Bridgers, George

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Sent: Monday, March 25, 2013 10:17 AM
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Subject: Comment Period Extension for the Draft Guidance for PM2.5 Permit Modeling

Regional Office and Federal Partner Agency Permit Modeling Contacts,

Based on numerous requests to extend the comment period for the Draft Guidance for PM2.5 Permit Modeling from throughout the permit modeling community, we are announcing a 45 day extension to the original 45 day comment period for the Draft Guidance for PM2.5 Permit Modeling. This extends the comment period for the draft guidance document to Friday, May 31, 2013. A notice to this effect has been posted to the EPA's SCRAM website and included in the draft guidance document download package, http://www.epa.gov/ttn/scram/guidance/guide/Draft_Guidance_for_PM25_Permit_Modeling.pdf.

The original intent of the April 17, 2013 comment deadline was to allow for a conversation of all of the comments received during the 2013 Regional, State, and Local Modelers' Workshop scheduled for the week of April 22nd in Dallas, TX. Given the importance of your thorough review of the draft guidance document and subsequent informed comments, we have decided to extend the comment deadline to May 31, 2013. We will still have several open forum discussions of the draft guidance document at the Regional, State, and Local Modelers' Workshop that should further assist in the formulation of comments.

Please note that the extension of the comment period may delay the revision of the draft guidance document to late summer or early fall depending on the level of comments received and any additional rule making that may occur in the interim. We will make every effort to keep the permit modeling community aware of the timing for the release of the Guidance for PM2.5 Permit Modeling after the comment period has closed.

Feel free to share this information with your respective state, local, and/or tribal permit modeling agencies. Do not hesitate to send me an email or call if you have additional questions or need anything clarified further.

Regards,
George

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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MAR 0 4 2013

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

MEMORANDUM

SUBJECT: Draft Guidance for $PM_{2.5}$ Permit Modeling

FROM: Stephen D. Page, Director
Office of Air Quality Planning and Standards

TO: See Addressees

INTRODUCTION

The Environmental Protection Agency (EPA) is providing the attached *Draft Guidance for $PM_{2.5}$ Permit Modeling* to the public for consideration, review, and comment. This document reflects the EPA's preliminary recommendations for how a stationary source seeking a Prevention of Significant Deterioration (PSD) permit may demonstrate that it will not cause or contribute to a violation of the National Ambient Air Quality Standards (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). The *Draft Guidance for $PM_{2.5}$ Permit Modeling* incorporates the modeling procedures and recommendations from the 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 fine particulate matter ($PM_{2.5}$) in a NAAQS compliance demonstration under the PSD program. The release of the final *Guidance for $PM_{2.5}$ Permit Modeling* at the conclusion of this review process will fulfill a need for additional guidance on demonstrating compliance with the $PM_{2.5}$ NAAQS, especially with regard to considerations of the secondarily formed component of $PM_{2.5}$.

BACKGROUND

The aforementioned March 23, 2010, guidance memorandum was developed in the context of several regulatory actions and proposals (described in Section I of the *Draft Guidance for $PM_{2.5}$ Permit Modeling*) that increased the likelihood that applicants for permits under the new source review (NSR) and PSD programs would be required to demonstrate compliance with the $PM_{2.5}$

NAAQS, rather than relying upon the PM_{10} Surrogate Policy[1]. However, the March 23, 2010, guidance memorandum did not fully address situations where a facility potentially could emit significant quantities of the $PM_{2.5}$ precursors, sulfur dioxide (SO_2) and oxides of nitrogen (NO_x), and possibly cause or contribute to a violation of the NAAQS, based on a combination of the facility's primary $PM_{2.5}$ emissions and the secondary formation of $PM_{2.5}$ from the facility's precursor emissions.

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 29, 2010. The Sierra Club petition requested that the EPA initiate rulemaking to designate 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 51 and, as appropriate, incorporate new analytical techniques or models for ozone and secondary $PM_{2.5}$.

As a part of this commitment, and in compliance with CAA Section 320, the EPA conducted the 10th Conference on Air Quality Modeling (10th Modeling Conference) in March 2012. At the 10th Modeling Conference, there were invited presentations of ongoing research on single source plume chemistry and photochemical modeling techniques, an overview presentation on the development of the *Draft Guidance for $PM_{2.5}$ Permit Modeling*, and several public forums and comments given pertaining to $PM_{2.5}$ NAAQS modeling. The open discussion during, and public comments received following, the 10th Modeling Conference were considered in preparation of this release of the *Draft Guidance for $PM_{2.5}$ Permit Modeling*. The release of this draft guidance document, the subsequent comment period, and the finalization of the *Guidance for $PM_{2.5}$ Permit Modeling* in 2013 is consistent with the EPA's commitments in the January 4, 2012, administrative grant of the Sierra Club petition.

The *Draft Guidance for $PM_{2.5}$ Permit Modeling* is intended as a statement of the EPA's preliminary recommendations with respect to conducting $PM_{2.5}$ PSD compliance demonstrations that account for contributions from secondary PM2.5. It is draft guidance for public review and comment and is not yet considered final EPA guidance. Since each permitting action will be considered on a case-by-case basis, this document does not limit or restrict any particular approach that applicants and permitting authorities may take to conduct the required compliance demonstrations. The draft guidance does not impose binding, enforceable requirements. This document does not substitute for statutory provisions or regulations, nor is it a regulation itself. Thus, this draft guidance document does not represent final agency action and cannot be relied upon to create any rights or obligations enforceable by any party.

[1] "Interim Implementation of New Source Review Requirements for PM2.5." John S. Seitz, EPA, October 23, 1997.

At the same time as the release of the *Draft Guidance for $PM_{2.5}$ Permit Modeling*, the EPA is also releasing a Question & Answer document that is intended to provide preliminary EPA answers to many of the questions that the EPA has received regarding the implications of a January 22, 2013, decision by the United States Court of Appeals for the District of Columbia Circuit. In this decision, the Court granted the EPA's request to vacate and remand to the EPA portions of two PSD $PM_{2.5}$ rules (40 CFR 51.166 and 40 CFR 52.21) addressing the Significant Impact Levels (SILs) for PM2.5 so that the EPA could voluntarily correct an error in these provisions. The Court also vacated the parts of these two PSD rules establishing a $PM_{2.5}$ Significant Monitoring Concentration (SMC), finding that the EPA was precluded from using the $PM_{2.5}$ SMCs to exempt permit applicants from the statutory requirement to compile preconstruction monitoring data. Portions of the *Draft Guidance for $PM_{2.5}$ Permit Modeling* reflect preliminary EPA views that are presented in the Question & Answer document on how to complete a $PM_{2.5}$ air quality impacts analysis in a manner that is consistent with the January 22, 2013, court decision and prior EPA statements. The EPA's views on this topic may be refined subsequently based on public comments that are submitted on this draft guidance document. The EPA also intends to develop a proposed rule to address the Court's decision.

ACKNOWLEDGEMENT

The EPA would like to recognize and thank members of the National Association of Clean Air Agencies (NACAA) for the recommendations in the January 7, 2011, final report from its $PM_{2.5}$ Modeling Implementation Workgroup (NACAA Workgroup). This NACAA Workgroup was formed with the objective of providing technical examples and recommendations that could aid in the agency's further development of $PM_{2.5}$ permit modeling guidance. The NACAA Workgroup was comprised of air dispersion modelers, permit engineers, and technical staff from state and local agencies throughout the country. The NACAA Workgroup's final report addressed three specific issues regarding $PM_{2.5}$ modeling implementation: 1) Emissions Inventories; 2) Secondary Formation; and 3) Representative Background Concentrations. The final report and recommendations were carefully reviewed and incorporated, where appropriate, in the *Draft Guidance for $PM_{2.5}$ Permit Modeling*.

REVIEW AND COMMENT

The EPA will accept comments on the attached *Draft Guidance for $PM_{2.5}$ Permit Modeling* through the close of business on April 17, 2013. This allows at least 45 days for consideration, review, and comment on the material presented in the draft guidance. For convenience, the draft guidance document is also available electronically on the EPA's SCRAM website, *http://www.epa.gov/ttn/scram/guidance_permit.htm*. Comments should be electronically submitted to Mr. George Bridgers of EPA's Air Quality Modeling Group at *bridgers.george@epa.gov*. Please contact Mr. Bridgers at (919) 541-5563 to make alternative arrangements if there are any issues with making an electronic submission.

The EPA intends to conduct a series of webinars providing an overview of the *Draft Guidance for $PM_{2.5}$ Permit Modeling* and allowing for an open exchange on the guidance documentation in advance of the close of the comment period. When scheduled, information on the webinars will be posted to the EPA's SCRAM website, *http://www.epa.gov/ttn/scram/*, under the Recent Additions section and shared with the dispersion modeling community through numerous email distributions.

Following the close of the comment period, the EPA will take into consideration all of the comments submitted and further engage with the dispersion modeling community on these comments at the 2013 Regional, State, and Local Modelers' Workshop currently scheduled for April 22-25, 2013, at the EPA Region 6 Offices in Dallas, Texas. The Regional, State, and Local Modelers' Workshop will allow for an open dialogue on further clarifications, potential amendments, and considerations for additions to the final guidance documentation. Following the interactions at this Workshop and any other engagements with the dispersion modeling community through spring 2013, the EPA intends to revise the *Draft Guidance for $PM_{2.5}$ Permit Modeling* as appropriate and provide a final version of the document by July 31, 2013.

SUMMARY

In summary, the EPA is releasing the *Draft Guidance for $PM_{2.5}$ Permit Modeling* to the public for consideration, review, and comment. The *Draft Guidance for $PM_{2.5}$ Permit Modeling* incorporates the modeling procedures and recommendations from the 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 compliance demonstration under PSD. The EPA will accept comment through April 17, 2013, and will subsequently engage with the stakeholders on the comments submitted at the 2013 Regional, State, and Local Modelers' Workshop. Soon thereafter, the EPA intends to revise the *Draft Guidance for $PM_{2.5}$ Permit Modeling* as appropriate and provide a final version of the document.

If there are any questions regarding the Draft $PM_{2.5}$ Permit Modeling Guidance, please contact Mr. George Bridgers of EPA's Air Quality Modeling Group at (919) 541-5563 or *bridgers.george@epa.gov*.

