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

JAN 25 2010

OFFICE OF THE
SCIENCE ADVISOR

Gary S. Sayler, Ph.D
Chair, Board of Scientific Counselors
Center for Environmental Technology
The University of Tennessee
676 Dabney Hall
Knoxville, Tennessee 37996

Dear Dr. Sayler:

On June 8-10, 2009, the Clean Air Research Program Subcommittee of the Board of Scientific Counselors (BOSC) met in Research Triangle Park, North Carolina to evaluate the Office of Research and Development's (ORD) Clean Air Research program. The Subcommittee presented a report of its findings and recommendations to the Executive Committee of the BOSC on September 15, 2009, and the Executive Committee, in turn, provided a final BOSC report to the ORD on October 15, 2009. With this letter, I am pleased to enclose the Agency's response to the final BOSC report of its review of the Clean Air Research program.

The Clean Air Research program greatly appreciates the insights, advice, and recommendations offered by the BOSC. The attached narrative presents an overview of specific recommendations made by the BOSC and provides a brief comment on how the Clean Air Research program has taken the findings into consideration. A table that summarizes each recommendation, the action to be taken, and the timing for completion of these actions is also attached.

As you are aware, ORD conducts periodic evaluations of its research programs' progress at intervals of 4 to 5 years. The purpose of these reviews is to determine progress with regard to relevance, quality, performance, and scientific leadership. The reviews also focus on identifying how the scientific community and our programmatic partners use ORD's scientific results to protect human health and the environment. In addition to these formal reviews, ORD will be providing a mid-cycle progress report. The timing for the Clean Air Research program mid-cycle progress report will likely be in late 2011. In this context, we look forward to working with you and the members of the subcommittee again.

Sincerely,

Kevin Teichman

Kevin Y. Teichman, Ph.D.
Deputy Assistant Administrator for Science

Office of Research and Development's Response to the Board of Scientific Counselors Report on ORD's Clean Air Research Program

(final report received October 2009)

January 2010

BOSC Clean Air Subcommittee:
Kenneth L. Demerjian (Chair), State University of New York
Praveen Amar, NESCAUM
Tina Bahadori, American Chemistry Council
Melvyn Branch, University of Colorado
Bart E. Croes, California Air Resources Board
Henry Felton, New York State Department of Environmental Conservation
Rogene F. Henderson, Lovelace Respiratory Research Institute
Jonathan Levy, Harvard University
Murray A. Mittleman, Beth Israel Deaconess Medical Center
Ira B. Tager, University of California, Berkeley
Gregory Yarwood, Environ International Corporation

Submitted by:
Dr. Daniel L. Costa, Sc.D., DABT
National Program Director for Clean Air
Office of Research and Development

The Clean Air Subcommittee of the Board of Scientific Counselors (BOSC) conducted a review of the Office of Research and Development's (ORD's) Clean Air Research program. The review process was carried out through a series of conference calls and a face-to-face meeting during May and June 2009. The draft report was vetted by the BOSC Executive Committee in September 2009, and the final report was transmitted to ORD by the BOSC Executive Committee in October 2009. This document is a response to the Subcommittee recommendations provided in the report as laid out in the narrative.

The Subcommittee review and comments regarding the content of the Clean Air Research program were, overall, very positive. The Subcommittee was particularly impressed with the extensive preparations by EPA investigators, both intramural and extramural, which they felt provided a well-organized, integrated, and comprehensive presentation of the work being performed under the Program. In keeping with the criteria for program evaluation as requested by ORD, the Subcommittee provided a rating for each of the long-term goals (LTGs): both were rated as "*exceeds expectations*."

The following narrative restates each recommendation found in the Executive Summary (Section I) of the report and provides our response. The table following the narrative summarizes ORD's response and indicates ORD action items and the anticipated timing to achieve these actions or their essential elements. Additional advice given in the body of the report is appreciated.

