



# THE NORTH CAROLINA SMOKE MANAGEMENT PROGRAM



## GUIDELINES FOR MANAGING SMOKE FROM FORESTRY BURNING OPERATIONS



NORTH CAROLINA  
FOREST SERVICE

[ncforestservice.gov](http://ncforestservice.gov)



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- NC State University - College of Natural Resources
- NC State Parks
- NC Wildlife Resources Commission
- NC Division of Air Quality
- South Carolina Forestry Commission
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- US Department of Defense
- USDI Fish and Wildlife Service
- USDI National Park Service

## INTRODUCTION

Fire has been an important process in North Carolina's forests for millennia. Even before Native Americans were present, lightning strikes caused fires that burned through the forest unabated until weather changes or a natural barrier such as a river stopped them. Native Americans used fire to clear out the understory to improve visibility and increase palatable forb production to attract game animals. They also used fire for clearing land for agriculture as their society became more agrarian. European settlers used fire for the same purposes. In the latter part of the 19<sup>th</sup> century, as large areas of forest were harvested, massive fire conflagrations occurred, sometimes burning hundreds of thousands of acres in a single event. Citizens and governments alike became concerned about the effects of these extreme fires on the landscape, and forest fire protection laws were passed. The NC Forest Service was established in 1915 with its primary focus on controlling wildfires. Federal agencies such as the US Forest Service and the National Park Service also controlled all fires that occurred on their lands.

In the latter half of the 20<sup>th</sup> century, forestry professionals began to realize that burning of the forests in a controlled manner produced many benefits such as hazardous fuels reduction, wildlife habitat improvement, restoration of fire dependent ecosystems, and control of vegetation competing with crop trees. These prescribed burns were planned and executed to contain the fire to a certain area, but consideration for smoke impacts was not much of a factor.

Population was growing at a remarkable rate during this same period and not just in urban areas. People were building homes in the forest, what is now called the Wildland-Urban Interface (WUI). Many of these newcomers were not accustomed to prescribed fire or smelling smoke. In addition, large areas of forest in the eastern part of the state were being cleared and drained for agriculture from the 1960s-early 1980s. The debris was often piled and burned. This led to dense smoke lingering around towns and roads, often for weeks at a time, particularly if organic soil was also burned. This led to automobile accidents and public health hazards. Media attention and public outcry built.

It became apparent that if prescribed burning were to continue to be a tool for managing forests, smoke from these burns would have to be managed. The North Carolina Forest Service adopted smoke management guidelines that utilized the conservative Ventilation Index System (VIS) to manage smoke. Although voluntary for the general public, they were required for any state agency who used prescribed fire.

Most burners were following the guidelines. Occasionally something out of their control, such as an unpredicted weather change, caused issues in a smoke sensitive area (SSA). Lawsuits and tort claims arising from these circumstances discouraged prescribed burning. To address this issue, the NC Legislature passed the NC Prescribed Burning Act in 1999. In summary, if a Certified Burner burns for a

prescribed purpose under the provisions of the Act, the smoke from their burn is not considered a nuisance, and they will not be liable for any civil action resulting from smoke from their burn.<sup>1</sup>

One of the provisions in the Act that must be followed to receive liability protection is that burners must follow the NC smoke management guidelines. Shortly after the Prescribed Burning Act was passed, the limitations of VIS became apparent. At about the same time, computerized smoke modeling was being refined. Several research burns were conducted in NC using smoke modeling, demonstrating that smoke could be properly managed from some burns that would not have been allowed under VIS. Therefore, Atmospheric Dispersion Modeling (ADM) of smoke, along with VIS, are now part of the Smoke Management Program and guidelines.

Although prescribed burners are not required to be certified to burn in NC, all burners must abide by all federal and NC pollution laws and regulations.

From 2010-2019, an average of approximately 69,000 acres in North Carolina have been burned by prescription on forested state and private lands each year. As part of its Strategic Plan<sup>2</sup>, the NC Forest Service will "...develop and implement strategies and actions to increase the annual non-industrial private forest landowner acreage treated with prescribed fire..." This Smoke Management Program is part of that action and should increase opportunities for prescribed burn practitioners to increase acreage burned in North Carolina while continuing to protect the public from the potential health and safety hazards of prescribed fire smoke.

The SMP may have applicability on wildfires. It is understood that managing smoke on an out-of-control wildfire is not really possible, and that protecting life and property from the direct threat of wildfire are higher priorities than smoke management. However, smoke management can be applied to mitigate issues arising from certain fire control techniques. Managers may also utilize this process to better notify specific areas/communities of potential forecast smoke impacts. Wildfire managers should consider smoke management when making such tactical decisions.

## PURPOSE

The primary purpose of the Smoke Management Program (SMP) is to mitigate the effects of smoke from forestry related prescribed burning on Smoke Sensitive Areas (SSAs). The primary impetus is the Clean Air Act of 1970 and subsequent amendments in 1977 and 1990. The Clean Air Act established National Ambient Air Quality Standards (NAAQS) for the entire country. These standards are set for many different types of pollutants. However, the US Environmental Protection Agency (EPA) has determined

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<sup>1</sup> It is recommended that all burners read the entire Act which can be found at [https://www.ncleg.net/EnactedLegislation/Statutes/HTML/ByArticle/Chapter\\_106/Article\\_80.html](https://www.ncleg.net/EnactedLegislation/Statutes/HTML/ByArticle/Chapter_106/Article_80.html) and the associated NC Administrative Code (Subchapter 60B, Section.0900), at <https://tinyurl.com/NCAC-NCFS>

<sup>2</sup> [https://www.ncforestservice.gov/strategic\\_plan/index.htm](https://www.ncforestservice.gov/strategic_plan/index.htm)

that the primary health hazard concern from smoke emissions from prescribed burns is particulate matter of 2.5 microns in diameter or less, or PM<sub>2.5</sub>.

In addition to establishing the standards, the Clean Air Act required states to develop State Implementation Plans to achieve compliance with the NAAQS. On a state-wide scale, emissions from forestry related prescribed burns minimally impact air quality. However, they can cause problems in localized areas around the burn if not done under the proper conditions. The SMP and smoke management guidelines are part of North Carolina's effort to control PM<sub>2.5</sub> and are intended to be used by burners to mitigate smoke from prescribed burns so that the PM<sub>2.5</sub> standards are not exceeded.

