

April 1, 2008

MEMORANDUM

SUBJECT: Advisory Council on Clean Air Compliance Analysis: Review of the Characterization of Uncertainty in the Estimated Benefits of Reduced PM-Mortality using Expert Elicitation

FROM: Lydia Wegman, Division Director
Health and Economic Impacts Division
Office of Air Quality Planning and Standards

TO: Holly Stallworth, Designated Federal Official
EPA Science Advisory Board Staff Office

Attached are charge questions prepared by the Environmental Protection Agency's (EPA's) Office of Air Quality Planning and Standards (OAQPS) in preparation for a review by the Advisory Council on Clean Air Compliance Analysis on the Characterization of Uncertainty in the Estimated Benefits of Reduced PM-Mortality using Expert Elicitation that is tentatively scheduled for a public meeting to be held in Washington, D.C. on May 8-9, 2008.

cc: Lisa Conner, HEID/CIMG

ADVISORY COUNCIL ON CLEAN AIR COMPLIANCE ANALYSIS

Charge Questions: Review of the Characterization of Uncertainty In the Estimated Benefits of Reduced PM-Mortality Using Expert Elicitation

May 8-9, 2008 Meeting

Background:

In 2002, the National Research Council (NRC) published a Report to Congress, titled “Estimating the Health-Risk-Reduction Benefits of Proposed Air Pollution Regulations” (available at: www.nap.edu). One of the recommendations of the NRC was that:

“EPA should begin to move the assessment of uncertainties from its ancillary analyses into the primary analysis by conducting probabilistic, multiple-source uncertainty analyses. This shift will require specification of probability distributions for major sources of uncertainty. These distributions should be based on available data and expert judgment.”

As part of the effort to implement the NRC recommendations, EPA has recently initiated several efforts to develop methods for characterizing uncertainty in risk and regulatory impact analyses.

In particular, the EPA has completed a multi-year effort to characterize uncertainties in the estimated benefits of reduced premature mortalities associated with exposures to PM_{2.5}. Based on the NRC recommendations, the EPA used expert elicitation to quantitatively assess the suite of uncertainties in the relationship between exposures to PM and the incidence of mortality. While several well-known epidemiological and toxicological studies evaluate this association in a quantitative manner and investigate issues contributing to uncertainty in the concentration-response function, these studies are not able to capture the full suite of issues that arise in quantifying the incidence of premature mortality. Exposure misclassification, confounding from other pollutant exposures, evidence of a causal relationship, and the shape of the concentration-response function are all factors that influence the level of uncertainty in the final estimate of mortality-related benefits from air pollution regulations. The PM-Mortality Expert Elicitation addressed these factors quantitatively and provided the probabilistic distributions of uncertainty from 12 independent experts.

This multi-year project began with the conduct of a smaller-scale pilot elicitation to test the feasibility of performing such a study and to inform a benefits analysis, namely the Non-Road Diesel (NRD) RIA (EPA 2004). The SAB Council was asked to comment on the use of expert elicitation as a method for characterizing uncertainty in the PM-mortality relationship as the pilot elicitation protocol was nearing completion (*Advisory on Plans for Health Effects Analysis in the Analytical Plan for EPA's Second Prospective Analysis*, March 2004, URL given below). The pilot elicitation reported results from only five independent experts using the draft protocol. That analysis was independently peer reviewed (RTI, 2004), with an eye toward informing the more complete elicitation under development at the time.

The PM-Mortality Expert Elicitation, or the “full” elicitation as it is sometimes called, has undergone a peer review focused on the design and conduct of the study (RTI, 2006). The focus of that peer review was on the design of the elicitation itself, rather than the way in which EPA integrated the findings into a benefit analysis within a regulatory context. The topics covered in the peer review included:

- Method for Selecting Experts
- Design of the Elicitation Protocol
- Background Materials provided to Experts
- Communication with the Experts Pre- and Post-Elicitation, and Content, Organization, and Completeness of the Final Study Report.

In addition, we have published an article titled, “*Expert Judgment Assessment of the Mortality Impact of Changes in Ambient Fine Particulate Matter in the U.S.*,” in a peer-reviewed journal that describes the findings of the elicitation (ES&T, 2008). However, our interpretation and use of the PM-Mortality Expert Elicitation results in a regulatory context has not been externally peer reviewed.

