

1 UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
2 WASHINGTON D.C. 20460  
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OFFICE OF THE  
ADMINISTRATOR  
SCIENCE ADVISORY BOARD

11 DATE

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13 EPA-SAB-.....

14  
15 Honorable Lisa P. Jackson  
16 Administrator  
17 U.S. Environmental Protection Agency  
18 1200 Pennsylvania Avenue, N.W.  
19 Washington, D.C. 20460  
20

21 Subject: Review of "Valuing Mortality Risk Reductions for Environmental Policy: A  
22 White Paper" (December 10, 2010)  
23

24 Dear Administrator Jackson:  
25

26 The EPA National Center for Environmental Economics (NCEE) requested the Science  
27 Advisory Board's advice on how the Agency should value mortality risk reductions in its  
28 benefit-cost analyses of environmental policy. The NCEE asked the SAB to review its White  
29 Paper entitled "Valuing Mortality Risk Reductions for Environmental Policy" (December 2010)  
30 and respond to charge questions. To respond to this advisory request, the SAB's Environmental  
31 Economics Advisory Committee was augmented with additional experts. The EEAC Committee  
32 met on January 20 – 21, 2011 to deliberate on NCEE's questions. We provide detailed comments  
33 in the attached responses to charge questions and highlight some key points below.  
34

35 The White Paper recognizes a longstanding problem with the term "value of statistical  
36 life" (VSL). A "statistical life" has traditionally referred to the aggregation of small risk  
37 reductions across many individuals until that aggregate reflects a total of one statistical life. For  
38 example, a decreased risk of mortality in the U.S. of 1 in a million would result in 310 "statistical  
39 lives" saved (given a population of 310 million). The VSL has been a shorthand way of referring  
40 to the monetary value or tradeoff between income and mortality risk reduction, i.e. the  
41 willingness to pay for small risk reductions across large numbers of people, but it has lead to  
42 confusion because many have interpreted it as referring to the loss of identified lives. In  
43 recognition of the confusion and controversy caused by the VSL term, the White Paper proposed  
44 replacing the VSL term with "value of mortality risk." We enthusiastically endorse a  
45 terminology change, but in our view, a term like "value of risk reduction" (VRR) would better  
46 communicate the notion that value is derived from reducing risks rather than the risks

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1 themselves. While we recommend this terminology, we recognize that we are not experts in risk  
2 communication and suggest that EPA consider focus groups or some other mechanism to explore  
3 the language that best communicates this concept to the public. Improved public communication  
4 is needed to dispel common misconceptions around this issue.  
5

6 When valuing risk reduction, it is important to communicate exactly what kind of risk is  
7 being reduced since the public may value risk reduction of one kind of mortality (e.g. cancer)  
8 differently from risk reduction of another kind (traumatic injury). The White Paper notes that  
9 research suggests that people are willing to pay more for mortality risk reductions that involve  
10 cancer than for risk reductions from accidental injury and proposes a placeholder value that  
11 could be used for this cancer differential while the Agency pursues long-term research to  
12 differentially value other types of risks. We endorse the Agency’s proposal to apply different  
13 values to different contexts. We also encourage the Agency to explore alternative methods that  
14 we identify for estimating these context-specific values from the available research base.  
15

16 The White Paper correctly notes that the amount of money people would be willing to  
17 pay for “public” risk reductions (that affect everyone) can differ from willingness to pay for  
18 “private” risk reductions (that affect only the individual or household). While we agree with this  
19 conceptually, there is little empirical evidence that altruistic concerns are significant drivers of  
20 values for risk reduction and hence we do not recommend excluding values estimated for either  
21 public or private risk reductions from consideration.  
22

23 The SAB was asked a number of technical questions about EPA’s database of mortality  
24 risk reduction values and the most appropriate statistical approach for deriving a value for  
25 mortality risk reduction from existing studies. In the attached, we offer specific technical  
26 recommendations on criteria that should be used to select studies for inclusion in the database.  
27

28 Lastly, the SAB supports the Agency’s plan to update its estimates for valuing risk  
29 reduction on a regular basis. The estimates that the agency currently uses are based on studies  
30 that are at least 20 years old and do not take into consideration the wealth of newer studies that  
31 make use of better techniques and better data. To avoid using estimates based on outdated  
32 research in the future, the Agency should establish a protocol for updating regularly the estimates  
33 of the value of risk reduction that it uses in its work.  
34

35 Thank you for the opportunity to provide advice on this White Paper. The SAB looks  
36 forward to receiving the Agency’s response.  
37  
38  
39

40 Sincerely,  
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This report has been written as part of the activities of the EPA Science Advisory Board, a public advisory committee providing extramural scientific information and advice to the Administrator and other officials of the Environmental Protection Agency. The Board is structured to provide balanced, expert assessment of scientific matters related to problems facing the Agency. This report has not been reviewed for approval by the Agency and, hence, the contents of this report do not necessarily represent the views and policies of the Environmental Protection Agency, nor of other agencies in the Executive Branch of the Federal government, nor does mention of trade names or commercial products constitute a recommendation for use. Reports of the EPA Science Advisory Board are posted on the EPA Web site at: <http://www.epa.gov/sab>.



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4 Washington, D.C.

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## Executive Summary

1  
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3  
4 This report was prepared by the Science Advisory Board (SAB) Environmental  
5 Economics Advisory Committee Augmented for Valuing Mortality Risk Reduction (the  
6 “Committee”) in response to a request by EPA’s National Center for Environmental Economics  
7 (NCEE) to review its draft White Paper “Valuing Mortality Risk Reductions for Environmental  
8 Policy” (December 10, 2010). The Committee deliberated on the charge questions during a  
9 January 20 – 21, 2011 face-to-face meeting and a subsequent conference call on March 14, 2011.  
10 The Committee’s draft report was considered and approved by the Chartered SAB in a public  
11 teleconference on ..... Three topics were highlighted in the charge questions: EPA’s proposed  
12 terminology change, willingness to pay for cancer risk reductions, and the treatment of altruism.  
13 Other charge questions covered the selection criteria for inclusion in EPA’s database of studies,  
14 the income elasticity of mortality risk reduction values, EPA’s statistical approach for deriving  
15 an estimate, more timely updates to the Agency’s guidance and other methods for valuing health  
16 risk reduction. This Executive Summary highlights the Committee’s major findings and  
17 recommendations.

18  
19 *EPA’s Proposed Terminology Change.* The White Paper discusses problems associated  
20 with the popular misunderstanding of the “value of statistical life” (VSL) metric that has  
21 traditionally been used in benefit-cost analysis. The VSL concept arose in benefit-cost analysis  
22 to express society’s willingness to pay for health risk reductions. Since risk-reducing  
23 environmental policies come with a cost, decisions are best made when a policy’s cost is  
24 compared with its benefits, of which one category is society’s willingness to pay for health risk  
25 reductions. Much indignation has been expressed in public and political settings over the VSL  
26 term because it is often perceived as the value of life itself or the value of an individual’s life  
27 when, in fact, the term is meant to refer to society’s willingness to pay for small changes in risk.  
28 In the jargon of economics, VSL describes individuals’ marginal rate of substitution between  
29 health risks and income or wealth. To better communicate this concept, SAB agrees with NCEE  
30 that the Agency should move away from the traditional VSL term in favor of a new term of art  
31 that conveys the tradeoff between income and small reductions in health risk. While we favor  
32 (and use in our advisory) a term like “value of risk reduction” (VRR) or “value of mortality risk  
33 reduction”, we encourage the Agency to undertake some research, possibly including focus  
34 groups, on how best to communicate this tradeoff to the public. EPA needs a term that captures  
35 the value of small risk reductions that can be aggregated over large numbers of people, not a  
36 term that is easily confused with the value of life itself. In addition to finding ways to  
37 communicate the tradeoff between income and health risk reductions, we encourage the Agency  
38 to explain the type of risk to be reduced while seeking ways to differentiate willingness to pay  
39 for one kind of health risk reduction versus another. Since these values express demands for  
40 different goods by different groups of people, a single “one size fits all” metric used to express  
41 the marginal rate of substitution between health risks and income oversimplifies the many  
42 complex policy contexts in which EPA operates.

43  
44 *Willingness to Pay for Cancer Risk Reductions.* Reducing environmental cancer risk is  
45 an important part of EPA’s mission to protect human health. Thus a key question is how to

1 account for individuals' preferences for reducing cancer risks relative to other types of health  
2 risks. In fact, many health threats addressed by environmental policies consist of illness profiles  
3 with long latencies and substantial periods of morbidity prior to death. NCEE has correctly  
4 noted that some research finds a "cancer premium," i.e. a higher willingness to pay for cancer  
5 risk reductions than for other kinds of mortality risk reductions, though other good studies find  
6 no evidence of a differential. NCEE asked the SAB to comment on a placeholder value that  
7 could be used for this cancer premium while the Agency pursues long-term research to  
8 differentially value different types of risks. We believe that the "first-cut" estimate of a 50  
9 percent differential for cancer should be refined before application. This refinement should take  
10 into account the different baselines used in current studies (e.g., fatal accident, chronic disease)  
11 and recognize that several good studies find small differences between cancer and other risks  
12 while others find large differences.  
13

