February 25, 2004

MEMORANDUM:

TO: Ron Evans, Group Leader
Innovative Strategies and Economics Group

FROM: Lisa Conner, Pilot Elicitation Project Lead
Innovative Strategies and Economics Group

SUBJECT: Response to Peer Review of *An Expert Judgment Assessment of the Concentration-Response Relationship between $PM_{2.5}$ Exposure and Mortality*

In April 2004, EPA published a report titled, *An Expert Judgment Assessment of the Concentration-Response Relationship between $PM_{2.5}$ Exposure and Mortality*, which documents a pilot expert elicitation conducted by EPA (in collaboration with the Office of Management and Budget) that was intended to more fully characterize uncertainty in the estimate of mortality resulting from exposure to PM. This pilot elicitation was designed with a limited scope and time frame for completion in a one-year time frame, and to provide EPA with an opportunity to improve its understanding of the design and application of expert elicitation methods to economic benefits analysis and lay the groundwork for a more comprehensive elicitation. In July 2004, the EPA commissioned a peer review of the pilot from a panel of four experts on the topics of expert elicitation, decision analysis, and uncertainty characterization.[6]

Attached to this memorandum is a response to recommendations and comments received from the peer review which was prepared by Industrial Economics, Inc. (IEc), the consulting firm that implemented the pilot elicitation for EPA. The EPA project team has reviewed the IEc memo and agrees with the content and responses provided on the peer review. EPA will fully consider the comments and recommendations raised in the peer review, as well as other lessons learned from the pilot, as we design and implement a subsequent full-scale expert elicitation of the PM2.5-mortality relationship.

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6 A full report of the peer review is available at www.epa.gov/ttn/ecas/benefits.html.

Memorandum

29 September 2004

TO: Lisa Conner, EPA

CC: Bryan Hubbell, EPA

FROM: Katy Walker, Tyra Gettleman, and Henry Roman,
Industrial Economics, Inc.

SUBJECT: Response to Peer Review Comments on Expert Elicitation

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Introduction

This memorandum presents our response to the comments from the July 2004 peer review (www.epa.gov/ttn/ecas/benefits.html) of the Industrial Economics, Incorporated (IEc) report, *An Expert Judgment Assessment of the Concentration-Response Relationship between $PM_{2.5}$ Exposure and Mortality*. We believe that the four peer reviewers (Drs. Crawford-Brown, Frey, Morgan and Stieb) provided a thorough and rigorous assessment of the Expert Elicitation Pilot Study. We found their comments to be very helpful in identifying ways to improve the elicitation study design. We plan to address the issues they identified when developing the full-scale elicitation characterizing uncertainty in the $PM_{2.5}$ / mortality concentration-response relationship.

In this memorandum, we review the three major concerns cited by the reviewers, discuss our responses, and describe how the concerns are likely to be addressed in planning the future elicitation study.

Peer Review Comments and Responses

Elicitation Encoding Methodology

Three of the reviewers expressed concern regarding the elicitation encoding process, including the sequencing of questions and responses. During the pilot study, some of the experts provided judgments based on a central tendency before providing judgments on extreme values (upper and lower bounds). The peer reviewers noted that this type of sequencing might be associated with the anchoring and adjustment heuristic, which could result in underestimates of uncertainty (overconfidence bias). The reviewers suggested alternative direct encoding methodologies reported in the literature that are intended to reduce the potential for use of the

anchoring and adjustment heuristic. For example, two reviewers suggested using a fixed value method instead of the fixed probability method used in the pilot study. In the fixed value method, experts are asked to assign percentiles first to extreme values and subsequently to fixed values selected in random order. As noted by one reviewer, indirect encoding methods (interval methods and use of a reference lottery) have also been used, but have not been as acceptable to experts with quantitative expertise.

We note that the pilot study protocol did ask the experts to begin developing distributions by discussing the maximum and minimum values they believed possible, but that some of the experts were uncomfortable with this approach, and preferred to begin by specifying a central tendency value. Nonetheless, we recognize the potential for overconfidence bias the latter approach may introduce. In the protocol for the full-scale study, we will re-evaluate the choice of encoding methodology, focusing on the support for direct vs. indirect methods and, in particular on fixed probability vs. fixed value methods. Our goal will be to develop strategies for consistent encoding across experts that have had demonstrated success with experts like those involved in the pilot study and that minimize potential overconfidence bias due to anchoring and adjustment.

Communication between Experts

The reviewers also felt that the experts should have communicated before and/or after the individual interviews. The reviewers thought group communication would allow the experts to begin thinking about all of the relevant knowledge and competing lines of reasoning in the literature, in advance of the interviews. The reviewers also thought that the experts should have had the opportunity to view the judgments of other participants (anonymously) and make adjustments to their responses, either through a post-elicitation workshop or through circulation of expert response summaries among the group.

We agree with the reviewers, and feel that the communication between experts is important as a conditioning step and a knowledge-sharing experience. We will encourage the interaction of the experts in the full-scale study through a pre-elicitation workshop. In addition, we will encourage post-interview interaction, ideally through a post-elicitation workshop, to give experts the opportunity to alter their responses after reviewing and evaluating the responses of other experts (see also discussion below).

Combining Expert Judgments

The reviewers also commented on the issue of combining expert judgments. Several of the reviewers preferred that the expert opinions not be combined or stated that they knew of no agree-upon method for combining results from expert elicitations. One reviewer did not feel that it was appropriate to combine the individual distributions into a single estimate. Two of the reviewers indicated that if the expert judgments were to be combined, then they were reasonably comfortable with combining the judgments using equal weights. Some of the reviewers, however, did not agree with the manner (i.e., the mathematical approach) in which the expert

judgments were combined in the pilot study[1]. Reviewers commented that the combination of judgments using averaging across experts might generate results with which none of the experts would agree. Another concern raised by reviewers is that the extremes of the distributions are not captured by the current approach.

We agree in principle with the reviewers concerns about combining experts' distributions. As we note on page 70 of our report, we present a combined distribution for illustrative purposes but do not recommend the use of the combined distribution in benefits analysis. We believe it is important to present each expert's distribution separately, to preserve the diversity of opinion, and we recommend that each expert's distribution be used in separate model runs to generate benefit estimates that can then be pooled using equal weights. This approach is consistent with the recommendation of Dr. Crawford-Brown. EPA used the pooled benefit approach when applying the elicitation results in Appendix B of the Regulatory Impact Analysis (RIA) for the Clean Air Nonroad Diesel Rule (EPA, 2004).

As part of the planning for the full-scale elicitation, we will consider with the project team the value of, and ultimate goals for, presenting a combined distribution in addition to individual expert distributions. Given the objectives we define, we will evaluate other combination methods including both mathematical approaches and "group process" methods such as the collective expert workshop discussed in Bunitz et al., 1995, and a NUREG report, recommended by Dr. Morgan. The latter could be considered for use during a post-elicitation workshop, for example, providing the opportunity for expert interaction, and for developing a collective judgment.

References

United States Environmental Protection Agency. May 2004. Final Regulatory Analysis: Control of Emissions from Nonroad Diesel Engines. Appendix B. EPA420-R-04-007. http://www.epa.gov/nonroad-diesel/2004fr.htm#ria

[1] The reviewers that were in favor of combining the results felt that the equal weighting scheme implemented in the report was the most appropriate. The reviewers rejected the technique of assigning unequal weights to experts based on an initial calibration, a view that we fully support.