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OFFICE OF AIR QUALITY PLANNING AND STANDARDS

Technical Note – Guidance for Developing Enhanced Monitoring Plans

INTRODUCTION

On October 1, 2015 EPA substantially revised the Photochemical Assessment Monitoring Stations (PAMS) requirements in 40 CFR part 58 Appendix D. As part of the revision, EPA required state and local monitoring agencies ("monitoring agencies") to make PAMS measurements (including hourly averaged mixing height) at NCore sites in CBSAs with a population of 1,000,000 or more ("required PAMS sites"). The revisions also required state monitoring agencies with Moderate and above 8-hour O_3 nonattainment areas and states in the Ozone Transport Region (OTR) to develop and implement an Enhanced Monitoring Plan (EMP) detailing enhanced O_3 and O_3 precursor monitoring activities to be performed to better understand area specific ozone issues. In addition, the rule specifies that the EPA Regional Administrators have the authority to approve the EMPs (and other aspects of PAMS) for their respective state.

The purpose of this technical note is to provide guidance to monitoring agencies for developing EMPs. Note this guidance is not intended to provide additional requirements for state monitoring agencies, but rather to provide additional information that is intended to provide clarity on the intent of the requirement and to assist monitoring agencies as they develop their EMPs. Furthermore, the examples of potential monitoring options provided here are intended to be illustrative and are not limiting.

EMP REQUIREMENT

The EMP requirement is located in 40 CFR part 58, Appendix D, paragraph 5(h) and states –

> *"(h) States with Moderate and above 8-hour O_3 nonattainment areas and states in the Ozone Transport Region as defined in 40 CFR 51.900 shall develop and implement an Enhanced Monitoring Plan (EMP) detailing enhanced O_3 and O_3 precursor monitoring activities to be performed. The EMP shall be submitted to the EPA Regional Administrator no later than October 1, 2019 or two years following the effective date of a designation to a classification of Moderate or above O_3 nonattainment, whichever is later.[1] At a minimum, the EMP shall be reassessed and approved as part of the 5-year network assessments required under 40 CFR 58.10(d). The EMP will include monitoring activities deemed important to understanding the O_3 problems in the state. Such activities may include, but are not limited to, the following:*

[1] The EPA previously provided guidance suggesting that all States in the OTR submit EMPs by July 1, 2018. Many States in the OTR have already made these submissions. https://www3.epa.gov/ttnamti1/files/ambient/pams/PAMS%20Monitoring%20Network%20and%20EMP%20Plan%20Guidance.pdf.

(1) Additional O_3 *monitors beyond the minimally required under paragraph 4.1 of this appendix,*

(2) Additional NO_x *or* NO_y *monitors beyond those required under 4.3 of this appendix,*

(3) Additional speciated VOC measurements including data gathered during different periods other than required under paragraph 5(g) of this appendix, or locations other than those required under paragraph 5(a) of this appendix, and

(4) Enhanced upper air measurements of meteorology or pollution concentrations."

As discussed in the preamble to the final rule (published in the Federal Register on October 26, 2015, page 65292), the details of what an enhanced monitoring plan needs to include are intentionally limited to allow monitoring agencies as much flexibility in determining what enhanced ozone monitoring is needed to understand their specific ozone issues. Examples of what might be included in an EMP are provided, such as additional O_3 monitoring sites beyond the minimally required sites, but the examples do not restrict additional monitoring options the monitoring agency may desire.

In addition to states in the OTR, the requirement for an EMP is applicable to any state with a moderate or above O_3 non-attainment area under the 1997, 2008, and 2015 8-hour O_3 NAAQS. For states with moderate and above O_3 non-attainment areas under the 1997 or 2008 NAAQS and states in the OTR, the EMPs are due October 1, 2019. At this point, no states have moderate or above O_3 non-attainment areas for the 2015 NAAQS that are not classified as moderate or above under the 1997 or 2008 NAAQS. If at some point in the future, an area is classified as moderate or above in a state that does not currently have a moderate or above area, that state will have 2-years from the date of designation to submit an EMP.

