OFFICE OF INSPECTOR GENERAL

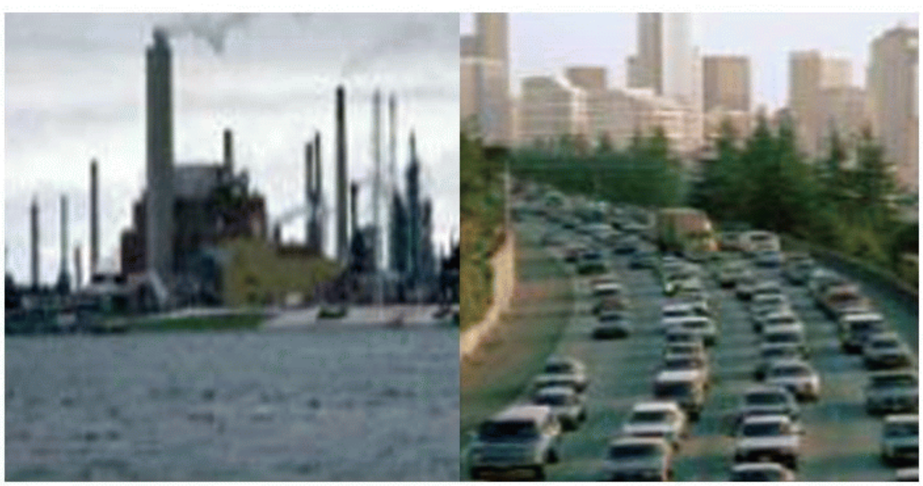
Catalyst for Improving the Environment

Evaluation Report

EPA Needs to Direct More Attention, Efforts, and Funding to Enhance Its Speciation Monitoring Program for Measuring Fine Particulate Matter

Report No. 2005-P-00004

February 7, 2005



Report Contributors:

Patrick Milligan
Mark S. Phillips
Kevin Good
Sarah Fabirkiewicz

Abbreviations

APM	Annual Performance Measure
CEM	Continuous Emissions Monitor
EPA	Environmental Protection Agency
FRM	Federal Reference Method
GPRA	Government Performance and Results Act
IMPROVE	Interagency Monitoring of PROtected Visual Environments
NAAQS	National Ambient Air Quality Standards
NARSTO	North American Research Strategy for Tropospheric Ozone
NEI	National Emissions Inventory
NO_x	Nitrogen Oxide
OAQPS	Office of Air Quality Planning and Standards
OAR	Office of Air and Radiation
OIG	Office of Inspector General
ORD	Office of Research and Development
$PM_{2.5}$	Particulate $Matter_{2.5}$
RPO	Regional Planning Organization
SIP	State Implementation Plan
SO_2	Sulfur Dioxide
STAR	Science to Achieve Results
STN	Speciation Trends Network

Cover Photo: Fine particles come from a variety of sources.
Source: US EPA, Region 1, presentation titled Fine Particles in the Air dated April 10, 2003.

U.S. Environmental Protection Agency
Office of Inspector General

2005-P-00004
February 7, 2005

At a Glance

Catalyst for Improving the Environment

Why We Did This Review

We sought to determine whether EPA's $PM_{2.5}$ speciation air monitoring network is sufficient to (a) adequately identify sources of fine particulate matter ($PM_{2.5}$), and (b) facilitate the development of effective control strategies to reduce $PM_{2.5}$ to safe levels. Determining the chemical make-up of a particle – known as speciation – is largely accomplished through data generated by this network.

Background

Airborne particulate matter 2.5 microns or less in size ($PM_{2.5}$) is comprised of a complex mixture of particles composed of sulfate, nitrate, ammonium, organic carbon, elemental carbon, and organic and inorganic compounds. Tens of thousands of premature deaths yearly are associated with exposure to excess levels of $PM_{2.5}$. By 2010, EPA estimates that compliance with $PM_{2.5}$ emission control strategies will cost industry more than $37 billion annually. EPA's speciation monitoring network is a critical component in the development of these control strategies.

For further information, contact our Office of Congressional and Public Liaison at (202) 566-2391.

To view the full report, click on the following link:
www.epa.gov/oig/reports/2005/20050207-2005-P-00004

EPA Needs to Direct More Attention, Efforts, and Funding to Enhance Its Speciation Monitoring Program for Measuring Fine Particulate Matter

[redacted]

EPA has made substantial progress in establishing a speciation monitoring network to facilitate the development of $PM_{2.5}$ control strategies, but still faces a number of challenges in ensuring that the controls are implemented at the right sources. The development of control strategies is best approached through collaborative processes that use emissions inventories, ambient monitoring data, and air quality modeling. Although the speciation network provides information for understanding the make-up and origin of $PM_{2.5}$, the network does not fully assist in providing the data for EPA and States to identify or quantify the chemical make-up of $PM_{2.5}$ particles, reliably trace particles back to their source, or account for chemical changes that occur after particles are released into the atmosphere. Speciation data are available to begin working on control strategies, and EPA and the States are beginning the development of control strategies; however, increased monitoring efforts are needed.

Under the Clean Air Act, States with $PM_{2.5}$ nonattainment areas have until February 2008 to develop control strategies for reducing $PM_{2.5}$, and an additional 2 years to reach attainment with the $PM_{2.5}$ standard. Also, with justification, the Act allows EPA to grant a State an extension of up to 5 years to reach full attainment. Data from EPA's speciation network will be vital to ensuring that pollution controls are implemented at the right sources. Otherwise, some facilities may install unneeded controls, while some needed controls may go uninstalled; ultimately, compliance may be further delayed and more costly.

Agency officials acknowledge that improved speciation data will be needed for EPA to overcome the uncertainties associated with $PM_{2.5}$ particle origin. In 2004, EPA budgeted over $43 million for $PM_{2.5}$ monitoring, with about $16.4 million for operation of the existing speciation monitoring network. However, only about $800,000 was budgeted for improving its capability to address uncertainties with $PM_{2.5}$ particle origin. According to manufacturers and some Agency officials we contacted, increased partnering between EPA and monitor manufacturers may be needed if advanced speciation monitors are to be developed in time to help agencies develop air pollution control strategies that ensure controls are implemented at the right sources.

[redacted]

We recommend that EPA increase its research on technologies that can more fully identify the chemical make-up of $PM_{2.5}$, account for the atmospheric impacts on $PM_{2.5}$, and assay the resultant changes that occur to the composition of the particle. This includes increasing opportunities for cooperation with the private sector to develop improved continuous speciation monitors. In its response to the draft report, EPA disagreed with certain issues; however, the Agency stated that the recommendations generally align with their current improvement efforts.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
INSPECTOR GENERAL

February 7, 2005

MEMORANDUM

SUBJECT: EPA Needs to Direct More Attention, Efforts, and Funding to Enhance Its Speciation Monitoring Program for Measuring Fine Particulate Matter
Report No. 2005-P-00004

FROM: J. Rick Beusse /s/
Director for Program Evaluation, Air Issues

TO: Jeffrey R. Holmstead
Assistant Administrator for Air and Radiation (6101A)

William Farland
Acting Deputy Assistant Administrator for Science,
Office of Research and Development (8101R)

Attached is our final report regarding the Environmental Protection Agency (EPA) Particulate Matter Ambient Speciation Monitoring Program. This report contains findings regarding EPA's need to direct more attention, effort, and funding toward its Ambient Speciation Monitoring Program. Also, the report contains corrective actions the Office of Inspector General (OIG) recommends. This report represents the opinion of the OIG, and the findings contained in this report do not necessarily represent the final EPA position. Final determination on matters in this report will be made by EPA managers in accordance with established procedures.

EPA's Office of Air and Radiation provided us with a response on January 31, 2005, that consolidated its comments to the draft report with those from the Office of Research and Development. We included EPA's consolidated response in its entirety as Appendix H.

Action Required

In accordance with EPA Manual 2750, as the action official, you are required to provide this office with a written response within 90 days of the final report date. Since this report deals primarily with the EPA Office of Air and Radiation's Ambient Speciation Program, the Assistant Administrator for Air and Radiation was designated the primary action official. As such, he should take the lead in coordinating the Agency's response. The response should address all recommendations. For the corrective actions planned but not completed by the response date, please describe the actions that are ongoing and provide a timetable for completion. If you do not concur with a recommendation, please provide alternative actions addressing the findings reported. We appreciate the efforts of EPA officials and staff, as well as external stakeholders, in working with us to develop this report. For your convenience, this report will be available at http://www.epa.gov/oig.

If you or your staff have any questions regarding this report, please contact me at (919) 541-5747 or Patrick Milligan, Assignment Manager, at (215) 814-2326.

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Chapter 1
Introduction

Purpose

Severe health effects are associated with exposure to excess levels of airborne fine particulate matter ($PM_{2.5}$), including tens of thousands of premature deaths and hospital admissions, and hundreds of thousands of doctor visits, work and school absences, and respiratory illnesses yearly. The Environmental Protection Agency (EPA) first established the $PM_{2.5}$ standard[1] in 1997, and in September 2004 reconfirmed the serious health effects from exposure to excess levels of $PM_{2.5}$. In June 2004, EPA alerted 21 States that 244 counties, with a collective population of 99 million people, were likely to exceed the $PM_{2.5}$ standard.

Determining the chemical make-up of a particle – known as "speciation" – is an important part of the effort to reduce $PM_{2.5}$ levels, and is accomplished largely through data generated by EPA's ambient air speciation monitoring program. The program is designed to help EPA and the States better understand the chemical composition of the particle; what happens to the particle after it is released in the atmosphere; how the particle can be traced to its source of origin, also known as source apportionment; whether implemented controls are having the desired effect on air quality; and the potential health effects of $PM_{2.5}$. To reduce ambient air levels sufficient to attain the $PM_{2.5}$ standard, EPA, State, local, and tribal agencies will have to overcome substantial challenges in identifying and controlling the sources of $PM_{2.5}$. EPA's speciation monitoring is central to identifying those sources, facilitating the development of effective control strategies, and gauging their success. EPA estimates that compliance with $PM_{2.5}$ emission control strategies will cost industry more than $37 billion annually by 2010. Thus, it is critical that controls be implemented at the right sources. Otherwise, some facilities may install unneeded controls, while some needed controls may go uninstalled; ultimately, compliance may be further delayed and more costly.

EPA recognizes the importance of speciation data to achieving its long-term goals, and has efforts underway to improve its speciation monitoring program. Therefore, we examined the challenges facing EPA with the intent of bringing attention to areas on which the Agency should further focus its efforts. Specifically, we sought to determine whether the $PM_{2.5}$ ambient air speciation monitoring program is sufficient to: (1) adequately identify sources of $PM_{2.5}$, and (2) facilitate the development of effective control strategies to reduce $PM_{2.5}$ to safe levels.

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[1] EPA's $PM_{2.5}$ standard requires that levels of fine particles remain at or below 65 micrograms per cubic meter of air over a 24-hour period, and at or below 15 micrograms per cubic meter of air on an average annual basis.

Background

$PM_{2.5}$ and Its Health Effects

Particulate Matter (PM) includes acids, metals, and the solid or liquid droplets in gases, and other harmful airborne substances that can be breathed into the lungs. PM sources include automobiles, diesel engines, power plants, industrial facilities, wood combustion, and dust from roads. Some particles are large or dark enough to be seen as soot or smoke; others can only be detected with an electron microscope.

EPA has been concerned about the adverse effects of PM on human health and the environment since the early 1970s. The first airborne particles to be regulated were referred to as Total Suspended Particulate Matter, which included a broad range of large and small particles. Today, EPA no longer monitors for Total Suspended Particulate Matter, but instead regulates several smaller-sized particles, since they are more likely to slip past body defenses (nose, throat, and larynx) and penetrate deep into the lungs. EPA regulates two types of smaller airborne particles, as shown in Table 1.1.

Table 1.1: Types of Regulated Particulate Matter

Type[a]	Description	Date Regulated
PM_{10}	Particles less than or equal to 10 microns in diameter (about one-seventh the diameter of a human hair).	1987
$PM_{2.5}$	"Fine" particles, which are less than or equal to 2.5 microns in diameter (about 1/30th the diameter of a human hair).	1997

[a]A new PM standard – PM_c (known as "coarse") – is being considered by EPA to apply to the fraction of PM between 2.5 and 10 microns. EPA's current schedule should provide for a final standard in late 2005.

Every 5 years, EPA revisits standards to ensure they reflect current information and are protective of human health. The newer category – $PM_{2.5}$ – was established as a National Ambient Air Quality Standard (NAAQS) in 1997. This standard requires that levels of fine particles remain at or below 65 micrograms per cubic meter of air over a 24-hour period, and at or below 15 micrograms per cubic meter of air on an average annual basis. EPA established this standard as a result of a growing body of scientific evidence indicating that these fine particles are most damaging to health since they can penetrate the lung tissues easier and deeper.

Compliance with NAAQS is measured using ambient monitoring, but because people experience adverse health effects from the air that they breathe, it is important to understand how ambient concentrations relate to actual human exposures. For $PM_{2.5,}$ recent exposure studies have demonstrated that ambient monitors are reasonable surrogates for human exposure to ambient $PM_{2.5}$ and sulfates. However, for other components of ambient PM, relationships between ambient concentrations and actual human exposures have not been established.

When breathed, particulate matter can accumulate in the respiratory system. Fine particulate matter is associated with such adverse health effects as heart and lung disease and increased respiratory disease, and symptoms such as asthma, decreased lung function, and even premature death. Sensitive groups that appear to be at greatest risk include the elderly, individuals with cardiopulmonary disease, and children. Also, PM is a major cause of reduced visibility, and adversely impacts vegetation and ecosystems.

$PM_{2.5}$ in the atmosphere is composed of a complex mixture of particles: sulfate, nitrate, and ammonium[2] particles; organic carbon composed of a large number of individual organic species and elemental carbon; and other inorganic material.

- "Primary" particles are emitted directly into the air as solid or liquid particles. Examples include elemental carbon from diesel engines or forest fires, and condensible organic particles from gasoline engines.

- "Secondary" fine particles are formed in the atmosphere through the chemical reactions of precursor gas emissions, including organic gases, nitrogen oxides, sulfur oxides, and ammonia. Often at least half of the $PM_{2.5}$ mass consists of secondary particles formed through a change in composition, making it a challenge to identify a particle's source of origin.

Furthermore, depending on particle size and meteorological conditions, such as wind speed and direction, excess levels of $PM_{2.5}$ and precursor species that originated in one area may be transported by the wind to another area. Fine particles below 2 microns may travel thousands of miles, while larger particles - 10 microns in size or larger - may only travel a few hundred meters. For example, certain eastern States have alleged that some of their particulate problems can be attributed to power plants located hundreds of miles away in the Upper Ohio Valley.

Scope and Methodology

To assess whether the $PM_{2.5}$ speciation monitoring network is sufficient to identify sources of $PM_{2.5}$ and facilitate the development of effective control strategies to reduce $PM_{2.5}$ by State, local, and tribal agencies, we discussed $PM_{2.5}$ speciation data challenges, monitoring capabilities, and monitoring limitations with officials from:

- EPA's Office of Air Quality Planning and Standards

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[2] Two common forms of secondarily formed $PM_{2.5}$ occur when acid sulfates and nitric acid react with ammonia in the atmosphere, creating ammonium sulfate and ammonium nitrate, respectively. Ammonium (NH_4) is made up of ammonia (NH_3) and hydrogen (H), and is formed when NH_3 gas reacts with a hydrogen ion from an acidic species either in the gas phase or in solution (e.g., $NH_3(g) + HNO_3(g) = NH_4NO_3(s)$). Ammonium is only in the aerosol phase, while NH_3 is in the gas phase or can be dissolved in water where it quickly reacts with an acidic species.

- EPA's Office of Research and Development
- EPA Regions 3, 5, and 9
- Selected State air pollution control agencies (Pennsylvania Department of Environmental Protection; California Air Resources Board; Illinois Environmental Protection Agency; North Carolina Department of Environment, Health, and Natural Resources, Air Protection Division; and the Georgia Department of Natural Resources, Environmental Protection Division)
- The State and Territorial Air Pollution Program Administrators/Association of Local Air Pollution Control Officials
- Regional Planning Organizations (the Mid-Atlantic Regional Air Management Association,[3] and the Central Regional Air Planning Association[4]
- Three major $PM_{2.5}$ monitor manufacturers (Met-One, Inc., Rupprecht & Patashnik Co., Inc., and Thermo, Inc.)
- Academia (Clarkson University and University of Maryland)

We also reviewed key reports and studies related to $PM_{2.5}$ and specifically the speciation of $PM_{2.5}$, including:

- NARSTO report - *Particulate Matter Science for Policymakers: A NARSTO*[5] *Assessment*
- National Research Council's report - *Research Priorities for Airborne Particulate Matter, Volume IV*
- National Research Council's report - *Air Quality Management of the United States*
- Clean Air Interstate Rule
- MANE-VU's Speciation Network Data Review
- Draft of 40 Code of Federal Regulations, Part 51 Proposed Rule to Implement The Fine Particle Ambient Air Quality Standards
- *EPA's National Ambient Air Monitoring Strategy*

Our review of the speciation monitoring network did not include an independent evaluation of the quality of the data generated by the monitors or an analysis of the

[3]The Mid-Atlantic Regional Air Management Association is a voluntary, non-profit association of 10 State and local air pollution control agencies that work together to prevent and reduce air pollution in the Mid-Atlantic Region. Members include the States of Delaware, Maryland, New Jersey, North Carolina, Pennsylvania, Virginia, and West Virginia; the District of Columbia; and Philadelphia and Allegheny Counties in Pennsylvania.

