UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C. 20460

OFFICE OF THE ADMINISTRATOR
SCIENCE ADVISORY BOARD

May 21, 2009

EPA-CASAC-09-010

The Honorable Lisa P. Jackson
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Ave., NW
Washington, D.C. 20460

Subject: Consultation on EPA's *Particulate Matter National Ambient Air Quality Standards: Scope and Methods Plan for Urban Visibility Impact Assessment*

Dear Administrator Jackson:

The Clean Air Scientific Advisory Committee (CASAC) Particulate Matter (PM) National Ambient Air Quality Standards (NAAQS) Review Panel met on April 2, 2009 to provide a consultation on EPA's Draft *Particulate Matter National Ambient Air Quality Standards: Scope and Methods Plan for Urban Visibility Impact Assessment* (February 2009). The CASAC uses a consultation as a mechanism for technical experts to provide comments on an EPA draft plan for developing technical assessments as part of CASAC's responsibilities in the NAAQS review process. In this letter, CASAC offers some general thoughts on the visibility plan. More specific written comments by the individual members are enclosed.

The Plan could be improved by providing more background and justification regarding the importance of visibility as a health endpoint. CASAC also suggests that EPA consider ways of developing and implementing a visibility monitoring approach based on direct measurement of visibility using low cost instruments such as a size selective integrating nephelometer in combination with an aethalometer. EPA might also consider ways to analyze and present network design and operation plans to use direct measurement of visibility to characterize PM effects for both the primary and secondary PM NAAQS. Consistent with our comments on the Integrated Science Assessment for Particulate Matter (First External Review Draft, December 2008), we would also recommend that EPA identify and briefly characterize additional metrics, other than visibility, for ecosystem and environmental impacts of PM that could be the

foundation for future assessments even if there are insufficient data to support the current assessment as a basis for a new secondary NAAQS.

As this is a consultation, we do not expect a formal response from the Agency. We thank the Agency for the opportunity to provide advice early in the PM NAAQS review process and look forward to the First Draft PM NAAQS Urban Visibility Impact Assessment in October 2009.

Sincerely,

/Signed/

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

Enclosures: Enclosure A: CASAC Particulate Matter Review Panel Roster
Enclosure B: Compendium of Individual Comments

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Enclosure A

Clean Air Scientific Advisory Committee
Particulate Matter Review Panel

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Enclosure B

Compendium of Individual Comments

CASAC Particulate Matter Review Panel on

PM NAAQS: Scope and Methods

Plan for Urban Visibility Impact Assessment (Feb. 2009)

Comments from Dr. Lowell Ashbaugh

Ashbaugh Review of Scope and Methods Plan for Urban Visibility Impact Assessment

Chapter 1 – Introduction

Charge questions

1. What are the Panel members' views on the general structure and overall design of the planned analyses?
2. Is the plan clear and transparent in its description of the planned approaches? Are the various assumptions and judgments that must be made in carrying out the planned assessments clear and transparent?
3. Given the goals set forth for the planned analyses, has the plan appropriately drawn from the existing scientific and technical information in developing the overall approach? Are there relevant features that should be added or modified in the planned approach?
4. In addition to the sub-daily PM2.5 alternative standard considered in the last PM NAAQS review and summarized in this chapter, an alternative standard structure is being considered in this review. This alternative structure would use daylight hourly PM light extinction, which can be measured either by a combination of instruments (nephelometer – PM light scattering and aethalometer – PM light absorption) or calculated from PM speciation and concurrent relative humidity data using a linear algorithm.
    a. What are the Panel members' views regarding this alternative structure and its utility in the context of this PM NAAQS review?
    b. What are the Panel members' views regarding advantages and disadvantages of this alternate structure compared to the sub-daily PM mass concentration approach?

The general structure and overall design of the planned approaches to the "standard" assessment of the public preferences for and value of urban visibility are good. I particularly like the idea of assessing whether these preferences vary across the country in cities with differing backdrops. However, it's not clear what the EPA is planning to do regarding the alternative secondary standard. The discussion of the "standard" assessments in sections 1.3.1 and 1.3.2 uses declarative sentences that start out "we are planning to …", but the alternative standard discussion in section 1.3.3 is much less clear. The foundation for the alternative standard is presented well but the section does not contain a clear plan. It contains phrases such as "could include" or "would then be specified."

The plan for the "standard" assessment draws appropriately from the existing scientific and technical information, building upon prior studies of visibility impact in remote areas to investigate urban visibility impact. The discussion of the alternative standard also draws upon earlier work to lay out the foundation, but does not go further to set forth a plan.

Overall, I like the concept presented in the alternative secondary standard structure. PM mass measurements for a sub-daily 4-hour period, and especially speciation of such measurements, pose difficult technical challenges. The amount of PM collected in such a short time is hard to

measure gravimetrically and even harder to analyze for speciated components. I am concerned about the use of “known relationships between PM mass and speciated components” to relate PM mass to PM light extinction. This concept assumes the speciation fractions during the daylight hours (or the 4-hour period) are the same as those measured during a 24-hour period. This is clearly not the case with nitrate particles, and is likely not the case for other species, either. Further investigation or review of existing information is needed here.

Comments from Dr. David A. Grantz

This plan provides a good distillation of the newly released Integrated Science Assessment for PM, First External Review Draft (December 2008). It therefore reflects both the strengths and weaknesses of that document. The following represent suggestions for revision of the Plan, not in order of importance nor priority, and focusing on Section 1 (Introduction) but not limited to that section.

1. Better define the meaning and mode of application of the "policy relevant" filter to be applied in all aspects of this review.

