UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

MAY 20 2014

MEMORANDUM

SUBJECT: Guidance for $PM_{2.5}$ Permit Modeling

FROM: Stephen D. Page Michael Koerber for
Director

TO: Regional Air Division Directors, Regions 1-10

This memorandum and attachment, titled "Guidance for $PM_{2.5}$ Permit Modeling," provides guidance on demonstrating compliance with the fine particulate matter ($PM_{2.5}$) National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration (PSD) increments, especially with regard to considerations of the secondarily formed component of $PM_{2.5}$. This document reflects the EPA's recommendations for how a major stationary source seeking a PSD permit may demonstrate that it will not cause or contribute to a violation of the NAAQS and PSD increments for $PM_{2.5}$, as required under section 165(a)(3) of the Clean Air Act (CAA) and 40 CFR Sections 51.166(k) and 52.21(k).

A draft version of this guidance document was provided to the public on March 4, 2013, for a 90-day comment period. The document was revised in response to public comments and additional information provided through on-going interactions with various stakeholders.

Noteworthy changes made to the draft version include:

- Clarifications throughout with respect to procedures for adequately addressing primary and secondarily formed $PM_{2.5}$.
- Inclusion of an example hybrid (qualitative/quantitative) secondary $PM_{2.5}$ impact assessment.
- Revision of a second tier cumulative $PM_{2.5}$ NAAQS compliance approach.
- Revision of Section V and other sections relative to PSD increment for $PM_{2.5}$.

Please distribute the attached guidance document to state, local, and tribal governments, as appropriate. If you have any questions regarding this document, please contact Tyler Fox, Air Quality Modeling Group Leader, Air Quality Assessment Division/OAQPS, at (919) 541-5562, fox.tyler@epa.gov.

Attachment

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Guidance for $PM_{2.5}$ Permit Modeling

EPA-454/B-14-001
May 2014

Guidance for $PM_{2.5}$ Permit Modeling

U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Air Quality Assessment Division
Research Triangle Park, North Carolina

TABLE OF CONTENTS

Disclaimer

This document recommends procedures for permit applicants and permitting authorities to use to show that they have satisfied the criteria for obtaining or issuing a permit under applicable regulations. This document is not a rule or regulation, and the guidance it contains may not apply to a particular situation based upon the individual facts and circumstances. This guidance does not change or substitute for any law, regulation, or any other legally binding requirement and is not legally enforceable. The use of non-mandatory language such as "guidance," "recommend," "may," "should," and "can," is intended to describe EPA policies and recommendations. Mandatory terminology such as "must" and "required" are intended to describe controlling requirements under the terms of the Clean Air Act and EPA regulations, but this document does not establish legally binding requirements in and of itself. This document does not create any rights or obligations enforceable by any party or impose binding, enforceable requirements on any permit applicant for a PSD permit or PSD permitting authority.

Executive Summary

The U.S. Environmental Protection Agency (EPA) is providing this “Guidance for $PM_{2.5}$ Permit Modeling” to fulfill a need for additional guidance on demonstrating compliance with the fine particulate matter ($PM_{2.5}$) National Ambient Air Quality Standards (NAAQS) and the Prevention of Significant Deterioration (PSD) increments, especially with regard to considerations of the secondarily formed components of $PM_{2.5}$. This guidance incorporates the modeling procedures and recommendations from the EPA’s March 23, 2010, guidance memorandum, “Modeling Procedures for Demonstrating Compliance with $PM_{2.5}$ NAAQS,” and further clarifies procedures for adequately addressing primary and secondarily formed $PM_{2.5}$ in a NAAQS and PSD increments compliance demonstration. This guidance is consistent with the EPA’s *Guideline on Air Quality Models*, also published as Appendix W of Title 40 of the Code of Federal Regulations (CFR) Part 51. The release of this “Guidance for $PM_{2.5}$ Permit Modeling” is also consistent with the commitments contained in the EPA’s January 4, 2012, grant of a July 28, 2010, petition filed by the Sierra Club.

Because of the complex chemistry of secondary formation of $PM_{2.5}$, the EPA's judgment in the past has been that it was not technically sound to assign with particularity specific models that must be used to assess the impacts of a single source on $PM_{2.5}$ concentrations. Instead, the EPA has determined it was appropriate to satisfy the requirements of Section 165(e)(3)(D) of the Clean Air Act (CAA) by recommending that the “[c]hoice of methods used to assess the [$PM_{2.5}$] impact of an individual source depends on the nature of the source and its emissions,” as stated in Section 5.2.2.1.c. of Appendix W. As such, the appropriate methods for assessing $PM_{2.5}$ impacts are determined as part of the normal consultation process with the appropriate permitting authority. A modeling protocol should be developed by the permit applicant and approved by the appropriate permitting authority to ensure that the analysis conducted will conform to the recommendations, requirements, and principles of Section 10.2.1 of Appendix W. This guidance is intended to inform that process through recommendations regarding appropriate methods to assess secondary $PM_{2.5}$ impacts from the precursor emissions from the new or modifying source by providing the permit applicant and the appropriate permitting authority with both focus and flexibility. As experience is gained with these NAAQS and increments compliance demonstrations (and as the EPA moves forward to consider single source modeling techniques pursuant to its grant of the petition from the Sierra Club), this guidance will likely evolve such that the EPA will be able to provide further specificity on assessing the impacts of a single source on $PM_{2.5}$ concentrations.

This guidance document is broken down into five primary sections:

- I. Background – The first section provides the relevant regulatory actions and historical context to this guidance starting with the promulgation of the initial $PM_{2.5}$ NAAQS in 1997; chronicling the PM_{10} Surrogate Policy that for a period of time was relied upon for demonstrating compliance with the $PM_{2.5}$ NAAQS; and arriving at the present where there is a need for an assessment of both the primary and secondary $PM_{2.5}$ impacts, as appropriate, of a new or modifying source for demonstrating compliance with $PM_{2.5}$ NAAQS and increments.
- II. Guidance Overview – The second section provides a general overview of the steps that a permit applicant would routinely take under the PSD program for demonstrating compliance with the $PM_{2.5}$ NAAQS and increments. The concepts of significant emissions rates (SERs) and significant impact levels (SILs) are introduced and then presented in the context of a source impact analysis and a cumulative impact

analysis. The ramifications of the January 22, 2013, decision from U.S. Court of Appeals for the District of Columbia Circuit on the use of SILs in a source impact analysis or otherwise are included for reference and consideration throughout the remaining sections. Four assessment cases (Table ES-1) are then introduced with respect to assessing the primary and secondary $PM_{2.5}$ impacts through either the source impact analysis or the cumulative impact analysis.

- III. Source Impact Analysis for the $PM_{2.5}$ NAAQS – The third section provides a detailed discussion of a screening assessment of primary and secondary $PM_{2.5}$ impacts from a new or modifying source using a SIL. The specifics of the four assessment cases (Table ES-1) are presented along with appropriate approaches for assessing the primary and secondary impacts of $PM_{2.5}$. For assessing the primary $PM_{2.5}$ impacts from the direct $PM_{2.5}$ emissions from the new or modifying source, the typical use of an appropriate preferred dispersion model for near-field $PM_{2.5}$ modeling listed in Appendix W, currently AERMOD for most applications, or an approved alternative model is recommended. For assessing the secondary $PM_{2.5}$ impacts from the precursor emissions from the new or modifying source, three different approaches are described. These approaches are 1) a qualitative assessment, 2) a hybrid qualitative/quantitative assessment utilizing existing technical work, and 3) a full quantitative photochemical grid modeling exercise.
- IV. Cumulative Impact Analysis for the $PM_{2.5}$ NAAQS – The fourth section provides a detailed discussion of the assessment of primary and secondary $PM_{2.5}$ impacts from a new or modifying source with the inclusion of the primary and secondary $PM_{2.5}$ impacts of nearby sources and of monitored background. There are specific

discussions of the modeling inventory and the monitored background. Section IV concludes with information on determining significant contributions to modeled violations.

- V. PSD Increments for $PM_{2.5}$ – The fifth section provides a detailed discussion of the assessment of primary and secondary $PM_{2.5}$ impacts of a new or modifying source with respect to the increments.

Table ES-1. EPA Recommended Approaches for Assessing Primary and Secondary $PM_{2.5}$ Impacts by Assessment Case

Assessment Case	**Description of Assessment Case**	**Primary Impacts Approach**	**Secondary Impacts Approach**
Case 1: No Air Quality Analysis	Direct PM2.5 emissions < 10 tpy SER NOx and SO2 emissions < 40 tpy SER	N/A	N/A
Case 2: Primary Air Quality Impacts Only	Direct PM2.5 emissions ≥ 10 tpy SER NOx and SO2 emissions < 40 tpy SER	**Appendix W preferred or approved alternative dispersion model**	N/A
Case 3: Primary and Secondary Air Quality Impacts	Direct PM2.5 emissions ≥ 10 tpy SER NOx and/or SO2 emissions ≥ 40 tpy SER	**Appendix W preferred or approved alternative dispersion model**	**• Qualitative** **• Hybrid qualitative / quantitative** **• Full quantitative photochemical grid modeling**
Case 4: Secondary Air Quality Impacts Only	Direct PM2.5 emissions < 10 tpy SER NOx and/or SO2 emissions ≥ 40 tpy SER	N/A	**• Qualitative** **• Hybrid qualitative / quantitative** **• Full quantitative photochemical grid modeling**

In summary, this "Guidance for $PM_{2.5}$ Permit Modeling" recommends technical approaches for conducting $PM_{2.5}$ NAAQS and PSD increments compliance demonstrations which include adequate accounting for contributions from primary $PM_{2.5}$ concentrations from a proposed new or modifying source's direct $PM_{2.5}$ emissions and from secondarily formed $PM_{2.5}$ concentrations resulting from the source's $PM_{2.5}$ precursor emissions. This guidance does not create any rights or obligations enforceable by any party or impose binding, enforceable requirements on any permit applicant for a PSD permit or PSD permitting authority. Since each permitting action will be considered on a case-by-case basis, this document does not limit or restrict any particular justifiable approach permit applicants and permitting authorities may take to conduct the required compliance demonstrations. Each individual decision to issue a PSD permit must be supported by a record sufficient to demonstrate that the proposed construction and operation of a stationary source will not cause or contribute to a violation of the applicable $PM_{2.5}$ NAAQS and PSD increments. While this document illustrates a particular approach that the EPA considers appropriate and acceptable as a general matter, permit applicants and permitting authorities should examine all relevant information regarding air quality in the area that may be affected by a proposed new or modified source and evaluate whether alternative or additional analysis may be necessary in a given case to demonstrate that the criteria for obtaining a permit are satisfied. This document does not represent a conclusion or judgment by EPA that the technical approaches recommended in this document will be sufficient to make a successful compliance demonstration in every permit application or circumstance.

Permitting authorities retain the discretion to address particular issues discussed in this document in a different manner than the EPA recommends so long as the approach is adequately justified, supported by the permitting record and technical literature, and consistent with the applicable requirements in the CAA and implementing regulations, including the terms of an approved State Implementation Plan (SIP).

Furthermore, this guidance does not represent final agency action with respect to applicable legal requirements or the approvability of any particular permit application. To improve the quality of this guidance, the EPA has solicited public comment and considered the comments submitted. The EPA has revised the draft guidance in response to many points raised in public comment, but this document does not reflect a final determination by the EPA as to any issue raised in public comments. Concerns expressed in public comments about the permissibility or sufficiency of the approach recommended in this guidance for making the required demonstration in particular circumstances may be raised in the context of each individual permit application and should be considered by the permitting authority in light of the record in each instance before making a final determination to issue or deny a PSD permit.

Acknowledgements

We would like to acknowledge contributions from members of the National Association of Clean Air Agencies (NACAA) $PM_{2.5}$ Modeling Implementation Workgroup (NACAA Workgroup) in providing a detailed set of recommendations (NACAA, 2011) to the EPA with regards to $PM_{2.5}$ permit compliance demonstration modeling. This NACAA Workgroup was comprised of state and local air permitting agency dispersion modelers, permit engineers, and technical staff from throughout the country. In particular, we recognize Jim Hodina (Linn County Public Health), Bob Hodanbosi (Ohio EPA, Division of Air Quality), and Clint Bowman (Washington Department of Ecology) for their roles as Chairpersons for the Emissions Inventories, Secondary Formation from Project Source, and Representative Background Concentrations Sub-workgroups, respectively.

We would also like to acknowledge the contributions of the staff of the EPA Office of Transportation and Air Quality (OTAQ) for their input and assistance in the development of this document. The EPA's "Transportation Conformity Guidance for Quantitative Hot-spot Analyses in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas" (U.S. EPA, 2013a) guidance document served as a foundation for many aspects of the modeling guidance contained within this document.

Finally, there were numerous comments received with respect to issues and concerns of demonstrating compliance with the NAAQS and increments for $PM_{2.5}$ during the formal public comment period for the 10th Conference on Air Quality Modeling and comprehensive comments received specific to the overall guidance and recommendations presented here through the comment period for the "Draft Guidance on $PM_{2.5}$ Permit Modeling" (U.S. EPA 2013b). This invaluable feedback along with additional information gleaned through ongoing interactions with

various stakeholders have been particularly useful in the consideration of a range of acceptable options for $PM_{2.5}$ NAAQS and PSD increments compliance demonstrations and aided the EPA in the completion of this guidance document

I. Background

Under Section 165(a)(3) of the CAA, a PSD permit applicant must demonstrate that emissions from the proposed construction and operation of a facility "will not cause, or contribute to, air pollution in excess of any (A) maximum allowable increase or maximum allowable concentration for any pollutant… , [or] (B) national ambient air quality standard…" This requirement is implemented in the PSD regulations at 40 CFR 52.21(k)(1) (and at 40 CFR 51.166(k)(1) with slightly different wording) as follows:

> (k) *Source impact analysis*—(1) *Required demonstration*. The owner or operator of the proposed source or modification shall demonstrate that allowable emission increases from the proposed source or modification, in conjunction with all other applicable emissions increases or reductions (including secondary emissions), would not cause or contribute to air pollution in violation of:
>
> (i) Any national ambient air quality standard in any air quality control region; or
>
> (ii) Any applicable maximum allowable increase over the baseline concentration in any area.

On July 18, 1997, the EPA revised the NAAQS for particulate matter (PM) to add new annual and 24-hour standards for fine particles using particulate matter less than 2.5 micrometers or $PM_{2.5}$ as the indicator.[1] The EPA revised the 24-hour NAAQS for $PM_{2.5}$ on September 21, 2006, by lowering the level of the standard from 65 $\mu g/m^3$ to 35 $\mu g/m^3$.[2] In the September 21, 2006, action, the EPA also retained the previous 1997 annual standard for $PM_{2.5}$ and the 24-hour standard for PM_{10}, and revoked the previous annual standard for PM_{10}. Subsequently, the

---

[1] See 62 Fed. Reg. 58652.

[2] See 71 Fed. Reg. 61144.

Agency revised the $PM_{2.5}$ standard again on December 14, 2012, by lowering the level of the annual $PM_{2.5}$ NAAQS from 15 $\mu g/m^3$ to 12 $\mu g/m^3$ and retaining the 24-hour standards for $PM_{2.5}$ and PM_{10}.[3] The annual $PM_{2.5}$ standard is met when the 3-year average of annual arithmetic mean concentrations is less than or equal to 12.0 $\mu g/m^3$. The 24-hour $PM_{2.5}$ standard is met when the 3-year average of the annual 98th percentile 24-hour concentrations is less than or equal to 35 $\mu g/m^3$.

On October 20, 2010, EPA established maximum allowable increases for $PM_{2.5}$.[4] These values are also frequently described as the PSD increments. For Class I areas, the increments for $PM_{2.5}$ are 1 $\mu g/m^3$ for the annual averaging time and 2 $\mu g/m^3$ for the 24-hour averaging time. In Class II areas, the increments are 4 $\mu g/m^3$ for the annual period and 9 $\mu g/m^3$ for the 24-hour period.

To address the compliance demonstration for the $PM_{2.5}$ NAAQS, on October 23, 1997, citing significant technical difficulties with respect to $PM_{2.5}$ monitoring, emissions estimation, and modeling, the EPA established a policy known as the PM_{10} Surrogate Policy (U.S. EPA, 1997). This policy allowed permit applicants to use compliance with the applicable PM_{10} requirements as a surrogate approach for meeting $PM_{2.5}$ New Source Review (NSR) requirements until certain technical difficulties were resolved. On May 16, 2008, the EPA promulgated final rules governing the implementation of the NSR program for $PM_{2.5}$, which facilitated phasing out the application of the PM_{10} Surrogate Policy to permits involving $PM_{2.5}$.[5] With regard to nonattainment NSR permits, the rule provided that as of July 15, 2008 (the rule's effective date), permit applicants and permitting authorities would no longer be able to use the

---

[3] See 78 Fed. Reg. 3086.

[4] See 75 Fed. Reg. 64864.

[5] See 73 Fed. Reg. 28321.

PM_{10} Surrogate Policy to satisfy the NSR requirements for $PM_{2.5}$. With regard to PSD permits, the rule provided that PSD permits issued under the federal PSD program at 40 CFR 52.21 would no longer be allowed to rely on the PM_{10} Surrogate Policy as of the effective date of the rule. The exception to this outcome was that the rule also provided a “grandfathering provision” allowing permit applicants for federal PSD permits covered by 40 CFR 52.21, with complete permit applications submitted as of July 15, 2008, to continue relying on the PM_{10} Surrogate Policy. The 2008 rule also provided that states with approved PSD programs for $PM_{2.5}$ could continue to use the PM_{10} Surrogate Policy until May 2011 (when SIP revisions containing provisions to meet the new requirements in the 2008 rule were due), or until the EPA approved the revised SIP for $PM_{2.5}$, whichever occurred first.

On June 1, 2009, in response to a petition challenging the continued use of the PM_{10} Surrogate Policy for issuing PSD permits, the EPA issued a 3-month administrative stay of the grandfathering provision for $PM_{2.5}$ affecting federal PSD permits to give the EPA time to propose repealing the challenged grandfathering provision.[6] On September 16, 2009, the original 3-month stay was extended to June 22, 2010, to allow additional time for the EPA to propose repealing the grandfathering provision from the $PM_{2.5}$ NSR implementation rule for federal PSD permits issued under 40 CFR 52.21.[7] On February 11, 2010, the EPA published its proposal to repeal the grandfathering provision.[8] These actions cite the fact that the technical difficulties that necessitated the PM_{10} Surrogate Policy had been largely, although not entirely, resolved. As part of the proposed rulemaking to repeal the grandfathering provision contained in the federal PSD program, the EPA also proposed to require an early end to the use of the PM_{10} Surrogate Policy

---

[6] See 74 Fed. Reg. 26098.

[7] See 74 Fed. Reg. 48153.

[8] See 75 Fed. Reg. 6827.

for state PSD programs that the EPA had already approved as part of the SIP required by 40 CFR 51.166.

On May 18, 2011, the EPA published a final rule, titled "Implementation of the New Source Review (NSR) Program for Particulate Matter Less Than 2.5 Micrometers ($PM_{2.5}$); Final Rule to Repeal Grandfather Provision" (76 Fed. Reg. 28646), that repealed the grandfathering provision. In that final action, the EPA ended the use of the PM_{10} Surrogate Policy for PSD permits under the federal PSD program for sources that were covered by the grandfathering provision (that is, those sources for which a complete permit application was submitted before July 15, 2008) and that were not yet issued a permit by the effective date of the final rule. [9] The final rule also reaffirmed that as of May 2011, states with SIP-approved PSD programs for $PM_{2.5}$ could no longer use the PM_{10} Surrogate Policy. After the final rule became effective, in order for any PSD permits to be issued through the federal PSD program or a state SIP, such permit applications were to be reviewed directly against the $PM_{2.5}$ requirements. The demonstration must show, at a minimum, that the source's emissions are controlled to a level that satisfies Best Available Control Technology (BACT) requirements for $PM_{2.5}$ and that the emissions (filterable and condensable[10]) would not cause or contribute to a violation of any NAAQS for $PM_{2.5}$.

On March 23, 2010, the EPA issued a guidance memorandum titled "Modeling Procedures for Demonstrating Compliance with $PM_{2.5}$ NAAQS" (U.S. EPA, 2010b) to assist sources and permitting authorities in carrying out the required air quality analysis. The guidance memorandum recommended certain interim procedures to address the fact that compliance with the $PM_{2.5}$ NAAQS is based on a statistical form, and that there are technical complications

---

[9] Sources that applied for a PSD permit under the federal PSD program on or after July 15, 2008, were already excluded from using the 1997 PM10 Surrogate Policy as a means of satisfying the PSD requirements for PM2.5. See 73 Fed. Reg. 28321.

[10] See 40 CFR 51.165(a)(l)(xxxvii)(D), 51.166 (b)(49)(i)(a), and 52.21(b)(50) (i)(a).

associated with the ability of existing models to estimate the impacts of secondarily formed $PM_{2.5}$ in the atmosphere resulting from emissions of $PM_{2.5}$ precursors. For the latter issue, the EPA recommended that special attention be given to the assessment of monitored background air quality data since such data account for the contribution of both primary and secondarily formed $PM_{2.5}$ in the atmosphere associated with both nearby and regional sources.

On January 7, 2011, the NACAA Workgroup delivered a final report (NACAA, 2011), including a set of specific recommendations, to the EPA. The NACAA Workgroup was formed in early 2010 with the objective of providing technical recommendations to the Agency to aid in further development of $PM_{2.5}$ permit modeling guidance. The NACAA Workgroup's final report addressed three specific issues regarding $PM_{2.5}$ modeling implementation: 1) Emissions Inventories; 2) Secondary Formation from Project Source; and 3) Representative Background Concentrations.

The need for additional clarification on addressing both the primary and secondarily formed $PM_{2.5}$ in NAAQS compliance demonstrations was heightened following an administrative action on January 4, 2012, in which the EPA granted a petition submitted on behalf of the Sierra Club on July 28, 2010 (U.S. EPA, 2012a). The Sierra Club petition requested that the EPA initiate rulemaking to establish air quality models for ozone and $PM_{2.5}$ for use by all major sources applying for a PSD permit. In the petition grant, the EPA committed to engage in rulemaking to evaluate updates to the *Guideline on Air Quality Models* as published as Appendix W of 40 CFR Part 51 and, as appropriate, incorporate new analytical techniques or models for ozone and secondarily formed $PM_{2.5}$. As a part of this commitment and in compliance with Section 320 of the CAA, the EPA conducted the 10th Conference on Air Quality Modeling

(10th Modeling Conference) in March 2012. [11] At the 10th Modeling Conference, there were invited presentations of ongoing research of single source plume chemistry and photochemical grid modeling techniques, an overview presentation on the development of the "Draft Guidance for $PM_{2.5}$ Permit Modeling", and several public forums and subsequently written comments given pertaining to $PM_{2.5}$ NAAQS modeling.

Based on the EPA's March 23, 2010, guidance memorandum, the NACAA Workgroup final report recommendations, input from a mixture of stakeholders through numerous forums, and permit applicant-submitted $PM_{2.5}$ compliance demonstrations up to that point, the EPA prepared the "Draft Guidance on $PM_{2.5}$ Permit Modeling" and released it for public comment on March 4, 2013. During the course of the public comment period following the release of the draft guidance, the EPA received numerous comprehensive comments that provided invaluable feedback on the document and on the newly recommended approaches for $PM_{2.5}$ NAAQS and PSD increments compliance demonstrations. This feedback along with additional information gleaned through ongoing interactions with various stakeholders was particularly useful in the consideration of a range of acceptable options for $PM_{2.5}$ NAAQS and PSD increments compliance demonstrations and aided the EPA in the completion of this guidance document.

This "Guidance for $PM_{2.5}$ Permit Modeling" recommends appropriate technical approaches for conducting a $PM_{2.5}$ NAAQS and PSD increments compliance demonstration which includes adequate accounting for contributions from primary $PM_{2.5}$ concentration from a proposed new or modifying source's direct $PM_{2.5}$ emissions and from secondarily formed $PM_{2.5}$ concentrations resulting from the source's $PM_{2.5}$ precursor emissions. This guidance is consistent with the EPA's *Guideline on Air Quality Models*. The release of this "Guidance for $PM_{2.5}$ Permit

---

[11] Additional information regarding and presentations from the 10th Modeling Conference can be found on the SCRAM website at: http://www.epa.gov/ttn/scram/10thmodconf.htm.

Modeling" is also consistent with the commitments contained in the EPA's January 4, 2012, grant of the July 28, 2010, petition filed by the Sierra Club.

Since each permitting action will be considered on a case-by-case basis, this guidance does not limit or restrict any particular justifiable approach permit applicants and permitting authorities may take to conduct the required compliance demonstrations. Prospective permit applicants should recognize the importance of the consultation process with the appropriate permitting authority. This process will help identify the most appropriate analytical techniques to be used for conducting a $PM_{2.5}$ NAAQS and PSD increments compliance demonstration, including addressing the impacts of individual sources on secondary $PM_{2.5}$ formation, pursuant to Section 5.2.2.1.c of Appendix W.

In addition to this guidance, other recently issued EPA guidance of relevance for consideration in permit modeling for $PM_{2.5}$ includes:

- "Model Clearinghouse Review of Modeling Procedures for Demonstrating Compliance with $PM_{2.5}$ NAAQS," February 26, 2010 (U.S. EPA, 2010a);
- "Modeling Procedures for Demonstrating Compliance with $PM_{2.5}$ NAAQS," March 23, 2010 (U.S. EPA, 2010b);
- "Transportation Conformity Guidance for Quantitative Hot-spot Analyses in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas," November 2013 (U.S.EPA, 2013); and
- "Interim Guidance on the Treatment of Condensable Particulate Matter Test Results in the PSD and NSR Permitting Programs," April 8, 2014 (U.S. EPA, 2014a).

The guidance listed above, in addition to other relevant support documents, can be found on the SCRAM website at http://www.epa.gov/ttn/scram/.

This Page Intentionally Left Blank

II. Guidance Overview

This modeling guidance provides recommendations on how to conduct a $PM_{2.5}$ NAAQS and PSD increments compliance demonstration under the PSD program. It is based on and is consistent with Appendix W. Appendix W is the primary source of information on the regulatory application of air quality models for SIP revisions for existing sources and for NSR and PSD programs for permitting new and modifying sources.

The complexity of secondary $PM_{2.5}$ formation has historically presented significant challenges for the identification and establishment of particular models for assessing the $PM_{2.5}$ impacts of individual stationary sources (NARSTO, 2004; Seinfeld and Pandis, 1998; Cohan and Napelenok, 2011). Because of these considerations, the EPA's judgment in the past has been that it was not technically sound to assign with particularity specific models that must be used to assess the impacts of a single source on $PM_{2.5}$ concentrations.[12] Instead, the EPA has chosen to satisfy the requirements of the CAA, Section 165(e)(3)(D) through a process of determining particular models or other analytical techniques that should be used on a case-by-case basis because the "[c]hoice of methods used to assess the [$PM_{2.5}$] impact of an individual source depends on the nature of the source and its emissions," as stated in Section 5.2.2.1c. of Appendix W. As such, the appropriate methods for assessing $PM_{2.5}$ impacts are determined as part of the normal consultation process with the appropriate permitting authority. A modeling protocol should be developed by the permit applicant and approved by the appropriate permitting authority to ensure that the analysis conducted will conform to the recommendations, requirements, and principles of Section 10.2.1 of Appendix W.

---

[12] We note that this technical judgment has no effect on the obligation of sources subject to PSD to conduct a source impact analysis and demonstrate that a proposed source or modification will not cause or contribute to a violation of any NAAQS or applicable increment. See 40 CFR 51.166(k); 52.21(k). That is, the inclusion of a process rather than a specific preferred model in Appendix W does not relieve the source of the requirement to make this demonstration, which necessarily involves an analysis.

Due to the potentially important contribution from secondary formation of $PM_{2.5}$ and the more prominent role of ambient monitoring data in the cumulative analysis to represent background $PM_{2.5}$ concentrations including secondary formation from precursors from nearby sources, certain aspects of standard modeling practices used for PM_{10} and other criteria pollutants may not be appropriate for $PM_{2.5}$. For example, the contribution from secondary formation of $PM_{2.5}$ is not explicitly accounted for by the current preferred dispersion model (i.e., AERMOD), which is used to simulate dispersion of direct $PM_{2.5}$ emissions. Given these issues, PSD modeling of secondarily formed $PM_{2.5}$ should currently be viewed as screening-level analyses under Appendix W, analogous to Section 5.2.4 of Appendix W regarding dispersion modeling for nitrogen dioxide (NO_2) impacts due to the importance of chemistry in the conversion of nitric oxide (NO) emissions to ambient NO_2 and lack of a specified "refined" model.[13] The recommendations presented in this guidance for demonstrating compliance with the $PM_{2.5}$ NAAQS through dispersion modeling and other techniques have been developed with the factors listed above in mind.

As with any modeling analysis conducted using approved models identified in Appendix W, alternative models and methods may be considered on a case-by-case basis, subject to approval by the EPA Regional Office in accordance with the recommendations in Section 3.2. Additionally, Section 10.2.2 of Appendix W could potentially be given consideration in select situations. The provisions of Section 10.2.2 acknowledge that there are circumstances where there is no applicable model for a particular NAAQS compliance demonstration and that data

---

[13] Section 5.2.4 of Appendix W puts forth a 3-tiered screening approach for NO_2 NAAQS compliance demonstrations to obtain estimates of NO_2 for PSD and SIP planning purposes. The level of conservativeness in the tiered approaches decreases as fewer assumptions are made and a more detailed analysis is applied with the 3rd tier approach being the use of detailed screening techniques based on dispersion modeling.

from an array of ambient monitors surrounding the facility to be permitted could be used in lieu of modeling if appropriately justified.

Given the complexity of the technical issues that arise in the context of demonstrating compliance with the $PM_{2.5}$ NAAQS, we strongly encourage following the recommendations in Section 10.2.1 of Appendix W that "[e]very effort should be made by the Regional Office to meet with all parties involved in either a SIP revision or a PSD permit application prior to the start of any work on such a project. During this meeting, a protocol should be established between the preparing and reviewing parties to define the procedures to be followed, the data to be collected, the model to be used, and the analysis of the source and concentration data." Furthermore, we recommend that the consultative process involve regular communication between the appropriate permitting authority and the permit applicant at key milestones to ensure timely resolution of issues that may arise.

As necessary, the EPA Regional Office may seek clarification from the EPA's Office of Air Quality Planning and Standards (OAQPS) on technical issues and areas of concern in a modeling protocol or NAAQS compliance demonstration. Through these interactions and subsequent resolutions of the specific issues, clarifications of preferred modeling procedures can ultimately become official EPA guidance. This can happen in several ways: 1) the preferred procedures are published as regulations or guidelines; 2) the preferred procedures are formally transmitted as guidance to the Air Division Directors in the EPA Regional Offices; 3) the preferred procedures are formally transmitted as guidance to the EPA Regional Office modeling contacts as a result of a regional consensus on technical issues; or 4) the preferred procedures are relied upon in decisions by the EPA's Model Clearinghouse that effectively establish national precedent that the approach is technically sound. The Model Clearinghouse is the EPA focal point for the review of the technical adequacy of pollutant modeling to satisfy regulatory criteria and other NAAQS compliance demonstration techniques. Model Clearinghouse memoranda involving interpretation of modeling guidance for specific applications, as well as clarification memoranda addressing needs to clarify guidance more generally, are available at the Support Center for Regulatory Atmospheric Modeling (SCRAM) website at: http://www.epa.gov/ttn/scram.

The guidance that follows is appropriate for those new or modifying sources locating or located in an area classified as attainment or unclassifiable for $PM_{2.5}$. This document is intended to provide recommendations on how to conduct $PM_{2.5}$ NAAQS and PSD increments compliance demonstrations under the PSD program following the progressive steps shown in Figure II-1 (NAAQS) and Figure II-2 (Increments). The EPA has historically allowed the use of screening tools to help facilitate the implementation of the PSD program and streamline the permitting process in circumstances where proposed construction is projected to have an insignificant (or *de minimis*) impact on air quality. These screening tools have included SERs, SILs, and significant monitoring concentrations (SMCs). The use of these screening tools at each progressive step on the left side (attainment or unclassifiable areas) of Figure II-1 and Figure II-2 are described in more detail in Sections II.1, II.2, and II.3.