RESPONSE TO GENERAL OVERALL PROGRAM RECOMMENDATIONS

1. *ORD develop a working definition for the term "multipollutant approach" as it pertains to its LTGs and the expectations of its various stakeholders.*

   Response: The term "multipollutant (MP) approach" has varied meaning to whoever uses the term and as such, a clear working definition by ORD is warranted. The "MP approach" goes beyond the statistical treatment of data that segregates impacts of component pollutants monotonically. As the term is being used by the Clean Air Research program, a "MP approach" refers to a strategic research approach to air quality assessment and management. Such an approach will have to account for the different needs of the various stakeholders. For example, a MP approach for an industrial sector will be very different from a MP approach for a geographic region (e.g., city, state). The "approach" itself will:

   - utilize multidisciplinary research to provide insights into and estimate impacts of air pollution in a "holistic" manner, which considers the physical, chemical, and biological properties of individual components and their potential interactions

   - generate data and tools that can be used to identify potential control and management strategies that can reduce impacts beyond that of approaches targeting singular NAAQS and air toxics pollutants

   The MP approach may range from "source to health outcome" studies, use of predetermined mixtures of "dominant" air pollutant constituents to examine fundamental interactions (chemical and/or biological) or to assess the influence of a more "realistic"

ambient mixture on a given primary (e.g., NAAQS) pollutant to better appreciate its impact in relevant exposure circumstances - as needed by the individual NAAQS assessment mandate. The goal is to establish a program that takes into consideration the complexity of air quality and its impacts. The intent is to understand key sources, chemistries, and biological impacts that will yield the greatest opportunities for risk reduction.

2. *ORD strengthen Federal Reference Method (FRM)/Federal Equivalent Method (FEM) methods development by ascertaining the state of the measurement science for each NAAQS pollutant ahead of the review cycle, and subsequently initiating intramural or extramural research programs to develop and improve methods as needed.*

   Response: ORD has historically had a very strong methods development investment and placed high priority on the Federal Reference Methods (FRM) and Federal Equivalent Methods (FEM) program. However, over the recent past, evolving science priorities (e.g., source attribution and exposure research) have impacted our ambient air methods development and evaluation program. As a result, our ability to support the FRM/FEM program beyond critical activities (e.g., FRMs for $PM_{2.5}$ and $PM_{10-2.5}$) has been limited. However, with the renewed emphasis on the 5-year review for all criteria pollutant NAAQS, we recognize the need identified by the reviewers. Over the last 18 months, we have been actively engaged with OAQPS as to their methods needs. We realized during these discussions that we also have not done an adequate job of communicating the research we actually have ongoing in methods development both intramurally as well as through the STAR program (e.g., $6M since 2003). We have identified ORD methods points-of-contact for each NAAQS team, and we have suggested that the methods portion of the NAAQS planning documents include a review of the existing state of the science for measurements at the time of review and decision point. We are also developing a research task designed to leverage existing data to bring some of the existing FRMs up to the state of the science for some of the NAAQS. For example, as part of the SO_2 NAAQS review, we utilized existing information for ORD studies and vendors to quickly propose a new FRM for SO_2 based on newer technology (UV fluorescence), which could be used in addition to the existing FRM based on wet chemistry. We are also better coordinating (and communicating) our various field campaigns designed for other purposes to allow for methods testing and validation when possible. We continue to work with our stakeholders (primarily OAQPS but others through organizations such as the National Association of Clean Air Agencies [NACAA]) to ensure that this issue gains the requisite visibility and priority within the Agency

3. *ORD revise the procedures for designation of an approved instrument method, which will accommodate and provide incentives for the development and introduction of new measurement technologies for air quality monitoring.*

   Response: This recommendation is partially addressed in recommendation #2 above. ORD clearly recognizes the critical need for reliable and robust FRM/FEM technologies for NAAQS implementation as well as up to date procedures for their use as described in Part 53 of the Code of Federal Regulations. In implementing the FRM/FEM research program, ORD also recognizes the need to balance the need for confidence in the methods used to

implement the NAAQS with flexibility to allow for innovation and advancement in monitoring technologies.

