July 31, 2000

EPA-SAB-CASAC-LTR-00-006

Honorable Carol M. Browner
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Subject: Review of the US EPA Response to Section 6102(e) of the Transportation Equity Act for the 21st Century

Dear Ms. Browner:

The Clean Air Scientific Advisory Committee (CASAC), as mandated under section 109 of the Clean Air Act Amendments of 1977 (42 U.S.C. 7409), provides advice to you on the scientific and technical issues associated with the national ambient air quality standards (NAAQS). To provide you and your staff with the most relevant and up to date advice on the scientific basis for the particulate matter NAAQS, we have established the CASAC Technical Subcommittee on Fine Particle Monitoring (the "Subcommittee"). This Subcommittee has been active over the past several years working closely with staff of the Office of Air and Radiation and the Office of Research and Development.

Most recently, the Subcommittee was asked to conduct a very rapid review of the Agency's report to Congress on its response to Section 6102(e) of the Transportation Equity Act for the 21st Century. That review was conducted via a public teleconference on June 21, 2000. Following that Subcommittee meeting, and after careful review, the full CASAC met on July 28, 2000 via public teleconference, during which it reviewed and approved the attached Subcommittee report.

The CASAC is pleased to establish an interactive advisory relationship with the Agency through this Subcommittee, and looks forward to assisting the Agency in optimizing the design and implementation of its fine particle monitoring system and the utility of the information that system will provide.

Sincerely,

Dr. Joe L. Mauderly, Chair
Clean Air Scientific Advisory Committee

U.S. Environmental Protection Agency
Science Advisory Board
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NOTICE

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Report of the

Clean Air Scientific Advisory Committee (CASAC)

Technical Subcommittee on Fine Particle Monitoring

June 28, 2000

Dr. Joe L. Mauderly, Chair
Clean Air Scientific Advisory Committee (CASAC)
USEPA Science Advisory Board
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Subject: Review of the US EPA Response to Section 6102(e) of the Transportation Equity Act for the 21st Century

Dear Dr. Mauderly:

The Technical Subcommittee on Fine Particle Monitoring of the Clean Air Scientific Advisory Committee (CASAC) of EPA's Science Advisory Board, met via public teleconference on Wednesday, June 21, 2000 to review the US EPA response to Section 6102(e) of the Transportation Equity Act for the 21st Century. This response to Congress was prepared by EPA's Office of Research and Development (ORD).

Background

Section 6102(e) of the Transportation Equity Act for the 21st Century requires the U.S. Environmental Protection Agency to verify the performance of the sampler that was designated by 40 CFR Part 50, Appendix L (July 1997) to be the Federal Reference Method (FRM) sampler for $PM_{2.5}$. In the Act, Congress specified that:

> *The Administrator shall conduct a field study of the ability of the PM2.5 Federal Reference Method to differentiate those particles that are larger than 2.5 micrograms in diameter. This study shall be completed and provided to the Committee on Commerce of the House of Representatives and the Committee on Environment and Public Works of the United States Senate no later than 2 years from the date of enactment of this Act.*

In response to this requirement, ORD prepared the report *Response to Section 6101(e) of the Transportation Equity Act for the 21st Century* (EPA Report Number 600/R-00/033 dated May 10, 2000), which presents results from several field studies conducted by both EPA and non-EPA researchers. The report encompasses work done both before and after promulgation of the $PM_{2.5}$ standard.

Review Process and Charge to the Subcommittee

Prior to submitting the report to the Subcommittee for a full independent peer review, ORD had the draft report reviewed by two external expert reviewers. Changes responsive to the comments of these two reviewers were incorporated into the draft report prior to the Subcommittee review. For the peer review, the Agency has asked that the Subcommittee respond to the following three questions:

a) Has the proper methodology been used to address the requirement in the Transportation Equity Act?

b) Was the methodology applied correctly? and

c) Is the Report's interpretation correct?

The Subcommittee also decided to address the following question:

d) Has the submitted Report responded to the Congressional mandate/request as stated in the Act?

The Agency sent the Subcommittee copies of the draft report along with additional background materials several weeks prior to the public teleconference. The teleconference was announced in the Federal Register and hosted from a conference room at EPA Headquarters. Although opportunity was afforded for oral public commentary, there were no oral or written comments from the public prior to or during the teleconference.

Subcommittee Responses to the Charge

a) Has the proper methodology been used to address the requirement in the Transportation Equity Act?

