P R E F A C E

The use of prescribed fire as a resource management tool has long been regarded as indispensable. In order to lessen the impact of smoke generated from prescribed burning on public health and welfare, the Virginia Department of Forestry has developed voluntary smoke management guidelines. Application of these guidelines will minimize concentrations of smoke in sensitive areas and assist in maintaining air quality standards.

Promotional emphasis on fire prevention has created a misconception that all fire is bad. Various southern ecosystems depend on fire as do many silvicultural recommendations. Fire can be both good or bad depending on when, where, and how it occurs. With proper training and planning prescribed burn managers will know the when, where, and the how to use fire to benefit the resources. How well we manage smoke from prescribed fires will determine our future use of this valuable and indispensable resource management tool.

The general public has a great influence over how we manage the resources of the forest. Many forest regulations are based on public emotion instead of scientific facts. Public relations are an essential part of a prescribed burn. The prescribed fire manager should feel obligated to minimize effects on the nearby residents and be prepared to "sell" his or her job to the general public. The following statements have been taken from an article by Mark Glisson. His article is based on the premise that the public image of the prescribed burner is critical to the success and continuation of prescribed burning.

- Image has everything to do with how we are perceived and may have little to do with what we actually are.
- Attitude may be the most individualized of the ingredients of a good public image. Each burner must consciously strive to be friendly and courteous in their public encounters.
- The old adage that there is no substitute for experience should be capitalized on. If the public feels that the burner is a professional, that they know their stuff, there will be less fear. For government employees, the image of professionalism is ever more critical than for most. The common perception of "typical government employees" who waste taxpayers money with incompetence and laziness must be overcome. One of the best demonstrations of knowledge and ability are the best methods for dispelling myths.
- Attention to appearance should be considered essential to projecting a professional image. Particularly if the burner is a member of a uniformed agency, special care should be taken to create in others a positive association between the uniform and those who wear it.
- The equipment should be adequate and as modern as possible. It should look good also. Dented and scratched trucks, unpainted equipment, or tools poorly treated all combine to give the impression of haphazard operations. All equipment should be functional and treated with pride.

Be honest with yourself, and remember that whatever the image of the prescribed burner is, it is a direct result of our own success or failures. Never assume that the benefits of burning are understood or that the public is to blame for the image dilemma. The responsibility for improving image is ours alone.

A C K N O W L E D G M E N T S

The Forest Protection Team of the Virginia Department of Forestry would like to thank those who had the foresight to realize that smoke management would someday become critical to our profession. The first publication in Virginia on smoke management was prepared by Roland B. Geddes, District Forester, in March 1981 and was revised by Don T. Morton, Assistant Chief of Fire Management, in July 1989. The Virginia Department of Forestry is very fortunate to have had leadership in the past that provided a firm foundation for those of us who followed, and one to build upon. We would also like to thank our current State Forester, James W. Garner who continues to provide leadership and direction as prescribed burning increases in it's use as a valuable forest management tool, and smoke management becomes even more critical.

I N T R O D U C T I O N

This publication provides guidelines for planning and managing smoke from prescribed fires to:

A. Minimize ambient air quality impairment.

B. Prevent smoke from being carried to, or accumulating in, areas sensitive to smoke.

C. Recommend burning guidelines to supplement the regulations established by the State Air Pollution Control Board.

This guide applies to all prescribed fires, and is not limited to any one agency or region.

Prescribed fire stewardship emphasizes the immediate safety aspects of personnel conducting the burn; the health, safety, and property of others that may be directly affected by the fire, and the potential for off-site effects of smoke on public health and visibility. We emphasize, however that the prescribed fire manager cannot merely comply with standards and regulations. They must exercise professional and moral judgment in carrying out their duties.

CHAPTER 1

SMOKE MANAGEMENT OBJECTIVES AND REGULATORY REQUIREMENTS

Objectives

Prescribed fires produce varying quantities of smoke, an elusive by-product which can be a major concern. Therefore, smoke management must be considered in every prescribed fire plan. Awareness of smoke production and transport characteristics will enable us to refine existing smoke management prescriptions.

Three basic objectives of smoke management are:

1. Identify and avoid smoke-sensitive areas,
2. Reduce emissions, and
3. Disperse and dilute smoke before it reaches smoke-sensitive areas.

The key to good smoke management lies in the resource manager's ability to use prescribed fire with minimal smoke impact. This is done by combining favorable meteorological conditions with a variety of prescribed fire techniques designed to keep smoke emissions to a minimum.

Regulations For Open Controlled Burning

Open burning in Virginia is regulated by the State Air Pollution Control Board and the Virginia Department of Forestry.(Synopses of these regulations are included in the Appendix) The State Forester has accepted responsibility for the development, dissemination, and administration of a smoke management plan for burning related to forestry programs. Nothing contained in this plan shall be construed as allowing any person to be in violation of any regulations, laws, ordinances, or orders of the Commonwealth of Virginia or other governmental entity having jurisdiction, or to relieve any person from the consequences of damages or injuries which may result from the negligent conduct during any burning operation.

A typical definition of "open controlled burning" is: *Any fire from which the products of combustion are emitted into the atmosphere with out passing through a stack or chimney*.

The State Air Pollution Control Board has established regulations for the control and abatement of air pollution, which was last revised in 1997. Sections of the regulations that refer to and impact prescribed burning are #9 VAC 5-40-5600, 5610, 5620, 5630, and 5631. Section 9 VAC 5-40-5630, #9 specifically states that open burning is permitted for approved forest management practices provided the following conditions are met :

a. The burning shall be at least 1000 feet from any occupied building unless the occupants have given prior permission, other than a building located on the property on which the burning is conducted; and

b. The burning shall be attended at all times.

Please refer to the complete text of the "Emission Standards For Open Burning (Rule 4-40) available from the Air Pollution Control Board.

In the event that an Air Pollution Health Advisory, Alert, Warning, or Emergency is reported from the Department of Air Pollution Control, the Virginia Department of Forestry will suspend it's burning operations and recommend to all cooperators that their burning be suspended as well.

Prescribed Fire Managers have a professional, legal, and personal responsibility to assure the success of the smoke management program. They must voluntarily curtail burning if their portion of an air shed is becoming overloaded with smoke or local weather factors are likely to create such problems even though no burning restrictions have been issued.

CHAPTER 2

SMOKE PRODUCTION, CHARACTERISTICS, AND EFFECTS

This chapter discusses the combustion process, the effect of fuel properties on smoke production, the characteristics, and health hazards of smoke.

Stages of Combustion

Figure 1

Pre-ignition Phase

Heat is being absorbed by the fuel, water vapor moves to the fuels surface and escapes. In this phase the internal temperature of the fuel is being raised, causing certain components of wood to decompose, releasing organic gases and vapors. This processes is called pyrolysis. When these very hot gasses and vapors mix with oxygen they will ignite.