The current FRM/FEM procedures actually can accommodate the introduction and development of new technologies. First, the FEM program is designed to allow the introduction of new methods that may be used in addition to FRMs. In addition, the use of performance based methods, as opposed to technology design specific methods, will allow new methods to be proposed as either FRM or FEM. As an example, as part of the 2006 PM NAAQS, new performance based criteria were proposed for Class III FEMs and several continuous methodologies have since been approved as FEM for both $PM_{2.5}$ and $PM_{10-2.5}$. It is also important to note that the FRM/FEM program has not been stagnant and that new monitoring technologies have been introduced and adopted. Since 2005, the FRM/FEM program has approved 14 new FRM, 23 FEM, and 39 modifications to FRM and FEM. Finally, given ORD's role in the FRM/FEM program, one of the keys to facilitating the introduction of new technologies into the air monitoring networks is for ORD to stay abreast of the latest monitoring technologies and support development and evaluation of new monitoring technologies through it own research program. ORD must do this by leveraging its research investments and by working closely with extramural air monitoring scientists and vendors. Toward that end, ORD has included and will continue to include the use and evaluation of new methods in its field research programs (e.g., Near Road Program and Cleveland Multiple Air Pollutant Study). In addition, ORD has used past STAR grants and, where possible, will utilize future STAR grants to develop and evaluate new methods. ORD is always receptive to receiving information and data for air monitoring vendors. ORD is also working to improve communication between the Air research program and the Small Business Research Initiative (SBIR) program, which can be used as a mechanism to support the development of new technologies available for designation as FRM and FEM. Nevertheless, the recognition of a need to press ahead on these methods issues is appreciated by the program.

4. *The planning and resource allocation for the Clean Air Research Program to address research priorities reflecting stakeholder needs is developed through negotiation between the [National] Program Director and participating ORD laboratories, which retain budgetary authority. ORD review the rationale for this management decision and consider a more balanced approach for resource management under the direction of the Clean Air Research Program.*

Response: EPA's Office of Research and Development (ORD) manages its resources in strict accordance with the Agency's *Resource Management Directive 2520,* which designates the ORD Assistant Administrator as the sole Allowance Holder, i.e., the individual who is ultimately responsible for program performance and accountability. Because of its broad mission and extensive research portfolio, ORD operates under a matrix-managed structure that sets out the roles and responsibilities of the National Program Directors (along one side of the matrix) and those of the Directors of our Research Laboratories and Centers (along the second side). Specifically, NPDs are responsible for laying out the strategic direction of our national programs. The Laboratory and Center Directors are responsible for conducting the research and development and managing their respective organizations. The ORMA Director is responsible for leading ORD-wide planning, formulation, and accountability efforts for the

budget. ORD believes that this matrix management structure offers a balanced and effective approach for the management of the resources for which the Assistant Administrator is ultimately responsible. We will continue to seek ways to improve our ability to produce quality science that is relevant to EPA's mission and supports effective decision-making.

5. *ORD further evaluate the judicious use of satellite data with existing ground-based measurements before embarking on more extended use of satellite data.*

Response: The increasing stream of available satellite data, including atmospheric chemical and aerosol parameters of interest, is a potential windfall of useful information for air quality analysis and modeling. We currently have some work in this area through our internal grants program (Advanced Modeling Initiative – AMI), as well as some work ongoing through the STAR program – the Harvard PM Center is currently doing some work exploring applications to exposure estimations. However, we recognize that these data are themselves the result of modeling algorithms using the direct radiance measurements from satellites as raw inputs. Furthermore, most of the available data from satellites represent column integrations through the full atmosphere. Therefore we are quite careful in how we use and interpret this rich data source. Satellites are also able to fill in large spatial gaps of unmonitored regions of the United States and the globe, making this data source especially attractive. Most of the satellite data applications have made use of the data in subjective manners (e.g., confirming relative magnitudes of emission source areas; locating regions of transported dust and wildfires/biomass burning – BlueSkyRains program). In other more quantitative applications of satellite data, we use ground monitoring data as a confirmatory check wherever possible.