The recurring restatement of the "policy relevant" caveat (beginning with three mentions on page 1-1) is an indicator of a problem throughout this document (and the ISA upon which it is based). Once the focus on visibility as the (only) surrogate for welfare impacts of PM was established, other information seems to have become not "policy relevant". The previous Criteria Document for PM (US EPA 2006), and related agency actions, did not find sufficient data on non-visibility parameters to inform a secondary standard (page 1-4, line 8-13). This might have initiated focused research in the intervening period but did not.

The current Plan, in its approach to these other impacts, does not ascribe to them sufficient gravity to encourage the research needed for the next PM assessment cycle. This contrasts with similar material related to human health endpoints of $PM_{10-2.5}$, some of which are appropriately to be addressed in the current review cycle (see 2009 Health Plan, Section 3.6, first paragraph).

It would be useful near the beginning of the discussion to insert a comprehensive definition of "policy relevant", its mode of application in the current review process, and a brief consideration of the likely consequences of doing so. This filter is an important behind the scenes driver of the review, is a new addition to the process, and should receive some discussion.

2. Combine and expand the discussion of "other" welfare effects of PM (not related to visibility), pointing to data and approaches that while outside the current scope of work may be useful in the future.

The minimal discussion of non-visibility impacts in the text (page 1-4 and pages 1-10 to 1-11), is augmented by a slightly more complete presentation in Appendix A. I suggest that these be combined, and placed within the text. This section should be expanded, to more closely parallel the visibility sections, to call attention to data that are feasible to obtain but currently lacking, that might usefully inform the secondary standard setting process. These data could address a) ecosystem impacts of locally relevant particles (analogous to the local approach taken with respect to humidity/PM relationships to visibility), b) effects on climate (considerable data now reaches the stage of likely causality, and more is known about climate forcing and PM than is indicated (pages A7-A9), c) fouling of leaf surfaces and possible interference with gas exchange

and radiation interception, particularly in urban locations, d) interception and scattering of incident radiation at the vegetated landscape scale.

The text (1-12, line 16), refers to an "initial qualitative approach" to non-visibility impacts, to be found in Appendix A. However, there is no approach, nor goal, nor suggestion of needed data, to be found in Appendix A. In combining the Appendix with the main text, such approaches and goals should be added.

In the summary of ecosystem affects (page 1-4, line 3-5), the review of the previous CD for PM is missing the previous emphasis on transport. While the previous review concluded that chemical composition dominates ecosystem effects of PM, the transport to and within ecosystems depends strongly on particle size and distance between source and receptor. This should be included in the discussion.

3. **The focus on visibility, an aesthetic parameter, should be linked more closely to other potential impacts of PM that are more representative of damage, otherwise reliance on visibility introduces a number of unintended consequences.**

The exclusive emphasis on visibility may have unintended consequences in the future. Proposed solutions to the temporal mismatch (page 1-19, lines 20-29) between health related and visibility related averaging periods, will require development of FRM hourly monitors and lead to the discounting of nighttime PM values. The suggested focus on daylight hours is primarily to bring cohesion to the visibility (rather than PM) data in the face of varying RH. This leaves the dark period as a potential window of opportunity for dumping of PM-rich emissions, to avoid a more restrictive potential secondary standard. The skewing of the averaging period by use of visibility as a surrogate for welfare effects should be resisted as much as possible. An approach is to use calculated visibility, once fully validated (see #3, below), in daylight and nighttime hours, or over 24 hour averaging periods e.g. page 1-20, lines 1-7).

The acceptance of a secondary standard by regulated communities will depend on its being relatively simple and intelligible to these communities and to the public. The proposed regulation of calculated visibility, rather than of PM concentration, is problematic in this regard. If visibility is to be regulated, then appropriate FRMs and appropriate PRB levels must be established. As PRB levels likely vary across the country, it must be established that regionally valid PRBs for visibility reflect similar concentrations of PM. The alternative (page 1-20, line 8-22), to set a uniform national visibility standard may prove untenable because PRB visibility is expected to differ regionally. This situation is further complicated by seasonal trends in RH, which will lead to seasonality of NAAQS for PM. It appears unlikely that regulated communities will embrace a standard that implies regionally differing levels of PM, to achieve differing levels of visibility.

Given the likely regional variability in PRB for visibility, the use of locally relevant scenes for valuation should be given greater consideration (page 1-19, lines 5-12), despite the complexity of this approach. Fewer total scenes might be evaluated, but with greater precision and local

relevance, than is suggested in the plan. This might allow scope for locally relevant "valuation" (page 1-19, line 10) which could be a powerful metric.

4. Define UVA and its relationship to the REA and ISA, at the point of its first introduction.

It is not clear from the text what the relationship between the urban visibility assessment (UVA) and Risk and Exposure Assessment (REA) is. This may only be semantic and can be easily addressed with a few additional words on page 1-1, near line 21.

5. Greater attention should be paid to linking reconstructed (calculated) light extinction to measurements of visibility.

The generality of the relationship between reconstructed visibility parameters, (calculated as functions of $PM_{2.5}$ and RH), is documented by reference to a strong correlation of such parameters with $PM_{2.5}$ (page 1-7, lines 5-12). The reasoning is somewhat circular. Better to focus on relationships between measured visibility parameters and PM concentrations to demonstrate these relationships, and on relationships between measured and reconstructed visibility to support the methodology. To this end, an appropriate goal of this review cycle (page 2-7) is the proposed development and validation of an urban optimized IMPROVE algorithm.