The Subcommittee commends the authors for writing a generally thoughtful and useful report. It is a difficult problem to make direct measurements of the size penetration performance of a sampler in the field where it is hard to use generated monodisperse particles as is possible in the laboratory. They have made use of a number of field studies to examine the performance of the FRM in comparison with a number of other sampling devices. Of particular note is the hybrid approach in which the Well Impactor Ninety-Six (WINS) impactor was operated in the field to produce typical particle loadings. It was then returned to the laboratory where particle penetration studies for specific sized particles could be made. This is a useful and effective approach to determine the effects of field operation on the system performance.

Neither the program of testing the FRM nor the Report directly outlines a set of sampling questions to be answered and a related strategy. For example, there did not seem to be a strategy to examine the range of meteorological conditions and particle

compositions that might affect the FRM performance. Thus, there has been a reasonable program of field sampling and analysis, but it has not yet been fully placed in a context of a strategy to fully test the capabilities of the sampling system.

b) Was the methodology applied correctly?

These studies suggest that the WINS is performing as might be expected from the earlier laboratory studies that examined its particle penetration properties. Thus, the report provides evidence from laboratory and field studies regarding the effectiveness of the FRM sampler at making a relatively sharp separation of particles smaller than 2.5 μm aerodynamic diameter from particles larger than 2.5 μm.

The Subcommittee therefore concludes that, in general, the work presented in the Report did use a proper methodology and applied the methodology correctly. One significant question is whether the methodology has been applied across a wide enough range of conditions to fully explore the limits of acceptable system performance. There were studies in Philadelphia, Rubidoux, Phoenix, Research Triangle Park, and Atlanta. However, there were no specific studies under severe cold weather conditions. Most of the studies (Four Cities Study) were done during the winter and thus these systems were also not tested under extreme high temperatures. There were high humidity conditions in Atlanta, but high temperature and low humidity conditions in high dust areas such as Phoenix were not tested.

We would suggest that in the future, it would be useful to extend these studies to a more complete range of conditions. It would also be helpful to make more direct measurements of the penetration characteristics of the system. With care, we believe that an Aerodynamic Particle Sizer (APS) could be used to make the necessary direct measurements to confirm the results presented in the Report. It may also be possible to generate a distinctive aerosol with known size distributions so that the penetration properties of the system could be directly measured. For example, an aerosol consisting of known relative concentrations of several sizes of polystyrene latex (PSL) particles covering the range of 1 to 5 μm could be produced in which each size has a distinctive fluorescent label. The material collected on the filter could then be easily analyzed for its particle size distribution and the inlet penetration characteristics could thus be ascertained.

There is also a question of the long-term performance of these systems. It is not possible within the two year period to test the possibility of changes in system performance over extended use. Thus, there needs to be a strategy and a commitment for ongoing testing and evaluation of the FRM performance as additional experience in its operation is obtained. In addition, a summary of the initial year of operational experience by the state and local air quality agencies who are using the FRM would be useful in evaluating the system's performance.

c) Is the Report's interpretation correct?

In general, the Subcommittee concluded that the results of the reported studies were appropriately interpreted within the range of conditions under which testing was performed. One aspect of the discussion was the comparison of results with earlier work by Tsai and Cheng [1995]. Because these studies did not correspond with the conditions in the FRM, the Tsai and Cheng results were "adapted" in order to make the presentation provided in the Report. The Subcommittee feels that it would be better to eliminate the quantitative aspects of this comparison because of the required changes in the published results. Qualitative comparisons with this work are appropriate to be included.

In the Report, there is confusion between the ability of the FRM to accurately separate particles based on aerodynamic diameter and the ability to accurately measure the mass of $PM_{2.5}$. These are quite different questions. On page 24, the Report states: "Most importantly to this presentation, this study demonstrated again that the WINS is capable of preventing coarse particle intrusion that can lead to an overestimate of PM2.5 mass concentration." We agree with this conclusion. However, on page 19, it says: "The three studies highlighted in this chapter demonstrate clearly that the FRM effectively measures PM2.5 mass concentration as well as - or in some cases better than the other methods." We do not agree that this conclusion is warranted given that there is no absolute standard for the airborne particulate mass that can serve to test this assertion. Given the existence of a number of problems with semivolatile particulate components and the retention/elimination of particle bound water, these studies cannot address the question of accurate mass concentration measurements and it is not appropriate to make such a conclusion.