Figure II-1. Overview of PM$_{2.5}$ NAAQS Compliance Demonstration for New or Modifying Sources under NSR/PSD Programs

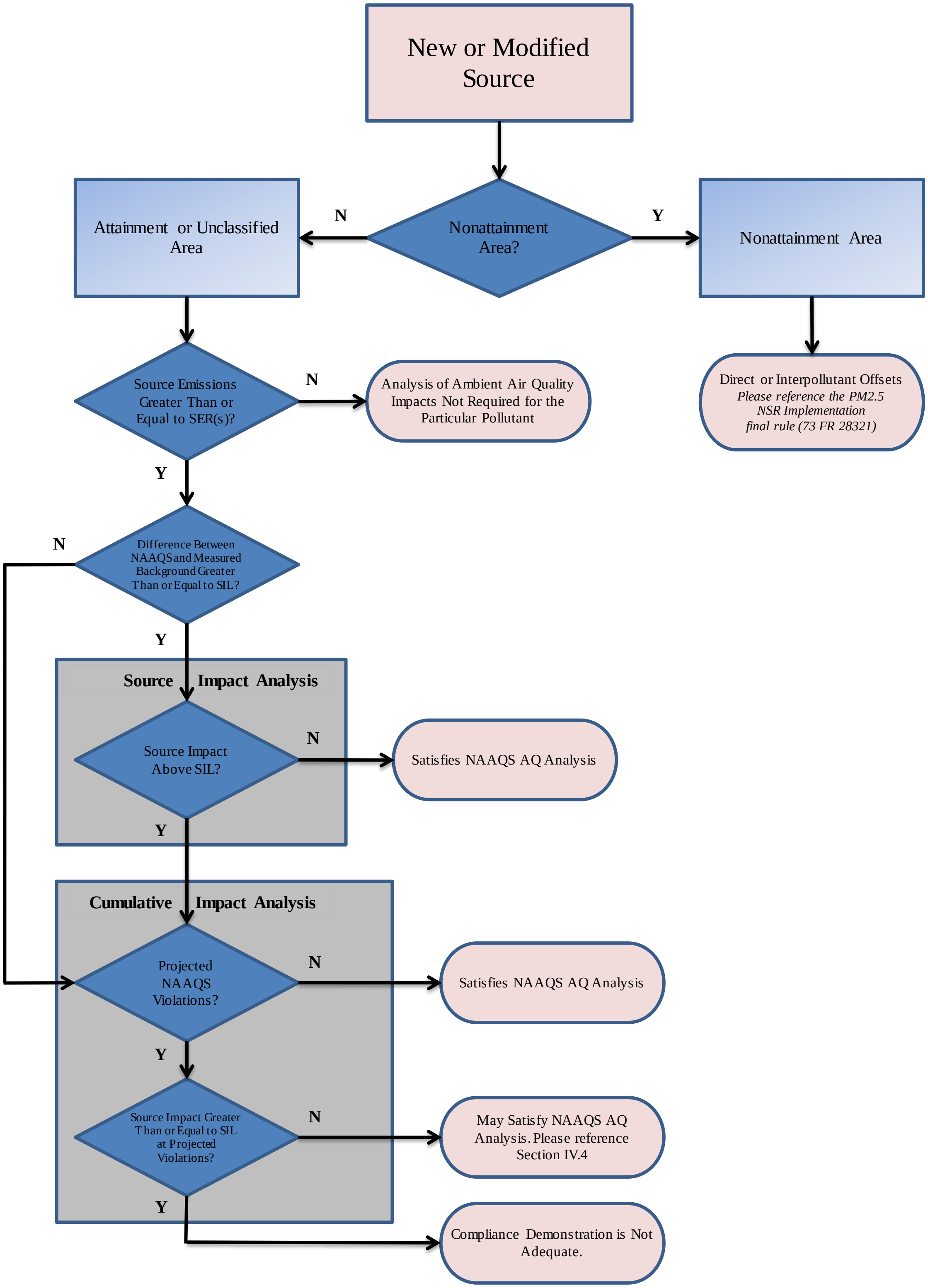
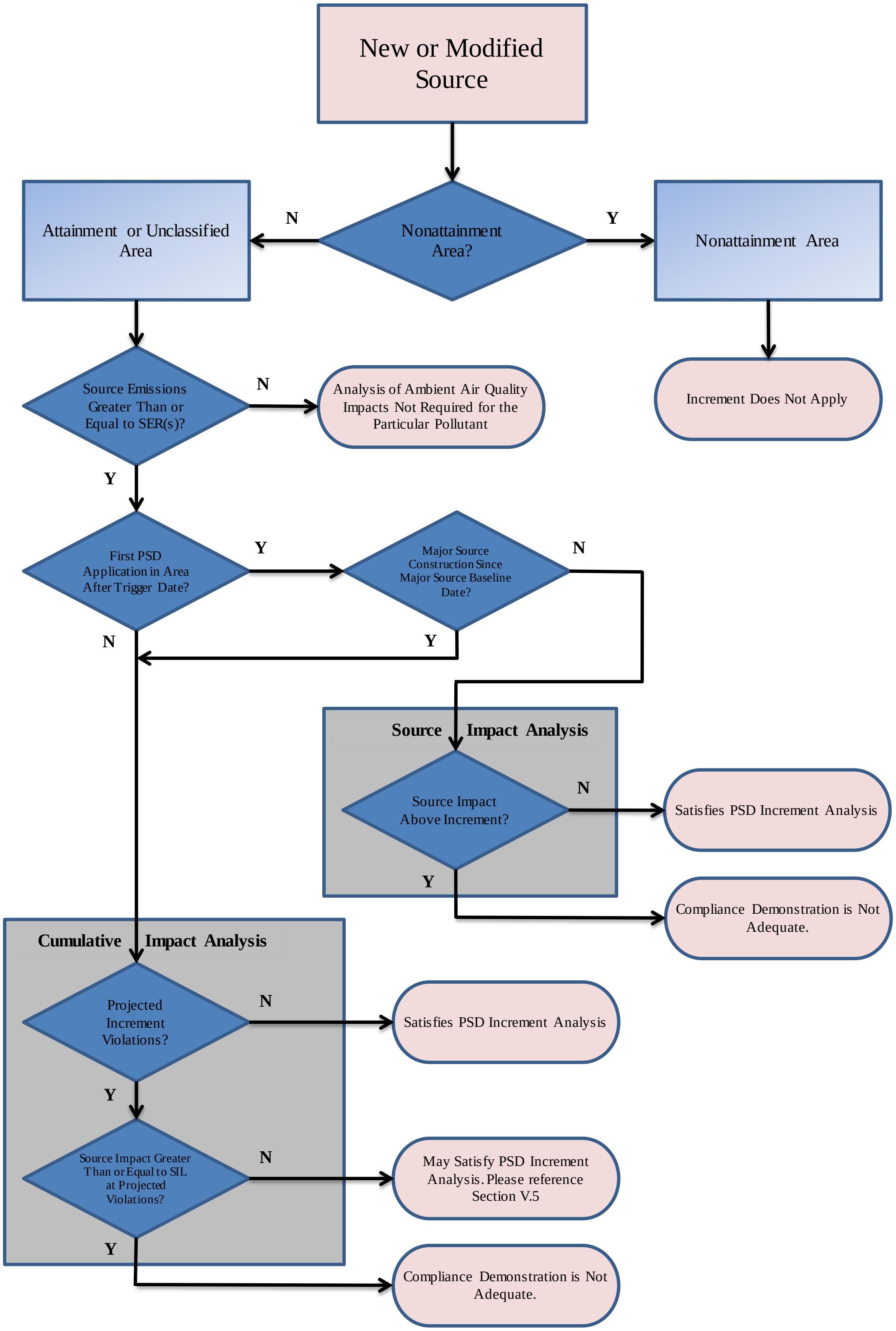


Figure II-2. Overview of PSD Increments Compliance Demonstration for New or Modifying Sources under NSR/PSD Programs



II.1 Significant Emissions Rates

EPA regulations only require an analysis of ambient air quality impacts for pollutants that a source emits (or that a modification of a source increases) in an amount equal to or greater than the significant emission rate for that pollutant defined in EPA regulations.[14] The EPA promulgated SERs for $PM_{2.5}$ and for the $PM_{2.5}$ precursors, nitrogen oxides (NO_x) and sulfur dioxide (SO_2), in 2008 as part of the first phase of PSD amendments to address $PM_{2.5}$.[15] (74 Fed. Reg. 28321 at 28333). The $PM_{2.5}$ SER for direct emissions of primary $PM_{2.5}$, defined as 10 tons per year (tpy) of direct $PM_{2.5}$ emissions, and the $PM_{2.5}$ precursor SERs, defined as either 40 tpy of NO_x or 40 tpy of SO_2, are used to determine whether any proposed new major stationary source or major modification will emit sufficient amounts of direct $PM_{2.5}$ and/or $PM_{2.5}$ precursors, i.e., equal to or above the respective SERs, to require review for $PM_{2.5}$ under the PSD program.

II.2 Screening and Source Impact Analysis

The EPA has historically supported the use of screening techniques in the PSD program to determine the extent of the air quality analysis that must be carried out to demonstrate that the source's emissions will not cause or contribute to a violation of any NAAQS or increment. [16]

---

[14] See 40 CFR 51.166(m)(1)(i); 40 CFR 52.21(m)(1)(i).

[15] The EPA's final NSR rules for $PM_{2.5}$ do not require regulation of volatile organic compounds (VOC) or ammonia (NH_3) as precursors to $PM_{2.5}$ for the PSD program. However, a state may demonstrate to the Administrator's satisfaction or the EPA may demonstrate that VOC emissions in a specific area are a significant contributor to that area's ambient $PM_{2.5}$ concentrations. See 74 Fed. Reg. 28321. If so, then permit applicants with project sources having emissions of these pollutants should consult with the appropriate permitting authority and EPA Regional Office about how to deal with these emissions for the purposes of a NAAQS or PSD increments analysis.

[16] This has been consistent with overall support for screening techniques in the modeling guidelines. See, 40 CFR Part 51, Appendix W, Sections 2.2 and 4.2.1. The Guideline observes that "use of screening techniques followed, as appropriate, by a more refined analysis is always desirable." 40 CFR Part 51, Appendix W, Section 2.2.c. With respect to PSD permit review specifically, the Guideline says the following: "The purpose of [screening] techniques

Using this screening approach, when a proposed source's modeled impacts are found to be greater than the level of a SIL identified by the EPA, the EPA has called for a cumulative impact analysis (considering the combined impact of the proposed source and other sources in the affected area) to demonstrate that the proposed source will not cause or contribute to a violation of the NAAQS. On the other hand, the EPA has generally said that if the proposed source's modeled impacts are found to be below the level of a SIL identified by EPA for the relevant pollutant, this showing may be sufficient to demonstrate that the source will not cause or contribute to a modeled violation of the NAAQS.[17] However, the EPA has also acknowledged that there can be circumstances where a showing that the air quality impact of a proposed source is less than a SIL value identified by the EPA is not sufficient by itself to demonstrate that a source will not cause or contribute to a violation of the NAAQS or increment.

Prior to 2010, EPA had expressed support in guidance for applying the values in Section 51.165(b)(2) of its regulations as SILs that could be used as part of a demonstration that a source does not cause or contribute to a violation of the NAAQS. However, when the EPA added SILs for $PM_{2.5}$ in 2010 to paragraph (k)(2) of its Section 51.166 and 52.21 regulations, the Agency observed that "the use of a SIL may not be appropriate when a substantial portion of any NAAQS or increment is known to be consumed." (75 Fed. Reg. 64894). The EPA also said that "notwithstanding the existence of a SIL, permitting authorities should determine when it may be appropriate to conclude that even a *de minimis* impact will "cause or contribute" to an air quality problem and to seek remedial action from the proposed new source or modification." (75 Fed. Reg. 64892).

---

is to eliminate the need of more detailed modeling for those sources that clearly will not cause or contribute to ambient concentrations in excess of either the National Ambient Air Quality Standards (NAAQS) or the allowable prevention of significant deterioration (PSD) concentration increments." *Id.* Section 2.2.a.

[17] See 72 Fed. Reg. 54112 at 54139 and 75 Fed. Reg. 64864 at 64890.

In the course of litigation challenging the SILs for $PM_{2.5}$, the EPA acknowledged that the regulatory language the EPA adopted in Sections 51.166(k)(2) and 52.21(k)(2) did not provide sufficient flexibility for permitting authorities to exercise discretion to conduct or require additional analysis in some circumstances where the EPA had advised doing so. As a result, the EPA requested that the U.S. Court of Appeals for the District of Columbia Circuit remand and vacate these provisions so the EPA could take corrective action. On January 22, 2013, the court granted this request and observed that, under the language in Sections 51.166(k)(2) and 52.21(k)(2), sources in some scenarios would not be required to demonstrate that they would not cause or contribute to a violation of the NAAQS or increments, even though, based on Petitioner's arguments, the sources likely would cause or contribute to a violation in such scenarios. The court concluded this would contravene the statutory command in Section 165(a)(3) of the Act. 705 F.3d at 464-65. The court also said that on remand the EPA may choose to promulgate regulations that "include SILs that do not allow the construction or modification of a source to evade the requirements of the Act as do the SILs in the current rule" and that such regulations would be subject to further review by the court. (Id. at 464).

EPA does not interpret the court's decision to preclude the use of SILs for $PM_{2.5}$ as part of a demonstration that a source will not cause or contribute to a violation of the $PM_{2.5}$ NAAQS. However, to ensure that PSD permitting decisions meet the requirements of the CAA, permitting authorities that continue using SILs for $PM_{2.5}$ must ensure that they select and apply such SILs in a manner that is consistent with the court's decision and the EPA's statements from the preamble of the 2010 regulation adopting SILs for $PM_{2.5}$. The EPA is developing a proposed rule to address the issues identified by the EPA and the court's decision. If necessary and as appropriate, this guidance will be amended after this rulemaking is proposed and subsequently finalized. In the interim, permitting authorities may not apply the SIL provisions in the vacated and repealed Sections 51.166(k)(2) and 52.21(k)(2). Furthermore, permitting authorities should not apply any state regulations that have not yet been amended to conform to the repeal of these provisions and still contain regulatory text that is the same as or has a similar effect as the paragraph (k)(2) language, particularly in the types of scenarios described in the court decision and the EPA's 2010 preamble to the $PM_{2.5}$ Increments, SILs, and SMC Rule. [18] However, with appropriate safeguards, the EPA believes permitting authorities may continue to select and apply SILs values for $PM_{2.5}$ to support PSD permitting decisions and to determine the level of analysis needed to demonstrate that a source will not cause or contribute to violation of the NAAQS.[19] These safeguards involve two related considerations – the particular values of the SILs to be used and how those values are used.

The court decision does not preclude the use of SILs for $PM_{2.5}$, but requires that the EPA correct the error in the SIL regulations for $PM_{2.5}$ at 51.166(k)(2) and 52.21(k)(2). As a first step, on December 9, 2013, the EPA issued a final rule removing these sections of its regulations from the CFR (78 Fed. Reg. 73698). Until the EPA completes a rulemaking to replace these provisions, the EPA believes permitting authorities may continue to apply SILs for $PM_{2.5}$ to support a PSD permitting decision, but permitting authorities should take care to ensure that SILs are not used in a manner that is inconsistent with the requirements of Section 165(a)(3) of the CAA.

Permitting authorities have the discretion to select the particular $PM_{2.5}$ SIL values that are

---

[18] Prevention of Significant Deterioration (PSD) for Particulate Matter Less Than 2.5 Micrometers ($PM_{2.5}$) – Increments, Significant Impact Levels (SILs) and Significant Monitoring Concentration (SMC). See 75 Fed. Reg. 64864 (October 20, 2010).

[19] The topic of the level of analysis needed for PSD increments compliance analysis is discussed in more detail in Section V.

used to support a permitting decision, but the values used should be supported by either a permitting record or regulation that supports the use of those values in the particular manner they are used.[20] Permitting authorities may not rely on the values contained in the vacated Sections 51.166(k)(2) and 52.21(k)(2) of the EPA's regulations as a screening tool without providing additional justification in the permitting record. However, with additional justification, it may be permissible in some cases for a permitting authority to use the same $PM_{2.5}$ SIL values as listed in the vacated Sections 51.166(k)(2) and 52.21(k)(2) to demonstrate that a full cumulative impacts analysis is not needed to make the NAAQS compliance demonstration

To the extent a permitting authority wishes to use any of the SILs values in the vacated Sections 51.166(k)(2) or 52.21(k)(2) as a screening tool to determine whether it is necessary to conduct a cumulative analysis of NAAQS compliance, the permitting authority must first examine background air quality concentrations to determine whether a substantial portion of the NAAQS has been consumed.[21] For this purpose, the EPA recommends using the preconstruction monitoring data compiled to meet the requirements of Section 51.166(m) or 52.21(m) of the EPA's regulations. If the preconstruction monitoring data are sufficiently representative of the air quality in existence before the increase in emissions from the proposed source and the difference between the $PM_{2.5}$ NAAQS and the measured $PM_{2.5}$ background concentrations in the

---

[20] The EPA has previously observed that the absence of an EPA-promulgated SIL does not preclude PSD permitting authorities from developing and applying SILs to support permitting decisions. *See,* Response to Comments, Implementation of New Source Review (NSR) Program for Particulate Matter Less Than 2.5 Micrometers in Diameter ($PM_{2.5}$) at 82 (March 2008) [EPA-HQ-OAR-2003-0062-0278]. However, the EPA has also observed that, "[t]he application of any SIL that is not reflected in a promulgated regulation should be supported by a record in each instance that shows the value represents a *de minimis* impact." *See,* NO_2 NAAQS Guidance at 13; and *Mississippi Lime* at 41 (granting the petition for review where the permitting authority failed to substantiate in the record which SIL it applied and its reasons for doing so).

[21] The recent court decision vacating the $PM_{2.5}$ SMC from the PSD regulations will mean that each PSD application must include ambient monitoring data representative of the area of concern. These data need not be collected by the PSD permit applicant if existing data are determined by the permitting authority to represent the air quality in the area of concern over the 12-month period prior to the submittal of a complete PSD application.

area is greater than or equal to the SIL value selected from the vacated Sections 51.166(k)(2) and 52.21(k)(2), then the EPA believes it would be sufficient in most cases for permitting authorities to conclude that a source with an impact equal to or below that SIL value will not cause or contribute to a violation of the NAAQS and to forego a cumulative modeling analysis for $PM_{2.5}$ with respect to the NAAQS.

The above comparison of background air quality concentrations and the NAAQS would not by itself provide adequate justification for foregoing a cumulative modeling analysis for the $PM_{2.5}$ increments. Such an approach would be inappropriate because it would not ensure that there is sufficient "headroom" within the allowable increment to absorb a source contribution equal to the SIL. However, a permitting authority may still be able to justify reaching a determination that a new or modified source will not cause or contribute to a violation of the increments without performing cumulative modeling for increments.

Since the trigger date has only recently been established (i.e., October 20, 2011), for the next several years, a new or modified source being evaluated for increments compliance will often be the first source with increment-consuming emissions in the area. As indicated in Figure II-2, under this situation, a permitting authority may have sufficient reason to conclude that the impacts of the new or modified source (based on the approach for conducting source impact analysis described below) may be compared directly to the allowable increments, without the need for a cumulative modeling analysis. Such a situation would involve the new or modified source representing the first PSD application in the area after the trigger date, which establishes the minor source baseline date and baseline area, and confirmation that no relevant major source construction has already occurred since the major source baseline date.

II.3 Cumulative Impact Analysis

As part of a NAAQS compliance demonstration, a cumulative impact analysis for $PM_{2.5}$ accounts for the combined impacts of direct and precursor emissions from the new or modifying source, of direct emissions from nearby sources (as appropriate), and of monitored background levels of $PM_{2.5}$ that account for secondary $PM_{2.5}$ impacts from regional transport, secondary $PM_{2.5}$ impacts from precursor emissions from nearby sources, and primary $PM_{2.5}$ impacts from background sources not included in the modeled inventory. The cumulative impacts are then compared to the NAAQS to determine whether the source will cause or contribute to a violation of the NAAQS. Several aspects of the cumulative impact analysis for $PM_{2.5}$ will be comparable to analyses conducted for other criteria pollutants, while other aspects will differ due to the issues identified earlier.

The measured background levels incorporated into a cumulative analysis should be based on the preconstruction monitoring data gathered in accordance with the requirements of the EPA regulations. 40 CFR 51.166(m)(1)(iii)-(iv); 40 CFR 52.21(m)(1)(iii)-(iv) (2). The EPA regulations contain an exemption from the preconstruction monitoring requirements in cases where ambient concentrations or the predicted impact of the source are less than the SMC. 40 CFR 51.166(i)(5)(i) ; 40 CFR 52.21(i)(5)(i). In the decision mentioned above, a U.S. Court of Appeals vacated the SMC for $PM_{2.5}$. *Sierra Club v. EPA*, 705 F.3d 458. The court concluded that the $PM_{2.5}$ SMC provisions (51.166(i)(5)(i)(c) and 52.21(i)(5)(i)(c)) were inconsistent with the requirements of Section 165(e)(2) of the CAA. The EPA has subsequently removed the $PM_{2.5}$ SMC provisions from the regulation.[22] Thus, permitting authorities may no longer rely on the SMCs for $PM_{2.5}$ to exempt permit applicants from compiling preconstruction monitoring data for

---

[22] See 78 Fed. Reg. 73698.

$PM_{2.5}$ in accordance with Sections 51.166(m) and 52.21(m) of the EPA's regulation. However, the EPA believes PSD permit applicants may continue to meet the preconstruction monitoring requirements in these regulations by gathering for purposes of the permitting analysis data already available from existing monitors that are determined by the applicable permitting authority to be representative of background conditions in the affected area.[23]

Where the screening analysis described in Section II.2 above is insufficient to show that a source will not cause or contribute to a violation of the PSD increments, a cumulative impact assessment would be necessary to make the demonstration. A cumulative assessment accounts for the combined impact of the new or modifying source's emissions and those emissions changes from sources that affect the increment. The cumulative impacts are then compared to the PSD increments to determine whether the new or modifying source emissions will cause or contribute to a violation of the PSD increments.

---

[23] "EPA has long implemented the PSD program pursuant to the understanding that representative data may be substituted where circumstances warrant." (*In re: Northern Michigan University Ripley Heating Plant*, PSD Appeal No. 08-02, slip op. at 58 (Feb. 18, 2009));

"…the prospective PSD source must use existing … representative air quality data or collect … monitoring data." (52 Fed. Reg. 24672 (July 1, 1987) at 24686); and

With regard to the PSD requirement for monitoring data, "use of 'monitoring data' refers to either the use of existing representative air quality data or monitoring the existing air quality." (Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD), EPA-450/4-80-012, November 1980, at page 3).

II.4 Assessment Cases for Source Impacts

To support the processes shown in Figure II-1 and Figure II-2, the EPA is recommending four different assessment cases shown in Table II-1 that define which air quality analyses, *if any*, a permit applicant should conduct to demonstrate compliance with the $PM_{2.5}$ NAAQS and PSD increments.

Table II-1. EPA Recommended Assessment Cases that Define Needed Air Quality Analyses of Source Impacts

Assessment Case	Description of Assessment Case	Assess Primary Impacts of Direct $PM_{2.5}$ Emissions?	Assess Secondary Impacts of Precursor Emissions of NO_x and/or SO_2?
Case 1: No Air Quality Analysis	Direct PM2.5 emissions < 10 tpy SER NOx and SO2 emissions < 40 tpy SER	NO	NO
Case 2: Primary Air Quality Impacts Only	Direct PM2.5 emissions ≥ 10 tpy SER NOx and SO2 emissions < 40 tpy SER	**YES**	NO
Case 3: Primary and Secondary Air Quality Impacts	Direct PM2.5 emissions ≥ 10 tpy SER NOx and/or SO2 emissions ≥ 40 tpy SER	**YES**	**YES**
Case 4: Secondary Air Quality Impacts Only	Direct PM2.5 emissions < 10 tpy SER NOx and/or SO2 emissions ≥ 40 tpy SER	NO	**YES**

The four assessment cases presented in Table II-1 include:

- For “Case 1—No Air Quality Analysis,” if direct $PM_{2.5}$ emissions are less than the SER of 10 tpy and both NO_x and SO_2 emissions are individually less than the respective SERs of 40 tpy, then no modeled compliance demonstration is required.[24]
- For “Case 2—Primary Air Quality Impacts Only,” if the direct $PM_{2.5}$ emissions are greater than or equal to the SER of 10 tpy and both NO_x and SO_2 emissions are individually less than the respective SERs of 40 tpy, then a modeled $PM_{2.5}$

---

[24] See 40 CFR 51.166(m)(1)(i); 40 CFR 52.21(m)(1)(i)

compliance demonstration is required for only the direct $PM_{2.5}$ emissions based on dispersion modeling and no modeling to account for impacts of precursor emissions from the project source is necessary.

- For “Case 3—Primary and Secondary Air Quality Impacts,” if the direct $PM_{2.5}$ emissions are greater than or equal to the SER of 10 tpy and NO_x and/or SO_2 precursor emissions are greater than or equal to the respective SERs of 40 tpy, then a modeled $PM_{2.5}$ compliance demonstration is required for the direct $PM_{2.5}$ emissions based on dispersion modeling and the permit applicant should also assess the potential impact of the significant precursor emissions from the project source. The accounting of the precursor emissions impact on secondary $PM_{2.5}$ formation may be: a) qualitative in nature; b) based on a hybrid of qualitative and quantitative assessments utilizing existing technical work; or c) a full quantitative photochemical grid modeling exercise. The EPA anticipates only a few situations would require explicit photochemical grid modeling.
- For “Case 4—Secondary Air Quality Impacts Only,” if the direct $PM_{2.5}$ emissions are less than the SER of 10 tpy, but the NO_x and/or SO_2 precursor emissions are greater than or equal to the respective SERs of 40 tpy, then a modeled $PM_{2.5}$ compliance demonstration for the direct $PM_{2.5}$ emissions is not required, but the permit applicant should assess the potential impact of the significant precursor emissions from the project source. Similar to “Case 3,” the accounting of the precursor emissions impact on secondary $PM_{2.5}$ formation may be: a) qualitative in nature; b) based on a hybrid of qualitative and quantitative assessments utilizing existing technical work; or c) a full quantitative photochemical grid

> modeling exercise. Again, the EPA anticipates that only a limited number of situations would require explicit photochemical grid modeling.

Details regarding the source impact analysis and cumulative impact analysis associated with Cases 2, 3, and 4, where project emissions are equal to or greater than the respective SERs for direct $PM_{2.5}$ emissions only (Case 2), for both direct $PM_{2.5}$ and precursor emissions of NO_x and/or SO_2 (Case 3), or for precursor emissions of NO_x and/or SO_2 only (Case 4), are provided in Sections III and IV (NAAQS) and Section V (Increments).

This Page Intentionally Left Blank

III. Source Impact Analysis for the $PM_{2.5}$ NAAQS

This section provides details regarding the recommended approaches for conducting the source impact analysis associated with each of the four assessment cases presented in Table III-1 so long as the SIL has been appropriately justified for use in each NAAQS compliance demonstration as described in Section II.2. In each of the assessment cases, the analysis should begin by evaluating the impacts of direct $PM_{2.5}$ emissions and/or $PM_{2.5}$ precursor emissions based upon the total amount of these emissions as compared to the respective SERs.

Table III-1. EPA Recommended Approaches for Assessing Primary and Secondary $PM_{2.5}$ Impacts by Assessment Case

Assessment Case	**Description of Assessment Case**	**Primary Impacts Approach**	**Secondary Impacts Approach**
Case 1: No Air Quality Analysis	Direct PM2.5 emissions < 10 tpy SER NOx and SO2 emissions < 40 tpy SER	N/A	N/A
Case 2: Primary Air Quality Impacts Only	Direct PM2.5 emissions ≥ 10 tpy SER NOx and SO2 emissions < 40 tpy SER	**Appendix W preferred or approved alternative dispersion model**	N/A
Case 3: Primary and Secondary Air Quality Impacts	Direct PM2.5 emissions ≥ 10 tpy SER NOx and/or SO2 emissions ≥ 40 tpy SER	**Appendix W preferred or approved alternative dispersion model**	• **Qualitative** • **Hybrid qualitative / quantitative** • **Full quantitative photochemical grid modeling**
Case 4: Secondary Air Quality Impacts Only	Direct PM2.5 emissions < 10 tpy SER NOx and/or SO2 emissions ≥ 40 tpy SER	N/A	• **Qualitative** • **Hybrid qualitative / quantitative** • **Full quantitative photochemical grid modeling**

A modeled NAAQS compliance demonstration is not required for Case 1 since neither direct $PM_{2.5}$ emissions nor $PM_{2.5}$ precursor (NO_x and/or SO_2) emissions are equal to or greater than the respective SERs. Case 1 is the only assessment case that does not require a modeled NAAQS compliance demonstration. Each of the remaining three assessment cases would necessitate a source impact analysis.

The simplest or most traditional assessment case is Case 2 where only direct $PM_{2.5}$

emissions are greater than or equal to the SER. For Case 2, the permit applicant would only need to demonstrate that ambient $PM_{2.5}$ impacts associated with its increase in direct $PM_{2.5}$ emissions are below a SIL based on dispersion modeling using AERMOD or other appropriate preferred model listed in Appendix A of Appendix W, or an alternative model subject to the provisions of Section 3.2 of Appendix W.

Since both direct $PM_{2.5}$ emissions and NO_x and/or SO_2 precursor emissions are equal to or greater than the respective SERs for Case 3, this will likely be the most challenging of the four assessment cases. As with Case 2, the ambient $PM_{2.5}$ impacts associated with direct $PM_{2.5}$ emissions can be estimated based on application of an appropriate preferred dispersion model for near-field $PM_{2.5}$ modeling listed in Appendix W, currently AERMOD for most applications, or an approved alternative model. However, AERMOD does not account for secondary formation of $PM_{2.5}$ associated with the source's precursor emissions. Since the source also emits quantities of $PM_{2.5}$ precursors above the respective SERs for Case 3, some assessment of their potential contribution to secondary $PM_{2.5}$ is necessary. The assessment of NO_x and/or SO_2 precursor emission impacts on secondary $PM_{2.5}$ formation may be: a) qualitative in nature; b) based on a hybrid of qualitative and quantitative assessments utilizing existing technical work; or c) a full quantitative photochemical grid modeling exercise. The EPA anticipates that only a limited number of situations would require explicit photochemical grid modeling.

Since direct $PM_{2.5}$ emissions are below the applicable SER for Case 4, the source impact analysis in this case would only address the potential contribution to secondary $PM_{2.5}$ from NO_x and/or SO_2 precursor emissions, and would not require any modeling of direct $PM_{2.5}$ emissions. As discussed above for Case 3, the assessment of the precursor emission impacts on secondary $PM_{2.5}$ formation for Case 4 may be: a) qualitative in nature; b) based on a hybrid of qualitative and quantitative assessments utilizing existing technical work; or c) a full quantitative photochemical grid modeling exercise. As with Case 3, the EPA anticipates that only a few situations would require explicit photochemical grid modeling.

III.1 Assessing Primary $PM_{2.5}$ Impacts

The assessment of primary $PM_{2.5}$ impacts from the proposed new or modifying source is generally the same for the NAAQS and increments and should be consistent with Appendix W. As noted above, Appendix W recommends specific models as “preferred” for specific types of applications, based on model performance evaluations and other criteria. The purpose of recommending the use of a particular preferred model is to ensure that the best-performing model is used in assessing PM impacts from a particular project and is employed in a consistent fashion.[25] In 2005, the EPA promulgated AERMOD as the Agency’s preferred near-field dispersion model for a wide range of regulatory applications in all types of terrain based on extensive developmental and performance evaluation.[26] For NSR/PSD modeling for the $PM_{2.5}$ NAAQS, the AERMOD modeling system should be used to model direct $PM_{2.5}$ emissions unless another preferred model is more appropriate, such as the Buoyant Line and Point source dispersion model (BLP), or the use of an alternative model can be justified consistent with Section 3.2 of Appendix W.

---

[25] The best performing model is one that best predicts regulatory design values for a particular pollutant. The EPA’s *Protocol for Determining the Best Performing Model* (U.S. EPA, 1992) defines appropriate methodologies and statistical criteria for this evaluation. According to the document, “For a pollutant… for which short-term ambient standards exist, the statistic of interest involves the network-wide highest concentration…the precise time, location, and meteorological condition is of minor concern compared to the magnitude of the highest concentration actually occurring.”

[26] The final rule can be found at: http://www.epa.gov/scram001/guidance/guide/appw_05.pdf. Extensive documentation is available describing the various components of AERMOD, including user guides, model formulation, and evaluation papers. See EPA’s SCRAM website for AERMOD documentation: www.epa.gov/scram001/dispersion_prefrec.htm#aermod

As noted in the EPA's March 23, 2010, $PM_{2.5}$ guidance memorandum, although dry and/or wet deposition may be important processes when estimating ambient concentrations of PM in general, these factors are expected to be minor for $PM_{2.5}$ due to the small particle size. In addition, there may be additional uncertainty associated with deposition modeling for $PM_{2.5}$ due to the fact that deposition properties may vary depending on the constituent elements of $PM_{2.5}$. Therefore, use of deposition algorithms to account for depletion in estimating ambient $PM_{2.5}$ concentrations should be done with caution and only when clear documentation and justification of the deposition parameters is provided.

The AERMOD modeling system includes the following components:

- AERMOD: the dispersion model (U.S. EPA, 2004a; U.S. EPA, 2014b);
- AERMAP: the terrain processor for AERMOD (U.S. EPA, 2004b, U.S. EPA, 2011a); and
- AERMET: the meteorological data processor for AERMOD (U.S. EPA, 2004c; U.S. EPA, 2014c).

Other components that may be used, depending on the application, are:

- BPIPPRIME: the building input processor (U.S. EPA, 2004d);
- AERSURFACE: the surface characteristics processor for AERMET (U.S. EPA, 2008);
- AERSCREEN: a screening version of AERMOD (U.S. EPA, 2011b; U.S. EPA, 2011c); and
- AERMINUTE: a pre-processor to calculate hourly average winds from ASOS 2-minute observations (U.S. EPA, 2011d).