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Draft Guidance for $PM_{2.5}$ Permit Modeling

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EPA 454/D-13-001
March 2013

Draft 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

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Executive Summary to the Draft Guidance

The U.S. Environmental Protection Agency (EPA) is providing the Draft Guidance for $PM_{2.5}$ Permit Modeling to the public for consideration, review, and comment. The Draft Guidance for $PM_{2.5}$ Permit Modeling incorporates the modeling procedures and recommendations from the Stephen Page, 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 fine particulate matter ($PM_{2.5}$) in a National Ambient Air Quality Standard (NAAQS) and increment compliance demonstration under Prevention of Significant Deterioration (PSD). This draft guidance document is also consistent with the EPA's *Guideline on Air Quality Models*, also published as Appendix W of 40 CFR Part 51. The release of the Guidance for $PM_{2.5}$ Permit Modeling at the conclusion of this review process will fulfill a need for additional guidance on demonstrating compliance with the $PM_{2.5}$ NAAQS, especially with regard to considerations of the secondarily formed component of $PM_{2.5}$, as noted in the March 23, 2010, Stephen Page guidance memorandum, and is consistent with the EPA's commitments in the Gina McCarthy, January 4, 2012, administrative grant of the July 28, 2012, Sierra Club petition.

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 permit reviewing 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 permit reviewing authority with both focus and flexibility. As experience is gained with these NAAQS compliance demonstrations, 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.

The Draft Guidance for $PM_{2.5}$ Permit Modeling is broken down into five primary sections:

- I. Background – A historical narrative of the relevant regulatory actions to this draft guidance document starting with the promulgation of the initial $PM_{2.5}$ NAAQSs in 1997; chronicling the period of time that the PM_{10} Surrogate Policy was relied upon for demonstrating compliance with the $PM_{2.5}$ NAAQS; and arriving at the present with the 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 increment.
- II. Guidance Overview – A general overview of the steps that an applicant would routinely take under the PSD program for demonstrating compliance with the $PM_{2.5}$ NAAQS and increment. The concepts of significant emissions rates (SER) and significant impact levels (SIL) are introduced and then presented in the context of a

significant impact analysis and a cumulative impact analysis. The ramification 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 significant impact analysis or otherwise is 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 significant impact analysis or the cumulative impact analysis.

- III. Significant Impact Analysis – A detailed discussion of the assessment of primary and secondary $PM_{2.5}$ impacts, with respect to the applicable SIL, from a new or modifying source. 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: Following the discussion and concepts presented in Section III, a detailed discussion of the assessment of primary and secondary $PM_{2.5}$ impacts, with respect to the NAAQS, 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. $PM_{2.5}$ Increment Analysis: A detailed discussion of the assessment of primary and secondary $PM_{2.5}$ impacts of a new or modifying source with respect to the increment.

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, the Draft Guidance for $PM_{2.5}$ Permit Modeling recommends appropriate technical approaches for conducting a $PM_{2.5}$ NAAQS compliance demonstration that includes more adequate accounting for contributions from secondarily formed $PM_{2.5}$ concentrations resulting from a proposed new or modifying source's precursor emissions. The EPA is providing the Draft Guidance for $PM_{2.5}$ Permit Modeling for public review and comment through

April 17, 2013, with the intent of issuing final guidance by July 31, 2013.

The Draft Guidance for $PM_{2.5}$ Permit Modeling is intended as a statement of the EPA's preliminary recommendations with respect to conducting $PM_{2.5}$ PSD compliance demonstrations that account for contributions from secondary $PM_{2.5}$. It is draft guidance for public review and comment and is not yet considered final EPA guidance. Since each permitting action will be considered on a case-by-case basis, this document does not limit or restrict any particular approach applicants and permitting authorities may take to conduct the required compliance demonstrations. The draft guidance does not impose binding, enforceable requirements. This document does not substitute for statutory provisions or regulations, nor is it a regulation itself. Thus, this draft guidance document does not represent final agency action and cannot be relied upon to create any rights or obligations enforceable by any party.

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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 exemplary roles as Chairpersons for the Emissions Inventories, Secondary Formation from Project Source, and Representative Background Concentrations Sub-workgroups, respectively.

There were numerous comments received with respect to issues and concerns of demonstrating compliance with the NAAQS for $PM_{2.5}$ during the formal public comment period for the 10^{th} Conference on Air Quality Modeling. Several of these commenters and other communications from various stakeholders have provided the EPA with additional information and recommendations that have been particularly useful in the consideration of a range of acceptable options for $PM_{2.5}$ NAAQS compliance demonstrations.

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 the Draft Guidance for $PM_{2.5}$ Permit Modeling. The OTAQ's "Transportation Conformity Guidance for Quantitative Hot-spot Analyses in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas" (U.S.EPA, 2010a) guidance document served as a foundation for many aspects of the modeling guidance contained within this document.

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I. Background

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 ($PM_{2.5}$) as the indicator. (62 FR 58652). 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 $\mu g/m^3$. (71 FR 61144). 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 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}. (78 FR 3086). 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 98^{th} percentile 24-hour concentrations is less than or equal to 35 $\mu g/m^3$.

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 the 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 included several changes to the way in which the PM_{10} Surrogate Policy would be applied to the permitting process for permits involving $PM_{2.5.}$ (73 FR 28321). With regard to nonattainment NSR permits, the rule provided that as of July 15, 2008 (the rule's effective date), states would no longer be able to use the PM_{10} Surrogate Policy to satisfy the 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 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 State Implementation Plan (SIP) revisions containing 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. (74 FR 26098). On September 16, 2009, the original 3-month stay was extended to June 22, 2010, to allow additional time for the EPA to formally propose repeal of the grandfathering provision from the $PM_{2.5}$ NSR implementation rule for federal PSD permits issued under 40 CFR 52.21. (74 FR 48153). On February 11, 2010, the EPA published its proposal to repeal the grandfathering provision. (75 FR 6827). 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 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 the Implementation of the New Source Review (NSR) Program for Particulate Matter Less Than 2.5 Micrometers ($PM_{2.5}$) (76 FR 28646) final rule that repealed the grandfathering provision.[1] 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.[2] After the final rule became effective, in order for those permits to be issued, such applications will have to be reviewed directly against the $PM_{2.5}$ requirements or, alternatively, use a surrogate approach for $PM_{2.5}$ (other than the PM_{10} Surrogate Policy) that is consistent with the applicable case law. 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 will not cause or contribute to a violation of any NAAQS for $PM_{2.5}$.

On March 23, 2010, to assist sources and permitting authorities in carrying out the required air quality analysis, the EPA issued, a guidance memorandum entitled "Model Procedures for Demonstrating Compliance with $PM_{2.5}$ NAAQS" (U.S. EPA, 2010b). 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 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

[1] No action was taken with regard to the proposed early ending of the PM_{10} Surrogate Policy in SIP-approved states because the original date for terminating the policy's use had already ended.

[2] 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. (73 FR 28321).

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 $PM_{2.5}$ Modeling Implementation Workgroup (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 29, 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 51 and, as appropriate, incorporate new analytical techniques or models for ozone and secondary $PM_{2.5}$. As a part of this commitment with the Sierra Club and in compliance with Section 320 of the CAA, the EPA conducted the 10^{th} Conference on Air Quality

Modeling (10th Modeling Conference) in March 2012. [3] 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 written comments given pertaining to $PM_{2.5}$ NAAQS modeling.

Based on the previous March 23, 2010, guidance memorandum, the NACAA Workgroup final report recommendations, input from a mixture of stakeholders through numerous forums, and recent applicant-submitted $PM_{2.5}$ compliance demonstrations, the EPA prepared this Draft Guidance on $PM_{2.5}$ Permit Modeling. This draft guidance document recommends appropriate technical approaches for conducting a $PM_{2.5}$ NAAQS and increment compliance demonstration which includes more adequate accounting for contributions from secondarily formed $PM_{2.5}$ concentrations resulting from a proposed new or modifying source's precursor emissions. In keeping with the EPA's commitments with the Sierra Club petition grant, the EPA is providing the Draft Guidance for $PM_{2.5}$ Permit Modeling for public review and comment through April 17, 2013, with the intent of issuing final guidance by July 31, 2013.

Prospective permit applicants should recognize the importance of the consultation process with the appropriate permit reviewing authority. This process will help identify the most appropriate analytical techniques to be used for conducting a $PM_{2.5}$ NAAQS and increment 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:

[3] 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.

- "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" December 2010 (U.S.EPA, 2010c).

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/.

II. Guidance Overview

This modeling guidance provides recommendations on how best to conduct a $PM_{2.5}$ NAAQS and increment 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 complex chemistry of secondary formation of $PM_{2.5}$ is well documented and has historically presented significant challenges with the identification and establishment of particular models for assessing the impacts of individual stationary sources on the formation of this air pollutant (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. Instead, the EPA has chosen to satisfy the requirements of the CAA, Section 165(e)(3)(D) by recommending that the "[c]hoice of methods used to assess the [PM2.5] 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.[4] As such, the appropriate methods for assessing $PM_{2.5}$ impacts are determined as part of the normal consultation process with the appropriate permit reviewing 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.

[4] 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. 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 monitored background concentrations of $PM_{2.5}$ to account for background levels of $PM_{2.5}$ in the cumulative analysis, certain aspects of standard modeling practices used for PM_{10} and other criteria pollutants may not be appropriate for $PM_{2.5}$. Given these issues, and especially the important contribution from secondary formation of $PM_{2.5}$, which is not explicitly accounted for by the current preferred dispersion model (i.e., AERMOD) used to simulate dispersion of direct $PM_{2.5}$ emissions, PSD modeling of secondarily formed $PM_{2.5}$ should currently be viewed as screening-level analyses under Appendix W, analogous to the screening nature of the guidance in Section 5.2.4 of Appendix W regarding dispersion modeling for nitrogen dioxide (NO_2) impacts given the importance of chemistry in the conversion of nitric oxide (NO) emissions to ambient NO_2 and lack of a specified "refined" model.[5] 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 under 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 recognize that there are circumstances where there is no applicable model for a particular compliance demonstration and that data from an array of ambient monitors surrounding the permitted facility could be used in lieu of modeling if appropriately justified.

[5] Section 5.2.4 of Appendix W puts forth a 3-tiered screening approach for NO_2 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.