The discussion of needed visibility parameters, use of models to obtain them, and suitable averaging periods, is spread over much of the existing text. This should be consolidated into the text preceding introduction of the urban optimized IMPROVE algorithm, possibly prior to discussion of appropriate PRB for visibility (section 2.1.1). This would allow determination of what is needed for each purpose, and then how best to achieve it.

6. Maintain effort to provide quantitative valuation of welfare effects, including in this case visibility impairment.

The welfare effects and associated secondary standards have not been as influential as primary health standards for a variety of reasons. Valuation can be an important tool for welfare impacts. It is a mistake for the current plan to dismiss this goal as too complex (page 3-6, line 11-12), even if only incremental progress can be made in the current review cycle.

7. Minor error.

It is stated that both average radius and number of cloud droplets declines with increasing PM derived CCN (page A-9, lines 9-10). Droplet number is likely to increase with decreasing radius under these conditions.

8. The summary of previous rulemaking should be revised to include the recent court decision of 24 February 2009.

The discussion (page 1-5, lines 1-10) is incomplete due to court action after preparation of this draft Plan. This should be addressed for completeness, as the current treatment is now somewhat misleading.

9. Revise text to condense and focus arguments.

The lengthy discussion on visibility impairment and its relationship with fine PM (page 1-6, line 16 to page 1-8, line 4) is somewhat diffuse and does not lead to a clear conclusion. The objective of the section should be laid out initially, and the key conclusion summarized at the end. This might be facilitated by bringing it all into a single subsection under 1.1.1.

10. Elaborate upon key elements that are mentioned in passing.

Important other protections of visibility contained in the Regional Haze Rule and elsewhere receive passing mention (page 1-11, lines 13-20). These are key to understanding the goals of this Plan and should be expanded upon.

Certain states have enacted visibility rules (page 1-8, line 18). As above, it would be helpful to know which states, what rules, and some indication of successes and shortcomings of the approaches taken.

Comments from Dr. William Malm

Chapter 1 – Introduction

The introductory section presents an overview of the goals and planned approaches for conducting urban visibility assessments.

1. What are the Panel members' views on the general structure and overall design of the planned analyses?

Very energetic for the assumed time frame to complete the assessment.

2. Is the plan clear and transparent in its description of the planned approaches? Are the various assumptions and judgments that must be made in carrying out the planned assessments clear and transparent?

The plan is transparent in it description; however, the assumptions and associated uncertainties are yet to be determined.

3. Given the goals set forth for the planned analyses, has the plan appropriately drawn from the existing scientific and technical information in developing the overall approach? Are there relevant features that should be added or modified in the planned approach?

I suggest that the approach is overly complex and may go beyond the information that is currently available, or at best easily available.

4. In addition to the sub-daily PM2.5 alternative standard considered in the last PM NAAQS review and summarized in this chapter, an alternative standard structure is being considered in this review. This alternative structure would use daylight hourly PM light extinction, which can be measured either by a combination of instruments (nephelometer – PM light scattering and aethalometer – PM light absorption) or calculated from PM speciation and concurrent relative humidity data using a linear algorithm.

a. What are the Panel members' views regarding this alternative structure and its utility in the context of this PM NAAQS review?

I think this is a great idea; set a standard based on extinction derived from direct measurements of scattering and absorption. If the standard is violated, there are a number of ways to estimate which of the major species is primarily responsible. For

instance, it might be a nearby (or distant) wildfire whose effect might be assessed in a variety of ways including measurements, models, and just plain old human observations.

b. What are the Panel members' views regarding advantages and disadvantages of this alternate structure compared to the sub-daily PM mass concentration approach?

A standard based on direct measurement of extinction is much superior.

5. The public's preferences for urban visual air quality (VAQ) levels were assessed in the last review in part by considering results from past western U.S. urban preference studies that used scenes with distant mountain backdrops.

a. What are the Panel members' views on the usefulness of the planned approach to conduct a focus group study in different regions of the country with different scene types to enhance our understanding of the applicability of this earlier body of work to U.S. urban areas in general?

This is an excellent idea, especially if one can pick representative scenes with realistic distributions of haze.

b. What are the Panel members' views regarding the scope and approach envisioned for this effort, given the time available in this review?

A lot to get done within the time frame specified.

Chapter 2 – Assessment of Urban Visibility Conditions

1. Visibility impairment is caused by both PM2.5 and PM10-2.5, though the latter is less effective on a per unit concentration basis and there is less available PM10-2.5 data available in urban areas with which to conduct an assessment. PM in the atmosphere includes liquid water which contributes to light extinction but is removed when filter samples are desiccated prior to mass and composition analysis.

c. What are the Panel members' views regarding to what degree and using what approaches EPA should assess the role of PM10-2.5 in urban light extinction?

Could set the standard on only visibility impairment associated with PM2.5 and fit nephelometers with 2.5 inlets. Could use adjacent IMPROVE monitors to estimate coarse PM. Could design nephelometers to cycle between PM2.5 and PM10 and directly measure coarse PM scattering; there would be little extra cost to do this.

Could assume a constant seasonal background for coarse PM, although the background could vary significantly between urban areas. I would favor a direct measurement with nephelometers.

d. What are the Panel members' views regarding the advantages and disadvantages of using direct measurements of ambient PM light extinction (e.g., nephelometerplus aethalometer, or transmissometer) compared to using a linear algorithm that includes particle composition and concurrent relative humidity to calculate (reconstitute) PM light extinction?