Flaming Phase

This begins when the fuel reaches ignition temperature and erupts into flames. The products of flaming combustion are predominately carbon dioxide (CO_2) and water vapor. This water vapor is not the result of the heating of the fuels as in the pre-ignition phase but rather a product of the combustion process. The temperatures in this phase range between 600 and 2500 degrees Fahrenheit. When mixed with oxygen, the

heated gasses ignite, oxidation occurs, and smoke is produced. Some organic gasses cool and condense without passing through the flame zone. Others pass through the flames and are only partially oxidized producing a great variety of emissions. Some compounds with higher molecular weights cool and condense into tar droplets and soot particles. These make up the visible smoke component with which we are primarily concerned. *The more inefficient the burning the more soot and tar particles produced.*

Smoldering Phase

In this phase the overall reaction rate of the fire has diminished to a point at which the concentration of combustible gases above the fuel is too low to support a persistent flame. The temperature drops and gasses condense, thereby producing smoke. The chemical process is incomplete and a large amount of smoke is produced. Emissions from a smoldering fire are at least **twice** that for a flaming fire. The heat released is seldom enough to sustain a convection column. The smoke produced during this phase is virtually soot-free consisting mostly of tar droplets. With insufficient heat to produce a convective column, the smoke is concentrated close to the ground.

Glowing Phase

All volatile material in the fuel has been driven off. Oxygen in the air can now reach the fuel, the surface of the charcoal begins to burn with a characteristic yellow glow. There is no visible smoke. Carbon monoxide and carbon dioxide are the main products. This phase continues until the temperature drops or until only non combustible gray ash remains.

Fuel Properties As They Affect Smoke Production

The total volume of smoke produced from a prescribed fire depends primarily upon the amount of fuel consumed. Smoke production can last from less than an hour to several weeks. The manner in which combustion and smoke production take place depends primarily on fuel moisture and such physical fuel properties as fuel size, fuel arrangement, and total amount of fuel.

Fuel Moisture

Fuel moisture is controlled by two major factors: weather and the curing stage.
The amount of moisture in fuels greatly affects the ease of ignition and the efficiency with which live and dead vegetation burn. By affecting flame temperature, hence combustion efficiency, moisture in the fuel affects the amount and character of emissions. The cleanest fire is the most efficient fire because, by definition, its combustion is the most complete. On the other hand, though the emissions per unit of fuel burned will be greater at higher fuel moistures, the total smoke produced from a burn may be less if some fraction of the fuel, typically the larger round fuels and the duff, have enough moisture that they do not totally burn.

Fuel Size and Arrangement

With a given fuel moisture, the time necessary to ignite and consume the fuels depend on the size (surface area) and arrangement. The greater the surface area and the greater the space between fuels, the faster they will burn. As the fuels become packed more tightly and surface area is reduced, the combustion efficiency is decreased and smoke production will increase.

Fuel Loading

When using fire in areas with light fuel loads such as grasslands and frequently burned pine stands (usually under 4 tons per acre), total smoke production is low because smoldering combustion is minimal. The heaviest fuel loadings are normally encountered in piled logging debris, and burning these areas will have the most adverse impact on smoke management.

Fuel Continuity

Both horizontal and vertical continuity affects the amount of fuel consumed. Sustained ignition will not occur when spacing between the fuel is too large. More smoldering will occur and thereby more smoke will be produced.

Chemical and Physical Characteristics of Smoke

Products from the combustion of forest fuels are mainly carbon-containing compounds. The most important pollutants being particulate matter and carbon monoxide(CO).

Two products of complete combustion are carbon dioxide(CO2) and water, these make up over 90% of the total emissions. Under ideal conditions it takes 3.5 tons of air to completely burn 1 ton of fuel. The combustion of 1 ton of fuel will produce the following:

Carbon Dioxide(CO2)	2,000 to 3,500 lbs
Water Vapor	500 to 1,500 lbs
Particulate Matter	10 to 2000 lbs
Carbon Monoxide(CO)	20 to 500 lbs
Hydrocarbons	4 to 40 lbs
Nitrogen Oxides	1 to 9 lbs
Sulfur Oxide	Negligible amounts

Carbon Dioxide is not considered a pollutant, but Carbon Monoxide, Hydrocarbons, Nitrogen Oxides, and Sulfur Oxides are.

Carbon Monoxide is the most abundant air pollutant produced by prescribed fires. Its negative effect on human health depends on duration of exposure, concentration, and level of activity during exposure. Dilution occurs rapidly enough to minimize the health hazards.

Hydrocarbons are an extremely diverse group of compounds that contain hydrogen, carbon, and sometimes oxygen. The majority of the hydrocarbons have no harmful effects.

Nitrogen Oxides are produced primarily from oxidation of the nitrogen contained in the fuels. Most forest fuels contain less than 1% nitrogen, of that amount 20% may be converted to nitrogen oxide when burned.

Sulfur Oxides are produced in negligible quantities because of the low elemental sulfur content of forest fuels. Sulfur is lost from the site during burning as is nitrogen.

Particulate Matter is the most important pollutant emitted by fire and is largely responsible for low visibility and aggravated respiratory conditions. It is a complex mixture of solids and tars. Particulate matter from wood smoke has a size range near the wavelength of visible light (0.4 - 0.7 micrometers). This makes the particles excellent scatters of light and, therefore, excellent reducers of visibility. Many are too small to be seen with the naked eye and may stay suspended in the atmosphere for weeks and even years. These very small particles may not be filtered out by smoke masks and may penetrate deeply into the lungs.

Particulate matter is *the* major problem from forestry smoke. All smoke management systems are based on it.

Particulate matter is described and regulated on the basis of it's size.

70% by mass are less than 2.5 microns (i.e., pollen)

20% by mass are between 2.5 and 10 microns (i.e., dust)

10% by mass are greater than 10 microns (i.e., fly-ash)

1 micron = 1/25,000 of an inch.

Emission Rates

A. Emission rate is defined as the amount of smoke produced per unit of time.
B. Down wind concentrations of particulate matter in smoke are related directly to the emission rate at the fire source; the emission rate, in turn, is affected by the amount of fuel being burned, and the rate at which it burns.
C. Backing fires are most efficient and produce the least amount of smoke.
D. Head fires consume half the available fuel, are less efficient and produce more smoke.
E. Ring fires are heavy smoke producers as are aerial ignited burns.

Residual Smoke

Residual smoke is defined as the smoke produced from smoldering combustion and not contained in a convection column. During the active combustion stage of almost all

prescribed burns, smoldering combustion takes place near flaming fuels. Much of the smoke from the smoldering fuel is entrained into the convection column induced by the flames and carried aloft. When flaming ceases, the convection column dissipates and all subsequent smoke produced remains near the ground as residual smoke.