[4]The Central Regional Air Planning Association is an organization of States, Tribes, Federal agencies, and other interested parties that identifies regional haze and visibility issues and develops strategies to address them. The Association, one of five Regional Planning Organizations across the United States, includes the States and tribal areas of Arkansas, Iowa, Kansas, Louisiana, Minnesota, Missouri, Nebraska, Oklahoma, and Texas.

[5] Formerly an acronym for "North American Research Strategy for Tropospheric Ozone," NARSTO is a public/private partnership, whose membership spans government, the utilities, industry, and academia throughout Mexico, the United States, and Canada. Its primary mission is to coordinate and enhance policy-relevant scientific research.

monitoring results. We evaluated the network's size, the location of the monitors, the capabilities and limitations of the monitors, and EPA management of the network. We did not evaluate emission inventories and atmospheric modeling; our review of these components of the overall $PM_{2.5}$ program was limited to how these measurement tools are interdependent with the speciation monitoring network. We conducted our evaluation in accordance with the *Government Auditing Standards* issued by the Comptroller General of the United States. Our fieldwork was conducted from March to October 2004. On February 3, 2005, we held a meeting with officials from the Office of Air and Radiation (OAR) to discuss the Agency's consolidated response to the draft report.

Prior OIG Coverage - *Decline In EPA Particulate Matter Methods Development Activities May Hamper Timely Achievement of Program Goals* (Report No. 2003-P-00016, issued September 30, 2003).

Results in Brief

EPA has made substantial progress in establishing a speciation monitoring network that assists it in identifying and facilitating the development of control strategies for sources of $PM_{2.5}$, but still faces a number of challenges in ensuring that the controls are implemented at the right sources. The development of control strategies is best approached through collaborative processes that use emissions inventories, ambient monitoring data, and air quality modeling. Although the speciation network provides information on understanding the make-up and origin of $PM_{2.5}$, the Agency's ambient monitoring network does not fully assist in providing the data needed for EPA or States to identify or quantify the chemical make-up of $PM_{2.5}$ particles, reliably trace particles back to their source, or account for chemical changes that occur after particles are released into the atmosphere. Speciation data are available to begin work on developing control strategies, and EPA and the States are in the process of using the available monitoring data from the Speciation, Supersites, and other State and private monitoring networks to begin development of control strategies; however, increased monitoring efforts are needed.

Rules promulgated under the Clean Air Act[6] allow States that have $PM_{2.5}$ nonattainment areas until February 2008 to develop control strategies for reducing $PM_{2.5}$, and an additional 2 years to reach attainment with the $PM_{2.5}$ standard. Also, with appropriate justification, the Act allows EPA to grant a State an extension of up to 5 years, or until February 2015, to reach full attainment. Data from EPA's speciation network will be vital to ensuring that pollution controls are implemented

[6] Section 172 of the 1990 Clean Air Act required EPA to designate attainment based upon the National Ambient Air Quality Standards. On July 18, 1997, EPA issued the rule, entitled "National Ambient Air Quality Standards for Particulate Matter" (40 CFR Sec. 50.7), providing EPA with the authority to designate nonattainment areas.

at the right sources. Otherwise, some facilities may install unneeded controls, while some needed controls may go uninstalled; ultimately, compliance may be further delayed and more costly.

Agency officials acknowledge that improved speciation data will be needed for EPA to overcome the uncertainties associated with $PM_{2.5}$ particle origin. In 2004, EPA budgeted over $43 million for $PM_{2.5}$ monitoring, with about $16.4 million for operation of the existing speciation monitoring network. However, only about $800,000 was budgeted for improving the Agency's capability to address the uncertainties with $PM_{2.5}$ particle origin. According to manufacturers and some Agency officials we contacted, increased partnering between EPA and monitor manufacturers may be needed if advanced speciation monitors are to be developed in time to help State and local agencies develop air pollution control strategies that ensure controls are implemented at the right sources.

We recommend, among other things, that EPA increase its research on technologies that can more fully assist in identifying the chemical make-up of $PM_{2.5}$ and, as such, account for the atmospheric impacts on $PM_{2.5}$, and assay the resultant changes that occur to the composition of the particle. This would include greater attention to providing opportunities for cooperation with the private sector to develop improved continuous speciation monitors. Detailed recommendations are at the end of Chapter 3.

EPA's Office of Air and Radiation provided us with a response that consolidated its comments to the draft report with those from the Office of Research and Development (ORD). Although EPA disagreed with certain issues, the Agency stated that the recommendations generally align with their current improvement efforts. We included the Agency consolidated response in its entirety as Appendix H. EPA did not agree with statements in the report that implied the currently available speciation data was insufficient to help EPA and the States "fully" develop effective control strategies. Nonetheless, our work with external stakeholders, and key documents issued by NARSTO suggested limitations in the available speciation data that would hinder EPA and the States from fully developing effective control strategies to address the excess levels of $PM_{2.5}$. Where appropriate, we modified the report based on the Agency's consolidated response, as well as several technical clarifications and comments also provided by EPA. Our evaluation of the Agency's consolidated response is in Appendix I.

Chapter 2

Speciation Monitoring Critical to Controlling Fine Particulate Matter and Reaching Attainment

EPA and the States gathered 3 years of monitoring data to determine which areas of the country are in nonattainment of the $PM_{2.5}$ standard. The Federal Reference Method (FRM) network consists of approximately 1,000 ambient air monitors used to identify those areas of the country where people are exposed to unhealthy levels of airborne $PM_{2.5}$, and to what extent these areas exceed the $PM_{2.5}$ standard. These FRM monitors measure the mass, or weight, of the fine particles gathered on their filters, but provide no information about a particle's chemical make-up. EPA uses FRM data to determine whether areas are in nonattainment of the $PM_{2.5}$ mass-based standard. However, those areas in non-attainment will need, among other things, speciation data to help them identify the source of the $PM_{2.5}$ and determine the chemical composition of the particle.

Nonattainment Areas Recommended

In February 2004, States and Tribes recommended to EPA those areas to be designated as being in nonattainment of the $PM_{2.5}$ standard. Nonattainment areas are those with air quality levels exceeding the standards, plus nearby areas contributing to such violations (also known as partial counties).

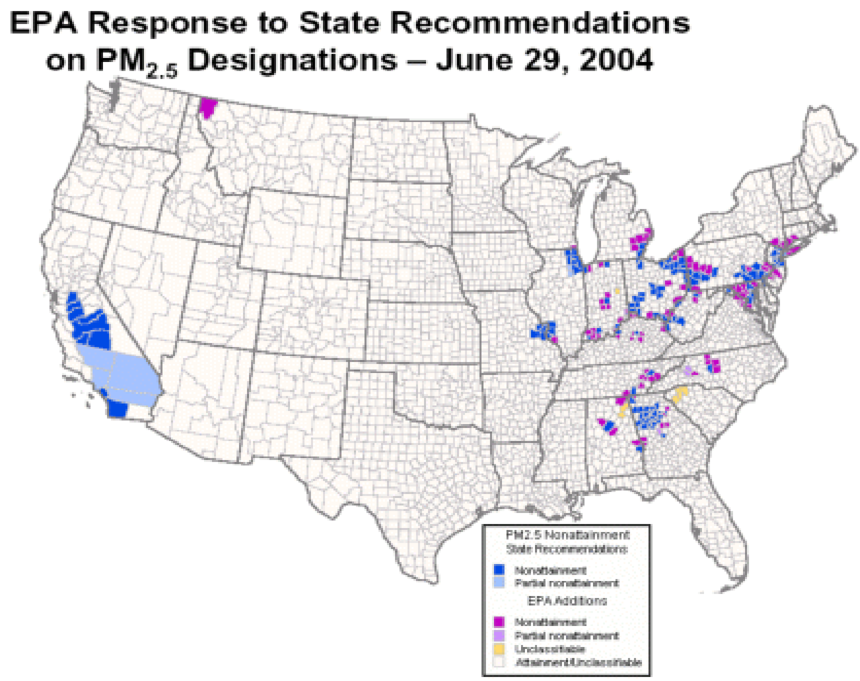
EPA evaluated the recommendations, and in some cases revised the State and tribal submittals. In June 2004, EPA alerted 21 States that 244 counties, with a collective population of 99 million people, were potentially nonattainment areas for the new standard. This represents 35 percent of the Nation's total population of 285 million people. The nonattainment areas that EPA added to those initially recommended by States and Tribes magnified the seriousness of the $PM_{2.5}$ problem nationwide, adding over 100 counties with 20 million people.

Table 2.1 provides details on the nonattainment areas recommended, and Chart 2.1 provides a map showing the location of those areas.

Table 2.1: Nonattainment Areas Recommended

	Number of Counties		Total Counties	Population Affected By High Levels of $PM_{2.5}$
	Full	Partial		
States and Tribes	133	9	142	79 million people
EPA	233	11	244	99 million people

Chart 2.1: Areas Anticipated To Be In Nonattainment[a]



a Note: this chart shows EPA and State recommendations for nonattainment areas based on their analysis of the monitoring data; these are not the only areas where monitoring data exceeded the $PM_{2.5}$ standard one or more times in the last 3 years. Source: www.epa.gov/pmdesignations.

By February 2005, EPA is expected to officially designate those areas of the United States that exceed the $PM_{2.5}$ standard. These States have until February 2008 to develop control strategies for reducing $PM_{2.5}$, and an additional 2 years to reach attainment with the $PM_{2.5}$ standard. Also, with appropriate justification, the Act allows EPA to grant States an extension of up to 5 years, or until February 2015, to reach full attainment. As shown in Table 2.2, there are many activities involved in developing and approving the State Implementation Plan (SIP) control strategy, including public notice and comment, promulgating legally enforceable State regulations, and in some cases enacting State legislation.

Table 2.2: Key Activities and Milestones for Controlling $PM_{2.5}$

Type of Activity	Milestone
EPA Designates $PM_{2.5}$ Nonattainment Areas in Federal Register Notice	December 2004
Public comment period	December 2004 - February 2005
Nonattainment designations become final	February 2005
States Begin Developing SIP/Control Strategies	February 2005
EPA Issues Guidance to States on Development of Control Strategies[a]	June 2005
SIP Project Planning: - Define Scope, Develop Preliminary SIP Development Plan - Identify and Refine Key Program or Legal Issues and Resolve - Develop Technical Analysis and Inventory Preparation Plan - Data Gathering, Clarification, and Decisions - Finalize Preliminary SIP Development Plan	February 2005 - February 2008
SIP Development Phase: - Technical Data Gathering and Modeling - Control Strategy Development - Attainment Demonstration Draft SIP Writing, Review SIP Draft, and Recommend Changes Required: - Implementation of All Reasonable Available Control Measures - Implementation of Reasonable Available Control Technology - Reasonable Further Progress - Comprehensive, Accurate, Current Emissions - Identification and Quantification of New Emissions Allowed - Permits for New and Modified Stationary Sources - Enforceable Emission Limitations, and Other Control Measures - Preparation of Contingency Measures	February 2005 - February 2008
SIP State and Local Adoption Phase: - Public Involvement and Formal Hearing Process - Finalize SIP, Adopt SIP, Submit to EPA - EPA Reviews SIP and SIP Development Schedule	February 2005 - February 2008
SIP Approval Phase: - EPA Receives SIPs - EPA Conducts Technical and Legal Review - Write Federal Register Notice - SIPs Approved as Final	February 2008 - February 2010
States Required to Reach Attainment	February 2010
Possible 5-Year Extension to Reach Attainment	February 2015

[a] Step out of sequence due to EPA delays in developing and issuing $PM_{2.5}$ control strategy guidance.

While Table 2.2 depicts a number of key activities that EPA, State, local, and tribal agencies will need to accomplish and the milestones they must meet in order to reach attainment with the 1997 $PM_{2.5}$ standard by 2010, it is not an all inclusive list of activities. Appendix A shows the 23 major steps in the SIP development and approval process.

EPA has not yet set specific dates for when States must complete the many interim activities to meet the February 2008 deadline for completing a control strategy. After EPA makes designations, it is required to promulgate a schedule defining when States must complete the interim steps necessary to meet Clean Air Act requirements. Once nonattainment designations have been determined, affected States must develop control strategies as part of their SIPs. A SIP embodies the compilation of regulations, programs, and control strategies States plan to implement to meet the NAAQS and reduce pollution to levels that meet the health standard. Delays in reaching attainment goals may result in EPA levying economic sanctions against States, such as withholding highway funds. More importantly, delays in reaching attainment can result in tens of thousands of premature deaths. Once attainment is reached, SIPs also help to maintain acceptable levels of $PM_{2.5}$.

From a public health standpoint, informed decisions made by EPA now and in the next few years will be vital to ensuring that State, local, and tribal agencies meet the milestones associated with reducing harmful levels of $PM_{2.5}$. Although EPA and State, local, and tribal agencies may have up to 10 years (2005 to 2015) to lower the excess levels of $PM_{2.5}$, many challenges must first be overcome. Accurate and reliable speciation data will be necessary for EPA and State, local, and tribal agencies to meet these Clean Air Act deadlines. Although the speciation network provides some information for understanding the make-up and origin of $PM_{2.5}$, there are many other factors that also contribute to ultimately reducing harmful levels of PM. EPA needs to ensure that it has: (1) a speciation program that assists State, local, and tribal agencies to fully identify and quantify the chemical make-up of $PM_{2.5}$ particles, reliably trace particles back to their source(s), and fully account for chemical changes that occur after particles are released into the atmosphere; (2) robust and accurate $PM_{2.5}$ emission inventories; (3) effective atmospheric $PM_{2.5}$ models; (4) timely and appropriate guidance documents; and (5) timely and effective national controls.

Other Programs Impact $PM_{2.5}$ Levels

In developing the control strategy through the SIP, EPA and the States also consider emission reductions achieved from national programs directed at reducing $PM_{2.5}$. One of those national programs is the Acid Rain Cap-and-Trade Program, which is designed to achieve emission reductions of Sulfur Dioxide (SO_2) and Nitrogen Oxide (NO_X), the primary causes of acid rain. A second national program, the NO_X SIP Call (formally known as *Finding of Significant Contribution and Rulemaking for Certain States in the Ozone Transport Assessment Group for Purposes of Reducing Transport Ozone*), requires 21 States in the eastern half of the United States to revise their SIPs to help ensure that NO_X emission reductions are achieved to mitigate the regional transport of ozone across State boundaries. Efforts to control SO_2 and NO_X affect $PM_{2.5}$ control efforts because SO_2 and NO_X can undergo a chemical reaction in the atmosphere that transforms those pollutants into $PM_{2.5}$. Also, there are two national programs which are expected to reduce $PM_{2.5}$ emissions from mobile sources – the Nonroad

Diesel rule issued in June 2004 and the Clean Diesel Truck and Bus Rule finalized in 2000. In addition, the Clean Air Interstate Rule, which is currently in the proposed rulemaking phase, is expected to lower $PM_{2.5}$ emissions. However, EPA does not expect that national programs alone will bring nonattainment areas into compliance with the $PM_{2.5}$ standards. Details on these national control programs are in Appendix B.

Speciation Data Critical to Overall Success of $PM_{2.5}$ Program

To accurately identify the source of a $PM_{2.5}$ particle, EPA and the States must first understand its chemical make-up. Determining the chemical make-up of a particle – known as "speciation" – is largely accomplished through data generated by EPA's ambient air speciation monitoring program. Speciation data are an integral part of the interdependent components that collectively comprise a successful $PM_{2.5}$ program. This is because the data allow EPA and States to "groundtruth" other key aspects of the $PM_{2.5}$ program, most notably their ability to:

- Gauge the accuracy and reliability of emission inventories.
- Assess the validity[7] of atmospheric, source-apportionment, and transport-and-fate models and assumptions.
- Measure the progress of national- and local-scale efforts to reduce $PM_{2.5}$ emissions by providing data on the amount of sulfate, nitrate, ammonium, organic and inorganic compounds, and other PM-related substances found in the air.

EPA's Speciation Monitoring Program

As shown in Table 2.3, EPA's Speciation Monitoring Program consists primarily of two networks:

- The Speciation Trends Network (STN)[8]

- The Interagency Monitoring of PROtected Visual Environments (IMPROVE) Network

More details on these networks are in Appendix C.

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[7] We recognize that model validation is an iterative process that may never reach perfection; validation is discussed here in terms of reducing model uncertainty and narrowing the range of possible outcomes, and in turn, enhancing user and public confidence in model predictions.

[8] The Speciation Trends Network (STN) consists of 54 trends monitors. There are also 215 State and Local Air Monitoring Stations (SLAMS), not considered trends monitors, that provide speciated data. For purposes of this report, when we refer to the STN, we are referring to both the 54 trends monitors and the 215 SLAMS monitors.