As directed in the 1990 Clean Air Act Regional Haze Rule, states are also required to take steps to improve visibility in certain National Parks and Wilderness areas, known as Class 1 areas<sup>3</sup>, by reducing haze. The ultimate goal is to return visibility in these areas to its natural state by 2064. The SMP is part of North Carolina's effort to reach this goal, as stated in the 2007 Regional Haze State Implementation Plan and subsequent revisions<sup>4</sup>.

Maintaining visibility, particularly on the roadways, is another important consideration when undertaking prescribed burning activities. Although not specifically addressed in the NC Prescribed Burning Act, mitigation action should be considered when smoke from prescribed fire may impact road(s).

The NC Prescribed Burning Act provides some liability relief for Certified Burners and non-Certified Burner landowners who are burning 50 acres or less of their own land at one time. This protection is only granted if burners follow certain provisions under the law. One of these provisions is that they follow the current smoke management guidelines and SMP.

Finally, it is important to point out that the SMP is NOT intended to tell burners how to burn. Prescribed fire is a complex and potentially dangerous tool and should be used only by those trained and experienced in its use.

## WRITTEN BURN PLAN

A written burning plan should be prepared well in advance for all prescribed burns. The plan should be specific for the area to be burned. The NC Prescribed Burning Act outlines the necessary requirements for a burning plan if the burner wishes to receive liability protection under the Act. The following items must be included (Items in parenthesis are not directly quoted from the Act. They are included to further assist the burner in preparing the plan):

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<sup>3</sup> For a current list of Class 1 areas, go to <https://www.epa.gov/visibility/list-areas-protected-regional-haze-program>

<sup>4</sup> <https://deg.nc.gov/about/divisions/air-quality/air-quality-planning/state-implementation-plans/regional-haze-state-sip>

- The landowner's name and address.
- A description of the area to be burned (including location by latitude and longitude, distance/direction to SSAs, mineral or organic soil, and number of acres to be burned.).
- A map of the area to be burned (also showing location of nearest SSAs).
- An estimate of tons of the fuel located on the area (in available tons)
- The objectives of the prescribed burning.
- A list of the acceptable weather conditions and parameters for the prescribed burning sufficient to minimize the likelihood of smoke damage and fire escaping onto adjacent areas.
- The name of the certified prescribed burner responsible for conducting the prescribed burning (and his/her Certified Burner number).
- A summary of the methods that are adequate for the particular circumstances involved to be used to start, control, and extinguish the prescribed burning, including firebreaks and sufficient personnel and firefighting equipment to contain the fire within the burn area.
- Provision for reasonable notice of the prescribed burning to be provided to homes and businesses located adjacent to the burn site to avoid effects on health and property.

Other items that burners should consider including:

- Contingency plan, if smoke is not dispersing as predicted or fire escapes control.
- Contact information for the local NCFS office.

See Appendix 5 for a sample Prescribed Fire Plan form. Burners may use this form, modify it to suit their needs, or create their own plan.

To receive liability protection, burn plans must be submitted in advance to the NCFS. See Appendix 4 for contact information.

## **SMOKE MANAGEMENT PROCEDURES**

The SMP determines whether a burn (or if using Ventilation Index System, a series of burns) whose smoke has the potential to mix together within a 16,000 acre airshed (simple circle) will potentially exceed allowable smoke volume and density in a smoke sensitive area (SSA). Currently, there are two different methods for determining allowable emissions. The methods are the Ventilation Index System (VIS) and Atmospheric Dispersion Modeling (ADM). The VIS and ADM are separate, independent methods for managing smoke. Both are described in this section.

### **VENTILATION INDEX SYSTEM**

The Ventilation Index System (VIS) is the traditional method of managing smoke from prescribed fire in North Carolina. VIS relies upon several readily available data inputs to determine whether a burn will meet the smoke management guidelines. It is a very simple method that requires no formal training to use. Access to the internet and completion of the written burning plan will provide all data necessary. Completion of the Certified Burner training course will also be helpful in understanding some of the terms and methodology. A worksheet to assist the burner can be found in Appendix 1. The numbers on the worksheet correspond with the instruction numbers.

### Using VIS

1. Locate the ventilation rate and the nighttime smoke dispersion for the burn location from the appropriate National Weather Service (NWS) Fire Weather Daily Text Forecast. The forecasts can be found on the NCFS website under Fire Environment. The ventilation rate formula is **mixing height (ft.) X transport wind speed (MPH) = ventilation rate.**
2. Determine the Burning Category from Table 1.

**Table 1: Burning Category**

Ventilation Rate	Burning Category
0-14,760	0
14,760 to 33,499	1
33,500 to 44,999	2
45,000 to 59,999	3
60,000 to 111,999	4
112,000 or greater	5

3. What type of burn will be conducted? – **Open or Understory.**
4. When you will be burning? – **Day Only or Day and Night.**
5. Determine **location of downwind Smoke Sensitive Areas (SSAs)** that your smoke could impact (schools, hospitals, homes, occupied chicken houses, etc.)
6. Determine **distance to downwind SSAs** (based on wind direction provided by NWS and the burn tract location. Keep in mind down drainage smoke drift or when burning near water features).
7. Using data collected, determine **allowable tonnage** to be burned from Table 2.
8. Estimate **total tons of available fuel to be consumed** in burn from Table 3. If you are not confident in making this determination, contact your local NCFS office for assistance.
9. If your burn will exceed the allowable tonnage, you will need to alter your plans (burn on a more favorable day, decrease acreage to be burned, etc.)
10. If you determine your burn will not exceed the allowable tonnage, and you decide to burn, call the local NCFS District Office on the day of the burn to give them your smoke management information. Remember, if others are burning in the same vicinity and smoke from the multiple burns will mix together in the same 16,000 acre airshed, you may have to alter your burning plans (burn fewer acres or postpone the burn).
11. Follow the Smoke Management Guidelines shown below while executing your burn.