Smoldering combustion frequently causes visibility problems immediately down wind of a burn when the convection column dissipates.

If residual smoke persists into the night or the next day, special problems may arise. In flat terrain, wind is usually minimal at night, causing smoke to build up in the vicinity of the burn. Any nearby drainage's may also have an increased concentration of residual smoke. In addition, the particulate matter may serve as nuclei for fog formation if the relative humidity approaches the water saturation point. Residual smoke can and will flow down drainage's causing possible visibility and other problems.

Residual smoke persisting for several days poses additional problems because the burn manager cannot make reliable predications of the wind speed and direction much beyond the day of the burn. The best burn plans should contain provisions to minimize the residual smoke.

Secondary Emissions

Secondary emissions pollutants are formed in the atmosphere by photochemical transformation of primary emissions. They include oxidants such as ozone.

Health Hazards Of Smoke

Firefighters can face unhealthy levels of smoke when patrolling or holding fire lines on the downwind edge of a wildfire or prescribed fire, during direct attack of an escaped prescribed fire, or while mopping up.

The following is based on an article by Breysse, 1984, in which he discusses the health hazards of smoke.

Inhalation of smoke from whatever source can cause acute or chronic damage to health. The acute, or immediate, symptoms are caused by exposure to high concentrations of smoke over short periods of time. Manifestations range from irritation of the eyes and respiratory tract, to impaired judgment.

More critical are repeat exposures to relative low concentrations. These may result in respiratory allergies, bronchitis, emphysema, and cancer. Chronic health hazards are by far the more significant, because 15 or more years usually pass before the victim is disabled.

Some concerns have been expressed as to the amount, if any, of herbicide residue in the smoke that is produced from lands treated with herbicides. A recent study examined 14 sites that were treated with Arsenal, Garlon 4, Pronone 10G, Velpar ULW, and Tordon. The tract sizes ranged from 3 to 380 acres, and all were burned within 30 to 169 days after treatment. Seventy personal and seventy area monitors were employed in the study. NO herbicide residues were detected in any of the monitoring devices used in the study.

The health implications of short-term exposure and the potential health effects of long-term exposures have not yet been quantified.

C H A P T E R 3

S M O K E M A N A G E M E N T

This chapter introduces principles of smoke management strategies for prescribed fire. Smoke management practices include;

- ❑ fuel management.
- ❑ fire prescriptions to reduce available fuel loading or improve combustion efficiency.
- ❑ firing and mop up techniques to reduce emissions.
- ❑ scheduling to enhance convection or dispersion.
- ❑ scheduling to ensure plume trajectory moves away from sensitive areas.
- ❑ coordinating burning locations for the best overall result.

Determining The Need For A Smoke Management Program

Smoke management techniques must be considered by anyone who uses fire as a management tool. Smoke management involves prioritizing individual burns, monitoring fuel conditions, monitoring surface and upper air meteorological parameters, predicting down wind particulate and visibility impacts. The following questions must be considered in developing the smoke management plan.

A. Will smoke from prescribed burning result in public health and safety problems such as on highways or airports?

B. Are there any other areas which should be considered as smoke sensitive?

C. Will smoke from prescribed burning result in complaints from the public?

D. Can the topography or weather conditions cause poor smoke dispersion? Mountainous terrain and stagnant high pressure systems usually cause the most problems.

E. Are there limitations on the number of days available for prescribed burning because of fire hazard or stagnation problems?

F. Will prescribed burning impact any areas where visibility is an important value?

G. How is the health and safety of the work force being impacted?

Control Strategies

Avoidance, dilution, and reduction of emissions are ways to manage smoke from prescribed fires.

Avoidance

Pollution can often be prevented by scheduling prescribed fires during conditions that make intrusions of smoke into smoke-sensitive areas unlikely. The most obvious way to avoid pollution impacts is to burn when the wind is blowing away from all smoke-sensitive areas. Most fires have an active burning period and a residual period. Wind direction during both periods must be considered.

At night, drainage winds can carry smoke toward smoke sensitive areas. Residual smoke is especially critical at night.

Dilution

Smoke concentration can be reduced by diluting smoke through a greater volume of air, either by scheduling during good dispersion conditions or burning at slower rates (burning smaller or narrower strips or smaller areas). **Caution:** Burning at slower rates may mean that burning continues into the late afternoon or evening, when atmospheric conditions become more stable.

The time of day at which ignition occurs is also an important consideration because mixing height and transport wind speed are likely to change during the day and night. Generally, a burn early in the day encounters improving ventilation factors; an evening burn encounters deteriorating ventilation factor.

Emission Reduction

Emission reduction can be an effective control strategy for attaining smoke management objectives. Effective firing techniques and proper scheduling can minimize the smoke output per unit area treated. For example, backing fires minimize the inefficient smoldering phase of a prescribed fire.

Techniques To Minimize Smoke Production And Impacts

Prescribed burning, though necessary for accomplishing certain resource management objectives, can degrade air quality. The practice of prescribed burning carries with it an obligation to eliminate or minimize any adverse environmental effects, including those cause by smoke. The following guidelines will help reduce impacts.

Have clear objectives

Be sure you have clear resource management objectives which consider the impact of smoke on the total environment - - both on site and off site.

Obtain and use weather forecasts

Weather information and fire-weather forecasts are available to all resource managers. Be sure to use them. To obtain forecast information, contact your nearest Department of Forestry office, or contact the Virginia Department of Forestry web site at (**www.state.va.us/~dof/dof.htm**). The weather information is needed to determine what will happen to the smoke, as well as to determine the behavior of the fire.

Do not burn when air pollution health advisories are in effect, during pollution episodes, or when temperature inversions exist

Under such conditions, smoke tends to stay near the ground and will not readily disperse.

Comply with air pollution control and smoke management regulations

Know the regulations for air pollution control in Virginia and your locality.

Burn when conditions are good for rapid dispersion

The atmosphere should be unstable so smoke will rise and dissipate; but not so unstable as to cause a control problem. Determine whether the direction and volume of smoke will affect public safety on highways and populated areas. Use caution when near or upwind of smoke-sensitive areas. Burning should be done when transport wind will carry smoke away from heavily traveled roads, airports, and populated areas.

Notify the Virginia Department of Forestry

This will allow the Department of Forestry to inform you of any weather conditions and/or any other burns that may impact your plans.

Notify the local Fire Department dispatcher, nearby residents and adjacent landowners

This is common courtesy, as well as a requirement in some areas. All concerned will know the burn is not a wildfire, and you will get advance notice of any adverse public reaction.

