UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C. 20460

OFFICE OF THE ADMINISTRATOR
SCIENCE ADVISORY BOARD

April 20, 2010

EPA-CASAC-10-009

The Honorable Lisa P. Jackson
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

Subject: CASAC Review of *Particulate Matter Urban-Focused Visibility Assessment – Second External Review Draft* (January 2010)

Dear Administrator Jackson,

The Clean Air Scientific Advisory Committee (CASAC) Particulate Matter (PM) Review Panel met on March 10–11, 2010 to review the *Quantitative Health Risk Assessment for Particulate Matter – Second External Review Draft* (February 2010) and *Particulate Matter Urban-Focused Visibility Assessment – Second External Review Draft* (January 2010). In this letter, CASAC offers general comments on the *Particulate Matter Urban-Focused Visibility Assessment*, followed by our consensus responses to the Agency's charge questions. Comments from individual panelists are also enclosed.

CASAC was favorably impressed with the quality and clarity of the second draft *Particulate Matter Urban-Focused Visibility Assessment (UFVA*). As we indicated in our letter of November 24, 2009 regarding the first draft of the *UFVA*, CASAC strongly supports the introduction of a new PM light extinction indicator for a secondary standard to protect against adverse effects on visibility. We concur with an hourly averaging time as the most appropriate to represent the nearly instantaneous nature of human perception of impaired visibility. We also agree with the 20 to 30 deciview (dv) range of light extinction levels as a reasonable representation of the levels of visibility impairment considered acceptable based on currently available studies.

The *UFVA* presents logical and persuasive arguments for use of a PM light extinction indicator, with a 1-hour (daylight) averaging time as a sound basis for a secondary PM standard to protect urban visibility. The *UFVA* also presents and evaluates reasonable ranges for the level (20 to 30 deciviews) and form (90th to 98th percentile) that such a standard might take, and clearly illustrates the differences among the many resulting optional combinations of levels and forms in terms of protectiveness and/or stringency across the 15 diverse urban study areas selected for this analysis. The approaches employed here, the ranges of options considered, and the estimates of visual

air quality resulting from the various combinations of options considered should provide a sound basis for more detailed consideration in the *Policy Assessment.*

In addition, if the Agency is also considering options of using a $PM_{2.5}$ light extinction indicator or a $PM_{2.5}$ mass indicator as the basis for secondary PM standard, it would be important to see a more detailed comparison of the affected $PM_{2.5}$ concentrations, species compositions and levels of visibility protection that would result from the use of alternative PM_{10} light extinction, $PM_{2.5}$ light extinction or $PM_{2.5}$ mass indicators.

In its second draft UFVA, EPA staff were responsive to previous CASAC recommendations, adding a detailed logit analysis to better understand similarities and differences in results of the urban visibility preference studies, recalculating estimated extinction levels using a 90% relative humidity (RH) screen, and considering (90th, 95th and 98th) percentiles based on all available daylight hours as well as on the single worst daylight hour in each day.

CASAC recommends the addition of an integrative summary chapter to the *UFVA.* At present, it lacks a summary that brings main findings and their implications together. This chapter might be included as an executive summary or as new chapter at its conclusion. CASAC has also identified needs for the next review cycle in terms of further research on a number of topics related to urban visibility; these needs should be assembled, highlighted and prioritized. In particular, there is a need for the Agency to conduct additional urban visibility preference studies over a broad range of urban areas and viewing conditions, to further evaluate and refine the range of visibility levels considered to be acceptable in the current assessment.

We thank the Agency for the opportunity to provide advice on the UFVA, and look forward to continued discussions with the Agency as we review the first draft *Policy Assessment for the Review of the Particulate Matter National Ambient Air Quality Standards* (March 2010).

Sincerely,

/Signed/

Dr. Jonathan M. Samet
Chair
Clean Air Scientific Advisory Committee

Enclosures A: CASAC Particulate Matter Review Panel Roster
B: CASAC Responses to Charge Questions
C: Individual Panelists' Responses to Charge Questions

Enclosure A

Clean Air Scientific Advisory Committee
Particulate Matter Review Panel

CHAIR
Dr. Jonathan M. Samet, Professor and Chair, Department of Preventive Medicine, University of Southern California, Los Angeles, CA

CASAC MEMBERS
Dr. Joseph Brain, Philip Drinker Professor of Environmental Physiology, Department of Environmental Health, Harvard School of Public Health, Harvard University, Boston, MA

Dr. H. Christopher Frey, Professor, Department of Civil, Construction and Environmental Engineering, College of Engineering, North Carolina State University, Raleigh, NC

Dr. Donna Kenski, Data Analysis Director, Lake Michigan Air Directors Consortium, Rosemont, IL

Dr. Armistead (Ted) Russell, Professor, Department of Civil and Environmental Engineering, Georgia Institute of Technology, Atlanta, GA

Dr. Helen Suh, Associate Professor, Harvard School of Public Health, Harvard University, Boston, MA

Dr. Kathy Weathers, Senior Scientist, Cary Institute of Ecosystem Studies, Millbrook, NY

CONSULTANTS
Dr. Lowell Ashbaugh, Associate Research Ecologist, Crocker Nuclear Lab, University of California, Davis, Davis, CA

Prof. Ed Avol, Professor, Preventive Medicine, Keck School of Medicine, University of Southern California, Los Angeles, CA

Dr. Wayne Cascio, Professor, Medicine, Cardiology, Brody School of Medicine at East Carolina University, Greenville, NC

Dr. David Grantz, Director, Botany and Plant Sciences and Air Pollution Research Center, Riverside Campus and Kearney Agricultural Center, University of California, Parlier, CA

Dr. Joseph Helble, Dean and Professor, Thayer School of Engineering, Dartmouth College, Hanover, NH

Dr. Rogene Henderson, Senior Scientist Emeritus, Lovelace Respiratory Research Institute, Albuquerque, NM

Dr. Philip Hopke, Bayard D. Clarkson Distinguished Professor, Department of Chemical Engineering, Clarkson University, Potsdam, NY

Dr. Morton Lippmann, Professor, Nelson Institute of Environmental Medicine, New York University School of Medicine, Tuxedo, NY