Table 2.3: $PM_{2.5}$ Speciation Monitoring Program

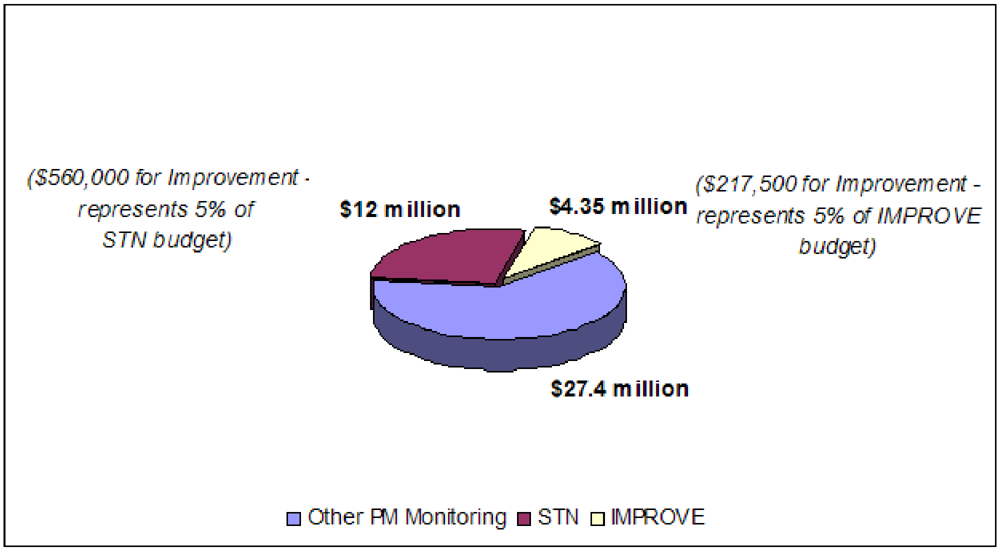
Name	No. of Monitors	Purpose of Network	Operated By
STN	269	Generates data on chemical makeup of $PM_{2.5}$. Capable of measuring concentration levels of sulfate, nitrate, ammonium, and trace elements including metals, elemental carbon, and organic carbon. The STN is designed to complement the FRM network.	State and Local Agencies
IMPROVE	162	Measures visibility conditions, tracks visibility changes, and determines causes for visibility impairment in U.S. National Parks and Wilderness Areas. In 1999, IMPROVE network of about 50 monitors increased to 162 monitors to supplement Regional Haze and $PM_{2.5}$ programs. IMPROVE network monitors are mostly located in rural areas, and provide measurements of regional and background levels of $PM_{2.5}$ concentrations. The same chemical components are measured by IMPROVE as are measured by the STN, although differences exist between the methods employed to collect and analyze the collected sample.	National Park Service and other Federal Land Managers*

* Includes Forest Service, Fish and Wildlife Service, and Bureau of Land Management.

Several other networks are also used to monitor $PM_{2.5}$. The previously noted FRM network, consisting of 990 monitors nationwide, measures the mass of $PM_{2.5}$, but not its chemical make-up. The Photochemical Assessment Monitoring Station (PAMS) network provides measurements of NO_X, volatile organic compounds, and ozone. The Clean Air Status and Trends Network (CASTNET) provides measures of sulfate, nitrate, and ammonium ions, nitric acid (HNO_3), and SO_2. Since the latter two measure NO_X, SO_2, or HNO_3, all of which play a role in $PM_{2.5}$ formation, some of the data generated from these two networks can also be supportive of developing and measuring progress with $PM_{2.5}$ emission reduction strategies.

In Fiscal Year 2004, EPA budgeted approximately $43.75 million for PM ambient air monitoring efforts. As shown in Chart 2.2, about $16.4 million was spent on speciation monitoring between the STN and the IMPROVE network, but the majority of those funds were dedicated to the operation of the current monitoring network and the analysis of monitoring samples. Collectively, the funds budgeted for improving both the existing speciation networks (STN and IMPROVE) totaled about $800,000.

Chart 2.2: FY 2004 Funding Budgeted for PM Air Monitoring (Total $43.75 million)



To implement a successful $PM_{2.5}$ attainment program, it is critical for EPA to have speciation data that identify and quantify to the greatest extent possible the chemical make-up of $PM_{2.5}$ particles and associated uncertainties in the measurements and, as such, assist in reliably tracing particles back to their source(s), and fully assist in accounting for chemical changes that occur after particles are released into the atmosphere. Knowing this information will better enable EPA and the States to control the sources of $PM_{2.5}$ and improve the quality of the air. Also, ambient $PM_{2.5}$ data are a primary method by which EPA and the States measure progress toward attaining safe air quality. Below is a description of how improved speciation monitoring data could improve EPA's $PM_{2.5}$ emissions inventory and modeling efforts.

Speciation Data Used to Groundtruth Emissions Inventory Estimates and Modeling Assumptions

EPA and the States primarily use three interdependent tools for managing its $PM_{2.5}$ programs: ambient air monitoring data, emissions inventory data, and atmospheric modeling.[9] These sources of information are used to make key management decisions, prioritize issues, budget resources, measure progress in meeting $PM_{2.5}$ goals, and develop effective control strategies. Of the three elements, monitoring data is the one most relied upon and recognized as the truest depiction of what is occurring in the ambient air. As a result, unless the improvement of monitoring data is a high priority to EPA, it will be limited in its ability to help effectively control $PM_{2.5}$.

[9] Although we did not perform an evaluation of EPA's emissions inventory or atmospheric modeling, EPA regional, State, and Regional Planning Organization (RPO) officials cited concerns about the reliability of these two sources of information. Likewise, a review performed by NARSTO reached similar conclusions.

Emission Inventories Verified With Speciation Monitoring Data

EPA maintains a database of air emissions information called the National Emissions Inventory (NEI). NEI contains annual emission estimates of stationary, area, and mobile sources of air pollution. With input from State, local, and tribal air agencies, EPA amasses this inventory for $PM_{2.5}$ and for each of the remaining five criteria air pollutants,[10] as well as estimates for the hazardous air pollutants, also known as air toxics. EPA, NARSTO, and the States have described emission inventories as the foundation to developing effective control strategies upon which everything else is built. For details, see Appendix D.

There are a variety of methods used by industry and the States to develop these emissions inventory estimates, some more reliable than others. One of the most reliable is when a facility has a Continuous Emission Monitor (CEM) installed at the point where the emissions are released into the atmosphere. These monitors are designed to measure the emissions on a continual basis, thereby increasing data accuracy and reliability. However, the majority of facilities do not have CEMs installed and must therefore rely on less dependable methods of estimating emissions. Often, facilities use emission factors generally developed by monitoring emissions from several facilities and computing an average emission rate, which is then applied to the entire industrial sector. This approach does not always accurately account for differences in plant operations such as raw materials used and equipment operated, and as a result is often recognized as unsuitable for estimating an individual facility's emissions.

EPA regional, State, and RPO officials expressed concerns about the $PM_{2.5}$ Emissions Inventory and how effective a tool it will be for developing control strategies. For example, one State official said he had low confidence in the existing inventories and that a good emissions inventory was, in his estimation, two generations of inventories (at least 6 years) away from being sufficient to rely on for developing control strategies. Likewise, previous studies performed by the Government Accountability Office, EPA Office of Inspector General, and NARSTO identified similar concerns.[11]

Through the use of air quality models, ambient monitoring data can be compared to emissions inventory data to determine the level of consistency between data sets and identify any discrepancies. When differences are identified, EPA generally examines how the emission inventory can be improved, recognizing that the monitoring data are the more reliable measure of atmospheric conditions.

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[10] Six common air pollutants found nationwide that harm human health and the environment are called *criteria* pollutants because EPA sets standards for these pollutants by first developing health-based criteria.

[11] GAO Report: EPA Should Improve Oversight of Emissions Reporting By Large Facilities (April 2001, GAO-01-46). OIG Report: Decline In EPA Particulate Matter Methods Development Activities May Hamper Timely Achievement of Program Goals (September 2003, Report No. 2003-P-00016). NARSTO Report: Particulate Matter Science for Policy Makers - A NARSTO Assessment (February 2003).

Emission estimates include not only $PM_{2.5}$ but also data on some of the components or precursors of $PM_{2.5}$, such as volatile organic compounds or semi-volatile organic compounds, SO_2, and NOx. Speciation data are used to determine whether the emission estimates are consistent with what is being measured on the filter. This comparison also helps EPA determine the extent to which $PM_{2.5}$ may have been secondarily formed in the atmosphere. The emissions inventory data are also used as an input to atmospheric modeling. Therefore, the reliability of the models – discussed in the next section – is dependent upon the accuracy of the emissions data, which is verified in part by the speciation monitoring data.

Modeling Efforts Rely on Both Emissions and Speciation Data

Atmospheric models are the primary analytical tool in most air quality assessments, which enables air quality managers to evaluate different emission reduction scenarios to predict the impact of achieving desired reductions and improving the air. The models allow model users to estimate the impact of various factors influencing air quality, including meteorological conditions, changes in emissions, and the effectiveness of proposed emission reduction scenarios. They do this by making assumptions about the origin of particles, the type of particles, the effectiveness of control strategies, and a host of other factors called model inputs. For details on atmospheric modeling, see Appendix E.

There are two key models used for assessing the $PM_{2.5}$ and precursor impacts of various sources, also known as source apportionment, and these models are only as accurate as the data (emissions and monitoring data) used to generate the modeling results. Specifically:

- ***Chemical Transport Models*** help EPA identify individual $PM_{2.5}$ emitters at the facility level by using data from the emission inventory, along with meteorological conditions, to forecast changes in atmospheric concentrations if emission rates change. These models are important because they provide a means of linking primary $PM_{2.5}$ and precursor emissions with those that are formed secondarily in the atmosphere. Also, transport models assist in the improvement of the emission inventories and ambient monitoring networks.

- ***Source Receptor Models*** are not used to predict future ambient conditions, but they explain events that have occurred, thus leading to an improved understanding of the atmospheric impact. Receptor models start with inputs of monitoring data, and work backward to determine the sources that are contributing to levels of $PM_{2.5}$ found at the monitoring sites, also known as receptors. Receptor models help identify general source categories such as diesel exhaust or coal-fired power plants, known as source apportionment.

EPA and State officials we contacted agreed that more analysis should be done in the area of tracer species analyses, and that the source profiles found in the SPECIATE database need to be updated. Further, NARSTO's February 2003 study concluded that similar improvements were needed. EPA recently initiated an update of the database that it plans to complete in 2005. EPA officials estimate that this area could be improved within 3 to 5 years, if it receives the proper funding and priority.

EPA, State, and RPO officials said there is room for improvement with regard to the current models and, as the science progresses, the models should also improve. NARSTO reported that chemical transport models can properly represent the formation of sulfate. However, the formation of nitrate is more difficult to represent because it requires knowledge of temperature, relative humidity, and ammonia concentrations. The current state of scientific understanding on the formation of secondary organic aerosols is insufficient, and as a result $PM_{2.5}$ modeling predictions at the present time have substantial uncertainties. Continuous and semi-continuous speciation data would help decrease these limitations.

Speciation Data Needed to Improve Understanding of PM Exposure and Health Effects

Current NAAQS for PM are supported by findings from epidemiological studies that have demonstrated positive associations between ambient PM mass measurements and observed health impacts. As a result, the current PM NAAQS uses particle mass as the indicator for the standard. However, there are questions about the relative toxicity of various PM species and PM from various sources, as well as whether a NAAQS that is based upon a metric other than mass is needed. PM speciation data are needed to address these questions. Specifically, data are needed to characterize the spatial (space) and temporal (time) patterns of PM species and PM from various sources to improve our understanding of human exposure to PM. This information in turn is important for epidemiological studies that are investigating associations between observed health impacts and exposure to PM species. However, the spatial and temporal gaps in the existing speciated monitoring programs make it difficult to understand whether ambient measurements of PM species are relatively homogeneous or heterogeneous across space and time, which in turn makes it difficult to classify human exposure for epidemiological studies. Enhanced speciated data are needed to address this problem.

Chapter 3
EPA Faces Many Challenges In Identifying and Controlling Fine Particulate Matter

Although EPA has made substantial progress in establishing a speciation monitoring network that assists it in identifying and controlling sources of $PM_{2.5}$, the Agency faces a number of challenges in implementing a program that ensures that controls are implemented at the right sources. Although the speciation network provides some information for understanding the make-up and origin of $PM_{2.5}$, the data provided by the network do not presently allow EPA and States to identify and quantify the chemical make-up of $PM_{2.5}$ particles to a sufficient degree to reliably trace particles back to their source of origin, or fully account for chemical changes that occur after particles are released into the atmosphere. There are some speciation data available to begin developing control strategies, but EPA and the States are not yet equipped with the speciation information necessary to fully develop effective control strategies that take into account a full understanding of $PM_{2.5}$ chemical make-up, its sources, and the extent to which each source contributes to overall $PM_{2.5}$ levels.

EPA still has time to overcome these challenges, but increased efforts will be needed to ensure that the States meet the milestones associated with reducing harmful levels of $PM_{2.5}$ expeditiously and at the least cost to industry. One of the more promising approaches to obtaining information for better understanding, tracking, and helping to control $PM_{2.5}$ is the use of continuous and semi-continuous monitors that would measure real-time $PM_{2.5}$ levels. Semi-continuous monitors for speciation are available for carbon, nitrate, and sulfate. However, to date, continuous speciation data are limited, and improved speciation monitors are needed to overcome this challenge. Increased partnering with $PM_{2.5}$ monitor manufacturers may help expedite not only the use of continuous monitor data, but may also result in the development of other advanced speciation monitor methods. Key Agency officials agreed that continuous and semi-continuous speciation monitors would be the most likely approach to providing the robust data set needed.

Limitations of Current Tools Used to Monitor and Assess $PM_{2.5}$ Air Quality

The speciation network, emission inventories, models, guidance documents, and national control efforts are the primary tools EPA uses to operate its $PM_{2.5}$ program. These tools provide EPA officials with the information for making key management decisions, prioritizing issues, budgeting and allocating resources, and measuring progress in meeting its $PM_{2.5}$ program goals of reducing $PM_{2.5}$ to safe levels. Because EPA recognizes that these tools need improvement, the

Agency is working to increase the reliability and usability of the information. Table 3.1 elaborates on the uses and limitations of each of these tools.

Table 3.1: Uses and Limitations of Tools To Develop Control Strategies

Tool	Uses	Limitations
$PM_{2.5}$ Speciation Monitoring Program	Resulting data used to verify, evaluate, improve, and "groundtruth" emission inventories and models. Much is also learned from data analysis efforts toward understanding atmospheric processing and accumulation of $PM_{2.5}$ on local and regional scales.	States need more and improved speciation monitoring data to adequately identify and control sources of $PM_{2.5}$. Difficulties exist in adequately determining carbon composition, such as the fractions and individual species of carbon; accounting for secondary formation; and obtaining real-time data. There are no standards to assess uncertainty and biases in monitoring data. Limited partnering with monitor manufacturers hampers development of monitor advancements.
$PM_{2.5}$ Emission Inventories	Used to support monitoring activities and as data input into atmospheric modeling.	EPA officials, States, and RPOs expressed concerns about the reliability of emission inventories. For example, the accuracy and representativeness often are limited for emission factors and activity factors.
$PM_{2.5}$ Models	Plans and predicts effectiveness of specific control strategies and identifies relative source contributions; helps to support and improve monitoring data and emission inventories; also assists in monitor siting.	EPA officials, States, and RPOs expressed concerns about the reliability of models. Current modeling predictions have large uncertainties. Much room for improvement, especially as science progresses.
Guidance Documents	Provides specific requirements, deadlines, and suggestions to State, local, and tribal agencies regarding development of control strategies and related efforts to lower $PM_{2.5}$ levels.	State officials must begin developing control strategies in February 2005, but EPA does not plan to issue guidance for developing the strategies until June 2005. State officials anticipate the guidance will not be specific enough to adequately assist the States.
National $PM_{2.5}$ Controls	National efforts specifically designed to address transport of $PM_{2.5}$ across State borders.	The Clean Air Interstate Rule and Nonroad Diesel Rule will not be implemented until after the SIPs are due.

Ideally, all these tools should be fully developed today in order to place State, local, and tribal agencies in the best position to begin developing their control strategies in February 2005. State officials also expressed concern that they will not have sufficient information to develop effective strategies within the time allotted due partly to the limitations with each of these tools. As noted above, EPA does not anticipate issuing the guidance for developing control strategies until June 2005, eliciting concern among some State officials we contacted.

Challenges in Measuring Carbon and Ammonium, and Accounting for Transport, Make it Difficult to Fully Identify and Quantify Components of $PM_{2.5}$

Generally, $PM_{2.5}$ consists of six major components: sulfate, nitrate, ammonium, organic carbon, elemental carbon, and crustal material, the latter estimated from a group of trace metals that come primarily from soil. Because the composition of $PM_{2.5}$ differs in various parts of the country, it is important for States to know the prevailing composition of $PM_{2.5}$ in their area to adequately regulate the pollutant. The speciation network is one of the most important tools available to the States and EPA to estimate the composition of $PM_{2.5}$. However, there are limitations associated with existing speciation monitors, and some officials are concerned about how this may impact their efforts to ensure that controls are implemented at the right sources. If not properly implemented, some facilities may install unneeded controls, while some needed controls may go uninstalled. Ultimately, compliance may be further delayed and more costly, and more people will suffer adverse health effects longer.

An EPA regional official told us that in developing control strategies to address local pollution problems, the State will need to manage with the data that exists. The challenges presented to the States are greatly compounded by the fact that over half of the $PM_{2.5}$ is secondarily formed in the atmosphere. To fully identify and quantify the components of $PM_{2.5}$ and to accurately identify the source of the particle, EPA and States will need to better understand:

- The chemical make-up of the particle, especially the carbon components;
- Chemical reactions that occur to the particle after it is released into the atmosphere, especially ammonia's impact; and
- The transport of $PM_{2.5}$, wherein particles may travel considerable distances from their point of origin depending on meteorological conditions and the size of the particle.

EPA will need to increase its efforts in the research of $PM_{2.5}$, including the development of more sophisticated methods for monitoring and measuring $PM_{2.5}$.

More Information Needed on Carbon Components to Accurately Identify Sources of $PM_{2.5}$

Carbon is arguably the most important constituent of $PM_{2.5,}$ and is estimated to comprise between 30 and 60 percent of the total $PM_{2.5}$ mass, with considerable variability between locations and over time. EPA officials stated that because carbon is a difficult pollutant to measure, sample, and analyze, not enough is currently known about the carbon component of $PM_{2.5}$. EPA officials said that as $PM_{2.5}$ levels decrease and as carbon becomes more prevalent, knowing more about the carbon component will assist the Agency in evaluating emission reduction strategies and gauging progress in reducing PM.