Burn under favorable moisture conditions

The prescribed fire manager can reduce smoke by selecting the correct combination of fuel moistures and burning only those fuels that must be removed to meet the burn objective. If the objective is to remove fine and intermediate fuels to reduce wildfire hazard, the burn should be accomplished when the relative humidity is low enough for fine and intermediate fuels to burn readily and larger fuels and duff are wet. If the objective is to expose the mineral soil, the burn should be conducted when the larger fuels and duff are dry enough to burn with a minimum of smoldering.

Use backing fires when applicable

This is because backing fires, with their slow rate of spread and relatively long residence time, cause a higher fraction of the fuel to be consumed in the flaming stage of combustion rather than in the smoldering stage. Since total smoke production per unit of fuel burned is considerably less during flaming combustion, backing fires favor lower total smoke production.

Burn in small blocks when appropriate

The larger the area being burned, the more visibility is reduced down wind and higher the concentration of particulate put into the air.

Mop-up

Burn out and start mop-up as soon as possible to reduce impacts of residual smoke on visibility and health.

Have an emergency plan

Be prepared to control traffic on nearby roads if wind direction changes. Be prepared to construct control lines and stop a prescribed burn if it is not burning according to plan or if weather conditions change.

Weather Interactions

As weather patterns change, so does smoke behavior. General pressure patterns and fronts have pronounced effects on transport wind and stability characteristics of the atmosphere and affect how well the smoke will disperse.

Wind

The obvious first consideration in evaluating whether a burn will impact a sensitive area is to determine which direction the wind is blowing or will blow. Both the surface wind and the wind aloft will affect behavior.

Surface wind

Surface wind can result from general large-scale weather patterns or from local effects such as the sea breeze and mountain-valley flows. Local winds can be reinforced or destroyed by the general wind depending on the strength and direction of each. Large-scale or general surface wind patterns are those associated with fronts, troughs, and ridges. Understanding surface wind characteristics, either from local wind or general wind, is important to smoke management. To avoid sensitive areas, lengthy low-intensity burns may have to be accomplished during periods when no significant wind changes are expected. Local winds will transport smoke to various locations at different times of the day and night.

Another point to consider is that strong surface winds tend to bend plumes over, thereby not allowing maximum height development. In such cases, the smoke

produced from the convective and nonconvective phases will be under the influence of surface wind patterns.

Upper winds

Upper winds are also important in smoke management. Sudden changes in wind speed or direction (wind shear) as a result of terrain influences, stability changes, or frontal boundaries can profoundly affect fire behavior and plume rise. Another concern with upper winds is that, although surface wind direction may be acceptable in keeping smoke from impacting a sensitive area, upper winds from a different direction may blow smoke over or through another sensitive area. The smoke manager must fully understand the total wind pattern that is affecting the area during the burn, as well as the wind that will be affecting the area after the burn. Initial success at keeping smoke away from one sensitive area will be overshadowed by a failure to recognize wind shifts which result in impacts on other sensitive areas.

Fronts

Smoke movement and dispersion differ drastically with the type of front. The speed of an approaching front is an important consideration when executing burns. A slow moving front results in steadier wind speeds and gradually changing wind directions. A rapidly moving front has more sudden changes in wind speed direction.

Cold fronts

Cold fronts typically have rapid wind shifts and gusty winds. Behind a strong cold front, the air mass is generally unstable, which facilitates smoke dispersion and good visibility. Smoke impacts behind a strong cold front tend to be short, but high concentrations may occur locally. Control problems may be associated with strong cold-fronts, however.

Warm fronts

Burning associated with warm frontal activity can result in high smoke concentrations for long periods of time. Wind speeds are typically lighter and shifts in direction are more gradual compared to cold front. This results in a given area being down wind of a burn for a longer period.

Stationary fronts

The variable and changing wind conditions that characterize stationary fronts make forecasting smoke movement difficult within the frontal zone. Light wind generally blows in opposite directions on either side of the front. Poor mixing and dispersion can be expected near the front with light winds, precipitation, and reduced visibility.

Dispersion

Dispersion refers to those processes within the atmosphere which mix and transport pollutants away from a source. The concentration of smoke experienced at downwind

locations greatly depends upon weather conditions at the fire site and on the down-wind smoke path. *Atmospheric dispersion mainly depends on three characteristics of the atmosphere: atmospheric stability, mixing height, and transport wind speed.*

Stability

Stability affects the mixing of smoke during the convective phase as well as during the nonconvective phase of the burn.

Stable atmosphere

A poor time to burn is when the atmosphere is stable. During the main convective phase in a stable atmosphere, smoke will-at best-rise to some altitude and remain there. More likely, the smoke will start settling to the lowest levels of the atmosphere, and high smoke concentrations will result.

The smoke from the smoldering phase will remain near the surface and be moved around by the surface wind. Stable conditions are readily apparent to the observant manager. Indicators are cloudless nights with light winds; hazy conditions and reduced visibility: clouds with a flattened or layered appearance; and light winds.

Unstable atmosphere

An unstable atmosphere tends to have cumulus clouds with good vertical height, good visibility, strong, gusty winds, and hot, clear days. Unstable air masses tend to aid good mixing of smoke plumes with little, if any, long-term volumes of smoke. For most prescribed burning, a slightly unstable atmosphere tends to produce an optimum dispersion pattern, particularly when surface wind speeds are moderate. (See Figure 2 on page 18)

Relative humidity

Other than its relationship to fine fuel moisture and subsequent fire behavior, the major impact of relative humidity is on visibility. As relative humidity increases, natural visibility may decrease due to increased water vapor in the air.

The significance of relative humidity to prescribed burning is that, as smoke particles are added to the atmosphere, they combine with the water vapor at these higher humidities to significantly reduce visibility. Smoke particles can also be the stimulus for fog or cloud formation, which reduces visibility.

Mixing height

Atmospheric mixing height is that height through which relatively vigorous mixing takes place. A mixing height exists only when the lower atmosphere is unstable or neutral. Above this height is a layer of stable air which acts to suppress vertical mixing. The result is as if a "lid" were placed upon the atmosphere, above which smoke penetrates very slowly.

Figure 2

The higher this "lid", the better are the conditions for smoke management. This is because a reasonably deep layer of vigorous mixing is needed to maintain low background concentrations in the lower atmosphere. During stable atmospheric regimes, there is no mixing height; that is, there is no height below which dispersion processes are rapid. Because high smoke concentrations are maintained for extended distances in such conditions, NO BURNING SHOULD OCCUR.

Visibility Protection

Visibility is the optical clarity of the atmosphere. It is usually expressed as the distance a small object can be just distinguished from a light background. At high relative humidities, a small concentration of smoke can trigger fog formation. On roadways, high humidity combined with smoke has led to tragedy. Poor visibility of this nature is caused by condensation of atmospheric moisture on smoke particles, resulting in a greatly increased number of particles of the size range that blocks out light. This condensation process begins for certain types of airborne particles at relative humidities around 70 percent. As the humidity increased to nearly 100 percent, condensation is much more likely. Visibility protection is an important goal of smoke management.