Given the complexity of the technical issues that arise in the context of demonstrating compliance with the $PM_{2.5}$ NAAQS, we strongly encourage adherence to 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 compliance demonstration. Through these interactions and subsequent resolutions of the specific issues, clarifications and interpretations of modeling procedures can ultimately become official EPA guidance. This can happen in several ways: 1) the procedures are published as regulations or guidelines; 2) the procedures are formally transmitted as guidance to the Air Directors in the EPA Regional Offices; 3) the procedures are formally transmitted as guidance to Regional Office Modeling Contacts as a result of a regional consensus on technical issues; or 4) the procedures are relied upon in decisions by the EPA's Model Clearinghouse that effectively establish national precedent. The Model Clearinghouse is the EPA focal point for the review of regulatory criteria pollutant modeling and other NAAQS compliance demonstration techniques. Model Clearinghouse memoranda involving decisions with respect to 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 presented in this document is intended to provide recommendations on how best to conduct a $PM_{2.5}$ NAAQS and increment compliance demonstration under the PSD program following the steps shown in Figure II-1. The guidance is applicable to those new or modifying sources locating or located in an area classified as attainment or unclassifiable for $PM_{2.5}$. The aspects of each progressive step or block within the Attainment or Unclassified Area portion of Figure II-1 are described in more detail in Sections II.1, II.2, and II.3.

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 EPA established a SER for $PM_{2.5}$ in a 2008 rule and promulgated SILs and an SMC for $PM_{2.5}$ in 2010. (73 FR 28321 and 75 FR 64864).

However, on January 22, 2013, the U.S. Court of Appeals for the District of Columbia Circuit vacated the SMC for $PM_{2.5}$ and two provisions in EPA's PSD regulations containing SILs for $PM_{2.5}$. (*Sierra Club v. EPA*, No. 10-1413 (D.C. Circuit), 2013 WL 216018). The Court concluded that the $PM_{2.5}$ SMC provisions (51.166(i)(5)(c) and 52.21(i)(5)(i)(c)) were inconsistent with the requirements of Section 165(e)(2) of the CAA. The Court granted the EPA's request to remand and vacate the SIL provisions in Sections 51.166(k)(2) and 52.21(k)(2) of the regulations so that the EPA could correct an error in these provisions that came to the EPA's attention after the court challenge was filed. The vacated provisions of the regulations inadvertently restricted the discretion of permitting authorities to conduct or require more than a

screening analysis in some circumstances where the EPA had called for permitting authorities to consider whether additional analysis was needed to make the demonstration required by Section 165(a)(3) of the CAA.

Due to the court decision, the EPA will not rely, and advises permitting authorities with SIP-approved PSD programs not to rely, on the SMCs for $PM_{2.5}$ to exempt permit applicants from compiling preconstruction monitoring data for $PM_{2.5}$ in accordance with Sections 51.166(m) and 52.21(m) of the EPA's regulation. [6] However, the EPA believes PSD permit applicants may continue to meet the preconstruction monitoring requirements in these regulations by using data from existing monitors that are determined by the applicable permitting authority to be representative of background conditions in the affected area.[7] The court decision does not preclude the use of SILs for $PM_{2.5}$, but requires that EPA correct the error in the SIL regulations for $PM_{2.5}$ at 51.166(k)(2) and 52.21(k)(2). In the interim, 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. This document provides some preliminary guidance on how to use SILs for $PM_{2.5}$ in a manner consistent with the CAA.

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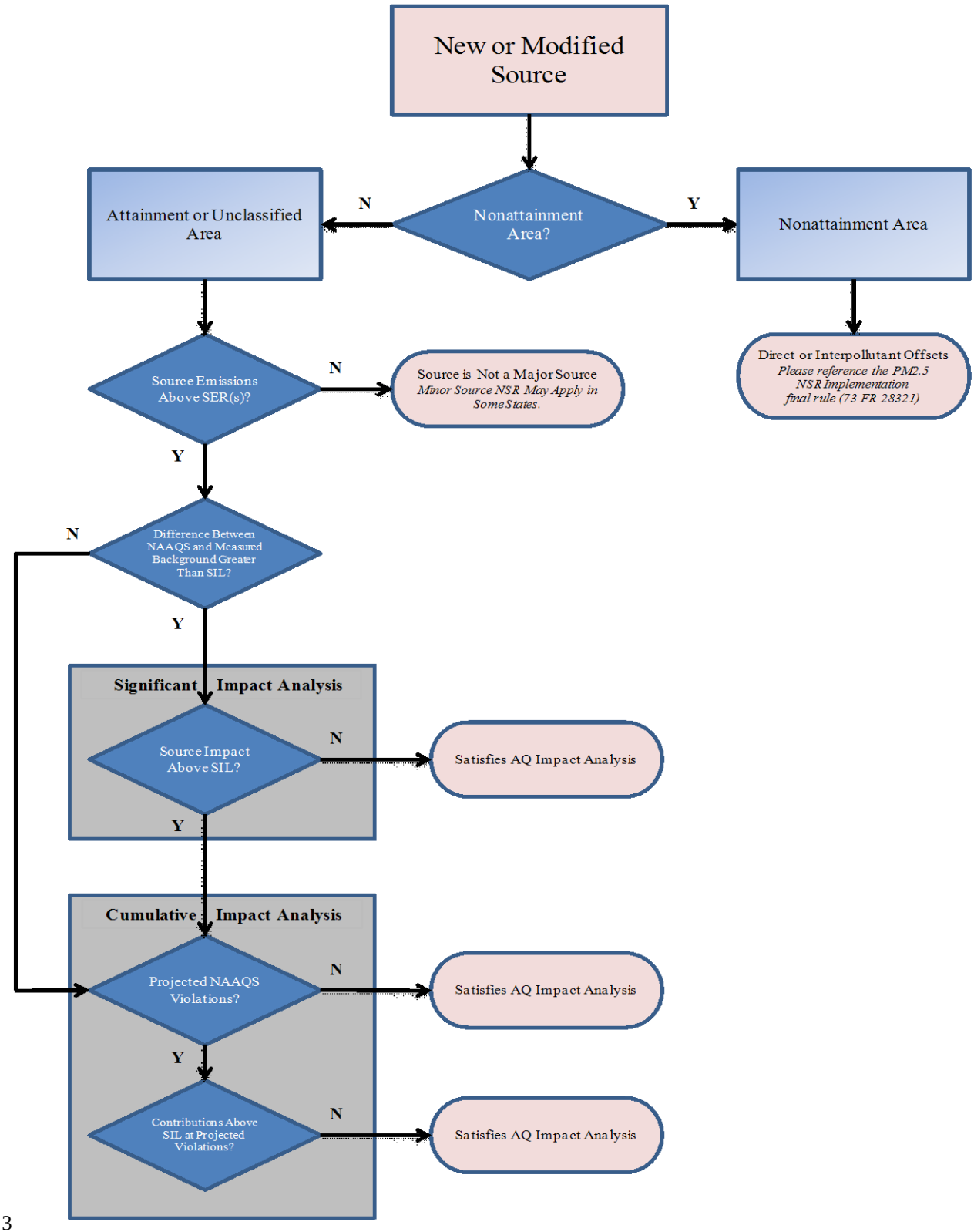
[6] This includes both the SMCs in the EPA's regulations and any SIP-approved state regulation. The EPA will provide guidance on the topic of existing SIP-approved regulations at a later date.

[7] "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 FR 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).

Figure II-1. Overview of NAAQS Compliance Demonstration for New or Modifying Sources Under NSR/PSD Programs



II.1 Significant Emissions Rate

The EPA promulgated SERs for $PM_{2.5}$ and for the $PM_{2.5}$ precursors, nitrogen oxide (NO_x) and sulfur dioxide (SO_2), in 2008 as part of the first phase of PSD amendments to address $PM_{2.5}$.[8] (74 FR 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 40 tpy of NO_x and/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 SER, to require review under the PSD program.

II.2 Significant Impact Analysis

Section 165(a)(3) of the CAA requires that proposed new and modified major stationary sources seeking a permit must demonstrate that their additional pollutant emissions will not cause or contribute to a violation of any NAAQS or increment. This requirement is implemented in 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.

The EPA has historically supported the use of SILs to help determine the scope of the required air quality analysis that must be carried out to demonstrate that the source's emissions

[8] 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 these emissions in a specific area are a significant contributor to that area's ambient $PM_{2.5}$ concentrations. (74 FR 28321).

will not cause or contribute to a violation of any NAAQS or increment. When a proposed source's modeled impacts are found to be greater than the level of the applicable SIL, 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. The EPA has observed that if the source's modeled impacts are found to be below the level of the SIL 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. (72 FR 54112 at 54139 and 75 FR 64864 at 64890). However, the EPA has also recognized that there can be circumstances where a showing that the air quality impact of a proposed source is less than the SIL is not sufficient by itself to demonstrate that a source will not cause or contribute to a violation of the NAAQS or increment.

When the EPA promulgated SILs for $PM_{2.5}$ in 2010, 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 FR 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 FR 64892).

In the course of litigation challenging the SILs for $PM_{2.5}$, the EPA recognized 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 Court remand and vacate these provisions so the EPA could take corrective action. 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 increment, 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. (Op. at 10, 2013 WL 216018, *4). 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. (Op. at 11, 2013 WL 216018, *5).

The Court's decision does not 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 $PM_{2.5}$. 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 continuing to evaluate the January 22, 2013, decision from the D.C. Circuit Court of Appeals and will develop a proposed rule to address the issues identified by the EPA and the Court's decision. In the interim, the EPA advises against continuing to apply the SIL provisions in the vacated Sections 51.166(k)(2) and 52.21(k)(2) (or in state regulations that 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 $PM_{2.5}$ SILs rules. 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. These safeguards involve two related considerations – the particular values of the SILs to be used and how those values are used.

Permitting authorities have the discretion to select the particular $PM_{2.5}$ SIL values that are 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.[9] The EPA advises against relying 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 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, the permitting authority must first examine background air quality concentrations to determine whether a substantial portion of the NAAQS has been consumed.[10] 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.

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[9] 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).

[10] 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. This data need not be collected by the PSD applicant if existing data is 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.

If the preconstruction monitoring data shows that the difference between the $PM_{2.5}$ NAAQS and the measured $PM_{2.5}$ background concentrations in the area is greater than the applicable SIL value 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 below that SIL value will not cause or contribute to a violation of the NAAQS and to forego a cumulative modeling analysis for $PM_{2.5}$.

II.3 Cumulative Impact Analysis

A cumulative impact analysis accounts for the combined impacts of direct and precursors emissions from the new or modifying source, direct 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 source will cause or contribute to a violation of the NAAQS. Several aspects of the cumulative impact assessment for $PM_{2.5}$ will be comparable to assessments conducted for other criteria pollutants, while other aspects will differ due to the issues identified earlier.