Dr. Helen Suh MacIntosh, Associate Professor, Environmental Health, School of Public Health, Harvard University, Boston, MA

Dr. William Malm, Research Physicist, National Park Service Air Resources Division, Cooperative Institute for Research in the Atmosphere, Colorado State University, Fort Collins, CO

Mr. Charles Thomas (Tom) Moore, Jr., Air Quality Program Manager, Western Governors' Association, Cooperative Institute for Research in the Atmosphere, Colorado State University, Fort Collins, CO

Dr. Robert F. Phalen, Professor, Department of Community & Environmental Medicine; Director, Air Pollution Health Effects Laboratory; Professor of Occupational & Environmental Health, Center for Occupation & Environment Health, College of Medicine, University of California Irvine, Irvine, CA

Dr. Kent Pinkerton, Professor, Regents of the University of California, Center for Health and the Environment, University of California, Davis, CA

Mr. Richard L. Poirot, Environmental Analyst, Air Pollution Control Division, Department of Environmental Conservation, Vermont Agency of Natural Resources, Waterbury, VT

Dr. Frank Speizer, Edward Kass Professor of Medicine, Channing Laboratory, Harvard Medical School, Boston, MA

Dr. Sverre Vedal, Professor, Department of Environmental and Occupational Health Sciences, School of Public Health and Community Medicine, University of Washington, Seattle, WA

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Dr. Holly Stallworth, Designated Federal Officer, EPA Science Advisory Board Staff Office

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Enclosure B

CASAC Responses to Charge Questions

1) In general, what are the Panel's views on the level of detail provided in the body of the report and associated appendices? Does the Panel agree that all of this information is useful to retain or is there material that the Panel would recommend deleting? Does the Panel have any suggestions regarding the organization and distribution of information throughout the document and in the appendices?

While a substantial level of detail has been provided in the *UFVA*, many of the calculations included therein are complex, and a wide range of optional combinations of levels and forms is presented and compared. The report is long, but its completeness and detail are useful, particularly given that we are looking, for the first time, at a very different indicator for this secondary standard. The discussion is clear, and the associated appendices are valuable for examining questions raised by the main text. The CASAC would not recommend deleting any of the material. With the few exceptions noted below, the organization is good as it stands, both in the main body of the report and in the appendices.

Chapter 2 may contain more information than is required with respect to the individual cities. Much of this material could be moved to the appendices. The memo of 2/3/2010 on the statistical analysis of the preference studies should also be placed in the appendices, and consolidated with related material from Chapter 2 to avoid redundancy. Similarly, much of the material in sections 4.1.3 and 4.1.4 might be better suited to an appendix. In any case, the transition into future monitoring site characteristics (middle of page 4-2) is rather abrupt, and might be more appropriate for inclusion in the Policy Assessment, where it could be expanded based on recent feedback from the CASAC Ambient Air Monitoring and Methods Subcommittee.

The SANDWICH method described in Chapter 3 does not include sea salt, which can be an important contributor to PM at coastal sites. The sea salt component of PM may be a source of uncertainty in the light extinction calculation at these sites. The SANDWICH approach has other sources of uncertainty that should be mentioned. Relying on mass closure to determine the hourly organic carbon assumes that all other species are accurately determined. This is problematic for nitrate, as well as for sea salt. These factors should be mentioned as areas of uncertainty that are associated with this method.

2) In the Panel's view, to what extent does the logit analysis presented in Chapter 2 of the second draft Visibility Assessment, and further expanded and described in the supplemental memorandum, add value to the urban visibility preference study analysis and provide additional support for combining and comparing the results from the four cities, as shown in Figure 2-16? What are the Panel's views on the clarity and adequacy of the descriptions associated with such a combined assessment and on the conclusions that can be drawn from the assessments? Please

provide comments on any additional insights that might be drawn from these analyses or on any additional caveats that should be considered.

The analysis presented in Section 2.6 and summarized in Figure 2-16 is quite reasonable. The characteristics of the studies that produced the data are discussed. The modeling approach is clearly presented and explained, with an appropriate level of detail, given that this approach has not been previously described in EPA visibility documents. Figure 2-16 is very useful for comparing the four realizations of the model in comparison to the study data. Table 2-3 provides valuable information regarding the statistical significance of each model coefficient. The results in Table 2-3 are appropriately explained. The model is appropriately critiqued in terms of goodness-of-fit, statistical significance of the coefficients, and the interpretation of the coefficients. The limitations of the model with respect to limitations of the underlying data are appropriately discussed.

The text does a good job of identifying limitations associated with the sample population in the UBC study (all participants were university students and therefore had advanced educational background), and discusses the broader socioeconomic distribution of the population participating in the Phoenix study. Absent is a comparable discussion of the demographic distribution in the second Washington DC study, other than noting the relatively small size of the sample population, and limitation that all participants were employees of the research firm conducting the study. It is therefore likely that all participants were well educated, and may have understood the methods and goals of the study better than the populations participating in the other studies. Since this is a preference study, this point is worth acknowledging in the text.

The additional information presented in the supporting memo by Stratus Consulting is very helpful and should be retained as an attachment or in an appendix. The memo evaluates several alternative specifications of a logit model, of which the one presented in the assessment is Model 2. Confidence intervals on the predicted mean were estimated using a numerical method, and verified with another numerical method. Models 1 and 2 are generally found to provide similar results. Thus, the results of the assessment are not substantially sensitive to the choice in functional form between these two models. Overall, the use of the logit model is reasonable, since the output is a binary variable. The model is appropriately evaluated and reasonably represents the data to which it was fit. The limitations of the underlying data are discussed qualitatively. The overall findings are reasonably supported by the data, model, and appropriately take into account limitations of the data. The associated discussion presents a number of reasonable hypotheses that could account for the significant differences in the acceptability response curves among the different cities, and could explain why some of the study results have greater variability than others.

While it is appropriate to move forward on the basis of available data, CASAC believes the data suggest some heterogeneity that needs to be explored with further research, especially to evaluate potential differences among regions or among cities that have different inherent scenic characteristics. The need for additional urban visibility preference studies, using consistent and robust survey methods, over a broader range of

urban areas and viewing conditions, should be emphasized as a research priority. The results from these studies could help refine a secondary PM light extinction standard in future NAAQS review cycles.

