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**Charge Questions for SAB-EEAC Review of an EPA White Paper: “Valuing mortality risk for environmental policy: a meta-analytic approach” and Technical Memorandum: “Income Elasticity of VSL”**

**February 2016**

**White Paper: Meta-analysis dataset**

The White Paper assembles a database of stated preference and hedonic wage estimates of the value of statistical life (VSL) and, where possible, their standard errors. Criteria for inclusion in the database are based on recommendations from the SAB-EEAC (U.S. EPA Science Advisory Board 2011) (see section 4.4, page 13-20). EPA requests comments on whether the selection criteria previously recommended by the SAB-EEAC were appropriately interpreted and applied both for selecting studies to include in the meta-analysis and for selecting estimates within studies. **In answering questions 1(a) – 1(c), in addition to responding to the specific questions, please comment, in general, on whether the selection criteria previously recommended by the SAB-EEAC have been appropriately interpreted and applied in the White Paper.**

**1a. Evidence of validity for stated preference studies:** The SAB noted in its earlier advisory report (U.S. EPA Science Advisory Board 2011) that each selected stated preference study “should provide evidence that it yields valid estimates” (page 16). The SAB did not, however, specify how validity should be assessed. In applying this criteria, EPA included studies and estimates that passed a weak scope test or provided other evidence of validity (e.g., a positive coefficient on the risk variable as in the appendix for Viscusi, Huber and Bell 2014) as explained in Appendix B of the White Paper. Please comment on whether the methods EPA used in the White Paper to assess the validity of studies and estimates are appropriate and scientifically sound.

**1a.** For this white paper, the EPA’s interest is in mortality risk valuation for the U.S. general adult population. The EPA’s application of criteria to include studies that provide at some (possibly weak) evidence of validity largely relies on (a) publication of studies in refereed literature and (b) evidence (possibly weak) of passing a scope test. The EPA’s approach emphasizes evidence of validity based on criteria of a scope test, and this criteria is reasonably based on economic theory that the value of a risk reduction should respond to the size of that risk reduction. The white paper, however, does not confirm (in it’s summaries of included studies, particularly Appendix B), that all studies followed sound practice of construct and other criterion validity, although publication in refereed literature can be viewed as confirmation of state-of-the-art practice. Therefore, the EPA’s approach appears scientifically sound and reasonable. It bears noting that EPA did not restrict it’s included-studies only to those studies that satisfied the scope test *and* (statistical) proportionality between estimated willingness to pay and the size (magnitude) of risk reduction addressed; such an absolute restriction would have further restricted EPA’s database for the white paper. Within the context of methodological uncertainties that necessarily remain in well-implemented studies, this more stringent criteria seems more likely to exclude information that

provides sound insight to VSL, so that it is reasonable to conclude that EPA retained studies appropriate for developing a scientifically valid and reasonably unbiased estimate of VSL for the general adult U.S. population.

However, the SAB and EPA might, in future, address the concern that of 33 published studies identified by EPA (white paper, p. 10), only 9 studies provided information used in the analysis (white paper, p. 11). Of the 24 studies eliminated, some may have provided evidence of validity without passing other criteria (such as using samples that were not considered sufficiently representative of the U.S. adult population). In some of these 24 cases, the studies may offer scientifically valid information on VSL that could be used “to understand how to adjust results that use other sample frames” (quoting SAB report distributed with Administrator Jackson’s letter [EPA-SAB-11-011], p. 15). From this perspective, it bears at least future consideration as to whether available, scientifically-sound studies based on a relatively non-representative sampling frame can be used to improve estimates drawn from scientifically-sound studies based on a more completely representative sampling frame. Integration of such information across studies likely would need to remain for a future research agenda. Such research might create opportunities to build representative estimates from a portfolio of studies with a more narrowly constructed sampling frame or study population, whereby that portfolio could cover much of the breadth of the heterogeneity existing in a U.S. general population. By this comment, I wish simply to point out that criteria for accepting studies in the present calculation raises the prospect that included studies offer scientifically sound VSL information while also risking that some excluded studies could have provided additional, scientifically sound VSL information. By this perspective, I reiterate that EPA’s practice in the white paper is reasonable.

**1b. Construct of the risk variable in hedonic wage studies:** The SAB noted in its earlier advisory that the EPA should “Eliminate any study that relies on risk measures constructed at the industry level only (not by occupation within an industry)” (U.S. EPA Science Advisory Board 2011, page 18). It is not clear whether the SAB’s parenthetical addition was meant as an example or as a directive. Only four studies constructed the risk variable by occupation and industry and met other selection criteria. In applying this criteria EPA included studies and estimates where the risk measure is differentiated by industry and at least one other characteristic (e.g., occupation, gender, age). Please comment on whether the hedonic wage studies included in the White Paper constructed the risk variable in a manner appropriate for use in the meta-analysis.