6. *ORD coordinate ammonia and PM emission studies with current industry-funded research on concentrated animal feeding operations (CAFO) sources at various universities.*

Response: One of the main goals of the Clean Air Program is to leverage its research with other organizations having similar interests or ongoing work. These efforts require considerable up-front planning and negotiation, and no matter how much we do, there is always a need for more. In the recent past, ORD has had a considerable number of collaborations with industry, academia (e.g., NCSU), States, and other Federal Agencies (e.g., USDA) on the issues of ammonia and PM emissions from Concentrated Animal Feeding Operations (CAFOs). ORD has conducted laboratory and field research to improve the measurement methods and emissions factor estimates of ammonia from several types of CAFOs along with measurements of other CAFO emissions including methane and nitrogen compounds (e.g., nitrous oxide). The focus of this research was to assess the relative contributions of fugitive emissions from animal housing (both power ventilated and natural convection), lagoons, and spray field applications. In addition, measurement methods were developed and adapted such as optical remote sensing methods. These methods were used to characterize the emissions to refine measurement approaches and to explore opportunities that only modern, remote methodologies can provide for the diffuse sources associated with CAFOs and similar facilities. The technique utilizes open-path spectroscopic instrumentation to obtain path-integrated pollutant concentration information along multiple plane-configured

optical paths. These data were assimilated with wind vector information using a plane-integrating computer algorithm to yield a mass emission flux for the source. Working with OAR, ORD has also supported industry-funded research to develop a protocol for the field measurements. However, in light of other priorities, ORD has recently curtailed much of its work in this area, and currently we have no plans for intramural scientists to conduct any additional research or to analyze data from the industry-funded research in this area. New projects expected to be funded by the STAR program will focus on understanding ammonia emissions and we expect grantees to use data from other sources. When possible, we will suggest other useful ammonia data sources to assist grantees in acquiring data.

RESPONSE TO RECOMMENDATIONS ON LTG 1

1. *CMAQ and other air quality models should continue to be a high priority for sequential refinement, given that this is one of the more efficient ways in which ORD's research results are utilized to make air quality management decisions. Emphasis on CMAQ development should focus not only on the size and mass of PM, but also on the components of PM, including the characterization of the chemistry and physics of organic aerosols (both primary and secondary aerosols), and the further characterization of anthropogenic and biogenic precursor emissions. Such developments have direct implications on meeting the near-term needs of OAQPS and states in the preparation of $PM_{2.5}$ SIPs.*

   Response: The CMAQ and similar air quality models are key tools to implement air quality improvement and management strategies of both the Agency and the states and air quality management locales. As such, these air quality models remain high priorities for continued research and development, with a focus on those aspects of the modeling system that remain most uncertain. We have emphasized the physical and chemical modeling aspects of PM in recent years, especially organic aerosols, including SOA, primary organics, and now there is considerable focus on the non-carbon components of organic material. We have also emphasized the need for accurate representation of the interactions between gas-, aqueous-, and aerosol-phase chemistry within comprehensive modeling frameworks. We are also continuing our research into the fate of total nitrogen, including nitrate aerosol, and the roles of NH_3, N_2O_5, HNO_3, and sea salt in the cycle of nitrogen production and loss. Additionally, we are also devoting resources to the characterization of previously "unclassified" components of $PM_{2.5}$ mass, to improve our modeling of total $PM_{2.5}$. In this spirit, we are collaborating with EPRI and CMU on bringing a new representation of aerosol aging into CMAQ (Volatility Basis Set). We are also continuing to research and improve the emission inventories of PM and its precursors; note especially the current work on reconciling the BEIS and MEGAN biogenic inventories.

   We currently support through our STAR program seven extramural grants aimed at improving our understanding of organic aerosol and its representation in air quality models (http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/recipients.display/rfa_id/449/records_per_page/ALL). Additionally, twelve new grants will be funded in early 2010 to

improve knowledge about emissions from the transportation and animal operations sectors (note the links to ammonia emission estimates from the efforts described above and that discussed in #2 below), as well as projects to develop new emission inventory techniques and to better understand emissions of coarse PM (See http://epa.gov/ncer/rfa/2009/2009_star_air_pollution.html).