14 Building from the recognition that WTP to reduce cancer risks may differ from WTP to  
15 reduce other fatal risks, the SAB recommends that EPA work toward developing a set of  
16 estimates of VRR corresponding to policy-relevant contexts defined by the type or characteristics  
17 of the risk (e.g., associated morbidity, latency) and of the affected population (e.g., age, health,  
18 income). Economic theory and empirical evidence suggest that WTP can vary with these  
19 characteristics and that a single value of mortality risk reduction is not appropriate for all  
20 contexts. Developing this set of estimates will be challenging because the available empirical  
21 estimates do not cover all relevant contexts and there is substantial, poorly understood variation  
22 among estimates from different studies. The SAB describes several methods for developing this  
23 set of estimates and encourages EPA to evaluate the validity and relevance of these methods for  
24 informing policy analysis. Proposed approaches include: (1) using only primary estimates  
25 obtained for the specific context; (2) developing adjustment factors to transfer estimates from  
26 other contexts; (3) developing meta-regression equations; and (4) structural benefit-transfer  
27 methods to characterize appropriate values across multiple contexts.  
28

29 *Altruism.* NCEE asked us to comment on how altruism should be treated in valuing risk  
30 reductions for environmental policy. The White Paper correctly notes that the amount of money  
31 people would be willing to pay for "public" risk reductions (that affect everyone) can differ from  
32 willingness to pay for "private" risk reductions (that affect only the individual). Differences may  
33 be a result of altruism, either paternalistic or pure (also called non-paternalistic). Pure altruism  
34 occurs when altruists respect the preferences of the beneficiary and care about the net welfare  
35 effect on the beneficiary. Paternalistic altruism occurs when benefactors substitute their own  
36 preferences for that of the beneficiary, e.g., care about the risk reduction but not about any costs  
37 imposed on the beneficiary. The literature is clear that values driven by paternalistic altruism  
38 should be counted while values driven by pure altruism need not be counted as they do not affect  
39 the sign of net benefits. (Preferences concerning the distribution of benefits or costs in the  
40 population affect the evaluation and should be counted.)  
41

42 Although the theory is clear, economic analysis has not evolved to the point of being able  
43 to separately measure portions of total value attributable to paternalistic and non-paternalistic  
44 altruism. In addition, there is little empirical evidence that altruistic concerns are significant

1 drivers of values for risk reduction. Hence the SAB recommends that the Agency make no  
2 adjustments for altruistic considerations.  
3

4 *Database Development.* EPA asked the SAB about inclusion criteria for its database of  
5 stated preference and hedonic wage studies. The SAB finds that the distinction between stated  
6 preference (SP) and revealed preference (RP) studies is less important than accounting for  
7 differences in risk and individual characteristics. In the attached report, specific  
8 recommendations are offered in response to NCEE's questions about selection criteria and  
9 weaknesses in data sets. Overall, the SAB concluded the choice of econometric techniques for  
10 combining disparate estimates should depend on the number of estimates to be drawn from each  
11 study and the number of observations available for the meta-analysis.  
12

13 *Income Elasticities.* The Agency asks for advice concerning procedures for updating its  
14 values to account for income growth. The SAB notes that the decision on how to adjust values of  
15 risk reduction (VRR) for income growth over time is related to the approach used to estimate the  
16 VRR (or range of VRRs) for a particular application. The SAB recommends developing  
17 estimates of income-elasticity as part of the process used to estimate appropriate VRRs for  
18 different contexts described above.  
19

20 *Updating Values of Risk Reduction.* The Agency requested guidance on whether it was  
21 sensible to use a simplified approach for updating the values of risk reduction using a set of  
22 available studies to fit a parametric distribution. The SAB strongly endorses EPA's proposal to  
23 update VRR estimates routinely as improved information becomes available and urges the  
24 Agency to establish a protocol for regular updates. The current estimates depend upon studies  
25 that are 20 – 35 years old and it is time to take advantage of a wealth of new studies and better  
26 data. In principle, any of the methods described above for estimating VRRs in different contexts  
27 could be updated to include new literature.  
28

29 *Long-Term Research.* To support improved value estimates in the longer term, the SAB  
30 encourages EPA to work toward using structural preference functions, although the committee  
31 believes that it will be some time before such an approach will be ready for implementation.  
32 The Agency also should encourage research to obtain revealed and stated preference estimates  
33 for the types of risk and types of affected populations that are most relevant to environmental  
34 policy contexts.  
35

1 **Introduction**  
2

3 To frame our response to the charge questions, we begin by providing some perspective  
4 on the concept of valuing mortality risk reduction and its use in estimating the benefits of  
5 environmental policies. This perspective is followed by responses to the specific charge  
6 questions.  
7

8 The economic theory concerning valuation of reductions in mortality risk is well  
9 developed but application to evaluation of environmental policies is challenging. First, there is a  
10 limited set of empirical studies available for reliably determining values of mortality-risk  
11 reduction and how these values depend on characteristics of the risk and affected population.  
12 Second, the conventional term used to describe the value of risk reduction (the “value of a  
13 statistical life,” or VSL) is easily misinterpreted, leading to confusion about key concepts. As  
14 discussed below, we applaud EPA’s proposal to adopt an alternative to the conventional term  
15 and use the term “value of risk reduction” (VRR) in our discussion.  
16

17 From an economic perspective, VRR is an individual- and risk-specific value defined as  
18 the individual’s marginal rate of substitution between money and mortality risk. It has units of  
19 dollars per change in probability of death in a specified time period (e.g., the current year). This  
20 marginal rate of substitution can be used to estimate the money value of a small change in risk  
21 (by multiplying the change in probability by the rate); analogously, the rate is often estimated  
22 from information about the monetary value that an individual judges to be equivalent to a small  
23 change in risk.  
24

25 VRR is often characterized using the maximum amount an individual could pay for a risk  
26 reduction without making himself worse off. In other words, an individual’s willingness to pay  
27 (WTP) for a risk reduction  $\Delta p$  is defined as the amount of money such that the individual is  
28 indifferent between his initial position (with initial risk and wealth) and a position in which his  
29 mortality risk (in the specified period) is reduced by  $\Delta p$  and his wealth is reduced by WTP.  
30 Alternatively, one can define VRR using the amount of money the individual would require as  
31 compensation to forgo a risk reduction; i.e., he is indifferent between having his initial wealth  
32 with the risk reduction  $\Delta p$ , and forgoing the risk reduction but having his wealth increased by his  
33 willingness to accept compensation (WTA). For the small risk changes that are usually relevant  
34 to environmental policy, these two estimates of VRR ( $WTP/\Delta p$  and  $WTA/\Delta p$ ) should be nearly  
35 equal.<sup>1</sup>  
36

37 Economic theory implies that VRR is likely to depend on characteristics of the individual  
38 and the risk. We highlight five key implications of standard theory for valuing mortality risk.  
39

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<sup>1</sup> In this example, WTP is the compensating variation and WTA is the equivalent variation for the risk reduction. One can also define VRR using WTA compensation for a risk increase (i.e., compensating variation for a risk increase) and WTP to prevent a risk increase (i.e., equivalent variation for a risk increase). Under conventional economic theory, these two values of VRR should be identical to the two defined in the text for infinitesimally small risk changes. Empirically, estimates of WTA are often much larger than estimates of WTP, as discussed in response to charge question 4.a.i (Stated Preferences Studies).

1 First, the amount of money an individual judges as equivalent to a change in risk (both  
2 WTP and WTA) should be larger for a larger risk change. Moreover, for small changes in risk  
3 (for which WTP or WTA is a small share of wealth or income), the money value should be  
4 nearly proportional to the risk change, which is equivalent to saying the rate of substitution  
5 between money and the change in risk is nearly constant (e.g., if a risk reduction of one in one  
6 million is worth \$10, then an otherwise similar risk reduction of two in one million is worth  
7 \$20).<sup>2</sup>  
8

9 Second, VRR depends on the individual's wealth or income, i.e., on his ability to pay. It  
10 seems intuitive and is consistent with economic theory and empirical evidence that a richer  
11 person will generally be willing to pay more for (and demand greater compensation to forgo) a  
12 risk reduction.  
13

14 Third, VRR is likely to depend on other individual characteristics, such as age, life  
15 expectancy, future health prospects, responsibility to care for dependents, and other factors.  
16 Intuitively, the benefit of surviving the current period depends on the future conditions one is  
17 likely to face, and willingness to spend money to improve survival (or to accept compensation to  
18 forgo an improvement) depends on the other demands on an individual's wealth. For these  
19 factors, however, economic theory does not provide clear implications and empirical estimates  
20 are limited in coverage and quality.  
21

22 Fourth, VRR is likely to depend on other characteristics of the risk, including both  
23 objective and subjective characteristics. Objective characteristics include latency (time between  
24 exposure and subsequent illness or death) and the duration and severity of associated morbidity  
25 (these attributes can be described as an "illness profile"). Subjective characteristics include the  
26 extent to which the hazard which presents the risk is perceived as under the individual's control,  
27 voluntarily accepted, familiar, well-understood, and/or dreaded. Again, theory and empirical  
28 evidence provide only limited information on how these factors affect VRR.  
29

30 Fifth, the monetary value to an individual of any given program to reduce mortality risk  
31 may also depend on program characteristics in addition to the individual's personal risk  
32 reduction. For example, individuals may have different values for risk reductions provided  
33 through public goods that affect other people (such as cleaner ambient air) and risk reductions

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<sup>2</sup> Many stated-preference studies estimate that the rate of substitution between money and risk change varies substantially with the magnitude of otherwise similar small risk changes. If this finding accurately represents individuals' preferences, it implies that individuals' indifference curves between wealth and the probability of surviving the specified time period are sharply curved or kinked within the range of survival probabilities in question. It seems implausible that different individuals, facing different initial mortality risks, will have sharp curves or kinks in their indifference curves in precisely the small regions needed to account for this empirical finding and more plausible that the finding reflects a limitation of contingent-valuation methods. Sharply diminishing marginal WTP with the size of the risk reduction, as often found in stated-preference studies, implies that an individual would value a second risk reduction of  $\Delta p$  much less than an initial risk reduction of  $\Delta p$ . This seems unreasonable, from the perspectives of economic theory and common sense, except when payment for the initial risk reduction substantially reduces ability to pay for the second increment. If it were accepted as a valid description of individual preferences, then valuation of environmental policies would need to account for it by using sharply different VRRs for individuals obtaining larger and smaller risk reductions (Hammit and Treich, 2007).