**Table 2: Maximum allowable tonnage that can be allocated to an airshed based on the distance to the nearest downwind smoke sensitive area and the category day.**

Burn Category	1 <sup>5</sup>	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5
Burn Type	Under Story <sup>6</sup>	Open	Under story	Open	Under story	Open	Under story	Open	Under story	Open	Under story	Open	Under story	Open	Under story	Open	Under story
Nighttime Smoke Dispersion	Any	Stag. V. Poor	Stag. V. Poor	Excel. Good Fair	Excel. Good Fair	Stag. V. Poor	Stag. V. Poor	Excel. Good Fair	Excel. Good Fair	Stag. V. Poor	Stag. V. Poor	Excel. Good Fair	Excel. Good Fair	Stag. V. Poor	Stag. V. Poor	Excel. Good Fair	Excel. Good Fair
Time of Burn	Day Only	Day Only	Day Only	Day or Night	Day or Night	Day only	Day Only	Day or Night	Day or Night	Day Only	Day Only	Day or Night	Day or Night	Day Only	Day Only	Day or Night	Day or Night
Distance to SSA (mi.)																	
0< $\frac{1}{2}$	0	0	0	0	0	0	0	0	0	0	0	0	1030	0	0	0	1350
$\frac{1}{2}$ <5	50	360	720	720	1080	450	900	900	1350	720	1440	1440	2160	900	1800	1800	2700
5<10	100	720	1440	1440	2160	900	1800	1800	2700	1400	2880	2880	4320	1800	3600	3600	5400
10<20	150	1080	2160	2160	3024	1350	2700	2700	4150	2160	4320	4320	6480	2700	5400	5400	8100
20<30	150	1200	2400	2400	3600	1600	3200	3200	4800	2500	5000	5000	7500	3000	6000	6000	9000
30+	200	1440	2880	2880	4320	1800	3600	3600	5400	2880	5760	5760	8640	3600	7200	7200	10800

**Table 3: Estimating Forest Fuel Loading**

Fuel Type	Estimated Available Tons Per Acre*		
	Low	Medium	High
Pine litter	3	6	12
Hardwood Litter	3	5	7
Mixed litter	4	6	8
Brush < 2 ft.	4	7	10
Brush 2 - 4 ft.	6	8	15
Brush > 4 ft.	10	20	30
Light (thin) slash	5	10	20
Medium (chopped) slash	10	20	40
Heavy (clearcut harvest) slash	30	40	60
Short grass (Wire grass)	2	5	7
Tall grass (Broomsedge/Marsh)	3	6	8

\*This information is based on results of actual sample measurements and has represented accurately the fuel availability based on the selected loading range. Research studies and surveys that provide more accurate site-specific information concerning tonnage or fuel availability can be used.

<sup>5</sup> Minimum mixing height must be at least 1,640 feet and the minimum transport winds must be at least 9 mph.

<sup>6</sup> **Understory** refers to burning under standing timber but could also include burning in light fuels such as grasses.

**Open** refers primarily to site preparation burning but could also include burns with long term smoldering potential.

## **Smoke Management Guidelines for use with VIS**

### **Category 0**

No burning.

### **Category 1**

Daytime burning only, with a minimum predicted mixing height of 1,640 feet and minimum transport wind of 9 MPH. Burning starts after the inversion is no longer present. Active fire burning and significant smoke production will cease two hours prior to sunset. At this time the fire should be appreciably burned out with smoke production substantially ended.

### **Category 2**

Burning is usually only during the Daytime. Burning starts after the inversion is no longer present. If Nighttime Smoke Dispersion (NSD) is poor, burning will cease by sunset and when NSD is very poor, the active fire burning and significant smoke production will cease two hours prior to sunset. At these times the fire should be appreciably burned out with smoke production substantially ended. If the forecast NSD is fair or good, then burning past sunset is permissible.

### **Category 3**

If an inversion is present, then ignition of the burn must be delayed until after the inversion is no longer present. If NSD is predicted to be poor, then burning will cease by sunset, and when NSD is very poor, the active fire burning and significant smoke production will cease two hours prior to sunset. If forecasted NSD is poor or very poor, only daytime burning is allowable. The fire should be appreciably burned out by the end of this time frame, with smoke production substantially ended.

If the NSD is fair or good, then daytime burning (all hours) and nighttime burning are permissible. If nighttime burning is allowed, ignition prior to receiving the new category day the following morning will be allowed based on the current category day. All burns (including those ignited earlier that morning) must comply with the new category day when issued.

### **Category 4**

Daytime burning (all hours) and nighttime burning is permissible with forecasted fair or good NSD. Nighttime ignitions prior to receiving the new category day the following morning will be based on the current category day. All burns (including those ignited earlier that morning) must comply with the new category day when issued.

If the forecasted NSD is poor, burning will cease by sunset and when the NSD is very poor, burning will cease two hours prior to sunset. If forecasted NSD is poor or very poor, then only daytime burning will be permitted. The fire should be appreciably burned out by the end of the respective time frames with smoke production substantially ended.

### **Category 5**

Daytime burning - (all hours) and nighttime burning is permissible with forecasted fair or good NSD. Nighttime ignition prior to receiving the new category day the following morning will be based on the current category day. All burns (including those ignited earlier that morning) must comply with the new category day when issued.

If the predicted NSD is poor then, burning will cease by sunset and when the NSD is very poor, burning will cease two hours prior to sunset. If forecasted NSD is poor or very poor, then only daytime burning will be permitted. The fire should be appreciably burned out by the end of the respective time frames with smoke production substantially ended.

### **Organic Material - Residual Burning**

When organic material is ignited during prescribed burning activities, and the material continues to burn, a daily evaluation will be made to estimate the acres continuing to burn within a given 16,000-acre area and approximate daily tonnage that will be consumed. The standard daily burning rate of undisturbed organic material is 16 tons/acre/day. This assumes that one solid acre burns at the same rate of approximately one inch per day. Adjustments to the daily burning rate of organic material and to the actual number of acres on fire are necessary to assess the impact or residual burning within each 16,000-acre area. The tonnage derived from residual burning will be subtracted from the available total tonnage each day to determine the adjusted tonnage that can be burned within the 16,000-acre area.

### **Nighttime Burning**

Favorable wind conditions, direction and speed are essential in order to generate an acceptable rate of spread to the fire, dissipate its convective heat and disperse its smoke. Under the present NC SMP, 20 ft wind speeds need to be equal to or better than 9 mph in order to conduct prescribed fire operations at night or early morning hours. Nighttime dispersion for smoke management is currently determined by wind speed as outlined in the table below.

**Table 4: Nighttime Smoke Dispersion**

<b>Nighttime Dispersion</b>	<b>Forecast Surface Wind</b>	<b>Interpretation</b>
Stagnant	Near Calm	Day burning needs to conclude 3 hrs. prior to sunset / <b>No Burning at night</b>
Very Poor	2-4 MPH	Day burning needs to conclude 2 hrs. prior to sunset / <b>No Burning at night</b>
Poor	5-8 MPH	Day burning needs to conclude prior to sunset / <b>No Burning at night</b>
Fair	9-12 MPH	<b>Nighttime burning permissible</b>
Good	>12 MPH	<b>Nighttime burning permissible</b>
Excellent	>14 MPH	<b>Nighttime burning permissible but dangerous</b>

## **ATMOSPHERIC DISPERSION MODELING**

### **Models that may be used to manage smoke**

A current list of all approved models will be maintained by the NC Forest Service. It may be found in Appendix 2.