I think a direct measurement is the obvious and best way to go; there is less uncertainty as to whether there is a standard violation and would be cost effective in that only two easily calibrated and operated instruments are used. If there is a standard violation, all data analysis tools can be brought to bear in assessing why the standard was violated as opposed to relying on a subset of those tools to measure the variable of concern.

e. What are the Panel members' views regarding the importance of refining the IMPROVE algorithm so that it is optimized for urban areas in order to estimate PM light extinction for use in this assessment?

Assume some much simpler algorithm to estimate extinction from PM. There will always be a large degree of uncertainty or variability in directly linking bext to individual species, and the data requirements to do this as "right" as possible are significant (real-time particle number size distribution along with continuously speciated data would be desirable).

2. This plan anticipates using the same approach to estimate policy-relevant background PM levels as in the health risk assessment. What are the Panel members' views on this planned approach and its use in the context of the urban visibility conditions assessment?

Given all the uncertainties in emission inventories (like NH3, which is key to understanding transport of secondary aerosols), deposition rates (given the dependence on surface characteristics), gross underestimations for SOA production and so forth, why does one think a model can develop reliable estimates of PRB? At least CTM estimates and background data should be combined to come up with a best estimate with uncertainty bounds (+/- factors of ? probably 2 or more). These issues are even more important if it is anticipated that CTM results can be meaningfully used for hourly concentrations of relevant species.

3. The planned approach includes consideration of high time resolution PM mass and component concentrations as well as PM light extinction data, together with relative humidity values, to assess recent air quality as well as air quality simulated to just meet current and alternative standards under consideration. However, such high time resolution data are not broadly available.

a. What are the Panel members' views on this planned approach or on other approaches or data sources that might be explored?

All data and past modeling efforts should be brought to bear to make this assessment. The approach should be simple and transparent, with defined, broad objectives so that large uncertainties are recognized and accepted. The goal should be to develop methodologies that are unbiased, in that on the average you get it right even if there are large and significant errors on short time scales.

b. What are the Panel members' views regarding useful approaches for characterizing the uncertainties associated with the urban visibility conditions assessment?

I didn't see where there was a detailed plan on assessing uncertainties.

Chapter 3 – Quantitative Visual Air Quality Impact Assessment

1. EPA plans to conduct public preference studies to supplement the information from past studies concerning VAQ levels that impact public welfare. The planned approach is to conduct an investigative focus group in one location to develop the approach that will then be used in group interviews in four urban areas. The proposed approach would ask participants to view an urban-specific iconic scene and a generic scene in each study location, all selected to be sensitive to changes in PM light extinction using WinHaze superimposed haze levels.

a. What are the Panel members' views regarding the appropriateness of EPA's preference study approach and its adequacy to accomplish the goals outlined in the plan?

I think the approach is appropriate and adequate.

b. What are the Panel members' views with respect to alternative approaches that could be considered in this review to acquire this and/or additional relevant information?

2. EPA is not planning to include monetary valuation study questions (e.g. willingness to pay, conjoint analysis) in the studies conducted for this review.

a. What are the Panel members' views regarding the usefulness of adding valuation questions to the proposed four urban-areas group interview surveys and the adequacy of such limited information to inform estimate of the value of improved visibility in the broader nationwide context?

Because this is a welfare-based standard, I suggest that adding a monetary value to a visibility level is not necessary and even inappropriate.

b. What are the Panel members' views with respect to possible approaches for estimating monetary values associated with improved visibility that should be considered?

Page 1.4: It would be helpful here to have a discussion, a listing of what the standards are, annual versus 24 hr, primary versus secondary.

Page 1.5: The statement, "Visibility which can be defined as the degree to which the atmosphere is transparent to visible light…," is patently wrong. The discussion in the following sentences of the document is also incongruent with this statement. "Transparent" (of transmittance) is only a small (part significant) part of visibility impairment.

Page 1.6: The statement, "Visibility is often described in terms of visual range, extinction, or haziness," is correct. However, a sentence should be added to state that none of these metrics really captures "visibility". Probably the best metric would be contrast transmittance weighted in proportion to the wavelength sensitivity of the human eye. Even this metric would not take into account color shifts and human perceptual responses. One has to take some approach to characterizing visibility, but the EPA should show that it recognizes all the associated limitations.

The statement, "Direct relationships exist…," is not true. There are approximate relationships between species and extinction. Apportionment of particle chemistry (species) to extinction is an ill-defined problem and in principle cannot be done (White, 1986). Briefly discuss the problem of internal mixtures. (This discussion is lacking in the PM assessment write up as well)

"…reasonable estimates…" What does reasonable mean? Each person has his own interpretation. Estimating extinction from PM measurements can easily be in error by a factor of 2 or more; is that reasonable? State the uncertainties that might be expected.

Wording of the paragraph, "Due to regional…," is cumbersome. Consider rewriting.

Page 1.7, first paragraph: The whole discussion of correlation doesn't seem to be relevant. One can have a high degree of correlation between variables that are different by orders of magnitude. So if you have a correlation between PM and extinction, it doesn't mean you know anything about the level of extinction based on the PM value.

Second paragraph again has this meaningless discussion about correlations. The Schmidt et al. (2005) reference keeps coming up; was this peer reviewed?

Page 1.8: I think the rationale that a 12-4 visibility standard has greater importance than a 24-hr standard is spurious. Most people drive to and from work early in the morning and later in the afternoon. It is this time period when most people have an opportunity to see and appreciate their surrounding landscape, not when they are sitting in their offices in the middle of the day.

Second paragraph: There is one reference to VAQ and public awareness. I think that a proper literature review and summary of all the public awareness/well being should be carried out. The 3 or 4 urban visibility studies, I would guess, are only a subset of one kind of study that has been carried out.