Before running AERMOD, the user should become familiar with the user's guides associated with the modeling components listed above and the most recent version of the AERMOD Implementation Guide (U.S. EPA, 2009). In addition to these documents, detailed guidance on the use of the AERMOD modeling system for estimating primary $PM_{2.5}$ impacts is provided in Appendix B. Because AERMOD is limited to modeling only direct $PM_{2.5}$ emissions, additional or alternative approaches must be used to provide an assessment of the secondary $PM_{2.5}$ impact from the proposed new or modifying source, as discussed in more detail in the following sections.

III.2 Assessing Secondary $PM_{2.5}$ Impacts

This section provides more detail on the recommended approaches for assessing the impacts of precursor emissions on secondary $PM_{2.5}$ formation for Cases 3 and 4 presented in Table III-1 including:

- a qualitative assessment;
- a hybrid of qualitative and quantitative assessments utilizing existing technical work; and
- a full quantitative photochemical grid modeling exercise.

III.2.1 Qualitative Assessments

In a number of NAAQS compliance demonstrations requiring an assessment of the impact from secondary $PM_{2.5}$ formation, it is anticipated that a holistic qualitative analysis of the new or modifying emissions source and the atmospheric environment in which the emissions source is to be located will suffice for determining that secondary $PM_{2.5}$ impacts associated with the source's precursor emissions will not cause or contribute to a violation of the 24-hour or annual $PM_{2.5}$ NAAQS. Each NAAQS compliance demonstration will be unique and may require multiple factors to be considered and assumptions to be thoroughly justified as a part of the qualitative assessment. A well-developed modeling protocol that includes a detailed conceptual description of the current air pollution concentrations in the area (see Appendix A for examples of elements of a conceptual description) and of the nature of the emissions sources surrounding the new or modifying emissions source is paramount for determining the necessary components of an acceptable qualitative assessment of the impact from secondary $PM_{2.5}$ formation.[27] With appropriate consultation, submittal, and subsequent approval of the modeling protocol by the appropriate permitting authority, many potential problems and unintended oversights in the qualitative assessment can be resolved early in the process or avoided all together.

In the development of an appropriate conceptual description of $PM_{2.5}$ to support a qualitative assessment of the impact from secondary $PM_{2.5}$ formation, it is important to fully characterize the current $PM_{2.5}$ concentrations in the region where the new or modifying emissions source is to be located. This characterization should take into consideration not only the most current 24-hour and annual $PM_{2.5}$ design values, which would typically be used as background concentrations in a cumulative modeling demonstration, but should also include an understanding of the seasonality and speciated composition of the current $PM_{2.5}$ concentrations and any long term trends that may be occurring. Understanding whether or not $PM_{2.5}$

---

[27] For more detailed information on the development of such conceptual descriptions for an area, please refer to the following:

Chapter 10 of “Particulate Matter Assessment for Policy Makers: A NARSTO Assessment.” P. McMurry, M. Shepherd, and J. Vickery, eds. Cambridge University Press, Cambridge, England (NARSTO, 2004).

Section 11, “How Do I Get Started? 'A Conceptual Description'” of “Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze.” U.S. Environmental Protection Agency, Research Triangle Park, North Carolina (U.S. EPA, 2007a).

In addition, relevant regional examples include: “Conceptual Model of $PM_{2.5}$ Episodes in the Midwest”, January 2009, Lake Michigan Air Directors Consortium; and “Conceptual Model of Particulate Matter Pollution in the California San Joaquin Valley,” Document Number CP045-1-98, September 8, 1998.

concentrations are higher or lower in certain seasons or fairly uniform throughout a year and determining whether there are particular component species (e.g., sulfates, nitrates, and elemental or organic carbon) that dominate the makeup of high, low, and average $PM_{2.5}$ concentrations will help guide the degree of analysis and ultimately the justification that will be required in the qualitative assessment based on the magnitude and characteristics of any significant precursor emissions from the source. It may also be important to describe the typical background concentrations of certain chemical species that participate in the photochemical reactions that form secondary $PM_{2.5}$, such as NH_3, VOC, and ozone. It is possible that there are mitigating factors for secondary $PM_{2.5}$ formation given limitations of other chemical species important in the photochemical reactions, e.g., minimal NH_3 in the ambient environment that could limit any precursor pollutant from readily reacting to form secondary $PM_{2.5}$. The qualitative assessment should include a narrative explaining how any identified significant precursor emissions and subsequent secondary $PM_{2.5}$ formation could contribute to the existing $PM_{2.5}$ concentration environment in the region.

A good conceptual description will also characterize the meteorological conditions that are representative of the region and are associated with periods and/or seasons of higher and lower ambient 24-hour $PM_{2.5}$ concentrations. Identification of meteorological phenomena that typically occur during periods of high 24-hour $PM_{2.5}$ concentrations, such as low-level temperature inversions, stagnant high pressure systems, etc., can be extremely important in understanding the importance, or lack thereof, of photochemistry and secondary $PM_{2.5}$ formation for the higher ambient $PM_{2.5}$ concentrations. The analysis and understanding of meteorological conditions will also inform the assessment of the seasonality of the 24-hour $PM_{2.5}$ concentrations in the region. The qualitative assessment should expand upon the characterization of meteorology described in the conceptual description to explain any meteorological factors that could limit or enhance the formation of secondary $PM_{2.5}$ from any significant precursor emissions.

Analysis of existing photochemical grid modeling developed for regional haze, ozone, and $PM_{2.5}$ SIPs or other photochemical grid modeling used in related sensitivity projects or analysis to support prior air quality rules may also be considered to help understand the general response of secondary $PM_{2.5}$ formation to certain magnitudes of a precursor pollutant in that region. While the new or modifying emissions source may emit a significant level of a precursor pollutant under PSD regulations, that level of emission may be extremely small when compared against the total emissions of that precursor pollutant throughout the region. The qualitative assessment of the impact from secondary $PM_{2.5}$ formation can be strengthened if substantial regional decreases or increases of that precursor pollutant have been demonstrated through photochemical grid modeling exercises do not cause significant decreases or increases of secondary $PM_{2.5}$.

An example of a thoroughly developed qualitative assessment of the potential for secondary $PM_{2.5}$ formation to cause or contribute to a violations of the NAAQS was provided by the EPA Region 10 Office through a response to public comments document regarding a CAA permit issued for Shell's *Discoverer* drill ship and support fleet to explore for oil and gas in the Chukchi Sea off Alaska. While the environment in and around the Chukchi Sea and North Slope of Alaska is unique when compared to the rest of the United States, the various components contained within this qualitative assessment provide a template that could be followed, with appropriate modifications, in the development of other case-specific qualitative assessments. An excerpt from this response to public comments document is provided in Appendix C.

As shown in the EPA Region 10 example, the qualitative assessment of the potential for secondary $PM_{2.5}$ formation by Shell's *Discoverer* drill ship and support fleet was developed in a narrative manner integrating numerous factors specific to the North Slope region of Alaska that provided sufficient evidence that the $PM_{2.5}$ NAAQS would not be violated in this particular case. The qualitative assessment examined the regional background $PM_{2.5}$ monitoring data and aspects of secondary $PM_{2.5}$ formation from existing sources; the relative ratio of the combined modeled primary $PM_{2.5}$ impacts and background $PM_{2.5}$ concentrations to the level of the NAAQS; the spatial and temporal correlation of the primary and secondary $PM_{2.5}$ impacts; meteorological characteristics of the region during periods of precursor pollutant emissions; the level of conservatism associated with the modeling of the primary $PM_{2.5}$ component and other elements of conservatism built into the overall NAAQS compliance demonstration; aspects of the precursor pollutant emissions in the context of limitations of other chemical species necessary for the photochemical reactions to form secondary $PM_{2.5}$; and an additional level of NAAQS protection through a post-construction monitoring requirement. While each of the components of the EPA Region 10 example may or may not be necessary, this example should provide a useful template for other qualitative assessments under this guidance, recognizing that additional components may be essential in other qualitative assessments of the potential for secondary $PM_{2.5}$ formation.

III.2.2 Hybrid Qualitative/Quantitative Assessment

The qualitative assessment discussed above is largely focused on a determination that the proposed new or modifying source precursor emissions, in combination with the estimated primary $PM_{2.5}$ impacts (if applicable for Case 3), will not cause or contribute to a violation of the

24-hour and/or annual $PM_{2.5}$ NAAQS. However, it may not always be possible to provide such a justification without some quantification of the potential secondary $PM_{2.5}$ impacts from the proposed new or modifying source's precursor emissions. In such cases, the EPA expects that existing air quality model-based information regarding the potential for SO_2 and NO_x precursor emissions to form secondary $PM_{2.5}$ concentrations may be used to establish an appropriate estimate of secondary $PM_{2.5}$ impacts from the proposed new or modifying source. As described above, there may be situations where the proposed new or modifying source's total ambient impact (i.e., primary and secondary impacts) is less than a SIL, and the record demonstrates that no further air quality assessment would be needed to demonstrate that the source would not cause or contribute to a violation of any NAAQS. Otherwise, a cumulative impact assessment would be necessary, which is discussed in Section IV.

To inform a hybrid qualitative/quantitative assessment, the existing air quality model-based information would need to be appropriate in terms of representing the type of source, its precursor emissions, and its geographic location, in addition to those elements of the conceptual description discussed above for the qualitative assessment. The quantitative modeling information may be available from past or current SIP attainment demonstration modeling, published modeling studies, or peer-review literature with estimates of model responsiveness to precursor emissions in contexts that are relevant to the new or modifying source. The estimates of model responsiveness, such as impact on $PM_{2.5}$ concentrations per ton of SO_2 emissions, could then be used in conjunction with the precursor emissions estimates for the proposed new or modifying source to provide a quantitative estimate of the impact of such precursor emissions on the formation of secondary $PM_{2.5}$ concentrations. The estimates should be technically credible in representing such impacts and it may be advisable for the estimate to reflect an upper bound of potential impacts.

The NACAA Workgroup final report (NACAA, 2011) provides details on potential approaches to quantify the secondary $PM_{2.5}$ impacts from a proposed new or modifying source that may be appropriate to inform a hybrid qualitative/quantitative assessments of $PM_{2.5}$ impacts (See Appendix C and D of NACAA, 2011). One suggested method in the final report is to convert emissions of precursors into equivalent amounts of direct $PM_{2.5}$ emissions using "pollutant offset ratios" and then use a dispersion model to assess the impacts of the combination of direct $PM_{2.5}$ emissions and the equivalent direct $PM_{2.5}$ emissions. The "pollutant offset ratios" referenced in the final report were those put forth by the EPA in the 2008 "Implementation of the New Source Review (NSR) Program for Particulate Matter Less Than 2.5 Micrometers ($PM_{2.5}$)" final rule (73 Fed. Reg. 28321) concerning the development and adoption of interpollutant trading (offset) provisions for $PM_{2.5}$ under state nonattainment area NSR programs for $PM_{2.5}$.[28] The EPA's July 23, 2007, technical analysis titled "Details on Technical Assessment to Develop Interpollutant Trading Ratios for $PM_{2.5}$ Offsets," describes the method used to establish the original "preferred" precursor offset ratios (U.S. EPA, 2007b).

We do not support using the specific results from the EPA's 2007 technical assessment in this context without additional technical demonstration specific to the source(s) and area(s) for which the ratios would be applied. However, we expect that the EPA Regional Offices, with assistance from the OAQPS, may assist state/local air permitting agencies, as necessary, to

---

[28] In the preamble to the 2008 final rule (73 Fed. Reg. 28321), the EPA included preferred or presumptive offset ratios, applicable to specific $PM_{2.5}$ precursors that state/local air agencies may adopt in conjunction with the new interpollutant offset provisions for $PM_{2.5}$, and for which the state could rely on the EPA's technical work to demonstrate the adequacy of the ratios for use in any $PM_{2.5}$ nonattainment area. In a July 21, 2011 memorandum, EPA changed its policy and stated that it no longer supported the ratios provided in the preamble to the 2008 final rule as presumptively approvable ratios for adoption in SIPs containing nonattainment NSR programs for $PM_{2.5}$. Memorandum from Gina McCarthy, Assistant Administrator to Regional Air Division Directors, "Revised Policy to Address Reconsideration of Interpollutant Trading Provisions for Fine Particles ($PM_{2.5}$)" (U.S. EPA, 2011e).

structure appropriate technical demonstrations leading to the development of appropriate source and area-specific offset ratios for $PM_{2.5}$ that may be appropriate for the purposes of estimating potential secondary $PM_{2.5}$ impacts. As described in the EPA's July 21, 2011, memorandum addressing reconsideration of the interpollutant trading provisions for the 2008 final rule, the EPA acknowledged that existing models and techniques are adequate to "conduct local demonstrations leading to the development of area-specific ratios for $PM_{2.5}$ nonattainment areas" and provided a general framework for efforts that may be relevant in developing appropriate "pollutant offset ratios" for use in hybrid qualitative/quantitative assessment of secondary $PM_{2.5}$ impacts (U.S. EPA, 2011e).

An example of a hybrid qualitative/quantitative assessment of secondary $PM_{2.5}$ impacts was developed by a permit applicant, Sasol, for a major facility expansion in Southern Louisiana through close coordination with the EPA Region 6 Office and the Louisiana Department of Environmental Quality (LDEQ). Sasol and LDEQ worked closely with Region 6 to ensure that the ambient impacts analysis was robust and defendable. In this particular hybrid assessment, Sasol took an approach of using the formerly presumptive interpollutant trading ratios for NO_x and SO_2 to $PM_{2.5}$ offsets and conservatively applied them in an illustrative example to demonstrate how relatively inconsequential the impacts of secondary $PM_{2.5}$ formation would be in the area of significant impact surrounding their facility. Sasol did not seek to directly apply the formerly presumptive interpollutant trading ratios in an absolute sense. Rather, the intention was to present the analysis in a manner to determine if further technical justification would be required or if the application of the formerly presumptive interpollutant trading ratios was adequate in a hybrid qualitative/quantitative sense. A more detailed discussion of Sasol's hybrid assessment is provided in Appendix D.

The EPA also notes that the NACAA Workgroup “considered, but rejected, other methods for assessing secondary $PM_{2.5}$ impacts, including use of a simple emissions divided by distance (Q/D) metric and use of AERMOD with 100 percent conversion of SO_2 and NO_x concentrations to $(NH_4)_2SO_4$ and $(NH_4)NO_3$.” The EPA has reviewed the detailed discussion provided in Appendix E of the NACAA Workgroup final report and agrees with these conclusions.

III.2.3 Full Quantitative Photochemical Grid Modeling

In those rare cases where it is deemed necessary to estimate secondary $PM_{2.5}$ impacts with full quantitative photochemical grid modeling, the candidate model for use in estimating single source impacts on secondarily formed $PM_{2.5}$ should meet the general criteria for an “alternative model” outlined in Section 3.2.2 of 40 CFR 51.112 and 40 CFR Part 51, Appendix W, for condition (3) where “the preferred model is less appropriate for the specific application, or there is no preferred model,” i.e.,

i. The model has received a scientific peer review;
ii. The model can be demonstrated to be applicable to the problem on a theoretical basis;
iii. The databases that are necessary to perform the analysis are available and adequate;
iv. Appropriate performance evaluations of the model have shown that the model is not biased toward underestimates; and
iv. A protocol on methods and procedures to be followed has been established.

Section 3.2.1 of Appendix W also discusses appropriate methodologies for evaluating performance of models for regulatory applications, including the EPA's "Protocol for Determining the Best Performing Model" (U.S. EPA, 1992). The determination of acceptability of a particular model and approach for such an alternative model application is an EPA Regional Office responsibility that may also include consultation with the EPA Headquarters, if appropriate.

As noted in the NACAA Workgroup final report, photochemical grid models provide a complete characterization of emissions, chemical transformation, transport, and deposition using time and space variant meteorology. The EPA's modeling guidance for $PM_{2.5}$ attainment demonstrations (U.S. EPA, 2007a) identifies both the Comprehensive Air Quality Model with Extensions (CAMx) (ENVIRON, 2011; Nobel et al., 2001; Russell, 2008) and the Community Multiscale Air Quality (CMAQ) model (Byun and Schere, 2006; Foley et al., 2010). These state-of-the-science photochemical grid models have been used by the EPA for air quality modeling to support federal rulemaking and by state/local air permitting agencies for their air quality planning efforts. Some photochemical grid models have been instrumented with extensions that allow for the identification of impacts from specific sources to important receptor locations. These extensions generally fall in the categories of source apportionment and source sensitivity, and of sub-grid plume treatment and sampling, as described below.

Based on the current capabilities of photochemical grid models and consistent with the NACAA Workgroup report, the EPA recommends the following approaches be considered to estimate secondary $PM_{2.5}$ impacts from a proposed new or modifying source using this type of model:

- "Brute force zero-out" or difference method where two model simulations are conducted, one with all existing sources and a second, counterfactual simulation with all existing sources and the new source emissions, with the difference being taken as the contribution from the new or modifying source.

- Instrumented techniques such as
    - Source apportionment tools where the precursor emissions from the new or modifying source are tracked to provide a contribution estimate for that individual source, or
    - Higher-order decoupled direct method (HDDM) which tracks the sensitivity of results to the emissions from a new or modifying source to provide coefficients relating source emissions to air quality response.

The NACAA Workgroup final report notes that these approaches represent fundamentally different methods and may result in different estimates for secondary $PM_{2.5}$ impacts depending on the non-linear chemical processes. The EPA, state/local permitting agencies, and others within the atmospheric modeling community continue to apply these techniques to test and evaluate their suitability for estimating single source impacts on secondarily formed $PM_{2.5}$. These efforts are critically important to inform current application of these models and techniques for purposes of assessing the secondary $PM_{2.5}$ impacts from a proposed new or modifying source, as well as to inform efforts to evaluate updates to Appendix W with new analytical techniques or models for ozone and secondary $PM_{2.5}$ per the commitments contained in the EPA's January 4, 2012, grant of the July 28, 2010, petition filed by the Sierra Club.[29]

---

[29] Several photochemical grid modeling approaches that allow for estimation of the secondary $PM_{2.5}$ impacts from a proposed new or modifying source were presented during the Emerging Models / Techniques Session of the 10th

Photochemical grid models that have been instrumented with source apportionment techniques track emissions from specific sources through the chemical transformation, transport, and deposition processes to estimate the source's contribution to predicted air quality at downwind receptors (Baker and Foley, 2011). Source sensitivity approaches provide information about how model predicted concentrations change based on an increase or decrease in emissions from a specific source. The difference in air quality between the original baseline simulation and the simulation where emissions are perturbed provides a quantitative estimate of that source's contribution to the cumulative impact estimate.

Another approach to differentiate the contribution of single sources on changes in model predicted air quality is the higher-order decoupled direct method (HDDM), which tracks the sensitivity of model results to emissions for a specific source through all chemical and physical processes in the modeling system (Bergin et al., 2008). Sensitivity coefficients relating source emissions to air quality are estimated during the model simulation and output at the resolution of the photochemical grid model. An important difference between source apportionment and source sensitivity is that source apportionment answers the "contribution" question, "How much did a source contribute overall to modeled air quality?" and source sensitivity answers the "responsiveness" question, "How will modeled air quality change if the source's emissions change?"

In some instances where the source and critical receptors are in very close proximity, the source and receptors may be located in the same photochemical grid model cell. Since physical and chemical processes simulated in the model represent a volume average, this may not adequately (or appropriately) represent the gradients of pollution that may exist between the

---

Modeling Conference. Additional information regarding and presentations from the 10th Modeling Conference can be found on the SCRAM website at: http://www.epa.gov/ttn/scram/10thmodconf.htm.

source and receptors. One approach to more explicitly represent the spatial gradient in source-receptor relationships when they are in close proximity would be to use smaller sized grid cells. Grid resolution would be defined such that the source and receptors are no longer in the same grid cell. Ideally, there would also be several grid cells between the source and receptors to best resolve near-source pollution gradients.

In these situations of close proximity between the source and receptors, a photochemical grid model instrumented with sub-grid plume treatment and sampling may be an alternative approach for characterizing these relationships. Sub-grid plume treatment extensions in photochemical grid models typically solve for in-plume chemistry and use a set of physical and chemical criteria for determination of when puff mass is merged back into the host model grid. However, accounting for source specific impacts both at the sub-grid and grid levels is challenging and enhancements to traditional implementations of this approach may be necessary to fully capture source impacts for permit applications.

For this guidance, the EPA is not prescribing in detail how photochemical grid models (or their instrumented extensions) should be applied for the purposes of conducting a NAAQS compliance demonstration since these details may involve case-specific factors that would need to be part of the consultative process with the appropriate permitting authority and reflected in the agreed-upon modeling protocol. With this in mind, we recommend that the modeling protocols for this purpose should include the follow elements:

1. Overview of Modeling/Analysis Project
    - Participating organizations
    - Schedule for completion of the project
    - Description of the conceptual model for the project source/receptor area

- Identify how modeling and other analyses will be archived and documented
- Identify specific deliverables to the appropriate permitting authority

2. Model and Modeling Inputs

- Rationale for the selection of air quality, meteorological, and emissions models
- Modeling domain
- Horizontal and vertical resolution
- Specification of initial and boundary conditions
- Episode selection and rationale for episode selection
- Rationale for and description of meteorological model setup
- Basis for and development of emissions inputs
- Methods used to quality assure emissions, meteorological, and other model inputs

3. Details on the approach for comparison to the SIL and/or NAAQS

4. Model Performance Evaluation

- Describe ambient database(s)
- Describe evaluation procedures and performance metrics

As stated previously, we expect that the EPA Regional Offices, with assistance from the OAQPS, may assist states, as necessary, to structure appropriate technical demonstrations leading to the development of appropriate photochemical grid modeling applications for the purposes of estimating potential secondary $PM_{2.5}$ impacts.

III.3 Comparison to the SIL

Where a permit applicant wishes to compare the proposed source’s total ambient $PM_{2.5}$ impacts to a SIL in order to make the required demonstration that a source does not cause or contribute to a violation of the NAAQS, the compliance demonstration will vary depending on whether Case 2, 3, or 4, where direct $PM_{2.5}$ and/or precursor emissions are equal to or greater than the respective SERs, is applicable.

For Case 2, where only direct $PM_{2.5}$ emissions are equal to or greater than the applicable (10 tpy) SER, the SIL may be compared to the modeled estimates of ambient primary $PM_{2.5}$ concentrations due to direct emissions using the preferred AERMOD dispersion model (or acceptable preferred or alternative model). The modeling methods used in this initial source impact assessment phase of the $PM_{2.5}$ analysis for Case 2 are similar to the methods used for other pollutants, including the use of maximum allowable emissions, following Table 8-2 of Appendix W. However, due to the form of the $PM_{2.5}$ NAAQS, we recommend that a SIL be compared to either of the following, depending on the meteorological data used in the analysis:

- The highest of the 5-year averages of the maximum modeled 24-hour or annual $PM_{2.5}$ concentrations predicted each year at each receptor, based on 5 years of representative National Weather Service (NWS) data; or
- The highest modeled 24-hour or annual $PM_{2.5}$ concentrations predicted across all receptors based on 1 year of site-specific meteorological data, or the highest of the multi-year averages of the maximum modeled 24-hour or annual $PM_{2.5}$ concentrations predicted each year at each receptor, based on 2 or more years, up to 5 complete years of available site-specific meteorological data.

These metrics represent the maximum contribution that project emissions could make to the air quality impact at any receptor, given the form of the NAAQS, and therefore provide an appropriate part of the basis for determining whether a cumulative modeling analysis would be needed.

For Case 3, where the source's direct $PM_{2.5}$ emissions and emissions of at least one precursor are equal to or greater than the respective SERs, the comparison of the SIL would need to address both primary and secondary $PM_{2.5}$ ambient impacts associated with the proposed source. As with Case 2, the ambient impacts due to direct $PM_{2.5}$ emissions would be estimated using the preferred AERMOD dispersion model (or acceptable alternative model). However, the comparison to the SIL will depend on the type of assessment conducted for the secondary $PM_{2.5}$ impacts from the source. As noted above, the assessment of the precursor emission impacts on secondary $PM_{2.5}$ formation may be: a) qualitative in nature; b) based on a hybrid of qualitative and quantitative assessments utilizing existing technical work; or c) a full quantitative photochemical grid modeling exercise.

Since any SIL that is used should represent a specific insignificant (or *de minimis*) ambient concentration of $PM_{2.5}$ that may be used to demonstrate that a source will not cause or contribute to a NAAQS violation without conducting a cumulative impact assessment, basing the initial source impact analysis for Case 3 on a qualitative assessment (or a hybrid of qualitative and quantitative assessments) of secondary $PM_{2.5}$ ambient impacts may be difficult to justify. This is because there would be no specific quantitative estimate of total $PM_{2.5}$ impacts for comparison to the SIL, unless a valid argument can be made that secondary $PM_{2.5}$ impacts associated with the source's precursor emissions will be very small (e.g., precursor emissions barely exceed the respective SERs and/or the chemical environment is not conducive to secondary formation). As such, when using either of these approaches, it may be appropriate to forego the SIL assessment and focus on the NAAQS compliance demonstration using a cumulative impact analysis.

For cases where a full quantitative photochemical grid modeling assessment of secondary $PM_{2.5}$ is conducted, the SIL comparison for Case 3 should be based on the combined ambient impacts of primary and secondary $PM_{2.5}$. However, the primary and secondary $PM_{2.5}$ impacts may be combined in various ways which may entail greater or lesser degrees of conservatism. For example, combining the peak estimated primary $PM_{2.5}$ impact with the peak estimated secondary $PM_{2.5}$ impact, unpaired in time and space would likely result in a conservative estimate of combined impacts since, as noted above, peak impacts associated with a source's direct $PM_{2.5}$ and precursor emissions are not likely well-correlated in time or space. On the other hand, the conservatism associated with combining peak estimated primary and secondary impacts for comparison to a SIL would likely make such an approach easier to justify than other approaches for combining estimated primary and secondary $PM_{2.5}$ impacts.

The other extreme for combining primary and secondary $PM_{2.5}$ impacts for comparison to a SIL for Case 3, relative to combining peak primary and peak secondary impacts unpaired in time and space, would be full temporal and spatial pairing of estimated primary and secondary $PM_{2.5}$ impacts. Such an approach may not be feasible in many cases, given that the dispersion modeling and photochemical grid modeling may be based on different data periods. Furthermore, full temporal and spatial pairing of primary and secondary $PM_{2.5}$ impacts may not be appropriate in many cases due to the fact that photochemical grid modeling represents gridded concentration estimates whereas dispersion modeling produces estimates at discrete receptor locations and given the limitations in the skill of both the dispersion model and the photochemical grid model to accurately predict impacts on a paired in time and space basis. On the other hand, some degree of temporal pairing of primary and secondary $PM_{2.5}$ impacts on a seasonal or monthly basis should be appropriate in most cases, recognizing the general lack of correlation between primary and secondary impacts.

The permitting authority and the permit applicant should thoroughly discuss the details regarding combining modeled primary and secondary $PM_{2.5}$ impacts for Case 3 and should reach agreement on a protocol during the initial review of the modeling protocol. It may be appropriate for the protocol to specifically identify multiple tiers for combining the modeled primary and secondary $PM_{2.5}$ impacts with the more conservative approaches being easier to justify. The permitting authority should ensure that any approach for combining estimated primary and secondary $PM_{2.5}$ impacts for comparison to a SIL for Case 3 conforms to the recommendations described above for Case 2 regarding the form of the modeled estimate. Accordingly, the approach should be based on the highest of the multi-year averages of the maximum modeled 24-hour or annual $PM_{2.5}$ concentrations predicted each year at each receptor, which represents the maximum contribution that the source's emissions could make in a cumulative impact assessment.

For Case 4, where the source's precursor emissions are equal to or greater than the respective SERs but direct $PM_{2.5}$ emissions are not, the SIL comparison would only address secondary $PM_{2.5}$ ambient impacts associated with the proposed source. The assessment of the precursor emission impacts on secondary $PM_{2.5}$ formation may be: a) qualitative in nature; b) based on a hybrid of qualitative and quantitative assessments utilizing existing technical work; or c) a full quantitative photochemical grid modeling exercise. As discussed above for Case 3, since a SIL should represent a specific insignificant (or *de minimis*) ambient concentration of $PM_{2.5}$ that may be used to demonstrate that a source will not cause or contribute to a violation without a cumulative impact assessment, basing the source impact analysis on a purely qualitative assessment of secondary $PM_{2.5}$ ambient impacts or a hybrid of qualitative and quantitative assessments, utilizing existing technical work for Case 4, may be difficult to justify unless a demonstrably conservative estimate of the secondary $PM_{2.5}$ contribution can be made that is below a SIL. As such, when using either of these approaches, it may be appropriate for the permitting authority to recommend the permit applicant to forego the SIL assessment and focus on the NAAQS compliance demonstration using a cumulative impact analysis. However, it may be more feasible for the permitting authority to allow the permit applicant to apply a SIL to full photochemical grid model estimates of secondary $PM_{2.5}$ for Case 4 than for Case 3 since the issues associated with combining modeled estimates of primary and secondary $PM_{2.5}$ would not apply for Case 4. In these cases, the highest of the multi-year averages of the maximum modeled 24-hour or annual $PM_{2.5}$ concentrations predicted each year at each receptor should be compared to a SIL, since these metrics represent the maximum contribution that the source could make.

This Page Intentionally Left Blank

IV. Cumulative Impact Analysis for the $PM_{2.5}$ NAAQS

Where the screening analysis described in Section II is insufficient to show that a source will not cause or contribute to a violation of the NAAQS, a cumulative impact assessment would be necessary to make the NAAQS compliance demonstration. A cumulative assessment accounts for the combined impact of the new or modifying source's emissions, emissions from other nearby sources, and representative background levels of $PM_{2.5}$ within the modeling domain. The cumulative impacts are then compared to the NAAQS to determine whether the new or modifying source emissions will cause or contribute to a violation of the NAAQS. This section provides details on conducting an appropriate cumulative impact assessment for the $PM_{2.5}$ NAAQS.

The cumulative impact assessment should include the following components of $PM_{2.5}$ impacts, as appropriate, for comparison to the NAAQS:

- Proposed new or modifying source
    - Primary impacts on $PM_{2.5}$, i.e., from direct $PM_{2.5}$ emissions
    - Secondary impacts on $PM_{2.5}$, i.e., from precursor (NO_x and/or SO_2) emissions
- Nearby sources
    - Primary impacts on $PM_{2.5}$, as appropriate
- Monitored background of $PM_{2.5}$ that accounts for secondary $PM_{2.5}$ impacts from regional transport, secondary $PM_{2.5}$ impacts from nearby sources, and primary $PM_{2.5}$ impacts from background sources not included in the modeled inventory.

As with the source impact analysis discussed previously, the primary impacts related to direct $PM_{2.5}$ emissions from the proposed new or modifying source and nearby sources should be estimated based on the AERMOD dispersion model (or other acceptable preferred model or an approved alternative model) while the estimate of secondary $PM_{2.5}$ impacts from the proposed new or modifying source will vary depending on whether the assessment of the proposed source's precursor emission impacts on secondary $PM_{2.5}$ formation are: a) qualitative in nature; b) based on a hybrid of qualitative and quantitative assessments utilizing existing technical work; or c) based on a full quantitative photochemical grid modeling exercise. As noted above, secondary impacts on $PM_{2.5}$ from regional transport and precursor emissions from nearby sources should be accounted for through representative monitored background concentrations.

IV.1 Modeling Inventory

The current guidelines on emission inventories for purposes of NAAQS compliance modeling contained in Section 8.1 of Appendix W will generally be applicable for the $PM_{2.5}$ modeling inventory. The guidelines in Appendix W address the appropriate emission level to be modeled, which in most cases is the maximum allowable emission rate under the proposed permit. The remainder of this section will focus on the modeling inventory of direct $PM_{2.5}$ emissions that should be used in dispersion modeling of primary $PM_{2.5}$ impacts. Although the EPA's "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze" (U.S. EPA, 2007a) provides some guidance relevant to applications involving full quantitative photochemical grid modeling, additional considerations and guidance regarding modeling inventories for such analyses in support of $PM_{2.5}$ NAAQS compliance demonstrations in PSD permitting under this guidance will be provided by EPA on a case-by-case basis.

As discussed in more detail in the EPA's March 1, 2011, clarification memorandum regarding Appendix W modeling guidelines for the 1-hour NO_2 NAAQS (U.S. EPA, 2011f), Section 8.2.3 of Appendix W emphasizes the importance of professional judgment in the identification of nearby and other sources to be included in the modeled emission inventory and establishes “a significant concentration gradient in the vicinity of the [proposed] source” as the main criterion for this selection. Appendix W also suggests that “the number of such [nearby] sources is expected to be small except in unusual situations.” (Section 8.2.3.b). The EPA’s March 1, 2011, guidance also includes a detailed discussion of the significant concentration gradient criterion included in Section 8.2.3.b of Appendix W, indicating that the significant concentration gradient criterion suggests that the emphasis on determining which nearby sources to include in the cumulative modeling analysis should focus on the area within about 10 kilometers of the project location in most cases. However, several application-specific factors should be considered when determining the appropriate inventory of nearby sources to include in the cumulative modeling analysis, including the potential influence of terrain characteristics on concentration gradients and the availability and adequacy of ambient monitoring data to account for background sources.