A senior Office of Air Quality Planning and Standards (OAQPS) official told us that EPA knows enough about how much of $PM_{2.5}$ is carbon, but they need more information on what type of carbon compounds comprise the $PM_{2.5.}$ The official explained that to better understand the carbon component of $PM_{2.5}$, EPA needs to know more about the two fractions of carbon – elemental and organic, as well as the individual species that compose the organic carbon fraction. Accurately measuring organic species is critical to help identify the source of up to 70 percent of the particles, a key step in developing control strategies. For example, the elemental carbon can be the result of forest fires or the combustion of diesel engines, while some organic particles originate from the combustion of gasoline engines as well as from a number of natural sources (e.g., forest fires). Without knowing the breakdown of the carbon component, EPA and the States' ability to target the source of the pollution may be hindered. A senior OAQPS official said there needs to be more work in organic chemistry if EPA is to better understand the impact of the organic component on air pollution. He also said that this will largely be accomplished through the development of new and advanced monitors that measure the organic species of $PM_{2.5}$. He did not believe the present monitors employed by the STN and IMPROVE network would provide these data.

Knowing more about organic species in the air is important because it will further EPA's understanding of atmospheric events as they relate to air pollution and improve the Agency's capacity to model pollution events, evaluate emission inventories, and better understand the link between sources and locations where people are exposed to air pollution. In its February 2003 report, NARSTO also emphasized the need for improved organic speciation monitoring, stating that:

> *Current organic speciation explains only 10 to 20 percent of total organic compounds in the aerosol phase, and more work in this area is needed.*

In agreement with NARSTO, the Agency noted that sufficient speciation of organic aerosols will require improvements in both monitoring and analytical capabilities. However, as noted above, the funds budgeted for improving the existing STN and IMPROVE network were less than 5 percent of the ambient air monitoring funds budgeted for the $PM_{2.5}$ speciation program.

It should be noted that ORD is working with OAQPS, the research community, States, the IMPROVE community and other Federal agencies, and academia to better understand both collection and analysis methods for measuring carbon. Examples of this collaboration include the Supersites Program and two recent solicitations from the Science to Achieve Results (STAR) program, ORD's extramural research grants program. Also, for the last 4 years, EPA has operated an analytical laboratory dedicated to measuring organic compounds in PM. EPA is also working collaboratively with the Supersites Program and the PM Health Centers to better measure and characterize organic aerosols in an effort to identify which compounds produce the highest risk to human health. However, our work suggests that EPA will need to invest more in this complex area to sufficiently understand the carbon component of $PM_{2.5}$, where the particle originated, and the potential impacts on human health.

Increased Effort Needed to Fully Understand the Impact of Ammonia on $PM_{2.5}$

$PM_{2.5}$ is formed in two ways – primary formation and secondary formation. Primary formation of $PM_{2.5}$ occurs when a particle with a stable chemical form is directly emitted into the air as a solid or liquid. This type of $PM_{2.5}$ is more easily traced to its original source because its components have not been altered since leaving the source. However, often over half of $PM_{2.5}$ in the ambient air is a result of secondary formation, which occurs when chemical reactions of gases in the atmosphere either form new particles or condense onto other particles in the air. Two common forms of secondarily formed $PM_{2.5}$ occur when acid sulfates and nitric acid react with ammonia in the atmosphere, creating ammonium sulfate and ammonium nitrate, respectively.

EPA and State air quality managers told us that the sulfate-nitrate-ammonium phenomenon presents a formidable challenge to them in identifying particle origin and developing an effective control strategy. According to EPA studies, when ammonium sulfate is collected on a Teflon filter, it typically absorbs moisture and increases in mass. However, the Teflon filter is equilibrated under controlled conditions to minimize the amount of water adsorbed to ammonium sulfate. Overestimation of $PM_{2.5}$ due to moisture adsorption is especially important because the $PM_{2.5}$ NAAQS standard is based on particle mass. The adsorption of water for ammonium sulfate has been eliminated in the speciation monitoring network due to the use of the nylon filter and analytical measurement techniques used.

Conversely, the $PM_{2.5}$ mass of ammonium nitrate may be underestimated because nitrates are volatile in nature. EPA's Speciation Guidance document notes that "nitrate losses during and after sampling have been well documented." Up to 50 percent of ammonium nitrate can be lost due to volatilization, generally due to evaporation when the temperature rises during and after collection on the Teflon filter. Studies are needed to determine how much nitrate is lost on the nylon filter. Measuring ammonium nitrates is further complicated by the fact that once on the filter, ammonium nitrate can break apart and return to its original compounds of nitric acid and ammonia, depending on air temperature and humidity conditions. The STN and the IMPROVE network address the volatilization loss with the use of nylon filters which chemically bond with the nitric acid, thereby retaining the deposit on the filter. However, ammonium is more complicated because the nylon filter does not bond with the ammonia, which could result in volatility loss.

From an emissions inventory perspective, ammonia is the least understood of these three interacting compounds. The largest sources of ammonia are generally unregulated by EPA and the States at the present time and, as a result, EPA is unable to determine the amount of ammonia emissions. Ammonia does provide an environmental benefit in some instances by neutralizing acid (sulfuric and nitric acids). Also, the costs and benefits of regulating ammonia are not fully understood. For example, airborne ammonia is more likely chemically to combine with acid sulfates over nitrate when more acid sulfate is available. When sulfate is controlled and levels are reduced, the excess ammonia chemically combines with nitrate instead to create ammonium nitrate. Although there is some research being conducted in this area, unknowns regarding such ammonia interactions impact EPA's ability to effectively control $PM_{2.5}$ and make it difficult to develop a clear strategy for reducing $PM_{2.5}$ to safe levels.

EPA officials told us that if EPA had more information on ammonia, the Agency could better inform decisionmakers on the potential advantages and disadvantages of regulating ammonia. As a result, EPA has taken steps to start an emission inventory for ammonia. The speciation network could play a major role in improving the Agency's understanding of ammonia by providing a constant measure of this gas phase species through the speciation network. According to an ORD official, measurements of ammonia and nitric acid, while desired, have not been included in the network due to operational resources and cost. These are gaseous, not particle, species, and therefore cannot be obtained from particle filter measurements made by the Speciation network and require different sample collection and analysis methods. However, the envisioned NCore Level 2 sites[12] plan to measure ammonia and nitric acid as part of the multi-pollutant strategy.

More Accurate Accounting of Particle Transport Vital to Determining Source of $PM_{2.5}$

One of the most challenging aspects of identifying and controlling $PM_{2.5}$ is what happens to the particle after it is emitted from the pollution source; whether it comes from a stationary, area, or mobile source; or whether it is formed secondarily in the atmosphere. Finding the source of particles is difficult not only because the particles can change composition and molecular make-up, but particles are also capable of regional transport. Particles may travel considerable distances from their point of origin depending on meteorological conditions and the size of the particle. Airborne $PM_{2.5}$ has a lifetime of several days, enabling particles to be carried hundreds and sometimes even thousands of miles in some instances.

According to the NARSTO study, as well as EPA and State officials we contacted, $PM_{2.5}$ nonattainment problems typically result from a combination of local source emissions and transported emissions from upwind areas. The Clean Air Act requires that a SIP contain adequate provisions to prohibit sources in one State from emitting air pollutants in amounts that contribute significantly to nonattainment, or interfere with maintenance, in one or more downwind States. To adequately address the transport issue and ultimately bring areas of the country into attainment, EPA plans to combine simultaneous emission reduction efforts at the local, regional, and national levels. However, with the annual cost of compliance to industry estimated at more than $37 billion by the year 2010, there are concerns that without improved speciation monitoring data on carbon, ammonium/ammonia, and transport, some sources may dispute whether they are the source of the $PM_{2.5}$ emissions.

[12]The NCore network is EPA's plan to repackage and enhance their existing ambient air monitoring networks. EPA wants to more effectively leverage all of the existing major networks to produce an integrated multiple pollutant approach to air monitoring. The overall structure of Ncore will range from the most complex near-research grade sites (Level 1) to sites which measure only one pollutant (Level 3).

EPA Has Made Efforts to Address Challenges in Obtaining Speciation Data to Identify Sources and Develop Control Strategies

EPA has several efforts underway to enhance its $PM_{2.5}$ speciation monitoring capabilities, including: (1) attempts to supplement the STN data with speciation data from the IMPROVE Network; (2) a continuous speciation monitoring pilot study to assess the viability of these continuous monitors supplementing the speciation data obtained from the STN; and (3) various speciation monitoring research efforts to better understand the unknown characteristics of $PM_{2.5}$, such as the PM Supersites Program. The Agency's work in each of these areas is critical for EPA and the States to effectively manage their $PM_{2.5}$ programs. To make the progress necessary to control excess levels of $PM_{2.5}$ within the time frames mandated by the Clean Air Act, EPA will need to more vigorously pursue existing projects and undertake new efforts to improve its ability to effectively regulate $PM_{2.5}$. Below is a description of EPA's ongoing efforts, the benefits derived, and the work still needed to adequately identify sources of $PM_{2.5}$ and facilitate the development of effective control strategies to reduce $PM_{2.5}$ to safe levels.

Supplementing STN With IMPROVE Data Provides Some Useful Information But Compatibility Is Limited

One way EPA is trying to obtain sufficient speciation data to identify sources of $PM_{2.5}$ is by taking advantage of data generated from the IMPROVE network, a collection of 162 rural monitors operated primarily by the Department of Interior's Federal land management agencies, along with State, local, and tribal agencies. However, because the purpose, design, and desired results of the IMPROVE and STN vary significantly, there are mixed views within EPA regarding the extent to which IMPROVE can supplement the STN, and, as such, differing views on the level of effort that should be expended in trying to make the two networks compatible. Table 3.2 shows key differences in how the monitors were manufactured, where they are located, and how they are operated.

Table 3.2: Comparison of IMPROVE and STN Networks

Key Features	IMPROVE	STN
Location	Rural Areas	Urban Areas
Sampler Design	One design for the entire network	Samplers are provided by four manufacturers, each with its own design, but they have been shown to be comparable for most species. Approximately 90 percent of the monitors were supplied by one of the four manufacturers.
Operation & Maintenance	Trained federal land managers	Professional air quality monitoring technicians
Frequency of Filter Replacement	Every third day	Every third day
Shipping & Handling	Regular mail - no temperature control. ORD and OAQPS are involved in a study to determine if the shipping method impacts the amount of semi-volatile material collected on the filters. Preliminary results are expected soon.	Shipped by a commercial carrier - cold storage to preserve accuracy of results.
Measurement Differences	Utilizes specific blank correction techniques for reporting carbon data.	Does not utilize specific blank correction techniques for reporting carbon data.

Started in 1985 with about 50 monitors, the IMPROVE network was designed to help monitor visibility in the U.S. National Parks; as such, the IMPROVE monitors were sited in rural areas throughout the United States. The STN was established in 1999 by EPA regulation as a companion to the mass-based FRM network, which measures particle mass for compliance with the $PM_{2.5}$ NAAQS health-based standard but does not speciate particles. Because EPA's principal focus is protection of public health, the STN is located in highly populated urban areas, contrary to the rural IMPROVE monitors.

While the design is different between the two networks (rural vs. urban), both networks collect and measure the same species (see Table 3.2). However, there are differences in the collection and analysis methods which can result in differences in the reported concentrations by each type of monitor. In addition, the IMPROVE network measures light-absorption and light-scatting because of their importance to understanding visibility degradation in clean areas. Filters from both the STN and IMPROVE monitors are collected and analyzed every 3 days; however, officials told us that continuous data are also important because it provides real-time data.

EPA and some RPOs are conducting comparison studies to identify whether the data from the two networks are comparable. In 2001, EPA selected six locations (three urban and three rural) and sited an IMPROVE monitor next to an STN monitor to determine the compatibility of the two networks by comparing how closely the monitoring results matched. At the time of our work, there was not a firm completion date for the comparison study; however, the ORD official responsible for overseeing the study told us that the first 2 years of data will be presented to EPA and State officials at a conference scheduled for February 2005. During 2004, EPA phased in the implementation of an additional 9 urban sites, and expects data to become available beginning in the Fall of 2005.

Although preliminary findings from the study have shown similar results for sulfate measurements, EPA and State officials have concerns about the compatibility of the two networks primarily because of the differences in some of the $PM_{2.5}$ constituents each network measures. For example, EPA has found that because the STN and IMPROVE monitors use different methods for measuring carbon, the amount of elemental carbon is overestimated by the IMPROVE method and underestimated by the STN method. Likewise, there are some differences in how sulfate is reported. However, a senior OAQPS official said that based on the first year of results from the six-city study, the impact of these differences is negligible.

The difficulty of finding a method to make the carbon data of the two networks agree has fueled the discussion of what should be done in the interim to help EPA and State, local, and tribal agencies identify sources and develop effective control strategies. Views are mixed within EPA on how to proceed with integrating the IMPROVE network and the STN. One viewpoint is that the most practical and logical approach would be to move toward more consistency and compatibility by replacing the STN with new IMPROVE samplers. In 1999, State officials and others within EPA believed that because the IMPROVE monitor was designed for use in rural areas, where pollution levels are generally lower, it was still uncertain how the monitors will perform in urban areas. However, EPA officials stated that, over time, this became less of a concern because initial results showed the IMPROVE monitors functioned well in urban areas. Still, there are some EPA officials who believe that instead of replacing the STN, it is more reasonable to continue their ongoing efforts to make the data of these two networks more compatible.

EPA is working to better understand the uncertainties associated with the two methods, including ORD's program for examining the analytical differences between the STN method and the IMPROVE method for measuring carbon. To clearly understand the extent to which these two networks are compatible, EPA will need to invest more in identifying the differences between the two networks and resolving the uncertainties identified. Answers to these questions will be important in designing and implementing effective pollution control strategies.

Continuous Speciation Monitor Pilot Study May Help Identify Sources and Develop Control Strategies

Monitor manufacturers and State and EPA officials we contacted said that continuous speciation monitors are among the more promising near-term technologies for understanding the components of $PM_{2.5}$. In July 2002, EPA began a pilot study to test three types of continuous monitors – nitrate, sulfate, and carbon – to determine how compatible these continuous monitors were with the STN monitors, and to what extent the monitors can be used to supplement the STN. The study was scheduled to be completed by July 2005 and initially planned for 12 sites, with each site having the three continuous monitors sited beside an existing STN monitor. In August 2004, the OAQPS official responsible for performing the study told us that EPA had deployed continuous monitors at 5 of the 12 sites, is planning to add 3 sites by the end of 2004, and then add the remaining 4 sites in 2005.

EPA acknowledged that the study is behind schedule, and explained that there were some modifications needed on the monitoring equipment after the monitors were deployed. The OAQPS official also said that monitor manufacturers have been reluctant to address some of the equipment malfunctions because it is uncertain whether EPA will commit to ordering more of the continuous monitors in the future. The results of the study will help States develop effective control strategies; however, delays in completing the study may adversely impact the development of these strategies. As noted above, States must begin developing control strategies in February 2005, 4 months before the pilot study is scheduled to be completed. At that time, it appears that EPA will only have partial results on how continuous monitors can supplement the STN.

As shown in Table 3.3, for the three types of monitors (carbon, sulfate, and nitrate), the findings from the pilot study have been mixed.

Table 3.3: Status of EPA Pilot Study of Three Continuous Monitors

Monitor Type	Advantages / Limitations	Status
Continuous Carbon	Provides real-time data. Measures lower than the STN samplers at all sites.	July 2005[a]
Continuous Sulfate	Provides real-time data. Compares well with the STN samplers when the concentrations of sulfate levels are low. Does not compare as well at higher sulfate levels.	July 2005[a]
Continuous Nitrate	Provides real-time data. Consistently lower than the STN sampler measurements; however, there is better agreement at lower nitrate levels.	July 2005[a]

[a] As noted above, EPA is behind schedule with the study due to problems encountered deploying the monitors and the monitor manufacturers making the necessary modifications. By the end of the 3 years (July 2005), it is not likely that EPA will have collected the amount of data originally anticipated.

In addition to continuing the pilot study, EPA officials said they plan to work with monitor manufacturers to seek improvements of the existing monitors and to evaluate different continuous monitors at new sites. Through discussions with EPA and the monitor manufacturers, we found that there is room for improved communication among both parties. For example, the Chief Executive Officer of one leading monitor manufacturer told us that it would be helpful to them if EPA were to more clearly articulate its plans for speciation monitors, so that manufacturers could prioritize their own research and development efforts. With improved communication, both parties could better resolve problems identified and more quickly implement the continuous speciation strategy. EPA officials said that when acceptable performance has been demonstrated with continuous monitors, the Agency will increase the use of real-time data on the amount of sulfate, nitrate, and carbon found in ambient air. This will help identify particle origin and develop effective control strategies.

Supersites Studies Will Increase Understanding of $PM_{2.5}$

EPA has several ongoing efforts to better understand and characterize the properties of $PM_{2.5}$, with the PM Supersites Program being by far the most prominent effort. The PM Supersites Program is a $26.5 million ambient monitoring research program designed to compare and evaluate different monitoring methods, as well as testing new and emerging measurement methods that may ultimately advance the scientific community's ability to measure the physical and chemical components of PM in the air. The program is intended to help address the scientific uncertainties associated with the measurement of ambient concentrations and atmospheric processes, and source-receptor relationships of $PM_{2.5}$. The Supersites Program also was designed to support health and exposure studies, but not fund them directly. EPA established eight Supersites in 1999 and 2000 through 5-year cooperative agreements with leading atmospheric sciences universities throughout the United States. The PM Supersites Program results should help EPA and the States with their efforts to develop effective control strategies.