1 provided through private goods that affect only themselves or their households (cleaner indoor  
2 air at their residence). Their values may also depend on the distribution of risk reductions within  
3 the population (e.g., whether disadvantaged populations are disproportionately affected) and the  
4 mechanism through which costs are paid (e.g., income taxes, electricity prices).

5  
6 Recognizing that VRR is a metric that can vary with both individual and risk  
7 characteristics, the conceptually appropriate method to estimate the benefits to the U.S.  
8 population of a change in mortality risk that results from environmental policy is to estimate the  
9 risk changes faced by each individual over time, value these changes using the appropriate  
10 individual VRRs, and sum the results over the population. In contrast, an alternative “short-cut”  
11 approach is conventionally applied. The short-cut approach is to multiply the number of people  
12 in the population by the population-mean risk reduction (yielding the number of “lives saved”)  
13 and multiply that by the population-mean VRR. The short-cut approach will yield the correct  
14 result only in special cases, specifically when any of three conditions hold: (a) all individuals  
15 face the same risk reduction; (b) all individuals have the same VRR; or (c) individual risk  
16 reductions and VRRs are uncorrelated in the population. If none of these conditions holds, the  
17 short-cut approach can produce a substantially biased estimate of population benefits as a result  
18 of “premature aggregation” (Cameron 2010, Hammitt and Treich 2007). Note that the short-cut  
19 approach requires only the population-mean VRR (for the risk in question) but correct valuation  
20 generally requires information on how VRR varies among individuals.

21  
22 Because appropriate valuation of reductions in mortality risk generally requires  
23 information on how VRR varies among individuals and with risk characteristics, the SAB  
24 recommends that EPA orient its approach toward (a) recognizing the conceptually appropriate  
25 method to estimate population benefits and (b) developing a set of estimates of VRR for policy-  
26 relevant cases characterized by risk and individual characteristics (or a function relating VRR to  
27 risk and individual characteristics). This orientation would be a departure from the older notion  
28 of identifying “the value of a statistical life” that is appropriate for policy evaluation. (EPA has  
29 already moved away from this older notion, e.g., by recognizing that cancer risks may be valued  
30 differently than fatal injury risks.) The SAB recognizes that developing a set of context-specific  
31 VRRs will be challenging, due to limitations of the empirical literature. This implies that, for the  
32 near term, place-holder values will be needed for many contexts, perhaps obtained using VRRs  
33 estimated for other contexts with or without adjustment. Nevertheless, the SAB recommends that  
34 economic evaluation of environmental policies specify the conceptually appropriate approach  
35 and explicitly acknowledge the necessity to apply pragmatic proxies for that ideal given data  
36 limitations.

37  
38 Conceptually appropriate, context-specific estimates of VRR should account for  
39 uncertainty about the VRR for each case, ideally as a probability distribution. Developing this set  
40 of estimates is challenging because of limited theoretical guidance and empirical evidence  
41 concerning how VRR varies with risk and individual characteristics. Moreover, estimates of  
42 VRR are highly variable, both within and between studies. This variability makes it difficult to  
43 distinguish differences in VRR associated with risk and individual characteristics from random  
44 variation and from differences in study design. Many effects of study characteristics on VRR  
45 estimates are not well understood. In estimating the VRR for each case, one confronts a tradeoff

1 between using only studies that are specifically relevant to that case and using estimates for other  
2 cases, whether neighboring or more distant, perhaps by estimating a functional relationship of  
3 values to risk and individual characteristics. The former choice will tend to minimize bias at the  
4 cost of higher variance, especially variance of the difference in valuation between cases. It may  
5 even lead to illogical differences in VRR between cases. The latter choice will tend to increase  
6 bias but reduce variance and provide a smoother relationship between values and characteristics.  
7

8         The SAB acknowledges that heterogeneity in WTP across types of risks will be more  
9 palatable to some audiences than heterogeneity across affected subpopulations. In the past, for  
10 example, the Agency has been criticized for considering VRRs that differ by individuals' age.  
11 This is, however, a failure of communication rather than any theoretical ambiguity about whether  
12 economics admits for different demands by different types of people. It can be difficult to convey  
13 the distinction between the "intrinsic value of different human beings" and the "different WTP of  
14 people in different circumstances." However, this difficulty does not justify using the wrong  
15 benefit measure for proposed policies.  
16  
17

## Responses to Charge Questions

### Charge Question 1

**Current EPA guidelines and standard practice use “Value of Statistical Life” (VSL) as the metric for valuing mortality risks. Section 3.1 of the white paper discusses the VSL terminology commonly used in mortality risk valuation exercises in greater detail. The white paper suggests that the Agency move away from using the traditional VSL terminology in favor of a new term for estimates of the marginal rate of substitution between health risks and income (see section 3.1). Specifically, the white paper suggests that the Agency refer to these estimates as the “value of mortality risk,” and report the associated units using standard metric prefixes to indicate the size of the risk change, e.g., \$/mr/person/yr (dollars per milli[10<sup>-3</sup>]-risk per person per year), or \$/μr/person/yr (dollars per micro[10<sup>-6</sup>]-risk per person per year), etc. Does the Committee agree that the Agency should pursue such a change? Does the Committee believe that making these changes would ease or exacerbate the misunderstandings documented by Cameron (2010)? Would some other terminology or approach be preferable? Please explain.**

The SAB strongly supports replacing the “value of statistical life” (VSL) with a term that more accurately reflects what is being measured. The Committee encourages EPA to consider replacing VSL with “value of risk reduction” (VRR) and using VRR to delineate different types of risk. For example, there might be a VRR for sudden workplace death, a VRR for cancer death, a VRR for heart disease, and so forth. A VRR might also vary demographically (eg., a VRR for cancer death for men 40 to 50 years old). The committee chose not to recommend standard units but did discuss micro-risk, milli-risk and nano-risk as obvious possibilities.

The EPA’s White Paper proposed the terminology “value of mortality risk” (VMR) to replace VSL. The SAB believes that the new term should include “reduction” since the value is typically derived from a reduction in risks rather than from the risks themselves and used to value risk reductions. Also, VMR gives the impression that people have a positive value for risk. Using risk reduction avoids this confusion. The committee also felt that using “mortality” does not always provide a complete description of the risks involved. Different types of risks are often intertwined in valuation studies, and policies often lead to changes in mortality as well as morbidity risks. For example, the morbidity (and other factors such as dread) associated with cancer is difficult to separate from the mortality risk of cancer. Excluding “mortality” allows for morbidity VRR and mortality VRR distinctions that encompass a broader array of risks. As noted above, the SAB suggests that morbidity or mortality VRR be accompanied by a policy-specific classification of the type of probabilistic outcome, the target population, etc.

While the SAB recommends the terminology VRR, we recognize that we are not experts in communication. For this reason, we suggest that EPA consider testing the VRR terminology and explore alternative terminologies in focus groups, discussions, and presentations with relevant user groups. Along these lines and in response to the public misconceptions of VSL documented in Cameron (2010), the SAB recommends EPA consider conducting or sponsoring research into effective communication of VRR and its role in benefit-cost analysis to the general public. Numerous public comments in response to an article about the VSL in the popular press

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1 suggest that many people also have difficulty with the use of the word “value.”<sup>3</sup> Many non-  
2 economists seem to believe that the word value means “intrinsic worth,” rather than the  
3 economists’ notion of willingness to pay, and they bridle at the idea that their government would  
4 presume to put a dollar value on their lives. In any event, the change from VSL to something like  
5 VRR as well as the other suggested changes (e.g., from one value of VRR to values for specific  
6 policy-related risk changes) provide a prime opportunity to engage in effective public  
7 communication. There have been calls in the past for EPA to start research programs on public  
8 communication and recent developments in climate change communication further highlight the  
9 importance of public communication in the effectiveness of policy making and implementation.

10  
11           Regardless of the exact language chosen, the SAB believes that making such a change  
12 will contribute to easing the public misunderstanding of VSL. We applaud EPA’s leadership in  
13 this suggestion.

14

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<sup>3</sup> See Binyamin Appelbaum, “As U.S. Agencies Put More Value on a Life, Businesses Fret,” New York Times, February 16, 2011 and the inventory of public comments available at [http://pages.uoregon.edu/cameron/vita/Stakeholder\\_misconceptions.pdf](http://pages.uoregon.edu/cameron/vita/Stakeholder_misconceptions.pdf).

1 **Charge Question 2**

2 **Experts generally agree that *value function transfers* can outperform *point value transfers* in**  
3 **cases where the characteristics of the risks and/or the exposed populations differ between**  
4 **the source studies and the policy context in measurable ways. That is, the more**  
5 **commodity- and individual-specific attributes that can be included in the benefit transfer**  
6 **exercise, the better the estimate of willingness to pay. Charge questions 2 and 3 inquire**  
7 **about whether applications of benefits transfer methods to value mortality risk reductions**  
8 **from environmental pollutants can be improved by controlling for more of the attributes**  
9 **that distinguish the source studies from the policy scenario.**

10  
11 **The white paper concludes that research since the 2000 EPA Guidelines suggests that**  
12 **people are willing to pay more for mortality risk reductions that involve cancer than for**  
13 **risk reductions from accidental injury (see section 3.3). Our preliminary review suggests**  
14 **that a “cancer differential” of up to 50% over immediate accidental or “generic” risk**  
15 **valuation estimates may be reasonable. Conceptually, would the weight of evidence (both**  
16 **theoretical and empirical) suggest there is a cancer differential? If so, does the Committee**  
17 **believe that our estimate of the differential is appropriate? If not, how does the Committee**  
18 **recommend the Agency incorporate cancer differentials in benefits analysis involving**  
19 **reduced cancer risks?**

20  
21 The SAB commends EPA for its effort to develop appropriate values for mortality risk  
22 reductions rather than applying a “one size fits all” value to all cases. As discussed in the  
23 introductory section, theory suggests that VRR depends on characteristics of the risk and the  
24 individual.