Consistent with the March 1, 2011, guidance, the EPA cautions against the application of very prescriptive procedures for identifying which nearby sources should be included in the modeled emission inventory for NAAQS compliance demonstrations, such as the procedures described in Chapter C, Section IV.C.1 of the draft “New Source Review Workshop Manual” (U.S. EPA, 1990). This caution should not be taken to imply that the procedures outlined in the draft “New Source Review Workshop Manual” are flawed or inappropriate. Cumulative impact assessments based on following such procedures will generally be acceptable as the basis for permitting decisions, contingent on an appropriate accounting for the monitored contribution.

Our main concern is that following such procedures in a literal and uncritical manner may increase the likelihood of double-counting modeled and monitored concentrations in many cases, resulting in cumulative impact assessments that are overly conservative and would unnecessarily complicate the permitting process in some cases. The identification of which sources to include in the modeled emissions inventory should be addressed in the modeling protocol and, as necessary, discussed in advance with the permitting authority.

Since modeling of direct $PM_{2.5}$ emissions has not been frequently conducted to date, the availability of an adequate direct $PM_{2.5}$ emission inventory for nearby sources may not exist in all cases. Recommendations for developing $PM_{2.5}$ emission inventories for use in PSD applications will be addressed separately, but existing SIP inventories for $PM_{2.5}$ or statewide PSD inventories of sources for refined modeling may provide a useful starting point for this effort.

IV.2 Monitored Background

Sections 8.2.2 and 8.2.3 of Appendix W provide recommendations for determination of background concentrations for inclusion in cumulative impact assessments for NAAQS compliance, which should account for impacts from existing sources that are not explicitly included in the modeled inventory and natural sources. From newly-acquired pre-construction monitoring data and/or existing representative air quality data gathered for purposes of a permitting analysis, permit applicants should assess and document what the background monitoring data represent to the extent possible, including any information that may be available from the state or other agency responsible for siting and maintaining the monitor.[30] It is also worth noting that the relative makeup of $PM_{2.5}$ components and temporal patterns associated with the highest 24-hour $PM_{2.5}$ levels may differ considerably from the relative amounts of $PM_{2.5}$ components associated with annual average $PM_{2.5}$ levels, especially in western states.

The determination of monitored background concentrations of $PM_{2.5}$ to include in the $PM_{2.5}$ cumulative impact assessment may entail different considerations from those for other criteria pollutants and may also depend on whether the application involves full quantitative photochemical grid modeling. An important aspect of the monitored background concentration for $PM_{2.5}$ is that the ambient monitoring data should, in most cases account for the contribution of secondary $PM_{2.5}$ formation associated with existing sources impacting the modeling domain in addition to the background levels of primary $PM_{2.5}$ associated with background sources that are not included in the modeled inventory. As with other criteria pollutants, consideration should also be given to the potential for some double-counting of the impacts from modeled emissions that may be contributing to the background monitored concentrations, but this should generally be of less importance for $PM_{2.5}$ than the representativeness of the monitor for secondary contributions, unless the monitor is located relatively close to nearby sources of primary $PM_{2.5}$ that could be impacting the monitor. Also, the nature of secondary $PM_{2.5}$, monitored background concentrations of $PM_{2.5}$ are likely to be more homogeneous across the modeling domain in most cases compared to most other pollutants, although this will also depend on the potential for local sources of primary $PM_{2.5}$ to be contributing to the monitored concentrations.

Depending on the nature of local $PM_{2.5}$ levels within the modeling domain, it may be

---

[30] Please note in the case of an existing source seeking a permit for a modification, there is potential overlap across secondary contributions from monitored background and from precursor emission from the existing source. In such cases, recommendations for excluding monitored values when the source in question is impacting the monitor in Section 8.2.2.b of Appendix W may need to be modified to avoid overcompensating in cases where the monitored concentrations are also intended to account for the existing project source's contributions to secondary $PM_{2.5}$.

appropriate to account for seasonal variations in monitored background $PM_{2.5}$ levels which may not be correlated with seasonal patterns of the modeled primary $PM_{2.5}$ levels. For example, maximum modeled primary $PM_{2.5}$ impacts associated with fugitive or other low-level emission sources are likely to occur during winter months due to longer periods of stable atmospheric conditions, whereas maximum ambient levels of secondary $PM_{2.5}$ in the eastern United States typically occur during spring and summer months due to high levels of sulfates. The use of temporally-varying monitored background concentrations in a cumulative impact analysis is discussed in more detail in Section IV.3.

IV.3 Comparison to the NAAQS

Combining the modeled and monitored concentrations of $PM_{2.5}$ for comparison to the $PM_{2.5}$ NAAQS entails considerations that differ from those for other criteria pollutants due to the issues identified above. The discussion below addresses comparisons to the NAAQS in the context of dispersion modeling of direct $PM_{2.5}$ emissions only (for Case 2), and also provides guidance regarding NAAQS comparisons for applications involving qualitative, hybrid qualitative/quantitative, or full quantitative photochemical grid modeling assessments of secondary $PM_{2.5}$ impacts (for Cases 3 and 4).

Given the importance of secondary contributions for $PM_{2.5}$ and the potentially high background levels relative to the $PM_{2.5}$ NAAQS, greater emphasis is generally placed on the monitored background contribution relative to the modeled inventory for $PM_{2.5}$ than for other pollutants. This is true for both NAAQS and increments assessments. Also, given the probabilistic form of the $PM_{2.5}$ NAAQS, careful consideration should be given to how the monitored and modeled concentrations are combined to estimate the cumulative impact levels.

The representative monitored $PM_{2.5}$ design value, rather than the overall maximum monitored background concentration, should generally be used as the monitored component of the cumulative analysis. The $PM_{2.5}$ design value for the annual averaging period is based on the 3-year average of the annual average $PM_{2.5}$ concentrations. The $PM_{2.5}$ design value for the 24-hour averaging period is based on the 3-year average of the annual 98th percentile 24-hour average $PM_{2.5}$ concentrations. Details regarding the determination of the annual 98th percentile monitored 24-hour value based on the number of days sampled during the year are provided in the data interpretation procedures for the $PM_{2.5}$ NAAQS, Appendix N to 40 CFR Part 50.

It should be noted here that although the monitored design values for the $PM_{2.5}$ standards are defined in terms of 3-year averages, this definition does not preempt or alter the Appendix W requirement for use of 5 years of representative NWS meteorological data or at least 1 year of site-specific data for air quality modeling purposes. [31] The 5-year average based on use of representative NWS meteorological data, or an average across one or more (up to 5) complete years of available site-specific data, serves as an unbiased estimate of the 3-year average for purposes of modeling demonstrations of compliance with the NAAQS. Modeling of "rolling 3-year averages," using years 1 through 3, years 2 through 4, and years 3 through 5 as recommended in the EPA's "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze", is not required.[32]

The EPA's March 23, 2010, clarification memo recommended as a First Tier that the modeled annual (or 24-hour) concentrations of primary $PM_{2.5}$ to be added to the monitored

---

[31] See 40 CFR Part 51, Appendix W, Section 8.3.1.2.b.

[32] The "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze" can be found on the SCRAM website at: http://www.epa.gov/ttn/scram/guidance/guide/final-03-pm-rh-guidance.pdf

annual (or 24-hour) design value for comparison to the NAAQS should be based on the highest average of the modeled annual (or 24-hour) averages across 5 years for representative NWS meteorological data or the highest modeled annual (or 24-hour) average for one year (or multi-year average of 2 up to 5 complete years) of site-specific meteorological data using the same procedures recommended for the initial source impact analysis. The memo cited several issues, especially the importance of the contribution from secondary formation of $PM_{2.5}$ from precursor emissions and the fact that such contributions are not explicitly accounted for by the dispersion model, as the basis for viewing modeling of $PM_{2.5}$ as screening-level analyses, analogous to the screening nature of the guidance in Section 5.2.4 of Appendix W regarding dispersion modeling for NO_2 impacts, given the importance of chemistry in the conversion of NO emissions to ambient NO_2.

Recognizing that the primary focus and motivation for this guidance is to provide recommendations on appropriate tools and methodologies to account for the potential contribution from a new or modifying source's precursor emissions on ambient $PM_{2.5}$ levels, it is appropriate to reassess the EPA's March 23, 2010, guidance under this broadened paradigm. Since each of the four cases outlined above, based on comparisons of the project's direct $PM_{2.5}$ and precursor emissions with the respective SERs, involves some assessment of the source's potential secondary $PM_{2.5}$ impacts, we recommend as a new First Tier that the modeled design value be added to the monitored design value from a representative monitor. This represents no fundamental change with respect to the modeled annual concentration. However, the modeled 24-hour concentration to be added to the monitored design value would now be based on the multi-year average of the 98th percentile of modeled annual 24-hour concentrations rather than the multi-year average of the highest (100th percentile) of modeled annual 24-hour concentrations.

For Case 2, where only the project's direct $PM_{2.5}$ emissions are equal to or greater than the SER, the modeled design value should be based on AERMOD (or other acceptable preferred or alternative model) estimates of primary $PM_{2.5}$ impacts combined with the monitored design value. The monitor should be representative in that it accounts for the contribution of secondary $PM_{2.5}$ formation associated with existing sources within the modeling domain, in addition to the background levels of primary $PM_{2.5}$ associated with background sources that are not included in the modeled inventory. For Case 3, where both the project's direct $PM_{2.5}$ emissions and precursor emissions are equal to or greater than the respective SERs, the cumulative impact for comparison to the NAAQS should be based on the sum of the modeled design value for primary $PM_{2.5}$ impacts (from dispersion model estimates based on the project's and other nearby source's direct $PM_{2.5}$ emissions), the modeled design value for secondary $PM_{2.5}$ impacts (from a qualitative, hybrid, or quantitative assessment accounting for the project's precursor $PM_{2.5}$ emissions), and the monitored design value (same representativeness caveats as with Case 2). For Case 4, where only the project's precursor emissions are equal to or greater than the respective SERs, the cumulative impact for comparison to the NAAQS should be based on the sum of the modeled design value for secondary $PM_{2.5}$ impacts (from a qualitative, hybrid, or quantitative assessment as with Case 3) and the monitored design value (same representativeness caveats as with Cases 2 and 3). The resulting cumulative $PM_{2.5}$ concentrations would then be compared to the annual $PM_{2.5}$ NAAQS of 12 $\mu g/m^3$ and 24-hour $PM_{2.5}$ NAAQS of 35 $\mu g/m^3$.

The recommendations provided above constitute a First Tier modeling analysis for $PM_{2.5}$ NAAQS compliance demonstrations that should be acceptable without further justification. For applications where impacts from primary $PM_{2.5}$ emissions are not temporally correlated with background $PM_{2.5}$ levels, combining the modeled and monitored contributions as described above may be overly conservative in some situations. For example, there are areas of the country where background $PM_{2.5}$ levels are substantially higher on average during the summer months as compared to the winter months; however, the projected modeled impacts from the new or modified source may be substantially greater in the winter rather than in the summer. In such cases, a Second Tier modeling analysis that would involve combining the monitored and modeled $PM_{2.5}$ concentrations on a seasonal (or quarterly) basis may be considered. The use of a seasonally-varying monitored background component is likely to be a more important factor for the 24-hour NAAQS analysis than for the annual NAAQS. Careful evaluation of when model projections of $PM_{2.5}$ impacts and background $PM_{2.5}$ levels peak throughout the year is strongly advised before embarking on a Second Tier modeling analysis. This is because the First Tier approach may adequately capture the temporal correlation and would otherwise make a Second Tier modeling analysis unnecessary. As a part of this evaluation process, consultation with the appropriate permitting authority is advised.

The AERMOD model provides several options for specifying the monitored background concentration for inclusion in the cumulative impact assessment. The options that are most relevant to $PM_{2.5}$ analyses include an option to specify a single annual background concentration that is applied to each hour of the year (appropriate for the First Tier annual and 24-hour analyses described above), and an option to specify four seasonal background values that are combined with modeled concentrations on a seasonal basis (appropriate for a Second Tier 24-hour analysis). The AERMOD model also allows the user to track the contribution from background concentrations to the cumulative modeled design value.

For the Second Tier 24-hour modeling analyses, it is recommended that the distribution of monitored data equal to and less than the annual 98th percentile be appropriately divided into seasons (or quarters) for each of the three years that are used to develop the monitored design value. This results in data for each year (for three years) which contains one season (quarter) with the 98th percentile value and three seasons (quarters) with the maximum values which are less than or equal to the 98th percentile value. The maximum concentration from each of the seasonal (or quarterly) subsets should then be averaged across these three years of monitoring data. The resulting average of seasonal (or quarterly) maximums should then be included as the four seasonal background values within the AERMOD model. Therefore, the monitored concentrations greater than the 98th percentile in each of the three years would not be included in the seasonal (or quarterly) subsets. These excluded monitored concentrations are the same values that are excluded when determining the monitored design value. An example of the calculations for a Second Tier 24-hour modeling analysis is provided in Appendix E.

For a monitor with a daily (1-in-1 day monitor) sampling frequency and 100% data completeness, this would mean that the top seen monitored concentrations for each year would be excluded from the seasonal (or quarterly) subdivided datasets. Similarly, for a monitor with every third day (1-in-3 day monitor) sampling frequency and 100% data completeness, the top two monitored concentrations for each year would be excluded from the seasonal (or quarterly) subdivided datasets. The monitored concentrations excluded from the subdivided datasets could primarily come from one or two seasons (or quarters) each year or could be evenly distributed across all four seasons (or quarters) each year. Additionally, the monitored concentrations not included in the subdivided datasets could shift seasonally (or quarterly) from one year to the next. Given the reasoning for considering a Second Tier 24-hour analysis (lack of temporal correlation between modeled and monitored concentrations), it is likely that the monitored data greater than the 98th percentile would be concentrated in one or two season as opposed to evenly distributed throughout the year. As mentioned earlier, one should reference Appendix N of 40 CFR Part 50 to determine the appropriate 98th percentile rank of the monitored data based on the monitor sampling frequency and valid number of days sampled during each year.

Since several recent permit applications have come to our attention proposing to combine monitored background and modeled concentrations on an hour-by-hour basis, using hourly monitored background data collected concurrently with the meteorological data period being processed by the model, we feel compelled to include a discussion of the potential merits and concerns regarding such an approach in the context of $PM_{2.5}$ NAAQS compliance demonstrations. On the surface, the hourly pairing or "paired sums" approach could be perceived as being a more “refined” method than what is recommended in the First or Second Tier methods and, therefore, more appropriate for assessing the impacts from primary $PM_{2.5}$ emissions. However, the implicit assumption underlying this approach is that the background monitored levels for each hour are spatially uniform and that the monitored values are fully representative of background levels at each receptor for each hour. Such an assumption clearly ignores the many factors that contribute to the temporal and spatial variability of ambient $PM_{2.5}$ concentrations across a typical modeling domain on an hourly basis.

The complexities of the $PM_{2.5}$ ambient monitoring network also present special challenges with a "paired sum" approach that are not present with the other NAAQS pollutants. The Federal Reference Method (FRM) $PM_{2.5}$ monitoring network is based on 24-hour samples that are taken on average every third day at the 1-in-3 day monitors. The frequency of daily or 1-in-1 day $PM_{2.5}$ monitors is steadily increasing but is relatively limited to the largest cities and metropolitan regions of the U.S. Various methods to "data fill" the 1-in-3 day monitoring database to create a pseudo-daily dataset have been explored in a few situations , but none of these data filling methods have been demonstrated to create a representative daily $PM_{2.5}$ dataset that the EPA would consider acceptable for inclusion in a $PM_{2.5}$ NAAQS compliance demonstration. The use of continuous $PM_{2.5}$ monitors, which are more limited in number compared to the FRM monitors and may require careful quality assurance of individual hourly measurements, may be an option but should be discussed in advance with the appropriate permitting authority.

Considering the spatial and temporal variability throughout a typical modeling domain on an hourly basis and the complexities and limitations of hourly observations from the current $PM_{2.5}$ ambient monitoring network, we do not recommend a "paired sums" approach on an hour-by-hour basis. Furthermore, the pairing of daily monitored background and 24-hour average modeled concentrations is not recommended except in rare cases of relatively isolated sources where the available 1-in-1 day FRM/FEM monitor can be shown to be representative of the ambient concentration levels in the areas of maximum impact from the proposed new source. In most cases, the seasonal (or quarterly) pairing of monitored and modeled concentrations previously described in the Second Tier method should sufficiently address situations to which the impacts from primary $PM_{2.5}$ emissions are not temporally correlated with background $PM_{2.5}$ levels. Any monitor-model pairing approach aside from the First or Second Tier methods should be justified on a case-by-case basis in consultation with the appropriate permitting authority and the appropriate EPA Regional Office.

IV.4 Determining Whether Proposed Source Causes or Contributes to Modeled Violations

If the cumulative impact assessment following these recommendations results in modeled violations of the $PM_{2.5}$ NAAQS, then the permit applicant will need to determine whether the project's emissions cause or contribute to the modeled violations. The EPA has previously supported showing the proposed source does not cause or contribute by showing that the source does not make a "significant contribution" to the modeled violation based on a comparison of the modeled impacts from the project emissions associated with the modeled violation, paired in time and space, to the SIL for the relevant pollutant and averaging period contained in 40 CFR 51.165(b) of the EPA's regulations. The EPA has interpreted this regulation to support the conclusion that a source with an impact below the relevant value in section 51.165(b)(2) does not significantly contribute to either an existing violation of the NAAQS in a nonattainment area or violations predicted in an attainment area based on a cumulative analysis.[33]

The January 22, 2013, court decision did not vacate the $PM_{2.5}$ SIL value in section 51.165(b) of the EPA's regulations. However, the court recognized that the language in section 51.165(b)(2) operates in a manner different from sections 51.166(k)(2) and 52.21(k)(2), which were vacated by the court. The court observed that section 51.165(b)(2) "simply states that a source may be deemed to violate the NAAQS if its exceeds the SILs in certain situations." (705 F.3d at 465-66). For this reason, the court did not see the need to resolve the Petitioner's challenge to the EPA's methodology for determining the $PM_{2.5}$ values in section 51.165(b)(2) of the regulations, which are the same as the Class II area values in the vacated sections 51.166(k)(2) and 52.21(k)(2). The court decision did not directly address the use of the values in

---

[33] See 75 Fed. Reg. at 64,890; 61 Fed. Reg. 38,250, 38,293 (July 23, 1996); *In re Prairie State Generating Co.*, 13 E.A.D. 1, 103-09 (EAB 2006). EPA has sometimes described this step as a "culpability analysis."

section 51.165(b)(2) to determine whether a source causes or significantly contributes to a modeled violation. However, in light of other elements of the court decision, the EPA advises permitting authorities to consult with the EPA before using the SIL value for $PM_{2.5}$ in section 51.165(b)(2) as the basis for concluding that a source with an impact below this value does not cause or contribute to a modeled violation.

A demonstration that a proposed source does not make a significant contribution should be based on a comparison of the modeled concentrations at the receptor location showing the violation to a SIL, across 5 years for representative NWS meteorological data and the modeled concentration for 1 year, or multiyear average of 2 up to 5 complete years, of site-specific meteorological data. For a violation of the annual $PM_{2.5}$ NAAQS, the average of the predicted annual concentrations at the affected receptor(s) should be compared to a SIL, while the average of the predicted annual 98th percentile 24-hour average concentrations at the affected receptor(s) should be used for the 24-hour $PM_{2.5}$ NAAQS.

V. PSD Increments for $PM_{2.5}$

As cited in Section II of this guidance, section 165(a)(3) of the CAA requires that proposed new and modified major stationary sources seeking a PSD permit must demonstrate that their proposed emissions increases will not cause or contribute to a violation of any NAAQS or PSD increment. Based on the flow diagram presented in Figure II-2 in Section II, this section describes the EPA's recommendations for completing the required analysis of the PSD increments for $PM_{2.5}$.

V.1 Overview of PSD Increments

The term "increment" generally refers to what the CAA calls the "maximum allowable increase" of an air pollutant that is allowed to occur above the applicable baseline air quality concentration for that pollutant. Thus, by establishing the maximum allowable increase for a particular pollutant and averaging period, any cumulative increase in the ambient concentration of that pollutant that is greater than the amount allowed is considered "significant deterioration."

In order to apply the increment concept as part of a PSD permit review, it is necessary to identify the affected geographic area in which the increment will be tracked and the emissions changes that affect increment. The relevant geographic area for determining the amount of increment consumed is known as the "baseline area." [34] The baseline area may be comprised of one or more attainment or unclassifiable areas for a particular pollutant that are in a particular state. In accordance with the definition of "baseline area," the area is an "intrastate area" and does not include any area in another state. At a minimum, the baseline area is the attainment or unclassifiable area in which a PSD source will locate. Within any baseline area, three key dates

---

[34] "Baseline area" is defined in the PSD regulations at 40 CFR 51.166(b)(15) and 52.21(b)(15).

will apply in order to track increment: (1) trigger date; (2) minor source baseline date; and (3) major source baseline date. The trigger date is a fixed date, which is the earliest date after which proposed sources must track increment in the baseline area. In turn, the minor source baseline date is the date on which the first PSD application in a baseline area is submitted to the PSD permitting authority after the trigger date. Depending upon the number of separate attainment areas that exist for a particular pollutant in the state, there may be a number of minor source baseline dates that apply to different baseline areas established in that state. Beginning with the PSD source whose complete application has established the minor source baseline date in a particular area, any increase or decrease in actual emissions from any major or minor source henceforth will consume or expand the available PSD increments for that baseline area. Finally, the major source baseline date is a fixed date, which precedes the trigger date, after which construction related emissions solely from major stationary sources affect increment, as further explained below.

$PM_{2.5}$ emissions changes occurring before the minor source baseline date generally do not impact increment in an area, but are considered to contribute to the baseline air quality level also known as the baseline concentration, as described in more detail below. However, it is important to note that the CAA provides an exception for certain emissions changes that occur specifically at major stationary sources regardless of when those emissions changes actually occur. This date, as explained above, is the "major source baseline date." Specifically, for projects at major stationary sources on which construction commenced at a date prior to the major source baseline date, the emissions increases from such projects should be considered to contribute to the baseline air quality level even though the emissions change may not actually occur until after the minor source baseline date. Alternately, for projects at major stationary sources on which construction commenced after the major source baseline date, the project emissions will be considered to affect increment, even if the project actually begins operation before the minor source baseline date.

V.2 $PM_{2.5}$ Increments Considerations

In its 2010 $PM_{2.5}$ Increments, SILs, and SMC Rule, the EPA established $PM_{2.5}$ increments at the levels shown in Table V-1, as follows:

Table V-1. $PM_{2.5}$ Increments

	Class I	Class II	Class III
Increments, µg/m^3			
Annual arithmetic mean………………………………………	1	4	8
24-hour maximum………………………………………………	2	9	18

Source: Prevention of Significant Deterioration (PSD) for Particulate Matter Less Than 2.5 Micrometers (PM2.5) - Increments, Significant Impact Levels (SILs) and Significant Monitoring Concentration (SMC) final rule (75 FR 64864)

The $PM_{2.5}$ increments analysis includes many of the same technical considerations in assessing source impacts as discussed earlier in this guidance for $PM_{2.5}$ NAAQS compliance demonstrations, specifically the assessment cases described in Section II-4 and detailed in Table III-1. However, there are some important differences. The main difference is that the increments compliance demonstration is based on calculating the change in ambient $PM_{2.5}$ concentrations over the applicable baseline concentration, which includes proposed emissions increases from the new or modified source, increment-consuming emissions from other sources that affect increment consumption in the baseline area, and increment-expanding decreases in emissions from the same sources. Another key difference is that the cumulative impact analysis for increments is based on the actual emission changes occurring after a prescribed minor source baseline date (with the stated exception related to major sources commencing construction after the major source baseline date), whereas NAAQS analyses are generally based on the cumulative impact associated with the maximum allowable emissions from the new or modifying source and other nearby sources. Finally, it is important to note that the $PM_{2.5}$ NAAQS and increments for the 24-hour averaging period are defined in different forms and therefore must be analyzed differently.[35] The 24-hour $PM_{2.5}$ NAAQS is defined based on the 3-year average of the annual 98th percentile of the 24-hour average concentrations, while the 24-hour $PM_{2.5}$ increments are based on the second highest maximum 24-hour concentration.

The 2010 "$PM_{2.5}$ Increments, SILs, and SMC Rule" established October 20, 2011, as the "trigger date" and October 20, 2010, as the "major source baseline date" for $PM_{2.5}$ increments. The EPA developed the increment system for $PM_{2.5}$ generally following the same concepts that were previously applied for the increments for PM_{10}, SO_2, and NO_2. In each case, the framework reflects the statutory concepts set forth in the definition of "baseline concentration" contained in the CAA at section 169(4), which reads as follows:

> The term "baseline concentration" means, with respect to a pollutant, the ambient concentration levels which exist at the time of the first application for a permit in an area subject to this part, based on air quality data available in the Environmental Protection Agency or a State air pollution control agency and on such monitoring data as the permit applicant is required to submit. Such ambient concentration levels shall take into account all projected emissions in, or which may affect, such area from any major emitting facility on which construction commenced prior to January 6, 1975, but which has not begun operation by the date of the baseline air quality concentration determination (i.e., the minor source baseline date). Emissions of sulfur oxides and particulate matter from

---

[35] The annual NAAQS and increments for $PM_{2.5}$ are both measured as annual arithmetic mean values.

> any major emitting facility on which construction commenced after January 6, 1975, shall not be included in the baseline and shall be counted against the maximum allowable increases in pollutant concentrations established under this part.

Thus, from this definition, it can be seen that it is conceptually possible to measure "significant deterioration" in at least two separate ways. That is, either as (1) a direct modeled projection of the change in air quality after the applicable baseline date caused by all increment-consuming or expanding emissions compared to the maximum allowable increase of the air pollutant concentration (increment) in the baseline area, or (2) a determination of whether the ambient air quality concentration in a baseline area will exceed an allowable ambient air quality ceiling, determined by adding the maximum allowable pollutant concentration increase (increment) to the baseline air quality concentration (baseline concentration) for the baseline area.

Historically, because of various limitations associated with the use of ambient air quality monitoring data for measuring increment consumption,[36] the EPA elected to determine significant deterioration exclusively on the basis of the first approach, which models only the increment-related emissions increases or decreases to determine the resulting ambient air quality change and compares this value with maximum allowable pollutant concentration increases (increments) for a particular pollutant. However, the present technical challenges associated with the ability to estimate the impacts of secondarily formed $PM_{2.5}$ in the atmosphere resulting from emissions of $PM_{2.5}$ precursors make it necessary to consider alternative methods of assessing increments where the increments are affected by both direct $PM_{2.5}$ emissions and $PM_{2.5}$ precursor

---

[36] The EPA described certain limitations associated with the use of ambient air quality monitoring data for measuring increment consumption in the preamble to its proposed PSD regulations in 1979. For example, the CAA provided that certain emissions changes should not be considered to be increment consuming. These limitations generally continue to apply to the extent that certain emissions changes detected by an ambient monitor are not considered to consume increment. See 44 Fed. Reg. 51924 at 51944 (September 5, 1979).

emissions that form secondary $PM_{2.5}$. Accordingly, the remainder of this section provides recommendations for accomplishing the $PM_{2.5}$ increments analysis.

V.3 Screening Analysis for Increments

The comparison of background air quality concentrations and the NAAQS, as recommended in Section II of this document as an initial step for the NAAQS compliance demonstration, would not by itself provide adequate justification for foregoing a cumulative modeling analysis for the $PM_{2.5}$ increments. Such an approach would be inappropriate because it would not ensure that there is sufficient “headroom” within the allowable increment to absorb a source contribution equal to the SIL. However, a permitting authority may still be able to justify reaching a determination that a new or modified source will not cause or contribute to a violation of the increments without performing cumulative modeling for increments.

The EPA recommends that a justification for not performing cumulative modeling for $PM_{2.5}$ increments compliance should be based on (1) a comparison of the predicted impacts of the new or modified source and the allowable increment values, (2) information on the extent to which, if any, increment has already been consumed since either the major source baseline date (for major source construction prior to the minor source baseline date) or minor source baseline date by nearby sources that have been permitted prior to the source under analysis, and (3) information on increment consumption or expansion by more distant sources.

Since the trigger date has only recently been established (i.e., October 20, 2011), for the next several years a new or modified source being evaluated for increments compliance will often be the first source with increment-consuming emissions in the area. As indicated in Figure II-2, under this situation, a permitting authority may have sufficient reason to conclude that the impacts of the new or modified source (based on the approach for conducting source impact analysis described below) may be compared directly to the allowable increments, without the need for a cumulative modeling analysis. Such an approach would be appropriate when the new or modified source represents the first PSD application in the area after the trigger date, which establishes the minor source baseline date and baseline area, and no relevant major source construction has already occurred since the major source baseline date.

V.4 $PM_{2.5}$ Increments Analysis

The guidance provided under Sections III and IV regarding NAAQS compliance demonstrations should generally be applicable for $PM_{2.5}$ increments analyses, with the primary distinction that actual emission increases (or decreases) from only increment-affecting sources may be used instead of maximum allowable emissions in the cumulative impact analysis.

V.4.1 Source Impact Analysis

The EPA's recommendations on conducting the source impact analysis for $PM_{2.5}$ increments rely upon the same four assessment cases for NAAQS, as described in Section II.4. As shown in Table V-2, a modeled compliance demonstration is not required for Case 1 since neither direct $PM_{2.5}$ emissions nor $PM_{2.5}$ precursor (NO_x and/or SO_2) emissions are equal to or greater than the respective SERs. Case 1 is the only assessment case that does not require a modeled compliance demonstration for $PM_{2.5}$, whereas each of the remaining three assessment cases would necessitate a source impact analysis that should be conducted following the detailed recommendations provided in Section III for NAAQS analysis.

Table V-2. EPA Recommended Approaches for Assessing Primary and Secondary PM$_{2.5}$ Impacts by Assessment Case

Assessment Case	Description of Assessment Case	Primary Impacts Approach	Secondary Impacts Approach
Case 1: No Air Quality Analysis	Direct PM2.5 emissions < 10 tpy SER NOx and SO2 emissions < 40 tpy SER	N/A	N/A
Case 2: Primary Air Quality Impacts Only	Direct PM2.5 emissions ≥ 10 tpy SER NOx and SO2 emissions < 40 tpy SER	**Appendix W preferred or approved alternative dispersion model**	N/A
Case 3: Primary and Secondary Air Quality Impacts	Direct PM2.5 emissions ≥ 10 tpy SER NOx and/or SO2 emissions ≥ 40 tpy SER	**Appendix W preferred or approved alternative dispersion model**	• **Qualitative** • **Hybrid qualitative / quantitative** • **Full quantitative photochemical grid modeling**
Case 4: Secondary Air Quality Impacts Only	Direct PM2.5 emissions < 10 tpy SER NOx and/or SO2 emissions ≥ 40 tpy SER	N/A	• **Qualitative** • **Hybrid qualitative / quantitative** • **Full quantitative photochemical grid modeling**

V.4.2 Cumulative Impact Analysis

Where the screening analysis described above is insufficient to show that a source will not cause or contribute to a violation of the PSD increments, a cumulative impact assessment would be necessary to make the demonstration. A cumulative assessment accounts for the combined impact of the new or modifying source's emissions and those emissions changes from sources that affect the increments. The cumulative impacts are then compared to the PSD increments to determine whether the new or modifying source emissions will cause or contribute to a violation of the PSD increments. This section provides details on conducting an appropriate cumulative impact assessment for PM$_{2.5}$.

V.4.2.1 Assessing Primary PM$_{2.5}$ Impacts from Other Sources

To assess direct PM$_{2.5}$ emissions from increment-consuming or increment-expanding sources, the PM$_{2.5}$ increments analysis would follow the traditional approach involving modeling of only PM$_{2.5}$ emissions changes that affect the increment, and should be based on application of

AERMOD (or other appropriate preferred or approved alternative model), using actual emission changes associated with any increment-consuming or increment-expanding sources. The AERMOD model allows for inclusion of these emissions (represented as negative emissions for the sources expanding increment) in the same model run that includes the allowable increase in emissions from the project source, and will therefore output the net cumulative concentrations (although the “maximum” cumulative impacts will be output as zero if the cumulative impacts computed in the model are less than zero).

V.4.2.2 Assessing Secondary $PM_{2.5}$ Impacts from Other Sources

To assess changes in $PM_{2.5}$ precursor emissions from increment-consuming or increment-expanding sources, the assessment of potential impacts of secondary $PM_{2.5}$ due to those emissions changes may be: a) qualitative in nature; b) based on a hybrid of qualitative and quantitative assessments utilizing existing technical work; or c) a full source-specific quantitative photochemical modeling exercise.

Several promulgated rules have resulted in reductions in precursor emissions affecting ambient $PM_{2.5}$ concentrations across most areas in recent years.[37] This is particularly true in the Eastern U.S. As a result, in many cases, the potential for increment consumption due to secondary $PM_{2.5}$ impacts from existing sources may easily be addressed through a qualitative assessment, supported by data that generally confirms a downward trend in precursor emissions occurring after the applicable $PM_{2.5}$ minor source baseline date (or the major source baseline date). In such cases, the $PM_{2.5}$ increments modeling analysis may be simplified to focus solely on potential increment consumption associated with direct $PM_{2.5}$ emissions. For areas where $PM_{2.5}$

---

[37] Such rules would include the Clean Air Interstate Rule (CAIR), Mercury and Air Toxics Standards Rule (MATS), NOx SIP Call and multiple federal mobile source rules.

precursor emissions increases from other sources are known to contribute to $PM_{2.5}$ concentration increases within the baseline area and thus consume $PM_{2.5}$ increment, the photochemical grid modeling methods discussed in Section III may be appropriate for estimating the portion of $PM_{2.5}$ increment consumed due to secondary $PM_{2.5}$ impacts associated with those increases in precursor emissions.