2. *The combined use of modeling tools such as CMAQ and inverse-CMAQ modeling, and ambient and satellite measurements to improve estimates of ammonia and elemental carbon emissions should be applied to other pollutants/sources and other areas to demonstrate their wider applicability.*

   Response: We are approaching inverse modeling opportunities from two different directions. First, we continue to develop methods and tools to be able to perform this kind of work at a state-of-the-art level. We currently maintain CMAQ-DDM, which through the use of forward sensitivities enables a more efficient quantification of the relationship between emissions and modeled concentrations necessary to construct an inverse. We have also become active participants in the development of the CMAQ-Adjoint tool, which will provide another approach for formulating inverse relationships. Second, as was mentioned in the recommendation, we are applying the tools for various pollutants and data sources as these become available in the quality necessary to arrive at meaningful conclusions. In addition to ammonia and EC, we have successfully demonstrated an inverse application to NO_x emissions based on satellite measurements. As already noted, we strategically focus our efforts on those aspects of the models that are most uncertain and that if refined, would provide substantial gains in accuracy and model utility. The STAR program has supported a range projects involving both the use and the development of air quality modeling in the past and we anticipate funding new inverse-modeling work to improve emissions inventory development soon.

3. *ORD is encouraged to leverage its selection of emerging monitoring technologies and methods by selecting the ones that have the greatest potential for widespread use among state and local air quality monitoring agencies.*

   Response: We do recognize that it is important to develop and evaluate methods that have potential to be widely used by state and local air quality monitoring agencies. It is important to communicate with state and local air monitoring groups and with OAR to understand their needs and to get their input and insights on monitoring technologies of interest to them. As noted above, over the last few years, we have increased our efforts to interact with the monitoring community – not just within the federal OAQPS unit, but with the state and local user community. We have been reaching out to the air monitoring community by including or inviting their input in our review panel (e.g., this BOSC, other research meetings), attending meetings of the ambient monitoring subcommittee of the National Association of Clean Air Agencies (NACAA), attending the National Air Quality Conferences in Portland in 2008 and Nashville in 2009, as well as, meeting with Regional air program managers. We have also made significant efforts to interact more frequently with the monitoring groups in OAR both at the NPD level and at the ORD Lab/Center level. From these interactions, we are integrating emerging methods/measurement techniques into our field studies for testing and

development. As an example, we are working with OAR to evaluate equipment such as the UC Davis DRUM sampler, nephelometers, mini aethalometers, and passive ammonia samplers in our current field studies. We hope to continue to expand these activities and keep their priority status high within the overall ORD structure as we move forward in annual planning.

4. *The potential health effects of coarse particles in urban and rural environments should be examined*

Response: We agree with the BOSC that this is an important issue. Because of its importance, in 2008 NCER funded five grants to examine the health effects associated with exposure to coarse PM. Three of these grants are comparing the health effects of coarse PM in urban and rural environments. One project is investigating the toxicity of urban and rural coarse PM from several locations within the US and internationally. A second project will monitor the impact on cardiovascular outcomes in humans from controlled exposure to both urban and rural concentrated ambient coarse PM. Finally, results from detailed characterization of coarse PM collected at several locations in Denver, CO and the nearby rural community Greeley will be used in a comparative epidemiology study considering a broad range of health outcomes. Additionally, data on coarse PM collected at 10 locations in and around LA will be available to support health studies.

These studies complement health studies using coarse CAPs in Chapel Hill as well as coarse CAPs in Toronto as part of the Harvard PM Center. Additional work is ongoing in others of the PM Centers (e.g., UC Davis, Hopkins PM Center) and within the intramural field campaigns (e.g., Birmingham, Cleveland, and the near road studies sites). We are also working with Region 9 on a RARE project looking differentially at rural/urban differences in New Mexico. Finally, we are considering supporting additional projects investigating the health effects of coarse PM through the STAR program in the near future.