**1b.** The white paper indicate that EPA followed the suggestions of SAB to not rely on industry-level Hedonic-wage studies exclusively. The EPA has chosen to use studies based on a consistent data base (CFOI), differentiated by industry and one additional criterion/characteristic (white paper, p. 12). EPA emphasizes that its included studies provide information relative to the working population as a whole, which may imply (perhaps reasonably) omission of some information or studies that would include VSL information for older individuals, such as non-working retirees. Indeed, several of the included studies use age-restricted samples that would necessarily exclude information from individuals above retirement age (although included studies do not necessarily use the same upper age-limit, as identified in the white paper Appendix B).

**1c. Estimates for immediate risk reductions:** To estimate the average value of the marginal willingness to pay for reduced risk of immediate death, the EPA selected estimates

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from the Stated Preference literature that are most closely comparable to the accidental deaths from the hedonic wage literature. The EPA made several judgement calls in determining the appropriate estimates to use from the stated preference literature. Specifically, Viscusi, Huber and Bell (2014) estimate reductions in risk of bladder cancer that will occur in 10 years. The authors discount the estimates to derive a comparable estimate for an immediate risk reduction. Alberini, et al. (2004) estimate a willingness to pay for an annual reduction in risk over 10 years. We include estimates from both of these studies in the meta-analysis. Please comment on whether appropriate estimates from the stated preference literature were used in the White Paper to estimate the marginal willingness to pay for reduced risk of immediate death.

**1c.** From my perspective, including information for scientifically sound studies, when feasible and reasonable, is more likely to provide valid insight to VSL than would excluding studies by uncompromising application of stringent criteria. Based on information in the white paper, the Viscusi, Huber, and Bell (2014) and Alberini et al. (2004) studies sufficiently conform to criteria for scientifically valid studies using stated preferences. Using these estimates is appropriate. One question I have in this regard arises from clarity of presentation in the white paper and Charge Question 1c: In economic theory, the Viscusi, Huber and Bell estimates for death 10-years in the future would, naturally, underestimate the willingness to pay to avoid an immediate death; use of a 3% discount rate (white paper Appendix B, p. 56) is arguably appropriate for public policy decisions; but the 10-year future value should be compounded forward (upward) rather than discounted (downward) to obtain a current-period VSL of immediate death; the white paper should clarify that this adjustment was done consistent with economic theory.

For the Alberini et al. (2004) study, the annual risk reduction was 1/10000 or 5/10000 (depending on the authors' subsample of adults). This is appropriate as a measure of a risk reduction of these magnitudes. However, it remains unclear to this reading concerning adjustment factors that VSL estimate from Table B-3 (white paper Appendix B, page 48) to VSL estimates for this study in Table 6 (white paper, p. 17); this connection should be clarified in the white paper.

2. Please comment on whether relevant empirical studies in the stated preference and hedonic wage literatures are adequately captured in the White Paper. If additional studies should be included in the white Paper please provide citations.

**2.** I do not have suggestions for additional studies to include for consideration.

3. Some estimates in the meta-analysis dataset in the White Paper are constructed by weighting subpopulation-specific estimates within a study in order to approximate an estimate for the general population. The specific weights used are described in Appendix B of the White Paper. Please comment on whether the population-weighting approach used in the White Paper is appropriate and scientifically sound.

3. In general, the EPA approach to weighting is reasonable. The approach uses Census data from time frames corresponding to the study to weight sub-populations within a study in order to obtain a mathematically-equivalent estimate of the average VSL for the US general adult population. I have more significant concerns that EPA review and confirm the clarity of their approach(es) used and the accuracy of their implementation of the approach described. I note here some examples:

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First, somewhat trivially, it is not clear that all weights used add to one. In some cases, this is likely due to rounding error for the (usually 3) digits listed in Appendix B tables. These concerns are unlikely to have an substantive impact on the overall analysis or VSL estimates in the white paper: for example, weights in the top half of Table B-5 add to 0.999 while weights in the bottom half add to 1.088; weights in Table B-6 add to 0.999; weights in Tables B-8, B-13, and B-14 correctly add to 1.000. Weights in Table B-10 add to 1.1 (see next paragraph). While weights totaling 0.999 may be considered acceptable within the scope of common practice with rounding error, a total of weights that exceeds a magnitude of +/- 0.001 may be considered unacceptable. EPA should review and improve the precision/accuracy of this information.