3) What are the Panel's views on the extent to which the analysis of the frequency of co-occurrences of hourly relative humidity values below and above 90 percent with other meteorological events such as rain or fog (Chapter 3, section 3.3.5; Table 3-6) provides scientific support for consideration of how to address relative humidity in defining the form of a standard based on a PM light extinction indicator?

An informative, new analysis was presented in section 3.3.5 (as revised by the 3/4/10 memo from Philip Lorang and Mark Schmidt to the PM NAAQS Review Docket) comparing hourly daytime relative humidity (RH) and the incidence of natural weather visibility-impairing conditions (fog, rain, snow, etc.). CASAC concurred that this presentation provided a persuasive argument for the use of a 90% RH screen as an effective and efficient way to discard most of the hours potentially affected by natural weather conditions while removing only a small fraction of total daylight hours from consideration.

CASAC also found that a 90% RH screen was not only a logical revision for use in the *UFVA* assessment, but would also be an appropriate component of a new secondary NAAQS based on PM light extinction. It would be an effective way to remove periods when weather influences might be the dominant cause of visibility impairment from the regulatory metric, and would also have other benefits relating to PM light extinction measurements, such as accommodating spatial variability in RH and weather influences, minimizing effects of RH measurement errors at high humidity, and allowing for measurement modifications (such as a "smart heater" on a nephelometer) that could substantially reduce instrument maintenance needs and improve data quality.

4) In response to CASAC recommendations, descriptions of current conditions and results of just meeting NAAQS scenarios that considered all daylight hours were added to those based on maximum daily 1-hour indicators. The 98th percentile form was also included along with the 90th and 95th percentiles. Tile plots of hourly PM light extinction (Figure 3-12) and composition bar graphs of the top 10% of days for maximum daily 1-hour and aggregated individual daylight hours (Figure 3-13) were shown in part to help illuminate the similarities and differences between these various indicators with respect to current conditions. Similarly, additional figures and table entries were generated to illustrate the characteristics of various PM light extinction NAAQS scenario forms (Tables 4-2, 4-3, 4-5, and 4-7; Figures 4-1 through 4-3).

What are the Panel's views regarding EPA staff interpretations of these displays included in the text? Are there supplemental or alternative interpretations the Panel would suggest? Are there additional approaches the Panel would suggest regarding ways to summarize, display, or assess the results of these analyses, including similarities and differences between the various scenarios?

The revisions to accommodate the 90% RH screen, the inclusion of a higher (98th) percentile form, and consideration of an alternative way of calculating percentiles – based on all daylight hours, rather than just the worst hour in a day – were valuable additions to the *UFVA*. When these are combined with other options including 90th and 95th percentiles and different levels (64, 112, 191 Mm^{-1}) of PM light extinction, the many resulting options are complex and difficult to communicate and compare. The various new graphical displays are quite helpful in communicating this complex new information clearly and illustrating the differences and similarities among the many options.

CASAC found that the tile plots were especially informative and greatly helped to show the seasonal and diurnal patterns and similarities and differences across the different study areas. The stacked bar charts of maximum hourly extinction on top 10% days vs. compositions on top percentiles considering all daylight hours are useful for seeing differences between cities, and the accompanying interpretation and discussion are reasonable and informative. The plots also illustrate interesting differences in hourly compositions within individual cities for the (relatively few) hours which represent the single worst hours in a day. However, these comparisons do not really allow for a direct "apples vs. apples" comparison of the effect of calculating percentiles based on the single worst daylight hour each day, vs. using all daylight hours to calculate the percentiles.

It seems likely that the two optional approaches may tend to focus on different kinds of visibility impairing PM species, sources, meteorological conditions, times of day, and/or seasons. It would be useful to have a clearer picture of what their similarities and differences really are before recommending one approach over the other. Additional suggestions on approaches for this are included in comment from individual panelists. Several panelists also expressed concerns that some of the occasionally very high coarse particle contributions in a few of the cities (St. Louis and Los Angeles) appeared questionable, and might benefit from closer scrutiny or warrant some cautionary language in the *UFVA*.

Enclosure C

Compendium of Individual Preliminary Panelists Comments
Urban-Focused Visibility Assessment for Particulate Matter (January 2010)

Comments from Dr. Lowell Ashbaugh

January 2010 2nd External Review Draft Particulate Matter Urban-Focused Visibility Assessment,

Charge question 1

1) *In general, what are the Panel's views on the level of detail provided in the body of the report and associated appendices? Does the Panel agree that all of this information is useful to retain or is there material that the Panel would recommend deleting? Does the Panel have any suggestions regarding the organization and distribution of information throughout the document and in the appendices?*

The report contains a lot of detail, but it is presented well. The discussion is clear and the associated appendices are valuable for examining questions raised by the main text. I would not recommend deleting any of the material. The organization is good, both in the main body of the report and in the appendices. I have some comments on the presentation of material that I'll put later in this review.

The introductory material is excellent. It's short, but it's complete and it lays the foundation for review of the NAAQS. The overview of the science of visibility and PM might be too brief for readers new to the field, but the references are sufficient to fill in the details.

Charge question 2

2) *In the Panel's view, to what extent does the logit analysis presented in Chapter 2 of the second draft Visibility Assessment and further expanded and described in the supplemental memorandum add value to the urban visibility preference study analysis and provide additional support for combining and comparing the results from the four cities, as shown in Figure 2-16? What are the Panel's views on the clarity and adequacy of the descriptions associated with such a combined assessment and on the conclusions that can be drawn from the assessments? Please provide comments on any additional insights that might be drawn from these analyses or on any additional caveats that should be considered.*

The logit analysis is important to this assessment. It provides a common basis to analyze the results from the four studies in different cities and it sets forth a quantitative method to establish boundaries on the CPL levels. The discussion of the hypotheses that might explain the different VAQ acceptability responses is clear. There may be other factors involved in the differences between cities, but it would take more research to confirm or refute them. For example, one hypothesis that was not discussed is the possible differences in population that inhabits the different cities that makes them more or less sensitive to VAQ. Denver and BC are known for their outdoors activities; people who live there may be more attuned to the visual environment and more sensitive to poor VAQ. People living in Washington, DC may be less attuned to the outdoor environment and therefore less sensitive to poor VAQ.