RESPONSE TO RECOMMENDATIONS ON LTG 2

1. *Continue to pursue a multipollutant approach for both air quality management and research, but formally define the aspects of "multipollutant" that are of highest priority and will be pursued in the near term and long term.*

Response: ORD believes that a multipollutant (MP) approach is key to moving forward in air pollution research. A third of the BOSC review was devoted to proposed plans in this area, because we wanted to ascertain if the BOSC also felt strongly about the need for a multi-pollutant program. We are pleased that the BOSC does. In 2008, ORD held a workshop with OAR to better understand the regulatory impacts of EPA taking a MP approach, and ORD communicated its existing efforts (at the time) in MP research. OAQPS had already developed a MP strategy, which was being piloted in St. Louis and Detroit. We continue to work with OAQPS to try to incorporate their needs and uncertainties in this activity to the extent possible as we move ahead with our MP program. ORD and OAQPS are now planning for late 2010 (or early 2011), a workshop involving extramural scientists and experts on regulatory and research priorities and approaches that will pave a path for advances in MP science, which is inherently complex and historically has failed because of a lack of clear

goals and strategies. Meanwhile, ORD is in the process of articulating a formal MP research strategy that would lay out a blueprint for research in this area for the next 5-7 years which could be discussed at the proposed workshop.

In the near term, EPA is using the near-road research program as an initial prototype of MP research. This approach is intended to inform the future progression of multipollutant research. The near-road research program is focused on assessing the impacts of mobile sources on air quality, exposures, and health effects where the mixture of pollutants is present in a spatially confined environment. The approach taken to perform this research involves bringing together many scientific disciplines to tackle a complex problem that is simplified, to some degree, by examining a case involving relatively fresh source emissions. Longer term aspects of MP research will build on the approach used in the near-road program and will be addressed through the award of research grants and intramural research directed at understanding the complexities of multipollutants in urban airsheds. Since the BOSC review, EPA has released an RFA that is directed at examining (1) regional and temporal differences in air pollution risk, (2) the origins of specific constituents of multipollutant atmospheres that contribute to adverse health effects, (3) identifying populations that are at increased risk to air pollution mixtures, and (4) how health effects related to PM may be better understood in a multipollutant context. The results from this research will provide for more insight into multipollutant effects and will allow us to prioritize key facets of multipollutant research.

ORD also has ongoing work on direct source toxicology studies as well as preliminary work involving source–UV transformation conditioning (at the Harvard PM Center as well as in planning intramurally). The AQ models and laboratory atmospheric chemistry efforts are being incorporated in these activities. The impact of climate change on this activity is being considered, and the Clean Air Research program is leveraging its efforts with the Global and Biofuel research activities as it moves ahead.

2. *The Clean Air Research Program should consider developing a research framework to explore multipollutant exposures as they relate to the copollutant complex of PM components, ozone, NO_2 and air toxics and the potential positive and negative effects that may result from combinations of these pollutants on health outcomes.*

   Response: This recommendation has been partially addressed in response to related recommendations above. The MP approach is broad. We agree that ORD needs a framework from which to move forward and as noted we have adopted the "source to health outcome" approach as core to this framework. Studies of likely key interactions of pollutants identified in MP models and likely co-pollutants (PM and ozone for example) are being pursued in health studies. For example, studies are underway to examine health effects of PM with and without other gaseous co-pollutants such as NO_2 which has direct relevance to near road work. Studies are also being planned to examine both the chemical interactions, as well as health effects, of complex mixtures containing PM and either gases or organic vapors (air toxics) – especially those that relate to prime source emissions.

3. *More basic research on pollutant mixture exposure needs to be performed to support the design of multipollutant-based emission regulations and ambient standards. Because it is*

apparent that it will not be realistic to set air quality standards for pollutant mixtures or components of $PM_{2.5}$ in the near term, examining the health effect correlations from one or more source categories is a reasonable approach.

Response: We agree that more basic research needs to be directed at understanding the interactions of mixtures of air pollutants, and we are funding and performing research to address this very need. ORD is actively engaged in research to understand the relationship between mobile sources and adverse health effects through our near-road research program. The focus of the PM Centers program, funded from 2005-2009, was directed at understanding the linkages between source emissions and health effects. Future efforts will be directed at understanding the origins (sources and/or atmospheric formation) of multipollutant atmospheres and their impact on human health effects through intramural research and the award of extramural funding as part of the Air Centers, the successor program to the highly informative PM Centers program funded through NCER. These new centers will be key to the implementation of our MP program, and we intend to bring both the physical research of the laboratory and field campaigns in juxtaposition with the various air quality and exposure models that, through iteration, will aid this maturing science area.