V.4.2.3 Consideration of $PM_{2.5}$ Ambient Air Quality Monitoring Data

In light of the current technical complications associated with the ability to model precursor emissions to estimate secondarily formed $PM_{2.5}$ in the atmosphere, the EPA believes it may be possible under certain circumstances to use ambient air quality monitoring data for $PM_{2.5}$ as part of the cumulative impact analysis. This involves using ambient monitoring data as the primary means of assessing increment consumption or expansion for $PM_{2.5}$ by measuring ambient air quality on the minor source baseline date (baseline concentration) and thereafter to determine changes in air quality resulting from direct $PM_{2.5}$ emissions and $PM_{2.5}$ precursors. This document does not provide detailed recommendations for conducting the $PM_{2.5}$ increments analysis in this manner, but simply acknowledges that it may be possible in certain circumstances to use this approach for PSD permitting. There would continue to be a need to model projected impacts as part of the $PM_{2.5}$ increments analysis to include consideration of increment consumed by emissions that have not yet occurred. One should also consider the extent to which the available monitoring data adequately reflect the air quality changes caused by direct $PM_{2.5}$ and precursor emissions from sources impacting the baseline area.

Where the PSD permit applicant believes that this approach is potentially useful for conducting the $PM_{2.5}$ increments analysis for a particular PSD permit review, early coordination with the permitting authority is strongly encouraged to establish the appropriate baseline concentration(s) within the applicable baseline area and how subsequent ambient monitoring data in the area, when compared to the baseline air quality data, can be used to assess cumulative increment consumption. The EPA will work with air agencies to support this approach on a case specific basis. Based on these experiences, it is our intention to provide additional guidance setting forth more specific recommendations on this particular approach at a future date.

V.5 Determining Significant Contribution to an Increment Violation

As previously explained, the EPA does not anticipate the need to complete a cumulative increments analysis in most situations due to the recent setting of the trigger date for $PM_{2.5}$. Therefore, most $PM_{2.5}$ increments analyses will need to consider the emissions increases resulting only from the proposed new source or modification that establishes the minor source baseline date for an area. Consequently, we believe that permitting authorities will encounter few, if any, situations over the next several years in which there is a predicted increment violation.

Nevertheless, there may be situations where a cumulative increments analysis is necessary and that analysis projects a modeled increment violation. This guidance recommends that such violations be addressed in a manner similar to the NAAQS analysis described in Section IV of this document; that is, when a PSD applicant elects to use a SIL to show to the permitting authority that the source’s emissions do not make a significant contribution to a modeled violation, the EPA advises permitting authorities to consult with the EPA before allowing the use of a SIL value, including those $PM_{2.5}$ values contained in section 51.165(b)(2), as the basis for concluding that a source with an impact below this value does not cause or contribute to a modeled violation of the $PM_{2.5}$ increment.

VI. References

U.S. EPA, 1990: New Source Review Workshop Manual: Prevention of Significant Deterioration and Nonattainment Area Permitting – DRAFT. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. http://www.epa.gov/ttn/nsr/gen/wkshpman.pdf

U.S. EPA, 1992: Protocol for Determining the Best Performing Model. September 1992. EPA-454/R-92-025. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711.

U.S. EPA, 1997: Interim Implementation of New Source Review Requirements for $PM_{2.5}$. John Seitz Memorandum dated October 23, 1997. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, 27711. http://www.epa.gov/region7/air/nsr/nsrmemos/pm25.pdf

Seinfeld and Pandis, 1998. Atmospheric Chemistry and Physics: From Air Pollution to Climate Change. J. Seinfeld and S. Pandis. Wiley Interscience. New York, New York. ISBN 0 47 117815 2.

Nobel et al., 2001: Accounting for spatial variation of ozone productivity in NOx emission trading. C. Nobel, E. McDonald-Buller, Y. Kimura, and D. Allen. *Environmental Science & Technology*. 2001; 35, 4397-4407.

NARSTO, 2004. Particulate Matter Assessment for Policy Makers: A NARSTO Assessment. P. McMurry, M. Shepherd, and J. Vickery, eds. Cambridge University Press, Cambridge, England. ISBN 0 52 184287 5.

U.S. EPA, 2005. *Guideline on Air Quality Models*. 40 CFR Part 51 Appendix W. http://www.epa.gov/ttn/scram/guidance/guide/appw_05.pdf

Byun and Schere, 2006: Review of the governing equations, computational algorithms, and other components of the models-3 Community Multiscale Air Quality (CMAQ) modeling system. D. Byun and K. Schere. *Applied Mechanics Reviews*. 2006; 59, 51-77.

U.S. EPA, 2007a: Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze. April 2007. EPA-454/B-07-002. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. http://www.epa.gov/ttn/scram/guidance/guide/final-03-pm-rh-guidance.pdf

U.S. EPA, 2007b: Details on Technical Assessment to Develop Interpollutant Trading Ratios for $PM_{2.5}$ Offsets. Technical Analysis dated July 23, 2007. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711.

Bergin et al., 2008. Single Source Impact Analysis Using Three-Dimensional Air Quality Models. M. Bergin, A. Russell, T. Odman, D. Cohan, and W. Chameldes. *Journal of the Air & Waste Management Association*. 2008; 58, 1351–1359.

Russell, 2008: EPA Supersites Program-related emissions-based particulate matter modeling: Initial applications and advances. A. Russell. *Journal of the Air & Waste Management Association*. 2008; 58, 289-302.

Foley et al., 2010: Incremental testing of the Community Multiscale Air Quality (CMAQ) modeling system version 4.7. K. Foley, S. Roselle, K. Appel, P. Bhave, J. Pleim, T. Otte, R. Mathur, G. Sarwar, J. Young, R. Gilliam, C. Nolte, J. Kelly, A. Gilliland, and J, Bash. *Geoscientific Model Development*. 2010; 3, 205-226.

U.S. EPA, 2010a: Model Clearinghouse Review of Modeling Procedures for Demonstrating Compliance with $PM_{2.5}$ NAAQS. Tyler Fox Memorandum dated February 26, 2010. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. http://www.epa.gov/ttn/scram/guidance/mch/new_mch/MCmemo_Region6_PM25_NAAQS_Compliance.pdf

U.S. EPA, 2010b: Modeling Procedures for Demonstrating Compliance with $PM_{2.5}$ NAAQS. Stephen Page Memorandum dated March 23, 2010. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, 27711. http://www.epa.gov/ttn/scram/Official%20Signed%20Modeling%20Proc%20for%20Demo%20Compli%20w%20PM$_{2.5}$.pdf

ENVIRON, 2011: User's Guide Comprehensive Air Quality Model with Extensions. ENVIRON International Corporation, Novato, California. http://www.camx.com.

U.S. EPA, 2011a: Addendum - User's Guide for the AERMOD Terrain Preprocessor (AERMAP). EPA-454/B-03-003. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. http://www.epa.gov/ttn/scram/models/aermod/aermap/aermap_userguide.zip

U.S. EPA, 2011b: AERSCREEN User's Guide. EPA-454-/B-11-001. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. http://www.epa.gov/ttn/scram/models/screen/aerscreen_userguide.pdf

U.S. EPA, 2011c: AERSCREEN Released as the EPA Recommended Screening Model. Tyler Fox Memorandum dated April 11, 2011. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. http://www.epa.gov/ttn/scram/20110411_AERSCREEN_Release_Memo.pdf

U.S EPA, 2011d AERMINUTE User's Guide. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. http://www.epa.gov/ttn/scram/7thconf/aermod/aerminute_v11325.zip

U.S. EPA, 2011e: Revised Policy to Address Reconsideration of Interpollutant Trading Provisions for Fine Particles ($PM_{2.5}$). Gina McCarthy Memorandum dated July 21, 2011. U.S. Environmental Protection Agency, Washington, District of Columbia 20460. http://www.epa.gov/region7/air/nsr/nsrmemos/pm25trade.pdf.

U.S. EPA, 2011f: Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard. Tyler Fox Memorandum dated March 1, 2011. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. http://www.epa.gov/ttn/scram/guidance/clarification/Additional_Clarifications_AppendixW_Hourly-NO2-NAAQS_FINAL_03-01-2011.pdf

Baker and Foley, 2011. A nonlinear regression model estimating single source concentrations of primary and secondarily formed $PM_{2.5}$. K. Baker and K. Foley. *Atmospheric Environment*. 2011; 45:3758–67.

Cohan and Napelenok, 2011. Atmospheric Response Modeling for Decision Support. D. Cohan and S. Napelenok. *Atmosphere*. 2011; 2(3): 407-425.

NACAA, 2011: $PM_{2.5}$ Modeling Implementation for Projects Subject to National Ambient Air Quality Demonstration Requirements Pursuant to New Source Review. Report from NACAA $PM_{2.5}$ Modeling Implementation Workgroup dated January 7, 2011. Washington, District of Columbia 20001. http://www.epa.gov/ttn/scram/10thmodconf/review_material/01072011-NACAAPM2.5ModelingWorkgroupReport-FINAL.pdf

U.S. EPA, 2012a: "Sierra Club Petition Grant". Gina McCarthy Administrative Action dated January 4, 2012. U.S. Environmental Protection Agency, Washington, District of Columbia 20460. http://www.epa.gov/ttn/scram/10thmodconf/review_material/Sierra_Club_Petition_OAR-11-002-1093.pdf.

U.S. EPA, 2012b: Summary of Public Comments, 10th Conference on Air Quality Modeling. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, 27711. http://www.epa.gov/ttn/scram/10thmodconf/10thMC_Summary_of_Comments-Revised_10-05-2012.pdf

U.S. EPA, 2013a: Transportation Conformity Guidance for Quantitative Hot-spot Analyses in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas. November 2013. EPA-420-B-10-040. U.S. Environmental Protection Agency, Ann Arbor, Michigan 48105. http://www.epa.gov/oms/stateresources/transconf/policy/420b13053-sec.pdf and http://www.epa.gov/oms/stateresources/transconf/policy/420b13053-appx.pdf.

U.S. EPA, 2013b: Draft Guidance for $PM_{2.5}$ Permit Modeling. March 4, 2013. EPA-454-/B-11-001. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. http://www.epa.gov/ttn/scram/guidance/guide/Draft_Guidance_for_PM25_Permit_Modeling.pdf

U.S. EPA, 2014a: Interim Guidance on the Treatment of Condensable Particulate Matter Test Results in the PSD and NSR Permitting Programs. Stephen Page Memorandum dated April 8, 2014. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, 27711. http://www.epa.gov/ttn/emc/methods/psdnsrinterimcmpmemo4814.pdf

U.S. EPA, 2014b: Addendum – User's Guide for the AMS/EPA Regulatory Model – AERMOD. EPA-454/B-03-001. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. http://www.epa.gov/ttn/scram/models/aermod/aermod_userguide.zip

U.S. EPA, 2014c: Addendum - User's Guide for the AERMOD Meteorological Preprocessor (AERMET). EPA-454/B-03-002. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. http://www.epa.gov/ttn/scram/7thconf/aermod/aermet_userguide.zip

Appendix A: Draft Conceptual Description of $PM_{2.5}$ Concentrations in the U.S.

This appendix provides a brief summary of the current $PM_{2.5}$ monitoring networks and characterizes PM air quality in terms of its chemical composition, concentration levels, and spatial and temporal patterns across the nation based largely on ambient data and analyses contained in the EPA's The Particle Pollution Report,[38] Particulate Matter Staff Paper,[39] and new ambient data summaries based on 2008-2010 $PM_{2.5}$ mass and speciation data. It also discusses regional and local source contributions to urban $PM_{2.5}$ concentrations. Such information may be useful for permit applicants in preparing conceptual descriptions, as discussed in Section III.2.1 of this guidance.

1. $PM_{2.5}$ Monitoring Networks

1.1. $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Mass Networks

The 1997 promulgation of a fine particulate NAAQS (EPA, 1997) led to deployment of over 1500 $PM_{2.5}$ sites (about 1000 currently) used to determine whether an area complies with the standard. These sites use a Federal Reference Method (FRM) or Federal Equivalent Method (FEM), daily sampling over 24-hours, or every third or sixth day. Nearly 300 additional measurements not meeting FRM or FEM specifications are provided by the chemical speciation sites (Figure A-1). Approximately 600 stations provide indirect measurements of continuous (hourly resolution) $PM_{2.5}$ mass using a variety of techniques.

1.2. Interagency Monitoring of Protected Visual Environments (IMPROVE) Program

The IMPROVE network, with over 100 sites, has provided nearly a two-decade record of major components of $PM_{2.5}$ (sulfate, nitrate, organic and elemental carbon fractions, and trace metals) in pristine areas of the United States (Figure A-1). IMPROVE is led by the National Park Service; various federal and state agencies support its operations. The primary focus of the network is to track visibility and trends in visibility.

1.3. $PM_{2.5}$ Chemical Speciation Monitoring

In addition to the IMPROVE network, over 300 EPA speciation sites were added from 2000 - 2002 in urban areas of the United States to assist $PM_{2.5}$ assessment efforts. No FRM exists for particulate speciation, which is not directly required to determine attainment, and there are slight differences between monitors and methods used in the Speciation Trends Network (STN). However, the network's coverage (Figure A-1) across urban and rural areas has proved essential for a wide range of research and analysis. The speciation networks typically collect a 24-hour sample every three, and sometimes six, days.

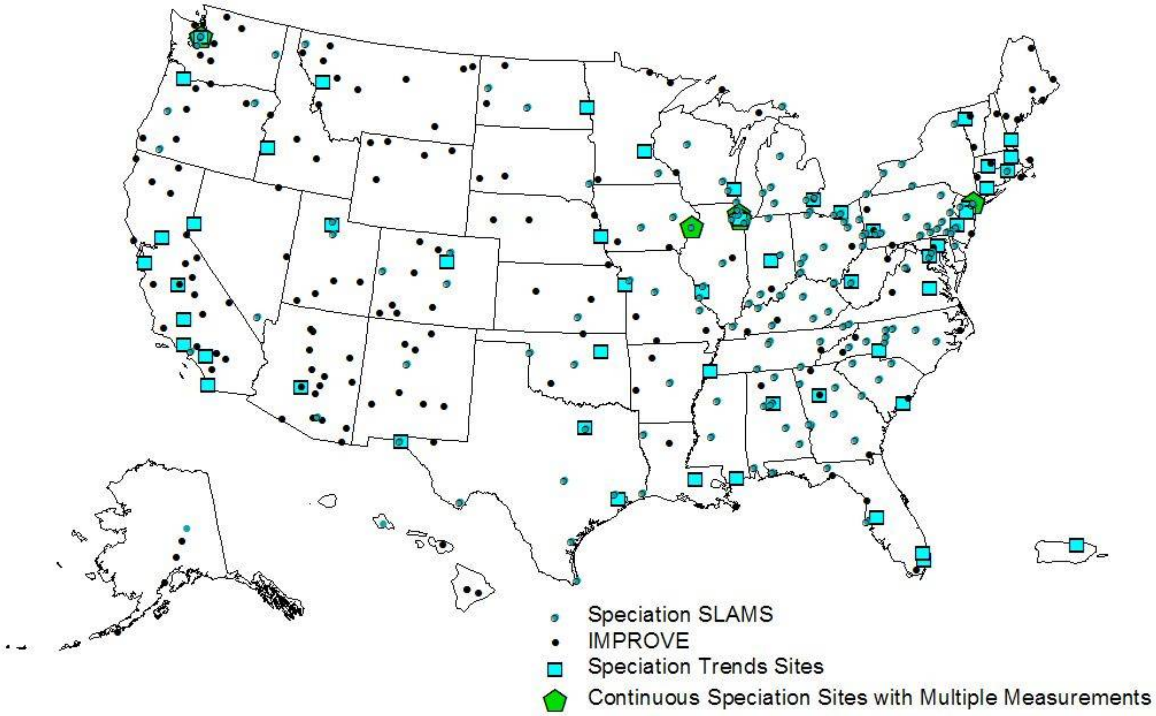
---

[38] The Particle Pollution Report: Current Understanding of Air Quality and Emissions through 2003. http://www.epa.gov/airtrends/aqtrnd04/pmreport03/pmcover_2405.pdf#page=1.

[39] Particulate Matter Staff Paper: Review completed in 2012. http://www.epa.gov/ttn/naaqs/standards/pm/s_pm_cr_sp.html.

Daily 24-hour speciation collection is limited to occasional efforts in the SEARCH (see below) network. Similarly, only a handful of sites provide near continuous speciation data, usually limited to some combination of sulfate, carbon (organic and elemental splits) and nitrate. This enables insight to diurnal patterns for diagnosing various cause-effect phenomena related to emissions characterization, source attribution analysis and model evaluation.

Figure A-1. Locations of chemical speciation sites delineated by program type



1.4. South Eastern Aerosol Research and Characterization (SEARCH) Study

This study experiment is an industry-funded network of 8 sites that originally emerged from the Southern Oxidants Study (SOS) in the 1990s and has operated for over a decade in response to the 1997 revisions to the national ambient air quality standards for ground-level ozone and particulate matter. SEARCH is part of a public-private collaboration that provides an array of standard criteria pollutant measurements but also includes daily 24-hour PM speciation at selected times and locations, gaseous ammonia, reactive nitrogen (NO_y), and true nitrogen dioxide (i.e., a measurement of NO_2 concentration unaffected by other nitrogen oxides, which contaminate FRM NO_2 measurements). These measurements had not been available in major government-funded routine networks and in order to identify sources of ozone precursors and fine particulate matter and to attribute health effects to specific components, the SEARCH project sponsors believe that it is necessary to measure pollutant composition as well as mass.

1.5. PM Supersites Program

This program provided highly resolved aerosol measurements at eight U.S. cities for several time periods from 1999 through 2004, with some sites collecting data after 2004.[40] A number of instrument configurations were deployed, ranging from additional locations for standard speciation monitors, to systems capturing near-continuous size-dependent speciation profiles.

2. Composition of $PM_{2.5}$

Particulate matter (PM) is a highly complex mixture of solid particles and liquid droplets distributed among numerous atmospheric gases which interact with solid and liquid phases. Particles range in size from those smaller than 1 nanometer (10^{-9} meter) to over 100 microns (1 micron is 10^{-6} meter) in diameter (for reference, a typical strand of human hair is 70 microns and particles less than about 20 microns generally are not detectable by the human eye). Particles are classified as $PM_{2.5}$ and $PM_{10-2.5}$, corresponding to their size (diameter) range in microns and referring to total particle mass under 2.5 and between 2.5 and 10 microns, respectively.

Particles span many sizes and shapes and consist of hundreds of different chemicals. Particles are emitted directly from sources and also are formed through atmospheric chemical reactions and often are referred to as primary and secondary particles, respectively. Particle pollution also varies by time of year and location and is affected by several aspects of weather such as temperature, clouds, humidity, and wind. Further complicating particles is the shifting between solid/liquid and gaseous phases influenced by concentration and meteorology, especially temperature.

Particles are made up of different chemical components. The major components, or species, are carbon, sulfate and nitrate compounds, and crustal materials such as soil and ash (Figure A-2). The different components that make up particle pollution come from specific sources and are often formed in the atmosphere. Particulate matter includes both “primary” PM, which is directly emitted into the air, and “secondary” PM, which forms indirectly from fuel combustion and other sources. Primary PM consists of carbon (soot)—emitted from cars, trucks, heavy equipment, forest fires, and burning waste—and crustal material from unpaved roads, stone crushing, construction sites, and metallurgical operations. Secondary PM forms in the atmosphere from gases. Some of these reactions require sunlight and/or water vapor. Secondary PM includes:

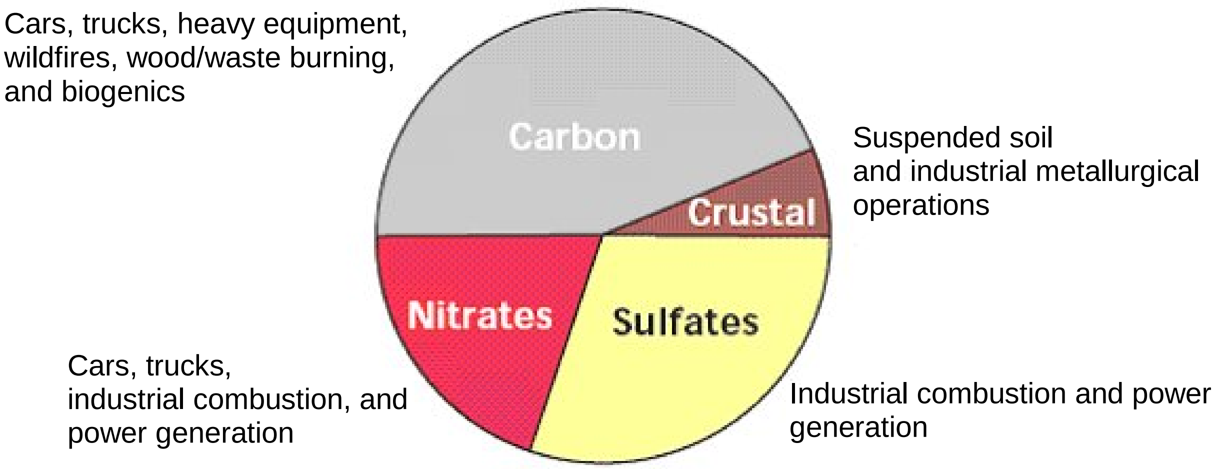
- Sulfates formed from sulfur dioxide emissions from power plants and industrial facilities;
- Nitrates formed from nitrogen oxide emissions from cars, trucks, industrial facilities, and power plants; and

---

[40] Solomon, P.A., P.K. Hopke, J. Froines, and R. Scheffe, 2008: Key Scientific and Policy and Health-Relevant Findings from the U.S. EPA’s Particulate Matter Supersites Program and Related Studies: An Integration and Synthesis of Results, J. Air & Waste Manage. Assoc., 58, S-1 – S-92.

- Carbon formed from reactive organic gas emissions from cars, trucks, industrial facilities, forest fires, and biogenic sources such as trees.

Figure A-2. National Average of Source Contribution to Fine Particle Levels



Source: The Particulate Matter Report, EPA-454-R-04-002, Fall 2004. Carbon reflects both organic carbon and elemental carbon. Organic carbon accounts for automobiles, biogenics, gas-powered off-road, and wildfires. Elemental carbon is mainly from diesel powered sources.

In addition, ammonia from sources such as fertilizer and animal feed operations contributes to the formation of sulfates and nitrates that exist in the atmosphere as ammonium sulfate and ammonium nitrate. Note that fine particles can be transported long distances by wind and weather and can be found in the air thousands of miles from where they were formed.

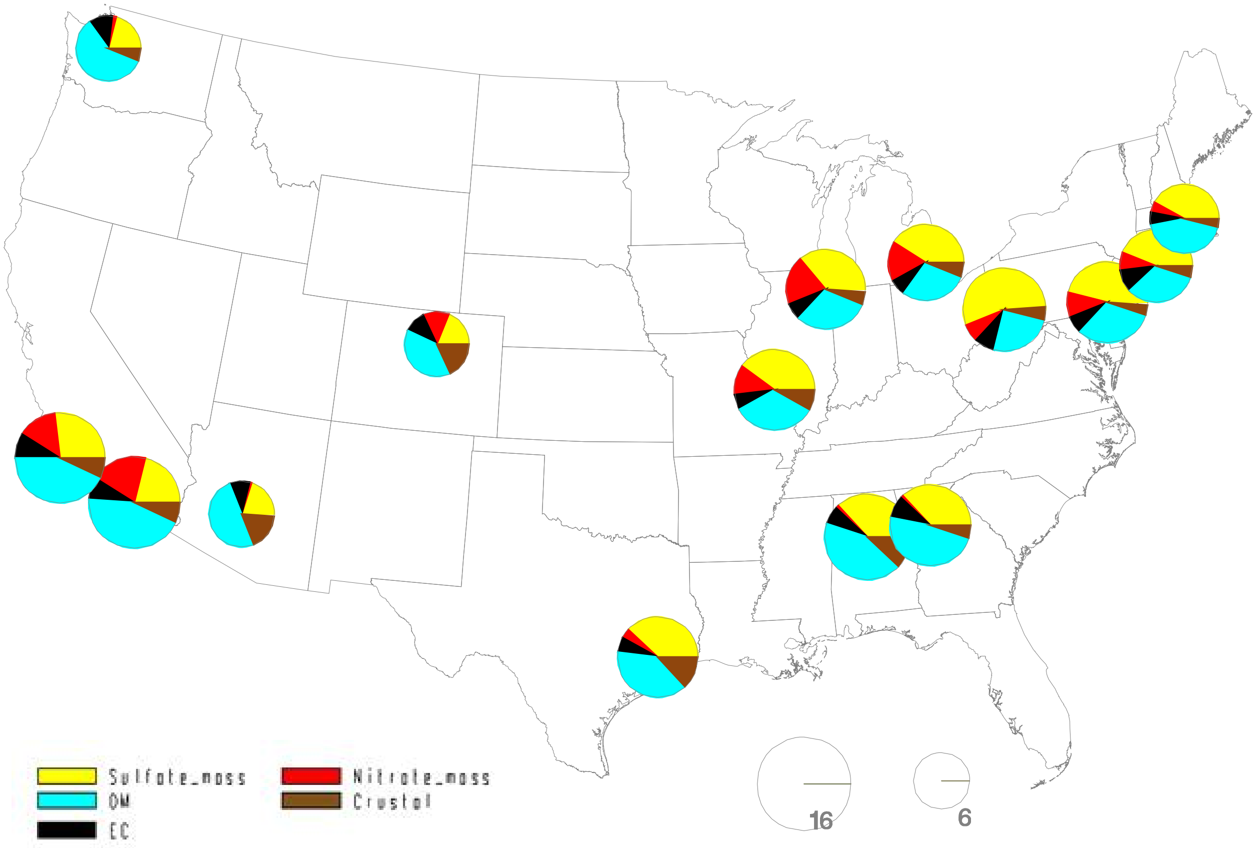
The chemical makeup of particles varies across the United States (as shown in Figure A-3).[41] For example, fine particles in the eastern half of the United States contain more sulfates than those in the West, while fine particles in southern California contain more nitrates than other areas of the country. Organic carbon is a substantial component of fine particle mass everywhere. This figure represents the composition of $PM_{2.5}$ as measured by the $PM_{2.5}$ FRM.[42]

---

[41] The 15 cities are the same ones included in the Integrated Science Assessment for Particulate Matter (2009) which includes a similar map based on 2005-2007 $PM_{2.5}$ data.

[42] Frank, N. H., Retained Nitrate, Hydrated Sulfates, and Carbonaceous Mass in Federal Reference Method Fine Particulate Matter for Six Eastern U.S. Cities, 'J. Air & Waste Manage. Assoc.' 2006, '56', 500-511.

Figure A-3. Annual Average $PM_{2.5}$ Composition in 15 Urban Areas: 2008-2010



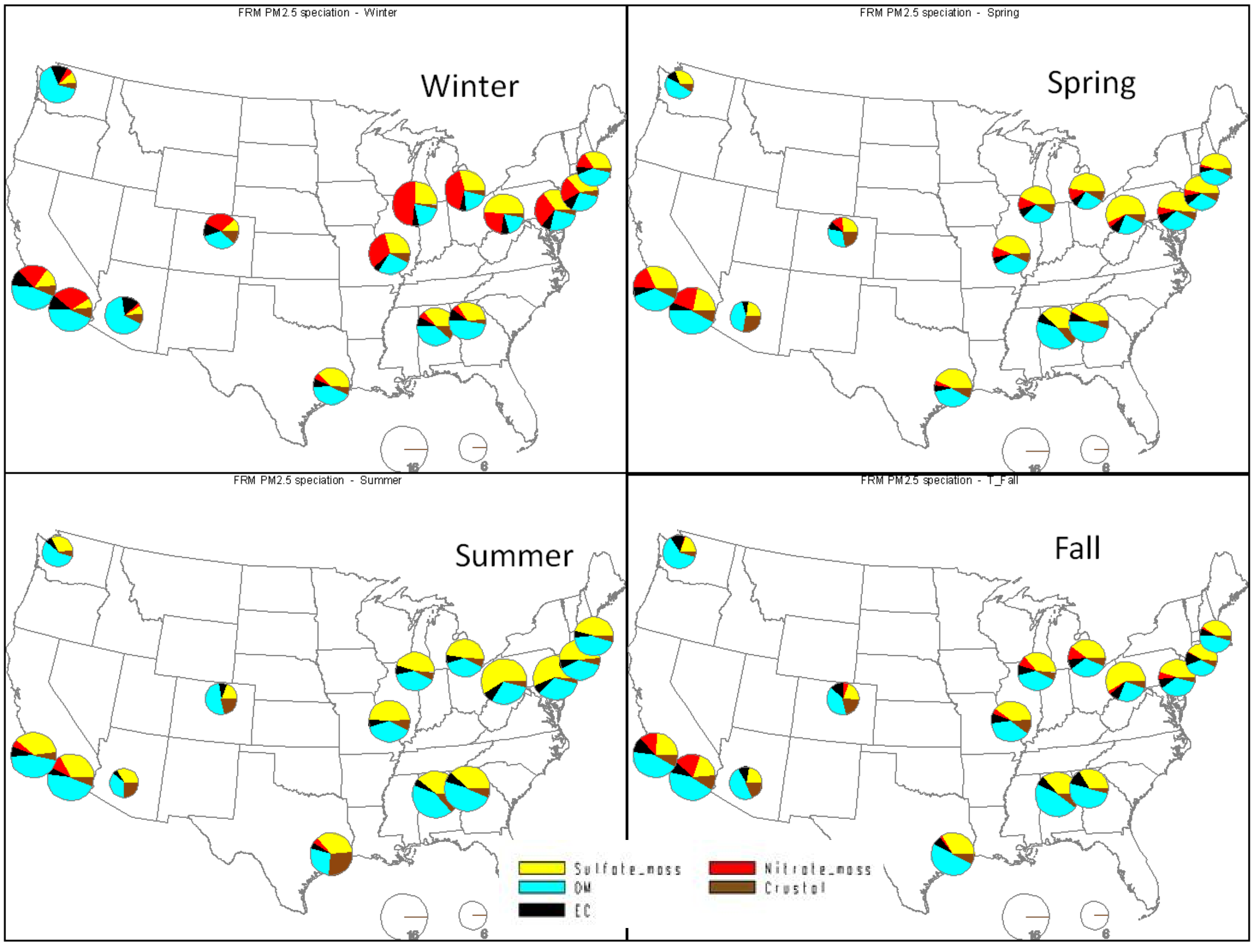
3. Seasonal and Daily Patterns of $PM_{2.5}$

Fine particles often have a seasonal pattern. Both daily values and quarterly average of $PM_{2.5}$ also reveal patterns based on the time of year. Unlike daily ozone levels, which are usually elevated in the summer, daily $PM_{2.5}$ values at some locations can be high at any time of the year. As shown in Figure A-4, $PM_{2.5}$ values in the eastern half of the United States are typically higher in the third calendar quarter (July-September) when sulfates are more readily formed from sulfur dioxide (SO_2) emissions from power plants in that region and when secondary organic aerosol is more readily formed in the atmosphere. Fine particle concentrations tend to be higher in the first calendar quarter (January through March) in the Midwest in part because fine particle nitrates are more readily formed in cooler weather. $PM_{2.5}$ values are high during the first (January through March) and fourth calendar quarter (October through December) in many areas of the West, in part because of fine particle nitrates and also due to carbonaceous particles which are directly emitted from wood stove and fireplace use. Average concentration from all locations reporting $PM_{2.5}$ with valid design values is shown.

Figure A-4. Quarterly Averages of $PM_{2.5}$ Concentration: 2008-2010

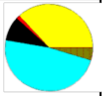
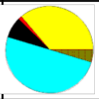
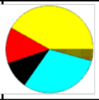
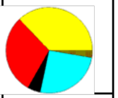
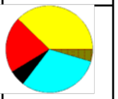
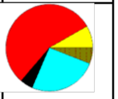
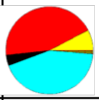
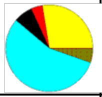
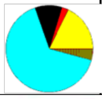
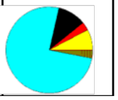
The composition of $PM_{2.5}$ also varies by season and helps explain why mass varies by season. Figure A-5 shows the average composition by season (spring, summer, fall and winter) for $PM_{2.5}$ data collected during 2008-10. In the eastern United States, sulfate are high in the spring (March-May) and summer (July-September). Nitrates are most evident in the midwest and western cities where its percentage is moderately high in the spring and fall (October-and highest during the winter.) Organic mass (OM) is high throughout the year.