Page 1.9: What are the "nonpollution" effects that could affect visibility?

Page 1.14: In some place, maybe in a discussion of Figure 1.1, there needs to be a discussion of just what is meant by urban visibility: what views, what times, etc., the whys and wherefores of why urban visibility is important, and under what circumstances. Some relevant discussion appears in Hyslop (2009).

Page 1.19, second paragraph: "…similarly sensitive to small increments…." I agree that the scenes should be similarly sensitive but not necessarily to small increments. They should be similar but only to realistic, expected increments and for some representative scene. As written it seems that the scene may be picked to be overly sensitive and not representative of a typical urban scene.

Last paragraph: Add some discussion as to what nighttime visibility is of importance. Some think that seeing the lights of an urban setting is what is being addressed when discussing nighttime visibility, when I think that what may be of concern is the visibility of the night skyscape.

Page 2.1: It is stated that "We will estimate PM light extinction from measured or estimated PM mass, composition, and RH, using a refined, urban-optimized linear algorithm" First, the equation will not be linear in that the f(RH) term is very nonlinear with RH. Second, because of all the limitations of apportioning extinction to mass composition in a defensible way, I suggest a very simplified version of the IMPROVE equation. Even the IMPROVE equation, which has been optimized for nonurban environments, can for any given 24-hr period, much less any shorter time increments, be in error by factors as much as 2 or more. Significant errors are also associated with the multiplier that is used to estimate POM from OC, as well as sampling bias associated with OC artifacts filter artifacts or with loss of SVOC particles that are dependent on sampling face velocities. All these uncertainties suggest that one should not try to create a false sense of understanding and accuracy by having an unduly complicated algorithm to estimate extinction from mass measurements, speciated or not.

Should the figure reference be 1.2 instead of 2.2?

Page 2.2: How will PRB be used in visibility standard setting – why does one need to know PRB?

The first paragraph under 2.1.1 needs either more background or a more clear presentation. "In the last staff paper….a possible secondary PM standard were (or was – or more possible secondary standards) compared to % tilepoints in the estimated distribution of 24 hr average PM PRB." Now, what am I suppose to take away from that statement? What is a policy relevant background? "…standards were compared to…" – to what end, for what purpose?

I am amazed at the statements concerning using CTM to estimate backgrounds because "This approach can provide more spatial and temporal resolution for estimating PRB compared to the use of measurements given the sparse nature of remote measurement sites and the concern the remote sites are affected by non local anthropogenic sources." I agree that one can derive more spatial and temporal resolution using a CTM but, again, to what end? Given all the uncertainties in emission inventories (like NH3, which is key to understanding transport of secondary aerosols), deposition rates (given the dependence on surface characteristics), gross underestimations for SOA production, and so forth, why does one think a model can develop reliable estimates of PRB, whatever that is? At least CTM estimates and background data should be combined to come up with a best estimate with uncertainty bounds (+/- factors of ? probably 2 or more).

Why not just make best estimates of PRB for broad areas of the country and go with that? Again, I believe all this modeling is giving a false sense of understanding. Make a best estimate and go with it, incorporating all current knowledge, which can include CTM runs.

Page 2.4: Here the discussion goes to PRB on an hourly basis. The model performance only deteriorates as one goes to shorter time frames. It would be interesting to estimate model uncertainty with the uncertainty in using a very simplified PM to b_{ext} algorithm. I would bet that the model uncertainty is far greater than any uncertainty in estimating bext from PM.

Under recent conditions I would suggest relying on available nephelometer and TEOM (or some other estimate of hourly PM) measurements to come up with a range of hourly b_{ext} values rather than estimate them from 24-hr-average PM filter-based measurements. Knowing the hourly distribution of b_{ext} is really what is needed for the assessment. It will not make much difference which species are responsible for the extinction. Of course, for any control strategy, b_{ext} will have to be linked back to the relevant species.

Page 2.6: Where is Table B-1? Is Table B-2 the relevant table?

Page 2.9, section 2.5: In am not certain there is sufficient available data to characterize uncertainties at the level suggested.

Page 3.4: "…that have long sight paths…." Better stated as sensitive view sheds. "…selected to have sensitive scenic elements…" might be changed to also state that not only will they be sensitive, but typical and not unusual.

Page 3.5: I don't think the strategy for selecting extinction ranges under the section assessment scenarios makes sense. Why would the maximum **hourly** value be restricted to something less than the current **24-hr-average** NAAQS level? If one is using hourly values, then it should be restricted to the max hourly value that would typically make up the 24-hr-average value. Depending on the distribution of hourly numbers that make up the 24-hr average, one would have significantly greater values than 35 $\mu g/m^3$, maybe as high as 100 $\mu g/m^3$ or more!

REFERENCES

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Comments from Mr. Rich Poirot

1. **Visibility impairment is caused by both $PM_{2.5}$ and $PM_{10-2.5}$, though the latter is less effective on a per unit concentration basis and there is less available $PM_{10-2.5}$ data available in urban areas with which to conduct an assessment. PM in the atmosphere includes liquid water which contributes to light extinction but is removed when filter samples are desiccated prior to mass and composition analysis.**

    c. **What are the Panel members' views regarding to what degree and using what approaches EPA should assess the role of $PM_{10-2.5}$ in urban light extinction?**

Coarse mass typically accounts for less than 10% of extinction in the eastern US, but is likely to be an important contributor to visibility impairment in arid southwestern urban areas. Phoenix should be a fairly extreme example, where IMPROVE data indicate coarse mass contributes about 25% of extinction on average, about 15% on the haziest 20% days and exceeds the effects of fine mass about 2% of the time. I don't see many reasons to exclude coarse mass in an assessment of urban extinction (and for that matter as a potential component of a secondary NAAQS regulatory metric, which might conceivably be composed of something like fine mass plus some small fraction of coarse mass) if data are available. If coarse data aren't available, a reasonable approximation might be made using fine crustal elements, or PM_{10} data from nearby sites. If an optical regulatory metric is being considered – such as measured by nephelometer, nephelometer plus aethalometer, or transmissometer – coarse particles will contribute to the measured effects, and may in some cases offer potential control options.