We would suggest that the discussion of the performance of the WINS relative to other technologies, particularly the sharp-cut impactor be more balanced. The Report appears to be more focused on justifying the choice of the WINS technology rather than presenting its characteristics and performance. Given some of the operational problems of the WINS involving the oil (crystallization, staff time commitment, etc.), it is useful to examine if other devices can provide similar aerodynamic performance without these difficulties. The *a priori* exclusion of other technologies does not appear warranted at this time.

d) Has the submitted Report responded to the Congressional mandate/request as stated in the Act?

The Subcommittee feels the Congressional inquiry focused on whether the FRM was accurately measuring the indicator chosen for the $PM_{2.5}$ NAAQS. This measurement includes the ability of the FRM to accurately separate particles larger than 2.5 µm from those which are smaller. However, the inquiry also includes the question as to whether

the measurements are compromised by problems under specific operating conditions. For example, it has been found that under certain circumstances, the oil in the WINS can crystallize. There is then a possibility of particle bounce from the solid oil surface leading to larger particles reaching the PM2.5. The crystallized oil clearly does not represent the surface that was tested for its capability to separate particles at 2.5 μm. Thus, it is not known how the penetration characteristics of the FRM change upon the crystallization of the oil in the WINS impactor and large particles may bounce from the surface and reach the $PM_{2.5}$ filter. There have been reports of other problems with the FRM samplers including observation of additional mass on the filters from passive loading (particles blowing into the system while not in operation) in certain manufacturer's designs and condensation of liquid water in the inlet leading to water in the WINS impactor. The manufacturers have made some changes in response to these reports and it would be useful to have a full compilation of problems reported, what has been done to correct these problems, and what are the plans to address the remaining issues.

Summary

In summary, the Subcommittee concludes that, in general, the Report meets the requirements set by the Act. It could be further strengthened by additions and changes suggested in this review. Because the particular section of the statute that required this report is not well known to the general air pollution community, it is suggested that a different, more descriptive title be given to the report and the reference to the statute be given in a subtitle.

In addition, the Report should not represent a termination of testing and evaluation of monitoring methods for airborne particulate matter. A long term study of the performance of the FRM is needed to assess the quality of the data coming from the mass monitoring network.

Sincerely,

Dr. Philip K. Hopke, Chair
Technical Subcommittee on Fine Particle Monitoring
Clean Air Scientific Advisory Committee

U.S. Environmental Protection Agency
Science Advisory Board
Clean Air Scientific Advisory Committee
CASAC Technical Subcommittee for Fine Particle Monitoring

Chair

Dr. Phil Hopke, Clarkson University, Potsdam, NY (Member of CASAC)

Members of CASAC

Dr. John Elston, State of New Jersey, Dept. of Environmental Protection & Energy, Trenton, NJ (Did not attend meeting)

Dr. Warren White, Washington University, St. Louis, MO

Members of Other SAB Committees

Dr. JoAnn Lighty, University of Utah, College of Engineering, Salt Lake City, UT (Member and Liaison from SAB Environmental Engineering Committee) (Did not attend meeting)

Dr. Morton Lippmann, Nelson Institute of Environmental Medicine, New York University, Tuxedo, NY (Interim Chair of the Science Advisory Board)

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Dr. Petros Koutrakis, Harvard University, Boston, MA

Dr. Debra Laskin, Environmental & Occupational Health Sciences Institute, Rutgers University, Piscataway, NJ (Did not attend meeting)

Dr. Peter H. McMurry, University of Minnesota, Department of Mechanical Engineering, Minneapolis, MN

Dr. Kimberly A. Prather, Department of Chemistry, University of California-Riverside, Riverside, CA (Did not attend meeting)

Dr. George T. Wolff, General Motors, Corporate Affairs, Detroit, MI (Did not attend meeting)

Mr. Mel Zeldin, Monitoring and Analysis Division, South Coast Air Quality Management District (SCAQMD), Diamond Bar, CA

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Appendix A - Individual Comments

Peter McMurry

Abstract: I recommend that the text be modified to read "2.5 micrometers in aerodynamic diameter" rather than "2.5 micrometers in diameter." The report eventually makes it very clear that separation is on the basis of aerodynamic diameter, but this should be made clear up front as well.