Figure A-5. Seasonal Speciation Profiles of $PM_{2.5}$ for Select Urban Areas: 2008-2010



The composition of the highest daily $PM_{2.5}$ values may be different than that for the annual average. Table A-1 provides 2008-10 data on daily $PM_{2.5}$ values and their composition on high mass days for various sites within large metropolitan areas (in the east: Birmingham, AL; Atlanta, GA; New York City, NY; Cleveland, OH; Chicago, IL; and St. Louis, MO; in the west: Salt Lake City, UT; and Fresno, CA). Mass is proportioned into five components: sulfates, nitrates, OM, elemental carbon (EC) and crustal material. For each site, the table shows the 2008-2010 annual average speciation profile, the breakdown for the top 10 percent of days per year and corresponding FRM mass. The table shows some notable differences in the percentage contribution of each of the species to total mass when looking at the high end of the distribution versus the annual average. Except for the southeast (where there is little nitrate in $PM_{2.5}$), nitrates are slightly higher in the top 10 percent of the $PM_{2.5}$ days. For the 2008-2010 measurements, the percent of sulfates is currently similar or slightly less on the top 10 percent of the days as compared to the annual averages. The portion of OM appears to be similar on the high days compared to the annual averages.

Table A-1. PM$_{2.5}$ Composition on High PM$_{2.5}$ Mass Days in Select Urban Areas: 2008-2010

Urban Area	Metric	Composition Percents (%)					PM2.5 Mass (ug/m3)	Ann. Avg	Top 10 %
		Sulfate	Nitrate	OM	EC	Crustal			
Atlanta	Ann Mean	35	1	46	9	5	12.2		
	Top 10%	35	1	49	8	5	22.3		
Birmingham	Ann Mean	37	1	42	7	9	14.1		
	Top 10%	34	1	47	8	9	27.4		
New York City	Ann Mean	44	9	26	12	5	11.3		
	Top 10%	41	13	30	10	4	24.2		
Cleveland	Ann Mean	40	13	27	7	9	13.4		
	Top 10%	42	15	26	7	7	28.5		
Chicago	Ann Mean	34	18	33	6	4	11.7		
	Top 10%	36	29	25	5	3	25.2		
St Louis	Ann Mean	40	13	29	7	7	12.3		
	Top 10%	37	20	30	6	4	24.2		
Salt Lake City	Ann Mean	13	27	36	7	12	10.2		
	Top 10%	8	55	25	5	6	35.3		
Fresno	Ann Mean	14	21	50	5	6	15.4		
	Top 10%	8	43	43	4	1	45.6		
San Diego	Ann Mean	26	4	54	7	5	12.4		
	Top 10%	16	14	58	7	2	23.2		
Tacoma	Ann Mean	17	2	62	9	4	9.4		
	Top 10%	8	3	74	10	3	25.1		

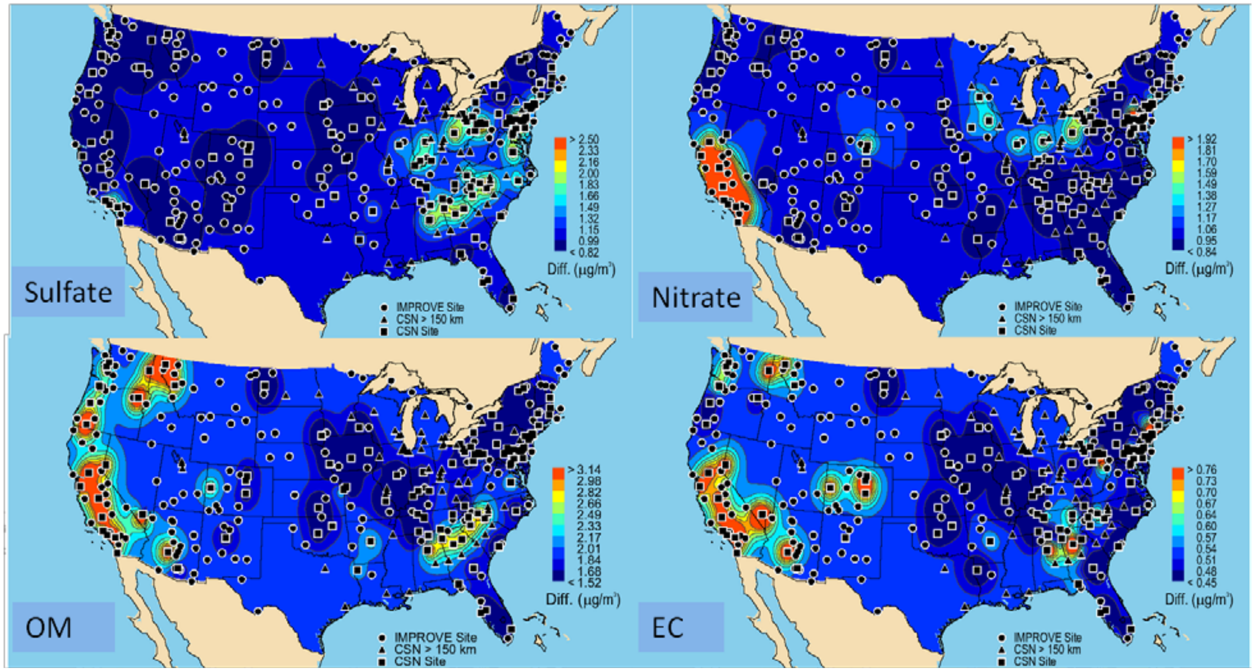
Note: The percentages do not add to 100% due to a small amount of passively collected fine particle mass included in the measurement of PM$_{2.5}$ by the FRM

🟨 Sulfate_mass
🟦 OM
⬛ EC
🟥 Nitrate_mass
🟫 Crustal

4. Regional and Local Sources of PM$_{2.5}$

Both local and regional sources contribute to particle pollution. Figure A-6 shows how much of the PM$_{2.5}$ mass can be attributed to local versus regional sources for 13 selected urban areas. In each of these urban areas, monitoring sites were paired with nearby rural sites. When the average rural concentration is subtracted from the measured urban concentration, the estimated local and regional contributions become apparent. Urban and nearby rural PM$_{2.5}$ concentrations suggest substantial regional contributions to fine particles in the East. The measured PM$_{2.5}$ concentration is not necessarily the maximum for each urban area. Regional concentrations are derived from the rural IMPROVE monitoring network.[43]

Figure A-6. "Urban excess" of locally generated $PM_{2.5}$ mass for four chemical components: sulfate, nitrate, organic mass (OM) and elemental carbon (EC)



Note: derived as the interpolated difference between urban CSN concentrations (squares) compared with nearby IMPROVE site concentrations within 150 km (circles). Annual mean concentrations from 2005-2008 are used. CSN sites not used in the analyses are shown as triangles.[44]

As shown in Figure A-6, we observe a large urban excess across the United State for most $PM_{2.5}$ species but especially for elemental carbon (EC) and organic mass (OM). Large excess for OM is observed in California, throughout the Northwest, and in the Southeast. The prevalence of urban excess in EC is seen more widely. Large urban excess of nitrates is seen in California. These results indicate that local sources of these pollutants are indeed contributing to the $PM_{2.5}$ air quality problem in these areas. As expected for a predominately regional pollutant, only a modest urban excess is observed for sulfates.

In the East, regional pollution contributes more than half of total $PM_{2.5}$ concentrations. Rural background $PM_{2.5}$ concentrations are high in the East and are somewhat uniform over large geographic areas. These regional concentrations come from emission sources such as power plants, natural sources, and urban pollution and can be transported hundreds of miles. The local and regional contributions for the major chemical components that make up urban $PM_{2.5}$: sulfates, carbon, and nitrates.

---

[43] Information regarding the IMPROVE monitoring network can be found at the following website: http://vista.cira.colostate.edu/improve

[44] Hand et. al., Spatial and Seasonal Patterns and Temporal Variability of Haze and its Constituents in the United States: Report V, 2011 (http://vista.cira.colostate.edu/improve/Publications/Reports/2011/2011.htm)

This Page Intentionally Left Blank

Appendix B: General Guidance on Use of Dispersion Models for Estimating Primary $PM_{2.5}$ Concentrations

This appendix provides general guidance on the application of dispersion models for estimating ambient concentrations of $PM_{2.5}$ associated with direct emissions of primary $PM_{2.5}$. This guidance is based on and is consistent with the EPA's *Guideline on Air Quality Models*, published as Appendix W of 40 CFR Part 51, and focuses primarily on the application of AERMOD, the EPA's preferred dispersion model for most situations. Appendix W is the primary source of information on the regulatory application of air quality models for State Implementation Plan (SIP) revisions for existing sources and for New Source Review (NSR) and Prevention of Significant Deterioration (PSD) programs. There will be applications of dispersion models unique to specific areas, (*i.e.*, there may be areas of the country where it is necessary to model unique specific sources or types of sources). In such cases, there should be consultation with the state or appropriate permitting authority with the appropriate EPA Regional Office modeling contact to discuss how best to model a particular source.

Recently issued EPA guidance of relevance for consideration in modeling for $PM_{2.5}$ includes:

- "Model Clearinghouse Review of Modeling Procedures for Demonstrating Compliance with $PM_{2.5}$ NAAQS" February 26, 2010 (U.S. EPA, 2010a);
- "Modeling Procedures for Demonstrating Compliance with $PM_{2.5}$ NAAQS" March 23, 2010 (U.S. EPA, 2010b); and
- "Transportation Conformity Guidance for Quantitative Hot-spot Analyses in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas" November 2013 (U.S.EPA, 2013a).

The guidance listed above, in addition to other relevant support documents can be found on the SCRAM website at: http://www.epa.gov/ttn/scram/.

The following sections will refer to the relevant sections of Appendix W and other existing guidance with summaries as necessary. Please refer to those original guidance documents for full discussion and consult with the appropriate EPA Regional Office modeling contact if questions arise about interpretation on modeling techniques and procedures.[45]

1. Model selection

Preferred air quality models for use in regulatory applications are addressed in Appendix A of the EPA's *Guideline on Air Quality Models*. If a model is to be used for a particular application, the user should follow the guidance on the preferred model for that application. These models may be used without an area specific formal demonstration of applicability as long as they are used as indicated in each model summary of Appendix A. Further recommendations for the application of these models to specific source problems are found in Appendix W. In

---

[45] A list of EPA Regional Office modeling contacts is available on the SCRAM website at: http://www.epa.gov/ttn/scram/guidance_cont_regions.htm.

2005, the EPA promulgated the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) as the Agency's preferred near-field dispersion model for a wide range of regulatory applications in all types of terrain based on extensive developmental and performance evaluation. For PSD/NSR modeling under the $PM_{2.5}$ NAAQS, AERMOD should be used to model primary $PM_{2.5}$ emissions unless use of an alternative model can be justified (Section 3.2, Appendix W), such as the Buoyant Line and Point Source Dispersion Model (BLP).

The AERMOD modeling system includes the following components:

- AERMOD: the dispersion model (U.S. EPA, 2004a; U.S. EPA, 2014a);
- AERMAP: the terrain processor for AERMOD (U.S. EPA, 2004b, U.S. EPA, 2011a); and
- AERMET: the meteorological data processor for AERMOD (U.S. EPA, 2004c; U.S. EPA, 2014b).

Other components that may be used, depending on the application, are:

- BPIPPRIME: the building input processor (U.S. EPA, 2004d);
- AERSURFACE: the surface characteristics processor for AERMET (U.S. EPA, 2008);
- AERSCREEN: a screening version of AERMOD (U.S. EPA, 2011b; U.S. EPA, 2011c); and
- AERMINUTE: a pre-processor to calculate hourly average winds from ASOS 2-minute observations (U.S. EPA, 2011d).

Before running AERMOD, the user should become familiar with the user's guides associated with the modeling components listed above and the AERMOD Implementation Guide (AIG) (U.S. EPA, 2009). The AIG lists several recommendations for applications of AERMOD that would be applicable for SIP and PSD permit modeling.

1.2. Receptor grid

The model receptor grid is unique to the particular situation and depends on the size of the modeling domain, the number of modeled sources, and complexity of the terrain. Receptors should be placed in areas that are considered ambient air (i.e., where the public generally has access) and placed out to a distance such that areas of violation can be detected from the model output to help determine the size of nonattainment areas. Receptor placement should be of sufficient density to provide resolution needed to detect significant gradients in the concentrations with receptors placed closer together near the source to detect local gradients and placed farther apart away from the source. In addition, the user may want to place receptors at key locations such as around facility fence lines (which define the ambient air boundary for a particular source) or monitor locations (for comparison to monitored concentrations for model evaluation purposes). The receptor network should cover the modeling domain. States may already have existing receptor placement strategies in place for regulatory dispersion modeling under NSR/PSD permit programs.

If modeling indicates elevated levels of $PM_{2.5}$ (near the standard) near the edge of the receptor grid, consideration should be given to expanding the grid or conducting an additional modeling run centered on the area of concern. As noted above, terrain complexity should also be considered when setting up the receptor grid. If complex terrain is included in the model calculations, AERMOD requires that receptor elevations be included in the model inputs. In those cases, the AERMAP terrain processor (U.S. EPA, 2004b; U.S EPA, 2011a) should be used to generate the receptor elevations and hill heights. The latest version of AERMAP (version 09040 or later) can process either Digitized Elevation Model (DEM) or National Elevation Data (NED) data files. The AIG recommends the use of NED data since it is more up to date than DEM data, which is no longer updated (Section 4.3 of the AIG).

2. Source inputs

This section provides guidance on source characterization to develop appropriate inputs for dispersion modeling with the AERMOD modeling system. Section 2.1 provides guidance on use of emission, Section 2.2 covers guidance on Good Engineering Practice (GEP) stack heights, Section 2.3 provides details on source configuration and source types, Section 2.4 provides details on urban/rural determination of the sources, and Section 2.5 provides general guidance on source grouping, which may be important for design value calculations.

2.1. Emissions

Consistent with Appendix W, dispersion modeling for the purposes of PSD permitting should be based on the use of continuous operation at maximum allowable emissions or federally enforceable permit limits (see Table 8-2 of Appendix W) for the project source for all applicable averaging periods. Also consistent with past and current guidance, in the absence of maximum allowable emissions or federally enforceable permit limits, potential to emit emissions (i.e., design capacity) should be used. Maximum allowable emissions and continuous operation should also be assumed for nearby sources included in the modeled inventory for the 24-hr $PM_{2.5}$ NAAQS, while maximum allowable emissions and the actual operating factor averaged over the most recent 2 years should be used for modeled nearby sources for the annual $PM_{2.5}$ NAAQS.

2.2. Good Engineering Practice (GEP) stack height

Consistent with previous modeling guidance and Section 6.2.2 of Appendix W, for stacks with heights that are within the limits of Good Engineering Practice (GEP), actual heights should be used in modeling. Under the EPA’s regulations at 40 CFR 51.100, GEP height, H_g, is determined to be the greater of:

- 65 m, measured from the ground-level elevation at the base of the stack;
- for stacks in existence on January 12, 1979, and for which the owner or operator had obtained all applicable permits or approvals required under 40 CFR Parts 51 and 52

  $$H_g=2.5H$$

  provided the owner or operator produces evidence that this equation was actually relied on in designing the stack or establishing an emission limitation to ensure protection against downwash;

- for all other stacks,

  $$H_g = H + 1.5L,$$

  where H is the height of the nearby structure(s) measured from the ground-level elevation at the base of the stack and L is the lesser dimension of height or projected width of nearby structure(s); or

- the height demonstrated by a fluid model or a field study approved by the EPA or the state/local permitting agency which ensures that the emissions from a stack do not result in excessive concentrations of any air pollutant as a result of atmospheric downwash, wakes, eddy effects created by the source itself, nearby structures or nearby terrain features.

For more details about GEP, see the Guideline for Determination of Good Engineering Practice Stack Height Technical Support Document (U.S. EPA, 1985).

If stack heights exceed GEP, then GEP heights should be used with the individual stack's other parameters (temperature, diameter, exit velocity). For stacks modeled with actual heights below GEP that may be subject to building downwash influences, building downwash should be considered as this can impact concentrations near the source (Section 6.2.2b, Appendix W). If building downwash is being considered, the BPIPPRIME program (U.S. EPA, 2004d) should be used to input building parameters for AERMOD. More information about buildings and stacks is provided in Section 6.5.

2.3. Source configurations and source types

An accurate characterization of the modeled facilities is critical for refined dispersion modeling, including accurate stack parameters and physical plant layout. Accurate stack parameters should be determined for the emissions being modeled. Since modeling would be done with maximum allowable or potential emissions levels at each stack, the stack's parameters such as exit temperature, diameter, and exit velocity should reflect those emissions levels. Accurate locations (i.e.. latitude and longitude or Universal Transverse Mercator (UTM) coordinates and datum)[46] of the modeled emission sources are also important, as this can affect the impact of an emission source on receptors, determination of stack base elevation, and relative location to any nearby building structures. Not only are accurate stack locations needed, but accurate information for any nearby buildings is important. This information would include location and orientation relative to stacks and building size parameters (height, and corner coordinates of tiers) as these parameters are input into BPIPPRIME to calculate building parameters for AERMOD. If stack locations and or building information are not accurate,

---

[46] Latitudes and longitudes to four decimal places position a stack within 30 feet of its actual location and five decimal places position a stack within three feet of its actual location. Users should use the greatest precision available.

downwash will not be accurately accounted for in AERMOD.

Emission source type characterization within the modeling environment is also important. As stated in the AERMOD User's Guide (U.S. EPA, 2004a; U.S. EPA, 2012a), emissions sources can be characterized as several different source types: POINT sources, capped stacks (POINTCAP), horizontal stacks (POINTHOR), VOLUME sources, OPENPIT sources, LINE sources, rectangular AREA sources, circular area sources (AREACIRC), and irregularly shaped area sources (AREAPOLY). Note that POINTCAP and POINTHOR are not part of the regulatory default option in AERMOD because the user must invoke the BETA option in the model options keyword MODELOPT while not including the "DFAULT" modeling option for these options to work properly. While most sources can be characterized as POINT sources, some sources, such as fugitive releases or nonpoint sources (emissions from ports/ships, airports, or smaller point sources with no accurate locations), may be best characterized as VOLUME or AREA type sources. Sources such as flares can be modeled in AERMOD using the parameter input methodology described in Section 2.1.2 of the AERSCREEN User's Guide (U. S. EPA, 2011b). If questions arise about proper source characterization or typing, users should consult the appropriate EPA Regional Office modeling contact.

2.4. Urban/rural determination

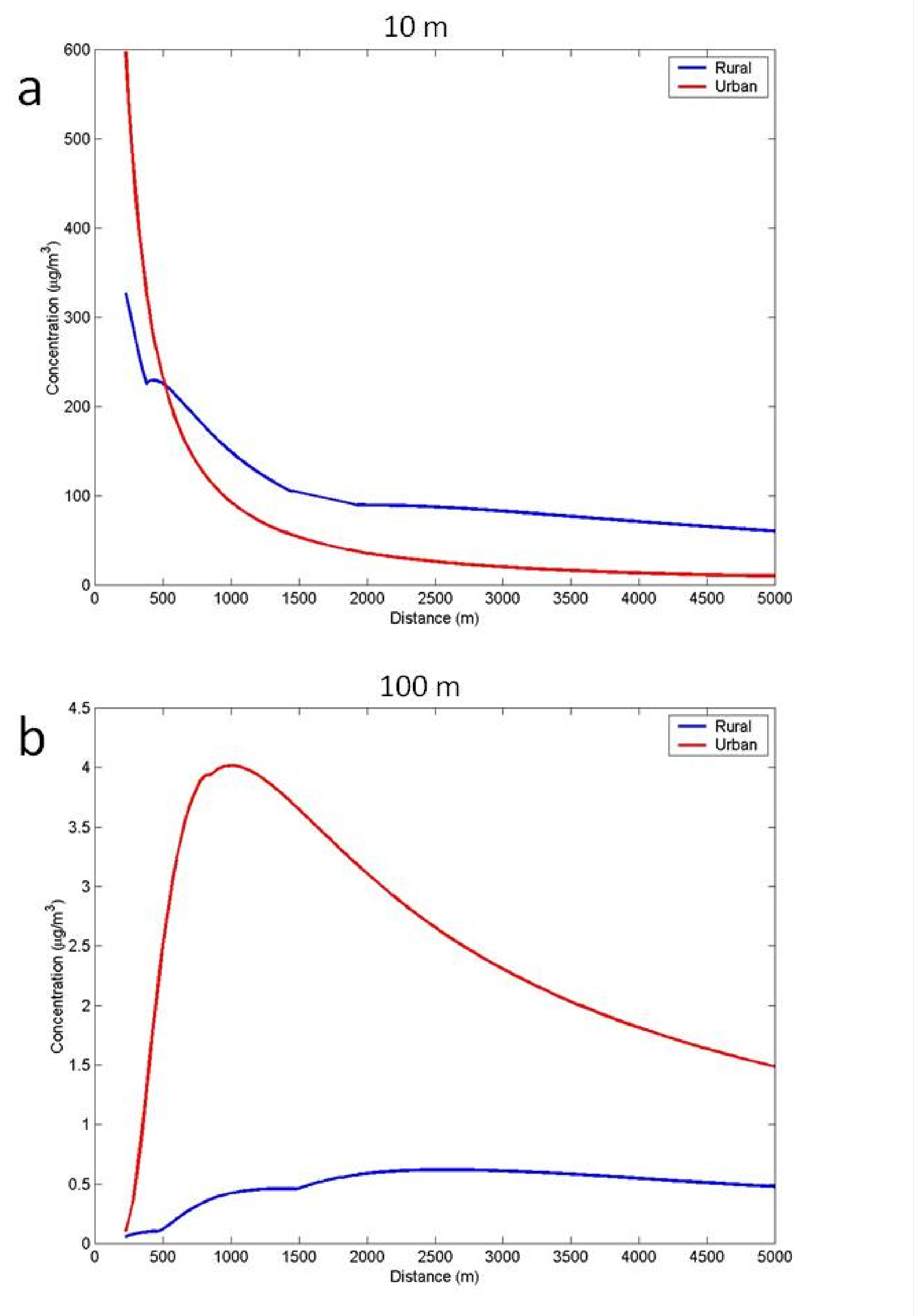
For any dispersion modeling exercise, the urban or rural determination of a source is important in determining the boundary layer characteristics that affect the model's prediction of downwind concentrations. Figure B-1 gives example maximum 24-hour concentration profiles for a 10 meter stack (Figure B-1a) and a 100 m stack (Figure B-1b) based on urban vs. rural designation. The urban population used for the examples is 100,000. In Figure B-1a, the urban concentration is much higher than the rural concentration for distances less than 750 m from the stack but then drops below the rural concentration beyond 750 m. For the taller stack in Figure B-1b, the urban concentration is much higher than the rural concentration even as distances increase from the source. These profiles show that the urban or rural designation of a source can be quite important.

Determining whether a source is urban or rural can be done using the methodology outlined in Section 7.2.3 of Appendix W and recommendations outlined in Sections 5.1 through 5.3 in the AIG (U.S. EPA, 2009). In summary, there are two methods of urban/rural classification described in Section 7.2.3 of Appendix W.

The first method of urban determination is a land use method (Appendix W, Section 7.2.3c). In the land use method, the user analyzes the land use within a 3 km radius of the source using the meteorological land use scheme described by Auer (1978). Using this methodology, a source is considered urban if the land use types I1 (heavy industrial), I2 (light-moderate industrial), C1 (commercial), R2 (common residential), and R3 (compact residential) are 50 percent or more of the area within the 3 km radius circle. Otherwise, the source is considered a rural source. The second method uses population density and is described in Section 7.2.3d of Appendix W. As with the land use method, a circle of 3 km radius is used. If the population density within the circle is greater than 750 people/km^2, then the source is considered urban. Otherwise, the source is modeled as a rural source. Of the two methods, the land use method is considered more definitive (Section 7.2.3e, Appendix W).

Caution should be exercised with either classification method. As stated in Section 5.1 of the AIG (U.S. EPA, 2009), when using the land use method, a source may be in an urban area but located close enough to a body of water or other non-urban land use category to result in an erroneous rural classification for the source. The AIG in Section 5.1 cautions users against using the land use scheme on a source by source basis, but advises considering the potential for urban heat island influences across the full modeling domain. When using the population density method, Section 7.2.3e of Appendix W states, “Population density should be used with caution and should not be applied to highly industrialized areas where the population density may be low and thus a rural classification would be indicated, but the area is sufficiently built-up so that the urban land use criteria would be satisfied...” With either method, Section 7.2.3(f) of Appendix W recommends modeling all sources within an urban complex as urban, even if some sources within the complex would be considered rural using either the land use or population density method.

Figure B-1. Urban (red) and rural (blue) concentration profiles for (a) 10 m buoyant stack release, and (b) 100 m buoyant stack release



Another consideration that may need attention by the user, and is discussed in Section 5.1 of the AIG, relates to tall stacks located within or adjacent to small to moderate size urban areas. In such cases, the stack height or effective plume height for very buoyant sources may extend above the urban boundary layer height. The application of the urban option in AERMOD for these types of sources may artificially limit the plume height. The use of the urban option may not be appropriate for these sources, since the actual plume is likely to be transported over the urban boundary layer. Section 5.1 of the AIG gives details on determining if a tall stack should be modeled as urban or rural based on comparing the stack or effective plume height to the urban boundary layer height. The 100 m stack illustrated in Figure B-1b, may be such an example as the urban boundary layer height for this stack would be 189 m (based on a population of 100,000) and equation 104 of the AERMOD formulation document (Cimorelli, et al., 2004). This equation is:

$$z_{iuc} = z_{iuo}\left(\frac{P}{P_o}\right)^{1/4} \qquad \text{(B-1)}$$

where z_{iuo} is a reference height of 400 m corresponding to a reference population P_o of 2,000,000 people.

Given that the stack is a buoyant release, the plume may extend above the urban boundary layer and may be best characterized as a rural source, even if it were near an urban complex. Exclusion of these elevated sources from application of the urban option would need to be justified on a case-by-case basis in consultation with the appropriate permitting authority.

AERMOD requires the input of urban population when utilizing the urban option. Population can be entered to one or two significant digits (i.e., an urban population of 1,674,365 can be entered as 1,700,000). Users can enter multiple urban areas and populations using the URBANOPT keyword in the runstream file (U.S. EPA, 2004a; U.S. EPA, 2012a). If multiple urban areas are entered, AERMOD requires that each urban source be associated with a particular urban area or AERMOD model calculations will abort. Urban populations can be determined by using a method described in Section 5.2 of the AIG (U.S. EPA, 2009).

2.5. Source groups

In AERMOD, individual emission sources' concentration results can be combined into groups using the SRCGROUP keyword (Section 3.3.11 of the AERMOD User's Guide (U.S, EPA, 2004a). The user can automatically calculate a total concentration (from all sources) using the SRCGROUP ALL keyword. For the purposes of design value calculations, source group ALL should be used, especially if all sources in the modeling domain are modeled in one AERMOD run. Design values should be calculated from the total concentrations (all sources and background). Individual source contributions outputs to the total concentration may be necessary to determine the culpability to any NAAQS violations.

3. Meteorological data

This section gives guidance on the selection of meteorological data for input into AERMOD. Much of the guidance from Section 8.3 of Appendix W is applicable to SIP and PSD permit modeling and is summarized here. In Section 7.2.1, the use of a new tool, AERMINUTE (U.S. EPA, 2011d), is introduced. AERMINUTE is an AERMET pre-processor that calculates hourly averaged winds from ASOS (Automated Surface Observing System) 1-minute winds.

3.1. Surface characteristics and representativeness

The selection of meteorological data that are input into a dispersion model should be considered carefully. The selection of data should be based on spatial and climatological (temporal) representativeness (Appendix W, Section 8.3). The representativeness of the data is based on: 1) the proximity of the meteorological monitoring site to the area under consideration, 2) the complexity of terrain, 3) the exposure of the meteorological site, and 4) the period of time during which data are collected. Sources of meteorological data are: National Weather Service (NWS) stations, site-specific or onsite data, and other sources such as universities, Federal Aviation Administration (FAA), military stations, and others. Appendix W addresses spatial representativeness issues in Sections 8.3.a and 8.3.c.

Spatial representativeness of the meteorological data can be adversely affected by large distances between the source and receptors of interest and the complex topographic characteristics of the area (Appendix W, Section 8.3.a and 8.3.c). If the modeling domain is large enough such that conditions vary drastically across the domain, then the selection of a single station to represent the domain should be carefully considered. Also, care should be taken when selecting a station if the area has complex terrain. While a source and meteorological station may be in close proximity, there may be complex terrain between them such that conditions at the meteorological station may not be representative of the source. An example would be a source located on the windward side of a mountain chain with a meteorological station a few kilometers away on the leeward side of the mountain. Spatial representativeness for off-site data should also be assessed by comparing the surface characteristics (albedo, Bowen ratio, and surface roughness) of the meteorological monitoring site and the analysis area. When processing meteorological data in AERMET (U.S. EPA, 2004c; U.S. EPA, 2014b), the surface characteristics of the meteorological site should be used (Section 8.3.c of Appendix W and the AERSURFACE User's Guide (U.S. EPA 2008)). Spatial representativeness should also be addressed for each meteorological variable separately. For example, temperature data from a meteorological station several kilometers from the analysis area may be considered adequately representative, while it may be necessary to collect wind data near the plume height (Section 8.3.c of Appendix W).

Surface characteristics can be calculated in several ways. For details see Section 3.1.2 of the AIG (U.S. EPA, 2009). The EPA has developed a tool, AERSURFACE (U.S. EPA, 2008) to aid in the determination of surface characteristics. The current version of AERSURFACE uses the 1992 National Land Cover Data. Note that the use of AERSURFACE is not a regulatory requirement but the methodology outlined in Section 3.1.2 of the AIG should be followed unless an alternative method can be justified.

3.2. Meteorological inputs

Appendix W states in Section 8.3.1.1 that the user should acquire enough meteorological data to ensure that worst-case conditions are adequately represented in the model results. Appendix W states that 5 years of NWS meteorological data or at least 1 year of site-specific data should be used(Section 8.3.1.2, Appendix W) and should be adequately representative of the study area. If 1 or more years of site-specific data are available, those data are preferred. While the form of the $PM_{2.5}$ NAAQS contemplates obtaining 3 years of monitoring data, this does not preempt the use of 5 years of NWS data or at least 1 year of site-specific data in the modeling. The 5-year average based on the use of NWS data, or an average across 1 or more years of available site specific data, serves as an unbiased estimate of the 3-year average for purposes of modeling demonstrations of compliance with the NAAQS.

3.2.1. NWS data

NWS data are available from the National Climatic Data Center (NCDC) in many formats, with the most common one in recent years being the Integrated Surface Hourly data (ISH). Most available formats can be processed by AERMET. As stated in Section 3.1, when using data from an NWS station alone or in conjunction with site-specific data, the data should be spatially and temporally representative of conditions at the modeled sources. Key points regarding the use of NWS data can be found in the EPA's March 8, 2013 clarification memo "Use of ASOS meteorological data in AERMOD dispersion modeling" (U.S. EPA, 2013b). The key points are:

- The EPA has previously analyzed the effects of ASOS implementation on dispersion modeling and found that generally AERMOD was less sensitive than ISCST3 to the implementation of ASOS.
- The implementation of the ASOS system over the conventional observation system should not preclude the consideration of NWS stations in dispersion modeling.
- The EPA has implemented an adjustment factor (0.5 knots) in AERMET to adjust for wind speed truncation in ASOS winds
  The EPA has developed the AERMINUTE processor (U.S. EPA, 2011d) to process 2-minute ASOS winds and calculate an hourly average for input into AERMET. The use of hourly averaged winds better reflect actual conditions over the hour as opposed to a single 2-minute observation.

While the EPA's March 8, 2013, memo states that ASOS should not preclude the use of NWS data in dispersion modeling, and Section 8.3.1.2 of Appendix W recommends the most recent five years of NWS data, Section 8.3.1.2 also recognizes cases where professional judgment indicates that ASOS data are inadequate and pre-ASOS, or observer based data may be considered for use. The appropriate permitting authority and EPA Regional Office modeling contact should be consulted when questions arise about the representativeness or applicability of NWS data.

3.2.2. Site-specific data

The use of site-specific meteorological data is the best way to achieve spatial representativeness. AERMET can process a variety of formats and variables for site-specific data. The use of site-specific data for regulatory applications is discussed in detail in Section 8.3.3 of Appendix W. Due to the range of data that can be collected onsite and the range of formats of data input to AERMET, the user should consult Appendix W, the AERMET User's Guide (U.S. EPA, 2004c; U. S. EPA, 2014b), and Meteorological Monitoring Guidance for Regulatory Modeling Applications (U.S. EPA, 2000). Also, when processing site-specific data for an urban application, Section 3.3 of the AERMOD Implementation Guide offers recommendations for data processing. In summary, the guide recommends that site-specific turbulence measurements should not be used when applying AERMOD's urban option in order to avoid double counting the effects of enhanced turbulence due to the urban heat island.

3.2.3. Upper air data

AERMET requires full upper air soundings to calculate the convective mixing height. For AERMOD applications in the U.S., the early morning sounding, usually the 1200 UTC (Universal Time Coordinate) sounding, is typically used for this purpose. Upper air soundings can be obtained from the Radiosonde Data of North America CD for the period 1946-1997. Upper air soundings for 1994 through the present are also available for free download from the Radiosonde Database Access website. Users should choose all levels or mandatory and significant pressure levels[47] when selecting upper air data. Selecting mandatory levels only would not be adequate for input into AERMET as the use of just mandatory levels would not provide an adequate characterization of the potential temperature profile.