With regard to understanding continuous monitors, the Supersites Program is evaluating several different continuous monitors by performing side-by-side comparisons at several of the sites. The studies include not only identifying differences in the results of the monitors, but also trying to understand why these differences occurred. For more details on the Supersites Program, see Appendix F.

ORD recognizes that the Supersites Program findings will aid EPA and States with their efforts to develop effective control strategies. As shown in Table 3.4 below, two of ORD's Annual Performance Measures (APM) under the Government Performance and Results Act (GPRA) relate to EPA's efforts in identifying and controlling $PM_{2.5}$.

Table 3.4: Key EPA Research and Development GPRA Measures

ORD Annual Performance Measure Under GPRA	Description
ORD 2005 APM[a]	*Deliver to OAR, States, and the scientific community data from the Supersites program via an internet accessible large relational database that can be utilized for air quality model evaluation and to perform integrated analyses of data from the various Supersites locations.*
ORD 2006 APM[b]	*Deliver to OAR and the States results from the Supersites program that can be used to prepare and evaluate SIPs [including control strategies]*

[a] Completion of the APM is expected no later than September 30, 2005.
[b] Completion of the APM is expected no later than September 30, 2006.

ORD's PM Research Program Includes Efforts to Improve Speciation Data and Source Identification

ORD is conducting research to address some of the limitations and challenges related to measuring and modeling speciated PM and improving source apportionment. Resources to address these issues in ORD's in-house research program total approximately $3 million annually and include:

- Organic aerosol sampling and analysis methods development;
- Development and application of receptor modeling tools;
- Analysis of PM Elemental composition by X-Ray Fluorescence;
- Development of chemistry modules for secondary organic aerosols and aerosol nitrates;
- Improved measurement methods for elemental carbon/organic carbon and for speciating organic PM;
- Evaluation of continuous methods for sulfate, nitrate, and carbon and related precursor species;
- The Detroit Exposure and Aerosol Research Study – includes research to understand human exposure to PM species and PM sources and to understand spatial and temporal distributions of PM species;
- PM Supersites Program;
- Development and evaluation of the Community Multiscale Air Quality chemical transport model, including specific improvements in predicting organic PM and nitrates; and
- Inverse modeling to improve ammonia emission inventories.

ORD's extramural grants program, Science to Achieve Results (STAR), recently issued two related grant solicitations. The first solicitation, *Measurement, Modeling, and Analysis Methods for Airborne Carbonaceous Fine Particulate Matter*, resulted in 16 grant awards totaling approximately $6.6 million. The goal of this grant solicitation is to conduct research that would improve measurement methods, models, and analysis techniques used to quantify emissions and ambient concentrations of $PM_{2.5}$. The focus is on studies that will provide insights in, and improved techniques to quantify, the organic and elemental carbon fractions of $PM_{2.5}$ and to more fully understand the specific chemical species that make up the organic fraction. The research results from the solicitation will allow identification of significant sources of $PM_{2.5}$ and enable EPA, State, local, and tribal agencies to design more effective and efficient air quality management plans. According to ORD officials, early results, such as journal articles, are expected by late 2005 and final results by 2008. The titles and institutions for each of these grants are included in Appendix G.

The second STAR solicitation, *Source Apportionment of Particulate Matter*, is expected to result in 11 grant awards totaling approximately $4.5 million dollars. The award of these grants is anticipated by early 2005.

Increased Partnering with Monitor Manufacturers Could Improve Monitoring Capabilities and Uses

EPA and State officials agree that there is a need for increased use of continuous speciation monitors that provide real-time information on the $PM_{2.5}$ collected at the monitoring site. Real-time data provide a more accurate depiction of what is occurring in the atmosphere, accounts more fully for meteorological impacts, and better pinpoints the sources of $PM_{2.5}$. Likewise, continuous monitoring data will provide the scientific community and the regulatory community with more useful data in overcoming the challenges associated with understanding and controlling $PM_{2.5}$. However, EPA and State officials, as well as monitor manufacturers, acknowledge that continuous speciation monitors need improvement before these monitors can effectively provide what is needed. Although EPA is currently conducting a pilot study to test continuous monitors in coordination with a major monitor manufacturer, both EPA and monitor manufacturer officials we contacted agreed that increased effort in developing effective continuous monitors is needed to meet the needs of the State, local, and tribal users.

EPA awards limited funding to monitor manufacturers for the development of new and improved monitors. However, an overall lack of partnering between EPA and $PM_{2.5}$ monitor manufacturers has contributed to limited progress in developing and deploying continuous monitors that would measure real-time $PM_{2.5}$ levels. The limited partnering is attributed, in part, to the manufacturers not having sufficient assurance that the research and development efforts will be worth the investment. OAQPS officials said that this lack of assurance results from the low number of monitors that EPA is often requesting. For example, EPA is interested in obtaining monitors for 12 sites, with several monitors at each site, totaling 30 to 40 monitors. OAQPS officials said that this volume of monitors does not provide EPA much leverage in influencing the manufacturer’s use of research and development resources. Monitor manufacturers we contacted told us they are seeking improved communications and more commitment from

EPA through both increased funding provided by the Agency and more certainty that there will be sufficient demand for the monitor when it is ready for use.

The Chief Executive Officer of one leading ambient air monitor manufacturer told us there was a need for stronger EPA leadership in developing partnerships with monitoring manufacturers, which would help his company prioritize the most worthwhile and promising projects to develop. He told us that, with a limited budget, his company must select between EPA and other governmental agencies as to what they believe to be the most worthwhile research and development projects for them to pursue. With regard to development of an improved monitor, the Chief Executive Officer said that EPA is becoming a lower priority because the Agency is not doing enough to involve and lead the monitoring manufacturers to the research and development areas that would be most promising. For example, the manufacturer has considered discontinuing the research and development of two promising continuous and near continuous speciation monitors because of a lack of partnering with EPA. One effort involved the development of a monitor that would record hourly measurements of specific metals frequently found in $PM_{2.5.}$ The second effort was to develop a continuous monitor to measure ultrafine particles.

A senior OAQPS official agreed that increased partnering was an "excellent suggestion," and that by providing manufacturers with increased research and development funding, the Agency would demonstrate a stronger commitment to the effort. Importantly, he noted that in his view EPA would need the more robust data provided from continuous monitors if EPA and the States are going to fully understand the chemical composition of particles, understand what happens to a particle after it is released in the atmosphere, and trace a particle to its origin. These are the steps necessary to ensure that States develop effective control strategies.

Conclusions

In September 2004, EPA researchers not only reconfirmed the previously identified serious health effects of exposure to excess levels of $PM_{2.5}$, but also found that such exposures adversely impact the heart. EPA officials agree that this is an acute health problem that needs to be addressed expeditiously. The Agency has made substantial progress in establishing a speciation monitoring network to aid in identifying and developing controls for sources of $PM_{2.5}$, but still faces a number of challenges in implementing a program that ensures that the controls are implemented at the right sources. With estimates of annual control costs to industry exceeding $37 billion by 2010, EPA is likely to face substantial implementation challenges unless the Agency can to a greater extent identify and quantify the chemical make-up of $PM_{2.5}$ particles and, as such, reliably trace particles back to their source of origin, and account for the changes that occur after particles are released into the atmosphere. Despite several years of effort, EPA's STN does not presently do this with sufficient certainty for all the constituents of $PM_{2.5}$.

EPA still has time to overcome these challenges, but increased efforts appear to be needed to ensure that these data will be available to help State, local, and tribal agencies meet the milestones associated with reducing harmful levels of $PM_{2.5}$ expeditiously and at the least cost to industry. It is highly important that controls be implemented at the right sources. Otherwise, some facilities may install unneeded controls, while some needed controls may go uninstalled; ultimately, compliance may be further delayed and more costly.

Recommendations

Due to the adverse health effects occurring annually from $PM_{2.5}$, as well as the estimated $37 billion annual compliance cost in the year 2010 to industry, we recommend that the Assistant Administrator for Air and Radiation, in collaboration with the Assistant Administrator for Research and Development, expand and expedite EPA's efforts to overcome the challenges associated with identifying and controlling $PM_{2.5.}$ In particular, we recommend that EPA:

3-1 Increase from 5 to 10 percent the OAQPS funding allocated for performing analytical assessments, adopting new methods, and conducting research on technologies that can more fully assist in identifying the chemical make-up of $PM_{2.5}$, account for the atmospheric impacts on $PM_{2.5}$, and assay the resultant changes that occur to the composition of the particle, with particular emphasis on:

a) Increasing and improving the speciated data for the six major components of $PM_{2.5}$ (sulfate, nitrate, ammonium, organic carbon, elemental carbon, and crustal material). This could be accomplished largely by the increased development and use of continuous speciation monitors.

b) Enabling EPA and State, local, and tribal agencies to perform more sophisticated analyses, through source-receptor modeling and other analysis and modeling methods, to better identify the source of the $PM_{2.5}$ and fill the gaps in the data generated from the STN and IMPROVE networks.

3-2 Identify the uncertainties associated with the comparability of similar speciation monitoring methods, such as the IMPROVE and STN methods, and develop short- and long-term plans to address these uncertainties and increase the usability of the data generated from the various speciation networks. Specifically:

a) Complete the six-site comparability study and incorporate the results of the study into Agency decisionmaking.

b) Expedite Agency efforts to determine whether the STN and IMPROVE monitors can produce adequately comparable data and, if not, determine which method should be further deployed to increase data consistency.

3-3 Increase Agency efforts to develop the data needed to conduct the more advanced analyses necessary to understand the behavior, characteristics, and chemical composition of $PM_{2.5}$, including:

a) Increasing efforts to develop methods to collect and measure source profiles at emissions sources, and the respective tracers in ambient air that uniquely identify those sources.

b) Identifying and minimizing the uncertainties associated with measuring the organic fraction of $PM_{2.5}$.

c) Adding the capability to measure ammonia to the ambient Speciation Network.

d) Developing and deploying continuous speciation monitors that help provide the real-time data needed to more accurately depict what is occurring in the atmosphere on a real-time basis and better pinpoint the sources of $PM_{2.5}$.

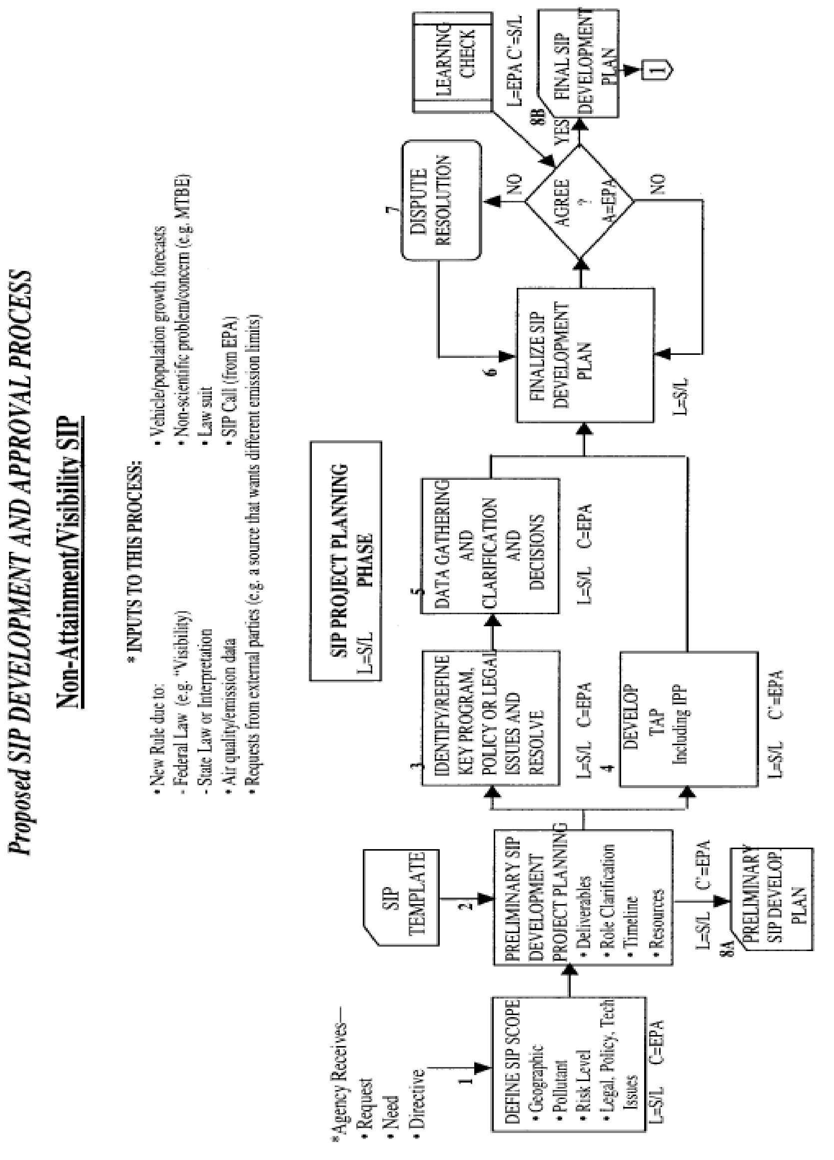
3-4 Address the challenges described in Recommendations 3-1, 3-2, and 3-3 by establishing a new workgroup or through an existing workgroup, comprised of officials from OAQPS, ORD, and selected EPA regions; State, local, and tribal agencies; State and Territorial Air Pollution Program Administrators/Association of Local Air Pollution Control Officials; RPOs; affected industries; academia; and monitor manufacturers.

3-5 Through the workgroup discussed in Recommendation 3-4, increase partnering efforts with monitor manufacturers to maximize the availability and use of current continuous speciation monitors and expedite the development of the next generation of speciation monitors to address the challenges described above. Given the health and economic consequences if controls are not implemented expeditiously and at the right sources, EPA should consider a joint EPA-private sector pre-competitive technological research program similar to the groundbreaking Partnership for a New Generation of Vehicles (PNGV) program that helped to develop a new generation of low emitting vehicles.

Agency Comments and OIG Evaluation

EPA made detailed comments on our draft report and, where appropriate, we made revisions. The Agency generally agreed with the recommendations in the report, but disagreed with the statements in the report that referred to the speciation monitoring network's inability to help EPA and the States to fully address the PM problems. With respect to recommendation 3-1, the Agency did not agree that EPA and the States could not develop control strategies. We agreed that some control strategies could be developed by EPA and the States, but some challenges still exist. We continue to believe that improved data from EPA's speciation network will be vital to ensuring that pollution controls are implemented at the right sources. Otherwise, some facilities may install unneeded controls; some needed controls may go uninstalled; and, ultimately, compliance may be further delayed and more costly. The Agency's consolidated response and our evaluation of that response are in Appendices H and I, respectively.

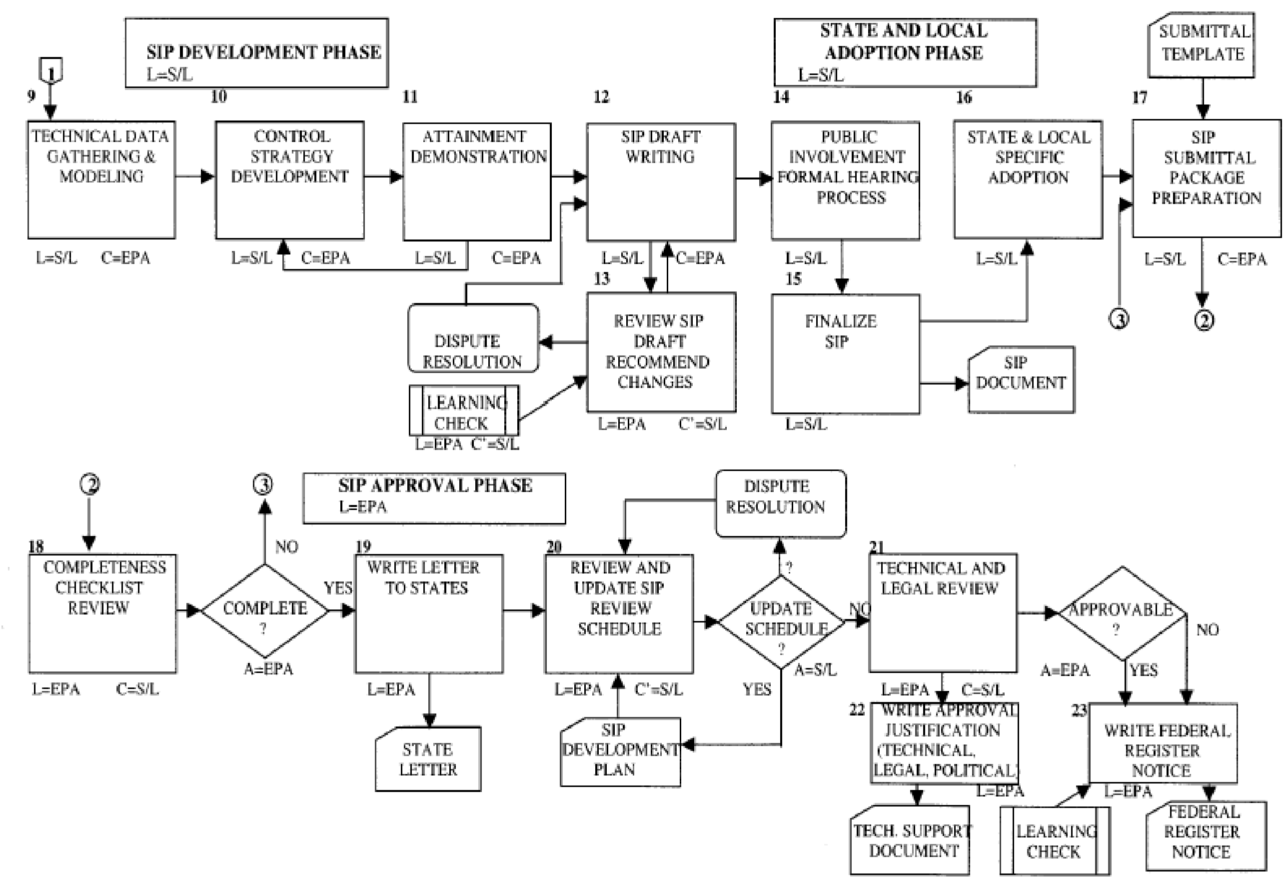
Major Steps in SIP Development and Approval Process



Source: "State Implementation Plan Process Improvement Project Final Report: Recommendations for improving the development and approval of State Implementation Plan (SIP) revisions in EPA Region 10," April 15, 2002.