Page 2-31 suggests that additional studies would be useful to gain further understanding. Are there plans for such studies? Is there an outline or more comprehensive listing of the

studies that would be useful? Such a list or discussion would be very useful if funding becomes available at some time in the future.

Charge question 3

3) *What are the Panel's views on the extent to which the analysis of the frequency of co- occurrences of hourly relative humidity values below and above 90 percent with other meteorological events such as rain or fog (Chapter 3, section 3.3.5; Table 3-6) provides scientific support for consideration of how to address relative humidity in defining the form of a standard based on a PM light extinction indicator?*

The analysis of the frequency of co-occurrences of rain and/or fog with relative humidity above or below 90 percent has a flaw in it. I don't believe it would change the conclusions, but on page 3-29, lines 11-12, is the statement "Based on this assessment, the 90% relative humidity cutoff criteria is effective in that on average less than 6% of the hours are removed from consideration…" This is not correct. It's correct that (except for Tacoma) less than 6% of the hours with RN≤90% co-occur with rain or fog. The number of daylight hours with relative humidity >90% and their percentage of all daylight hours is shown below (data extracted from Table 3-6). On average, about 10% of all hours in all study areas would be removed with the RH>90% criterion. This percentage varies from city to city, with a low of 1% at Phoenix and a high of 30% at Tacoma. Birmingham, Atlanta, Pittsburgh, Baltimore, and Philadelphia are also above 6%.

Study area	Number of Daylight hours with RH<=90%	Number of Daylight hours with RH>90%	Percent of Daylight Hours with RH>90%
Tacoma	18293	7987	30%
Fresno	24245	1615	6%
Los Angeles			
Phoenix	26045	235	1%
Salt Lake City	24989	1291	5%
Dallas	25519	761	3%
Houston			
St. Louis			
Birmingham	23826	2454	9%
Atlanta	23696	2584	10%
Detroit			
Pittsburgh	22254	4026	15%
Baltimore	22867	3413	13%
Philadelphia	24302	1978	8%
New York	24963	1314	5%
Overall total	**260999**	**27658**	**10%**

I can't reconcile the data in this table with Table G-1 in Appendix G, but the statement on page 3-29 is also not consistent with Table G-1. Whatever the cause

of the inconsistency, it should be rectified so that the statements and tables are consistent. If I've misunderstood the presentation, it should be clarified.

It's difficult to see the contrast in the distributions shown in Figure G-2. It's probably not important to see the difference (i.e. the distribution of extinction in the excluded hours), so I recommend the text be revised to bring the reader's attention to the important aspects of the plot. In particular, it appears that the horizontal bar on the display for each city shows the 90th percentile extinction design value, but it isn't mentioned in the text or in the table. It would be useful to highlight how the design value drops with the excluded hours.

Charge question 4

4) *In response to CASAC recommendations, descriptions of current conditions and results of just meeting NAAQS scenarios that considered all daylight hours were added to those based on maximum daily 1-hour indicators. The 98th percentile form was also included along with the 90th and 95th percentiles. Tile plots of hourly PM light extinction (Figure 3-12) and composition bar graphs of the top 10% of days for maximum daily 1-hour and aggregated individual daylight hours (Figure 3-13) were shown in part to help illuminate the similarities and differences between these various indicators with respect to current conditions. Similarly, additional figures and table entries were generated to illustrate the characteristics of various PM light extinction NAAQS scenario forms (Tables 4-2, 4-3, 4- 5, and 4-7; Figures 4-1 through 4-3).*

What are the Panel's views regarding EPA staff interpretations of these displays included in the text? Are there supplemental or alternative interpretations the Panel would suggest? Are there additional approaches the Panel would suggest regarding ways to summarize, display, or assess the results of these analyses, including similarities and differences between the various scenarios?

The tile plots in Figure 3-12 are an excellent way to show the hourly light extinction. I would like to see all plots scaled so the time periods directly correspond across the years. In particular, the 9-month plots for Houston and Phoenix should be scaled such that the 9 months shown correspond to the same period as in the 12-month plots, i.e. not stretched out to fill the space. All the 12-month plots are currently scaled slightly differently so that the same time period is not directly opposite for different years.

The staff interpretation of the plots is good, but the conditions at each city could be more fully explained. Section 3.4.5 has highlights of the extinction budgets for individual urban areas. I would like to see something similar for Section 3.4.4. For example, the description at Tacoma could read: *The hours excluded at Tacoma are primarily in the late fall and winter, and are generally in the morning. Occasional periods last all day. Few hours are excluded due to high RH in spring, summer, and early fall. High light extinction periods also occur more often in late fall and winter, and with few exceptions occur mostly in the early daylight hours in other seasons.* Fresno could be described as: *The hours excluded in Fresno due to high RH are exclusively in the late fall and winter. This is the fog season in California's Central Valley, and periods of high humidity can last for*

days at a time. The highest light extinction occurs during this period, also. Episodes of high light extinction also occur in spring and summer, sometimes lasting for many days. Many of these episodes last well into the afternoon. For Los Angeles, the following description could apply: *Most hours excluded due to high RH at Los Angeles occur during the morning, and are primarily in the spring, summer, and early fall. High light extinction periods occur at all times of the year, but are more frequent in the spring and summer. These periods generally last all day.* Each city has some characteristics that could be described more fully; this would more completely establish the conditions of high RH and light extinction in different urban areas of the country.

The extinction budgets shown in Figure 3-13 are very helpful in explaining the causes of poor VAQ in the different cities. I particularly like the separate displays of the top 10% of days and the top 10% of individual daylight hours. The staff interpretation of these plots is very good.

I question the high contribution to light extinction at Los Angeles from coarse PM during two of the top 10% of days. Having done considerable data validation of IMPROVE data, I can attest to the possibility of invalid values entering the database. I also know that hourly concentrations can be quite high under the right conditions, but such extreme values warrant further investigation of their validity. The explanation that the coarse PM is determined in part from measurements at Victorville could well explain the high values, and would make these values suspect for use at Los Angeles. There is no doubt that coarse PM measured at Victorville would be unrepresentative of coarse PM at Rubidoux, and especially in the wider South Coast Air Basin.