While the regulations specify that states with moderate or above O_3 non-attainment areas are required to develop an EMP, other states and local monitoring agencies may also wish to develop an EMP. The EPA intends to support additional voluntary EMP monitoring beyond the required states because O_3 precursors can and do cross state boundaries. Therefore, it may be important to perform EMP monitoring in upwind or downwind states. This was expressly acknowledged for the OTR, but areas like the Lake Michigan shoreline also have significant upwind and downwind impacts that should be considered. In addition, many areas have had a long history of O_3 issues and continued enhanced O_3 monitoring may be appropriate to ensure continued progress and to better characterize O_3 and precursor concentrations.

CONSIDERATIONS FOR DEVELOPING AN EMP

The primary objective of EMP monitoring is to collect monitoring data that helps States understand their ozone issues and to evaluate local control options to address those issues. It is recognized that monitoring staff may not be the appropriate persons to identify what data is needed to better understand the ozone issues in their state. As such, monitoring agencies should consider which partners are needed to successfully develop and implement an EMP.

State monitoring agencies are strongly encouraged to work with their air quality planning staff who may be more familiar with the state's ozone issues and data needs. Where appropriate, monitoring agencies are also encouraged to work with neighboring states to coordinate plans to help develop the larger

picture of ozone formation and transport in the multi-state area. Such coordination is essential in the OTR states due to the importance of transport in ozone formation in those states.

States with local monitoring jurisdictions are encouraged to work with local agencies to help identify the most appropriate locations and types of monitoring to include in an EMP. Local monitoring organizations are not required by the regulation to develop and implement an EMP, however, voluntary EMPs are encouraged and will be considered in addition to the state's EMP in funding considerations.

EPA Regional staff should be included early in the planning stages and may be available to assist with the planning and coordination activities. EPA's monitoring and modeling staff in OAQPS and ORD will also be available to assist with planning. It may also be desirable to seek assistance from multi-state planning organizations such as NESCAUM, MARAMA, or LADCO. These multistate organizations often have good insight into the questions needing to be answered to understand the larger ozone issues as well as being good resources to help facilitate and coordinate EMP planning across the airshed.

States may also want to look for other interested groups who may be able to assist in EMP planning and implementation. Other Federal agencies, such as NASA and NOAA, have interests in understanding ozone formation and atmospheric science, and as such may be able to provide resources such as access to equipment or data. States may also wish to partner with local colleges and universities where appropriate to assist with EMP development and implementation.

Once the appropriate team is assembled, the team can identify the specific questions needing answers and the best ways enhanced monitoring can help the state understand and address their ozone issues. The options included in the final EMP should reflect the degree and nature of the State's ozone issues. EMPs for States with more serious ozone issues will likely include more measurements and sophistication than for States with less serious ozone issues. Factors such as size and number of non-attainment areas, persistence of O_3 non-attainment, complex terrain, and multi-state transport should be considered when developing the scope of an EMP.

EMPs should also reflect the availability of resources (e.g., funding, staff availability). EPA will provide funding for EMPs through 105 grants. EPA Regional staff can help inform monitoring agencies how much 105 grant funding is available and how that funding will be distributed. States are also encouraged to leverage existing resources and monitoring where possible. As discussed above, other non-State partners may be able to provide resources that can help provide data useful to understand the State's ozone issues.

EXAMPLES OF MONITORING APPROPRIATE FOR INCLUSION IN AN EMP

The following is a summary of monitoring options that might be appropriate for inclusion in an EMP. This summary is not intended to be an exhaustive or limiting list, but illustrative of the types of monitoring appropriate for an EMP. Monitoring to be included in an EMP need not be new, and States are encouraged to document existing monitoring that is intended to help them understand their ozone issues as part of their EMP.

Additional* O_3 *and* NO_x *Monitors

The minimum number of required O_3 and NO_x monitoring sites are provided in 40 CFR part 58 Appendix D. A monitoring agency may wish to run additional O_3 or NO_x sites to help understand the extent of O_3

and NO_x pollution and for other purposes. It is recognized that many monitoring agencies are currently running more O_3 and NO_x monitors than are required under Appendix D. Monitoring agencies are encouraged to include existing O_3 or NO_x monitoring beyond the minimum required in their EMPs along with any new O_3 or NO_x monitoring arising from EMP planning.