#### Burn Smoke Situation Complexity

Prior to modeling smoke from a burn, burners should fill out the Complexity Worksheet found in Appendix 2. Depending upon complexity, burners will need different training. For moderate and high complexity burns, certification as an Atmospheric Dispersion Modeler (ADMer) will also be required.

#### *Low Smoke Situation Complexity*

Anyone who has successfully completed the NC Certified Burner training OR who meets the requirements of their agency to be a Burn Boss may use models designated only for low complexity smoke situations, after completing a short follow-on training. Current NC Certified Burners or agency burn bosses who have not had this model training should view the training video found on the NCFS YouTube channel, [URL of Video](#), and follow the outlined steps noted in the video.

#### *Moderate to High Smoke Situation Complexity*

Anyone who desires to use the approved models for moderate or high complexity smoke situations must be trained and become a Certified Atmospheric Dispersion Modeler (ADMer). Certified Burners who are not Certified ADMers may use models run by Certified ADMers to manage smoke.

Advanced Atmospheric Dispersion Modeling training will be developed and maintained by the NCFS in conjunction with the NC Fire Environment Committee (FEC).

This coursework is designed for burn bosses and smoke management professionals.

To become a Certified Atmospheric Dispersion Modeler, the following requirements must be met:

- Complete the NCFS Advanced Atmospheric Dispersion Modeling training appropriate for the track being pursued (either or both).
  - Track 1: PC Based HYSPLIT
  - Track 2: Web-based Framework (BlueSky Playground).
- Perform ADM runs for a minimum of 3 burns, when using PC HYSPLIT based analysis.
- Perform ADM runs for a minimum of 1 burn, when using BlueSky Playground (BSP).
- Runs and results of burn(s) shall be evaluated by a current Certified Atmospheric Dispersion Modeler appropriately certified.
- If the runs and results are acceptable, the evaluator shall send copies of the model run(s) and completed burn plans, along with the certification form (found in Appendix 3) to the NCFS Fire Environment Forester.
- ADMers certified prior to the inclusion of BSP may request to become certified in its use after completing familiarization activities on AirFire Tools - [BlueSky Playground Help Pages](#) and notifying the FE Forester.

Once certified, the new AD Modeler will receive a certificate from the NCFS Fire Chief which will designate him/her as an AD Modeler along with which track was utilized (PC Based and/or Online Based BSP).

A list of current Certified ADMers will be maintained by the NCFS and will be available on request.

### **Using Model Run Data for Smoke Management**

All models, regardless of smoke complexity, must be run within 24 hours prior to the burn. It is recommended that modelers use the most current weather data available prior to the planned ignition time. Modelers utilizing PC based analysis should retain a copy of the weather files (.MET) used for their records for at least 3 years.

Model run must show that the 24-hour National Ambient Air Quality Standard for PM<sub>2.5</sub>, primary and secondary, will not be violated as a result of particulate matter emitted from the burn. The current standards may be found at the US EPA website, <https://www.epa.gov/criteria-air-pollutants/naaqs-table>.

Model run output must be submitted to the local NCFS District Office with other smoke management data on day of burn. See Appendix 2 for a list of currently acceptable models and results that need to be submitted. NCFS District Office contact information can be found in Appendix 4 or on the NCFS website.

Model run submissions are to be considered independently, regardless of their proximity, time of burn, etc.

### **AIR QUALITY INDEX**

The NC Division of Air Quality uses the Air Quality Index (AQI) to forecast fine particulate matter (PM<sub>2.5</sub>) and ozone concentrations. Ozone forecasts are issued each day during the ozone season (March 1 – October 31). Daily PM<sub>2.5</sub> forecasts are issued year-round.<sup>7</sup> The AQI is a color-coded system. If the AQI forecast for a given area is code Orange, Red, or Purple, it is highly recommended that burning not be done that day in that area.

## **ADDITIONAL CONSIDERATIONS**

The following situations can result in smoke impacts that may not otherwise be anticipated. Use caution when encountering these situations, and if necessary, have an alternate plan available if they are encountered.

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<sup>7</sup> Current Air Quality Forecasts and an explanation of the color codes can be found at <https://airquality.climate.ncsu.edu/air/>

- Transport winds of more than 25 MPH, and surface wind speeds of more than 20 MPH. These conditions prevent smoke from rising and dispersing properly.
- Transport wind carries smoke over a body of water such as a lake, bay or wide river. Air is typically cooler over a body of water. This will allow smoke to descend to the ground.
- Burn causes a large plume of smoke on a sunny day that blocks out the sun, reducing heating of the ground. This can cause the smoke to descend to the ground.
- Transport wind direction moves smoke from a fire on the slope of a ridge toward and over the top of the ridge. Smoke may return to the ground in the wind eddy that can develop on the downwind side of the ridge.
- Smoke can move down drainages under low wind conditions. This occurs most often in mountainous terrain but can also occur in the piedmont or coastal plain.
- Temperature inversions can trap smoke near the ground. You should wait until the inversion burn off temperature is reached before commencing ignition.
- Burning in organic soil introduces another level of complexity. Ideally, burns on organic soil should be conducted when the soil moisture is high enough to prevent it from burning. However, if the fire does burn into the soil, it will need to be considered in the management of the smoke. See Fire Effects Tech Note 01 for more information, [nrcforests.gov/fire\\_control/pdf/technotes/FETN01.pdf](https://nrcforests.gov/fire_control/pdf/technotes/FETN01.pdf)

## **NOTIFICATION AND REPORTING**

Prescribed burners should provide information about their burn on the day of the burn to any NCFS office. See Appendix 4 for contact information. In addition to the written burn plan that has been previously submitted to the NCFS (as required by the Prescribed Burning Act), the following additional information will also need to be submitted:

- Tract Name
- Name of person in charge of burn and on-site contact information
- Distance to Smoke Sensitive Area(s), given current wind direction forecasts
- Time of ignition
- Any changes to the written burn plan (acres to be burned, estimated available tons to consume, etc.)
- Results of Atmospheric Dispersion Modeling, if applicable. See Appendix 2 for details.