Prescribed Burning Parameters

The reasons for using prescribed fire in Forest Resource Management are many, they include the following;

- ❑ Reduce hazardous fuels
- ❑ Prepare sites for seeding and planting
- ❑ Dispose of logging debris
- ❑ Improve wildlife habitat
- ❑ Manage competing vegetation
- ❑ Control disease
- ❑ Improve forage for grazing
- ❑ Enhance appearance
- ❑ Improve access
- ❑ Perpetuate fire-dependent species
- ❑ Manage endangered species

Your management objectives will dictate how and when fire will be utilized.
Table 1 on the following page lists the recommended parameters for prescribed burning operations in Virginia. These parameters should be followed to help accomplish your objectives and to minimize problems associated with smoke management, fire control, and personnel safety.

Prescribed fires aren't always beneficial, however. When conditions are wrong, prescribed fire can severely damage the very resource it was intended to benefit.

Recommended Parameters for Prescribed Burning Operations in Virginia

Siteprep and Growing Season Burns

Parameter	Recommended Standard
Temperature	Use caution when temperatures exceed 90 degrees F
Relative Humidity	Minimum 25%, Maximum 65%
Wind	Not to exceed 15 mph at 20 feet
Mixing Height	Needs to exceed 500 meters
Cumulative Severity Index	Not to exceed 500
Ventilation Factor	Needs to exceed 2000

Non-Siteprep Burns and Dormant Season Burns

Parameter	Recommended Standard
Temperature	60 degrees F or below
Relative Humidity	Minimum 30%, Maximum 55%
Wind	In Stand wind of 1 - 3 mph
Mixing Height	Needs to exceed 500 meters
Cumulative Severity Index	Not to exceed 300
Ventilation Factor	Needs to exceed 2000

Smoke Management Burning Guidelines

Numerous variables affect the behavior and resulting smoke from a prescribed burn. They are intended to assist the prescribed burn manager in evaluating the downwind effect of the smoke and to assist in making those management decisions that will minimize the adverse effects of the burning activities within the limits set by the Virginia Air Pollution Control Board. The final decision to conduct the burn as prescribed remains with the burn manager.

No forestry burning should be done in that portion of Virginia covered by an Air Pollution Health Advisory, Alert, Warning or emergency issued by the Department of Environmental Quality. All open burning is prohibited when an Air Pollution Alert, Warning, or Emergency has been declared.

All burns regardless of size need to follow the recommendations listed on pages 23, 24, and 25, and should be subjected to the screening procedure listed below.

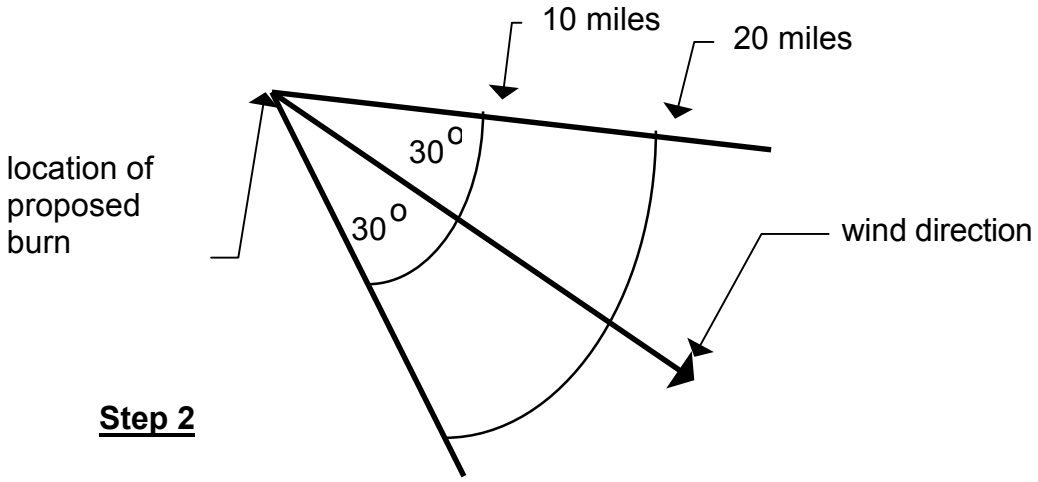
The following procedure, is adapted from the Southern Forestry Smoke Management Guidebook and A Guide For Prescribed Fire in Southern Forests and is used to identify those burns that pose smoke problems for specific sensitive areas.

Screening Procedure

Step 1

A. Locate the burn on a map. Draw a line representing the center line of the smoke plume (predicted wind direction) for twenty miles.

B. To allow for horizontal dispersion of the smoke, as well as shifts in wind direction, draw two other lines from the fire at an angle of 30 degrees from the center line as shown in the figure below.



Step 2

A. Identify and mark any smoke sensitive areas within the 30-degree lines plotted. These areas are potential targets for smoke from the burn. (Caution: If wind changes are predicted for the day of the burn or the night following the burn, plot the trajectory of the smoke for the second wind direction and locate any targets within 30 degrees of that line. The person planning the burn should also locate smoke sensitive targets in any direction that may be affected by an unanticipated wind change.) Examples of sensitive areas are airports, hospitals, nursing homes, interstate or other major high speed highways, heavily populated areas and Federal Class I air quality areas.

B. If no potential targets are found within 20 miles, you need only follow the recommendations to reduce smoke impact for all forestry burns found on the next page.

C. If targets are found, continue this screening system.

Step 3

A. If no targets are found within 10 miles, but are found between 10 and 20 miles, you may burn as prescribed provided the following recommended conditions are met:

   a) Afternoon mixing height is 500 meters (1,640 feet) or greater.

   b) Afternoon ventilation factor (mixing height in meters x transport wind speed in meters per second) is 2,000 or more.

   c) Visibility at burn site should be 5 miles or more.

   d) The area will be burned over by no later than one hour before sunset.

   If these conditions cannot be met, the burn should be postponed.

B. If targets are located within 10 miles, go to Step 4.

Step 4

Special caution should be exercised where targets are found within 10 miles of the burn. All of the minimum conditions listed in Step 3-A should be met. Other concerns such as the distance to the target, nature of the target, area of the burn, amount and nature of the fuel, fuel moisture, topography, presence of organic soil or a thick, root mat are only a part of the factors that combine to determine the quantity of smoke produced, its duration and concentration at various distances. Because of the complexity of these factors, a different wind direction for burns with smoke sensitive targets within 10 miles down wind should be considered.

If a different wind direction is not practical, an alternative to burning should be used.

