FEWG – A WORKING GROUP FOR THE NCFS MTM

NC SMOKE MANAGEMENT PROGRAM TECHNOTE 14 – MARCH 13, 2012

USING ATMOSPHERIC DISPERSION MODELS WITHIN NC's SMOKE MANAGEMENT **PROGRAM**

This Tech Note is designed to outline how atmospheric dispersion models (ADM) currently work within the current guidance of the North Carolina Smoke Management Program (SMP). The intent of this Tech Note is NOT to outline how to run ADMs. North Carolinas current SMP is based on the Ventilation Index System (VIS). VIS uses mixing height and transport winds to assess a "burn, no burn" day. For more information on the VIS, read NCFS Smoke Management Tech Notes 3, 4, 5 and 11.

Smoke modeling is used for preplanning prescribed burns (planned ignitions)or support of immediate Go / No-Go Decisions where the burn's smoke trajectory is projected, visibility impacts to smoke sensitive areas (SSAs), and potential particulate (PM2.5) levels are assessed and where those levels are at different times of the burn. Smoke modeling is also used by resource professionals to increase the number of burn days under the current VIS. Smoke modeling has also been used for wildfire (unplanned ignitions) where smoke production was excessive jeopardizing safety on transportation corridors and health of persons within SSAs or along the fire perimeter.

Smoke models use very specific inputs on fuel models, fuel tonnages, fuel consumptions, burning timeframes (how many acres are being burnt at what time of the day), current and forecasted weather, and atmospheric stability. If the actual progression of a prescribed burn does not follow the preplanned timed inputs, then the model will produce results different than what is experienced. Care needs to be exercised when using ADM whereby the implementation of the prescribed burn follows the preplanned burn scenario. If this does not occur, then the modeled output can be different than what actually takes place with regard to the smoke impacts.

Common sources of error when conducting a prescribed burn using ADMs include, but not limited to, missing the **"Smoke Management burnout window"**, extending the **"firing window"**, not assessing the **"dispersion window"** for 36 hours, inaccurate fuel consumption inputs, or lack of knowledge of the current SMP.

- The **"Smoke Management burnout window"** is the period of time a planned ignition needs to be completed. It has three stages. 1st Stage - Ignition this is the time it takes to completely fire the unit to be burned. 2nd Stage - Phases of Combustion (Flaming, Smoldering & Glowing) this is the time it takes for spreading flaming fronts to converge, in place burning with open flames to go out, and for "most" of smoldering and glowing combustion to finish. 3rd Stage - Smoldering Combustion and Residual Smoke, this is the time it takes for remaining smoldering fuels to go out or to be deemed at an acceptable level whereby all burn personnel can be released. The residual smoke from duff, organic soils or large fuels (100 or 1000 hr.) has assessed onsite and has been concluded to have been adequately dispersed from the burn area.

"SM burnout window" represents the best dispersion conditions. It is when most of the emissions from a planned ignition need to be released. The SM burnout window starts with the burn-off temperature and concludes with the Nighttime Smoke Dispersion (NSD) rating. For SM to be successful fire personnel need to skillfully complete planned ignitions within the SM burnout window. Extending planned ignitions beyond the day's burnout window is undesirable. It elevates risk for negative smoke impacts.

Under Ventilation Index System or with use of Atmospheric Dispersion Models, the "SM burnout window" identifies acceptable and best smoke dispersion conditions. For planned ignitions and successful smoke dispersion the three Stages need to be completed timely. It is very possible for the 3rd Stage of the SM burnout window to extend beyond the identified time period for the "burnout window". However, a majority of smoldering combustion and its residual smoke needs to be released within this window. If is determined during the course of the burn that there will be too much smoke from combustion (flaming or smoldering) extending well beyond the burnout window, the burn needs to be shutdown. Burning when vertical lift and horizontal movement is lost will not adequately disperse smoke and can be a factor for nuisance complaints and/or contribute to Smoke Induced Fog (Super Fog) events.