I have a few comments relating to particular sections of the assessment, and a few editorial comments that I'll list separately. First, the comments:

Page	Line	Comment
3-16		No suggestions – just a comment that this is an excellent description.
3-21	36-27	Sea salt is an important contributor at coastal sites. This may be a source of uncertainty in the light extinction calculation at these sites.
3-25	31-36	The approach described here has other sources of uncertainty that should be mentioned. Relying on mass closure to determine the hourly organic carbon assumes that all other species are accurately determined. This is problematic for nitrate, as pointed out just a few paragraphs earlier, and it leaves out sea salt that is an important contributor to mass at coastal sites. These factors should be mentioned as areas of uncertainty that are introduced by this method.
3-26	14-15	Setting negative values to zero introduces a bias in the results. There is inherent uncertainty in both PM_{10} and $PM_{2.5}$ measurements. During periods of very low coarse mass, the PM_{10} and $PM_{2.5}$ measurements are very close, and their uncertainties may cause the $PM_{2.5}$ measurement to be higher than the PM_{10} measurement. It's important to retain negative

		values as a measure of the uncertainty during low coarse mass periods.
3-32, 3-33		I have grave doubts about the outlier concentrations in these plots, particularly for Los Angeles and St. Louis. I have seen many cases of invalid high mass measurements of filter while performing data validation of IMPROVE samples. I have no doubt that there are high hourly PM concentrations for short periods, but the extreme values shown, coupled with the caveats mentioned, cast doubt on their validity.

I have the following suggestions for editorial changes in the document.

The Table of Contents is hard to read with the mix of all caps and mixed case font that is currently used. I suggest making Level 1 all caps, Level 2 small caps or mixed case, and Level 3 mixed case. This would more effectively set off the major and minor sections of the document in the Table of Contents. The appendices are good as they are.

In the list of acronyms/abbreviations, the description for IMPROVE should have an "s" at the end, i.e. "Interagency Monitoring of Protected Visual Environments". The description of NARSTO is out of date. It was originally the North American Research Strategy for Tropospheric Ozone, but is now just NARSTO. This could be noted in the description. For SMOKE, "Kernel" is misspelled.

Other editorial suggestions:

Page	Line	Suggestion
1-1	5	Change to "…which are to reflect accurately…"
2-11	15	"Visibility" in the graph heading is misspelled
2-20	8	I suggest using different colors or symbols in Figure 2-11. These are the same as are used in Figure 2-10, but they have different meanings. It would be a good idea to review all graphics with this in mind, in particular those that are adjacent to each other.
2-28	15	Do you mean to say "insignificant" as written, or "significant"? It looks to me as if this term is significant.
2-30	13	Change "it" to "is"
3-19	1	For some reason this line that ends a sentence appears as a heading in the Table of Contents. Please correct this.
3-32	12-13	Do you mean to say section 3.3.1? I can't find the referenced step in section 3.4.1.
3-33		Figure 3-7 might be better using a logarithmic scale on the y-axis. The linear scale compresses the bulk of the data to the point that differences between the cities are not distinguishable. A logarithmic scale would show the outliers and still allow the lower values to be observable.

Page	Line	Suggestion
3-35	16-17	It looks like the references to Figures 3-8b and 3-8a are reversed.
3-36	3	Fresno is listed as a city without a preference for morning high PM light extinction. The figures in Appendix E indicate otherwise. There are other cities that show such a preference that aren't listed here.
3-37		There is no units label on Figure 3-8. I assume it should be Mm^{-1}, but it should be on the graph.
3-44	31	Remove the first "a"
3-44	32	Change "than" to "that"
3-62	31	Change the comma to a semicolon
3-63	10 and 23	Remove "of" after "as high as"
3-63	25	End the sentence with a period
4-7	44	Change to "…in <u>one</u> or more…"
4-10	3	Figure 4-2 should be a square plot so the units have equivalent length on the x- and y-axes.
4-11	15	Table 4-4 says Dallas meets the 15/35 NAAQS, not Salt Lake City.
4-11	30	Table 4-5 should be the next one in sequence.
4-15, 4-16		The scale on Figures 4-3(a) and (b) is very high. Why? It compresses the bulk of the data and makes it difficult to see the differences between the cities.
App. F		The comments for Figure 4-3 also apply to the figures in Appendix F.
G-1	Para. 3	In the second line, change to "…prior to ~~the~~ their exclusion."
I-1	Para. 3	I believe the references to "top of figure" and "bottom of figure" should be interchanged.

Comments from Dr. David Grantz

3-16-10

Urban-Focused Visibility Assessment, Second External Review Draft

Charge Question 1) Level of detail provided in the body of the report and appendices and suggestions regarding organization of the document.

This review draft of the UFVA appears to be of appropriate length and complexity, with very few exceptions. Staff is to be commended for preparing an excellent document. Chapter 2 may contain more information than is required with respect to the individual cities. Much of this material could be moved to the Appendices. The memo of 2/3/2010 on the statistical analysis of the preference studies could also be placed in the Appendices, and consolidated with related material from Chapter 2 to avoid redundancy. Similarly, much of the material in sections 4.1.3 and 4.1.4 might be better suited to an Appendix. In any case, the transition into future monitoring site characteristics (middle of page 4 – 2) is rather abrupt.

Charge Question 2) Contribution of the logit analysis.

I remain concerned that despite the abundant statistical analysis of visual preference data performed since the first external review draft, the amount of data is simply insufficient to determine what level of air quality/visibility may be acceptable nationwide. The most important conclusions from these preliminary studies are the closely related concepts that (1) the range of haziness views presented to panelists is important, as suggested by Smith and Howell, and (2) that there may be true regional differences in expected air quality, due to the range of visibility to which residents have become accustomed. This is considered explicitly at the bottom of page 2 – 30, although it may be premature to attempt to identify the reasons for these differences. This has significant policy implications. While the agency has every reason to move forward on this, these results should be flagged throughout as tentative and subject to further research.

Charge Question 4) All daylight versus maximum daily 1-hour indicators.