Recommendations To Reduce Smoke Impact For All Forestry Burns:

A. Have a written prescribed burning plan including a sketch map prior to conducting the burn.

B. Obtain and use the best available weather forecasts. Use this information to predict fire and smoke behavior. Take wind and humidity measurements at the tract prior to and during the burning operation.

C. Comply with the provisions of the Virginia Air Pollution Control Board Regulations covering open burning and with all Virginia Forest Fire Laws.

D. Burn when atmospheric conditions are good for rapid dispersion of smoke. The atmosphere should be slightly unstable so smoke will rise and dissipate, but not so unstable as to cause a control problem.

E. Highway visibility must be considered. If an unexpected wind change should cause severe visibility reduction on any highway, be prepared to attempt to cut off the burn and to request assistance in traffic control from local law enforcement. Smoke warning signs should be placed on all roads where visibility may be reduced by smoke. Flaggers should be posted where visibility is significantly reduced. On all burns, mop-up along roads should begin as soon after burnout as possible to reduce the impact of residual smoke on visibility. Relative humidity is a critically important parameter for evaluating potential visibility hazard. A relative humidity at or above 70 percent indicates that a given concentration of smoke will restrict visibility more severely than in dry conditions. Relative humidities in the 80's and 90's may be associated with smoke-induced fog formation and visibility hazards, while natural fog often occurs when the relative humidity is in the 90's as well as at 100 percent. Burning within one mile of Interstate highways where fog can occur should be avoided. Fog problems may be greater in the fall months.

F. Virginia Air Pollution Regulations require that permission be obtained from the occupants of all dwellings located <u>within 1,000 feet</u> of the burn.

G. Volunteer Fire Departments (usually the local emergency dispatcher) and other local residents should be notified. This is very important to help prevent adverse public reaction.

H. If doubt exists concerning fire or smoke behavior, light a small test burn.

I. Use backing fires when possible. Backing fires give more complete combustion of fuel and produce less smoke. Even though slower and

sometimes more expensive, less pollutants are put in the air and visibility is less restricted. In those cases where a backing fire in scattered logging debris would not give fires of sufficient intensity for adequate planting site preparation, ring or head fires must be used. In those cases, special attention must be paid to any smoke sensitive targets downwind. Head fires produce more smoke but do not last as long as backing fires. Burning during the middle of the day or early afternoon (time of more unstable conditions) may result in less smoke concentrations at sensitive targets.

J. Minimize residual smoke caused by fuels that may smolder for hours or days after the burn. Care should be taken to keep fires out of piled logging debris at log decks, sawdust piles, chip piles or bark piles. If fire gets in any material that will smolder for days or weeks, an attempt should be made to extinguish the fire as soon as it burns down enough to be practical. Mop-up activities should be directed toward residual smoke control as well as toward preventing the escape of the fire.

K. When drought conditions exist (Cumulative Severity Index over 400), residual smoke can be expected and additional mop-up may be needed to prevent smoke related problems. Areas with organic soil or a thick root mat should not be burned when the soil or root mat is dry enough to continue to burn for long periods. Termination of burning should be considered if the Cumulative Severity Index reaches 600.

L. The burnout phase should be completed no later than one hour before sundown. Predicting smoke drift is more difficult at night. The wind may lessen or die out completely. The smoke and fog may collect in low lying areas, causing serious problems if highways or residences are in those areas.

M. Aerial ignition is often advantageous to use because more complete combustion is accomplished with a more intense prescribed burn. Additionally, by burning large acreages quickly, smoke is dissipated very rapidly.

Potential Problems

On all prescribed burns, take time to observe (1) fire behavior, (2) smoke dispersion, and (3) effects on the vegetation. Document this information by making it a part of the written plan.

When a potential problem is observed, stop burning and put the fire out if possible. Notify your office and the State Forestry Office immediately. Request help in getting out flaggers and signs along roads. Also, notify people who may be affected if smoke is threatening communities, airports, farms, or homes.

What to Do After An Incident Occurs

A. Investigate the incident to determine if it was caused by smoke from the prescribed burn. If not, determine and document the actual cause immediately. Do not wait! Valuable evidence will be lost.

B. Secure names, addresses, and telephone numbers of witnesses.

C. If at night, check to determine if fog was present in the area.

D. Check for other sources of smoke. Remember - it takes only a very small amount to smell, but a lot to cause reduced visibility.

E. Take pictures of both the incident site and the burn.

F. Secure weather records.

G. Seek expert advice.

A P P E N D I X

Glossary

Term	Definition
Air Contaminant	A dust, fume, gas, mist, odor, smoke, vapor, soot, pollen, carbon, acid or particulate matter or any combination thereof.
Air Mass	A wide spread body of air having approximately the same characteristics of temperature and moisture content throughout its horizontal extent. In addition, the vertical variations of temperature and moisture are approximately the same over its horizontal extent.
Air Pollution	The general term alluding to the undesirable addition to the atmosphere of substances (gases, liquids, or solid particles) either that are foreign to the natural atmosphere or are in quantities exceeding their natural concentrations.
Air Quality	The composition of air with respect to quantities of pollution there in; used most frequently in connection with "standards" of maximum acceptable pollutant concentrations. Used instead of "air pollution" when referring to programs.
Air Pollution Health Advisory	A statement issued by a National Weather Service Forecast Office when atmospheric conditions are stable enough such that the potential exists for pollutants to accumulate in a given area. The statement is initially issued when conditions are expected to last at least 36 hours. See Air Pollution Alert.
Ambient Air	Literally, the air moving around us; the air of the surrounding outside environment.
Anticyclone	An area of high atmospheric pressure with closed anticyclonic circulation. Anticyclonic flow is clockwise
Atmospheric Stability	The degree to which vertical motion in the atmosphere is enhanced or suppressed. Vertical motions and pollution dispersion are enhanced in an unstable atmosphere. A stable atmosphere suppresses vertical motion and limits pollution dispersion.
Available Fuel	The portion of the total combustible material that fire will consume under given conditions. This could be duff, woody, herbaceous material or litter.
Backing Fire	A fire spreading against the wind or downhill. Flames tilt away from the direction of spread.