p. 2, line 2: I don't know what is meant by "active" formation processes; I would delete "active"

p. 2, second paragraph: appears to be contradictory. I think it would be better if the paragraph were to begin by mentioning the various major sources of coarse particles (soil dust, sea salt, pollens, plant material, etc.) The paragraph could then continue with a discussion of formation mechanisms if it is felt this is necessary (I don't). I don't think one would argue that sea salt and pollen are produced by a mechanical process such as grinding, crushing and abrasion.

p. 2, third paragraph 3: I recommend that this be modified to read: "Typical ambient aerosol mass distributions exhibit a minimum..."

p. 8, paragraph beginning "The number concentration..." Although the context makes clear what is meant, I would not use the word "primary" to discuss the aerosols used to measure the impactor's size cut.

p. 8, ammonium fluorescein: are these solid particles known to be spherical? If not, what is the calibration error caused by the nonsphericity?

p. 12, reference to Tsai and Cheng (1995) article. The authors found it necessary to shift the data in this paper to a larger size to make their point. I feel this weakens the report. I'd be inclined to eliminate discussion of the Tsai and Cheng paper.

p. 13: "Use of the WINS in the field will not result in overestimation of mass concentrations, nor overcollection of large particles." The report focuses on size cuts, not on measurement of mass concentrations. I believe this sentence should be rewritten to indicate that the WINS will not lead to a significant overestimate of PM2.5 mass concentrations due to sampling of coarse particles.

p. 14, first complete paragraph: Did Kenny's measurements involve sampling for a total of 96 to 132 hours over a 5 week period?

p. 14, last paragraph: Please mention how PM10 was measured.

p. 19, first paragraph "The three studies highlighted in this chapter demonstrate clearly that the FRM effectively measures PM2.5 mass concentration as well as - or in some cases better than - the other

methods." Again, the report should focus on the WINS size cut and not on the accuracy of mass concentration measurements. See p. 24: "Most importantly to this presentation, this study demonstrated again that the WINS is capable of preventing coarse particle intrusion that can lead to an overestimate of PM2.5 mass concentration." YES.

p. 23. tables: Why is the increase in apparent PM2.5 crustal mass so much smaller than the increase in PM2.5 mass concentration? Is there a problem with estimation of crustal mass from elements? Or, is it something else (pollens, plant matter, etc.)?

p. 27, first bullet: "...may be described as "sharp."" I think it should be made clear that this is relative to other inertial separators that could be used as an inlet.

George Wolff

1. Generally good job in answering/addressing the questions

2. They need to clarify how they calculated the soil component.

3. It would be better if they showed a comparison with a few other PM2.5 species, in particular, elemental carbon, organic carbon, and nitrate. There are artifact issues involving these species, and it would be good to see a comparison between the various methods to show better confidence (if the data were collected).

Melvin Zeldin

Comments on the four specific charges questions are:

1) Yes

2) Yes

3) Yes

4) Not quite. While the report directly addresses the charge to conduct a field study, I believe Congress intended to assure that such monitors were accurately measuring PM fine. Under special studies, tests worked out to show the validity of the FRM. However, field experiences by state and local agencies using the FRM under more rigorous situations than occurred in the field tests, showed some problems with the FRMs, specifically, passive sampling, cold weather, oil crystallization, and other conditions. I think it would be best if the report contained a chapter on actual field experiences, the problems encountered, and how the problems have been overcome. (Some have not been corrected yet.)

Warren White

1. Why should the title be absolutely meaningless to 99.9999% of the nation's college graduates? This is like a 6th-grader handing in a paper titled 'Two paragraphs my teacher made me write'! Why not admit this is a report on 'The effectiveness of the FRM PM2.5 sample inlet for rejection of coarse particles'? Reference to section 6102(e) could be a subtitle for the Congresso-philes. If the report merits an agency number so that it can be retrieved from storage some day in the future, it also merits a title that can still be deciphered then.

2. It would be very helpful to add an index of inlets and samplers (and their manufacturers), indicating the combinations that were tested and the pages that discuss them. Anderson-RAAS, URG-MASS, Met One-SASS, AN 3.68, SCC 2.141, and MST -- these long alphanumeric strings all look like they should contain a lot of information, but they sure aren't obvious mnemonics. SCC is the only one that gets translated as an acronym/abbreviation.

3. The first of the bulleted conclusions (page 27) should be given substance. '...that the penetration curve may be described as "sharp"' is not a falsefiable statement. Surely the cut provided by the old dichot the WINS displaces was once described as "sharp"?