Proposed SIP DEVELOPMENT AND APPROVAL PROCESS

Non-Attainment/Visibility SIP (continued)



National Emission Control Programs Providing Benefit to $PM_{2.5}$ Emission Reduction Efforts

EPA has several ongoing and planned national efforts specifically designed to address the transport of $PM_{2.5}$ across State borders. State, local, and tribal agencies will need to consider how, if at all, these national efforts will impact local $PM_{2.5}$ emissions and how these national initiatives will affect the development of control strategies. A description of five of the more significant national efforts likely to result in benefits to the $PM_{2.5}$ program follows.

NO_X SIP Call

The rule, *Finding of Significant Contribution and Rulemaking for Certain States in the Ozone Transport Assessment Group Region for Purposes of Reducing Regional Transport of Ozone*, commonly known as the NO_X SIP Call, was issued final on October 27, 1998. This regulation required 22 jurisdictions (21 States and the District of Columbia) in the eastern half of the United States to revise their SIPs to help ensure that NO_X emission reductions are achieved to mitigate the regional transport of ozone precursors across State boundaries. The NO_X SIP Call rulemaking requires that these 22 jurisdictions adopt and submit SIP revisions that contain provisions adequate to prohibit sources from emitting NO_X in amounts that can contribute significantly to nonattainment of the 1-hour and 8-hour ozone national ambient air quality standards. The States were required to tighten controls on NO_X-emitting facilities during the ozone season, which covers a 5-month period from May 1 through September 30 each year. States had to be in compliance by May 31, 2004, with the exception of Georgia and Missouri, which must comply by May 1, 2005. The coal-fired electric utility industry, believed to be a significant contributor to $PM_{2.5}$ emissions, was one of the industrial sectors that was required to comply with the NO_X SIP Call.

Acid Rain Cap-and-Trade Program

As part of a two-phased approach, the Clean Air Act set a goal of reducing annual SO_2 emissions by 10 million tons below 1980 levels by placing a cap on the total emissions from a select group of the nation's largest fossil fuel-fired power plants. Phase I began in 1995 and affected 263 units at 110 mostly coal-burning electric utility plants located in 21 eastern and midwestern States. An additional 182 units joined the first phase of the program as substitution or compensating units. Emissions data for 1995 indicate that SO_2 emissions at these units were reduced nearly 40 percent below their required level. Phase II, which began November 2000, tightened the annual emission limits imposed on these large, higher-emitting plants, and also set restrictions on smaller, cleaner plants fired by coal, oil, and gas, encompassing over 2,000 units in all. The acid rain cap-and-trade program affects existing utility units serving generators with an output capacity greater than 25 megawatts, as well as all new utility units.

The acid rain cap-and-trade program introduced an allowance trading system that uses the incentives of the free market to reduce pollution. Under this system, affected utility units are allocated allowances[13] based on their historic fuel consumption and a specific emissions rate. Allowances may be bought, sold, or banked. Anyone may acquire allowances and participate in the trading system. This second phase set a permanent ceiling of 8.95 million allowances for total annual allowance allocations to utilities.

Clean Diesel Truck and Bus Rule

In 2000, EPA finalized the Clean Diesel Truck and Bus Rule. This rulemaking provides for the cleanest-running heavy-duty trucks and buses in history. Due to new control technologies and cleaner, low-sulfur fuel, these vehicles are expected to be over 90 percent cleaner than today's trucks and buses. Engine manufacturers will have flexibility to meet the new standards through a phase-in approach between 2007 and 2010, with new low sulfur diesel fuel provisions expected to go into effect by June 2006. When fully implemented, diesel soot emissions will be reduced by nearly 110,000 tons each year, resulting in preventing 8,300 premature deaths, preventing 1.5 million lost work days, 7,100 hospital admissions, and 2,400 emergency room visits for asthma every year, according to EPA.

Clean Air Nonroad Diesel Rule

Nonroad diesel emissions currently account for about 47 percent of total diesel PM and about 25 percent of total nitrogen oxides of the combined on-road and nonroad diesel emissions nationwide. The Nonroad Diesel rule issued in June 2004 is expected to reduce sulfur in fuels for diesel engines by 99 percent by setting tighter emission standards for diesel engines used in construction, agricultural, and industrial equipment. The rule sets standards for new engines that will be phased in beginning in 2008 with the smallest engines, and moving on to larger ones, until all but the very largest diesel engines meet both NOx and PM standards in 2014. Some of the largest engines (greater than or equal to 750 horsepower), will have one additional year to meet the emissions standards. When the full inventory of older nonroad engines has been replaced, the nonroad diesel program will annually prevent up to 12,000 premature deaths, one million lost work days, 15,000 heart attacks, and 6,000 children's asthma-related emergency room visits, according to EPA.

Planned Clean Air Interstate Rule

Similar to the acid rain and NO_x SIP call, the proposed Rule is designed to be a broad cap-and-trade approach to reducing emissions. The proposed rule targets SO_2 and NO_X emissions from power plants, which significantly contribute to pollution problems in other downwind States. These pollutants lead to formation of $PM_{2.5}$ and ground-level ozone that are associated with thousands of premature deaths and illnesses each year. EPA asserts that full implementation of this proposal would reduce SO_2 and NO_X emissions by approximately 70 percent from pre-implementation levels. EPA plans to propose this Rule by December 2004.

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[13] Each allowance permits a unit to emit 1 ton of SO_2 during or after a specified year.

Appendix C

Description of the Two Primary Ambient Speciation Networks

The STN and the IMPROVE network are the main components of the speciation program and generate the same type of speciation data using similar sampling and analytical approaches, collecting the samples on filters which are then analyzed for speciation results. State, local and tribal agencies deploy and operate the STN, while the Federal land managing agencies of the Department of the Interior operate the IMPROVE network.

Speciation Trends Network (STN) - The STN was initiated in 1999 to generate data on the chemical make-up of fine particles and to determine trends in concentration levels of selected ions, metals, carbon species, and organic compounds in $PM_{2.5}$. Mostly sited in urban areas, the STN monitors were placed at 269 locations across the nation, of which 54 trends monitors were sited by EPA and 215 were sited by State, local, and tribal agencies. Four manufacturers produce almost all of the STN monitors. Each manufacturer's speciation monitor varies in design and the method in which $PM_{2.5}$ is collected. The STN is intended to complement the activities of the much larger $PM_{2.5}$ FRM mass-only monitoring network used for attainment designations and aid in the development of control strategies to lower $PM_{2.5}$ levels to within the NAAQS standard. Some of the other uses of the STN are to:

- Develop annual and seasonal spatial characterization of aerosols;
- Conduct air trends analysis;
- Track the progress of control programs; and
- Integrate the STN data with the IMPROVE data.

IMPROVE (Interagency Monitoring of PROtected Visual Environments) - Maintained and operated by the National Park Service, the IMPROVE network was initiated in 1985 as a long-term monitoring program to measure visibility conditions, track changes in visibility, and determine the causes for visibility impairment in the U.S. National Parks and wilderness areas. Prior to 1999, the IMPROVE network consisted of about 50 monitors across the country, but in 1999 was expanded to supplement the Regional Haze and $PM_{2.5}$ programs. The IMPROVE network largely consists of 162 monitors located in rural areas providing measurements of background levels of $PM_{2.5}$ emissions. EPA is exploring ways that the IMPROVE network can supplement the STN to provide additional speciation information in support of developing control strategies. However, EPA has not yet determined the extent to which the IMPROVE monitors can augment the STN.

Appendix D

$PM_{2.5}$ Emissions Inventory and Its Relationship to Monitoring and Modeling

Once every 3 years EPA prepares a national database of air emissions information with input from the State, local, and tribal air agencies, and from industry. Known as the National Emissions Inventory (NEI), the database contains an estimate of the annual emissions from stationary and mobile sources that emit criteria air pollutants ($PM_{2.5}$ being one of these) and their precursors, as well as hazardous air pollutants. The NEI includes emissions information for all 50 States, estimated at the individual point level for major sources (facilities), as well as county level estimates for area, mobile, and other sources. The NEI database sorts emissions into three source categories:

- *Major* - stationary sources of emissions, such as an electric power plant, that can be identified by name and location.
- *Area* - small point sources, such as a home or office building, or a diffuse stationary source, such as a wildfire or agricultural tilling.
- *Mobile* - any kind of vehicle or equipment with a gasoline or diesel engine, including cars, trucks, airplanes, and ships.

The emission inventory provides an estimate of source data, some of which are speciated, for what is emitted into the atmosphere, while the speciation network provides speciated data of what is in the atmosphere. The two data elements are compared to identify major discrepancies and to determine how the emission inventory can be improved. Also, by identifying major differences in $PM_{2.5}$ levels when comparing emission inventory data and monitoring data, EPA learns more about the extent of secondary formation of particles.

Emission inventories are a good place to start to develop control strategies. They have been described as the foundation, upon which everything else is built. The source speciated data generated by the emission inventory are input into the chemical transport model to help predict the effects of various control strategy scenarios. The receptor models use speciated monitoring data as an input to help verify the accuracy of emission inventories. However, except for data from Continuous Emissions Monitoring Systems, emission inventories are largely estimates of sources' emissions based on emission factors and activity or usage profiles, whereas speciation monitors measure actual emissions found in the ambient air.

Appendix E

Atmospheric Modeling and Its Relationship to Monitoring and Emissions Inventory

Atmospheric models have become a primary analytical tool in most air quality assessments and a critical component in developing effective control strategies. Different air pollutants are closely related because they experience similar atmospheric processes and can often originate from the same source. For example, knowing more about how automobiles affect ozone, acid rain, and $PM_{2.5}$ formation will lead to a better understanding of how changes in the level of one pollutant, or its precursors, may lead to the changes and concentrations of another. Models enable air quality managers to run different emission reduction scenarios to predict what impact they would have on the air pollutants of concern, if their modeling assumptions are correct.

Models for assessing the impacts of $PM_{2.5}$ basically fall into two categories: chemical transport models and source receptor models. As shown in Table E-1, these two models use different approaches to help provide decisionmakers with the information needed to decide what emission controls are needed to lower $PM_{2.5}$ levels. It is the use of both types of models that help decisionmakers understand the impacts of both primary (best done by receptor models) and secondary (best done by chemical transport models) aerosols.

Table E-1: Uses of Source Receptor and Chemical Transport Models

Receptor Models	Chemical Transport Models
Receptor Oriented (Monitoring Sites)	Source Oriented
Identifies Sources	Identifies Sources
Estimating Contributions From Those Sources	Predict Changes In Future Concentrations
Evaluating Emission Inventories	Evaluating Emission Inventories
Helps Plan The Application Of Chemical Transport Models	Helps Select Sites For Monitoring
Helps Evaluate And Improve Chemical Transport Models Results	Helps Link Secondary Aerosols To Sources
Increases Understanding Of Atmospheric Environment	
Application To Secondary Aerosols Limited	
Diagnostic Model	

Receptor Models

Ambient air monitoring data are input into receptor models to help trace the particles found on the monitor back to the sources that are emitting the $PM_{2.5}$. As a result, the reliability of the model is directly dependent on the quality of the ambient air monitoring data. When used in conjunction with information on emissions, receptor models can identify areas of the emission inventories that need improvement. The receptor models are not used to predict future ambient conditions, but instead help to explain events that have occurred. However, the receptor models cannot fully account for the chemical processes occurring in the atmosphere that result in secondarily formed $PM_{2.5}$. Receptor models alone cannot characterize and quantify the relationships between the sources and the monitoring data. The best available approach currently for addressing the uncertainties in source-receptor relationships involves the application of multiple techniques. For example, use of receptor models, along with emission inventory data, speciation monitoring data, and chemical transport models will lead to a better understanding of $PM_{2.5}$ sources and formation.

Two key analyses performed to target and develop emission control strategies are source attribution and source apportionment, which both involve the identification of possible sources and the level of contribution. Source attribution identifies individual $PM_{2.5}$ emitters such as a specific refinery, while source apportionment identifies general source categories such as diesel exhaust and chemical manufacturers.

Chemical Transport Models

Chemical transport models are important tools because they help to link primary and precursors of secondary $PM_{2.5}$ emissions to ambient concentrations, and can assist in the improvement of the emission inventory and the location of ambient monitors. These source-oriented models use data from the emission inventory along with meteorological conditions to forecast changes in atmospheric concentrations if emission rates change. Specific uses of chemical transport models include:

- Primarily used to predict changes in ambient concentrations in emissions control scenarios, and thus, to allow more effective and efficient means for reducing PM levels through emission reduction strategies.
- Estimating the contributions of local and long-range sources.
- Finding potential errors in emission inventories (when modeled results differ significantly from ambient $PM_{2.5}$ concentrations, further analysis is required to determine whether the emission inventory inputs are more likely the cause of the discrepancy than the model).
- Assisting in the design and evaluation of $PM_{2.5}$ monitoring networks (because of the model's ability to make independent estimates of current atmospheric conditions, designers of $PM_{2.5}$ networks can use this information to evaluate how well the deployed network is representing the predicted results).

Before chemical transport models can fulfill their valuable roles, they must be evaluated using ambient speciation data and under various conditions to demonstrate their ability to predict atmospheric conditions. However, chemical transport models can never exactly represent atmospheric conditions, because of limitations in the scientific understanding of atmospheric processes.

Two other analyses performed by EPA that help the Agency better understand the speciation of PM are described below.

Source Profile and Tracer Species

Two important types of data fed into these models are source profiles and tracer species. Using speciation monitoring and emissions data, source profiles are in-depth analyses conducted at one plant or facility where the various chemicals being emitted are speciated. Tracer species analyses involve finding inert elements that are emitted from a plant or facility that do not change composition in the atmosphere. As a result, EPA is able to trace the known particle from the monitor back to the source. For example, some forms of coal contain unique elements allowing experts to determine the type of coal burned, enabling them to pinpoint sources by tracing which facilities burn that type of coal. Tracers allow EPA to have more confidence in their modeling results.

Back Trajectory Analysis

An important secondary tool or method used in conjunction with the source apportionment models is back trajectory analysis because it helps to improve and refine the source apportionment modeling results. Back trajectory analysis is a technique that incorporates data on sources contributing to the $PM_{2.5}$ levels measured by a receptor, with meteorological data (i.e., air flow patterns) to determine the likely source location. Continuous speciation monitors would impact this tool positively by assisting in comparing source and meteorological data to speciated ambient data.

Appendix F

Advanced $PM_{2.5}$ Research Conducted by Supersites Program

Each Supersites Project uses a mixture of routine and advanced measurement methods to better characterize the chemical and physical properties of PM in the air. The methods include measurement of PM mass and the chemical components of PM in a variety of size ranges, physical properties, precursor species, and related variables such as meteorological parameters. The methods development focuses on better understanding how and why PM accumulates in the air and relating PM at a receptor site back to its sources.

EPA officials describe the Supersites program as an in-depth characterization of PM in those Regions with the highest PM concentrations. Several of the specific studies being conducted at Supersites Projects directly address some of the challenges EPA faces in PM speciation. For example, at several sites, researchers are studying atmospheric measurements to characterize PM constituents, atmospheric transport, and source categories that affect the PM in their region, although some aspects might be generalized to other regions. This information is essential for understanding source-receptor relationships and the factors that affect PM at a given site (e.g., meteorology, sources, transport distances). This information is also essential for improving the scientific foundation for atmospheric models that investigate PM accumulation, exposure, and risk management questions. Other closely related efforts include:

- Comparing and evaluating different methods of characterizing PM (e.g., emerging sampling methods, routine monitoring techniques, and the FRM);

- Testing new and emerging measurement methods that may ultimately advance the scientific community's ability to measure the physical and chemical components of PM in the air and, thereby, better understand the process affecting PM in the air and to investigate exposure and health effects;

- Quantifying the impact of the various sources (transportation, power plants, etc.) on the PM concentrations in the area, including those locally generated versus those transported from upwind areas, which may be regional in nature; and

- Supporting regulatory agencies in the development of emissions reduction implementation plans that cost-effectively reduce particle concentrations on urban and regional scales.

ORD recognizes that the Supersites Program findings will largely benefit EPA and the States' with their efforts to develop effective control strategies. As part of reporting on its GPRA goals and measures, ORD has set two APMs that directly relate to EPA's efforts in identifying and controlling $PM_{2.5}$:

> ORD 2005 APM - *Deliver to OAR, States, and the scientific community data from the Supersites program via an internet accessible large relational database that*

can be utilized for air quality model evaluation and to perform integrated analyses of data from the various Supersites locations.