Term	Definition
Cold Front	The leading edge of a relatively cold air mass which moves in such a way that cold air displaces warmer air. The heavier cold air causes some of the warm air to be lifted. If the lifted air contains enough moisture, cloudiness, precipitation and even thunderstorms may result. If both air masses are dry there may be no cloud formation.
Convective Phase	The phase of a fire when most of the emissions are entrained into a definite convective column.
Convection Column	That portion of a smoke plume sharply defined by the buoyant forces of heated air and affluents.
CSI/Keetch-Byram Index	Cumulative Severity Index. An indication of drought, range from 0 to 800, with 800 indicating extreme drought conditions.
Cyclone	Loosely, a low pressure with counter-clockwise flow. On a very small scale the term is frequently misused to describe tornadoes. See Surface Low.
Deepening	A decrease in the central pressure of a low. This is usually accompanied by intensification of the cyclonic circulation (counter-clockwise wind flow around the low) See Filling.
Dispersion	In air pollution terminology, loosely applied to the removal (by whatever means) of pollutants from the atmosphere over a given area; or the distribution of a given quantity of pollutant throughout a volume of atmosphere.
Disturbance	A weather system usually associated with clouds, rain, and/or wind.
Divergence	The expansion or spreading out of a horizontal wind field. Generally associated with high pressure and light winds.
Emission	A release into the outdoor atmosphere of air contaminants.
Emission Rate	The amount of smoke produced per unit of time (lb/min). Emission Rate = Available Fuel x Burning Rate x Emission Factor.
Filling	An increase in the central pressure of a low. Counter-clockwise wind flow around the low usually decreases as filling occurs. See Deepening.

Term	Definition
Fine Particulate Matter	"Fine" particulates are those particles less than 10-15 microns in size. Fine particles have longer residence time in the atmosphere, are more harmful to health and have greater impact on visibility than larger particles. "Inhalable particulate" matter are those particles less than 10 microns in diameter. "Respirable particulate" matter are those particles less than 2.5 microns in size. Respirable particulates have an especially long residence time in the atmosphere and penetrate deeply into lungs. Particles from smoke are primarily in the respirable size range.
Firing Technique	A method of igniting an area to consume the fuel in a prescribed pattern; e.g., heading or backing fire, spot fire, strip-head fire, and ring fire.
Fuel Loading	The amount of fuel present expressed quantitatively in terms of weight per unit area.
Fuel Moisture Content	The quantity of moisture in fuel expressed as a percentage of the weight when thoroughly dried at 212 degrees F.
Fuel Type	An identifiable association of fuel elements of distinctive species, form, size, arrangement or other characteristics, that will cause a predictable rate of fire spread or difficulty of control, under specified weather conditions.
Head Fire	A fire spreading with the wind or uphill. Flames tilt in the direction of the spread.
Inversion	An increase of temperature with height in the atmosphere. Vertical motion in the atmosphere is inhibited allowing for pollution buildup. A "normal" atmosphere has temperature decreasing with height.
Micron	A unit of measurement equal to 1/25,000 of an inch.
Mixing Height	Measured from the surface upward, the height to which relatively vigorous mixing (random exchange of air parcels) due to convection occurs. Same as mixing depth. Use of this term normally implies presence of an inversion and the base of the inversion is the top of the mixed layer and defines the mixing height.
Non-convective-lift Fire Phase.	The phase of a fire when most emissions are not entrained into a definite convective column.

Term	Definition
Particulate Matter	Any liquid or solid particles. "Total suspended particulates" as used in air quality are those particles suspended in or falling through the atmosphere. They generally range in size from 0.1 to 100 microns.
Plume	The segment of the atmosphere occupied by the emissions from a single source or a grouping of sources close together. A convection column, if one exists, forms a specific part of the plume.
Prescribed Burning	Controlled application of fire to wild land fuels in either their natural or modified state, under such conditions of weather, fuel moisture, soil moisture, etc., as allows the fire to be confined to a predetermined area and at the same time to produce the intensity and heat and rate of spread required to further certain planned objectives of silviculture, wildlife habitat management, fire hazard reduction etc.
Pressure Gradient	The difference in atmospheric pressure between two points on a weather map. That is, the magnitude of pressure difference between two points at sea level, or at constant elevation above sea level. Wind speed is inversely related to pressure gradient. If distance between constant pressure lines is reduced by one-half, wind speed will be doubled. Conversely, if distance between lines is doubled, wind speed will be reduced by one-half.
Residual Combustion Stage	The smoldering zone behind the zone of an advancing front.
Residual Smoke	Smoke produced after the initial fire has passed through the fuel.
Smoke Management	Conducting a prescribed fire under fuel moisture and meteorological conditions, and with firing techniques that keep the smoke's impact on the environment within acceptable levels.
Smoldering Phase	The overall reaction rate of the fire has diminished to a point at which concentrations of combustible gases above the fuel is too low to support a persistent flame. The temperature drops and gases condense, the smoke produced is virtually soot-free, consisting mostly of tar droplets less than a micrometer in size.

Term	Definition
Stable Layer of Air	A layer of air having a temperature change (lapse rate) of less than dry adiabatic (approximately -5.4 degrees F per 1,000 feet) thereby retarding either upward or downward mixing of smoke.
Surface High	(High, High Pressure System, High Pressure Ridge) An area on the earth's surface where atmospheric pressure is at a relative maximum. Winds blow clockwise around highs in the Northern Hemisphere but, due to friction with the earth's surface, tend to cross constant pressure lines away from the high center. Air is usually subsiding within a surface high. This causes warming due to air compression. This in turn, results in stable atmospheric conditions and light surface winds.
Surface Low	An area on the earth's surface where atmospheric pressure is at a relative minimum. Winds blow counter-clockwise around lows in the Northern Hemisphere but, due to friction with the earth's surface, tend to cross constant pressure lines toward the low center. Upon converging at the low center, air currents are forced to rise. As air rises it cools due to expansion. Cooling reduces its capacity to hold moisture; so cloudiness and precipitation are common in lows. If a low center intensifies sufficiently it will take on the characteristics of a storm center with precipitation and strong winds.
Transport Wind Speed	A measure of the average rate of the horizontal transport of air within the mixing layer. May also be the wind speed at the final height of plume rise. Generally refers to the rate at which emissions will be transported from one area to another.
Ventilation Factor	Mixing Height in meters multiplied by Transport Wind speed in meters/sec.
Warm Front	The leading edge of a relatively warm air mass which moves in such a way so that warm air displaces colder air. Winds associated with warm frontal activity are usually light and mixing is limited. The atmosphere is relatively stable when compared to cold front activity.

Term	Definition
Wind Shear	A variation in wind speed and or direction in a layer of the atmosphere or between layers. The variation may be in the horizontal or vertical and may result in significant turbulence depending upon the magnitude of the wind speed/direction differences. A strong wind shear may act like an inversion and inhibit plume rise. It may also fracture the smoke plume, not allowing smoke to rise much above terrain levels. A strong horizontal anticylonic shear results in downward motion and may bring smoke aloft to the surface.

Synopsis of Forest Fire and Burning Laws

10.1-1141 -- *Civil Action* - Liability for Escaped Fires - If a person carelessly, negligently or intentionally without using reasonable care and precaution to prevent its escape, starts a fire on forestland, brushland or wasteland, he is liable for the costs of suppressing the fire.

10.1-1142-A -- Regulating the Burning of Woods, Brush, Etc. - Owner to cut and pile material for safe burning, and take reasonable care to prevent its escape. Class 3 Misdemeanor.