4. *Continue to survey clients and stakeholders on perceptions of and satisfaction with ORD's role in the source-to-health outcomes process.*

Response: We agree that the client surveys have provided useful insight into the perceptions of and satisfaction with the Clean Air Research program, and we intend to continue to conduct such surveys on a biennial basis. We will also be reviewing the questions and making refinements to make sure that the information we get from the surveys is useful in improving the usefulness of the research results from the program.

Table 1. Summary of the BOSC's Recommendations and ORD's Response and Proposed Actions Associated with Review of the Clean Air Research Program

Recommendation	ORD Response	ORD Actions (Timing)
General Overall Program Recommendations		
ORD develop a working definition for the term "multi-pollutant approach" as it pertains to its LTGs and the expectations of its various stakeholders.	The "multipollutant approach" (1) utilizes multidisciplinary research to gain holistic insights and estimates of impacts of air quality; and (2) provides assessments and opportunities to develop control and management strategies to reduce impacts beyond those of approaches targeting singular pollutants. The MP approach encompasses strategies that include studies conforming to a "source to health outcome" paradigm, use predetermined realistic mixtures designed to address specific interactions of the influence of mixtures on individual pollutant actions.	A framework is being developed and joint workshop is being planned with OAQPS for the late 2010/2011 time frame. A draft framework is planned for discussion at this workshop.
ORD strengthen Federal Reference Method (FRM)/Federal Equivalent Method (FEM) methods development by ascertaining the state of the measurement science for each NAAQS pollutant ahead of the review cycle, and subsequently initiating intramural or extramural research programs to develop and improve methods as needed.	We recognize the need identified by the reviewers and are actively engaging in discussions of the methods needs with OAQPS. Additional resources are being applied as allows for specific issues. All field campaigns are being coordinated to provide opportunities for ORD, OAQPS, or vendor testing.	The plan noted is active presently. Additionally ORD has identified points of contact for each NAAQS team (completed). We are including a review of the state of the science for measurements in the methods portion of the NAAQS planning documents (ongoing), and we are developing a research task designed to leverage existing data to bring some of the existing FRMs up to the state of the science for some of the NAAQS (ongoing)

Recommendation	ORD Response	ORD Actions (Timing)
ORD revise the procedures for designation of an approved instrument method, which will accommodate and provide incentives for the development and introduction of new measurement technologies for air quality monitoring.	We believe that the current FRM/FEM procedures can accommodate the introduction and development of new technologies. This flexibility needs to be better communicated and implemented.	Presently being implemented.
The planning and resource allocation for the Clean Air Research Program to address research priorities reflecting stakeholder needs is developed through negotiation between the Program Director and participating ORD laboratories, which retain budgetary authority. ORD review the rationale for this management decision and consider a more balanced approach for resource management under the direction of the Clean Air Research Program.	ORD believes that its matrix management structure offers a balanced and effective approach for the management of the resources for which the Assistant Administrator is ultimately responsible. We will continue to seek ways to improve our ability to produce quality science that is relevant to EPA's mission and supports effective decision-making.	
ORD further evaluate the judicious use of satellite data with existing ground-based measurements before embarking on more extended use of satellite data.	We agree that the increasing stream of available satellite data is a potential windfall of useful information for air quality analysis and modeling.	Pilot work is ongoing internally and through STAR. As the technologies and models improve, we will continue to use satellite data in a subjective manner and, wherever possible, use ground monitoring data as a confirmatory check. At some point, pilot testing with other exposure models may be pursued.

Recommendation	ORD Response	ORD Actions (Timing)
ORD coordinate ammonia and PM emission studies with current industry-funded research on concentrated animal feeding operations (CAFO) sources at various universities.	We collaborated with industry, academia, States, and other Federal Agencies on ammonia and PM emissions from CAFOs. These collaborations have been on emission estimates and measurement methods. Presently, ORD is not actively involved in generating additional data because of the ongoing industry study.	We will assess opportunities as they arise and resources allow in the context of overall priorities.