II.4 Assessment Cases

To support the process shown in Figure II-1, the EPA is proposing four different "assessment" cases shown in Table II-1 that define what air quality analyses, *if any*, an applicant would conduct to demonstrate compliance with the $PM_{2.5}$ NAAQS (annual and 24-hour).

Table II-1. EPA Suggested Assessment Cases that Define Needed Air Quality Analyses

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 SER of 40 tpy, then no compliance demonstration is required.
- For "Case 2—Primary Air Quality Impacts Only," if the direct $PM_{2.5}$ emissions are greater than the SER of 10 tpy and both NO_x and SO_2 emissions are individually less than the SER of 40 tpy, then a $PM_{2.5}$ compliance demonstration is required for only the direct $PM_{2.5}$ emissions based on dispersion modeling and no 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 the SER of 10 tpy and either NO_x or SO_2 precursor emissions are greater than their respective SERs of 40 tpy, then a $PM_{2.5}$ compliance demonstration is required for the direct $PM_{2.5}$ emissions based on dispersion modeling and the applicant must 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 completely qualitative in nature, may be based on a hybrid of qualitative and quantitative assessments utilizing existing technical work, or may be 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 either the NO_x or SO_2 precursor emissions are greater than their respective SERs of 40 tpy, then a $PM_{2.5}$ compliance demonstration for the direct $PM_{2.5}$ emissions is not required, but the applicant must 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 completely qualitative in nature, may be based on a hybrid of qualitative and quantitative assessments utilizing existing technical work, or may be a full quantitative photochemical grid modeling exercise. Again, the EPA anticipates only a few situations would require explicit photochemical grid modeling.

Details regarding the significant impact analysis and cumulative impact analysis associated with Cases 2, 3, and 4, where project emissions exceed the respective SER for direct $PM_{2.5}$ emissions only (Case 2), both direct $PM_{2.5}$ and precursor emissions of NO_x and/or SO_2 (Case 3), or precursor emissions of NO_x and/or SO_2 only (Case 4), are provided in Sections III and IV.

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III. Significant Impact Analysis

This section provides details regarding recommended approaches for conducting the significant impact analysis associated with each of the assessment cases shown in Table III-1 so long as the applicable SIL has been appropriately justified for use in each compliance demonstration as described in Section II.2. A modeled compliance demonstration is not required for Case 1 since neither the direct $PM_{2.5}$ emissions nor the NO_x or SO_2 precursor emissions exceed the respective SERs. However, each of the remaining three cases would include a significant impact analysis, with the simplest being Case 2 where only direct $PM_{2.5}$ emissions are greater than the SER. In this case, the applicant would only need to demonstrate that ambient $PM_{2.5}$ levels associated with the increase in direct $PM_{2.5}$ emissions are below the applicable 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.

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**

Since both direct $PM_{2.5}$ emissions and precursor emissions (NO_x and/or SO_2) exceed the respective SERs for Case 3, this will likely be the most challenging of the four 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 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. The EPA anticipates only a few situations would require explicit photochemical grid modeling.

Since direct $PM_{2.5}$ emissions are below the applicable SER for Case 4, the significant 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 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 models are used in assessing PM impacts from a particular project and are employed in a consistent fashion.[11] 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.[12] 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.

As noted in the March 23, 2010 $PM_{2.5}$ guidance memo, 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 $PM_{2.5}$.

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[11] 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* (EPA-454/R-92-025) 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."

[12] 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

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, 2012b);
- 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, 2012c).

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 emission on secondary $PM_{2.5}$ formation for Cases 3 and 4 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 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 background air pollution concentrations (see Appendix A for examples of relevant data) 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.[13] With appropriate submittal, consultation, and subsequent approval of the modeling protocol by the appropriate permit reviewing 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 $PM_{2.5}$ 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 carbons) that dominate the makeup of high, low, and average $PM_{2.5}$ concentrations will help guide the degree of analysis and ultimately 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

[13] 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, PM2.5, and Regional Haze." U.S. Environmental Protection Agency, Research Triangle Park, North Carolina (U.S. EPA, 2007a)

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 reductions or increases of that precursor pollutant have been demonstrated through photochemical grid modeling exercises to 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 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.

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 for comparison of the proposed new or modifying source's total ambient impact (i.e., primary and secondary impacts) to the applicable SIL. As described above, there may be situations where the proposed new or modifying source's ambient impact is

less than the applicable 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 or increment. 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 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, would 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 ($PM_{2.5}$) (73 FR 28321) final rule concerning the development and adoption of interpollutant trading (offset) provisions for $PM_{2.5}$ under state nonattainment area NSR programs for $PM_{2.5}$.[14] The EPA's July 23, 2007, technical analysis entitled "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 expect that the specific results from the EPA's 2007 technical assessment could be used generally 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 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 July 21, 2011, Gina McCarthy 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, 2011f).

[14] In the preamble to the 2008 final rule (73 FR 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.

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 data bases 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

v. 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* (EPA-454/R-92-025). The determination of acceptability of a particular model and approach for such an alternative model application is an EPA Regional Office responsibility (Section 3.2.2(a)) 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.

III.2.3.1 Use of Photochemical Grid Models for Secondary $PM_{2.5}$ Impacts

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:

- "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
    - Direct decoupled method (DDM) 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.
- Sub-grid plume treatment where plume sampling within a given grid cell provides higher resolution results that can be tracked with source apportionment tools or used in the "brute force zero-out" approach to estimate new or modifying source impacts.

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 EPA's commitments with the Sierra Club petition grant.[15]

III.2.3.2 Source Apportionment and Source Sensitivity in Photochemical Grid Models

Some photochemical grid models have been instrumented with source apportionment techniques, which 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 direct decoupled method (DDM), 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

[15] Several photochemical grid modeling approaches that allow for estimation of the secondary PM2.5 impacts from a proposed new or modifying source were presented during the Emerging Models / Techniques Session of the 10th 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.

change?"

III.2.3.3 Sub-grid Plume Treatment in Photochemical Grid Models

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 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 also appropriately characterize 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. In addition to tracking puffs at sub-grid scale, the photochemical grid modeling systems must be able to track and output surface layer sub-grid puff concentrations, i.e., "sub-grid plume sampling," to best represent receptor concentrations that are in close proximity to the source. Another inherent issue related to sub-grid plume sampling that must be considered is that some of the source's impacts on air quality are resolved in puffs at the sub-grid scale and some impacts are only resolved in the 3-dimensional grid space. Extracting just the sub-grid plume information or just

the 3-dimensional gridded model output would miss some of the source's contribution to air quality. In practice, it is likely that some type of source apportionment would be necessary to track the grid-resolved source contribution in addition to sub-grid plume treatment in order to fully capture source contribution.

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 permit reviewing 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 permit reviewing 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 the proposed source's ambient $PM_{2.5}$ impacts are to be compared to an applicable SIL as part of 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 exceed the respective SER) is applicable.

For Case 2, where only direct $PM_{2.5}$ emissions exceed the applicable (10 tpy) SER, the comparison to the applicable SIL is based on 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 significant 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 the applicable 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 exceed their respective SERs, the applicable SIL comparison would have 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 applicable 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 the applicable SIL represents a specific insignificant (or *de minimis*) ambient concentration of $PM_{2.5}$ that may be used to exempt the applicant from conducting a cumulative impact assessment, basing the initial significant 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 in most cases. This is because there would be no specific quantitative estimate of total $PM_{2.5}$ impacts for comparison to the applicable 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 SER 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 the applicable 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 the applicable 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 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 the applicable 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 exceed the respective SER but direct $PM_{2.5}$ emissions do 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 the applicable SIL represents a specific insignificant (or *de minimis*) ambient concentration of $PM_{2.5}$ that exempts the applicant from conducting a cumulative impact assessment, basing the significant 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 in most cases unless a demonstrably conservative estimate of the secondary $PM_{2.5}$ contribution can be made that is below the applicable SIL. As such, when using either of these approaches, it may be appropriate for the permitting authority to recommend the 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 applicant to apply the applicable 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 such be compared to the applicable SIL, since that represents the maximum contribution that the source could make.

IV. Cumulative Impact Analysis

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 account 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 the appropriate cumulative impact assessment for $PM_{2.5}$ based on comparable approaches applied for other criteria pollutants, as appropriate, and different approaches based on the technical issues identified previously.

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 $PM_{2.5}$ from direct $PM_{2.5}$ emissions
  - Secondary impacts on $PM_{2.5}$ from precursor emissions
- Nearby sources
  - Primary impacts on $PM_{2.5}$ from direct $PM_{2.5}$ emissions, as appropriate
- Monitored background of $PM_{2.5}$ that accounts for secondary $PM_{2.5}$ impacts from regional transport and precursor emissions from nearby sources, and primary $PM_{2.5}$ impacts from other background sources not included in the modeled inventory.

As with the significant 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 of $PM_{2.5}$.

IV.1 Modeling Inventory

The current guidance 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 guidance in Appendix W addresses 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 under this guidance will be addressed on a

case-by-case basis.

As discussed in more detail in the March 1, 2011, clarification memorandum regarding Appendix W modeling guidance 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 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.

In light of the March 1, 2011, guidance, the EPA cautions against the literal and uncritical application of very prescriptive procedures for identifying which nearby sources should be included in the modeled emission inventory for NAAQS compliance demonstrations, such as those 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 in themselves. 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. Such procedures might be characterized as being sufficient in most cases, but not always necessary to fulfill the requirements of a cumulative impact assessment.

Since modeling of direct $PM_{2.5}$ emissions has not been a routine requirement 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 and increment compliance, which should account for impacts from existing sources that are not explicitly included in the modeled inventory and natural sources. From pre-construction monitoring data and/or existing representative air quality data, 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.[16] 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 representative background monitored 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 monitored 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, due to the nature of secondary $PM_{2.5}$, background monitored concentrations of $PM_{2.5}$ are likely to be more homogeneous across the modeling domain in most cases, compared to 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.

[16] Please note in the case of an existing source seeking a permit for 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 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 $PM_{2.5}$.

Depending on the nature of local $PM_{2.5}$ levels within the modeling domain, it may be appropriate to account for seasonal variations in 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 background concentrations in a cumulative impact analysis is discussed in more detail in Section IV.3.

IV.3 Comparison to NAAQS

Combining the modeled and monitored concentrations of $PM_{2.5}$ for comparison to the $PM_{2.5}$ NAAQS also 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 NAAQS for $PM_{2.5}$, greater emphasis is generally placed on the monitored background contribution relative to the modeled inventory for $PM_{2.5}$ than for other pollutants. Also, given the probabilistic form of the $PM_{2.5}$ NAAQS, careful consideration must 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; for the 24-hour averaging period, the design value is based on the 3-year average of the 98^{th} percentile 24-hour average $PM_{2.5}$ concentrations. Details regarding the determination of the 98^{th} percentile monitored 24-hour value based on the number of days sampled during the year are provided in the data interpretation 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. 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, is not required.