The distinction between all daylight hours and maximum daily 1 hour indicators is not made completely clear in the document. This could be defined more definitively somewhere early in the text. In general, the abundant consideration of various indicators and end points is useful and probably unavoidable.

Other editorial points.

The definition of haziness in deciview units and light extinction in inverse mega meters on page 1 -- 6 is useful and well presented. However, visual range is used later in the document (first appearing on page 1 – 10) but is not defined here. Explanation of the utility of each parameter would help the narrative. While visual range may be most intuitive to many readers, it is dropped on page 1 – 15, in favor of explicit definition of CPLs in terms of light extinction. For general readability, explicit interconversion between the different measures could be carried through the document.

Page 1 – 13, lines 4 - 8: The relationship between organic compounds, carbon mass, and air mass aging needs to be better explained here.

Page 1 – 14, line 35: "indictor" or should be "indicator"

Page 3 – 44, line 32. "such than average" should be changed to "such that average".

Figures

Maps, Page 3 – 2. It is disconcerting to find Alaska, Hawaii, and Puerto Rico lumped into the Gulf of Mexico. There may be room off the Pacific and Atlantic coasts, respectively, if the legend were placed in the Gulf.

Figure 3 – 9, Page 3 – 40. The X axis labels are unclear.

Comments from Dr. Philip Hopke

1) In general, what are the Panel's views on the level of detail provided in the body of the report and associated appendices? Does the Panel agree that all of this information is useful to retain or is there material that the Panel would recommend deleting? Does the Panel have any suggestions regarding the organization and distribution of information throughout the document and in the appendices?

Yes, it is long and somewhat dry, but its completeness and detail are useful particularly given that we are looking at a very different indicator for this secondary standard. It is not obvious to me that alternative organization or distribution of the information would be more informative to the reader.

2) In the Panel's view, to what extent does the logit analysis presented in Chapter 2 of the second draft Visibility Assessment and further expanded and described in the supplemental memorandum add value to the urban visibility preference study analysis and provide additional support for combining and comparing the results from the four cities, as shown in Figure 2-16? What are the Panel's views on the clarity and adequacy of the descriptions associated with such a combined assessment and on the conclusions that can be drawn from the assessments? Please provide comments on any additional insights that might be drawn from these analyses or on any additional caveats that should be considered.

The logit analysis is useful in exploring these data. One point that is not adequately made regarding the Washington studies is that the DC photo is significantly different from the others in the lack of significant scenic features at a distance. There is a brief mention of this on the top of page 2-31 and only in comparison to Denver. However, all of the other studies have mountains some tens of miles from the point of view. I suspect that the lack of a distant object has significantly biased the acceptable level values upward. In fact the distance to the background features might well be a key factor in the acceptability ratings. Has there been an effort to look at the relationship between the 50% acceptability level and the maximum distance to visible objects in the pictures? That might be informative.

3) What are the Panel's views on the extent to which the analysis of the frequency of co-occurrences of hourly relative humidity values below and above 90 percent with other meteorological events such as rain or fog (Chapter 3, section 3.3.5; Table 3-6) provides scientific support for consideration of how to address relative humidity in defining the form of a standard based on a PM light extinction indicator?

This section seemed adequate.

4) In response to CASAC recommendations, descriptions of current conditions and results of just meeting NAAQS scenarios that considered all daylight hours were added to those based on maximum daily 1-hour indicators. The 98th percentile form was also included

along with the 90th and 95th percentiles. Tile plots of hourly PM light extinction (Figure 3-12) and composition bar graphs of the top 10% of days for maximum daily 1-hour and aggregated individual daylight hours (Figure 3-13) were shown in part to help illuminate the similarities and differences between these various indicators with respect to current conditions. Similarly, additional figures and table entries were generated to illustrate the characteristics of various PM light extinction NAAQS scenario forms (Tables 4-2, 4-3, 4-5, and 4-7; Figures 4-1 through 4-3).

What are the Panel's views regarding EPA staff interpretations of these displays included in the text? Are there supplemental or alternative interpretations the Panel would suggest? Are there additional approaches the Panel would suggest regarding ways to summarize, display, or assess the results of these analyses, including similarities and differences between the various scenarios?

I would suggest there be more exploration of what if any potential problems would arise if there would be for a PM2.5 visibility standard only. There are substantial advantages to establishing monitoring systems for fine particle scattering (nephelometers) that would avoid the difficulties of the predominately forward scattering by coarse particles. In most locations, it is likely that a PM10-2.5 primary standard could reduce the effect of this fraction on extinction to the point where it is not a significant part of the visibility problem. Such an approach would be easier to implement on both a monitoring and implementation basis.

Comments from Mr. Rich Poirot

Review Comments on 2nd Draft January 2010 PM UFVA, R. Poirot, 2/4/10

I thought the first draft UFVA was well done, especially considering the limited time schedule and complexity of the required calculations. In the second draft, EPA staff has been very responsive to CASAC recommendations, adding a detailed logit analysis to better understand similarities and differences in the urban visibility preference studies, recalculating estimated extinction levels using a 90% RH screen, and considering (90^{th}, 95^{th} and 98^{th}) percentiles based on all available daylight hours as well as based on the single worst daylight hour in each day. These additions represent a substantial body of new work, again conducted in a very limited time period, and as before the additional calculations and results are explained, compared and illustrated in clear detail.

The UFVA presents logical and persuasive arguments for use of a PM light extinction indicator with a 1-hour (daylight) averaging time as a sound basis for a secondary PM standard to protect visibility. The UFVA also presents reasonable ranges for the level (20 to 30 deciviews) and form (90^{th} to 98^{th} percentile) that such a standard might take, and clearly illustrates the differences among the many resulting optional combinations in terms of the protectiveness and/or stringency across the 15 diverse urban areas selected for this analysis.

I don't believe that any major revisions are required in this second draft, and that the methods employed here – if not some of the specific calculations – would make a sound basis for recommending and comparing optional ranges of a secondary PM light extinction standard in the upcoming Policy Assessment document.