4. Running AERMOD and implications for design value calculations

Recent enhancements to AERMOD include options to aid in the calculation of design values for comparison with the $PM_{2.5}$ NAAQS and to aid in determining whether emissions from the project source contributed significantly to any modeled violations. These enhancements include:

- The MAXDCONT option, which shows the contribution of each user-specified source group to the high ranked values for a specified target source group paired in time and space. The user can specify a range of ranks to analyze or specify an upper bound rank, i.e. 8th highest, corresponding to the 98th percentile for the 24-hour $PM_{2.5}$ NAAQS, and a lower threshold concentration value, such as the NAAQS for the target source group. The model will process each rank within the range specified, but will stop after the first rank (in descending order of concentration) that is below the threshold value if specified by the user. A warning message will be generated if the threshold is not reached within the range of ranks analyzed (based on the range of ranks specified on the RECTABLE keyword). This option may be needed to aid in determining which sources should be considered for controls.

---

[47] By international convention, mandatory levels are in millibars: 1,000, 850, 700, 500, 400, 300, 200, 150, 100, 50, 30, 20, 10, 7 5, 3, 2, and 1. Significant levels may vary depending on the meteorological conditions at the upper-air station.

For more details about the enhancements, see the AERMOD User's guide Addendum (U. S. EPA, 2014a).

Ideally, all explicitly modeled sources, receptors, and background should be modeled in one AERMOD run for all modeled years. In this case, one of the above output options can be used in AERMOD to calculate design values for comparison to the NAAQS and determine the area's attainment status and/or inform attainment/nonattainment boundaries. The use of these options in AERMOD allows AERMOD to internally calculate concentration metrics that can be used to calculate design values and, therefore, lessen the need for large output files, i.e. hourly POSTFILES.

However, there may be situations where a single AERMOD run with all explicitly modeled sources is not possible. These situations often arise due to runtime or storage space considerations during the AERMOD modeling. Sometimes separate AERMOD runs are done for each facility or group of facilities, or by year, or the receptor network is divided into separate sub-networks. In some types of these situations, the MAXDCONT output option may not be an option for design value calculations, especially if all sources are not included in a single run. If the user wishes to utilize one of the three output options, then care should be taken in developing the model inputs to ensure accurate design value calculations.

Situations that would effectively preclude the use of the MAXDCONT option to calculate meaningful AERMOD design value calculations include the following examples:

- Separate AERMOD runs for each source or groups of sources.
    - SIP modeling includes 10 facilities for 5 years of NWS data and each facility is modeled for 5 years in a separate AERMOD run, resulting in ten separate AERMOD runs.
- Separate AERMOD runs for each source and each modeled year.
    - 10 facilities are modeled for 5 years of NWS data. Each facility is modeled separately for each year, resulting in fifty individual AERMOD runs.

In the two situations listed above, the MAXDCONT option would not be useful as the different AERMOD runs do not include a total concentration with contributions from all facilities. In these situations, the use of 24-hour POSTFILES, which can be quite large, and external post-processing would be needed to calculate design values.

Situations in which the MAXDCONT options may be used but may necessitate some external post-processing afterwards to calculate a design value include:

- The receptor network is divided into sections and an AERMOD run, with all sources and years, is made for each sub-network.
    - A receptor network of 1,000 receptors is divided into four 250 receptor sub-networks. 10 facilities are modeled with 5 years of NWS data in one AERMOD run for each receptor network, resulting in four AERMOD runs. After the

AERMOD runs are complete, the MAXDCONT results for each network can be re-combined into the larger network.

- All sources and receptors are modeled in an AERMOD run for each year.
- Ten facilities are modeled with 5 years of NWS data. All facilities are modeled with all receptors for each year individually, resulting in five AERMOD runs. MAXDCONT output can be used and post-processed to generate the necessary design value concentrations. The receptor network is divided and each year is modeled separately for each sub-network with all sources.
- Ten facilities are modeled with 5 years of NWS data for 1,000 receptors. The receptor network is divided into four 250 receptor networks. For each sub-network, all ten facilities are modeled for each year separately, resulting in twenty AERMOD runs. MAXDCONT output can be used and post-processed to generate the necessary design value concentrations.

5. References

Auer, Jr., A.H., 1978: Correlation of Land Use and Cover with Meteorological Anomalies. Journal of Applied Meteorology, 17(5), 636-643.

Brode, R., K. Wesson, J. Thurman, and C. Tillerson, 2008: AERMOD Sensitivity to the Choice of Surface Characteristics, Paper 811, Air And Waste Management Association Annual Conference.

Cimorelli, A. J., S. G. Perry, A. Venkatram, J. C. Weil, R. J. Paine, R. B. Wilson, R. F. Lee, W. D. Peters, R. W. Brode, and J. O. Paumier, 2004. AERMOD: Description of Model Formulation, EPA-454/R-03-004. U.S. Environmental Protection Agency, Research Triangle Park, NC. http://www.epa.gov/ttn/scram/7thconf/aermod/aermod_mfd.pdfU.S

U.S. EPA, 1985: Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations), Revised. EPA-450/4-80-023R. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. http://www.epa.gov/ttn/scram/guidance/guide/gep.pdf

U.S. EPA, 1992: Screening Procedures for Estimating the Air Quality Impact of Stationary Sources. EPA-454/R-92-019. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. http://www.epa.gov/ttn/scram/guidance/guide/scrng.wpd

U.S. EPA, 1994: SO_2 Guideline Document. EPA-452/R-95-008. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

U.S. EPA, 2000: Meteorological Monitoring Guidance for Regulatory Modeling Applications. EPA-454/R-99-005. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. http://www.epa.gov/ttn/scram/guidance/met/mmgrma.pdf

U.S. EPA, 2004a: User's Guide for the AMS/EPA Regulatory Model – AERMOD. EPA-454/B-03-001. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. http://www.epa.gov/ttn/scram/models/aermod/aermod_userguide.zip

U.S. EPA, 2004b: User's Guide for the AERMOD Terrain Preprocessor(AERMAP). EPA-454/B-03-003. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. http://www.epa.gov/ttn/scram/models/aermod/aermap/aermap_userguide.zip

U.S. EPA, 2004c: User’s Guide for the AERMOD Meteorological Preprocessor (AERMET). EPA-454/B-03-002. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. http://www.epa.gov/ttn/scram/7thconf/aermod/aermet_userguide.zip

U.S. EPA, 2004d: User's Guide to the Building Profile Input Program. EPA-454/R-93-038. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711.

U.S. EPA, 2005. *Guideline on Air Quality Models*. 40 CFR Part 51 Appendix W. http://www.epa.gov/ttn/scram/guidance/guide/appw_05.pdf

U.S. EPA, 2008: AERSURFACE User’s Guide. EPA-454/B-08-001. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. http://www.epa.gov/ttn/scram/7thconf/aermod/aersurface_userguide.pdf

U.S. EPA, 2009: AERMOD Implementation Guide. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. http://www.epa.gov/ttn/scram/7thconf/aermod/aermod_implmtn_guide_19March2009.pdf

U.S. EPA, 2010a: Model Clearinghouse Review of Modeling Procedures for Demonstrating Compliance with $PM_{2.5}$ NAAQS. Tyler Fox Memorandum dated February 26, 2010. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. http://www.epa.gov/ttn/scram/guidance/mch/new_mch/MCmemo_Region6_PM25_NAAQS_Compliance.pdf

U.S. EPA, 2010b: Modeling Procedures for Demonstrating Compliance with $PM_{2.5}$ NAAQS. Stephen Page Memorandum dated March 23, 2010. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, 27711. http://www.epa.gov/ttn/scram/Official%20Signed%20Modeling%20Proc%20for%20Demo%20Compli%20w%20$PM_{2.5}$.pdf

U.S. EPA, 2011a: Addendum - User's Guide for the AERMOD Terrain Preprocessor (AERMAP). EPA-454/B-03-003. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. http://www.epa.gov/ttn/scram/models/aermod/aermap/aermap_userguide.zip

U.S. EPA, 2011b: AERSCREEN User's Guide. EPA-454-/B-11-001. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. http://www.epa.gov/ttn/scram/models/screen/aerscreen_userguide.pdf

U.S. EPA, 2011c: AERSCREEN Released as the EPA Recommended Screening Model. Tyler Fox Memorandum dated April 11, 2011. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. http://www.epa.gov/ttn/scram/20110411_AERSCREEN_Release_Memo.pdf

U.S EPA, 2011d AERMINUTE User's Guide. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. http://www.epa.gov/ttn/scram/7thconf/aermod/aerminute_v11325.zip

U.S. EPA, 2013a: Transportation Conformity Guidance for Quantitative Hot-spot Analyses in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas. November 2013. EPA-420-B-10-040. U.S. Environmental Protection Agency, Ann Arbor, Michigan 48105. http://www.epa.gov/oms/stateresources/transconf/policy/420b13053-sec.pdf and http://www.epa.gov/oms/stateresources/transconf/policy/420b13053-appx.pdf.

U.S. EPA, 2013b: Use of ASOS meteorological data in AERMOD dispersion modeling. Tyler Fox Memorandum dated March 8, 2013. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. http://www.epa.gov/ttn/scram/guidance/clarification/20130308_Met_Data_Clarification.pdf

U.S. EPA, 2014a: Addendum – User's Guide for the AMS/EPA Regulatory Model – AERMOD. EPA-454/B-03-001. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. http://www.epa.gov/ttn/scram/models/aermod/aermod_userguide.zip

U.S. EPA, 2014b: Addendum - User's Guide for the AERMOD Meteorological Preprocessor (AERMET). EPA-454/B-03-002. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. http://www.epa.gov/ttn/scram/7thconf/aermod/aermet_userguide.zip

This Page Intentionally Left Blank

Appendix C: Example of a Qualitative Assessment of the Potential for Secondary $PM_{2.5}$ Formation

In late 2011, the EPA Region 10 Office developed a qualitative assessment of the potential for secondary fine particulate matter ($PM_{2.5}$) formation to cause or contribute to a violation of the $PM_{2.5}$ National Ambient Air Quality Standard (NAAQS) through a response to public comments document regarding a Clean Air Act permit issued for Shell's *Discoverer* drill ship and support fleet to explore for oil and gas in the Chukchi Sea off Alaska. While the environment in and around the Chukchi Sea and North Slope of Alaska is unique when compared to the rest of the United States, the various components contained within this qualitative assessment provide a template that could be followed, with appropriate modifications, in the development of other case-specific qualitative assessments. An excerpt from this response to public comments document is provided below for reference.

As shown in the EPA Region 10 example, the qualitative assessment of the potential for secondary $PM_{2.5}$ formation by the Shell's *Discoverer* drill ship and support fleet was developed in a narrative manner integrating numerous factors specific to the North Slope region of Alaska that provided sufficient evidence that the $PM_{2.5}$ NAAQS would not be violated in this particular case. The qualitative assessment examined the regional background $PM_{2.5}$ monitoring data and aspects of secondary $PM_{2.5}$ formation from existing sources; the relative ratio of the combined modeled primary $PM_{2.5}$ impacts and background $PM_{2.5}$ concentrations to the level of the NAAQS; the spatial and temporal correlation of the primary and secondary $PM_{2.5}$ impacts; meteorological characteristics of the region during periods of precursor pollutant emissions; the level of conservatism associated with the modeling of the primary $PM_{2.5}$ component and other elements of conservatism built into the overall NAAQS compliance demonstration; aspects of the precursor pollutant emissions in the context of limitations of other chemical species necessary for the photochemical reactions to form secondary $PM_{2.5}$; and an additional level of NAAQS protection through a post-construction monitoring requirement. While each of the components of the EPA Region 10 example may or may not be necessary, this example should provide a useful template for other qualitative assessments under this guidance, recognizing that additional components may be essential in other qualitative assessments of the potential for secondary $PM_{2.5}$ formation.

Additional information regarding this EPA Region 10 Office permit action can be found through the following web link: http://yosemite.epa.gov/R10/airpage.nsf/Permits/chukchiap/.

Region 10 example:

> In support of the 2011 Revised Draft Permits, Region 10 provided a detailed explanation for why it believes that modeling secondary $PM_{2.5}$ emissions is not needed in order to determine that emissions of $PM_{2.5}$ precursors from the *Discoverer* and Associated Fleet would not, together with emissions of primary $PM_{2.5}$, cause or contribute to a violation of the 24-hour $PM_{2.5}$ NAAQS. The factors Region 10 relied on to reach this conclusion include:

1) The background $PM_{2.5}$ monitoring data considered in the air quality analysis is quality assured, quality controlled data from monitors operating for more than one year that Region 10 believes will have accounted for much of the secondary formation from existing regional emission sources that will occur in the Chukchi Sea and Beaufort Sea regions. Monitoring data show low levels of daily $PM_{2.5}$, generally in the range of 2 $\mu g/m^3$, with the higher $PM_{2.5}$ values generally occurring on days where windblown dust or fires are believed to be contributing factors. Thus, there is no indication that secondary formation of $PM_{2.5}$ from existing sources in the North Slope is currently causing or contributing to exceedances or a violation of the $PM_{2.5}$ NAAQS in the onshore communities.

2) Modeled primary $PM_{2.5}$ impacts from the *Discoverer* and Associated Fleet that, when using a conservative "First Tier" approach to combining modeled primary $PM_{2.5}$ impacts with monitored background $PM_{2.5}$ concentrations, are less than 67 percent of the $PM_{2.5}$ NAAQS. Thus, although not expected, considerable formation of secondary $PM_{2.5}$ emissions could occur before the NAAQS would be threatened.

3) Secondary $PM_{2.5}$ impacts associated with *Discoverer* and Associated Fleet precursor emissions are expected to be low near the emission release points where modeled concentrations associated with primary $PM_{2.5}$ emissions are highest, because there has not been enough time for the secondary chemical reactions to occur. Conversely, secondary $PM_{2.5}$ impacts are more likely to be higher farther from the *Discoverer* and the Associated Fleet where impacts from primary $PM_{2.5}$ emissions from the *Discoverer* and the Associated Fleet are expected to be lower. This makes it unlikely that maximum primary $PM_{2.5}$ impacts and maximum secondary $PM_{2.5}$ impacts from the *Discoverer* and the Associated Fleet will occur at the same time (paired in time) or location (paired in space). See March 23, 2010 $PM_{2.5}$ Guidance Memo at 9.

4) The relatively small amount of NO_X emissions (a $PM_{2.5}$ precursor) that will be authorized under these permits in comparison to existing NO_X emissions in the North Slope area in general, together with the generally low levels of $PM_{2.5}$ recorded at monitoring stations in the area, make it unlikely that NO_X emissions from the *Discoverer* and the Associated Fleet would cause or contribute to a violation of the $PM_{2.5}$ NAAQS.

5) The background concentrations of certain chemical species that participate in photochemical reactions to form secondary $PM_{2.5}$, including ammonia and volatile organic compounds, are expected to be negligible in the offshore air masses where the *Discoverer* will be permitted to operate. The emissions authorized under the permits of approximately 43 tons per year of VOC and 0.52 tons per year of ammonia [citation omitted] would also not be expected to result in the conversion of significant quantities of NO_X emissions to secondary particles in the areas impacted by primary $PM_{2.5}$ emissions.

> 6) There are several other conservative assumptions incorporated in the modeling of primary $PM_{2.5}$ emissions. These include the conservatism inherent in using a “First Tier” approach to combining modeled primary $PM_{2.5}$ impacts with monitored background $PM_{2.5}$ concentrations; assuming that the *Discoverer* will be operating in a single drilling location for 3 years, when it is more likely that the *Discoverer* will operate in a different location each year (if not more frequently); orienting the Associated Fleet with hourly modeled wind direction and using emission release characteristics based on actual meteorological conditions; and the fact that the background monitored data used to represent offshore conditions was collected onshore, where it is influenced by local sources, and is, therefore likely to be a conservative estimate of background $PM_{2.5}$ levels in the area of maximum impact near the *Discoverer*.
>
> 7) With respect to the Chukchi Sea impacts, the predominant easterly wind directions in the Chukchi Sea along with the distance between the project location and the existing sources in the North Slope oil and gas fields are such that emissions from the *Discoverer* and Associated Fleet are not likely to significantly contribute to the maximum ambient concentrations resulting from the existing source emissions.
>
> 8) Region 10 required post-construction monitoring in the previous permits because the conservative screening modeling resulted in predicted levels that were just below the 24-hour $PM_{2.5}$ NAAQS. With the additional emission reductions in direct $PM_{2.5}$ emissions and the use of a refined model, predicted $PM_{2.5}$ concentrations are now well below the NAAQS. However, Region 10 has decided to retain the post-construction monitoring requirement in order to obtain better information on the quantity of secondary particles in the North Slope communities.

Based on these factors, and consistent with current guidance, Region 10 believes that an adequate assessment has been made to demonstrate that the $PM_{2.5}$ NAAQS will be protected, accounting for primary $PM_{2.5}$ impacts and potential contributions due to $PM_{2.5}$ precursors from the *Discoverer* and the Associated Fleet, and that it is not necessary to use a photochemical model to further evaluate secondary $PM_{2.5}$ formation in these permitting actions.

This Page Intentionally Left Blank

Appendix D: Example of a Hybrid Qualitative/Quantitative Assessment of the Potential for Secondary $PM_{2.5}$ Formation

In late 2013/early 2014, a permit applicant, Sasol, engaged and closely coordinated with the EPA Region 6 Office and the Louisiana Department of Environmental Quality (LDEQ) in the development of a hybrid qualitative/quantitative assessment of the potential for secondary fine particulate matter ($PM_{2.5}$) formation to cause or contribute to a violation of the $PM_{2.5}$ National Ambient Air Quality Standard (NAAQS) for their proposed major facility expansions in Southern Louisiana. Sasol's expansion and new plant are a very large investment (up to $18 Billion), and Sasol and LDEQ worked closely with Region 6 to ensure that the ambient impacts analysis was robust and defendable. In this particular hybrid assessment, Sasol took an approach of using the formerly presumptive interpollutant trading ratios for NO_x and SO_2 to $PM_{2.5}$ offsets and conservatively applied them in an illustrative example to demonstrate how relatively inconsequential the impacts of secondary $PM_{2.5}$ formation would be in the area of significant impact surrounding their facility. In Sasol's case, the projected emissions increases of the direct $PM_{2.5}$ emissions and both $PM_{2.5}$ precursors of NO_x and SO_2 were above their respective Significant Emissions Rates (SERs). Sasol also performed an analysis of $PM_{2.5}$ speciated monitoring data to further support the amount of impacts of nitrates on high $PM_{2.5}$ values in the area is relatively small and corroborate the ratio based analysis. Thus, this situation is an example of a Case 3 assessment as presented in Table III-1 of this guidance.

It is important to note that the EPA revised the provisions of the interpollutant trading policy for $PM_{2.5}$ on July 21, 2011, as described in Section III.2.2 of this guidance, to remove the general presumptiveness of the interpollutant trading ratios without further technical justification. Sasol is located in Southwestern Louisiana near the coast but chose to use the western state value of 100 for NOx as a more conservative assessment. Sasol did not seek to directly apply the formerly presumptive interpollutant trading ratios in an absolute sense. Rather, the intention was to present the analysis in a manner to determine if further technical justification would be required or if the application of the formerly presumptive interpollutant trading ratios where adequate in a hybrid qualitative/quantitative sense.

Using the formerly presumptive interpollutant trading ratios resulted in total projected secondary $PM_{2.5}$ formation of 0.18 $\mu g/m^3$ for the 24-hour $PM_{2.5}$NAAQS and of 0.04 $\mu g/m^3$ for the annual $PM_{2.5}$ NAAQS. When considered along with the primary $PM_{2.5}$ impacts and representative background data, the secondary $PM_{2.5}$ impacts with respect to the 24-hour NAAQS would have to be on the order of 32 times higher and to the annual NAAQS would have to be at least 15 times greater before a potential projected violation might occur. This also assumes that the maximum secondary $PM_{2.5}$ impacts from the NO_x and SO_2 precursor emissions would occur at the same place and time as the maximum primary $PM_{2.5}$ impacts. Based upon Sasol's $PM_{2.5}$ primary modeling projecting maximum concentrations very close to the facility and decreasing 60% within three kilometers of the facility, it is very unlikely that the primary and secondary maximums would ever occur at the same receptors. So, it would take a considerable and unreasonably conservative change to the interpollutant trading ratios used in this example before the NAAQS could be threatened based on the total proposed emissions increases from this facility.

At the same time Sasol also conducted an analysis of speciated data at a nearby monitor to further corroborate the ratio analysis. There is a $PM_{2.5}$ monitor within ½ mile of the Sasol's property line, but it does not have speciated data collection. Sasol utilized a representative $PM_{2.5}$ monitor approximately 25 miles away that did have long-term speciated data. Sasol evaluated the $PM_{2.5}$ speciated data from the nearby monitor to support that nitrate is not a large contributer to high $PM_{2.5}$ values on an annual basis or even on the higher daily values in the colder months when nitrates would be expected to yield more secondary $PM_{2.5}$.

Given the close coordination with the respective permitting authorities, it was determined that a more thorough technical demonstration with respect to interpollutant ratios specific to this source and area was not warranted and that the illustrative use of the formerly presumptive interpollutant trading ratios was sufficient to demonstrate that secondary $PM_{2.5}$ formation would not cause or contribute to a violation of the NAAQS. The permit applicant's corroborative analysis of the $PM_{2.5}$ speciated data further supported that the main increase of emissions (NO_x) would not be expected to yield significant levels of secondary $PM_{2.5}$ and the applicable ambient standards will not be exceeded by this project.

Region 6 example:

> **Justification on Secondary $PM_{2.5}$ Approach**
> At a December 13, 2013, meeting and on a January 17, 2014, conference call EPA Region 6 requested an analysis to examine the fraction of sulfate and nitrate in the $PM_{2.5}$ measurements in the study area and additional justification on the modeling approach for secondary $PM_{2.5}$. This document presents the results of the requested analysis.
>
> Secondary $PM_{2.5}$ is formed primarily from reaction of sulfur dioxide (SO_2) emissions to form particulate sulfate and from nitrogen oxides (NO_x) reacting to form particulate nitrate. The approach used to estimate the secondary particulate is described in Section [Secondary Particulate Estimate *(listed below)*].
>
> With regard to NO_x. and SO_2, the Sasol project emissions are dominated by NO_x with annual emissions of 1,595 tons per year compared to SO_2 emissions of only 121 tons per year. EPA requested additional information on the secondary $PM_{2.5}$ formation from nitrate in the colder months.
>
> The $PM_{2.5}$ background monitor is the Westlake monitor located very near the project site. However, this monitor did not record speciated $PM_{2.5}$ data, so it is not possible to compute the sulfate and nitrate fractions at this location. Monitors with speciated $PM_{2.5}$ data include the Port Arthur Memorial School (AIRS: 48-245-0021) in Port Arthur, Texas, the Capitol Baton Rouge (AIRS: 22-033-0009), and the Shreveport (AIRS: 22-015-0008) monitors. The Port Arthur monitor was chosen as being the most representative because it is the closest monitor to the Sasol site and is in a less urban area than the Capitol Baton Rouge monitor and is not as far inland as the Shreveport monitor. The Port Arthur area is also located along the gulf coast and most closely represents the combination of a metropolitan size and industrial presence when compared to the Calcasieu Parish area where Sasol is located.

The Port Arthur monitor, located in Port Arthur, Texas, is approximately 25 miles west of the project. Given the regional nature of $PM_{2.5}$ concentrations, this monitor should be representative of the study area. The most recently available five years of data for this site was for 2006-2010 and was obtained from the USEPA. The data shows that nitrate makes up 2.6 percent of the average of the 24-hour concentrations of $PM_{2.5}$ and 2.3 percent of the 5-year average concentration. On the day with the highest 24-hour average $PM_{2.5}$ measurement, nitrate was 2.2 percent of the $PM_{2.5}$ concentration.

In general, the generation of $PM_{2.5}$ occurs more from nitrate during colder winter months than during the summer. Examination of the worst 10% of $PM_{2.5}$ days during the colder months (November through February) at the Port Arthur monitor for 2006-2010 reveals that the average nitrate contribution is 2.9 percent, only slightly higher than the 5-year average concentration. Thus, even on days with high $PM_{2.5}$ concentrations in the colder months, particulate nitrate is still a relatively small portion of the total $PM_{2.5}$ concentrations.

Based on this relatively low fraction of particulate nitrate in the observed $PM_{2.5}$, and the magnitude of existing NO_x emissions in the area, it is clear that secondary formation of particulate nitrate is not significant in the project area.

Particulate sulfate makes up 29.6 percent of the 5-year average of the 24-hour concentrations and 29.0 percent of the 5-year average concentrations. On the day with the highest 24-hour average $PM_{2.5}$ observation, sulfate was 10.6 percent of the $PM_{2.5}$ concentration.

Table 1 presents the total $PM_{2.5}$ ambient air impact estimated using the formerly approved interpollutant trading ratios. The nitrate equivalent ratio (1.026) is [6.5] times greater than the sulfate equivalent ratio ([1.004]). While sulfate does make up a significant portion of the total $PM_{2.5}$ mass, the projected increase in SO_2 emissions (121 tpy) from the Sasol GTL and LCCP projects are a very small fraction of the total SO_2 emissions in the large industrial area impacting Port Arthur (i.e. Beaumont/Port Arthur, Lake Charles, Houston/Galveston).

An implicit conservatism to the ratio approach that was used by Sasol is that the primary and secondary impacts occur at the same location at the same time. The 24-hour average modeled $PM_{2.5}$ concentration is presented in Figure 1. Examination of this figure reveals that the highest impact occurs very near the Sasol project border. Within a few kilometers of the project site, the concentrations fall significantly from the peak of modeled concentration of 9 $\mu g/m^3$ to less than 3 $\mu g/m^3$. Formation of secondary sulfate and nitrate particulate is a fairly slow process with conversion rates taking many hours to days. Thus, the peak secondary impacts are expected to occur well downwind of the peak primary impacts.

Given this information, the study team is comfortable that the ambient ratio analysis presented in the ozone and secondary $PM_{2.5}$ modeling report is an appropriate approach to estimating the secondary $PM_{2.5}$ impacts for the project.

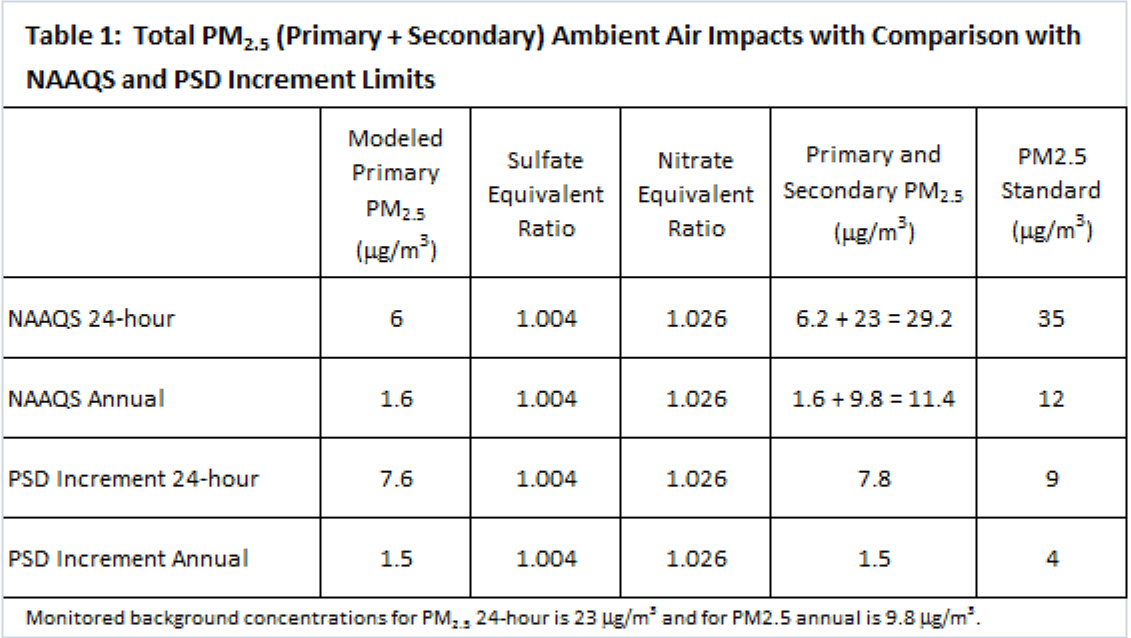
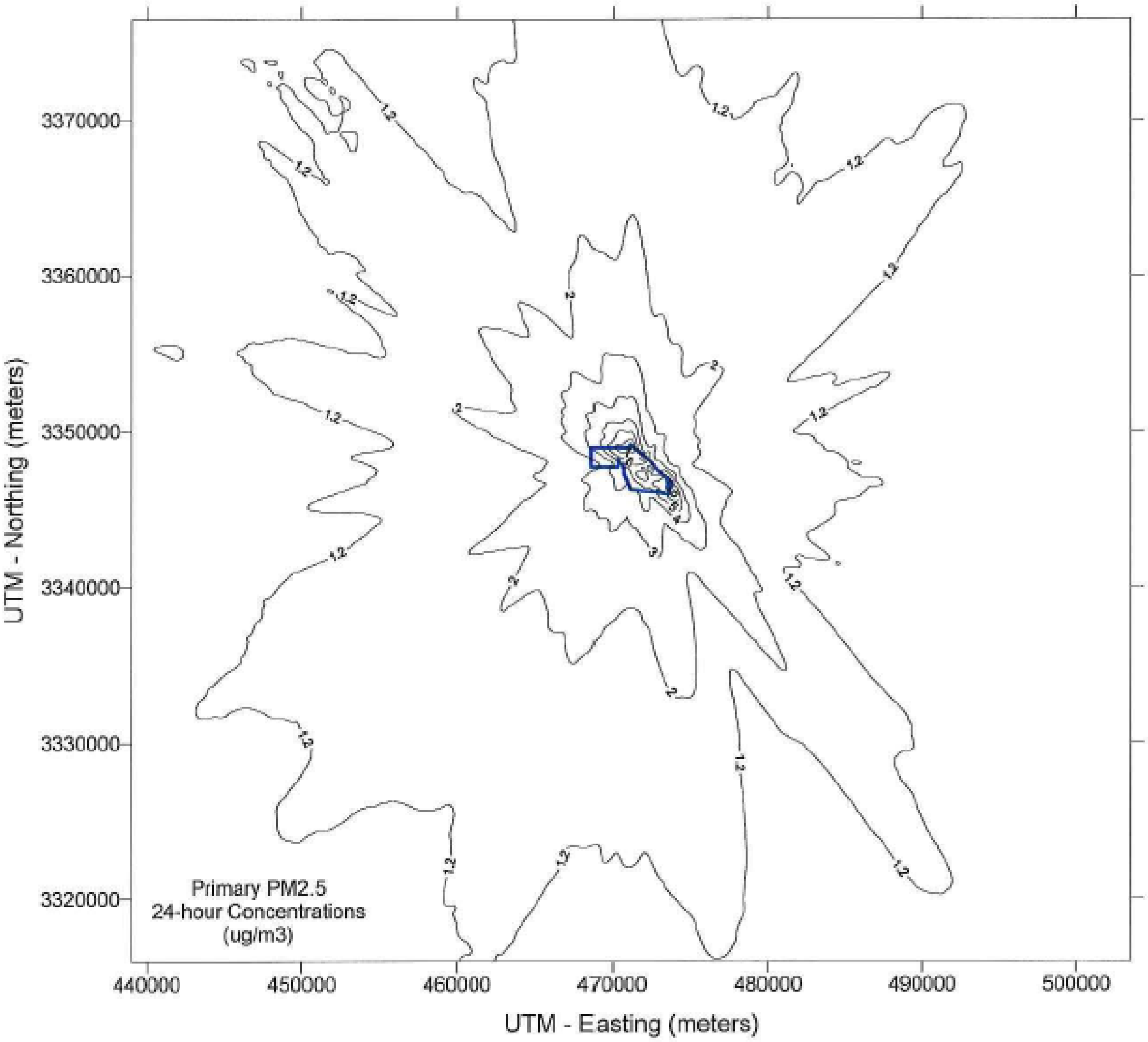


Table 1: Total $PM_{2.5}$ (Primary + Secondary) Ambient Air Impacts with Comparison with NAAQS and PSD Increment Limits

	Modeled Primary $PM_{2.5}$ ($\mu g/m^3$)	Sulfate Equivalent Ratio	Nitrate Equivalent Ratio	Primary and Secondary $PM_{2.5}$ ($\mu g/m^3$)	PM2.5 Standard ($\mu g/m^3$)
NAAQS 24-hour	6	1.004	1.026	6.2 + 23 = 29.2	35
NAAQS Annual	1.6	1.004	1.026	1.6 + 9.8 = 11.4	12
PSD Increment 24-hour	7.6	1.004	1.026	7.8	9
PSD Increment Annual	1.5	1.004	1.026	1.5	4

Monitored background concentrations for $PM_{2.5}$ 24-hour is 23 $\mu g/m^3$ and for PM2.5 annual is 9.8 $\mu g/m^3$.

Figure 1: Sasol Primary 24-hour Maximum PM2.5 Concentration Isopleth (μg/m^3). Peak value is 8.6 μg/m$^{3.}$



[Secondary Particulate Estimate]

Recent EPA guidance (EPA March 2013) has suggested the need to examine secondary particulate formation. Directly emitted sulfur or nitrogen compounds are likely to react with available water and other pollutants in secondary reactions to form particulate ammonium sulfate –$(NH_4)_2SO_4$ or ammonium nitrate –NH_4NO_3. These latter compounds are formed primarily downwind of the specific sources of concern, given reaction times, ambient temperature and other environmental factors. The sulfur compounds emitted by the two projects are in the form of SO_2. The nitrogen compounds emitted by the two projects are in the form of NO_x. The Sasol projects (GTL and LCCP combined) would have 1,595 tpy of NO_x, 121 tpy SO_2, and 612 tpy of direct $PM_{2.5}$ emissions.