25  
26 As noted, charge questions 2 and 3 inquire about the use of benefit-transfer methods.  
27 Charge questions 4 – 7 are also concerned with issues of inferring the appropriate VRR for a  
28 specific application from available studies. As explained in the introductory section, SAB  
29 recommends that EPA work toward developing a set of estimates of VRR for policy-relevant  
30 cases characterized by risk and individual characteristics. There are strong precedents for  
31 applying benefit-transfer methods to analyze non-health benefits of EPA policies. In that context,  
32 as with VRR, analysts confront choices between how much to rely on estimates that are specific  
33 to the application and how much to “borrow information” or extrapolate from estimates that are  
34 less similar to the application. There is no general answer to this problem. The best approach will  
35 be sensitive to the quality and number of available studies that estimate relevant values. In the  
36 case of death from traumatic injury, the set of empirical estimates is rich, including revealed-  
37 preference studies of wage differentials and consumer products (e.g., motor vehicles) and stated-  
38 preference studies of transportation hazards. For other applications, the empirical literature is  
39 much more limited and often includes only stated-preference studies.

40  
41 Given this background, SAB recommends that EPA explore alternative methods to  
42 estimate a distribution of appropriate VRRs for relevant cases (e.g., deaths associated with  
43 exposure to airborne fine particulate matter, fatal cancers associated with exposure to  
44 environmental carcinogens). Below, we suggest four possible methods. It may be appropriate to

1 use different methods for different policy-relevant cases to reflect differences in the number and  
2 quality of relevant studies.

3  
4 One approach would be to develop independent estimates for relevant cases, using only  
5 studies that are closely matched on risk and individual characteristics. This approach may be  
6 useful for some cases but not others, due to the limited coverage of the empirical literature.  
7

8 A second approach would be to develop a baseline distribution of estimates (perhaps for  
9 fatal injury) and a set of adjustment factors for risk and individual characteristics as warranted.  
10 Such adjustment factors might be developed for hazard characteristics (e.g., one or more cancer  
11 differentials appropriate for different types of cancer), individual characteristics (e.g., adjustment  
12 factors for age and income), and program characteristics (e.g., public programs versus private  
13 risk reductions). This approach could incorporate both direct estimates of VRR for different risks  
14 and risk-tradeoff studies that estimate only differentials in VRR between risks. This approach  
15 and the first approach could be informed using formal expert elicitation to identify the studies  
16 that are sufficiently closely matched to the policy context of interest and/or to estimate  
17 distributions of baseline estimates and adjustment factors.  
18

19 A third approach would be to develop a meta-regression model to estimate VRR as a  
20 function of risk and individual characteristics. The historical EPA approach, using the mean of  
21 26 studies, is an example of a meta-regression including only one term (an intercept). This  
22 approach could be extended to include a small number of categorical or indicator variables (e.g.,  
23 for cancer type, age or income categories) and/or a small number of continuous variables (e.g.,  
24 income or its logarithm). It may be appropriate to include variables describing study type  
25 (notably stated or revealed preference) to avoid confounding estimates of risk and individual  
26 characteristics with (poorly understood) effects of study type (at minimum, one should test for  
27 sensitivity to study type). Such a meta-regression can be viewed as a reduced-form or first-order  
28 approximation of a more complicated function relating VRR to risk and individual  
29 characteristics.  
30

31 A fourth approach would be to develop and estimate a structural preference function. An  
32 advantage of this approach is that its structure is consistent with economic theory, and so  
33 extrapolation from existing estimates can be performed with greater confidence (e.g., it may be  
34 possible to develop improved estimates of how VRR depends on the magnitude of the risk  
35 reduction). Moreover, it provides a method for incorporating other types of information, in  
36 addition to estimates of VRR, that are informative about individual preferences regarding  
37 mortality risk reduction. (As described in response to charge question 8, SAB judges that the  
38 structural-preference-function approach requires further development and testing before it should  
39 be relied on as a primary source of VRR estimates.)  
40

41 In evaluating the different approaches, one criterion is the degree of fit between the  
42 resulting estimated distribution for VRR in each specific context and the results from high-  
43 quality studies that estimate VRR for that context directly. A second criterion is the intuitive  
44 plausibility of the pattern of VRR distributions across contexts.  
45

1           In estimating VRRs and how they vary with risk and individual characteristics, the SAB  
2 suggests caution in using results from non-US populations. The effects of individual and  
3 population characteristics on VRRs may be sensitive to health-care and social-welfare programs  
4 and other factors that differ significantly between countries.  
5

6           In response to charge question 2, SAB recognizes that cancer is (after fatal injury) the  
7 risk for which the empirical literature provides the most information. In addition, there are some  
8 estimates of VRR for respiratory and other chronic disease. The SAB concurs with EPA's  
9 judgment that only the studies that compare values for cancer and other risk reductions are useful  
10 for evaluating possible differentials. These include valuation studies of two or more types of fatal  
11 risk and risk-tradeoff studies. Stated- and revealed-preference studies of only one type of risk,  
12 without internal comparison, are not useful because there is too much unexplained variation  
13 between studies to determine how much of the differential is associated solely with risk  
14 characteristics.  
15

16           The SAB believes that the "first-cut" estimate of a 50 percent differential for cancer  
17 should be refined before application. This estimate is justified in the white paper as  
18 approximating the average differential found in nine studies (reported in footnote 14, page 25).  
19 However, no control is made for the fact that different studies evaluate different types of cancer  
20 and compare it against different risks (e.g., injury, other disease) and the differential associated  
21 with the Van Houtven et al. (2008) study is misreported (the proportional WTP is 3 times higher  
22 but the differential is 2). Any quantitative estimate of a cancer differential will be sensitive to the  
23 weight given to the Van Houtven et al. study, which estimates a much larger effect than any of  
24 the other studies. (Note that six of the nine reported studies yield estimates between -0.15 and  
25 +0.30).  
26

27           Finally, in evaluating hazard-specific differentials it is important to distinguish between  
28 differentials that are conditional on characteristics of the illness profile (e.g., duration and  
29 severity of morbidity, latency) and differentials that do not control for these characteristics. In  
30 evaluating values of faster vs. slower deaths (e.g., from injuries vs. cancers), it seems important  
31 to control for whether the period of morbidity extends life or shortens the period of healthy life  
32 (i.e., is the comparison between instantaneous death and manifestation of a fatal disease at the  
33 same time or between instantaneous death and death from chronic disease at the same time?). In  
34 addition, some studies provide information on valuation of different types of cancer, suggesting  
35 that there is no single differential that is appropriate for all cancers.  
36

37           In sum, the SAB suggests that the magnitudes of cancer and other hazard-specific  
38 differentials should be evaluated as part of an integrated process used to estimate the value of  
39 mortality risk reduction and how it varies with risk and individual characteristics, using some of  
40 the methods described above.

1 **Charge Question 3**

2 **Environmental policies generally provide public risk reductions. However, research,**  
3 **particularly stated preference research, provides willingness to pay estimates for both**  
4 **public risk reductions as well as private risk reductions. And, some research indicates that**  
5 **individuals' willingness to pay for public risk reductions may be different than that for**  
6 **private risk reductions. One factor that may contribute to these differences is altruism,**  
7 **which, all else equal, should make values for public risk reductions larger than those for**  
8 **private risk reductions.**

- 9
- 10 **a. Should EPA rely on studies that estimate willingness to pay for both public and**  
11 **private risk reductions? If so, is it sufficient to control for this key characteristic**  
12 **in the modeling framework? Or, should EPA limit the analysis to studies**  
13 **according to the type of risk reduction in the study? If using only one type of**  
14 **study is recommended, should EPA use studies that estimate public or private**  
15 **risk reductions? If we are to limit the studies used to one type, is there a role for**  
16 **the excluded group?**

17

18 As described above, VRR may vary with program characteristics such as  
19 public or private risk reduction. The SAB does not recommend categorically  
20 restricting inference to studies that are only private or only public but exploring the  
21 estimated magnitude of the effect. If the effect is of sufficient magnitude to warrant  
22 accounting for it in economic evaluation of a program, it can be accounted for by  
23 using only studies that are closely matched to the required application or by adjusting  
24 results from other studies.