Low cost methods that are not Federal Reference Method or Federal Equivalent Measurement (FRM/FEM) technologies exist that may also be useful to understanding ozone issues. A number of low cost "sensors" for the measurement of O_3, NO_x, and VOCs are available or are becoming available that may be useful in understanding O_3 issues. While sensors generally are not believed to be able to provide FRM/FEM quality measurements at this time, when operated properly the data collected from sensors may be useful in evaluating the spatial variability of O_3 and O_3 precursors at a density not possible using conventional monitors. Low cost passive sampling methods also exist for the measurement of O_3, NO_x, and VOCs that may also provide useful information on the spatial variability of O_3 and O_3 precursors. Monitoring agencies are encouraged to consider how sensors and passive sampling can be used to help them understand the O_3 issues in their state especially as sensor technologies and techniques for using sensor data mature.

Additional or Alternative PAMS Sites

Prior to the 2015 revisions to the PAMS requirements, the PAMS network design featured multiple "types" of PAMS sites including:

- Type 1 - Upwind sites
- Type 2 - Maximum ozone precursor sites
- Type 3 – Maximum ozone concentration sites, and
- Type 4 – Downwind sites

The newly required PAMS sites are expected to be at NCore sites which are typically neighborhood scale sites. Individual NCore sites may not fit into any of the historic PAMS site types. In developing the new requirements, it was recognized that many states may have existing PAMS sites that may be more suitable for making the required PAMS measurements. As such, a waiver option was included to allow monitoring agencies to make PAMS measurements at alternative locations such as existing PAMS sites. Monitoring agencies should discuss any requested waivers for alternative PAMS sites in their Annual Network Plans (ANP) and EMPs as well as the status of those waiver requests.

As part of the EMP preparation, monitoring agencies may identify the need to run additional PAMS sites to better understand ozone formation and transport in their airshed. For example, upwind or downwind measurements may be important in areas with significant transport issues. Note however, because these sites are optional, monitoring agencies may elect to monitor a subset of PAMS measurements and may use alternative methods and sampling frequencies than those identified in the requirements and PAMS Technical Assistance Document (TAD). For example, a monitoring agency may wish to use canister sampling at additional PAMS sites to measure speciated VOCs on a 24-hour average 1-in-6 day sampling frequency rather than the hourly frequency for required PAMS sites. Monitoring agencies are encouraged to document any additional PAMS sites they intend to operate as part of their ANP and EMP including the measurements that will be made.

Measurements Made out of PAMS Season

At a minimum, PAMS measurements are to be taken during the PAMS season of June thru August at all required PAMS sites. Because the primary measurement objective of the PAMS required network is to create a consistent database of PAMS measurements across the network, no waiver was provided to allow monitoring agencies to change the required PAMS season. It is recognized that the required PAMS season of June thru August may not be sufficient to understand local ozone issues. As such, monitoring agencies may wish to make PAMS measurements during additional periods beyond the required PAMS season. Similar to additional PAMS sites, any measurements made outside of the PAMS required season would be optional and as such monitoring agencies may elect to use alternative sampling frequencies. For example, a monitoring agency may choose to measure carbonyls on a single 24-hour sample on a 1-in-6 day sampling frequency rather than the three 8-hr average samples on a 1-in-3 day sampling frequency required during the PAMS season. Also, monitoring agencies may wish to run continuous instruments year around. Those measurements that overlap with NCore (ozone, NO_x, various meteorological measurements) are already required to be made year-round. Monitoring agencies are encouraged to consider the value of making measurements of mixing height and speciated VOCs year-round during their EMP planning.