The 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 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 used for

the initial significant 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 document 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 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 their respective SER, 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 (based on the multi-year average of the 98^{th}-percentile of 24-hour values) be added to the monitored design value from a representative monitor. For Case 2, where only the project's direct $PM_{2.5}$ emissions exceed the SER, the modeled design value would be based solely on AERMOD (or other acceptable preferred or alternative model) estimates of primary $PM_{2.5}$ impacts. For Case 3, where both the project's direct $PM_{2.5}$ emissions and precursor emissions exceed the respective SER, 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 photochemical grid model estimates accounting for the project's precursor $PM_{2.5}$ emissions), and the monitored design value (from a

representative monitor accounting for the contribution of secondary $PM_{2.5}$ formation associated with existing sources representative of 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). 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 $PM_{2.5}$ compliance demonstrations that should be acceptable without further justification in most cases. For applications where impacts from primary $PM_{2.5}$ emissions are not temporally correlated with background $PM_{2.5}$ levels, as discussed above, combining the modeled and monitored contributions as described above may be overly conservative. In these cases, a Second Tier modeling analysis may be considered that would involve combining the monitored and modeled $PM_{2.5}$ concentrations on a seasonal or quarterly basis. 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.

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 described above), and an option to specify four seasonal background values to be combined with modeled concentrations on a seasonal basis (appropriate for a Second Tier analysis). As explained above, the monitored design value is the recommended input for the annual (First Tier) option, whereas the 98^{th} percentile of the values for each season, averaged across three years of monitoring, is the recommended input for Second Tier analyses. The appropriate rank associated with the 98^{th}

percentile of the 24-hour values for a season will depend on the sampling frequency of the particular monitor being used for background. For a monitor with a daily, 24-hour sampling frequency, the 98th percentile recommended rank is the 3rd highest 24-hour value for each season.[17] The AERMOD model also allows the user to track the contribution from background concentrations to the cumulative modeled design value.

IV.4 Determining Significant Contributions to Modeled Violations

If the cumulative impact assessment following these recommendations results in modeled violations of the $PM_{2.5}$ NAAQS, then the applicant will need to determine whether the project's emissions represent a significant contribution to those modeled violations. The EPA has previously supported making a "significant contribution" determination 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 section 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 51.165(b)(2) does not significantly contribute to either an existing exceedances of the NAAQS in a nonattainment area or exceedances predicted in an attainment area based on a cumulative analysis.[18]

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 the vacated Sections 51.166(k)(2) and

[17] An explanation of the rationale for using the 3rd highest 24-hour value to represent the 98th percentile is provided on page 19 of the March 1, 2011 memo "Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard" (U.S. EPA, 2010b).

[18] 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."

52.21(k)(2). 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." (Op. at 14). 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 section 51.165(b)(2) to determine whether a source significantly contributes to a modeled violation. However, in light of other elements of the court decision, the EPA advises a permitting authorities to consult with the EPA before using the SIL value for PM2.5 in section 51.165(b)(2) as the basis for concluding that a source with an impact below this value does not significantly contribute to a modeled violation.

The significant contribution determination should be made following the same procedures used during the initial significant impact analysis, based on a comparison of the average of the modeled concentrations at the receptor location showing the violation, 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 NAAQS, the average of the predicted annual values at the affected receptor(s) is compared to the applicable SIL, while the average of the 24-hour average concentrations at the affected receptor(s) should be used for the 24-hour NAAQS. Use of the average modeled concentration is appropriate in this context since it is consistent with the actual contribution of the source to the cumulative impacts at the receptor(s) showing violations and accounts for the fact that modeled violations of the 24-hour NAAQS represent average impacts across the modeling period.

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V. PM2.5 Increment Analyses

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 * * *.'' The ''maximum allowable increase'' of an air pollutant that is allowed to occur above the applicable "baseline concentration"[19] for that pollutant is known as the PSD increment. By establishing the maximum allowable increase in a particular area, an increment defines ''significant deterioration'' of air quality in that area. Under the EPA's 2010 Prevention of Significant Deterioration (PSD) for Particulate Matter Less Than 2.5 Micrometers (PSD) - Increments, Significant Impact Levels (SIL) and Significant Monitoring Concentration (SMC) final rule, increments for $PM_{2.5}$ became applicable on October 20, 2011, at the levels shown in Table V-1 based on the averaging period and area classification.

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

	Class I	Class II	Class III
Increments, $\mu g/m^3$			
Annual	1	4	8
24-hour	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)

Section 163(a) of the CAA stipulates that increments based on averaging periods other than an annual period the "maximum allowable increase" can "be exceeded during one such period per year." Consequently, compliance with the 24-hour $PM_{2.5}$ increments is based on comparison of the highest, second-highest 24-hour concentration increase over the entire receptor network for

[19] Section 169(4) of the CAA defines "baseline concentration" as "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."

each year modeled for the 24-hour increment. Similarly, the highest annual concentration over the entire receptor network for each year modeled is used for compliance with the annual increment.

The $PM_{2.5}$ increment analysis includes many of the same elements discussed above for $PM_{2.5}$ NAAQS analyses, with some important differences. The main difference is that the increment compliance demonstration is based on calculating the increase in ambient $PM_{2.5}$ concentrations over the applicable baseline concentration, which results from proposed emissions increases from the new or modified source, in combination with increment-consuming emissions from other sources within the baseline area impacted by the proposed source. Another key difference is that the increment analysis is based on the net impact of actual emission increases and decreases from increment-affecting sources, whereas NAAQS analyses are generally based on the maximum allowable emissions from all nearby sources. However, it should be noted that the statutory definition of "actual emissions" in Sections 52.21(b)(21) and 51.166(b)(21) allow for the reviewing authority to "presume that source-specific allowable emissions for the unit are equivalent to the actual emissions of the unit." Although the discussion above focuses on increment consumption associated with emission increases, decreases in actual emissions from increment-affecting sources may also be considered in the $PM_{2.5}$ increment analysis, which may result in expansion of the increment within the affected baseline area.

In practice, three dates related to the PSD baseline concept are important in understanding how to calculate the amount of increment consumed: (1) trigger date; (2) major source baseline date; and (3) minor source baseline date. The 2010 Final Rule established October 20, 2011, as the "trigger date" for $PM_{2.5}$ increments. That is, the first complete PSD

permit application submitted on or after that date in a given baseline area "triggers" the requirement for individual PSD applicants seeking to locate in that area to demonstrate that the $PM_{2.5}$ increments are not being violated. The date of the submittal of such PSD application is referred to as the "minor source baseline date" for the affected baseline area. The ambient concentration level on the minor source baseline date is referred to as the "baseline concentration," which is the starting point for $PM_{2.5}$ increment considerations and the air quality against which increment consumption is assessed. After the minor source baseline date, any increase in actual emissions (from both major and minor sources) consumes the PSD increment for that area. Likewise, any decrease in actual emissions relative to the baseline date may expand the available PSD increment. $PM_{2.5}$ emissions changes at minor sources and existing major sources occurring before the applicable $PM_{2.5}$ minor source baseline date generally do not consume increment, but are considered to contribute to the $PM_{2.5}$ air quality that exists on the minor source baseline date for the area of concern. However, the statutory definition of "baseline concentration" provides that actual emissions increases, as defined in Sections 52.21(b)(21) and 51.166(b)(21), associated with new or modified major stationary sources on which construction began after a "major source baseline date" must be considered to consume increment rather than count toward the baseline concentration All projected emissions associated with a major stationary source on which construction began before the major source baseline date are included in the baseline concentration, even if the source had not begin operation by that date. In the 2010 Final Rule, the EPA established a "major source baseline date" of October 20, 2010, for determining when such major source emissions associated with $PM_{2.5}$ should count toward the consumption of the $PM_{2.5}$ increments.

As a result of the differences noted above, the modeling inventories required for the

$PM_{2.5}$ NAAQS compliance demonstrations will generally not be appropriate or applicable for the $PM_{2.5}$ increment analysis. However, this does not preclude the PSD applicant from electing to model the permitted allowable emission increases for increment-consuming background sources where such emissions data are more readily accessible, as part of a conservative assessment for showing compliance with the increment. Also, as noted above, the reviewing authority may presume that source-specific allowable emissions for a unit are equivalent to the actual emissions of the unit in some cases. Furthermore, since the increment analysis is based on an assessment of impacts from actual emissions, rather than maximum allowable emissions, it may be feasible in some cases to rely on ambient data to account for background sources in relation to increment-consumption (or expansion), especially in relation to increment consumption/expansion due to secondary $PM_{2.5}$ impacts associated with precursor emissions, provided that representative ambient data are available that adequately account for changes in ambient $PM_{2.5}$ concentrations relative to the baseline concentration. Although ambient data have not traditionally been used to account for increment consumption/expansion associated with background sources, we believe that it may be warranted in some cases given the additional challenges associated with $PM_{2.5}$ increment analyses due to secondary impacts from precursor emissions. Early coordination with the appropriate reviewing authority is encouraged to identify the appropriate baseline concentration and baseline area for the proposed new or modified source, and the appropriate inventory of increment-affecting sources.

Once a $PM_{2.5}$ minor source baseline date is established for an area, the new emissions increase (including direct $PM_{2.5}$ and precursor emissions) from the major source that triggers the baseline date consumes a portion of the $PM_{2.5}$ increment in that baseline area, as do any subsequent emission increases that occur from any new or existing sources that affect that

particular $PM_{2.5}$ baseline area and any prior emission increases at major sources that have been newly constructed or modified since the major source baseline date. When the net impact resulting from total emissions changes of both direct $PM_{2.5}$ and precursor emissions impacting a particular $PM_{2.5}$ baseline area exceeds the maximum pollutant concentration increase defined by the $PM_{2.5}$ increment, additional PSD permits for $PM_{2.5}$ cannot be issued in that area until sufficient amounts of the increment are ‘‘freed up’’ via emissions reductions that may occur voluntarily (e.g., via source shutdowns) or by mandatory control requirements imposed by the reviewing authority. Moreover, the $PM_{2.5}$ air quality in a region cannot deteriorate to a level in excess of the applicable $PM_{2.5}$ NAAQS, even if the $PM_{2.5}$ increment in the area has not been fully consumed. Therefore, new or modified sources located in areas where the $PM_{2.5}$ concentrations are near the level allowed by the $PM_{2.5}$ NAAQS may not have full use of the amount of ambient $PM_{2.5}$ concentration increase allowed by the increment.