ORD 2006 APM - *Deliver to OAR and the States results from the Supersites program that can be used to prepare and evaluate SIPs [including control strategies]*

Two other APMs have been associated with the Supersites Program. Both focus on synthesizing findings associated with the development and evaluation of continuous monitors for mass and chemical components of PM. One of these, APM 25 was completed in 2003 and the other is a 2006 deliverable. EPA is planning another key outreach meeting in February 2005, entitled "2005 AAAR [American Association for Aerosol Research] PM Supersites Program and Related Studies." This is an international specialty conference with a focus on results from the Supersites Programs and other methods, measurements, modeling, and data analysis studies conducted during the last 5-7 years.

Appendix G

Recent Grant Awards from ORD's STAR Solicitation

Grant Title	Institution
Evaluation and Minimization of Organic Aerosol Sampling Artifacts Using Impactors and Quartz Fiber Filter Denuders	UC- Riverside
Application of Thermal Desorption GC-MS for the Analysis of Polar and Non-Polar Semi-Volatile and Particle-Phase Molecular Markers	UW-Madison
Advancing ATOFMS to a Quantitative Tool for Source Apportionment	UC- San Diego
Integrating the Thermal Behavior and Optical Properties of Carbonaceous Particles: Theory, Laboratory Studies, and Application to field Data	Univ of Illinois
Atmospheric Processing of Organic Particulate Matter: Formation, Properties, Long Range Transport, and Removal	Carnegie Mellon
Secondary and Regional Contributions to Organic PM: A Mechanistic Investigation of Organic PM in the Eastern and Southern United States	Rutgers
Source-Oriented Chemical Transport Model for Primary and Secondary Organic Aerosol	UC Davis
Development of Advanced Factor Analysis Methods for Carbonaceous PM Source Identification and Apportionment	Clarkson
Secondary Aerosol Formation from Gas and Particle Phase Reactions of Aromatic Hydrocarbons	UNC-Chapel Hill
Fundamental Experimental and Modeling Studies of Secondary Organic Aerosol	Caltech
Emissions Inventory and Process Reconciliation Using Molecular Markers and Hybrid/Inverse Photochemical Modeling with Direct Sensitivity Analysis	Georgia Tech
Understanding Thermal and Optical Carbon Analysis Methods	DRI
Particle Sampler for On-Line Chemical and Physical Characterization of Particulate Organics	MIT
Atmospheric Aerosols from Biogenic Hydrocarbon Oxidation	Univ of Colorado
Development and Application of A Mass Spectra-Volatility Database of Combustion and Secondary Organic Aerosol Sources for the Aerodyne Aerosol Mass Spectrometer	UC-Riverside
Aetahlometric Liquid Chromatographic Mass Spectrometric Instrument for Characterization of Carbonacceous Ambient Particulate Matter. Laboratory and Field Studies	Texas Tech

Consolidated EPA Response to Draft Report

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JAN 3 1 2005

OFFICE OF
AIR AND RADIATION

MEMORANDUM

SUBJECT: Response to the Draft Evaluation Report: EPA Needs to Direct More Attention, Efforts, and Funding to Enhance Its Speciation Monitoring Program for Measuring Fine Particulate Matter, Assignment No. 2003-1450

FROM: Jeffrey R. Holmstead
Assistant Administrator

TO: J. Rick Beusse
Director for Program Evaluation, Air Quality Issues

Thank you for providing us the opportunity to respond to the draft report from the Office of Inspector General (OIG) issued December 3, 2004. The purpose of this memorandum is to provide comments on the draft evaluation report, "EPA Needs to Direct More Attention, Efforts, and Funding to Enhance Its Speciation Monitoring Program for Measuring Fine Particulate Matter, Assignment No. 2003-1450." This response has been coordinated with EPA's Office of Research and Development (ORD).

See Appendix I Notes 1 and 2

The recommendations provided by the OIG generally align with our current improvement efforts. Our concerns with the OIG report pertain to: 1) characterization of the current state of affairs, and 2) the need to balance resources across all aspects of the air program. We disagree with negative statements in the report regarding the sufficiency of currently available speciation data to "fully" develop effective control strategies. Nevertheless, EPA recognizes that improvements are clearly needed in our current inventory, monitoring, and modeling programs to further improve the efficiency and credibility of control strategies.

OAR is experiencing a reduction in budget and expects to see limited funding in the coming years. With anticipation of static staff resources, the competing needs on our other monitoring networks, Biowatch, and the implementation of the National Ambient Air Monitoring

Strategy (NAAMS), we will need to prioritize efforts put forth on these recommendations. Prioritization will allow OAR to focus on those recommendations deemed most critical. We will consider the OIG final recommendations along with expected recommendations from the Clean Air Act Advisory Committee Air Quality Management review, and related recommendations received on an ongoing basis from Clean Air Scientific Advisory Committee's subcommittee on ambient air monitoring and methods.

General comments are provided in the attached response, along with several specific comments that are more technical in nature. ORD will include their comments as a marked-up copy of the report that will be provided separately to OAR and the OIG via email.

If you have additional questions or require clarification, please contact Peter Tsirigotis of my staff at (919) 541-9411.

Attachment

cc: Pete Cosier, Office of Air and Radiation, Audit Follow-up Coordinator (6102A)
Dr. Dan Costa, National Human and Environmental Effects Laboratory (B143-02)
Thomas C. Curran, Deputy Director, Office of Air Quality Planning and Standards (C404-04)
Dr. Gary J. Foley, Director, National Exposure Research Laboratory (MD-75)
Lek G. Kadeli, Acting Deputy Assistant Administrator for Management (8101R)
Ardra Morgan-Kelly, Audit Liaison, National Exposure Research Laboratory (D343-01)
William Lamason, Associate Director, Emissions, Monitoring and Analysis Division (C304-02)
Phil Lorang, Leader, Ambient Air Monitoring Group (D243-02)
Stephen D. Page, Director, Office of Air Quality Planning and Standards (C404-04)
Joann Rice, Ambient Air Monitoring Group (D243-02)
Dr. Rich Scheffe, Emissions, Monitoring and Analysis Division (C304-02)
Dr. Linda Sheldon, Director, Human Exposure and Atmospheric Sciences Division (E205-01)
Dr. Paul Solomon, Human Exposure and Atmospheric Sciences Division (D205-03)
Laurie Trinca, Audit Liaison, Office of Air Quality Planning and Standards (C404-2)
Peter Tsirigotis, Director, Emissions, Monitoring and Analysis Division (C304-02)
James Vickery, National Exposure Research Laboratory (D305-1)
Timothy Watkins, Deputy Director, Human Exposure and Atmospheric Sciences Division (E205-01)

Attachment

We have the following general comments on the draft conclusions and recommendations:

General Comments

(*1) We object to the statement in the draft report that "EPA and States are not yet equipped with the necessary information to fully develop effective control strategies."*

See Appendix I Note 1

The following statement is made or implied throughout the draft report (e.g., on pages 5, 13, and 17, and in the "At a Glance" section):

"Although some speciation data is available to begin work on developing control strategies, EPA and the States are not yet equipped with the necessary information to fully develop effective control strategies."

This position is not supported by the findings of others in the air quality science and policy communities. For example, the NARSTO community, which includes all major U.S. Federal, State and private sponsors of air quality research, in its 2003 report, *"Particle Matter Science for Policy Makers - a NARSTO Assessment,"* points out that "Policy makers are currently benefiting from research initiated five to ten years ago, or longer. This research provides a basic understanding on PM formation, transport, and its major contributing sources. It characterizes the areas of North America where PM concentrations, visibility reduction, and potential population exposure are the greatest. Despite considerable uncertainties, sufficient scientific confidence exists to devise management actions likely to improve air quality (emphasis added)." Corresponding comments have been received from the Clean Air Scientific Advisory Committee (CASAC) Ambient Air Monitoring and Methods Subcommittee in their review of the National Monitoring Strategy and have been among Clean Air Act Advisory Committee's (CAAAC) recommendations on improving air quality management.

See Appendix I Note 2

The OIG report correctly points out (p. 13) that "EPA and States primarily use three tools for managing its $PM_{2.5}$ programs: ambient monitoring data, emissions inventory data, and atmospheric modeling." However, EPA does not use these tools independently. The report's conclusion and affirmation it attributes to NARSTO that "unless improvement of monitoring data is a high priority to EPA, it will be limited in its ability to help effectively control $PM_{2.5}$" are seriously overstated and in error. As the NARSTO assessment points out (Synthesis, p. 24), "Source specific options to reduce PM concentrations are best approached through corroborative analysis using emissions inventories, ambient concentration measurements and air quality modeling. Given the strengths and limitations of any one of these science tools, it is recommended that they be used in an integrated manner..." No one of these three tools is more important than another. As an example, EPA integrated emissions inventories, modeling and speciation monitoring data when it evaluated the impact of regional SO_2 and NO_x as part of the Clean Air Interstate Rule (CAIR) [www.epa.gov/air/interstateairquality]. OAR and ORD are working together to address these issues through a variety of research efforts supported by PM Supersites, STAR Grants and other extramural activities, some of which are outlined in the OIG report on pages 44-45.

The OIG report makes the case that determining the chemical make up of PM is largely accomplished through data generated by EPA's ambient air speciation program, and the draft lists EPA's two principle networks, the STN and IMPROVE, with total investments of $16.5M yearly. Only brief mention is made of the 5-year $26.5 M Supersites program instituted to apply state-of-the-art monitoring and speciation methods to particle characterization. The report omits the fact that the Supersites program is an in-depth characterization of PM in those regions of the U.S. with the highest PM concentrations. EPA has established the program to address the very thing that the OIG has recommended. In fact, the Supersites program is the subject of a specialty conference by the American Association for Aerosol Research next month. This conference and the subsequent policy-relevant recommendations, through ORD's 2006 Annual Performance Measure (APM), will be very helpful to the Agency in making potential improvements to the monitoring program. Further, the OIG report should recognize the equally large measurement studies sponsored by States and private industry in California (CRAPACS) and the Southeast U.S. (SEARCH), and by other Federal agencies such as NOAA, DOE, and NASA in the Northeast U.S. (NEAQS). These studies collectively have produced a wealth of PM speciation information that will well equip States with the necessary information they need to develop effective control strategies.

See Appendix I Note 3

(2) The draft report inadequately describes the role of speciation monitoring for developing "effective" control strategies and the work being done at EPA.

See Appendix I Note 4

The roles of the Speciation program are to provide data for:

- assessing the effectiveness of emission reductions strategies through the characterization of air quality trends;
- supporting the development of predictive modeling tools and the application of source apportionment modeling for control strategy development;
- supporting programs aimed at improving environmental welfare, such as the Regional Haze program; and
- supporting health effects and exposure research studies.

This information is valuable in crafting control strategies to address the principal sources of PM problems, as well as to assist in better understanding the components of PM that are of greatest significance to human health effects.

The statement in item (1) also refers to developing "effective" control strategies. However, it is very difficult to say what is, and what is not, an "effective" control strategy. The real question is what pollutants do we need to reduce to minimize risk from PM? From that information, we need to develop effective control strategies. EPA has, in fact, implemented controls and reduced PM levels considerably. Lead from gasoline has been eliminated. Sulfate in the East has dropped due to SO_2 controls and nitrate also will likely drop due to the NO_x SIP call, as well as the Acid Rain Program. Further reductions may come from the proposed CAIR. We can identify the major sources (power plants, cars, etc) and address a big part of the PM problem, but once again the question is, are they the right sources to reduce the risk from PM? This leads to the need for speciation data to improve our understanding of the relative toxicity (and resulting risks) from various PM sources. In our response to the OIG position papers, we suggested adding a section/paragraph entitled "Speciation Data Needed to Improve Understanding of PM Exposure and Health Effects," which has been incorporated on page 16 of the draft report. The point of this suggested paragraph was to highlight the fact that to

See Appendix I Note 5

develop more "effective" control strategies, we need to understand what characteristic of PM drives the observed health impacts. In others words, is it particle size, composition, species or some combination that leads to health impacts? Speciated data are needed to support exposure and health research to answer these questions in addition to developing control strategies for $PM_{2.5}$, which is the emphasis of the report. The bottom line is that the most effective control strategy will consider the sources of PM that are responsible for the greatest health risk in addition to reducing $PM_{2.5}$ mass to meet the PM National Ambient Air Quality Standards (NAAQS).

(3) The report does not address the need to balance research priorities within the air research program and across other media.

The principal recommendation of the OIG report is that EPA needs to direct more resources to speciation monitoring. As pointed out in item (1) above, speciation monitoring is only one of three tools needed for PM NAAQS implementation; the other two are emissions characterization and air quality process understanding and modeling. EPA has carefully balanced its investment across all three tools to address the key remaining uncertainties. The need to fully integrate and balance these three tools is a point made in the National Resource Council's (NRCs) concluding report on PM research priorities (Report IV). Revisiting of this balance through our annual allocation process may be warranted, but a major shift that would come at the expense of the other two areas of research would be inappropriate and would not serve the interests of enhanced air quality management. It is also important to note that EPA must balance research investments supporting these three areas (monitoring, emissions characterization, and air quality modeling) with research needs in the areas of exposure, health effects, and control technology development.

See Appendix I Note 6

As part of the Agency's annual planning and budgeting process, ORD works with EPA's other program and regional offices to allocate funds across various research programs. This process ensures that media-specific recommendations are fully considered and that the areas of greatest need are given the highest priority. Using this process, the OAR has an opportunity to elevate the relative priority of research supporting PM speciation monitoring. It is important to note, however, that ORD is already making significant investments in this area of research with results and research products anticipated in the near future. Finally, ORD must balance EPA's needs for research not only within the air research program, but also across all environmental activities.

See Appendix I Note 6

Responses to the Recommendations

3-1 ***Increase from 5 to10 percent the OAQPS funding allocated for performing analytical assessments, adopting new methods, and conducting research on technologies that can more fully identify the chemical make-up of $PM_{2.5}$, account for the atmospheric impacts on $PM_{2.5}$, and assay the resultant changes that occur to the composition of the particle, with particular emphasis on:***

OAR supports the general intent of the recommendations. However, we are not endorsing the specific recommendation regarding the funding increase, which does not account for competing priorities in the air program. It is important to note that ORD also allocates funding to conduct research to address these issues.

See Appendix I Note 6

a) Increasing and improving the speciated data for the six major components of $PM_{2.5}$ (sulfate, nitrate, ammonia, organic carbon, elemental carbon, and crustal material).

To the extent that the recommendation implies equal attention to improvements for all six components across the nation, we disagree. This recommendation lacks specific detail regarding what is meant by "increasing and improving" the speciation data. Please clarify what is meant by "increasing and improving the speciated data." For example, does this refer to the number of sites (i.e., collect more spatial data) or their geographic distribution; does it refer to higher time resolution (i.e., implementation of continuous methods); or does it refer to measuring a larger number of species (i.e., focus on the organic species and methods of analysis with better limits of detection for the inorganic species)? It would be an inefficient and unproductive use of scarce resources, for instance, to increase speciation sampling for pollutants in parts of the nation where reliable emissions information indicates there are few or no significant sources. Also, we can measure all the species specified within a certain set of uncertainties, so is the report asking for improved methods that will reduce the uncertainties in the measurement methods? We recognize that there is room for improvement in some of the speciation methods currently used, especially for carbon measurements. ORD currently has several efforts underway to address these issues.

See Appendix I Note 7

b) Enabling EPA and State, local, and tribal agencies to perform more sophisticated analyses, through source-receptor modeling, to better identify the source of the $PM_{2.5}$ and fill the gaps in the data generated from the STN and IMPROVE networks.

We believe that the tools (emissions, modeling, and measurements) currently available to identify the sources of $PM_{2.5}$ are sufficient for developing effective control strategies for attainment of the NAAQS. Given the measurements that are available today, the current receptor modeling tools are capable of providing a broad characterization of the sources contributing to ambient $PM_{2.5}$ levels which can be used for developing effective control strategies. One potential complication is the level of expertise available, particularly in the State, local, and tribal agencies, to apply these tools. As a result, any additional near term investments may better be directed at developing and delivering guidance for applying source apportionment techniques, particularly receptor modeling approaches.

See Appendix I Note 8

While we believe that current receptor modeling tools are capable of supporting control strategy development; improvements in our measurements and modeling tools will certainly improve our ability to more specifically identify sources of PM. For example, to be able to separate and identify additional specific sources, detailed measurements (e.g., hourly measurements conducted on a daily basis as opposed to 24-hour integrated averages conducted on a 1-in-3 day basis) and improved modeling tools to take advantage of these measurements, would be needed. However, these enhancements would require substantial additional investments, well beyond the 5 to 10 percent suggested in this recommendation. EPA is committed to advancing the science in this area and has a program to develop improved source-receptor tools, but as stated previously, investments in this area must be balanced with investments in other priority research areas.

As noted in the OIG report (pp. 15-16), EPA is investing in improvements to emission source profiles by updating of the speciation source profile database (SPECIATE), planned for completion in 2005. SPECIATE will be an important resource in source apportionment studies.

3-2 Identify the uncertainties associated with the comparability of similar speciation monitoring methods, such as the IMPROVE and STN methods, and develop short- and long-term plans to address these uncertainties and increase the usability of the data generated from the various speciation networks. Specifically:

a) Complete the six-site comparability study and incorporate the results of the study into Agency decision making.

Besides the initial 6-site study, there have been an additional nine STN/IMPROVE sites added to assess comparability and informing network decisions. This information will also be used to develop a plan for future collocated sites to help understand the differences between the data generated. ORD plans to present data analysis results at the upcoming American Association for Aerosol Research meeting in Atlanta, Georgia, in February 2005. OAR is beginning the task of compiling the results from the first 6-site study and laying out questions specifically directed at informing the decision making and program improvements.

See Appendix I Note 9

b)Expedite Agency efforts to determine whether the STN and IMPROVE monitors can produce adequately comparable data, and if not, determine which method should be further deployed to increase data consistency.

