather predictions several days in advance and have all resources for burning ready to take advantage of proper conditions. Timing is important.

Sufficient tree size: Crop trees must be of sufficient root collar size and bark thickness to prevent the growing tissue from reaching the lethal level during flame front passage. The optimum size varies depending on air temperature and species. The colder the air, the smaller the stem that can withstand the passage of the flame front. Longleaf tends to have a thicker bark than loblolly and longleaf needles serve to protect the terminal bud better than loblolly. Fire may be passed under very young longleaf with root collar diameters of two inches or greater which are two feet or taller. The bigger the root collar and the taller the tree, the less risk of scorch. Loblolly, on the other hand, has thinner bark than longleaf and more exposed buds. Tree heights of 10-15 feet and root collar diameters of three inches and greater are required before burning can be done without too great a risk of unacceptable scorch.

Flat terrain: Burning in young stands can be done in flat to hilly terrain. It can be difficult to control flame length on slopes where slope breezes may form and convection temperature may be higher in the crowns. Normally young stands should only be burned using a backing fire. Burn block size should be kept small since the spread rate of backing fires is slow. Long narrow blocks are preferable. Larger areas may be burned in a burning window by breaking up the block with multiple cross firebreaks. Strip head firing should be avoided.

Night burning: Burning young pine stands can be done under nighttime conditions where smoke management requirements will permit. Night burning conditions can be cooler with steadier winds prior to 2 a.m. After 2 a.m., winds tend to subside. The passage of cold fronts may result in optimum conditions for night burning.

An experienced burn manager: An experienced burn manager is essential for successfully burning young stands. In order to gain experience, a novice burn manager can work with an experienced burn manager. Small burn blocks, 20 acres or less, can be attempted by the inexperienced burner just starting out. Larger blocks may be attempted as experience is gained. It is important to remain cautious. The risks are great and the values are typically high.

Chapter 15

Prescribed Burning in the Wildland Urban Interface and Ecologically-Sensitive Areas

15.1. The Wildland Urban Interface

The wildland urban interface (WUI, the term used here includes both the interface and the intermix conditions) has existed since people started living in communities, dating back to Native Americans. Fire has always been a problem when it goes where people don't want it. People have used fire in the WUI since prior to European settlement to prevent unwanted fire.

Farmers burn off fields as an agricultural treatment but also to prevent unwanted fire. Some urban dwellers have burned their lawns to improve grass growth. As people move into the hinterlands to enjoy the esthetics of rural living, they put themselves and their property into close proximity to wildland fuels. The new breed of interface residents does not have the fire background that earlier rural residents had and so they may unwittingly put themselves in a hazardous position. The challenge is to manage the fuels in close proximity to residences and other assets in such a way as to preserve the esthetic values that make the WUI attractive in the first place.

Fire can continue to be an efficient tool for managing fuels in the urban interface. Prescribed burning can be done without putting property and esthetics at risk. A keen understanding of all the factors involved is essential to success. Fire behavior doesn't change because the fire is in the WUI. What does change is the potential for damage to property and smoke problems. If these two factors can be dealt with then fire can be used.

The people in the WUI must be informed of the effectiveness and efficiency of fire. Smoke will be an acceptable nuisance when managed properly, viewed in relationship to catastrophic fire. Here again, the new WUI resident may not appreciate the risk.

The major difference between safe successful WUI burning and rural prescribed burning is tract size. The smoke from a three-acre burn does not result in the problem that the smoke from a 300-acre burn may cause. Track size and fuel load are very critical. In some cases, a pre-burn fuel treatment may be needed to get fuels down onto the ground.

15.2. WUI Firebreaks And Fire Control

Plowed or even raked firebreaks are unacceptable in some situations in the WUI. Plowing may not only be unsightly, but may also cause the formation of water channels that could result in erosion. Raking may disturb sensitive plants or animals. The burn plan for WUI and sensitive area burns must address these concerns. In some cases wet lines and foam may be the best alternative.

The major equipment difference for WUI burning is water. The control of burns around buildings calls for large quantities of water with an adequate delivery system similar to most rural fire departments. A garden hose connected to a domestic water source is inadequate. A very maneuverable engine capable of both delivering large quantities of water and being replenished rapidly is necessary. Multiple engines may be required if there are multiple exposures. The use of wet lines as firebreaks versus plowing bare soil may be important.


Type 7 engines

Mini engine

Water buffalo and large crew

A tanker capable of delivering a large quantity of water may be available from a local volunteer fire department. Some units are capable of drafting from local water sources. All tankers are capable of drawing water from a fire hydrant. Volunteer firemen usually enjoy a good burn and may very well join in for the experience.

WUI burning requires a large crew. All sides of the burn must be manned at all times until that area of the burn is dead out to prevent escapes that might result in property damage. Fire can do strange things . . . creep around, follow roots, and pop up where it might be least expected.

Tanker

A leaf blower can be a handy device for moving leaves and other light fuels away from buildings or for clearing a firebreak. The tank at the top of the blower shown here can be filled with water. By pulling a lever, the operator can inject water into the air stream which results in a mist. The mist serves to wet the line.

Class A foam

Class A foam can be used effectively to protect a structure and lay down a wet line. The foam material is biodegradable.