With these differences in mind, some of the recommendations provided above in Sections III and IV for $PM_{2.5}$ NAAQS compliance demonstrations based on the four assessment cases may also be applicable for increment analyses. For example, the increment assessment for Case 2, where only direct $PM_{2.5}$ emissions exceed the SER, should be based on application of AERMOD (or other appropriate preferred or approved alternative model), using the allowable increase in emissions from the project source plus actual emission changes associated with any increment-consuming or increment-expanding nearby sources. The AERMOD model allows for inclusion of increment-consuming and increment-expanding sources (represented as negative emissions) in the same model run, and will 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).

As discussed above in relation to the NAAQS, for Cases 3 and 4, where $PM_{2.5}$ precursor emissions from the proposed source exceed the respective SERs, the assessment of potential impacts on secondary $PM_{2.5}$ due to those emissions 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. Aside from the use of actual emission increases (or decreases) from increment-affecting sources instead of maximum allowable emissions from all nearby sources, the guidance provided under Sections III and IV in relation to NAAQS compliance for hybrid qualitative/quantitative and full source-specific quantitative photochemical modeling is largely applicable for increment analyses.

Several existing rules, including the current $PM_{2.5}$ NAAQS, have resulted in reductions in precursor emissions in most areas in recent years. As a result, in many cases the potential increment-consumption due to secondary $PM_{2.5}$ impacts from background sources may easily be addressed through a qualitative assessment, supported by trends in available precursor emissions data and ambient $PM_{2.5}$ monitored concentrations that net secondary $PM_{2.5}$ impacts associated with increment-affecting precursor emissions from background sources have not consumed increment. In such cases, the $PM_{2.5}$ increment analysis may be simplified to focus solely on potential increment consumption associated with direct $PM_{2.5}$ emissions. For other areas where increment-affecting precursor emissions may consume $PM_{2.5}$ increment, or for cases where the precursor emission increases from the project source are significant, the photochemical grid modeling methods discussed in Section III are also appropriate for estimating the portion of $PM_{2.5}$ increment that may be consumed due to secondary $PM_{2.5}$ impacts.

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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: 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, 2012c: 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

U.S. EPA, 2012d: 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

Appendix A: The Scope and Magnitude of the $PM_{2.5}$ Air Quality Problem

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,[20] Particulate Matter Staff Paper,[21] 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.

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

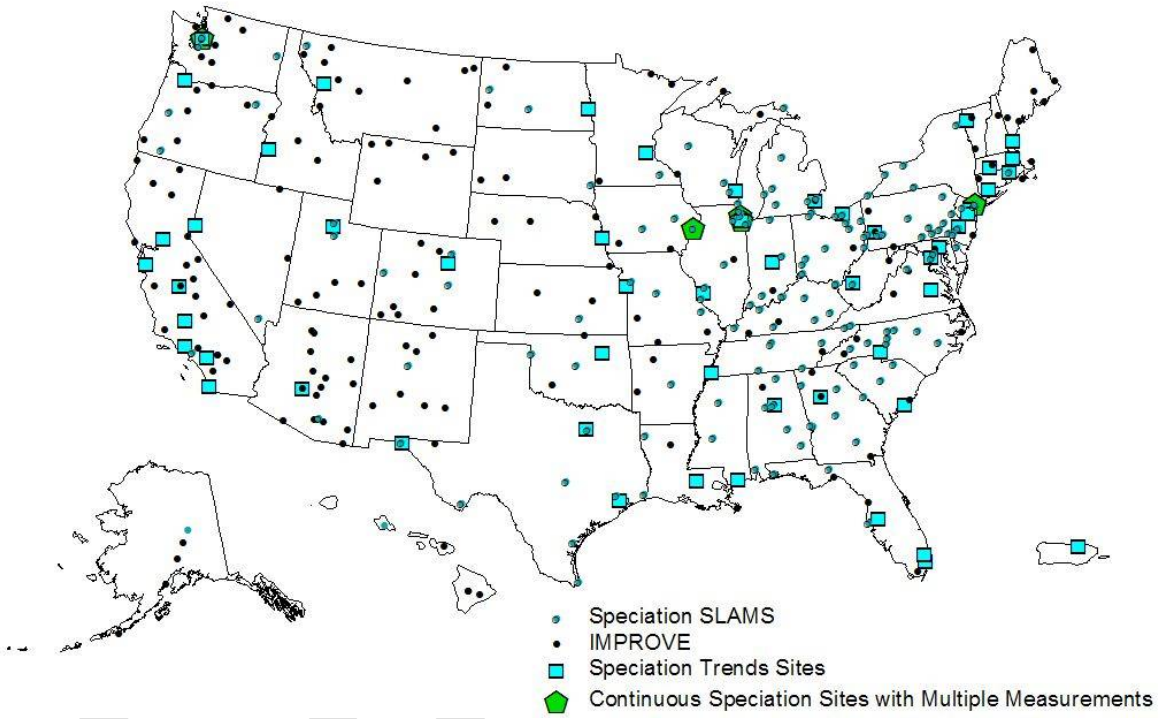
In addition to the IMPROVE network, over 300 EPA speciation sites were added from 2000 - 2002 in urban areas of the United States to assist $PM_{2.5}$ assessment efforts. No FRM exists for particulate speciation, which is not directly required to determine attainment, and there are slight differences 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.

[20] 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.

[21] 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.[22] 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 $PM_{10\text{-}2.5}$, 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.

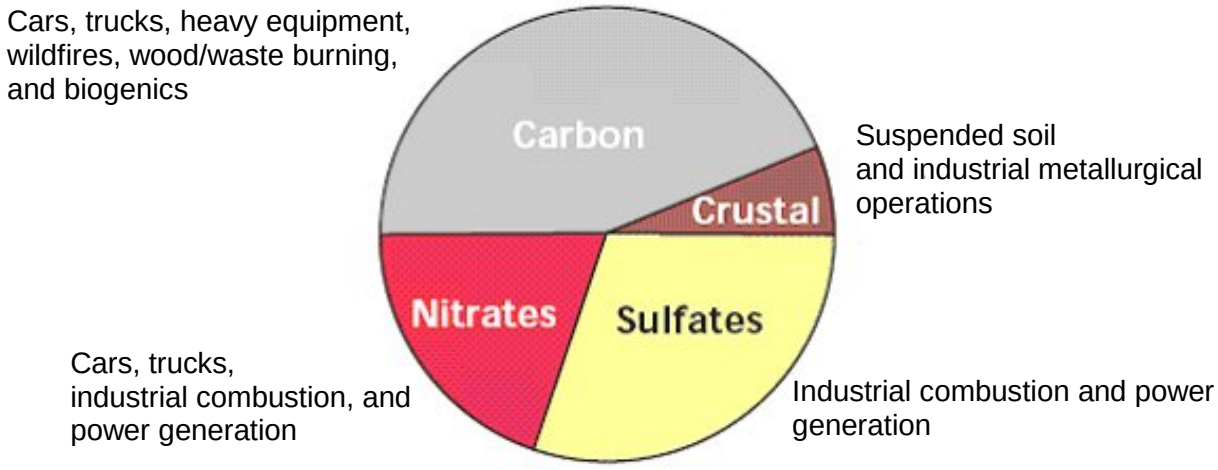
Particles span many sizes and shapes and consist of hundreds of different chemicals. Particles are emitted directly from sources and also are formed through atmospheric chemical reactions and often are referred to as primary and secondary particles, respectively. Particle pollution also varies by time 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
- Carbon formed from reactive organic gas emissions from cars, trucks, industrial facilities, forest fires, and biogenic sources such as trees.

[22] 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.

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



Source: The Particulate Matter Report, USEPA 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.

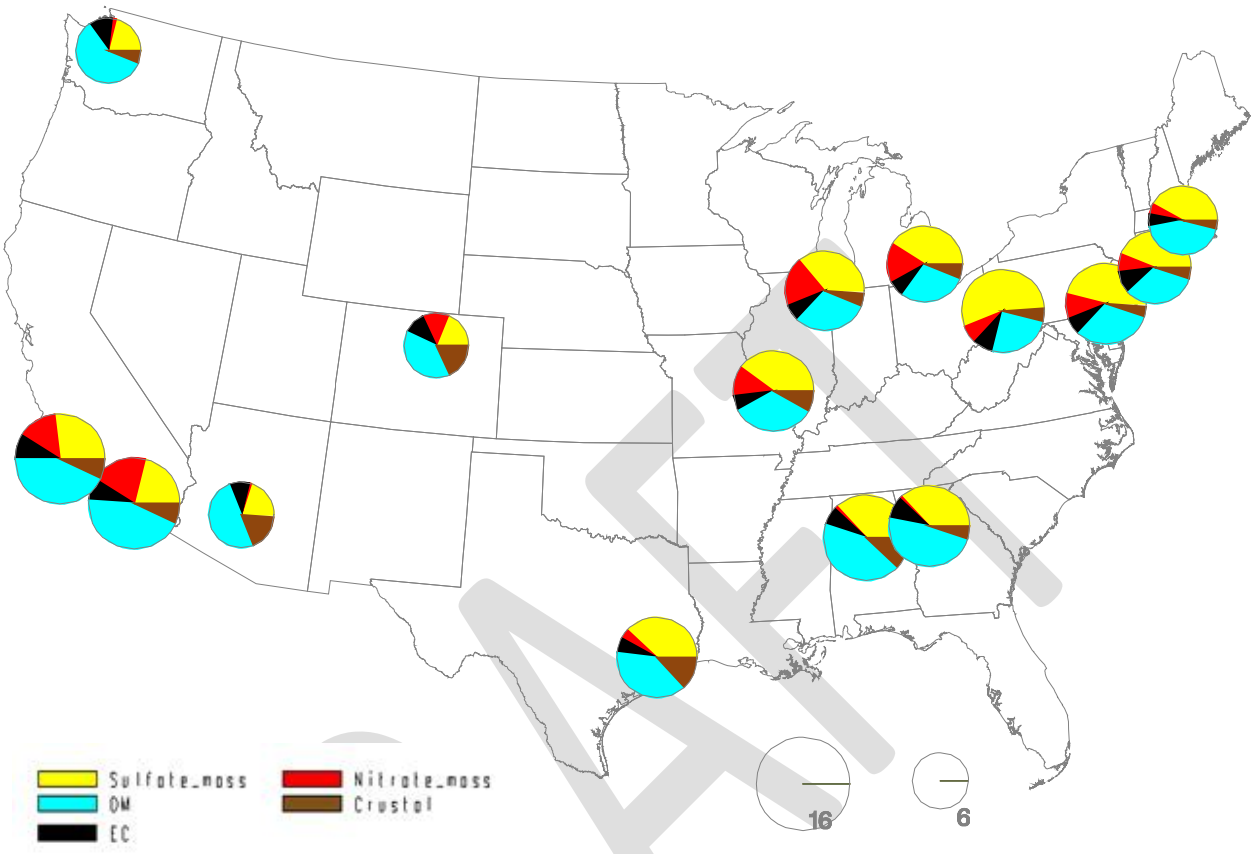
In addition, ammonia from sources such as fertilizer and animal feed operations contributes to the formation of sulfates and nitrates that exist in the atmosphere as ammonium sulfate and ammonium nitrate. Note that fine particles can be transported long distances by wind and weather and can be found 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).[23] 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.[24]

[23] 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.