When NSD rating is Moderate or Good, surface wind speeds are ≥ 9 mph. Prescribed Burning is permissible through the night. However at night when surface wind speeds are < 9 mph, NSD ratings can be Stagnant, Very Poor, or Poor and burning is not permissible past sunset. It is likely that dispersed smoke will stay at ground level.

Under Very Poor NSD smoke plume rise can stop as much as 2 hours prior to sunset. A "good rule to follow" is to add an additional hour for smoke to disperse for smoldering combustion for any NSD rating corresponding to surface wind speeds < 9 mph. For example, a Very Poor NSD rating would mean that 3 hours prior to sunset needs to be used as the guidance to determine the end of the "SM burnout window". For a Poor NSD rating, 1 hour prior to sunset needs to be used to determine the end of the "SM burnout window".

- The **"firing window"** is the time you start your firing activities on your burn until you stop actively lighting fuels. You should plan your firing window to properly fit within the confines of the SM burnout window. The SM burnout window can be determined by review of the NWS Fire Weather Forecast (FWF), spot forecast or NWS hourly weather data validated by the NWS fire weather forecaster. Therefore, the firing window needs to be completed well in advance of the ending time of the SM burnout window. This is necessary in order to allow for the spreading flaming fronts to come together at the specified time as determined by the burnout window. In order to properly evaluate smoke impacts for planned or unplanned ignitions, firing and dispersion windows need to be reviewed and determined. This takes careful planning, especially in mountainous terrain where downslope and down valley laminar air flows have to be considered or in areas where sea breeze, lake flows, or drainages can impact smoke dispersion. During the preplanning process there needs to be preparations for the "what if" or the unexpected events (ground or aerial ignition delays, spot

overs, unexpected weather delays, equipment failure, etc). Contingency planning and mitigating actions need to be prepared when using ADMs. Therefore, they can be implemented as needed.

- The **"dispersion window"** is simply a 36 hour window whereby the atmosphere's ability to disperse wildland fire's smoke is reviewed. This review includes the NWS FWF or Spot Forecast for today, tonight and tomorrow. This permits fire practitioners to attain a picture on how smoke will disperse during this period for planned or unplanned ignitions. Being informed of the atmosphere's ability to disperse smoke for 36 hours, assists in the consideration of implementing preplanned mitigation measures.

- By not knowing your fuel moistures (using current and forecasted National Fire Danger Rating System (NFDRS) or local field sampling), you may consume and therefore release more tonnage than anticipated. This can make your smoke disperse not in the manner as planned.

- ADMs compliment the current VIS. Using ADMs for daytime burning is still accomplished within the "SM burnout window" as determined by the NWS FWF or Spot Forecasts. It is dependent on burn off temperature and NSD which is the guidance from the VIS. Use of ADMs still utilizes the VIS guidance for determining the daytime burn window. ADMs and the daytime burnout window have permitted the burning of more acres and released tonnages than if burning under the present VIS. As stated above, burning at night is permissible **only** when surface wind speed is 9 miles or higher. Surface wind speeds determine the NSD. It is therefore essential to request and review spot weather forecasts and updated fire weather forecasts (FWF) in order to minimize smoke impacts. Also, when mixing heights are less than 1,640 feet and transport wind is less 9 mph the ability of the atmosphere to disperse smoke tends not to be suitable. Under these conditions air stagnation is possible. However the use of ADMs still makes burning on these poor dispersion days possible. This is accomplished because smoke plume impacts to smoke sensitive impacts and transportation corridors are examined for "Go /No-go" decisions and by adhering to the VIS guidance to accomplish the burn within the SM burnout window" as determined from NWS forecasts.

ADM Users need to be aware of the specific models strengths and weaknesses. When they are used a "mitigation plan" **is required** to be in place as part of the burn plan documentation. It is to be implemented immediately when onsite conditions warrant. If the burn is not going as projected and smoke impacts are likely, then mitigation will be required. The mitigation plan should cover your trigger points, actions needed, and additional resources needed and their appropriate response times. Every planned ignition should be prepared to deal with smoke issues should the model not accurately reflect the projected smoke dispersion.