- 25
- 26 **b. Studies that estimate willingness to pay for public risk reductions may allow**  
27 **EPA to better capture altruistic preferences in benefit-cost analysis. Did the**  
28 **white paper adequately capture the theory on how to incorporate altruism into**  
29 **the value of mortality risk reduction? How should altruistic preferences be**  
30 **treated in benefit-cost analysis? Should the Agency incorporate altruism into**  
31 **the value of mortality risk reductions, even if we are unable to distinguish the**  
32 **specific form of altruism involved (i.e., paternalistic or non-paternalistic)? More**  
33 **generally, what alternatives should the Agency pursue in the short-term to**  
34 **appropriately account for altruistic preferences when evaluating public**  
35 **programs, if any?**

36

37 The white paper does an adequate job of summarizing the literature on altruism  
38 in benefit-cost analysis. Values driven by paternalistic altruism are considered  
39 legitimate in benefit-cost analysis. The literature is clear that pure (non-paternalistic)  
40 altruism, in which the benefactor respects the preferences of the beneficiary, can  
41 result in over-counting benefits. This is because welfare gains that accrue to  
42 beneficiaries, and that are valued by altruists, depend on the net value to beneficiaries.  
43 If beneficiaries were to pay exactly their value for a larger quantity of a public good,  
44 then altruists would receive no altruistic welfare gain. However if beneficiaries paid  
45 less (more) than their value, altruists would receive an altruistic welfare gain (loss). In

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short, pure altruists care about both the benefits received and costs paid by beneficiaries; counting only the altruistic benefits is incorrect.

While the economic literature is clear on how values driven by paternalistic and non-paternalistic concerns should be treated in economic analysis, the state of the art in economic analysis has not evolved to the point of being able to separately measure portions of total value attributable to paternalistic and non-paternalistic altruism. In fact there is little empirical evidence that altruistic concerns are significant drivers of values for risk reduction. At present, the SAB recommends that the Agency make no adjustments for altruistic considerations.

1 **Charge Question 4**

2 **The two primary literatures used to assess willingness to pay for mortality risk reductions**  
3 **are stated preference studies and hedonic wage studies. The white paper assembles two**  
4 **databases summarizing studies in both literatures, capturing much of the information**  
5 **outlined in number 3 of the SAB-EEAC's recommendations dated October 2007 (see**  
6 **section 4).<sup>4</sup> These studies, or a subset thereof, would form the basis of revised guidance in**  
7 **the near term as well as possible future meta-analyses.**

- 8  
9 **a. The selection criteria employed in creating the two data sets are carefully**  
10 **outlined in the paper (see sections 4.1.2 and 4.2.4). Please consider these criteria**  
11 **in answering the following questions:**  
12 **i. Should additional criteria be added to screen studies for inclusion in the**  
13 **datasets? If so, please specify those criteria. Should any criteria be**  
14 **eliminated or modified?**  
15

16 The EPA assembled two databases summarizing stated preference and hedonic wage  
17 studies following the SAB-EEAC's recommendations dated October 2007 (see especially  
18 Section 4). As noted in the charge question, these criteria are intended to be used to identify  
19 appropriate studies for estimating VRR, whether as part of a meta-analysis or using some other  
20 approach. A set of eight criteria was used to select studies included in each database. The  
21 objective of the selection criteria -- to exclude low-quality studies and to ensure applicability to  
22 the US -- should be stated explicitly to ensure transparency and the selection of appropriate  
23 criteria. An additional criterion that should be added is that estimates should be restricted to  
24 those obtained for appropriate risk and population characteristics when that restriction is  
25 appropriate for the approach used to estimate VRR in a particular context (see the discussion of  
26 methods described in response to charge question 2). Below we answer each of the specific  
27 charge questions for each database separately (where appropriate).  
28

29 *Stated Preferences Studies*

30 With respect to stated preference studies, the white paper describes eight selection  
31 criteria. We respond to each:  
32

- 33 (1) Minimum sample size of 100.

34 The SAB believes that setting a minimum acceptable sample size is not a very useful  
35 criterion. Small samples are of concern for two reasons: the precision of the  
36 estimates is likely to be low and the sample is unlikely to adequately represent a  
37 population of interest. With regard to the first point, the relationship between sample  
38 size and precision of the estimated VRR depends on the study design, e.g., for a fixed  
39 sample size, one single-bounded binary-choice valuation question provides less  
40 precision than a double-bounded binary-choice question, which provides less  
41 precision than an open-ended question. (Note that the approaches that provide more  
42 precision may induce more bias and are not necessarily better.) Similarly, choice

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<sup>4</sup> The recommendations included specific features of hedonic wage and stated preference studies that should be identified in the studies.

1 experiments in which respondents make many choices may provide more precision  
2 than contingent-valuation studies in which respondents value only a single good.  
3 These considerations suggest that different minimum sample sizes should be  
4 developed for different types of stated preference (SP) studies, thereby compromising  
5 the simplicity of a sample-size criterion. A conceptually cleaner approach would be to  
6 develop a criterion based on precision of the estimate. The SAB understands that  
7 some SP studies do not report the precision or standard error of their estimates or  
8 information from which this can be approximated. Studies that do not report  
9 quantitative information about the uncertainty in their estimates do not follow  
10 established best research practices and thus are not of adequate methodological  
11 quality for use in determining VRR. Moreover, such studies seem unlikely to meet  
12 other criteria for methodological adequacy, such as providing evidence that the results  
13 can be interpreted as valid estimates of VRR (discussed below).  
14

15 With regard to the second point, studies with small samples often use convenience  
16 samples or other groups that are not representative of the general population. These  
17 studies are likely to be excluded by the second criterion, discussed below. If a study  
18 with small sample size uses a sample that is representative of the population of  
19 concern and provides adequate precision, it should be included in the analysis.  
20

21 (2) Sample frame based on general population.

22 The SAB suggests that the sample frame be the “appropriate population” rather than  
23 the general population, to the extent practicable. The EPA should be clear in its  
24 determination of what the appropriate sample frame is and seek studies that use that  
25 sample frame or can be used to understand how to adjust results that use other sample  
26 frames. For example, if the EPA is seeking to value reductions of risks that are  
27 specific to a particular segment of the population, the study should focus on obtaining  
28 values that are relevant for members of that segment of the population.  
29

30 (3) Conducted in a high-income country.

31 The SAB believes that surveys should ideally be limited to those conducted in the  
32 United States. To the extent that preferences, cultural norms, institutions, and  
33 demographic profiles can affect valuation of risk reductions, and that WTP estimates  
34 reflect such social, cultural and institutional environments, studies based on non-U.S.  
35 populations may provide biased estimates of U.S. values. Indeed, work using similar  
36 stated-preference instruments suggests there are significant differences in patterns of  
37 WTP even between countries as similar as the U.S. and Canada (Alberini et al., 2004,  
38 Cameron et al., 2010).  
39

40 (4) Results based on exclusive dataset.

41 The SAB disagrees with this criterion. In economic research, multiple estimates for  
42 an outcome of interest (in this case, a point estimate of the VSL) are often reported  
43 which are based partially or wholly on overlapping samples. Model uncertainty,  
44 covariate-measurement uncertainty, and interest in heterogeneity of impacts across  
45 subpopulations all lead to varying outcome estimates. Rather than apply a zero

1 weight to the information contained in all but one of the estimates arising from a  
2 single database, or from overlapping databases, the SAB recommends that the EPA  
3 include estimates based on its set of other criteria and take all estimates that meet  
4 those criteria. If possible, EPA should control statistically for within-study  
5 correlations.

6  
7 (5) Written in English.

8 The SAB agrees with this criterion.  
9

10 (6) Provides enough information to calculate a WTP estimate if one is not reported in the  
11 paper.

12 The SAB agrees with this criterion.  
13

14 (7) Provides estimates for willingness to pay (willingness to accept estimates were not  
15 included).

16 The SAB agrees that contingent valuation studies of WTA often yield results that  
17 differ substantially from estimates of WTP. The presence of income effects can  
18 justify some of the difference between these value constructs, as could limited  
19 substitutability of market goods (Hanemann 1991), but the reasons for occasionally  
20 very large divergences are not clear. Thus the SAB recommends that contingent  
21 valuation estimates of WTA should not be used. A second rationale for this advice is  
22 that most environmental policies and regulations do not involve compensating  
23 individuals for environmental damages but rather individual willingness to pay the  
24 costs of policies or regulations that reduce mortality risk.  
25

26 (8) Provides estimates for willingness to pay for risk reductions to adults (estimates for  
27 risk reductions to children are not included).

28 The SAB agrees that estimates of VRR for adults should be based on estimates of  
29 WTP for risk reductions to adults. Of course, the Agency also needs values for  
30 mortality-risk changes for children. VRR estimates for adults should not be  
31 automatically applied for children, so this criterion is not applicable in the case of  
32 children's risks.  
33

34 The SAB recommends an additional criterion: that the stated preference study should  
35 provide evidence that it yields valid estimates of VRR. There are many factors that can influence  
36 responses to a stated-preference survey in ways that cannot be interpreted as consistent with  
37 estimating the theoretical concept of interest. For example, respondents may give answers  
38 consistent with extraordinarily high or low values (e.g., "protest zeros" in open-ended questions).  
39 One form of evidence of validity is showing that the study passes a scope test, i.e., that estimated  
40 WTP increases with the size of the risk reduction that is valued. A weak scope test demands only  
41 that WTP increase in a statistically significant way with the size of the risk reduction; a strong  
42 test demands that WTP be proportional to risk reduction (for changes in mortality risk, economic  
43 theory implies that WTP is nearly proportional to the risk change with deviations occurring  
44 primarily through the income effect (Hammit and Graham 1999, Corso et al. 2001). External  
45 scope tests (that compare WTP between subsamples of respondents) are generally viewed as

1 superior to internal scope tests (that compare WTP within a sample) because respondents could  
2 provide mutually consistent estimates of WTP for different risk reductions even if their response  
3 to the first valuation question is random.  
4

#### 5 *Hedonic Wage Studies*

6 With respect to hedonic-wage studies, the White Paper describes eight selection criteria,  
7 of which four are based on a recently published meta-analysis by Bellavance et al. (2009). The  
8 four based on Bellavance et al. are listed below as criteria (5) through (8). The criteria, and the  
9 SAB's recommendation regarding each criterion, are described in turn below.