[24] 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.

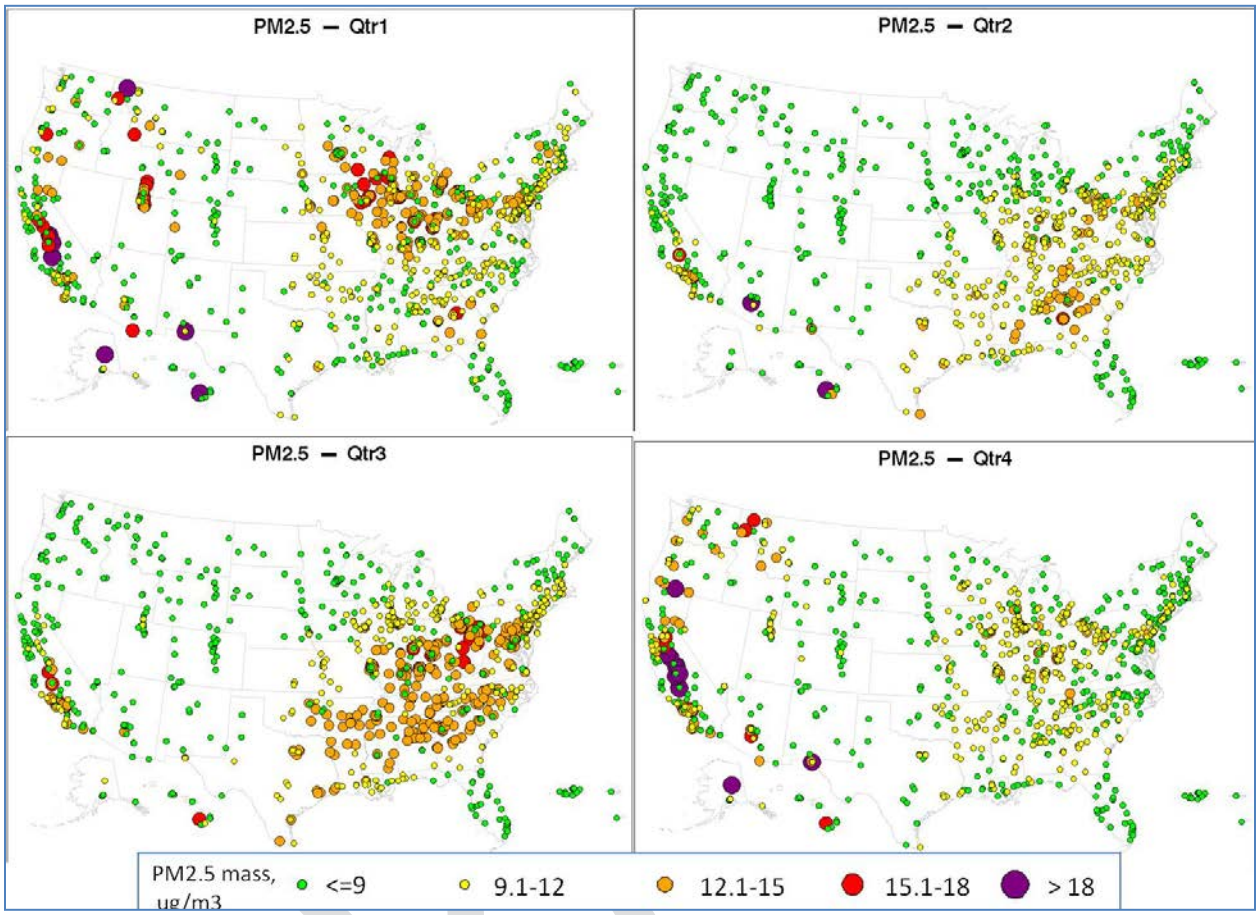
Figure A-3. Annual Average $PM_{2.5}$ Composition in 15 Urban Areas: 2008-2010



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

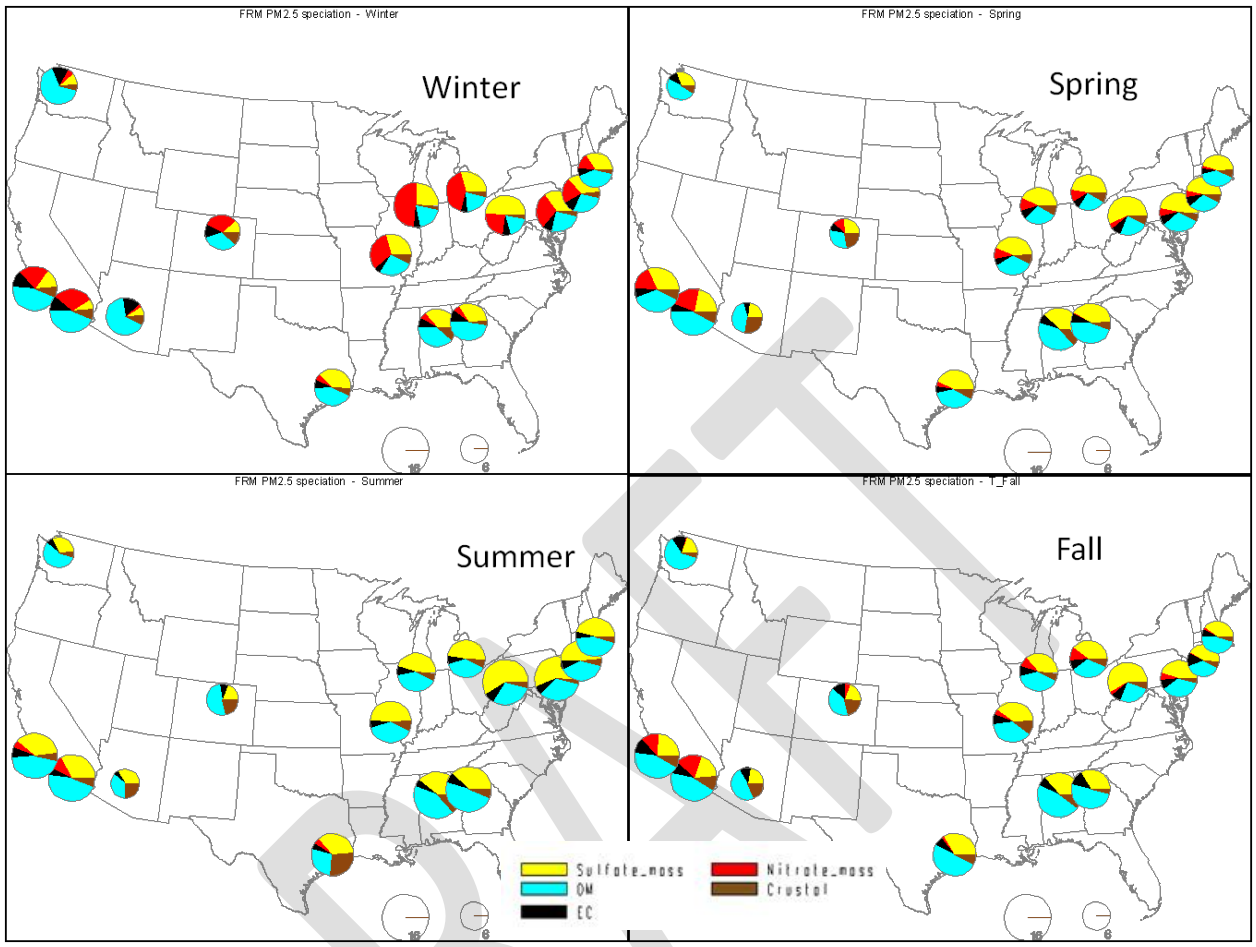
Fine particles often have a seasonal pattern. Both daily values and quarterly average of $PM_{2.5}$ also reveal patterns based on the time of year. Unlike daily ozone levels, which are usually elevated in the summer, daily $PM_{2.5}$ values at some locations can be high at any time of the year. As shown 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



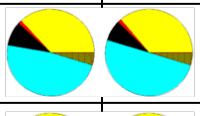
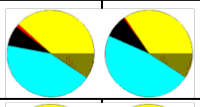
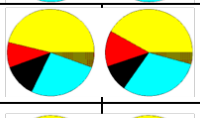
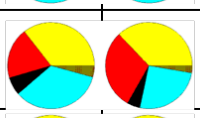
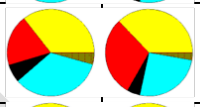
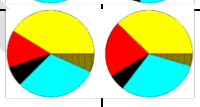
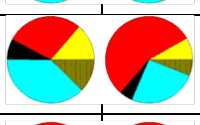
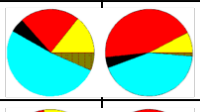
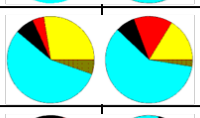
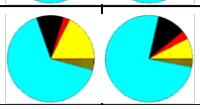
The composition of $PM_{2.5}$ also varies by season and helps explain why mass varies by season. Figure A-5 shows the average composition by season (spring, summer, fall and winter) for $PM_{2.5}$ data collected during 2008-10. In the eastern United States, sulfate are high in the spring (March-May) 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		