The NACAA/EPA recommendation to account for secondary $PM_{2.5}$ formation is to divide the projected emissions by a region average offset ratio. The national ratio for SO_2 is 40 and for NO_x is 100 for western states and 200 for eastern states. To be conservative, the western value was used in the analysis since it estimates a higher secondary ratio. The total $PM_{2.5}$ emissions are calculated by multiplying the primary $PM_{2.5}$ modeled concentration by the ratio obtained from the secondary equivalent $PM_{2.5}$ calculation.

For the Sasol combined project emissions the formulas are:

Total Equivalent $PM_{2.5}$ = Primary $PM_{2.5}$ + $(SO_2/40)$ + $(NO_x/100)$ = 612 + (121/400) + (1,595/100) = 631.0 ton/year

Total $PM_{2.5}$ Impact ($\mu g/m^3$) = Primary $PM_{2.5}$ Impact ($\mu g/m^3$) * (Total Equivalent Primary $PM_{2.5}$ (tpy) / Primary $PM_{2.5}$ (tpy))

Total Equivalent $PM_{2.5}$ / Primary $PM_{2.5}$ = 631.0 tpy / 612 tpy = 1.03

Hence the modeled impacts for $PM_{2.5}$ could be increased by a factor of 1.03 [(1.004 for SO_2 and 1.026 for NO_x)] to account for the secondary formation for those sources emitting significant amounts of secondary $PM_{2.5}$ precursor emissions.

Appendix E: Example of the background monitoring data calculations for a Second Tier 24-hour modeling analysis

This appendix provides an illustrative example of the calculations and data sorting recommendations for the background monitoring data to be used in a Second Tier 24-hour $PM_{2.5}$ modeling analysis. In this example, it was determined through discussion and coordination with the appropriate permitting authority that the impacts from the project source's primary $PM_{2.5}$ emissions were most prominent during the cool season and were not temporally correlated with background $PM_{2.5}$ levels that were typical highest during the warm season. So, combining the modeled and monitored contributions through a First Tier 24-hour $PM_{2.5}$ modeling analysis was determined to be potentially overly conservative. Extending the compliance demonstration to a Second Tier analysis allows for a more refined and appropriate assessment of the cumulative impacts on the primary $PM_{2.5}$ emissions in this particular situation.

The example provided is from an idealized Federal Reference Method (FRM) $PM_{2.5}$ monitoring site that operates on a daily (1-in-1 day) frequency with 100% data completeness. In this case, the annual 98th percentile concentration is the 8th highest concentration of the year. In most cases, the FRM monitoring site will likely operate on a 1-and-3 day frequency and will also likely have missing data due to monitor maintenance or collected data not meeting all of the quality assurance criteria. Please reference Appendix N to 40 CFR Part 50 to determine the appropriate 98th percentile rank of the monitored data based on the monitor sampling frequency and valid number of days sampled during each year.

The appropriate seasonal (or quarterly) background concentrations to be included as inputs to the AERMOD model per a Second Tier 24-hour $PM_{2.5}$ modeling analysis are as follows:

- Step 1 – Start with the most recent 3-years of representative background $PM_{2.5}$ ambient monitoring data that are being used to develop the monitored background $PM_{2.5}$ design value. In this example, the 3-years of 2008 to 2010 are being used to determine the monitored design value.

- Step 2 – For each year, determine the appropriate rank for the daily 98th percentile $PM_{2.5}$ concentration. Again, this idealized example is from a 1-in-1 day monitor with 100% data completeness. So, the 8th highest concentration of each year is the 98th percentile $PM_{2.5}$ concentration. The 98th percentile $PM_{2.5}$ concentration for 2008 is highlighted in Table E-1. The full concentration data from 2009 and 2010 are not shown across the steps in this Appendix for simplicity but would be similar to that of 2008.

- Step 3 – Remove from further consideration in this analysis the $PM_{2.5}$ concentrations from each year that are greater than the 98th percentile $PM_{2.5}$ concentration. In the case presented for a 1-in-1 day monitor, the top 7 concentrations are removed. If the monitor were a 1-in-3 day monitor, only the top 2 concentrations would be removed. The resultant dataset after the top 7 concentrations have been removed from further consideration in this analysis for 2008 is presented in Table E-2.

- Step 4 – For each year, divide the resultant annual dataset of the monitored data equal to or less than the 98th percentile $PM_{2.5}$ concentration into each season (or quarter). For 2008, the seasonal subsets are presented in Table E-3.

- Step 5 – Determine the maximum $PM_{2.5}$ concentration from each of the seasonal (or quarterly) subsets created in Step 4 for each year. The maximum $PM_{2.5}$ concentration from each season for 2008 is highlighted in Table E-3.

- Step 6 – Average the seasonal (or quarterly) maximums from Step 5 across the three years of monitoring data to create the four seasonal background PM2.5 concentrations to be included as inputs to the AERMOD model. These averages for the 2008 to 2010 dataset used in this example are presented in Table E-4. As noted above, the full concentration data from 2009 and 2010 are not shown across the steps in this Appendix for simplicity, but the seasonal maximums from 2009 and 2010 presented in Table E-4 were determined by following the previous five steps similar to that of 2008.

Table E-1. 2008 Daily $PM_{2.5}$ Concentrations

Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.
1-Jan	10.4	16-Feb	15.1	2-Apr	10.5	18-May	11.1	3-Jul	17.1	18-Aug	18.7	3-Oct	12.3	18-Nov	4.4
2-Jan	5.4	17-Feb	11.8	3-Apr	8.2	19-May	7.7	4-Jul	19.8	19-Aug	21.5	4-Oct	19.5	19-Nov	8.2
3-Jan	10.0	18-Feb	3.4	4-Apr	9.7	20-May	13.6	5-Jul	14.3	20-Aug	20.1	5-Oct	23.7	20-Nov	11.1
4-Jan	16.4	19-Feb	4.5	5-Apr	6.9	21-May	12.1	6-Jul	11.5	21-Aug	18.4	6-Oct	19.8	21-Nov	5.3
5-Jan	11.2	20-Feb	4.8	6-Apr	6.3	22-May	10.0	7-Jul	14.3	22-Aug	16.7	7-Oct	21.7	22-Nov	8.9
6-Jan	11.1	21-Feb	11.9	7-Apr	7.9	23-May	13.3	8-Jul	12.2	23-Aug	13.8	8-Oct	12.2	23-Nov	14.0
7-Jan	10.2	22-Feb	20.1	8-Apr	9.8	24-May	11.2	9-Jul	11.1	24-Aug	19.0	9-Oct	5.1	24-Nov	12.7
8-Jan	11.4	23-Feb	11.4	9-Apr	16.5	25-May	17.7	10-Jul	9.7	25-Aug	17.6	10-Oct	10.2	25-Nov	9.7
9-Jan	8.1	24-Feb	19.3	10-Apr	13.3	26-May	14.2	11-Jul	16.4	26-Aug	15.4	11-Oct	10.7	26-Nov	12.8
10-Jan	9.4	25-Feb	18.2	11-Apr	11.0	27-May	15.4	12-Jul	21.5	27-Aug	12.6	12-Oct	5.6	27-Nov	16.6
11-Jan	5.7	26-Feb	12.8	12-Apr	8.8	28-May	13.9	13-Jul	25.1	28-Aug	12.1	13-Oct	5.9	28-Nov	17.2
12-Jan	8.9	27-Feb	5.5	13-Apr	6.3	29-May	9.3	14-Jul	11.7	29-Aug	10.1	14-Oct	9.7	29-Nov	16.6
13-Jan	18.1	28-Feb	9.7	14-Apr	5.1	30-May	14.5	15-Jul	18.9	30-Aug	17.2	15-Oct	12.8	30-Nov	4.5
14-Jan	11.0	29-Feb	12.1	15-Apr	7.9	31-May	20.5	16-Jul	28.9	31-Aug	19.9	16-Oct	16.4	1-Dec	7.5
15-Jan	11.8	1-Mar	9.6	16-Apr	8.2	1-Jun	15.3	17-Jul	27.6	1-Sep	19.4	17-Oct	12.0	2-Dec	10.6
16-Jan	10.7	2-Mar	5.6	17-Apr	14.7	2-Jun	11.5	18-Jul	12.8	2-Sep	18.2	18-Oct	7.9	3-Dec	16.7
17-Jan	10.0	3-Mar	12.5	18-Apr	22.5	3-Jun	17.9	19-Jul	6.2	3-Sep	24.0	19-Oct	6.6	4-Dec	12.5
18-Jan	15.6	4-Mar	7.1	19-Apr	12.8	4-Jun	21.1	20-Jul	20.1	4-Sep	15.4	20-Oct	8.1	5-Dec	7.3
19-Jan	18.0	5-Mar	4.9	20-Apr	6.9	5-Jun	17.9	21-Jul	26.5	5-Sep	12.4	21-Oct	12.2	6-Dec	10.4
20-Jan	6.6	6-Mar	9.9	21-Apr	7.5	6-Jun	17.6	22-Jul	16.9	6-Sep	12.5	22-Oct	4.6	7-Dec	13.4
21-Jan	7.4	7-Mar	11.2	22-Apr	6.0	7-Jun	15.0	23-Jul	12.8	7-Sep	15.8	23-Oct	6.1	8-Dec	10.5
22-Jan	13.5	8-Mar	5.5	23-Apr	9.1	8-Jun	22.3	24-Jul	7.9	8-Sep	23.4	24-Oct	4.6	9-Dec	9.3
23-Jan	16.0	9-Mar	8.8	24-Apr	10.3	9-Jun	27.9	25-Jul	15.7	9-Sep	11.5	25-Oct	4.5	10-Dec	6.5
24-Jan	9.4	10-Mar	11.0	25-Apr	12.0	10-Jun	21.6	26-Jul	24.9	10-Sep	6.0	26-Oct	10.5	11-Dec	3.0
25-Jan	12.6	11-Mar	12.1	26-Apr	12.5	11-Jun	19.4	27-Jul	22.2	11-Sep	11.8	27-Oct	6.4	12-Dec	3.5
26-Jan	13.6	12-Mar	9.7	27-Apr	11.3	12-Jun	21.2	28-Jul	17.5	12-Sep	10.7	28-Oct	4.6	13-Dec	10.2
27-Jan	16.1	13-Mar	15.1	28-Apr	7.6	13-Jun	29.1	29-Jul	19.1	13-Sep	7.6	29-Oct	5.6	14-Dec	17.6
28-Jan	10.0	14-Mar	21.6	29-Apr	7.4	14-Jun	15.6	30-Jul	21.1	14-Sep	7.5	30-Oct	7.6	15-Dec	12.4
29-Jan	10.4	15-Mar	16.6	30-Apr	11.4	15-Jun	14.8	31-Jul	18.0	15-Sep	7.1	31-Oct	11.2	16-Dec	9.7
30-Jan	6.9	16-Mar	7.9	1-May	12.6	16-Jun	17.8	1-Aug	16.3	16-Sep	7.7	1-Nov	16.2	17-Dec	7.0
31-Jan	4.9	17-Mar	9.6	2-May	10.0	17-Jun	12.6	2-Aug	19.3	17-Sep	11.3	2-Nov	17.3	18-Dec	7.9
1-Feb	5.4	18-Mar	10.3	3-May	11.2	18-Jun	10.5	3-Aug	17.9	18-Sep	16.8	3-Nov	18.3	19-Dec	6.9
2-Feb	7.1	19-Mar	8.4	4-May	10.4	19-Jun	15.0	4-Aug	25.1	19-Sep	14.8	4-Nov	8.9	20-Dec	8.1
3-Feb	10.9	20-Mar	4.9	5-May	15.7	20-Jun	22.7	5-Aug	29.3	20-Sep	8.0	5-Nov	5.8	21-Dec	4.9
4-Feb	12.1	21-Mar	8.7	6-May	16.1	21-Jun	18.7	6-Aug	19.1	21-Sep	10.8	6-Nov	8.6	22-Dec	7.7
5-Feb	17.1	22-Mar	13.3	7-May	16.8	22-Jun	15.2	7-Aug	14.0	22-Sep	14.5	7-Nov	15.0	23-Dec	7.7
6-Feb	10.3	23-Mar	12.2	8-May	14.5	23-Jun	16.8	8-Aug	10.8	23-Sep	21.2	8-Nov	8.3	24-Dec	10.5
7-Feb	4.0	24-Mar	10.3	9-May	11.7	24-Jun	15.1	9-Aug	15.0	24-Sep	8.6	9-Nov	10.0	25-Dec	6.5
8-Feb	9.7	25-Mar	11.9	10-May	9.0	25-Jun	20.7	10-Aug	21.7	25-Sep	1.2	10-Nov	12.8	26-Dec	7.6
9-Feb	11.5	26-Mar	20.1	11-May	6.7	26-Jun	23.0	11-Aug	14.3	26-Sep	16.0	11-Nov	11.8	27-Dec	13.3
10-Feb	3.0	27-Mar	22.5	12-May	7.9	27-Jun	17.8	12-Aug	14.7	27-Sep	12.1	12-Nov	14.8	28-Dec	6.4
11-Feb	5.5	28-Mar	18.2	13-May	8.3	28-Jun	12.4	13-Aug	13.0	28-Sep	18.0	13-Nov	14.5	29-Dec	3.7
12-Feb	18.9	29-Mar	10.8	14-May	12.2	29-Jun	12.7	14-Aug	13.5	29-Sep	17.8	14-Nov	7.7	30-Dec	4.7
13-Feb	17.6	30-Mar	6.4	15-May	13.1	30-Jun	8.9	15-Aug	17.5	30-Sep	16.4	15-Nov	3.6	31-Dec	4.4
14-Feb	11.2	31-Mar	3.3	16-May	8.8	1-Jul	7.1	16-Aug	23.9	1-Oct	12.3	16-Nov	4.6		
15-Feb	14.4	1-Apr	7.8	17-May	8.2	2-Jul	13.8	17-Aug	18.4	2-Oct	8.2	17-Nov	7.8		

Annual 98th Percentile Concentration = 21.5 μg/m^3

Table E-2. 2008 Daily $PM_{2.5}$ Concentrations Less Than or Equal to the 98^{th} Percentile

Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.
1-Jan	10.4	16-Feb	15.1	2-Apr	10.5	18-May	11.1	3-Jul	17.1	18-Aug	18.7	3-Oct	12.3	18-Nov	4.4
2-Jan	5.4	17-Feb	11.8	3-Apr	8.2	19-May	7.7	4-Jul	19.8	19-Aug	21.5	4-Oct	19.5	19-Nov	8.2
3-Jan	10.0	18-Feb	3.4	4-Apr	9.7	20-May	13.6	5-Jul	14.3	20-Aug	20.1	5-Oct	23.7	20-Nov	11.1
4-Jan	16.4	19-Feb	4.5	5-Apr	6.9	21-May	12.1	6-Jul	11.5	21-Aug	18.4	6-Oct	19.8	21-Nov	5.3
5-Jan	11.2	20-Feb	4.8	6-Apr	6.3	22-May	10.0	7-Jul	14.3	22-Aug	16.7	7-Oct	21.7	22-Nov	8.9
6-Jan	11.1	21-Feb	11.9	7-Apr	7.9	23-May	13.3	8-Jul	12.2	23-Aug	13.8	8-Oct	12.2	23-Nov	14.0
7-Jan	10.2	22-Feb	20.1	8-Apr	9.8	24-May	11.2	9-Jul	11.1	24-Aug	19.0	9-Oct	5.1	24-Nov	12.7
8-Jan	11.4	23-Feb	11.4	9-Apr	16.5	25-May	17.7	10-Jul	9.7	25-Aug	17.6	10-Oct	10.2	25-Nov	9.7
9-Jan	8.1	24-Feb	19.3	10-Apr	13.3	26-May	14.2	11-Jul	16.4	26-Aug	15.4	11-Oct	10.7	26-Nov	12.8
10-Jan	9.4	25-Feb	18.2	11-Apr	11.0	27-May	15.4	12-Jul	21.5	27-Aug	12.6	12-Oct	5.6	27-Nov	16.6
11-Jan	5.7	26-Feb	12.8	12-Apr	8.8	28-May	13.9	13-Jul	RC	28-Aug	12.1	13-Oct	5.9	28-Nov	17.2
12-Jan	8.9	27-Feb	5.5	13-Apr	6.3	29-May	9.3	14-Jul	11.7	29-Aug	10.1	14-Oct	9.7	29-Nov	16.6
13-Jan	18.1	28-Feb	9.7	14-Apr	5.1	30-May	14.5	15-Jul	18.9	30-Aug	17.2	15-Oct	12.8	30-Nov	4.5
14-Jan	11.0	29-Feb	12.1	15-Apr	7.9	31-May	20.5	16-Jul	RC	31-Aug	19.9	16-Oct	16.4	1-Dec	7.5
15-Jan	11.8	1-Mar	9.6	16-Apr	8.2	1-Jun	15.3	17-Jul	RC	1-Sep	19.4	17-Oct	12.0	2-Dec	10.6
16-Jan	10.7	2-Mar	5.6	17-Apr	14.7	2-Jun	11.5	18-Jul	12.8	2-Sep	18.2	18-Oct	7.9	3-Dec	16.7
17-Jan	10.0	3-Mar	12.5	18-Apr	22.5	3-Jun	17.9	19-Jul	6.2	3-Sep	24.0	19-Oct	6.6	4-Dec	12.5
18-Jan	15.6	4-Mar	7.1	19-Apr	12.8	4-Jun	21.1	20-Jul	20.1	4-Sep	15.4	20-Oct	8.1	5-Dec	7.3
19-Jan	18.0	5-Mar	4.9	20-Apr	6.9	5-Jun	17.9	21-Jul	RC	5-Sep	12.4	21-Oct	12.2	6-Dec	10.4
20-Jan	6.6	6-Mar	9.9	21-Apr	7.5	6-Jun	17.6	22-Jul	16.9	6-Sep	12.5	22-Oct	4.6	7-Dec	13.4
21-Jan	7.4	7-Mar	11.2	22-Apr	6.0	7-Jun	15.0	23-Jul	12.8	7-Sep	15.8	23-Oct	6.1	8-Dec	10.5
22-Jan	13.5	8-Mar	5.5	23-Apr	9.1	8-Jun	22.3	24-Jul	7.9	8-Sep	23.4	24-Oct	4.6	9-Dec	9.3
23-Jan	16.0	9-Mar	8.8	24-Apr	10.3	9-Jun	RC	25-Jul	15.7	9-Sep	11.5	25-Oct	4.5	10-Dec	6.5
24-Jan	9.4	10-Mar	11.0	25-Apr	12.0	10-Jun	21.6	26-Jul	24.9	10-Sep	6.0	26-Oct	10.5	11-Dec	3.0
25-Jan	12.6	11-Mar	12.1	26-Apr	12.5	11-Jun	19.4	27-Jul	22.2	11-Sep	11.8	27-Oct	6.4	12-Dec	3.5
26-Jan	13.6	12-Mar	9.7	27-Apr	11.3	12-Jun	21.2	28-Jul	17.5	12-Sep	10.7	28-Oct	4.6	13-Dec	10.2
27-Jan	16.1	13-Mar	15.1	28-Apr	7.6	13-Jun	RC	29-Jul	19.1	13-Sep	7.6	29-Oct	5.6	14-Dec	17.6
28-Jan	10.0	14-Mar	21.6	29-Apr	7.4	14-Jun	15.6	30-Jul	21.1	14-Sep	7.5	30-Oct	7.6	15-Dec	12.4
29-Jan	10.4	15-Mar	16.6	30-Apr	11.4	15-Jun	14.8	31-Jul	18.0	15-Sep	7.1	31-Oct	11.2	16-Dec	9.7
30-Jan	6.9	16-Mar	7.9	1-May	12.6	16-Jun	17.8	1-Aug	16.3	16-Sep	7.7	1-Nov	16.2	17-Dec	7.0
31-Jan	4.9	17-Mar	9.6	2-May	10.0	17-Jun	12.6	2-Aug	19.3	17-Sep	11.3	2-Nov	17.3	18-Dec	7.9
1-Feb	5.4	18-Mar	10.3	3-May	11.2	18-Jun	10.5	3-Aug	17.9	18-Sep	16.8	3-Nov	18.3	19-Dec	6.9
2-Feb	7.1	19-Mar	8.4	4-May	10.4	19-Jun	15.0	4-Aug	25.1	19-Sep	14.8	4-Nov	8.9	20-Dec	8.1
3-Feb	10.9	20-Mar	4.9	5-May	15.7	20-Jun	22.7	5-Aug	RC	20-Sep	8.0	5-Nov	5.8	21-Dec	4.9
4-Feb	12.1	21-Mar	8.7	6-May	16.1	21-Jun	18.7	6-Aug	19.1	21-Sep	10.8	6-Nov	8.6	22-Dec	7.7
5-Feb	17.1	22-Mar	13.3	7-May	16.8	22-Jun	15.2	7-Aug	14.0	22-Sep	14.5	7-Nov	15.0	23-Dec	7.7
6-Feb	10.3	23-Mar	12.2	8-May	14.5	23-Jun	16.8	8-Aug	10.8	23-Sep	21.2	8-Nov	8.3	24-Dec	10.5
7-Feb	4.0	24-Mar	10.3	9-May	11.7	24-Jun	15.1	9-Aug	15.0	24-Sep	8.6	9-Nov	10.0	25-Dec	6.5
8-Feb	9.7	25-Mar	11.9	10-May	9.0	25-Jun	20.7	10-Aug	21.7	25-Sep	1.2	10-Nov	12.8	26-Dec	7.6
9-Feb	11.5	26-Mar	20.1	11-May	6.7	26-Jun	23.0	11-Aug	14.3	26-Sep	16.0	11-Nov	11.8	27-Dec	13.3
10-Feb	3.0	27-Mar	22.5	12-May	7.9	27-Jun	17.8	12-Aug	14.7	27-Sep	12.1	12-Nov	14.8	28-Dec	6.4
11-Feb	5.5	28-Mar	18.2	13-May	8.3	28-Jun	12.4	13-Aug	13.0	28-Sep	18.0	13-Nov	14.5	29-Dec	3.7
12-Feb	18.9	29-Mar	10.8	14-May	12.2	29-Jun	12.7	14-Aug	13.5	29-Sep	17.8	14-Nov	7.7	30-Dec	4.7
13-Feb	17.6	30-Mar	6.4	15-May	13.1	30-Jun	8.9	15-Aug	17.5	30-Sep	16.4	15-Nov	3.6	31-Dec	4.4
14-Feb	11.2	31-Mar	3.3	16-May	8.8	1-Jul	7.1	16-Aug	23.9	1-Oct	12.3	16-Nov	4.6		
15-Feb	14.4	1-Apr	7.8	17-May	8.2	2-Jul	13.8	17-Aug	18.4	2-Oct	8.2	17-Nov	7.8		

Annual 98th Percentile Concentration = 21.5 $\mu g/m^3$

RC = Above 98th Percentile and Removed from Consideration

Table E-3. 2008 Daily $PM_{2.5}$ Concentrations Less Than or Equal to the 98th Percentile by Quarter

Season / Quarter 1				Season / Quarter 2				Season / Quarter 3				Season / Quarter 4			
Date	**Conc.**	**Date**	**Conc.**	**Date**	**Conc.**	**Date**	**Conc.**	**Date**	**Conc.**	**Date**	**Conc.**	**Date**	**Conc.**	**Date**	**Conc.**
1-Jan	10.4	16-Feb	15.1	1-Apr	7.8	17-May	8.2	1-Jul	7.1	16-Aug	23.9	1-Oct	12.3	16-Nov	4.6
2-Jan	5.4	17-Feb	11.8	2-Apr	10.5	18-May	11.1	2-Jul	13.8	17-Aug	18.4	2-Oct	8.2	17-Nov	7.8
3-Jan	10.0	18-Feb	3.4	3-Apr	8.2	19-May	7.7	3-Jul	17.1	18-Aug	18.7	3-Oct	12.3	18-Nov	4.4
4-Jan	16.4	19-Feb	4.5	4-Apr	9.7	20-May	13.6	4-Jul	19.8	19-Aug	21.5	4-Oct	19.5	19-Nov	8.2
5-Jan	11.2	20-Feb	4.8	5-Apr	6.9	21-May	12.1	5-Jul	14.3	20-Aug	20.1	5-Oct	23.7	20-Nov	11.1
6-Jan	11.1	21-Feb	11.9	6-Apr	6.3	22-May	10.0	6-Jul	11.5	21-Aug	18.4	6-Oct	19.8	21-Nov	5.3
7-Jan	10.2	22-Feb	20.1	7-Apr	7.9	23-May	13.3	7-Jul	14.3	22-Aug	16.7	7-Oct	21.7	22-Nov	8.9
8-Jan	11.4	23-Feb	11.4	8-Apr	9.8	24-May	11.2	8-Jul	12.2	23-Aug	13.8	8-Oct	12.2	23-Nov	14.0
9-Jan	8.1	24-Feb	19.3	9-Apr	16.5	25-May	17.7	9-Jul	11.1	24-Aug	19.0	9-Oct	5.1	24-Nov	12.7
10-Jan	9.4	25-Feb	18.2	10-Apr	13.3	26-May	14.2	10-Jul	9.7	25-Aug	17.6	10-Oct	10.2	25-Nov	9.7
11-Jan	5.7	26-Feb	12.8	11-Apr	11.0	27-May	15.4	11-Jul	16.4	26-Aug	15.4	11-Oct	10.7	26-Nov	12.8
12-Jan	8.9	27-Feb	5.5	12-Apr	8.8	28-May	13.9	12-Jul	21.5	27-Aug	12.6	12-Oct	5.6	27-Nov	16.6
13-Jan	18.1	28-Feb	9.7	13-Apr	6.3	29-May	9.3	13-Jul	RC	28-Aug	12.1	13-Oct	5.9	28-Nov	17.2
14-Jan	11.0	29-Feb	12.1	14-Apr	5.1	30-May	14.5	14-Jul	11.7	29-Aug	10.1	14-Oct	9.7	29-Nov	16.6
15-Jan	11.8	1-Mar	9.6	15-Apr	7.9	31-May	20.5	15-Jul	18.9	30-Aug	17.2	15-Oct	12.8	30-Nov	4.5
16-Jan	10.7	2-Mar	5.6	16-Apr	8.2	1-Jun	15.3	16-Jul	RC	31-Aug	19.9	16-Oct	16.4	1-Dec	7.5
17-Jan	10.0	3-Mar	12.5	17-Apr	14.7	2-Jun	11.5	17-Jul	RC	1-Sep	19.4	17-Oct	12.0	2-Dec	10.6
18-Jan	15.6	4-Mar	7.1	18-Apr	22.5	3-Jun	17.9	18-Jul	12.8	2-Sep	18.2	18-Oct	7.9	3-Dec	16.7
19-Jan	18.0	5-Mar	4.9	19-Apr	12.8	4-Jun	21.1	19-Jul	6.2	3-Sep	24.0	19-Oct	6.6	4-Dec	12.5
20-Jan	6.6	6-Mar	9.9	20-Apr	6.9	5-Jun	17.9	20-Jul	20.1	4-Sep	15.4	20-Oct	8.1	5-Dec	7.3
21-Jan	7.4	7-Mar	11.2	21-Apr	7.5	6-Jun	17.6	21-Jul	RC	5-Sep	12.4	21-Oct	12.2	6-Dec	10.4
22-Jan	13.5	8-Mar	5.5	22-Apr	6.0	7-Jun	15.0	22-Jul	16.9	6-Sep	12.5	22-Oct	4.6	7-Dec	13.4
23-Jan	16.0	9-Mar	8.8	23-Apr	9.1	8-Jun	22.3	23-Jul	12.8	7-Sep	15.8	23-Oct	6.1	8-Dec	10.5
24-Jan	9.4	10-Mar	11.0	24-Apr	10.3	9-Jun	RC	24-Jul	7.9	8-Sep	23.4	24-Oct	4.6	9-Dec	9.3
25-Jan	12.6	11-Mar	12.1	25-Apr	12.0	10-Jun	21.6	25-Jul	15.7	9-Sep	11.5	25-Oct	4.5	10-Dec	6.5
26-Jan	13.6	12-Mar	9.7	26-Apr	12.5	11-Jun	19.4	26-Jul	24.9	10-Sep	6.0	26-Oct	10.5	11-Dec	3.0
27-Jan	16.1	13-Mar	15.1	27-Apr	11.3	12-Jun	21.2	27-Jul	22.2	11-Sep	11.8	27-Oct	6.4	12-Dec	3.5
28-Jan	10.0	14-Mar	21.6	28-Apr	7.6	13-Jun	RC	28-Jul	17.5	12-Sep	10.7	28-Oct	4.6	13-Dec	10.2
29-Jan	10.4	15-Mar	16.6	29-Apr	7.4	14-Jun	15.6	29-Jul	19.1	13-Sep	7.6	29-Oct	5.6	14-Dec	17.6
30-Jan	6.9	16-Mar	7.9	30-Apr	11.4	15-Jun	14.8	30-Jul	21.1	14-Sep	7.5	30-Oct	7.6	15-Dec	12.4
31-Jan	4.9	17-Mar	9.6	1-May	12.6	16-Jun	17.8	31-Jul	18.0	15-Sep	7.1	31-Oct	11.2	16-Dec	9.7
1-Feb	5.4	18-Mar	10.3	2-May	10.0	17-Jun	12.6	1-Aug	16.3	16-Sep	7.7	1-Nov	16.2	17-Dec	7.0
2-Feb	7.1	19-Mar	8.4	3-May	11.2	18-Jun	10.5	2-Aug	19.3	17-Sep	11.3	2-Nov	17.3	18-Dec	7.9
3-Feb	10.9	20-Mar	4.9	4-May	10.4	19-Jun	15.0	3-Aug	17.9	18-Sep	16.8	3-Nov	18.3	19-Dec	6.9
4-Feb	12.1	21-Mar	8.7	5-May	15.7	20-Jun	22.7	4-Aug	25.1	19-Sep	14.8	4-Nov	8.9	20-Dec	8.1
5-Feb	17.1	22-Mar	13.3	6-May	16.1	21-Jun	18.7	5-Aug	RC	20-Sep	8.0	5-Nov	5.8	21-Dec	4.9
6-Feb	10.3	23-Mar	12.2	7-May	16.8	22-Jun	15.2	6-Aug	19.1	21-Sep	10.8	6-Nov	8.6	22-Dec	7.7
7-Feb	4.0	24-Mar	10.3	8-May	14.5	23-Jun	16.8	7-Aug	14.0	22-Sep	14.5	7-Nov	15.0	23-Dec	7.7
8-Feb	9.7	25-Mar	11.9	9-May	11.7	24-Jun	15.1	8-Aug	10.8	23-Sep	21.2	8-Nov	8.3	24-Dec	10.5
9-Feb	11.5	26-Mar	20.1	10-May	9.0	25-Jun	20.7	9-Aug	15.0	24-Sep	8.6	9-Nov	10.0	25-Dec	6.5
10-Feb	3.0	27-Mar	22.5	11-May	6.7	26-Jun	23.0	10-Aug	21.7	25-Sep	1.2	10-Nov	12.8	26-Dec	7.6
11-Feb	5.5	28-Mar	18.2	12-May	7.9	27-Jun	17.8	11-Aug	14.3	26-Sep	16.0	11-Nov	11.8	27-Dec	13.3
12-Feb	18.9	29-Mar	10.8	13-May	8.3	28-Jun	12.4	12-Aug	14.7	27-Sep	12.1	12-Nov	14.8	28-Dec	6.4
13-Feb	17.6	30-Mar	6.4	14-May	12.2	29-Jun	12.7	13-Aug	13.0	28-Sep	18.0	13-Nov	14.5	29-Dec	3.7
14-Feb	11.2	31-Mar	3.3	15-May	13.1	30-Jun	8.9	14-Aug	13.5	29-Sep	17.8	14-Nov	7.7	30-Dec	4.7
15-Feb	14.4			16-May	8.8			15-Aug	17.5	30-Sep	16.4	15-Nov	3.6	31-Dec	4.4
Seasonal / Quarterly Maximum			**22.5**	**Seasonal / Quarterly Maximum**			**23.0**	**Seasonal / Quarterly Maximum**			**25.1**	**Seasonal / Quarterly Maximum**			**23.7**

Seasonal / Quarterly Maximum Concentration

RC = Above 98th Percentile and Removed from Consideration

Table E-4. Resulting Average of Seasonal (or Quarterly) Maximums for Inclusion into AERMOD

Seasonal / Quarterly Average Highest Monitored Concentration

(From Annual Datasets Equal To and Less Than the 98th Percentile)

	Q1	**Q2**	**Q3**	**Q4**
2008	22.5	23.0	25.1	23.7
2009	21.1	20.7	21.2	19.8
2010	20.7	22.6	23.5	20.7
Average	**21.433**	**22.100**	**23.267**	**21.400**

(Note, the complete datasets for 2009 and 2010 are not shown in Appendix E but would follow the same steps as for 2008)

United States
Environmental Protection
Agency

Office of Air Quality Planning and Standards
Air Quality Assessment Division
Research Triangle Park, NC

Publication No. EPA-454/B-14-001
[May 2014]