- 10  
11 (1) Use a sample size of greater than 100.

12 Sample size is not a significant concern for most wage-differential studies, which  
13 rely on large data sets of workers and actuarial risk estimates based on comprehensive  
14 fatality data. As noted in the discussion of stated-preference studies, sample size per  
15 se is not relevant to study quality or utility. Hedonic wage studies that are based on  
16 other sources (e.g., an original survey of workers) should be evaluated on a case-by-  
17 case basis for precision of estimates and representativeness of the sample.  
18

- 19 (2) Limit selected studies to those conducted in high income countries as defined by the  
20 World Bank.

21 The SAB recommends that the EPA base its analysis only on studies conducted on  
22 U.S. populations. Because hedonic wage equations estimate an equilibrium outcome  
23 based on preferences, demographic distributions and technologies, they will be  
24 unique to each country. Even if incomes are similar across countries, similarity in  
25 other conditions that affect the revealed marginal rates of substitution between risk  
26 and wages are not assured.  
27

- 28 (3) Omit studies based on the Society of Actuaries risk data.

29 The SAB agrees with this criterion. Charge Question 4a.ii. relates to this criterion  
30 and further comments are given in response to that charge question.  
31

- 32 (4) Omit studies that focused on extremely dangerous jobs (e.g., police).

33 The SAB agrees this is a reasonable criterion because the population included in these  
34 studies is not representative of the population affected by EPA regulations. Should  
35 there be a case where the EPA is evaluating extreme risks to a well-defined  
36 population, research concerning the risk preferences of that population would be  
37 relevant.  
38

- 39 (5) Retain only studies which employ a model specification "similar to that given" ( $\ln(w_i)$   
40  $= X_i\beta + \phi\rho_i + \mu_i$ ).

41 The SAB disagrees with this criterion if it is applied exactly as the White Paper  
42 suggests (that only cross-section OLS regressions are included in the database). For  
43 example, the criterion would imply that estimates based on panel data, instrumental  
44 variable, or quasi-experimental methods would be excluded. The SAB recommends  
45 that all estimates arising from conceptually sound methods be included.

- 1  
2 (6) Exclude studies based on specific cause of death.  
3 This criterion is appropriate when the goal is to provide an estimate of the value of  
4 reducing risks of workplace accidental deaths. The SAB notes, however, that the  
5 EPA should recognize that even within the context of accidental deaths, there is a  
6 great deal of heterogeneity (e.g., falls versus electrocution). The literature often  
7 aggregates these into a single measure of fatality risk but some new studies attempt to  
8 distinguish values by these risk characteristics (e.g., Scotton and Taylor, 2011).  
9  
10 (7) Exclude studies which use the same underlying sample of workers as other studies. In  
11 other words, if multiple VSL estimates are reported based on the same underlying  
12 survey sample for stated preference studies or the same worker sample for hedonic  
13 wage studies, prior recommendations suggest that only one VSL estimate from a  
14 given sample be incorporated into the meta-analysis.  
15 The SAB agrees that this approach is desirable when conducting meta-analyses of  
16 clinical trials to describe efficacy of a treatment on a health endpoint, but it is not a  
17 desirable approach for meta-analyses applied to economic research. As noted above  
18 for stated preference studies, in economic research, multiple estimates for an outcome  
19 of interest (in this case, an estimate of VRR) are often reported which are based  
20 partially or wholly on overlapping samples. Model uncertainty, covariate-  
21 measurement uncertainty, and interest in heterogeneity of impacts across  
22 subpopulations all lead to varying outcome estimates. Rather than apply a zero  
23 weight to the information contained in all but one of the multiple estimates, the SAB  
24 recommends that the EPA select observations for inclusion in the meta-data set or  
25 other applications based on its set of other criteria and include all estimates that meet  
26 those criteria.  
27  
28 (8) Exclude studies failing to report enough information to calculate the value of  
29 mortality risk reductions and/or the average probability of death.  
30 The SAB agrees with this criterion.  
31

32 *Additional comments:*

33 The EPA should consider adding the following criteria:

- 34  
35 (a) Hedonic-wage regressions should include a measure for nonfatal-injury risk, or at  
36 least provide evidence concerning the sensitivity of the estimated value of mortality  
37 risk to inclusion/exclusion of nonfatal risks.  
38  
39 (b) Hedonic-wage regressions should include an appropriate level of industry and  
40 occupational control variables to address the problem of unobserved job  
41 characteristics that often exists in these studies. Panel models that control for  
42 unobserved worker characteristics do little to alleviate this problem when the risk  
43 variable is constructed in such a way that it varies only by occupation and industry of  
44 the worker. Estimates from models that convincingly address unobserved job and

1 worker characteristics using the best methods available and appropriate for the data  
2 are preferred.

- 3  
4 (c) Eliminate any study that relies on risk measures constructed at the industry level only  
5 (not by occupation within an industry), even if the source of the risk data is the  
6 Census of Fatal Occupational Injuries (CFOI). For example, Smith, et al. (2004) use  
7 risks that vary only by industry of the worker. While there has not been direct  
8 evidence of the degree to which this practice introduces measurement error of the  
9 type discussed by Black and Kneisner (2003) and Black, Galdo and Liu (2003), it  
10 would seem likely to introduce important measurement error.  
11  
12 (d) Include only estimates that are based on an appropriate sample frame or can be used  
13 to adjust the sample frame for the policy context. This criterion follows the  
14 suggestion for criterion (2) for stated preference surveys.

15 **ii. Section 4.2.2 of the white paper discusses problems of measurement error**  
16 **associated with some common sources of occupational risk information**  
17 **among other concerns with the hedonic wage approach. Should EPA limit its**  
18 **selection of hedonic wage studies by the source of occupational risk**  
19 **information? For instance, studies relying on data from the Society of**  
20 **Actuaries (SOA) have been omitted from the described data set. Should the**  
21 **SOA studies be excluded? Should other sources be excluded as well?**  
22

23 EPA should exclude hedonic-wage studies that do not use adequate risk data. The quality  
24 of the risk estimates is critical to wage-differential estimates of VRR and there have been  
25 substantial improvements in risk data over time. The SOA data are not conceptually appropriate  
26 because they include deaths from non-occupational risks, for which no wage differential would  
27 be expected. Prior to 1992, Bureau of Labor Statistics (BLS) workplace fatalities were survey  
28 estimates, which the National Academy of Sciences had questioned due to the high rate of  
29 sampling errors.<sup>5</sup>  
30

31 Several sources provide additional details on the difficulties with past risk estimates.  
32 Drudi (1997) describes problems in constructing valid risk estimates. Black, Galdo and Liu  
33 (2003) and Black and Kneisner (2003) provide a critique of the previous risk measures and  
34 illustrate the unreliability of study estimates using these measures. Leigh (1995) highlights the  
35 issue of measurement error when using risk data that vary only by industry or by occupation of  
36 the worker. Viscusi (2004) finds that estimates of the value of mortality risk using estimates of  
37 risk by industry and occupation are roughly half as large as estimates using estimates of risk by  
38 industry.  
39

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<sup>5</sup> For example, the BLS estimated there to be 2,900 workplace fatalities in 1990 while the National Safety Council estimated 10,500 and the National Institute of Occupational Safety and Health estimated 5,500 (not including Connecticut and New York and using only death certificates, which Drudi (1997) reports identify as few as 35% of workplace deaths).

1           Lastly, there has been a steady decline in overall numbers of workplace deaths since  
2 1970. The labor force has shifted from manufacturing to service-oriented industries and  
3 exposures in the workplace have changed over time. Currently up to 15% of workplace deaths  
4 are homicides. The reliance on flawed data that are not representative of current conditions is  
5 not defensible.

6  
7           In summary, all studies that rely on data of lower quality than the CFOI should be  
8 excluded.

9  
10           **b. Should any of the studies included in the datasets be eliminated? If so, please**  
11           **specify those studies and the reasons for eliminating them.**

12  
13           *Stated Preference Studies*

14           The SAB prefers not to endorse or exclude specific studies. The appropriate strategy will  
15 be to consider the (revised) criteria recommended above and to revisit the database of studies  
16 with these criteria in mind.

17  
18           The SAB emphasizes that the studies used should adhere to best practices. The quantities  
19 being estimated should correspond to a theoretically sound microeconomic construct (i.e., based  
20 on the theory of consumer choice) that measures an appropriate concept of value. In general,  
21 these measures will involve marginal rates of substitution. Ideally, this marginal rate of  
22 substitution is between a specified risk reduction and money, which yields an estimate of  
23 willingness to pay for that risk reduction. However, risk-risk tradeoffs can also be expressed as  
24 marginal rates of substitution between risks. In combination with appropriate studies that  
25 produce marginal rates of substitution between one of the risks in such a pair and money, it may  
26 be possible to use risk-tradeoff information to calculate willingness to pay for the other risk.

27  
28           *Hedonic Wage Studies*

29           All studies not based on the U.S. workforce, not based on risk data of comparable or  
30 superior quality to the CFOI data, and not adhering to the other criteria discussed above should  
31 be excluded. The first two criteria eliminate all studies prior to Viscusi (2004). Additional  
32 criteria as discussed for 4.a. should be developed and studies after 2003 should be evaluated on  
33 these terms.