Recommendation	ORD Response	ORD Actions (Timing)
LTG 1 Recommendations		
CMAQ and other air quality models should continue to be a high priority for sequential refinement and development with a focus not only on the size and mass of PM, but also on the components of PM, including the characterization of the chemistry and physics of organic aerosols (both primary and secondary aerosols), and the further characterization of anthropogenic and biogenic precursor emissions.	We agree that CMAQ and other air quality models remain as high priorities items for continued research and development, with a focus on those aspects of the models that remain most uncertain.	Continued refinement of the models to address critical uncertainties (ongoing)
The combined use of modeling tools such as CMAQ and inverse-CMAQ modeling, and ambient and satellite measurements to improve estimates of ammonia and elemental carbon emissions should be applied to other pollutants/sources and other areas to demonstrate their wider applicability.	We agree and are approaching the inverse modeling opportunities from two different directions. First, we continue to develop methods and tools to be able to perform this kind of work. Second, we are applying the tools for various pollutants and data sources as these become available in the quality necessary to arrive at meaningful conclusions.	The development and application of models and tools are priority activities and will continue as the science evolves (ongoing).
ORD is encouraged to leverage its selection of emerging monitoring technologies and methods by selecting the ones that have the greatest potential for widespread use among state and local air quality monitoring agencies.	We agree that it is important to develop and evaluate methods that have potential to be widely used by state and local air quality monitoring agencies, and to communicate with state and local air monitoring groups and with OAR to understand their needs and to get their input and insights on monitoring technologies of interest to them.	We will continue to integrate emerging methods/measurement techniques into our field studies, and invest in methods research, working with OAQPS to prioritize this research. We will continue to attend meetings and involve ourselves with the monitoring community to better assess research needs. (ongoing)
The potential health effects of coarse particles in urban and rural environments should be examined	We agree with the BOSC that this is an important issue. Because of its importance, in 2008 NCER funded five grants to examine the health effects associated with exposure to coarse PM.	

Recommendation	ORD Response	ORD Actions (Timing)
LTG 2 Recommendations		
Continue to pursue a multi-pollutant approach for both air quality management and research, but formally define the aspects of "multipollutant" that are of highest priority and will be pursued in the near term and long term.	We believe that a multi-pollutant approach is key to moving forward in air pollution research. In the near term EPA is using the near-road research program as an initial prototype of multipollutant research.	Articulate a formal multi-pollutant research strategy that would lay out a blueprint for research in this area for the next 5-7 years. (within 1 year)
The Clean Air Research Program should consider developing a research framework to explore multi-pollutant exposures as they relate to the copollutant complex of PM components, ozone, NO2, and air toxics, and the potential positive and negative effects that may result from combinations of these pollutants on health outcomes.	ORD has already initiated research in this area. Studies are underway to examine health effects of PM with and without gaseous co-pollutants such as ozone and NO2. Studies are also being planned to examine both the chemical interactions, as well as health effects, of complex mixtures containing particular and either gases or organic vapors (air toxics).	
More basic research on pollutant mixture exposure needs to be performed to support the design of multi-pollutant-based emission regulations and ambient standards. Because it is apparent that it will not be realistic to set air quality standards for pollutant mixtures or components of PM2.5 in the near term, examining the health effect correlations from one or more source categories is a reasonable approach.	We agree that more basic research needs to be directed at understanding the interactions of mixtures of air pollutants, and we are funding and performing research to address this very need.	Focus intramural research and the Air Centers on understanding the origins (sources and/or atmospheric formation) of multipollutant atmospheres and their impact on human health effects. (ongoing)
Continue to survey clients and stakeholders on perceptions of and satisfaction with ORD's role in the source-to-health outcomes process.	We agree that the client surveys have provided useful insight into the perceptions of and satisfaction with the Clean Air Research program, and we intend to continue to conduct such surveys on a biennial basis.	Conduct client survey (every 2 years, beginning in 2011)