Disadvantages of including coarse mass include that it adds complexity and monitoring cost without providing a substantially better indicator in most locations. Coarse mass measurements are also likely to be less spatially representative than fine mass, and highest coarse mass concentrations may often be associated with natural windblown dust events. Light scattering by coarse mass is also not efficiently quantified by nephelometry, and complex data adjustments may be needed if an optical indicator is being considered for a secondary standard.

    d. **What are the Panel members' views regarding the advantages and disadvantages of using direct measurements of ambient PM light extinction (e.g., nephelometer plus aethalometer, or transmissometer) compared to using a linear algorithm that includes particle composition and concurrent relative humidity to calculate (reconstitute) PM light extinction?**

For conducting an assessment of visibility effects, preferences, valuation, etc., the optical measurement data are just not likely to be available in non-class-1 areas (except cities like Denver and Phoenix where they are used to assess compliance with visibility standards). Conceivably, and with much work (which would be interesting and productive), airport ASOS measurement data, with appropriate screens and/or adjustments for RH effects, might be used as the basis of an assessment of current effects, but the required effort would be substantial. Whereas, speciated $PM_{2.5}$ data from CSN (or urban IMPROVE) sites, with collocated or nearby PM_{10} in most cases would allow calculations of (every 3rd day, 24-hour) reconstructed extinction – similar to what's done for the Regional Haze Rule – with existing data. Conceivably, the 24-hour filter data might be combined with lower daytime-only RH data to produce extinction estimates more in line with the times when people are awake and outdoors experiencing visual air quality effects. As a rough approximation, the speciated filter data might be disaggregated to hourly values based on continuous mass measurements – either assuming the speciation remains constant throughout the day (which we know is wrong) or using some knowledge of the typical diurnal cycles of sulfate, nitrates EC, etc. Alternatively, you could make pretty reasonable hourly extinction estimates just using continuous fine mass and a generic (or regionally adjusted) aerosol extinction efficiency. A generic (or regional) aerosol f(RH) function would further improve these estimates.

In considering future regulatory metrics, using optical measurements would have the major advantages that the perceptible effect would be the indicator, and could reflect the much shorter (than 24 hour) averaging times and daylight conditions over which effects are perceived. The combination of nephelometer plus aethalometer would provide valuable continuous information on separate light scattering (of the actual ambient aerosol as people see and breathe it – not some hypothetical construct with some of the water and other volatile species artificially removed) and light adsorption (which, with a dual wavelength aethalometer, would add other visibility and health-relevant information on source influences like diesel exhaust and wood smoke).

Disadvantages of optical indicators include the costs and logistical problems of adding substantial new instrumentation, difficult (in some cases impossible) siting criteria for long-path transmissometers, inefficient measurement of coarse particle scattering by nephelometers, and need for (much) better standard operating and data processing procedures for aethalometers. Also with optical indicators, you know if and when an exceedance occurs, but not necessarily much about what caused it, for which much supplemental information may be needed. Whereas with a continuous mass -related indicator, you have a better sense of pollutant causality, but less certainty about the actual perceived effect at any given time. A species reconstructed extinction indicator provides a good link to pollutant causes, but has poor and intermittent time resolution

e. What are the Panel members' views regarding the importance of refining the IMPROVE algorithm so that it is optimized for urban areas in order to estimate PM light extinction for use in this assessment?

It seems logical that some revisions could be developed for the IMPROVE algorithm so that it is optimized for urban areas. However, I doubt that such revisions will end up being very substantial, and I'm not sure sufficient data exist to do this empirically for more than a few locations, in which case it will be hard to know whether the change is generic urban or city-specific. Possibly, some quick revisions could be based solely on the slightly different nature of the IMPROVE and CSN speciation data (for example to accommodate differences in the carbon measurement methods). We might also expect urban OC to be generally less aged (less oxygenated and smaller sizes) than rural counterparts. Possibly urban coarse particles will be "darker" and have higher extinction efficiencies than rural counterparts. If there are sufficient data, possible revisions to the equation should be considered, but if such data aren't available, this shouldn't be a major concern.

2. **This plan anticipates using the same approach to estimate policy-relevant background PM levels as in the health risk assessment. What are the Panel members' views on this planned approach and its use in the context of the urban visibility conditions assessment?**

I don't have a strong opinion on this. I assume the PRB estimates will be species-specific, which may be important, given that the most efficient light scattering and absorbing species (sulfates, nitrates, and EC) are predominantly anthropogenic. It might be interesting to compare the modeled PRB concentrations at IMPROVE sites with the haze reg estimates of "natural background". Theoretically, the difference between the two is from non-North American anthropogenic sources.