34  
35           **c. Is the committee aware of relevant empirical studies in the stated preference and**  
36           **hedonic wage literatures that are not adequately captured in this review? If so,**  
37           **please provide citations.**

38  
39           It is important that the EPA include the “grey literature” in its assembly of the two  
40 databases. Unpublished manuscripts, reports, dissertations, and other non-refereed materials  
41 should be evaluated based on the same criteria as the peer-reviewed publications. Meta-analytic  
42 methods specifically encourage inclusion of the grey literature to avoid “publication bias” (see  
43 Bergstrom and Taylor, 2006.). Should the EPA wish to go further than simply applying the  
44 criteria developed for the published literature, it could develop a two-stage process in which it

1 first solicits peer review of unpublished manuscripts and then applies its criteria to those studies  
2 that peer reviewers suggest are consistent with the quality of similar published work.

3  
4 Other studies to consider:

5 *Stated Preference Studies*

- 6 Bosworth, Cameron, and DeShazo (2010).
- 7 Cameron, DeShazo, and Stiffler (2010).
- 8 Cameron, DeShazo, and Johnson (2010a).
- 9 Cameron, DeShazo, and Johnson (2010b).
- 10 DeShazo and Cameron (2005a).
- 11 DeShazo and Cameron (2005b).

12  
13 *Hedonic Wage Studies*

- 14 Evans and Schaur (2010).
- 15 Evans and Smith (2006).
- 16 Kniesner, Viscusi, Woock, and Ziliak (2010).
- 17 Kochi and Taylor (2010)
- 18 Scotton (2010)

19  
20  
21  
22

1 **Charge Question 5**

2 **Income elasticities are discussed briefly in section 5 of the white paper. In keeping with**  
3 **Agency practice, we created the two databases by adjusting all estimates for income growth**  
4 **over time using an income elasticity value of 0.5 based on prior Agency reviews of the**  
5 **literature and results Viscusi and Aldy, 2003. In addition, we adjusted all estimates for**  
6 **inflation as well as for purchasing power parity where necessary, as recommended by the**  
7 **EEAC's October 2007 report. Does the Committee agree with this approach to accounting**  
8 **for income growth over time?**

9  
10 The question of how to adjust estimates of VRR before combining them in a meta-  
11 analysis is distinct from the question of how to adjust for use in policy analysis (discussed  
12 below). For meta-analysis, the SAB suggests that EPA not adjust VRR estimates for income  
13 growth but explore more flexible methods for understanding the effects on VRR of (a) the time  
14 period to which the data pertain and (b) the average sample income.

15  
16 **Does the Committee believe the Agency should adjust its value of income elasticity for use**  
17 **in policy analysis in light of recent findings in the literature?**

18  
19 Intuition, economic theory, and empirical estimates all suggest that VRR should increase  
20 with income, and so EPA should adjust for changes in income in evaluating benefits of risk  
21 reduction. It is likely that the income elasticity of VRR, like VRR itself, may vary with risk and  
22 individual characteristics.

23  
24 The literature on VSL income elasticity has employed several approaches and produced a  
25 wide range of results, including cross-section analysis of within-sample variation in CV data,  
26 meta-analysis of hedonic-wage studies, longitudinal analysis of hedonic-wage data for a  
27 particular population, and quantile analysis of hedonic-wage data. Estimates obtained from  
28 cross-section analysis of CV data range between 0.1 and 1.0 while longitudinal-study estimates  
29 range between 1.3 and 3.0. Quantile analysis yields elasticity estimates of 2.2 for the lowest  
30 decile of income and 1.2 for the highest decile of income.

31  
32 Consistent with its recommendations on VRR, the SAB recommends that EPA attempt to  
33 characterize the distribution of income elasticity and how it varies with risk and individual  
34 characteristics using one or more of the approaches described for characterizing VRR.

35  
36 **If so, what value or range of values does the Committee believe should be used?**

37  
38 See previous response.  
39

1 **Charge Question 6**

2 **The white paper describes a simplified approach for updating the Agency’s recommended**  
3 **mortality risk value estimate(s) (see section 5.1.1). This approach involves fitting a**  
4 **parametric distribution to the set of estimates from selected studies. This is similar to the**  
5 **approach used for EPA’s current default VSL estimate.**

- 6  
7  
8 **a. Should EPA pursue this approach for updating its mortality risk valuation guidance**  
9 **in the near term (until a more detailed analysis can be conducted)?**

10  
11 The SAB recommends that EPA explore some of the methods proposed above for  
12 estimating a distribution of VRR for relevant cases. Whichever method is used for a  
13 particular application can be updated over time. If it is not possible to develop an  
14 appropriate VRR for a particular case within the allowable time, placeholder estimates  
15 and sensitivity analysis may have to be used, but if this is done, it should be made clear  
16 how the policy context differs from the contexts within which the available WTP  
17 estimates have been measured and what assumptions are required to transfer benefit  
18 estimates to the policy context.

- 19  
20 **b. If so, should the databases on which values are based be created using only one**  
21 **estimate drawn from each study or multiple estimates from each study?**

22  
23 In general, it will be appropriate to include multiple estimates from each study  
24 (see response to charge question 4).

- 25  
26 **c. If only one estimate per study should be used, what criteria should the Agency apply**  
27 **in selecting the appropriate estimate? How would these criteria vary from one**  
28 **segment of the literature to the other? The paper describes the methods used to**  
29 **select independent estimates from each study. Does the Committee agree with the**  
30 **methods used?**

31  
32 Not relevant (see charge question 6b).

- 33  
34 **d. How important is it that estimates be drawn from non-overlapping subsamples? If**  
35 **multiple estimates per study are recommended in the construction of the meta-**  
36 **datasets, should the estimates be selected to avoid overlapping sub-samples?**

37  
38 Not relevant (see charge question 6b).

- 39  
40 **e. Does the Committee still favor analyzing the stated preference and hedonic wage**  
41 **estimates separately? If so, how should the separate results of these analyses be used**  
42 **in evaluating new policies? If not, how should they be combined in a single analysis?**

43  
44 The effects of risk and individual characteristics on VRR may be more important  
45 than the distinction between stated preference (SP) and revealed preference (RP) studies.

1           However, wage-differential studies and SP studies seem to yield systematically different  
2 estimates, even for reasonably similar risks (e.g., traffic fatalities). The reasons for this  
3 difference are not well understood.  
4

5           In evaluating how VRR varies with context, it may be necessary to distinguish SP and  
6 hedonic wage estimates to avoid confounding effects of risk or individual characteristics with  
7 study type. This does not imply that the two literatures must be treated independently. Indeed, to  
8 the extent that each literature provides useful information about the VRR in a particular context,  
9 or the variation of VRR between contexts, it is important to combine their results. Results from  
10 risk-tradeoff studies can provide useful information and should be considered for inclusion as  
11 well. Results from these literatures can be combined using some of the methods described in  
12 response to charge question 2. In addition, even though wage-risk studies may not address the  
13 types of illness profiles that are relevant to EPA policy contexts, these studies are vitally  
14 important for validation of relevant SP studies. Hedonic-wage estimates may bench-marked  
15 against the “sudden death in the current period” illness profile when this particular profile is  
16 covered by both types of studies. Consistency between SP and best-practices RP studies, for  
17 comparable types of risks and populations, will remain an important criterion for cross-validation  
18 of the estimates from SP studies. (Validation is more difficult for domains of SP studies which  
19 are not overlapped by available RP studies.)  
20

21           That said, it is important to acknowledge that poorly designed SP studies will continue to  
22 be plagued by all of the potential problems with SP research that have been identified over the  
23 years. As a generalization, many economists who have not invested in reading the stated  
24 preference literature are skeptical about SP as a class of research, preferring to reject all research  
25 in this class rather than to make the effort to learn how to discriminate between better and worse  
26 SP evidence. Those familiar with the literature are more likely to be of the opinion that a noisier  
27 estimate of the right construct may be preferable to a more precise estimate of the wrong  
28 construct—this is the familiar tradeoff between bias and efficiency. The Agency should help  
29 researchers identify the specific types of policy contexts for which better WTP estimates are  
30 most needed. Then researchers can focus on developing WTP estimates that are both more  
31 precise and less biased. The Agency can continue to encourage useful research by being very  
32 clear about the nature of the particular illness profiles that are most relevant to important  
33 environmental policy contexts and by persistently pointing out the deficiencies in the available  
34 WTP estimates.  
35

36           As noted above, there is scope for using studies of risk tradeoffs, despite the absence of  
37 WTP estimates in these studies, to translate RP estimates of WTP to reduce the risk of fatal  
38 workplace accidents into WTP to reduce other types of risks. Of course, estimation errors would  
39 have to be compounded across these two stages.  
40

- 41           **f. Would the Committee support the development and application of separate means**  
42 **or ranges generated from the two segments of the literature? Given separate means**  
43 **and/or ranges from each segment, should the results be weighted and combined to**  
44 **produce a single point estimate or range? If so, how? Are other presentations of the**

**1 results preferable? More generally, how should uncertainty in the estimated value(s)  
2 of mortality risk reductions be handled in benefits analyses?  
3**

4 The use of weighted averages of individual point estimates is only appropriate if these  
5 point estimates measure the same thing. Recent research highlights heterogeneity in WTP for  
6 risk reductions, as a function of both the type of risk to be reduced and the characteristics of the  
7 affected population. If multiple estimates are available for the same context, then these can be  
8 averaged, and it is appropriate to consider some sort of weighting scheme that reflects the  
9 relative precision of the different point estimates.