If the burner is using VIS to manage smoke, and the available tons exceed the allowable amount calculated from Table 2, the burner shall be informed by District Operations. The burner should be informed of possible alternatives, such as reducing acreage to burn that day.

For accurate reporting purposes, the burner should report actual acres burned and tons per acre (estimated) consumed at the conclusion of the burn. This should be done for all burns but is of particular importance if there is a change from what was reported prior to the burn.

The NCFS will make an annual report of smoke emissions from prescribed fire from forestry operations and from wildfires to the US EPA and NC Division of Air Quality. Data for this report will come directly from the online Smoke Management Database. Therefore, it is imperative that all prescribed burns that are reported to the District Offices be recorded properly in this Database.

## REVIEW AND UPDATING

The SMP will be reviewed by the NC FEC and revised as necessary. The initial review will be done approximately 1 year after initial approval by the NCFS Management Team. Subsequent reviews will be conducted at 2-year intervals thereafter. More frequent reviews may be done as circumstances warrant.

New methods of managing smoke, including new models or improvements to existing models, will be vetted and reviewed by the FEC for consideration for inclusion in the SMP. The FEC will develop the vetting process to be used.

## GLOSSARY OF TERMS

Atmospheric Dispersion Modeling (ADM)-The use of computer models, weather inputs and burn site data to determine the impacts of smoke from a burn.

Available Fuel- An estimate of the tons of fuel per acres that will be consumed by a fire. It is influenced by soil moisture, fuel arrangement, and other factors.

Burning Category-A scale of 0 to 5 based on the ventilation rate. For smoke dispersion, 0 is Stagnant and 5 is excellent.

Certified Burner-Someone who has successfully completed NC Certified Burner training and been issued a Certified Burner certificate and number. Also, a resident of another state that has prescribed burner certification in that state.

Class 1 Area-Certain federally owned lands that have been given special air quality protections to increase visibility by reducing haze.

Downwind-Opposite direction from which wind is originating. Example: if the wind direction at a certain point is from the west, then downwind is east of that point.

Fuel Load-An estimate of the entire accumulation of vegetative matter on a given area in tons per acre. See also Available Fuel.

Temperature Inversion- An increase in temperature with height in the atmosphere whereby vertical air movement is inhibited.

Mixing Height- The upper limit of a mixing layer of unstable air within which vigorous up and down movement of the atmosphere occurs. It is measured from the ground surface in feet.

National Ambient Air Quality Standards (NAAQS)-Standards established by the US Environmental Protection Agency, through the Clean Air Act, intended to protect human health and welfare from adverse effects of various outdoor air pollutants.

Non-industrial Private Forestland Owner- A forestland owner that is not a government or tribal agency or in the business of producing finished forest products.

North Carolina Fire Environment Committee (FEC)-An interagency committee with members who have an interest in prescribed fire and wildland fire in North Carolina. For more information, go to [https://www.ncforestservice.gov/fire\\_control/fc\\_fire\\_environment.htm](https://www.ncforestservice.gov/fire_control/fc_fire_environment.htm)

Prescribed Fire/Prescribed Burn-Application of fire to vegetative fuels under pre-determined conditions in a controlled area to accomplish one or more identified objectives. For the purposes of the SMP, it is assumed that fire is being applied as part of a forestry operation.

Organic soil-Soil with at least 20-30% decomposed organic content. For the purposes of the SMP, organic soil is any soil that could burn during a prescribed burn or wildfire.

PM<sub>2.5</sub>-Particulate matter that is 2.5 microns or less in diameter. Research has shown that particles of this size in the air have the greatest detrimental effect on human health.

Smoke Sensitive Area (SSA)- Area where smoke exceeding the National Ambient Air Quality Standard for PM<sub>2.5</sub> would likely cause harm. Examples include occupied/unmitigated schools, businesses, homes, and animal rearing facilities. Areas where reduced visibility could cause issues, such as roads, airports, or Class 1 areas, could be considered smoke sensitive areas, even if PM<sub>2.5</sub> standards would not be exceeded.

Transport wind- Expressed in speed and direction, it is the wind moving through the mixing layer. It is a smoke drift and dispersion indicator when used in conjunction with observed surface wind.

Ventilation Rate-The rate at which the lower atmosphere is able to diffuse and disperse smoke. It is the mathematical product of the mixing height and transport wind speed.

Wildfire-an unplanned wildland fire where the objective is to protect life and property by extinguishment.

APPENDIX 1-VENTILATION INDEX SYSTEM WORKSHEET

To be done on day of burn.

Tract Name: \_\_\_\_\_ Date: \_\_\_\_\_

Instruction

1. Ventilation Rate: \_\_\_\_\_
- 1a. Nighttime Smoke Dispersion: \_\_\_\_\_
2. Burning Category: \_\_\_\_\_
3. Type of Burn: \_\_\_\_\_
4. Day, or Day and Night: \_\_\_\_\_
5. Location of SSAs (compass direction from burn): \_\_\_\_\_
6. Distance to SSAs (miles): \_\_\_\_\_
7. Allowable tonnage: \_\_\_\_\_
8. Available tons to be consumed: \_\_\_\_\_
9. 7. minus 8.: \_\_\_\_\_

If the result in 9. is negative, you will exceed the allowable tonnage if you proceed with your burn today. Consider reducing the acreage burned, utilizing ADM, or postponing your burn for a more favorable day.

APPENDIX 2-APPROVED ADM MODELS AND COMPLEXITY WORKSHEET

<u>MODEL</u>	<u>USE</u>	<u>RESULTS TO SUBMIT TO NCFS</u>
PC HYSPLIT	General	KMZ and FEPS files
AirFire Tools - BlueSky Playground	General	Exported Variables and Results
VSmoke PC	Low Complexity Burns <sup>8</sup>	Complexity worksheet, screen shot of inputs and results of run.
VSmoke Web	Low Complexity Burns <sup>8</sup>	Complexity worksheet, screen shot of inputs and results of run.

<sup>8</sup> See Daytime Smoke Management Complexity Worksheet

## DAYTIME SMOKE MANAGEMENT COMPLEXITY WORKSHEET<sup>9</sup>

The following worksheet is provided as a guide to determining the complexity of a smoke management situation. Knowing the complexity will help determine which smoke model to use for a burn. NOTE: This worksheet is NOT applicable when active burning and significant smoke production will occur at night.