Regarding Table B-10, there appears to be a typographic error in the Weight column. While the weights listed add to 1.1 (= 0.855 + 0.155), it appears the weighted estimates in the last column are based on weights that add to 1.000 (= 0.855 + 0.145). EPA should review and improve the precision/accuracy of this information.

Regarding Table B-8, the exposition is confused (actually the wording in the paragraph above table B-8 does not conform to the mathematical procedure that is most likely to have been what EPA used and intended to describe). I believe the second sentence of the paragraph above Table B-8 should read: "*Each of the first four estimates were weighted with the weighted sum of the last five estimates such that six estimates were used to calculate each weighted average*" (where my underline-italics indicates the main modifications to the sentence in the white paper). If I am correct, then it appears that the weighted sums reported in Table B-8 would be consistent with my revision and based on a total of weights adding (appropriately) to 1.00.

However, this example of Table B-8 highlights another concern that may be related to Charge Questions below: Here, EPA has used one study to derive four estimates entered into the meta-analysis data base. In this case, all four of those estimates use the same values for five of their six components. SAB should consider criteria by which observations (observation-sets) derived from a single study are adequately recognized for non-independence by the material beginning with section 4.2 (white paper, p 25); the econometric error structure and corresponding assumptions implied by the foundations of error modeling laid out in equation (11) do not seem conceptually consistent with a data generating process of the type exemplified by Table B-8.

4. In some cases EPA estimated standard errors in the White Paper using information within studies or provided by the study authors, as described in Appendix B. Please comment on whether the methods used in the White Paper to estimate standard errors when such information was not readily available are appropriate and scientifically sound.

**4.** The information provided in the white paper seems appropriate and reasonable. However, Appendix B itself does not provide extensive details of these calculations.

### **White Paper: Analysis**

Section 4 of the White Paper describes methods used to estimate representative VSL estimates from the meta-analysis dataset and presents results.

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5. Please comment on whether the methodology used in the White Paper to analyze the data represents an appropriate and scientifically sound application of meta-analytic methods to derive generally applicable VSL estimates for environmental policy analysis.

5. The EPA approach appropriately recognizes the concern that several studies included in the meta analysis provide more than one observation in the meta analysis. In order to draw on the best available scientific information, it is appropriate draw multiple estimates from studies offering separable samples, subsamples or modeling approaches to estimating VSL for a general U.S. adult population. The approaches used cover a reasonable range of alternatives to approximate parameters (particularly variance parameters) that advanced statistical theory recommends, but that are either only weakly estimable or not knowable based on existing data and knowledge. The range of non-parametric approaches shows a limited range of effects on the central tendency (mean) VSL-estimate obtained, and the arguments for preferring estimator 2 in Table 7 indicate a conservative approach due to the lack of detailed data appropriate to implementing aspects of more advanced estimators; in particular, this estimator avoids the assumption of independence across observations drawn from a single study, so that the estimator does not give higher weight to studies that contributed larger numbers of estimates that may not have been statistically independent (such as estimates drawn from Table B-8 as previously noted above). Because EPA used these principles for statistically weighting estimates from a single study in implementing the parametric approach, I also believe the EPA's choices in the parametric analysis are appropriate and reasonable. Prior to the Advisory Committee's pending discussion, I believe the EPA approach and choices are appropriate and scientifically sound. The steps taken to provide robustness checks do not appear to reveal dramatic affects on the estimates of VSL that could be used in benefit cost analysis.

6. The White Paper classifies estimates into independent samples, also called groups, as described in Section 4. Estimates from some hedonic wage studies that use the same or very similar worker samples are grouped together for the analysis. Similarly, some of the stated preference estimates using the same sample are grouped together. Please comment on whether this methodology represents an appropriate and scientifically sound approach for accounting for potential correlation of results that rely on the same underlying data.

6. The EPA uses appropriate methods to avoid over-weighting studies used to generate multiple observations from overlapping or non-independent samples.

7. Section 4.1 of the White Paper presents an expression that characterizes optimal weights that account for sampling and non-sampling errors, a framework that guides EPA's approach. Please comment on whether this is an appropriate and scientifically sound approach for addressing sampling and non-sampling errors.

7. See response to Charge Question 5 above.

8. The analysis in the White Paper adopts both non-parametric and parametric approaches (sections 4.1 and 4.2, respectively). Please comment on whether these approaches span a reasonable range of appropriate, scientifically sound, and defensible approaches to estimating a broadly applicable VSL for environmental policy and whether there are other methods that are more appropriate than those used in the White Paper.