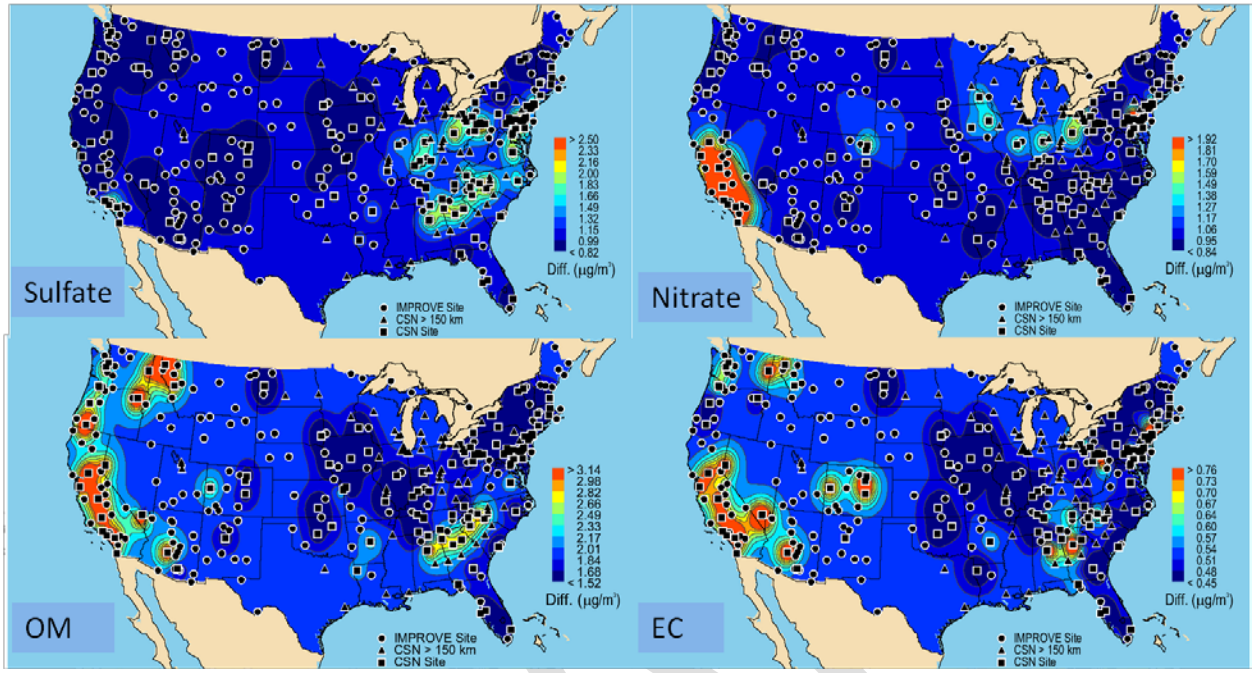
Note: The percentages do not add to 100% due to a small amount of passively collected fine particle mass included in the measurement of $PM_{2.5}$ by the FRM

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.[25]

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.[26]

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.

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

[26] 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)

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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 reviewing authority with the appropriate 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" December 2010 (U.S.EPA, 2010c).

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 modeling contact if questions arise about interpretation on modeling techniques and procedures.[27]

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

[27] 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, 2012a);
- 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, 2012b).

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 should 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)[28] 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,

[28] 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 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 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 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.

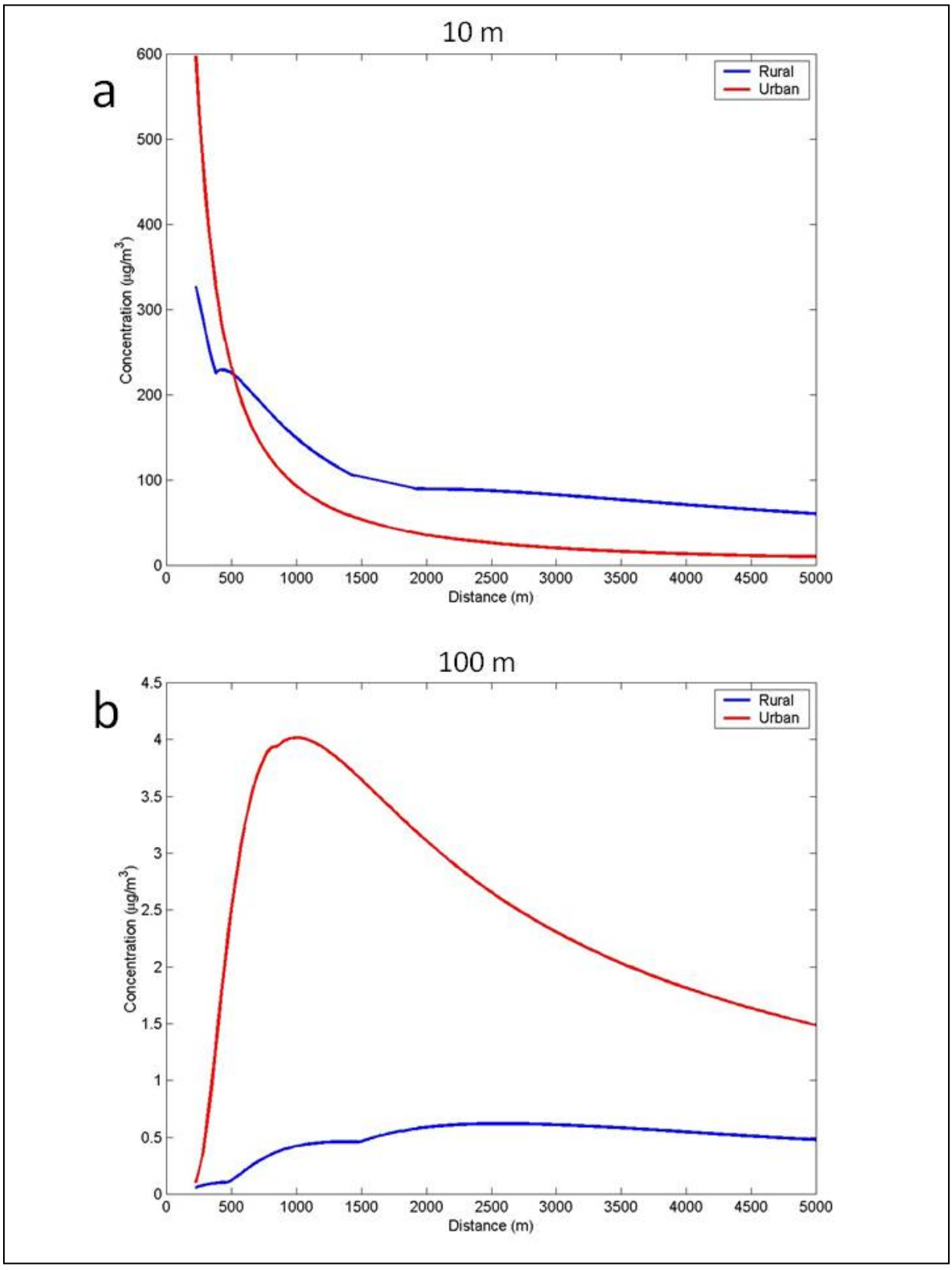
Determining whether a source is urban or rural can be done using the methodology outlined in Section 7.2.3 of Appendix W and recommendations outlined in Sections 5.1 through 5.3 in the AIG (U.S. EPA, 2009). In summary, there are two methods of urban/rural classification described in Section 7.2.3 of 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 reviewing 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, 2012b), 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 (including partial 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.

A recently discovered issue with ASOS is that 5-second wind data that are used to calculate the 2-minute average winds are truncated rather than rounded to whole knots. For example, a wind of 2.9 knots is reported as 2 knots, not 3 knots. To account for this truncation of NWS winds (either standard observation or AERMINUTE output), an adjustment of ½ knot or 0.26 m/s is added to the winds in stage 3 AERMET processing. For more details refer to the AERMET User's Guide Addendum (U.S. EPA, 2012b) and/or the appropriate EPA Regional Modeling Contact.

3.2.1.1. AERMINUTE

In AERMOD, concentrations are not calculated for variable wind (i.e., missing wind direction) and calm conditions, resulting in zero concentrations for those hours. These light wind conditions may be the controlling meteorological circumstances in some cases because of the limited dilution that occurs under low wind speeds which can lead to higher concentrations. The exclusion of a greater number of instances of near-calm conditions from the modeled concentration distribution may therefore lead to underestimation of 24-hour average $PM_{2.5}$ and annual $PM_{2.5}$ concentrations for design value calculation.

To address the issues of calm and variable winds associated with the use of NWS meteorological data, the EPA has developed a preprocessor to AERMET, called AERMINUTE (U.S. EPA, 2011d), that can read 2-minute ASOS winds and calculate an hourly average. Beginning with year 2000 data, NCDC has made the 1-minute wind data, reported every minute from the ASOS network freely available. The AERMINUTE program reads these 2-minute

winds and calculates an hourly average wind. In AERMET, these hourly averaged winds replace the standard observation time winds read from the archive of meteorological data. This results in a lower number of calms and missing winds and an increase in the number of hours used in averaging concentrations. For more details regarding the use of NWS data in regulatory applications, see Section 8.3.2 of Appendix W. For more information about the processing of NWS data in AERMET and AERMINUTE, see the AERMET (U.S. EPA, 2004c; U. S. EPA, 2012b) and AERMINUTE User's guides (U.S. EPA, 2011d).

Since the release of AERMINUTE in 2011, some permitting agencies have expressed concern that the inclusion of AERMINUTE output in AERMOD will lead to an increase in the conservatism of AERMOD output. This perceived increase in conservatism is due to an increase in hours with lower wind speeds input into AERMOD. The purpose of AERMINUTE is not to lead more conservative concentration estimates, but to increase the data quality and representativeness of the meteorological inputs into AERMOD. Concentrations are not calculated for hours with reported calm winds or variable winds. These calm or variable winds are due to the METAR reporting code used to report ASOS observations. In the METAR coding used to report surface observations beginning July 1996, a calm wind is defined as a wind speed less than 3 knots and is assigned a value of 0 knots. The METAR code also introduced the variable wind observation that may include wind speeds up to 6 knots, but the wind direction is reported as missing, if the wind direction varies more than 60 degrees during the 2-minute averaging period for the observation. These are often hours of interest because these are light wind conditions and important for the 24-hour $PM_{2.5}$ standard. With the use of AERMINUTE, hourly averages can be calculated for those hours with reported calm or missing winds because the 2-minute average winds in the one-minute data files have not been subjected to the METAR coding. In effect, AERMINUTE is obtaining data that was unavailable because of METAR coding, making the meteorological data more representative of the area.

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, 2012b), 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[29] 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.

For more details about the enhancements, see the AERMOD User's guide Addendum (U. S. EPA, 2012a).

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

[29] 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.

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.

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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.

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.

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