---

### *Acres in Flaming Combustion Stage per Hour*

- (1) Area to be burned \_\_\_\_\_ acres  
 (2) Expected duration of flaming combustion stage for burn \_\_\_\_\_ hours  
 (3) Divide (1) by (2) \_\_\_\_\_ acres/hour  
 (4) Select values based on (3)  
     < 150 acres/hr = 0  
     150-300 acres/hr = 1  
     > 300 acres/hr = 2  
 Score \_\_\_\_\_

### *Fuel Load Consumed*

- < 4 tons per acre = 0  
 4-8 tons per acre = 1  
 > 8 tons per acre = 2  
 Score \_\_\_\_\_

### *Topography*

- Flat terrain with no significant topography within 30 miles downwind of the burn unit = 0  
 Flat terrain with significant topography within 30 miles downwind of the burn unit = 1  
 Burn unit is in significant topography = 2  
 Score \_\_\_\_\_

### *Ambient Air Quality (based on AQI from <https://www.airnow.gov/state/?name=north-carolina>)*

- Good (green) = 0  
 Moderate (yellow) = 2  
 Other = 3 Recommend not burning.  
 Score \_\_\_\_\_

### *Atmospheric Dispersion Index (from [NWS Fire Weather Planning Forecast](#) for burning period)*

- Good/Very Good = 0  
 Fair = 1  
 Generally Poor = 2  
 Poor/Very Poor = 3  
 Score \_\_\_\_\_

### *Wildland Urban Interface (WUI)*

- No urban areas within 60 miles downwind of burn site = 0  
 Burn unit not in an urban area, but urban areas are within 60 miles downwind = 1  
 Burn site less than ½ mile from SSA = 3  
 Score \_\_\_\_\_

**Total** \_\_\_\_\_

### **Score Result Interpretation**

- 0-3 (with no individual elements receiving a score of greater than 2) = Low complexity smoke situation  
 4+ = Moderate to high complexity smoke situation
- 

<sup>9</sup> Adapted from [Introduction to Prescribed Fire in Southern Ecosystems, USDA Forest Service Southern Research Station, SRS-054](#), August 2012, Page 45.

APPENDIX 3-ATMOSPHERIC DISPERSION MODELING CERTIFICATION CHECKOFF SHEET

APPLICANT Name: \_\_\_\_\_

Address: \_\_\_\_\_

\_\_\_\_\_

Business Address: \_\_\_\_\_

\_\_\_\_\_

County: \_\_\_\_\_

Email Address: \_\_\_\_\_

Phone: \_\_\_\_\_

NC Forest Service Employee: Yes \_\_\_\_ No \_\_\_\_ If yes, what unit (District, Region, etc.): \_\_\_\_\_

Does applicant plan to contract services for atmospheric dispersion modeling? : Yes \_\_\_\_ No \_\_\_\_

ADM Certification Method being requested:  PC HYSPLIT  BlueSky Playground (Web Based)

**Certification Requirements**

Date and location of Advanced Atmospheric Dispersion Modeling course successfully completed.

\_\_\_\_\_

\_\_\_\_\_

**\*Model Run Evaluation #1:**

- a. Burn plan attached? Yes \_\_\_\_ No \_\_\_\_
- b. Approved model used? Yes \_\_\_\_ No \_\_\_\_
- c. Do model inputs match burn plan parameters (weather, fuels, etc.)? Yes \_\_\_\_ No \_\_\_\_
- d. Do model output show acceptable levels of PM<sub>2.5</sub> pollutants? Yes \_\_\_\_ No \_\_\_\_

**Model Run Evaluation #2:**

- a. Burn plan attached? Yes \_\_\_\_ No \_\_\_\_
- b. Approved model used? Yes \_\_\_\_ No \_\_\_\_
- c. Do model inputs match burn plan parameters (weather, fuels, etc.)? Yes \_\_\_\_ No \_\_\_\_
- d. Do model output show acceptable levels of PM<sub>2.5</sub> pollutants? Yes \_\_\_\_ No \_\_\_\_

**Model Run Evaluation #3:**

- a. Burn plan attached? Yes \_\_\_\_ No \_\_\_\_
- b. Approved model used? Yes \_\_\_\_ No \_\_\_\_
- c. Do model inputs match burn plan parameters (weather, fuels, etc.)? Yes \_\_\_\_ No \_\_\_\_
- d. Do model output show acceptable levels of PM<sub>2.5</sub> pollutants? Yes \_\_\_\_ No \_\_\_\_

*\*At a minimum, one model evaluation is satisfactory when utilizing BlueSky Playground only; three evaluations are still required when utilizing PC HYSPLIT.*

I hereby recommend that \_\_\_\_\_, Certified Burner  
Number \_\_\_\_\_, be certified as an Atmospheric Dispersion Modeler.