8. See response to Charge Questions 5 and 6 above. I believe the EPA approaches are scientifically sound and reasonable.

#### **White Paper: Results**

9. The White Paper presents estimates using parametric and non-parametric models, pooled across stated preference and hedonic wage studies as well as balanced (i.e., equal weight to each study type), and weighted using different approaches. Of the range of estimates presented (see Section 4) the White Paper proposes the use of estimates from the following models:
  - Non-parametric model, balanced, mean of study mean
  - Parametric, balanced

Please comment on whether these proposed estimates represent reasonable and scientifically sound conclusions from the analyses in the White Paper and whether there is a different set (or sets) of results that are preferable based on the data and analysis in the White Paper.

9. I believe the approaches used represent a reasonable and scientifically sound basis for estimating average VSL and uncertainty ranges for benefit cost analysis.

10. The results section of the White Paper concludes with an influence analysis. Please comment on whether this analysis is a reasonable way to characterize the influence of individual studies on the estimated VSLs, whether the results of the influence analysis suggest any changes or modifications to the estimation approach, and whether it is important to include an influence analysis.

10. The influence analysis illustrates that the VSL estimates are not dramatically affected by the inclusion of individual studies. This outcome raises the confidence in the basis for estimated VSL and its distribution for the general U.S. adult population. However, I believe a companion analysis would also be instructive: there appear to be studies (perhaps a few) that were excluded by various screening criteria, but nonetheless provide information at least on VSL for a general U.S. adult population; an additional inclusion analysis could be instructive regarding whether the exclusion of such studies is likely, in the main, to substantially affect the estimated VSL and estimated uncertainty recommended for use in benefit cost analysis. For example, some of the Hedonic studies excluded may address a general adult population but fail to use the CFOI data; would inclusion of such a study dramatically affect estimates derived?

#### **Establishing a Protocol for Future Revisions:**

11. In the previous SAB advisory report (USEPA Science Advisory Board 2011), the SAB endorsed the idea of establishing a standardized protocol and regular schedule for future updates to the Agency's mortality risk valuation estimates. Please comment on relevant statistical criteria for the inclusion of additional eligible estimates and/or the exclusion of older estimates that could

help inform the development of a standardized protocol for future updates and the timing or frequency of those updates.

**11.** Criteria for exclusion of older studies should consider whether there is evidence that willingness to pay distributions for VSL would have shifted for the general adult population in the time from the study implementation to the present. However, consider an example: Events like the recession started in 2008 could be an obvious example, but zealous exclusion of studies prior to 2008 would be unjustified because knowledge prior to the event is likely still valid. Rather, EPA or analysts should emphasize development of standards by which adjustments of older studies can be implemented to scale or calibrate older studies to contemporaneous conditions representative of the time of decision or benefit-cost analysis. Inclusion of scientifically sound studies should be viewed as preferable to exclusion, at least when analysts can use structural parameters to adjust for factors affecting a shift in mean VSL. In contrast, older studies could be viewed as providing relatively robust information on the variance of VSL and the concern might be to calibrate the mean while (perhaps) preserving the spread of uncertainty considered relevant.

12. In its 2011 report the SAB-EEAC recommended "...EPA work toward developing a set of estimates...for policy-relevant cases characterized by risk..." (U.S. EPA Science Advisory Board 2011, pp. 10). Among the studies that meet the selection criteria in the current White Paper, three stated preference studies provide values for reductions in risks of cancer (i.e., Hammitt and Haninger 2010, Chestnut, Rowe, and Breffle 2012, and Viscusi, Huber and Bell 2014). Only two of those studies (Hammitt and Haninger 2010 and Chestnut, Rowe, and Breffle 2012) allow for a within study comparison of values for cancer and non-cancer risk reductions. However, EPA could augment the literature by modifying the selection criteria to include studies from other countries or from the grey literature, and/or using other methods (e.g., risk-risk studies). Please comment on whether, and if so how, selection criteria for identifying studies for estimating a cancer differential should differ from those used in the current White Paper. Does the literature support a non-zero cancer differential?