10.1-1142-B -- 4 PM Burning Law - During the period **February 15 through April 30** it shall be unlawful to burn before 4:00 p.m. within 300 feet of woodland, brushland or field containing dry grass, although the precautions have been taken. Class 3 Misdemeanor.

10.1-1142-C -- Unattended fire - Unlawful to leave open-air fires burning within 150 feet of woodland, brushland or field containing dry grass or other inflammable material. Class 3 Misdemeanor.

18.2-86 -- Arson - If any person maliciously sets fire to any wood, fence, grass, straw or other thing capable of spreading fire on land shall be guilty of a Class 6 felony.

18.2-87 -- Intentionally set fires - Class 1 Misdemeanor and liability for suppression of fire if a person intentionally sets fire to brush, woods, etc. and if he intentionally allows the fire to escape to lands of another whereby the adjoining property is damaged or jeopardized.

18.2-88 -- Carelessly set fires - Class 4 Misdemeanor and liability for costs of suppression if a person carelessly or intentionally set fire whereby the property of another is jeopardized or damaged.

10.1-1158 -- Prohibition of all open burning where serious fire hazards exist. - Governor may prohibit open burning due to extreme fire conditions. Class 3 Misdemeanor.

9 VAC 5-40-5630 (9a) -- Burning shall be at least 1000 feet from any occupied building, unless occupants have given prior permission.

9 VAC 5-40-5630 (9b) -- The burning shall be attended at all times.

*Note: For complete information on the Fire Laws of Virginia refer to the Code of Virginia or "Virginia's Forest Fire Laws", Department of Forestry, Publication No. 2, Revised 1996. For complete information on the Regulations for the Control and Abatement of Air Pollution contact the State Air Pollution Control Board.

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Directory of Department of Forestry Regional Offices

Central Office, Charlottesville (804) 977-6555
Region One, Waverly (804) 834-2300
Region Two, Tappahannock (804) 443-2211
Region Three, Charlottesville (804) 977-5193
Region Four, Farmville (804) 392-4159
Region Five, Salem (540) 387-5461
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Toll Free 1-800-592-5482
Richmond (804) 527-5020
Woodbridge (703) 490-8922
Abingdon (540) 676-4800
Tidewater (804) 552-1840
Bridgewater (540) 828-2595
Roanoke (540) 562-3666

Prescribed Burn "Watch Out" Situations

IF ANY OF THE FOLLOWING CONDITIONS EXIST, ANALYZE FURTHER BEFORE BURNING:

- ❑ No written plan
- ❑ No map
- ❑ No safety/planning briefing
- ❑ Heavy fuels
- ❑ Dry duff and soil
- ❑ Extended drought
- ❑ Inadequate control lines
- ❑ No updated weather forecast
- ❑ Forecast does not agree with prescription
- ❑ Forecast does not agree with on site conditions
- ❑ Poor visibility
- ❑ Personnel and equipment stretched thin
- ❑ Burning a large area with hand crews
- ❑ Communications not available for all
- ❑ No backup plan or forces
- ❑ Notifications not made
- ❑ 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
- ❑ 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:

- ❑ Fire behavior erratic
- ❑ Spot fire or slop-over occurs and is difficult to control
- ❑ Wind shifting or other unforeseen change in weather
- ❑ Smoke not dispersing as predicted
- ❑ Public road or other sensitive are smoked in
- ❑ Burn does not comply with all laws, regulations, and standards
- ❑ Large fuels igniting and burning, not enough personnel to mop-up before dark and likely to smoke in a smoke sensitive area

S A M P L E

Prescribed Burning
Smoke Management Plan

I. Location and Identification

County_____ Coordinates_____ Location_____

_____

Acres_____ Tract Number_____ Parcel _____Map attached _____

Reason for the burn: Siteprep Understory Wildlife

II. Weather

	Forecast				On Site			
	Day		Night		Prior		At Conclusion	
A. Surface Wind:	_____	_____	_____	_____	_____	_____	_____	_____
	Direction	MPH	Direction	MPH	Direction	MPH	Direction	MPH
B. Transport Wind:	_____	_____	_____	_____	_____		_____	
	Direction	Meters/Sec	Direction	Meters/Sec	Direction		Direction	
C. Mixing Height: (Meters)	_____		_____					
D. Relative Humidity (%)	_____		_____		_____		_____	
E. Temperature:	_____		_____		_____		_____	

III. **Potential Smoke Targets**: Use double 30 degree template ------ Attach map

A. **None within 20 miles**: Proceed with burn, follow recommendations to reduce smoke impact for all forestry burns. (located on pages 23, and 24 in VA Smoke Management Guide)

B. **Target(s) within 10 to 20 miles**: The following minimum conditions must be met, and the above mentioned recommendations should also be followed.

Mixing Height: 500 meters (1,640 feet)
Ventilation Factor: 2,000 (mixing height in meters **multiplied by** transport wind speed in meters/sec)

C. **Target(s) within 5 to 10 miles----SPECIAL CAUTION NECESSARY**

Special caution should be exercised! All of the conditions in A and B above must be met and the following should be considered. The distance to the target, nature of the target, size of the burn, amount and nature of the fuel, fuel moisture, topography, and the presence of organic soil. These factors along with the meteorological conditions all combine to determine the quantity and duration of the smoke produced.

An alternative to burning may need to be prescribed unless conditions change allowing the potential target to not be impacted by the smoke from your burn.

IV. Other Considerations:

A. Notify Regional dispatcher, VFD, and adjacent homeowners of intent to burn. Remember permission is necessary from homeowners within 1,000 feet.

B. Post prescribed burning and if necessary smoke signs.

C. Comply with all Air Pollution Regulations, Local Ordinances, and Forest Fire Laws.

D. Keep fires out of large piles of debris and sawdust piles which may smoke for days.

E. If smoke crosses a road place a flag person at both ends with radio communication.

F. Burn completed 1 hour prior to sunset.

V. Burning Plan Strategy: Refer to attached map.

A. Burning Objectives _____

_____

_____

_____

B. Equipment on site.

Number of tractor/fire plow units _____

Number of Pickups _____

Burn trailer yes / no

Number of hand carried radios _____

Other, specify _____

C. Personnel on site.

Number of Virginia Department of Forestry employees _____

Number of non DOF laborers _____

Number of property owners _____

Other, specify _____

D. Starting Point (Show on map)_____

E. Ignition Method Drip Torch _____ Aerial _____ Other (specify) _____

F. Special Fire Control and Smoke Considerations,(adjacent pine plantations, crops, cutover, etc.)

_____

_____

_____

H. Planned Mop-up Activities _____

_____

_____

PREPARED BY:_____ DATE _____

Certification Number_____

Emission Standards for Open Burning

State Air Pollution Control Board