EVALUATOR Printed Name: \_\_\_\_\_

Signature: \_\_\_\_\_

Certified Burner Number: \_\_\_\_\_

Comments: \_\_\_\_\_

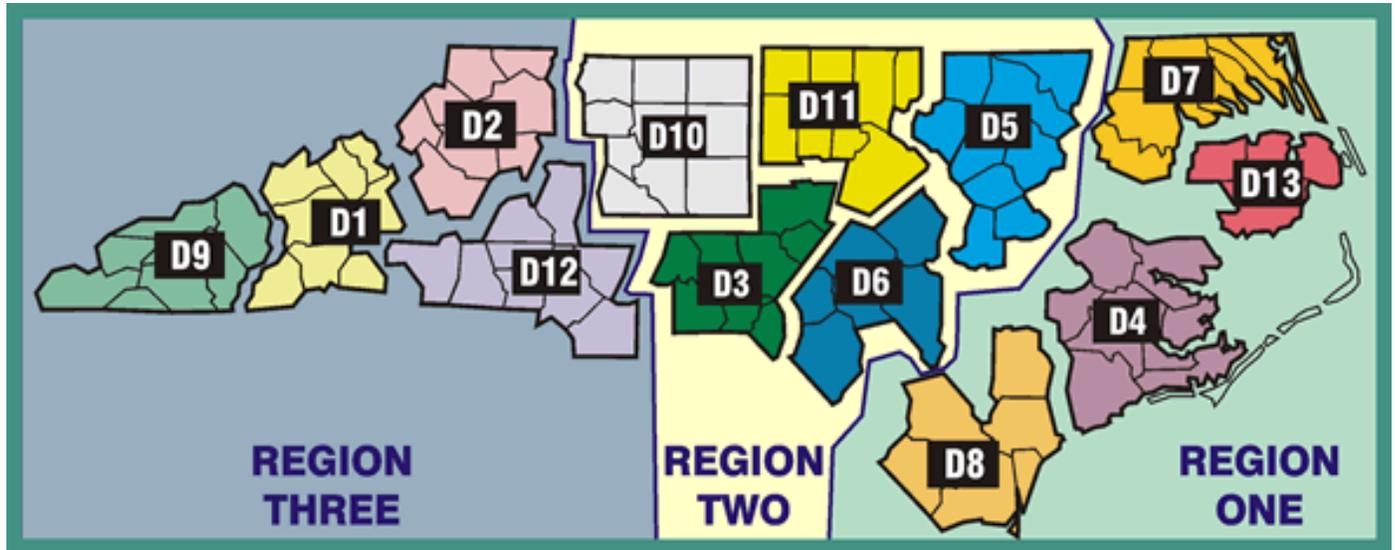
\_\_\_\_\_

\_\_\_\_\_

Mail, Fax, or scan and email to the Fire Environment Forester. INCLUDE COMPLETE BURN PLAN(S) AND  
MODEL RUN DATA RESULTS.

Fire Environment Forester  
NC Forest Service  
1616 Mail Service Center  
Raleigh, NC 27699-1616  
(919) 857-4806 FAX  
[coopsrm@ncagr.gov](mailto:coopsrm@ncagr.gov)

APPENDIX 4-NC FOREST SERVICE DISTRICT OFFICE CONTACT INFORMATION



District*	Location	Phone	Fax	Email
1	Asheville	828-667-5211	828-665-0331	d1opsrm@ncagr.gov
2	Lenoir	828-757-5611	828-757-5614	d2opsrm@ncagr.gov
3	Rockingham	910-997-9220	910-997-9224	d3opsrm@ncagr.gov
4	New Bern	252-649-6770	252-514-4768	d4opsrm@ncagr.gov
5	Rocky Mount	252-442-1626	252-442-1651	d5opsrm@ncagr.gov
6	Fayetteville	910-437-2620	910-437-2623	d6opsrm@ncagr.gov
7	Elizabeth City	252-331-4781	252-331-4817	d7opsrm@ncagr.gov
8	Whiteville	910-788-5050	910-788-5066	d8opsrm@ncagr.gov
9	Sylva	828-586-4007	828-586-4008	d9opsrm@ncagr.gov
10	Lexington	336-956-2111	336-956-3454	d10opsrm@ncagr.gov
11	Hillsborough	919-732-8105	919-732-4005	d11opsrm@ncagr.gov
12	Mount Holly	704-827-7576	704-827-4345	d12opsrm@ncagr.gov
13	Fairfield	252-926-3041	252-926-5746	d13opsrm@ncagr.gov

\*-for a list of counties within each district, go to  
[https://www.ncforestsservice.gov/contacts/contacts\\_main.htm](https://www.ncforestsservice.gov/contacts/contacts_main.htm)

**PRESCRIBED FIRE PLAN**

 Tract: \_\_\_\_\_  
 \_\_\_\_\_

 Date: \_\_\_\_\_  
 NCFS District: \_\_\_\_\_  
 County: \_\_\_\_\_

Latitude \_\_\_\_\_ Longitude \_\_\_\_\_

**PART 1: GENERAL INFORMATION**

Landowner: _____ Address: _____ _____ _____ Phone: _____ Agent: _____ Agent Phone: _____	<b>Estimates</b> Acres to Burn: _____ Bladed Line (miles): _____ Plowed Line (miles): _____ Hand Line (feet): _____ Other: _____ Other: _____	<b>Purpose of Burn</b> <input type="checkbox"/> Site Preparation <input type="checkbox"/> Silviculture <input type="checkbox"/> Hazard Reduction <input type="checkbox"/> Wildlife Habitat <input type="checkbox"/> Other: _____ _____
--	---	--

**PART 2: PRE-BURN PLANNING**

Specific Objectives: \_\_\_\_\_

Overstory Species: \_\_\_\_\_ Avg. Hgt. (ft.): \_\_\_\_\_ Avg. DBH(in.): \_\_\_\_\_

Age of Dominant Species: \_\_\_\_\_ Understory Species: \_\_\_\_\_

Fine Fuels: \_\_\_\_\_ Litter Depth (in.): \_\_\_\_\_ Fuel Type(Model): \_\_\_\_\_

% Slope: _____ Aspect: _____ Elevation (ft): _____ Soil: _____	Continuous	Patchy	Mineral	Organic
--	------------	--------	---------	---------

**For In-Stand Burning:** Basal Area (ft<sup>2</sup>/acre): \_\_\_\_\_ Ht. to Live Crown (ft.): \_\_\_\_\_ Allowable Scorch Height (ft.): \_\_\_\_\_

**Smoke Management:**

Direction to Smoke Sensitive Area (SSA)	<b>N</b>	<b>NE</b>	<b>E</b>	<b>SE</b>	<b>S</b>	<b>SW</b>	<b>W</b>	<b>NW</b>
Distance to SSA (miles)								

**Tonnage:** Estimated Acres \_\_\_\_\_ X Estimated Available Tons/Acre \_\_\_\_\_ = \_\_\_\_\_ Estimated Total Tons to be Burned

**Acceptable Range of Weather Parameters:**

Temp. (°F): \_\_\_\_\_ to \_\_\_\_\_ RH(%): \_\_\_\_\_ to \_\_\_\_\_ NWS 20' Wind Speed (MPH): \_\_\_\_\_ to \_\_\_\_\_

Wind Direction (Surface):  N  NE  E  SE  S  SW  W  NW

Mix Height (ft.): \_\_\_\_\_ to \_\_\_\_\_ Wind Direction (Transport):  N  NE  E  SE  S  SW  W  NW

Night-time Smoke Dispersion (minimum): \_\_\_\_\_ Acceptable Burn Categories:  1\*  2  3  4  5

KBDI: \_\_\_\_\_ to \_\_\_\_\_ Fine Fuel Moisture (%): \_\_\_\_\_ to \_\_\_\_\_

\*Tracts may be burned outside of VIS parameters by using Atmospheric Dispersion Modeling (ADM). ADM may only be used by those certified as an Atmospheric Dispersion Modeler by the NCFS. Model run data must be submitted to NCFS prior to ignition. Refer to the Smoke Management Program for details.