**12.** Developing estimates that reflect differentials for the form of mortality (rapid/instantaneous versus forms leading to protracted decline in quality of life), risks that may be controlled or influenced by individuals taking precautions, and consideration of the policy context that could lead to individuals observing (or perceiving) the potential for government subsidies to arise in assisting with risk reduction that might otherwise remain the responsibility of the individual. On this latter point, one might also evaluate validity based on whether a study shows evidence of changes in stated willingness to pay under conditions that enable or limit cheap riding within a realistic policy, consequential context (however, this suggestion is speculative at the current time and would require new research). Overall, EPA should strongly encourage research to develop the ability to calibrate VSL estimates for the characteristics of causes of mortality (or morbidity) as such research could substantially effect the validity of future benefit-cost analyses targeted toward a specific portfolio of causes of risk.

**Technical Memorandum: Income elasticity**

13. The EPA document *Technical Memorandum: Income Elasticity* presents a summary of the recent income elasticity literature based on a review presented in Robinson and Hammitt (2015). Please comment on whether Robinson and Hammitt (2015) and the EPA Technical Memorandum provide an appropriate and scientifically sound summary of the income elasticity of VSL (IEVSL) and income elasticity of non-fatal health effects literatures. If there are additional relevant empirical studies that should also be included in the summary, please provide citations.

**13.** I have no additional studies to suggest. The Robinson and Hammitt (2015) and EPA memorandum provide an appropriate and scientifically sound summary.

14. Several reported mean income elasticity estimates from stated preference studies are quite low, sometimes even zero. The “balanced” approach in the EPA Technical Memorandum does not include reported mean estimates of zero, but does include very low reported mean estimates (e.g., 0.1). Please comment on whether this an appropriate and scientifically sound choice. How should very low, non-zero, mean reported income elasticity results be addressed in the analysis?

**14.** Studies that meet criteria for validity, particularly construct and criterion validity, following state-of-the-art practice based on economic and econometric theory and method should be included. If these studies produce results with low estimates of income elasticity, such should be included in support of future benefit-cost analysis; studies should not be excluded by failure to produce a particular numerical result that is otherwise consistent with a consensus of economic theory and knowledge. Studies that provide an estimate of zero (or negative) income elasticity should, if otherwise meeting criteria for sound theoretical and methodological practice, likely provide evidence that the income elasticity is low; these studies can be used to augment the confidence (weight) placed on studies that provide positive but small estimates. However, economics consensus indicates that the income elasticity is expected, on sound theoretical grounds, to be positive. For this reason, estimates of non-positive income elasticity of VSLs should not necessarily be accepted as valid estimates of the income elasticity.

15. Please comment on whether the selection criteria applied by Robinson and Hammitt (2015) are clearly enumerated, appropriate, and scientifically sound and whether the additional inclusion of Viscusi, Huber, and Bell (2014) in the Technical Memorandum is appropriate based on results reported in the study’s on-line appendix (attached).

**15.** I believe the criteria are clearly enumerated, appropriate, and sound. I view the inclusion of Viscusi, Huber, and Bell (2014) as appropriate, given the evidence of (at least weak) sensitivity to scope in the on-line appendix and the application of that criteria as a foundation for inclusion of other studies.

16. Given the relatively limited number of studies upon which to draw for estimating the income elasticity of VSL, the EPA Technical Memorandum describes two alternatives for arriving at a central IEVSL estimate and range for use in environmental policy analysis. Of these alternatives which is the most appropriate and scientifically sound? Please provide the rationale for your choice. Would it be appropriate to consider using the alternative as a sensitivity or uncertainty characterization?

16. I recommend the approach that integrates results from both SP and HW studies that have met criteria enumerated for inclusion (such as, offering some evidence of validity). Drawing from a broader, methodologically pluralistic range of studies is more likely to provide a reasonable and scientifically sound estimate of key parameters, because methodological plurality (using studies based on the respective state-of-the-art) offers a hedge against the unavoidable simplifying assumptions that may be required for reasonable implementation of either of the broad categories of study types (SP or HW).

17. As described in Robinson and Hammitt (2015), there are limited data on income elasticity of non-fatal health effects. As a result the Technical Memorandum recommends using the IEVSL to estimate income elasticity for the value of these non-fatal health risks. Please comment on whether this represents an appropriate and scientifically sound approach given the available data.

17. I view the approach recommended by Robinson and Hammitt (2015) as appropriate, and preferred to assuming an absence of knowledge given the current status of the literature.

## References

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3/7/16 Preliminary draft comments from individual members of the SAB Environmental Economics Advisory Committee. These comments do not represent consensus SAB advice or EPA policy.

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Viscusi WK, Huber J, Bell J. 2014. Assessing whether there is a cancer premium for the value of a statistical life. *Health Economics* 23:384-396. [On-line appendix available at: <http://onlinelibrary.wiley.com/doi/10.1002/hec.2919/supinfo>]