See comment above. In addition, ORD has research underway that is targeted at identifying the "optimal" thermal-optical analysis method as noted in Appendices F and G of the OIG's report. Results from that research can aid in the identification of the method best suited for future deployment.

3-3 ***Increase Agency efforts to develop the data needed to conduct the more advanced analyses necessary to understand the behavior, characteristics, and chemical composition of $PM_{2.5}$, including:***

a) Increasing analytical work related to source profiling and tracer species, such as fingerprinting carbon to its original source.

Please clarify whether this recommendation addresses emissions-related monitoring, ambient-related monitoring, or both. An emissions-related recommendation would address "source profiling," while an ambient monitoring recommendation would address the measurement of "tracer species" in air, as opposed to the source. Since both source profiling and tracer species are mentioned, it could be assumed that the recommendation addresses both emissions and ambient monitoring. However, it is important to understand what (or how) source profiles are used and the relationship between source profiles and tracer species. Tracer species are unique markers for a source which are identified by measuring source profiles. A source profile is the chemical make-up (not the amount, but the fraction of the total) of the emissions coming from a source; the activity is how those vary over time.

See Appendix I Note 10

One possible way to clarify this recommendation would be to change the wording as follows, "Increase efforts to develop methods to collect and measure source profiles at emissions sources, and the respective tracers in ambient air that uniquely identify those sources." Such a recommendation should focus on two areas: 1) organic speciation; and 2) methods with lower limits of detection for important trace elements.

b) Identifying and minimizing the uncertainties associated with measuring the organic fraction of $PM_{2.5}$.

It is important to note that EPA has several significant ongoing efforts that address this topic and cover both improvements in the methods (sampling and analysis) and development of calibration and reference standards. EPA's efforts are noted in the OIG's draft report on pages 26 and 27, where discussions of the Supersites program and ORD's research efforts to improve Speciation are included. EPA is also developing methods to characterize $PM_{2.5}$ mass associated with the organic carbon as measured in the speciation program.

c) Re-evaluating the methods used in the measurement of ambient ammonia by developing the proper filter needed to measure $PM_{2.5}$ constituents that increase in mass from absorbing moisture, or, in other instances, the constituents [that] decrease in mass as a result of volatilization.

We ask that the OIG clarify the statement: "by developing the proper filter needed to measure $PM_{2.5}$ constituents that increase in mass from absorbing moisture or, in other instances, the constituents [that] decrease in mass as a result of volatilization."

See Appendix I Note 11

- In the body of the draft report, there is reference to water <u>absorption by</u> *ammonium sulfate*. However, if the concern is ammonium sulfate, then a filter will not make a difference because we use a Teflon filter for mass and it does not absorb water.

- If the draft report is referring to water <u>associated with</u> ammonium sulfate that possibly affects the measurement of sulfate, the filter is not an issue as we measure sulfate or sulfur mass directly and water does not impact the method. However, the water associated with hygroscopic ammonium sulfate is part of the measured $PM_{2.5}$ mass as collected by the Federal Reference Method (FRM) sampler on Teflon filter media. EPA recognizes that this must be considered when developing control strategies, as it did for the proposed CAIR.

- If the report is referring to the measurement of ammonium nitrate, nitrate and ammonium are measured directly, although there is evidence that ammonium is lost from nylon filters (4-City Study report). It is also unclear if this is a question about ammonia or ammonium since the two have been confused in the document. Measurements of ammonia and nitric acid have not been included in the speciation network. The current STN collects ions (including ammonium) on a nylon filter and includes a denuder to remove acid gases (including nitric acid) from the sample stream. Ammonia is not currently collected using the particle filter, but can be measured using other proven methods. These gas-phase measurements require different sample collection and analysis methods. Ammonia and nitric acid gas-phase measurements are being recommended as part of the EPA National Air Monitoring Strategy NCore level 2 network. EPA recognizes that ammonium nitrate is semi-volatile, and the amount of particle nitrate that is part of $PM_{2.5}$ mass as measured by the FRM is different than the nitrate measured by the speciation samplers. Methods are available to adjust for this difference for PM implementation and control strategy development.

- If the report is referring to the measurement of the precursor ammonia, these measurements are not done in either the STN or IMPROVE. Methods for ammonia are well documented in the literature and have been used in monitoring networks for 20+ years. So the question is: does the report refer to the need to measure ammonia properly in the networks?

- Reference is also made to the loss of volatile species and a decrease in mass. This does affect the mass of the "ambient" PM as measured on the Teflon filter, but this is noted in the FRM Regulations and is accounted for in the $PM_{2.5}$ standards as the health effects were measured against mass produced by similar fine particle samplers also using Teflon filters.

d) Developing and deploying continuous speciation monitors that help provide the real-time data needed to more accurately depict what is occurring in the atmosphere on a real-time basis and better pinpoint the sources of $PM_{2.5}$.

See Appendix I Note 12

EPA is taking action to address this concern. OAR has deployed a small network of continuous speciation study sites to aid in the development and implementation of continuous monitors at routine monitoring sites. This 5-site network has served the needs well in evaluating the operation and feasibility of the currently available continuous sulfate, nitrate and carbon monitors in a routine monitoring setting. The State participants in the study, along with EPA and the vendors, have used this study to help identify issues with the new monitoring technologies and improve them. OAR plans to expand this study to about 12 sites over the next 2 years, and include newly available continuous speciation monitors. As the new technologies are demonstrated for use in a routine setting, these sites will serve as the platform for the long-term continuous monitoring network.

3-4 Establish a stakeholders workgroup to address the challenges described in Recommendations 3-1, 3-2, and 3-3, comprised of officials from OAQPS, ORD, and selected EPA Regions; State, local, and tribal agencies; State and Territorial Air Pollution Program Administrators/Association of Local Air Pollution Control Officials; RPOs; affected industries; academia; and monitor manufacturers.

See Appendix I Note 13

In light of the many coordination and advisory processes already in place, we do not support the recommendation for a new workgroup. We acknowledge and value participation, feedback and input from our stakeholders, scientific experts, and air monitoring experts. Our current and upcoming mechanisms for soliciting input provides for better decision making and program improvement and development. OAR has access to the newly formed CASAC Ambient Air Monitoring and Methods Subcommittee. This subcommittee has representatives from State and local government agencies and academia. OAR is also in the process of forming an ambient air monitoring steering committee composed of EPA's ORD and OAR, EPA Regional offices, State, local and tribal agencies, and other Federal agencies. The CASAC subcommittee has recently reviewed the National Air Monitoring Strategy. The CASAC meetings are open to the public and have involved industry and the manufacturers. The combination of these two groups can be used to effectively vet ambient air monitoring issues and get sufficient and informed feedback on our plans to address challenges.

3-5 Through the workgroup discussed in Recommendation 3-4, increase partnering efforts with monitor manufacturers to maximize the availability and use of current continuous speciation monitors and expedite the development of the next generation of speciation monitors to address the challenges described above. Given the health and economic consequences if controls are not implemented expeditiously and at the right sources, EPA should consider a joint EPA-private sector pre-competitive technological research program similar to the groundbreaking Partnership for a New Generation of Vehicles (PNGV) program that helped to develop a new generation of low emitting vehicles.

EPA agrees with the intent of this recommendation. Improvements in communication with the vendor community add value to the development and implementation of current and future generations of continuous monitors. OAR has continually communicated with the vendors about monitoring needs and future directions. For example, we have a continuous monitoring study that requires us to keep in communication with the vendors to present issues, work with them on resolutions, and implement the latest version of their monitoring technologies. We have been open about the number of monitoring sites we anticipate and clear that we cannot recommend a specific vendor type. In contrast to the PNGV, the market for monitoring equipment is quite limited, so we respectfully disagree that PNGV is a suitable conceptual model for OAR's efforts on monitoring technology.

It is very important to recognize that EPA must be careful in establishing partnering relationships with monitoring vendors. Generally, the vendors are looking for some type of commitment from EPA, either to provide resources or to deploy methods in national monitoring networks. EPA must be extremely cautious about making such commitments, and in some cases, will not be able to do so, particularly with respect to recommending a specific vendor's instrument. ORD's Small Business Innovative Research (SBIR) program is another program that could be potentially be utilized and, in fact, has been utilized to address continuous PM mass technologies.

See Appendix I Note 14

Suggested Changes to the Text of the Report

In the section, *At a Glance*, under *What We Found*: Please revise the 2nd through 4th sentences related to insufficiency of the speciation data to effectively develop control strategies. As written, they are incorrect. Suggest revising the text as follows:

See Appendix I Note 15

"Although the speciation network provides information on understanding the make-up and origin of $PM_{2.5}$, the Agency's ambient monitoring network does not by itself provide the data needed for EPA or States to identify or quantify the chemical make-up of $PM_{2.5}$ particles, reliably trace particles back to their source, or account for chemical changes that occur after particles are released into the atmosphere. The development of control strategies is best approached through collaborative processes that use emissions inventories, ambient monitoring data, and air quality modeling. Speciation data is available to begin work on developing control strategies. EPA and the States are in the process of using the available monitoring data from the Speciation, Supersites, and other state and private monitoring networks to begin development of control strategies; however, increased efforts are needed."

In the section, *At a Glance*, under *What We Recommend*: Please consider revising the 2nd sentence of the 1st paragraph to read: "This would include promoting greater attention to providing opportunities for cooperation with the private sector to develop improved continuous speciation monitors."

See Appendix I Note 16

Page 1, 2nd paragraph: "…how the particle can be traced to its source of origin, also known as fingerprinting;…" Suggest change the wording "also known as fingerprinting" to "through the use of source apportionment modeling"

Page 11, 3rd bullet: Change the reference to "ammonia" instead of "ammonium". The Speciation program provides a measure of particulate ammonium but not gas-phase ammonia.

Page 16, 2nd paragraph: "The current state of scientific understanding on the formation of secondary organic aerosols is insufficient, and as a result PM modeling predictions at the present time have substantial uncertainties. Improved speciation data would help decrease these limitations." Suggest clarifying the data needs to support PM modeling predictions. If this is continuous or semi-continuous speciation data, then this should be clarified in the text.

Page 17: "Key Agency officials agreed that continuous speciation monitors would be the most likely approach to providing the robust data set needed." Insert the words "or semi-continuous" after continuous. Also include this text, "semi-continuous monitors for speciation are available for carbon, nitrate and sulfate. These monitors have the ability to provide more time resolved data."

Page 18, 2nd paragraph, 1st sentence: change "ammonia" to "ammonium"

Page 21, 2nd paragraph: There are issues with this and the next 2 paragraphs regarding the discussion of ammonia versus ammonium. The statement: "…ammonia is more complicated because the nylon filter does not bond with ammonia…"; ammonia is the gaseous, not the particle species. This discussion is confusing and needs clarification regarding the appropriateness of particle ammonium measurements in the speciation network and the need for supplemental gas-phase measurements of ammonia. Please contact Joann Rice in OAQPS, at 919-541-3372 for assistance in clarification.

Page 21, last paragraph, last sentence: "According to an ORD official, measurements of ammonia and nitric acid, while desired, have not been included in the network due to operational resources and cost." Please either delete the sentence or include the following statements for clarification: "These are gaseous, not particle species, and therefore cannot be obtained from particle filter measurements made by the Speciation network and require different sample collection and analysis methods. However, the NAAMS NCore Level 2 sites include plans to include ammonia and nitric acid measurements as part of the multi-pollutant strategy."

Page 22, 2nd paragraph: "…there are concerns that without improved speciation monitoring data on carbon, ammonia, …" change "ammonia" to ammonium. For clarification, a sentence could be added that expresses the need for gas-phase measurements of ammonia. Similar issues exist with the use of the word "ammonia" on page 24, 1st paragraph and in recommendations 3-1b) and 3-3c) starting on page 30. Please change these to "ammonium".

OIG Evaluation of Consolidated EPA Response to Draft Report

Note 1 - We agree that the Agency has enough information to begin the development of control strategies, as evidenced in the NARSTO report that states that research initiated 5 to 10 years ago provides a basic understanding of PM formation, transport, and its major contributing sources. In addition, we modified the report to further emphasize that monitoring data *assists* in the development of an effective control strategy. However, we continue to believe that increased efforts are needed to ensure that the States have the data needed to reduce harmful levels of $PM_{2.5}$ expeditiously and at the least cost to industry. EPA's response (page 46) similarly cites the need for improved speciation data, stating that speciated data is valuable in crafting control strategies to address the principal sources of PM problems, as well as to assist in better understanding the components of PM that are of greatest significance to human health effects. Further, key Agency officials agreed that EPA needed to increase funding from 5 to 10 percent for performing analytical assessments, adopting new methods, and conducting research on technologies that can more fully assist in identifying the chemical make-up of $PM_{2.5}$, account for the atmospheric impacts on $PM_{2.5}$, and assay the resultant changes that occur to the composition of the particle.

Note 2 - As shown in section entitled *Speciation Data Used to Groundtruth Emissions Inventory Estimates and Modeling Assumptions* (page 13), our draft report already noted that monitoring data is one of the three interdependent tools for managing $PM_{2.5}$ programs. We agree that all three tools are important to developing an effective control strategy. We do believe, however, that monitoring data, although perhaps no more important than emissions estimates and modeled assumptions, does provide more reliable, and thus more useful, data and, in this context, is used to groundtruth the other estimates and assumptions.

Note 3 - In Appendix F, we further defined the Supersites Program. However, we believe the report sufficiently characterizes the role of the Supersites Program, as well as other EPA activities that support EPA's PM program. For example, page 20 of the report mentions several EPA efforts underway, such as the STAR program, ORD's extramural research grants program, and the analytical laboratory dedicated to measuring organic compounds in PM. Also, because the eight Supersites are not a nationwide network, we do not agree that the Supersites Program addresses our recommendations.

Note 4 - We agree with EPA's description of the roles of the Speciation program and that it will be valuable in developing control strategies and in better understanding health effects. This is precisely why we believe improvements are needed in the Speciation program, as defined in the report's recommendations.

Note 5 - We agree that EPA has implemented controls and reduced PM levels, as described in the section entitled *Other Programs Impact $PM_{2.5}$ Levels* on page 10 of the report, which describes the programs and national control strategies EPA credits with these reductions. We also agree that, currently, it is difficult for EPA to say what is and is not an effective control strategy, which suggests that more information such as speciation data is needed. Finally, we also agree that more speciation data is needed to identify and control the PM sources posing the greatest health risk.

Note 6- We agree that the Speciation Monitoring program is only one of three tools needed for PM NAAQS implementation, the other two being emissions characterization and air quality process understanding and modeling. We also understand that the Agency must balance EPA's needs for research not only within the air research program, but also across all environmental activities. We are not recommending a major shift in resources to monitoring at the expense of emissions and modeling, but we do maintain that some level of increased effort is needed, and continue to believe that a 5-percent increase is appropriate. (Also see Note 1.)

Note 7 - We revised recommendation 3-1(a) to more specifically indicate that EPA should focus its efforts in the area of continuous speciation monitoring, which is also stated by EPA in its response to the draft report as being a need. We agree that efforts should include improved methods that will reduce the uncertainties in the measurement methods. Also, we did not recommend that EPA increase speciation sampling for pollutants in parts of the nation where reliable emissions information indicates there are few or no sources.

Note 8 - EPA stated that it is capable of providing a broad characterization of sources contributing to increased $PM_{2.5}$ levels. However, we believe that, as State and local agencies begin to require specific industrial sources to install expensive controls, a more narrow characterization will be needed. EPA expressed this viewpoint earlier in its response when it stated that speciated data will assist in better understanding the components of PM that are of greatest significance to human health effects, which would improve the input data needed to narrow characterizations. As our report notes, EPA still has time to overcome these challenges, but increased efforts will be needed.

Note 9 - In the section entitled *Supplementing STN With IMPROVE Data Provides Some Useful Information But Compatibility Is Limited*, we recognize EPA's efforts in assessing the comparability of STN and IMPROVE.

Note 10 - The recommendation mentions both source profiling and tracer species because both can impact source apportionment. We agree with EPA's comment and have modified the recommendation to be more specific as suggested in EPA's response.

Note 11 - We agree, and have revised the report and recommendation to reflect the Agency's comments by removing reference to developing the proper filter.

Note 12 - We agree that the Agency is taking actions to address this recommendation; however, we believe increased efforts are needed. In its response, EPA supports increased effort by stating that improvements in real-time measurements through increased use of continuous monitors will improve the Agency's ability to more specifically identify sources of PM.

Note 13 - We agree that the two existing workgroups can effectively address Recommendations 3-1, 3-2, and 3-3, provided the Agency implements these recommendations by addressing the issues cited in this report as part of the work carried out by either the steering committee or the Clean Air Scientific Advisory Committee's Ambient Air Monitoring and Methods Subcommittee.

Note 14 - We agree that the Agency must be careful in establishing partnering relationships with monitoring vendors, and be certain to maintain its independence. However, the monitor manufacturers' willingness to invest their own resources in research and development of new and improved monitoring equipment is an important resource for the development and improvement of the next generation of speciation monitors. Further, we do not see the dissimilarities with EPA's efforts to partner with the major auto manufacturers under PNGV, and our recommendation that the Agency partner with monitoring manufacturers under a similar approach.

Note 15 - We generally agree with the Agency's suggested revisions and have modified the report where appropriate. However, the speciation monitoring network's data currently are not sufficient to assist EPA and the States in fully tracing particles back to their source, or accounting for chemical changes that occur after particles are released into the atmosphere.

Note 16 - For the remainder of EPA's response under the section entitled *Suggested Changes to the Text of the Report*, we agree with the Agency's comments and have revised the report as appropriate.

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