1) **In general, what are the Panel's views on the level of detail provided in the body of the report and associated appendices? Does the Panel agree that all of this information is useful to retain or is there material that the Panel would recommend deleting? Does the Panel have any suggestions regarding the organization and distribution of information throughout the document and in the appendices?**

While a substantial level of detail has been provided in the UFVA, many of the calculations included here are very complex, and a fairly wide range of optional combinations of levels and forms are presented and compared. I think the level of detail provided is appropriate in relation to the level of complexity and the range of options considered, allowing the "interested reader" to understand just exactly how the many calculations have been made, and often providing several different views for "seeing" the results in several different contexts. For the "disinterested reader" there are several summary tables toward the end which condense most of the varied results to a single page or two. I don't believe the document could be better organized or more succinctly written.

2) **In the Panel's view, to what extent does the logit analysis presented in Chapter 2 of the second draft Visibility Assessment and further expanded and described in the supplemental memorandum add value to the urban visibility preference study analysis and provide additional support for combining and comparing the results**

from the four cities, as shown in Figure 2-16? What are the Panel's views on the clarity and adequacy of the descriptions associated with such a combined assessment and on the conclusions that can be drawn from the assessments? Please provide comments on any additional insights that might be drawn from these analyses or on any additional caveats that should be considered.

The logit analysis presented in chapter 2 helps in more clearly quantifying and understanding the similarities and differences among results from the 4 urban visibility preference studies. The associated discussion of the logit results and consideration of alternative hypotheses for the differences and similarities across the different study areas (and different study approaches) are also helpful. While the resulting 20 to 30 deciview range of visual air quality levels meeting a 50% acceptability criteria, remains rather broad, I doubt that much more can be learned or that this range could be substantially reduced by additional analyses of these limited results, and think that selecting a level or levels from within this 20 to 30 dv range is well justified for the initial establishment of a secondary PM standard. Additional studies using consistent methods and conducted over a range of different kinds of urban areas and different views will help refine this range in the future.

3) **What are the Panel's views on the extent to which the analysis of the frequency of co-occurrences of hourly relative humidity values below and above 90 percent with other meteorological events such as rain or fog (Chapter 3, section 3.3.5; Table 3-6) provides scientific support for consideration of how to address relative humidity in defining the form of a standard based on a PM light extinction indicator?**

Eliminating hours when RH exceeds 90% is a good idea - for conducting this assessment as well as for specifying conditions for and determining compliance with a secondary PM light extinction standard. The analysis presented in the 2nd draft UFVA provides a compelling demonstration that a 90% RH screen can efficiently eliminate periods when "natural" visibility-impairing weather events are occurring, and when PM light extinction is not likely to be the predominant cause of impaired visibility. The spatial (& temporal) variability of RH and weather (& PM species) are important related issues, in that there may be natural weather event impairing visibility along the sight path but not observed at the location of the RH (or PM or PM light extinction observation). I don't think its warranted here, but it might be possible to explore this possibility a bit by considering the RH and weather observations at a range of stations within say a 30 mile radius and looking for co-occurrences of RH above or below 90% and weather events across all the sites.

In addition to screening out weather events, there are other benefits of employing this RH screen. It will help avoid any public perception, however faulty, that the regulatory metric is influenced by uncontrollable weather events. RH can be difficult to measure, especially at high levels, such that an indicated RH of 90% may actually be significantly higher (or lower) than that. The hygroscopic growth curve gets very steep at high humidity such that a small error in the RH or (sulfate or nitrate) PM species measurement or in its spatial or temporal representativeness of the actual (or in the case of this assessment, estimated) extinction throughout the site path could result in a large error in estimated extinction, or in the visibility relevance of extinction measured at a single location. An RH screen might also allow for measurement options such as adding a "smart heater" to a nephelometer that would only kick in at high RH but would prevent larger water droplets from entering and soiling the

measurement chamber, reducing instrumental maintenance costs, and promoting better data quality and capture efficiency.

Screening out the higher RH values will slightly "dry out" the regulatory metric, eliminate some of the highest (but most uncertain) periods of estimated and measured PM extinction, shift the distribution downward and reduce, somewhat, the differences between East and West. It would also limit the extent to which the influences of hygroscopic sulfate and nitrate species are enhanced relative to the other PM species. At 95% RH the extinction efficiencies of ammonium sulfate and ammonium nitrate would be more than 22 m^2/g, compared to efficiencies of 10 m^2/g for EC, 4 m^2/g for organic matter, 1 m^2/g for fine soil and 0.6 m^2/g for coarse particles. At 90% RH the maximum extinction efficiencies of ammonium sulfate and ammonium nitrate would be limited to 12.5 m^2/g. This would be an "artificial" limit, and there will likely be hours of very poor visibility when natural weather is not the cause which will not be considered with this RH screen, but I think it's use is well justified for the other reasons indicated above, and that there are other benefits associated with having a slightly dryer and more stable regulatory metric.

4) **In response to CASAC recommendations, descriptions of current conditions and results of just meeting NAAQS scenarios that considered all daylight hours were added to those based on maximum daily 1-hour indicators. The 98th percentile form was also included along with the 90th and 95th percentiles. Tile plots of hourly PM light extinction (Figure 3-12) and composition bar graphs of the top 10% of days for maximum daily 1-hour and aggregated individual daylight hours (Figure 3-13) were shown in part to help illuminate the similarities and differences between these various indicators with respect to current conditions. Similarly, additional figures and table entries were generated to illustrate the characteristics of various PM light extinction NAAQS scenario forms (Tables 4-2, 4-3, 4-5, and 4-7; Figures 4-1 through 4-3).**

   What are the Panel's views regarding EPA staff interpretations of these displays included in the text? Are there supplemental or alternative interpretations the Panel would suggest? Are there additional approaches the Panel would suggest regarding ways to summarize, display, or assess the results of these analyses, including similarities and differences between the various scenarios?