10  
11

1 **Charge Question 7**

2 **We are interested in developing a standardized protocol for updating the Agency’s**  
3 **recommended mortality risk value estimates on a regular basis—for example, every 5 years**  
4 **or so—to incorporate new estimates from relevant economic valuation studies as they**  
5 **appear in the literature. Such a protocol might be based on the approach outlined in**  
6 **Section 5.1.1 or something similar. This approach, combined with a set of rigorous criteria**  
7 **for determining which new studies and value estimates are suitable for inclusion in the pool**  
8 **for meta-analysis, would allow the Agency to update its guidance in a more timely and**  
9 **transparent manner. (After a working protocol was put in place, it then could be modified**  
10 **over time to match changes in the Agency’s general mortality risk valuation approach and**  
11 **meta-analysis methods, as necessary. See charge question 8.) Does the committee believe**  
12 **that developing such a protocol is feasible and desirable? Please explain.**

13  
14 The SAB believes that the Agency should establish a regular schedule for updating its  
15 value of risk reduction (VRR) estimates. The central-tendency estimate that the agency currently  
16 uses is based on studies that are at least 20 and in some cases over 35 years old. Several of the  
17 studies included in the current pool would likely be disqualified from consideration in the future  
18 as a result of the criteria for qualifying studies recommended by the Agency in the White Paper  
19 and further criteria recommended by the SAB in response to charge question 4. Moreover, the  
20 current estimate does not take into consideration the wealth of new studies published over the  
21 last 20 years that make use of better techniques and better data. To avoid using VRR estimates  
22 based on decades-old and possibly obsolete research in the future, the Agency should establish a  
23 protocol for updating regularly the estimates of the value of risk reduction that it uses in its work.  
24

25 The protocol should include a procedure for updating all of the information needed to  
26 construct the value of risk reduction. This should include the following:

- 27 • Identification of recent additions to the literature on valuing risk reductions,  
28 particularly related to mortality risk, as well as studies that provide new estimates of  
29 the income elasticity of the value of risk reduction.
- 30 • Assessment of the quality of those studies and the estimates contained therein  
31 according to criteria established by the agency, as discussed above. Studies that do  
32 not meet these criteria should be excluded from consideration.
- 33 • The estimates of risk reduction gleaned from the set of qualified studies should be put  
34 into comparable real dollar terms using appropriate income elasticity and inflation  
35 adjustments.
- 36 • The procedure for combining estimates should be in line with the recommendations in  
37 response to charge questions 2, 6 and 8.
- 38 • All of these procedures should be adaptable to take account of new information and  
39 the results of new research that might enable the Agency to employ a new  
40 methodology for updating its VRR estimates, such as through developing and  
41 parameterizing a structural benefit transfer model.

42  
43 Updates of the Agency’s estimates should be performed on a regular schedule in order to  
44 take advantage of new research as it becomes available. The exact timing of these updates will

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1 depend on the supply of new studies, the availability of Agency resources to devote to the task  
2 and the nature of the review process for new estimates that the agency develops. The supply of  
3 research on valuing risk reductions has been growing in recent years as has the pace with which  
4 new studies are appearing and the Agency can have some influence on that supply through its  
5 research funding activities. While the supply of new research on this topic may be growing  
6 sufficiently fast to warrant annual updates of the VRR estimate, the requirements for review of  
7 new estimates produced by the Agency by the Scientific Advisory Board may make it desirable  
8 from the Agency's perspective to update on a less frequent basis, say every 2 or 3 years, or even  
9 5 years at the outside. All of these update schedules are a vast improvement over prior practice.

10  
11 Regular updates of the value of risk reduction will require an education process to make  
12 legislators, administration officials, and the general public aware that estimates of the values of  
13 risk reductions are not static. They can be expected to evolve over time as data are improved and  
14 methods are refined. Change in the terminology used should assist in this regard, but in  
15 conjunction with its efforts to educate the public about the change in terminology, EPA should  
16 also take care to inform people about its plans for updating these values and provide information  
17 on why this is necessary and important.

1 **Charge Question 8**

2 **In addition to the short-term issues that underlie charge questions 1-7, we are interested in**  
3 **supporting and conducting additional research to further develop EPA’s health risk**  
4 **valuation methods over the longer-term. In particular, we would like to begin the**  
5 **transition from the point value transfer approach to a benefit function transfer approach.**  
6 **With this longer-term research and guidance development objective in mind, please answer**  
7 **the following questions:**

- 8 **a. Should EPA continue to use its current approach—that is, a point value or range**  
9 **of values, possibly with an adjustment for cancer risks—or is there now a**  
10 **sufficient body of empirical research to support the development of a more**  
11 **detailed form of functional benefit transfer?**

12  
13 As described above, the SAB recommends that EPA work toward developing  
14 a set of estimates of VRR for policy-relevant contexts (defined by risk and population  
15 characteristics), together with appropriate characterization of uncertainty about these  
16 estimates. The body of empirical research is clearly sufficient to estimate values for  
17 occupational accidents and may allow estimation of VRR for some other contexts  
18 (e.g., certain types of cancer and of respiratory or heart disease). VRR can also be  
19 distinguished by income and perhaps some other individual characteristics.

- 20  
21 **b. If a functional transfer approach is feasible given the existing body of empirical**  
22 **results, should this be based on a meta-analysis or a calibrated structural**  
23 **preference function or perhaps some hybrid of these?**

24  
25 Alternative methods for characterizing the distribution of VRR and how it  
26 varies with risk and individual characteristics are discussed above (in response to  
27 charge question 2). The SAB recommends that EPA attempt to apply some of these  
28 approaches and evaluate the quality of the results for consistency with VRR estimates  
29 in particular contexts and for the plausibility of the pattern of results across contexts.

30  
31 Moving toward a structural preference function appears to be desirable. It  
32 would provide an integrated, consistent framework for understanding how individuals  
33 trade off risks against consumption and income. By doing so, it would provide a  
34 stronger theoretical foundation for the benefit transfer task commonly faced by EPA:  
35 using data on relatively well-studied risks, such as sudden accidental death, to infer  
36 willingness to pay for reductions in other risks. Moreover, as noted by Smith et al.  
37 (2006), a structural approach may allow additional data on other aspects of individual  
38 choice to be brought to bear on the problem. It may also provide a rigorous means for  
39 incorporating the results of risk-tradeoff studies which provide valuable information  
40 but are difficult to include in traditional calculations of willingness to pay for risk  
41 abatement.

42  
43 Although a structural approach would provide many benefits, additional  
44 research is needed. For example, the existing literature has used a small number of  
45 restrictive functional forms. Before the structural approach will be ready for routine

1 use, the effect of these restrictions must be investigated and the restrictions relaxed  
2 where possible. EPA should regard the structural approach as a high priority for  
3 research and an important long-term goal, but not yet as a replacement for traditional  
4 methods.

- 5  
6 **c. If the body of empirical literature is sufficient to estimate or calibrate some form**  
7 **of structural preference function, what are the key variables that should be**  
8 **included in such a function? That is, based on a priori theoretical considerations**  
9 **and previous empirical findings, which attributes of the affected individuals and**  
10 **the policy scenario should be included? What specifications are feasible given**  
11 **data availability?**

12  
13 As noted above, the theoretical and empirical literature on the structural  
14 approach is promising, but still at an early stage of development. The literature is not  
15 yet sufficient to estimate an authoritative model. As a research matter, a key initial  
16 consideration will be whether to formulate the model in terms of the attributes of risk  
17 (latency, morbidity, dread, etc.) or in terms of specific risks (cancer, heart disease).  
18 The former approach would be more versatile but the latter approach is likely to be  
19 more tractable in the short run. In research currently under review, for example,  
20 Cameron, DeShazo and Johnson (2010b) use both types of controls. Their stated  
21 preference conjoint choice study includes both the nature of the illness profile  
22 corresponding to a particular named health risk and the respondent's assessment of  
23 their personal subjective risk of the illness in question as well as their subjective  
24 impressions of the controllability of that type of risk.

- 25  
26 **d. Have the econometric issues we identified (unobserved heterogeneity,**  
27 **heteroskedasticity, and small sample size) been adequately addressed by the**  
28 **recent meta-analyses reviewed in Sections 4.1.1 and 4.2.3? Would the classical**  
29 **approaches that we suggest for overcoming these data limitations improve upon**  
30 **previous work? If a new meta-analysis is conducted, what statistical**  
31 **approach(es) would be preferred?**

32  
33 The econometric techniques that should be used in a meta-analysis will  
34 depend on the number of VRR estimates to be drawn from each study and the total  
35 number of observations available in the meta-analysis. For example, to be feasible,  
36 fixed effects estimators require a sufficient number of observations from each study.  
37 Random effects estimators assume that covariates in the model are uncorrelated with  
38 the error term, which may be reasonable under some circumstances but not others.

- 39  
40 **e. What role, if any, does the Committee believe that the life-cycle consumption**  
41 **and mortality risk framework could play in evaluating health risk reductions?**  
42 **In particular, does the Committee believe that this framework could be used as a**  
43 **foundation for some form of structural benefit transfer function?**  
44

1                   A life-cycle consumption model can be particularly useful for helping to  
2 understand how individuals vary risk reductions at different stages of the life-cycle,  
3 which is applicable to valuing risks that are most prevalent for different ages and for  
4 evaluating effects of latency. Results of life-cycle models can be highly sensitive to  
5 parameters such as discount rates. Using data from stated preference and hedonic  
6 wage studies to parameterize a life-cycle model is an ambitious task. It faces all of  
7 the difficulties noted above for structural preference approach but in an even more  
8 complex form. Allowing utility functions to be age-dependent and to depend on risk  
9 characteristics in a manner that varies with age will be difficult. It is also true that the  
10 standard life-cycle model assumes people are expected utility maximizers, which may  
11 not be a valid assumption. Before pursuing this approach EPA should evaluate the  
12 literature that has estimated life cycle models for the purpose of understanding  
13 savings and retirement decisions. An important question is how well these models  
14 have worked in that context.  
15

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