Special Studies

Special studies may be particularly useful to states in understanding their specific ozone issues. Shorter term (on the order of weeks to years) studies can be designed to help answer area specific questions regarding ozone formation. Special studies allow monitoring agencies to make more intensive or expensive measurements for a shorter period of time where the measurements might not be practical on a continuing basis. For example, states have partnered with the EPA, NASA, NOAA and others to make intensive special studies of a number of airsheds in recent years. Monitoring agencies are encouraged to include special studies in their EMPs as appropriate.

Due to the short-term nature of special studies it may be difficult for monitoring agencies to anticipate what measurements they may make as part of a special study for the purposes of creating a 5-year EMP. However, where possible monitoring agencies are encouraged to document special studies they are planning to participate in as part of their EMP. Not including a special study in an EMP does not preclude the state from using EMP funding for the study in following years.

Advanced Upper Air and Additional Meteorological Measurements

The PAMS regulations require states to measure hourly mixing height at required PAMS sites. It is expected that most states will use a ceilometer to meet this requirement. Other upper air systems also exist that may be appropriate for inclusion in an EMP. The following paragraphs discuss some upper air systems that may be appropriate for use in an EMP. This list is not intended to be exclusive and other systems may also be appropriate for use.

Prior to the recent PAMS revisions, the requirements called for “upper air measurements” at each PAMS area. Most states installed and operated Radar Wind Profilers equipped with Radio Acoustic Sounding Systems (RWP/RASS) to meet this requirement. In addition to obtaining estimates of mixing height from these systems, RWP also provides wind speed and wind direction measurements in the upper air. While these systems may be expensive to install and maintain, many states find great value in this information for understanding ozone formation and transport. As such, continued operation of these systems as part of an EMP may be appropriate.

A SODAR is similar to a RWP except that sound waves are used rather than radio waves and both are capable of measuring wind direction and wind speed versus height in the atmosphere. Also like RWP, algorithms have been developed to estimate mixing height from SODAR readings.

Several forms of LIDAR exist that are suitable for use in air quality measurements. Ceilometers, as discussed above, are a form or LIDAR capable of measuring mixing height based on relative fine particulate concentrations. Other forms include those that can be tuned to measure vertical profiles of one or more important atmospheric constituents such as ozone and water vapor. While these vertical profiles are of significant value on their own in understanding atmospheric chemistry, similar to ceilometers, algorithms have been developed to estimate mixing height based on the abrupt change in these constituents at the boundary layer. It is unlikely that these systems will find widespread use in the PAMS program as they are generally considered research grade at this time. However, where appropriate the addition of these vertical profiles can provide valuable information on the formation and transport of ozone.

Doppler LIDAR are also available that are capable of providing upper air wind speed and wind direction data similar to a RWP. A doppler LIDAR has several advantages over a RWP that include higher resolution data, lower capital cost, a smaller footprint (roughly the size of an office desk), and portability. Also, because they are light based they are less intrusive than RASS or SODAR systems making doppler LIDAR more suitable for long term use in urban areas. Doppler LIDARS have a similar vertical range to RWP of approximately 100 m to 5 km.

A microwave radiometer is a sensitive receiver that detects the microwave emissions of vapor and liquid water molecules in the atmosphere. These systems can be used to measure vertical gradients of temperature, relative humidity, and water vapor in the atmosphere. Microwave radiometers are relatively small (about twice the size of a mailbox) and have low operational costs.

The PANDORA spectrometer is an operational research instrument developed by NASA-Goddard to make total column measurements of O_3, SO_2, formaldehyde (HCHO), BrO, NO_2 and H_2O. NASA and EPA believe that these total column measurements collocated with the mixing height and other ground based measurements made at a select number of PAMS/EMP sites would be most valuable in evaluating current and future satellite air quality measurements. In the interest of supporting a network of PANDORA sites at these sites, NASA in partnership with the EPA is making a number of these instruments available to the PAMS/EMP community at no cost. PAMS/EMP sites would only be asked to host the equipment and provide internet access for the collection of the data by a central data system operated by NASA or EPA. The PANDORA spectrometer is very small and has low power requirements. In addition, the equipment runs unattended with minimal operator interaction.

FOR FURTHER INFORMATION

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