As an application in a regulatory context, the EPA has presented the results of the PM-Mortality Expert Elicitation in recent Regulatory Impact Analyses (RIA), including the RIA of the PM National Ambient Air Quality Standards (PM NAAQS RIA). In presenting the results of the elicitation, EPA strived to address the key concerns of the NRC, including:

- 1) Moving the assessment of uncertainties into its primary analyses
- 2) Conducting probabilistic, multi-source uncertainty analyses
- 3) Specification of probability distributions for major sources of uncertainty
- 4) Using empirical sources of data as well as expert elicitation to derive probability distributions
- 5) Conducting sensitivity analyses on some key sources of uncertainty
- 6) Distinguishing between data-derived components of the uncertainty assessment and those based on expert judgment.

The EPA requests that the SAB Council review the interpretation and application of the PM-Mortality Expert Elicitation results, using the PM NAAQS RIA benefits analysis chapter as an example, and provide guidance to the EPA on the appropriate use and

presentation of results from the PM-Mortality Expert Elicitation. Of particular interest is whether the EPA has adequately translated the experts' stated probabilistic distributions to a benefits analysis, and whether in the context of a benefits analysis the EPA should combine the mortality estimates based on the individual responses of the 12 experts or whether the individual mortality estimates should be presented separately.

The EPA also requests guidance from the SAB Council on methods for communicating uncertainty information to a wide variety of audiences including: scientists, policy analysts, decision makers, and the public. At issue is whether the EPA has adequately communicated the results of uncertainty analyses (e.g., whether the EPA should describe the 95th percentile of a probabilistic distribution of uncertainty to the public, or whether the range of benefits presented by the EPA should be based on the highest and lowest estimates of the experts).

Documents for Review:

The review materials will include:

- ❖ The PM NAAQS RIA benefits chapter (available at: <http://www.epa.gov/ttn/ecas/regdata/RIAs/Chapter%205--Benefits.pdf>),
- ❖ The Executive Summary of the PM NAAQS RIA (available at: <http://www.epa.gov/ttn/ecas/regdata/RIAs/Executive%20Summary.pdf>).

The PM NAAQS RIA benefits chapter provides an example of how the EPA has applied the PM-Mortality Expert Elicitation results. The Benefits chapter together with the Executive Summary and other materials provide examples of how the EPA communicates uncertainty to our target audiences.

In addition, the following background materials cited in the text above are provided as information on how the elicitation was conducted to help put the current peer-review request in context and to provide additional history on the PM-Mortality Expert Elicitation Study. These reference documents are not considered part of the requested review, but are provided as a courtesy on the background and history of the PM-Mortality Expert Elicitation study.

- The *Expanded Expert Judgment Assessment of the Concentration-Response Relationship between PM_{2.5} Exposure and Mortality* (Industrial Economics, 2006) [available at: http://www.epa.gov/ttn/ecas/regdata/Uncertainty/pm_ee_report.pdf]: provides an in-depth description of the elicitation process, the methods for selecting experts for participation in the assessment, the characterizations of uncertainties associated with the estimation of premature mortality as expressed by each expert.
- The Peer Review for the conduct and content of the PM-Mortality Expert Elicitation (Research Triangle Institute, 2006) [available at: http://www.epa.gov/ttn/ecas/regdata/Uncertainty/peer_review_summary_r

[ti_29sept06.pdf](#)]: provides a description of the peer review of the PM-Mortality Expert Elicitation protocol.

- “*Expert Judgment Assessment of the Mortality Impact of Changes in Ambient Fine Particulate Matter in the U.S.* (Environmental Science & Technology, 2008): describes the findings of the PM-Mortality Expert Elicitation
- The NonRoad Diesel RIA Appendix 9B (available at: <http://www.epa.gov/nonroad-diesel/2004fr/420r04007.pdf>): provides an alternative treatment and presentation of expert elicitation results for consideration using the results of the Pilot elicitation.
- Peer review of *An Expert Judgment Assessment of the Concentration-Response Relationship Between PM2.5 and Mortality* (Available at: http://www.epa.gov/ttn/ecas/regdata/Benefits/memo_7.30.04.pdf).
- *Advisory on Plans for Health Effects Analysis in the Analytical Plan for EPA’s Second Prospective Analysis - Benefits and Costs of the Clean Air Act, 1990-2020*; Advisory by the Health Effects Subcommittee of the Advisory Council on Clean Air Compliance Analysis (Available at: [http://yosemite.epa.gov/sab/sabproduct.nsf/08E1155AD24F871C85256E5400433D5D/\\$File/council_adv_04002.pdf](http://yosemite.epa.gov/sab/sabproduct.nsf/08E1155AD24F871C85256E5400433D5D/$File/council_adv_04002.pdf)): previous Council Advice related to the use of expert elicitation.