Type 7 engine with foam unit

15.3. Dealing With Neighbors And The Nuisance Factor

Public relations must be extensive and effective if WUI prescribed burning is to be accepted and tolerated. The burn manager planning a WUI burn should pay particular attention to neighbors, community leaders,and community officials. A pre-burn meeting for the stakeholders can be used to inform the public and allay concerns. In some cases, it may be necessary to get buy-in by the local fire chief.

WUI burns should only be conducted when the ventilation factor is high and the Dispersion Index is 61 or higher. A lot of good can be done with WUI burns, but the political impediments are great. WUI burning, while not new, is controversial in today's communities. The cost of doing the necessary public relations work will be high and demand exceptional communications skills.

15.4. Burning In Ecologically Sensitive Areas

The same control systems employed in the WUI may be employed in ecologically sensitive areas where "low impact" burning is required. Exposing mineral soil firebreaks may be unacceptable on some sites. Wet lines, raking, and leaf blowers can be put to good use, if the fire can be controlled in this manner. In some cases, a fuels management treatment may be required. In ecologically sensitive areas, the burn objective must be developed based on a sound knowledge of the plants and animals in the area and the effects of fire. In many cases fire is not only a tool to achieve a desired result within the plant and animal community, but is also essential to prevent uncontrolled fire from causing environmental degradation.

Chapter 16

Prescribed Burn Program Administration

Prescribed burning administration is more critical when an organization, company, or consultant plans to burn a large number of acres in multiple tracts during a season. Burning can be coordinated with other management activities and considerations such as herbicide application, fertilizer application, harvesting, hunting season, and nesting season. Finding the "window" that works for the burn objectives and the weather is important.

The burn plan is the essential tool for the administrator. The plan spells out the equipment and personnel requirements as well as the season of the burn and the acceptable wind direction. The administrator must provide for those requirements, similar to the administration of any function.

The number of days when the weather is suitable for burning in the dormant or growing season is limited In Alabama. In early spring, there may only be 14 days suitable for burning. In late summer, there may be a similar number. Nighttime burning conditions are even more constraining. The prescribed burn manager must be prepared when the weather window opens. People, equipment, and plans must be ready.

The administrator must assign priorities to individual burn projects. Then, according to the individual burn plans, the administrator must be prepared to select the next burn project to undertake based on weather, particularly wind direction, on the next available day. A chart of tracks arranged by priority, listing acceptable wind directions for individual tracks, can be a useful tool in this process.

Glossary

There are numerous glossaries of terms available:

- National Wildfire Coordinating Group (NWCG), Glossary of Wildland Fire Terminology **http://www.nwcg.gov/pms/pubs/glossary/index.htm**
- Wikipedia, Glossary of wildfire terms **http://en.wikipedia.org/wiki/Glossary_of_wildland_fire_terms**
- Glossary from *The Guide to Prescribed Burning in the South* **https://fp.auburn.edu/fire/**

The *Dictionary of Forestry* (Helms) is a good source for definition of terms. However, the following terms used in this book are not included in any of the above-listed glossaries.

Jump – the process of fire getting across a firebreak into a fuel that was not planned to be burned; fire ignited outside the perimeter of the main fire by a fire brand. Other related terms include escape, slop-over, and spotting.

Return interval - number of years between burns in a sequence of burns in a stand.

Terrestrial - of or pertaining to land as distinct from water.

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There are also numerous websites with information for those interested in prescribed burning.

About the Author

Kent Hanby's first experiences with wildland fire were as a child. On long walks in the woods in the area that is now the Samford University campus in south Jefferson County, Alabama, he and his grandfather would, on occasion, find a woods fire. They would break off a pine top and attempt to beat out the fire. The smell of woods smoke was not uncommon or unpleasant. Kent went on to become a forester, graduating from Auburn University in 1965, and later earning a Masters Degree from Yale University. While at Auburn majoring in Forestry, he completed the fire management course taught by Dr. Earl Debrunner.

In his first professional job, Kent worked with Union Camp Corporation in Sandersville, Georgia and later in Brunswick, Georgia. Fire was a commonly used management tool employed for site preparation and fuel reduction. Site preparation burns often exceeded 1,000 acres and it was not uncommon to burn 1,000 or more acres of young pine plantation in a night. Fuel reduction burns in intermediate stands often exceeded several thousand acres. Burning windrows was a common practice.

In September of 1996, Kent was certified as Certified Burn Manager # 387 in the state of Alabama. More recently he has served as the Director of Student Services in the Auburn University School of Forestry and Wildlife Sciences and as the instructor for the Fire Management and Use course. Retired from this position in June of 2003, Kent lives at 431 Dogwood Trail, Dadeville, Alabama 36853, and may be reached at 256-825-8593, or hanby@charter.net. He currently works as a consultant for prescribed fire matters and as an expert in litigation.

Kent is a member of, and the 2005 Chair of, the Society of American Foresters Fire Working Group, and a member of the Association for Fire Ecology. He also serves on the Alabama Prescribed Burn Council. He has collaborated with many professionals in matters pertaining to the use of fire and has participated in numerous conferences and workshops. Kent conducts educational workshops for Alabama Certified Prescribed Burn Managers to satisfy the continuing education requirement.

Notes

Notes

Burn Wise

Be Safe

Be Conservative

Be Cautious

Be Considerate of Neighbors and the Public

Follow the Guidelines

Burn with Confidence

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