3. **The planned approach includes consideration of high time resolution PM mass and component concentrations as well as PM light extinction data, together with relative humidity values, to assess recent air quality as well as air quality simulated to just meet current and alternative standards under consideration. However, such high time resolution data are not broadly available.**

    a. **What are the Panel members' views on this planned approach or on other approaches or data sources that might be explored?**

As indicated previously, I don't think its unreasonable to disaggregate the species data to hourly values using the continuous mass data – either by assuming uniform temporal composition or by weighting the species disaggregation by what we understand about photochemical production of sulfates, nitrates and secondary OC, as well as what we know about diurnal and day of week patterns in traffic emissions of EC, primary OC, road dust, etc. An alternative reasonable approach would be to just use the continuous fine mass data combined with generic dry scattering efficiencies and generic aerosol f(RH) growth functions. Possibly these functions could be varied on a regional or seasonal basis.

b. What are the Panel members' views regarding useful approaches for characterizing the uncertainties associated with the urban visibility conditions assessment?

I think the proposed approaches in the welfare assessment plan for characterizing uncertainty are reasonable. Many of the uncertainties associated with relating specific PM mass and/or species concentrations to optical effects are associated with the varying water content of the ambient aerosol. In terms of conducting assessments or specifying regulatory metrics, those uncertainties can be substantially constrained by limiting the time periods for consideration to those when water effects are least important. This uncertainty in the "aerosol to optics" relationship can also be reduced by use of an optical indicator (in which case we increase the uncertainty in the contributions from pollutant mass or species vs. water). This uncertainty can also be constrained by limiting the time periods for consideration to those when water effects are least important, at which times the effects of different species are also minimally important. Further, the visual air quality at any given $PM_{2.5}$ concentration (of typical composition) can always be described as: as least as bad as X , but getting worse, in a very predictable way, as humidity increases.

In addition to uncertainties in the relationship between aerosol and optical effects, different scenes can vary widely in their inherent sensitivities to changes in light extinction, with effects being cumulative and greatest over longer sight paths. There are also substantial variations in individual perception and preferences, and subsequently in the levels or ranges of visual air quality considered to be adverse. Much of this variability can and should be quantified using standard survey techniques, but it may be difficult to develop visual survey instruments which are representative of the kinds of views characteristic of individual urban areas which are "equivalent" to or exchangeable with views in other areas. A generic urban view without recognizable local landmarks may be inherently less scenic than the actual views characteristic of most individual urban areas.

One area of uncertainty relating to the regulatory metrics of secondary and primary standards that I believe is typically given insufficient attention is the <u>form</u> of the standard. Time ran short during the last PM NAAQS review cycle, and there was not time (or a sufficient technical basis) to consider and recommend a clear form of the proposed secondary standard. Staff & CASAC recommendations were for a sub daily 4 to 8-hour $PM_{2.5}$ indicator in the range of 20 to 30 ug/m^3. But the recommended range was so broad - 90^{th} or 92^{nd} to 98^{th} percentile – that it spanned a huge range, from being slightly more protective than the new 24-hour primary standard to being much less protective than the new primary standard. I think the lower bound (90^{th} percentile) of that recommended form was much too lenient and based on flawed rationale. In any event, I suggest the agency put some effort into better understanding the frequencies at which the public is willing to accept various degradations of visual air quality. Some consideration might also be given to including a temporally varying form as a component of a secondary standard. For example, in an analog to the progress-oriented regional haze regulations, maybe there could be a

requirement that the frequency of exceedances of a subdaily optical or PM threshold decrease over time. Possibly this concept of "improving visibility" – or a shift in the frequency distribution - could be explored by survey instrument, as I don't think its very likely that people have an absolute sense that it's the 36th or 18th or 7th haziest day a year that breaks the camel's back…

Comments from Dr. Ted Russell

Though generally pleased with the PM NAAQS Scope and Methods Plan for Urban Visibility Impact Assessment (hereafter, SM-Welfare) for how they plan to consider welfare impacts, they should go beyond urban visibility to include climate. Indeed, climate concerns might trump other concerns, and one could conceive of controls that might actually exacerbate climate forcing. As noted in the SM, there are significant uncertainties as to how PM will impact climate, but climate impacts have the potential to significantly impact our assessment of potential risks, particularly in terms of how specific components impact climate versus other components. As such, I am currently concerned that the SM-Welfare may miss a major piece of the necessary analysis. On the other hand, if one is just dealing with urban visibility, the current SM does provide a good roadmap to developing the information for providing advice on the potential revision to the secondary PM NAAQS. On the other hand, without consideration of the potential climate impacts, I would worry that the advice may not be fully informed. Dealing with the issue more fully here can help lay the foundation for the next review as well.

Like the SM-Health, I do note a few deficiencies, both in the document as well as the plan, e.g., (as noted in the SM-Health) it would have been very nice if the document had a section summarizing criticisms by CASAC and others on the prior risk and exposure assessments, and how they have responded. This could be done by grouping the types of comments made, and how they plan to address them, and where in the current document the planning takes on those criticisms, very much like a typical response to review document. This should become standard in the process.

Chapter 1

While I think that Chapter 1 does a fine job of laying out the issue, and noting that there is a relationship between PM levels and light extinction, it is written too much as the same chapter for the SM-Health in that it is oriented towards saying that strong relationships have been observed between PM and visibility. Unlike health, there is much less reason to address this issue by relying on statistics/finding associations. The underlying physics is well known. This should be the major focus. For one, it will focus the uncertainty assessment, and it will shift the discussion more to how certain are the effects. After laying out that the physics are well known, and that this can be addressed by first principle analyses if desired, one can then say that the correlations follow the physics. Indeed, after going through the rest of the SM-Welfare, I get the feeling that the problem is being made too big, and that the analyses are going to be overly complex, in part because we know so much more about the physics. I would reconsider what needs to be done here to provide the type of analysis that would lead to a different standard than for the primary NAAQS, and recognize that there is going to be much more known about the

physics here, so a certain amount of less detailed analysis can be tolerated because the uncertainties will still be quite reasonable.