We look forward to discussing the following charge questions with the Council at our upcoming meeting. Should you have any questions regarding the Characterization of Uncertainty in the Estimated Benefits of Reduced PM-Mortality using Expert Elicitation, please contact Lisa Conner at 919-541-5060 (conner.lisa@epa.gov).

Charge Questions:

1. In the PM NAAQS benefits chapter, has EPA accurately characterized each expert's concentration-response function as expressed in the PM-Mortality Expert Elicitation report and conveyed the differences in assumptions (including the influence of key empirical studies) that drive the differences among the concentration-response functions?
2. In applying the PM-Mortality Expert Elicitation results in EPA's benefit analysis, is our mathematical treatment of concepts such as the probability of causality, thresholds, and shape of the function technically sound, as well as transparent?
3. Do the tables, text, conclusions, and Executive Summary adequately distinguish the benefit estimates based on data-derived components of the uncertainty assessment from those based on expert judgment? How should the mortality estimates based on the elicitation be compared to those derived from the empirical studies of the PM-mortality association?
4. Does the EPA's present effort to incorporate uncertainty analyses and discussions into the primary analysis, as exemplified in the PM NAAQS RIA chapter, adequately address the NRC's request to move the assessment of uncertainties into its primary analyses? If not, what more could the EPA do to satisfy this request?
5. Has the EPA adequately communicated the uncertainty information associated with the PM premature mortality estimate to the audiences that the RIA addresses, including: scientists, policy analysts, decision makers, and the public?
 - a. Considering the examples provided by the EPA, are there other methods the EPA should use, instead of or in addition to those employed, to summarize and communicate the results of the PM-Mortality Expert Elicitation in the benefits chapter and the Executive Summary for communication to technical and non-technical audiences?
 - b. To what extent do the types of statements made in the Executive Summary of the PM NAAQS RIA successfully communicate the extent of uncertainty (and/or the certainty) in the estimate of PM premature mortality to those who are not familiar with the PM-Mortality Expert Elicitation?
 - c. Are there additional summary statements that are important to deduce from the results of the PM NAAQS benefits chapter to the Executive Summary?
6. Has the EPA adequately summarized the results of the PM-Mortality Expert Elicitation across the experts in the PM NAAQS RIA benefits chapter and executive summary?

In the PM NAAQS benefits chapter, the EPA presents the mortality results based on each of the twelve individual expert's responses along with results based on concentration-response functions derived from empirical studies. The EPA has also considered employing methods to aggregate results based on the elicitation into a single combined estimate. In particular, the EPA considered calculating a simple average of estimates across experts after the concentration-response functions of each expert had been applied in the benefits model (i.e., the average of the resulting estimation of the change in mortality incidence). Other options for summarizing the results include: a weighted average of the resulting change in incidence, a trimmed means approach, and a fitted distribution to the overall set of concentration-response functions.

- a.** Should the EPA continue to present the results of the individual experts in future benefits analyses as was done in the PM NAAQS RIA? Should the EPA develop metrics that aggregate across the individual experts? If aggregate measures are considered appropriate, should the EPA present these in addition to or instead of the individual estimates?
- b.** If a combination (aggregation) of results is considered appropriate, what technique for aggregation would you recommend?
- c.** If a combined estimate is considered appropriate, what interpretation should be applied to the percentiles of the uncertainty distribution derived from the elicitation (e.g., the mean estimate of a combined elicitation function, or the 5th -95th percentiles)?
- d.** If a combined distribution is not appropriate, how should the EPA characterize the estimates of the PM premature mortality effect? One option employed in the Executive Summary of the PM NAAQS RIA is to present the estimates as a range from the average value associated with the steepest concentration-response function to the average value associated with the flattest concentration-response function. Is this the best approach? What other options would you recommend?