I think applying the 90% RH screen, including a higher (98^{th}) percentile form and considering an alternative way of calculating percentiles – based on all daylight hours , rather than just the worst hour in a day – were valuable additions to the UFVA. When these are combined with other options including 90^{th} and 95^{th} percentiles, different levels (64, 112, 191 Mm^{-1}) of a secondary standard and assuming attainment of different levels of a primary standard (15/35, 12/25 ug/m^3), the many resulting options are complex and difficult to communicate and compare. I think the UFVA does an excellent job of presenting this information as clearly as possible.
I think the tile plots are very informative (not to mention beautiful!) and really help show the seasonal and diurnal patterns and similarities and differences across the different study areas. They also help show that the effect of the 90% RH screen tends to often be elimination of the first few early morning hours when fog is most likely and when its

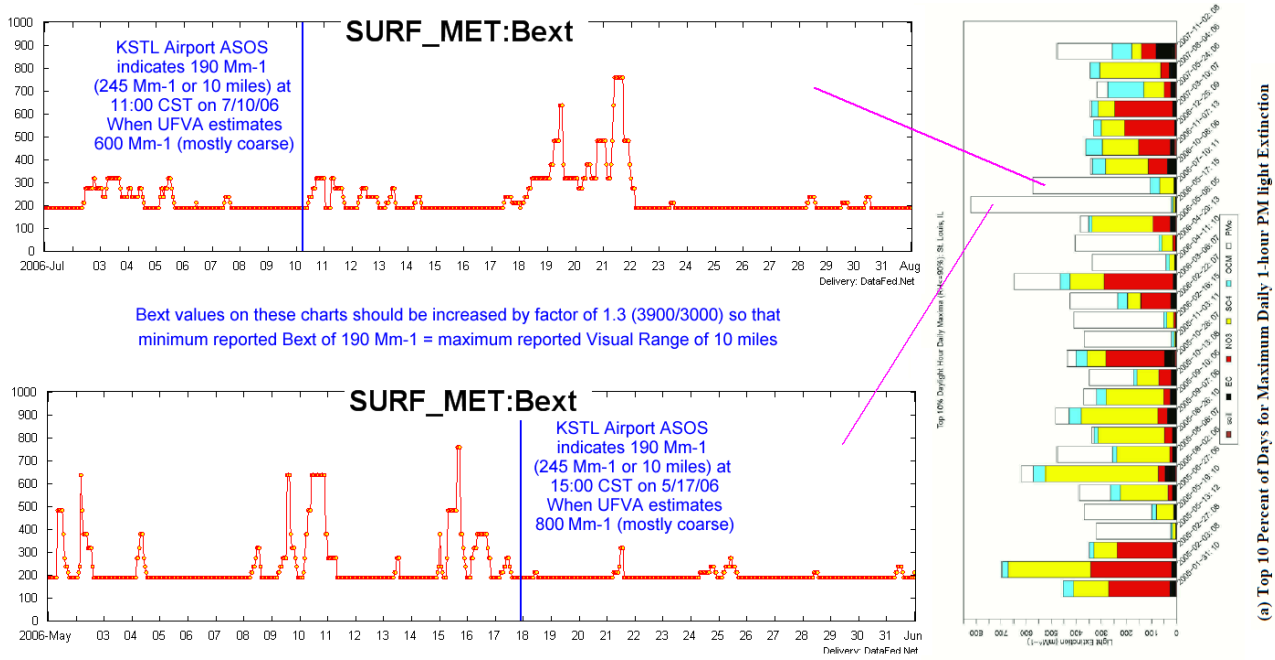
most difficult for human observers to discern the differences between natural and manmade effects, and provide added confidence that the use of this screen is appropriate. The plots of maximum hourly extinction on top 10% days vs. compositions on top percentiles considering all daylight hours are useful for seeing differences between cities, on different worst days (hours) and (to a lesser extent) for different high percentiles. I think the accompanying interpretation and discussion are reasonable and informative. I don't these graphs necessarily make for an effective direct comparison or evaluation of whether percentiles calculated from the single worst hour of each day would be a better regulatory metric. Personally, I think I prefer using all daylight hours to only using the worst single hour each day, since I think a day that's hazy all day long is more objectionable than one where its hazy for just one humid hour just after sunrise. I also don't think there are many 1-hr control strategies, especially for SOx and NOx (and NHx) sources, which I think get additionally emphasized by the single worst hour approach, with a consequent relative de-emphasis of carbonaceous pollutants. I also imagine that using all daylight hours would produce a more stable and somewhat dryer metric, reducing, somewhat, the differences between East and West. I think this could be important if the Agency finds it necessary to employ a traditional fixed "threshold-based" approach for the secondary NAAQS, rather than the "progress-based" approach recommended by the PM panel as scientifically preferable, and a conceptual approach to consider during implementation – even though it may not currently be a practical option for the Agency.

Possibly it would be informative to present side by side bar graphs showing an average of the compositions on the worst 10%, 5% and 2% hours calculated using the 2 different approaches. Are the compositions really much different? Would it be informative to know how many days would be involved using the 2 different approaches, or perhaps to consider the days or kinds of pollution events that tend to get considered in one approach but not the other?

Certain aspects of the discussion seem directed toward supporting the original worst hour of day approach – for example a repeated observation that the 98^{th} percentile using all daylight hours is not much different from the 98^{th} percentile using worst daylight hours and expressing the results of both approaches in Table 4.7 in units of single worst hour of day. As indicated, I think I conceptually prefer the all-hours approach but think it would be useful to see more clearly what the differences are. I don't think this is needed in the Risk Assessment, but maybe the Policy Assessment could explore these options in more detail.

Other Comments:

As indicated in comments on the 1st draft UFVA, I am very suspicious of the results for St. Louis and especially the extremely high coarse mass concentrations there – which often dominate the reconstructed extinction estimates during the haziest hours. I note that the 2 estimated haziest hours at STL for which the estimated coarse mass is the major contributor to extinction are 7/10/06 at 11:00 (estimated extinction of about 600 Mm^{-1}) and 5/17/06 at 15:00 (estimated extinction of about 800 Mm^{-1}). However, the ASOS visibility data from the STL airport (15 miles from downtown) indicates visibility was 10 miles or greater (Bext was 245 Mm-1 or less) during both of these time periods. I suggest discarding the STL estimates, or using other PM_{10} and $PM_{2.5}$ data for making



these estimates. Note that these Bext data were extracted from the Datafed.net system, in which a Koschmeider constant of 3000, rather than 3912 was used (incorrectly, I think) to convert the visual range data to extinction.