On page 1-19, line 27, there is the comment that visibility effects are less well understood at night. This is true, but it misses something larger. We still understand the optics, and the visibility effects are probably understood quite well enough. What is less well understood is the importance/value. Most folks, I suspect, would say that visibility at night is less important, and that is what drives how to proceed, not our lack of understanding.

On page 1-20, it would be best, if it is not too much trouble, to incorporate both composition and RH, and this should be relatively straight forward using CMAQ results. On the other hand, if this is a very burdensome analysis, (though I would think it actually might be easier), then the former approach is fine.

I am positively disposed to having a PM light-extinction-based standard and using a nepholometer/aetholometer pair to provide PM light extinction. This would minimize some issues in computing light extinction. However, it also adds an issue about how to simulate attainment as some additional uncertainties are added, though I think those are quite reasonable.

Chapter 2:

The plan to assess urban visibility conditions is reasonable in most cases, though it does get a bit unclear, and it reads as though what level of uncertainty is allowable has not been decided, leading to some areas where the levels of analysis do not match.

In regards to the PRB, they suggest using CMAQ results, but if that is too time consuming, they might use the prior review's analyses. Using CMAQ results should not be overly complex, and is preferable. They plan to use those results in many other ways, so they should make it so doing the PRB-light extinction calculation just part of what is routinely found. There is one problem with relying on CMAQ results, and this is found (I think) in the ISA. CMAQ will have considerable uncertainty in simulating PMcoarse from soil, and this can complicate finding the PRB. Table 3-26 in the ISA does not provide an evaluation of CMAQ PMcoarse results. Note, like the SM-Health, I would still be cautious about laying the poor performance of CMAQ in the west to grid resolution problems.

On page 2-4, they start dealing with how to address PM10-2.5. I am not convinced that much ado about nothing is being made. How important is the anthropogenic component of PM10-2.5 to visibility? I did not see this in the ISA (I saw course contribution, but not anthropogenic coarse contribution). Next, I think the approach being proffered in lines 28-29 is going to add unnecessarily to the uncertainty as it integrates two relatively large uncertainties. The first is the uncertainty in the source apportionment. The second is in the coarse-to-fine ratio. Both can be large. I would like to see how much anthropogenic PMcoarse adds to VAQ issues in urban

areas. If anthro-PMcoarse is high on days when dust is high, one is much less concerned given the optical relationship.

Section 2.1.3 assumes that the standard will be based on PM-mass, possibly with compositional information as well. A deficiency is that it glosses over how compositional information will be used as few places will have sub-daily compositional information. Unlike the SM-health analysis, compositional information plays a much larger role here. They should also add a section on the approach if they use aetholometer/nepholometer pairs to measure light extinction directly. In that case, meeting an alternative secondary PM standard will be much less uncertain: a whole set of calculations need not be done.

In response to the specific charge questions associated with Chapter 2:

1a (or c): Role of PMcoarse: As noted above, you should consider the importance of this component to visibility, noting that we are interested in the anthropogenic component, and that the anthropogenic component may be large when the natural component is large, so that has much less importance.

1b. As noted above, I am positively disposed to this approach. It does shift some uncertainties, but I think it reduces them and simplifies the process. In general, given our knowledge of the physics and chemistry of the system, we have a pretty good way of relating emission changes in the more important species to visibility changes.

1c. Revising the IMPROVE algorithm may not be necessary. A first assessment can be to see what might be gained, and see if much effort is required. Is a reanalysis going to reduce an uncertainty or bias to the degree it will influence the process. I suspect it is relatively straightforward, so it may be deemed appropriate even if it only slightly modifies the results.

2. For the most part, following the same method to estimate PRB is fine, though more attention to compositional information and PMcoarse must be included, including model evaluation and how high levels of PRB-light extinction correlate to high levels of anthropogenic light extinction.

3a. I applaud the use of more high resolution compositional information. You have identified SEARCH as providing such data. There are other high resolution data (e.g., from the Supersites and other special studies) that can provide information on how composition changes with time, and CMAQ can as well (though this will add other uncertainties).

3b. The uncertainties section is rather short at present, though correctly notes that there will be uncertainties in the light extinction calculation. However, I suspect those will be small. How CMAQ results are used, and uncertainties in those results, will be significant and should be assessed. How (and if) source apportionment is done on ambient data is also an issue. They

need to address the uncertainty in how well visibility improvement can be calculated and how well they can predict how PM composition will change with controls.

Chapter 3.

The central theme in Chapter 3 is the development of how to quantitatively value the impact of the perception of urban visual air quality on individuals, citing the lack of information about public preferences.

Appendix A.

Again, climate may be the single biggest welfare (and it is also linked to health) concern from PM. In the REA I think that much more emphasis on climatic impacts, positive and negative, and compositionally dependencies, should be given than is indicated here. It is actually quite possible to do a quantitative analysis, though such an analysis may be fraught with uncertainties. However, if the conclusion is that certain species that increase urban light extinction also enhance global warming, one might be very tempted to develop a standard that addresses those components. For example, if an aethalometer/nephelometer pair is used, one might be tempted to weight the light absorption component, or if it is done by component based on speciated PM mass, one might provide additional control on light absorbing species. Might one have a standard that sets a limit on total extinction, however, doubling (or more) the absorbing component?