Other Weather Considerations: \_\_\_\_\_  
 \_\_\_\_\_

**Special Situations or Instructions:** \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Prepared By: \_\_\_\_\_ Title: \_\_\_\_\_ Certified Burner # \_\_\_\_\_ Date: \_\_\_\_\_

**PART 3: PREPARATION FOR BURN**

Resources needed: \_\_\_\_\_

<b>Prior to ignition on day of burn, Burn Manager must confirm the following;</b>							
NCFS Notified	Y N N/A	NFDRS Values Acceptable	Y N N/A	Area checked for new SSAs	Y N N/A	Adjacent landowners notified	Y N N/A
County 911 Center Notified	Y N N/A	Fire Line Installed & Cleaned	Y N N/A	Point Forecast Evaluated	Y N N/A	Crew Briefed	Y N N/A
Known T&E Species, Cultural, Historic Resources Protected	Y N N/A	Burning Permit Obtained	Y N N/A	On-Site Weather within Parameters	Y N N/A	Other: _____	Y N N/A
Burn Manager: _____ Title: _____				Certified Burner # _____ Date: _____			

**PART 4: BURN EXECUTION**

Base Line Location: \_\_\_\_\_

Base Line Width: \_\_\_\_\_ or # of Fire Lines: \_\_\_\_\_

Firing Technique: \_\_\_\_\_ Aerial Ignition Spacing (Ch., Ft.): \_\_\_\_\_

Test Fire Behavior: \_\_\_\_\_

Ignition Started: Date: \_\_\_\_\_ Time: \_\_\_\_\_

Ignition Completed: Date: \_\_\_\_\_ Time: \_\_\_\_\_

Active Burning Completed: Date: \_\_\_\_\_ Time: \_\_\_\_\_

On-Site Weather Readings, etc.				
Time of Readings:				
Temp. (°F)				
RH (%)				
Wind Direction				
Wind Speed (MPH)				
Calculated FFM				
Trans. Wind Direction				
KBDI Value				

**PART 5: MOP-UP**

Critical Areas/Special Instructions: \_\_\_\_\_

Distance Inside Line to be Mopped Up (ft.): \_\_\_\_\_ Applicable BMPs Used: **Y N N/A** Tract in FPG Compliance: **Y N**

Fire line to Rehabilitate (ft.): \_\_\_\_\_

Follow Up Checks: Date: \_\_\_\_\_ Time: \_\_\_\_\_ By Whom: \_\_\_\_\_

Follow Up Checks: Date: \_\_\_\_\_ Time: \_\_\_\_\_ By Whom: \_\_\_\_\_

**PART 6: POST BURN EVALUATION**

Acres Actually Burned: \_\_\_\_\_

**Burn Objectives**

Met

Partially Met

Unsatisfactory

Fire Effects	
Scorch Height (ft.)	
Crop Tree Mortality (%)	
Soil Exposure (%)	
Slash Removed (%)	
Fire Line Rehab Satisfactory	Y N N/A

**Emissions:** Acres Burned \_\_\_\_\_ X Tons/ Acre Burned \_\_\_\_\_ = \_\_\_\_\_ Total Tons Burned

Observations/Damage/Recommendations for Follow Up: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Evaluated By: \_\_\_\_\_ Date: \_\_\_\_\_

**Estimated Forest Fuel Loading**

Fuel Type	Estimated Available Tons Per Acre*		
	Low	Medium	High
Pine litter	3	6	12
Hardwood Litter	3	5	7
Mixed litter	4	6	8
Brush < 2 ft.	4	7	10
Brush 2 - 4 ft.	6	8	15
Brush > 4 ft.	10	20	30
Light (thin) slash	5	10	20
Medium (chopped) slash	10	20	40
Heavy (clearcut harvest) slash	30	40	60
Short grass ( Wire grass)	2	5	7
Tall grass (Broomsedge/Marsh)	3	6	8

*\*This information is based on results of actual sample measurements and has represented accurately the fuel availability based on the selected loading range. Research studies and surveys that provide more accurate site-specific information concerning tonnage or fuel availability can be used.*

**Smoke Management Allowable Tonnage Table**

Burn Category	1 <sup>1</sup>	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5
Burn Type	Under story	Open	Under story	Open	Under story	Open	Under story	Open	Under story	Open	Understory	Open	Under story	Open	Under story	Open	Under story
Night Smoke Dispersion	Any	Poor to Very Poor	Poor to Very Poor	Good to Fair	Good to Fair	Poor to Very Poor	Poor to Very Poor	Good to Fair	Good to Fair	Poor to Very Poor	Poor to Very Poor	Good to Fair	Good to Fair	Poor to Very Poor	Poor to Very Poor	Good to Fair	Good to Fair
Time of Burn	Day Only	Day Only	Day Only	Day or Night	Day or Night	Day Only	Day Only	Day or Night	Day or Night	Day Only	Day Only	Day or Night	Day or Night	Day Only	Day Only	Day or Night	Day or Night
Miles to SSA																	
0<1/2	0	0	0	0	0	0	0	0	0	0	0	0	1030	0	0	0	1350
1/2 <5	50	360	720	720	1080	450	900	900	1350	720	1440	1440	2160	900	1800	1800	2700
5<10	100	720	1440	1440	2160	900	1800	1800	2700	1400	2880	2880	4320	1800	3600	3600	5400
10<20	150	1080	2160	2160	3024	1350	2700	2700	4150	2160	4320	4320	6480	2700	5400	5400	8100
20<30	150	1200	2400	2400	3600	1600	3200	3200	4800	2500	5000	5000	7500	3000	6000	6000	9000
30+	200	1440	2880	2880	4320	1800	3600	3600	5400	2880	5760	5760	8640	3600	7200	7200	10800

**PART 7: CONTINGENCY PLANS**

<b>If the fire escapes beyond the suppression capabilities of the burning crew, or smoke dispersion is not occurring as planned, then the following contingency plan will be implemented:</b>			
<b>Command:</b>	Who will declare an escaped fire & who will direct suppression efforts until additional resources arrive, if needed?		
<b>Trigger Points</b>	What trigger points will initiate implementation of your contingency plan?		
<b>Notifications:</b>	(list of who to notify, contact info and by whom)		
		By	
		By	
		By	
<b>Additional Resources Needed &amp; Acceptable Response Times</b>	(who/what are they; how will you contact them?)		
<b>Other Information:</b>			

<sup>1</sup> Predicted minimum mixing height of 1,640 feet AND minimum transport wind speed of 9 MPH.