Revised Departmental Guidance:

Treatment of the Value of Preventing Fatalities and Injuries in Preparing Economic Analyses

This guidance raises to $5.8 million the value of a statistical life to be used by analysts in the Department of Transportation when assessing the benefit of preventing fatalities.

Background

Executive Order 12866 requires agencies to examine the costs and benefits of both proposed and final regulatory actions. DOT administrations promulgate rules to enhance safety and protect the environment, for which the monetary value of preventing injuries and loss of life must be estimated among the benefits. Administrations also undertake investments and administrative actions that must be evaluated in terms of their safety benefits.

The benefit of preventing a fatality is measured by the Value of a Statistical Life (VSL), defined as the value of improvements in safety that result in a reduction by one in the expected number of fatalities. Estimates of VSL are derived from the concept of individual willingness to pay (WTP) for small reductions in risk. Several alternative techniques are available to estimate VSL, including both stated preference (based on verbal responses) and revealed preference (based on observed employment or consumption decisions). Economists surveying the research literature have been compelled to synthesize individual studies from different locations and time periods that have yielded divergent results. Recently, the secondary statistical technique of meta-analysis has supplemented primary research, replacing expert judgment or simple averages to derive most likely parameters from earlier studies that differ in methodology, date, and location. Synthesis of primary studies by any method requires the use of scaling parameters to allow for differences in original incomes and price levels.

Research into these values has been pursued for a generation, and estimating techniques, model specifications, and sources of data have continued to evolve. Nevertheless the uncertainty of estimates has not been substantially reduced. Although it is important for agencies to adopt consistent policies, officials should recognize the essentially subjective quality of VSL and of the decisions for which it is employed. The standard we are adopting may be seen as a central tendency, but there can be no assurance that the assumption of higher or lower values would not improve the net benefits of decisions. Therefore, examination of a range of alternative values must be regarded as an essential component of the analytical process.

The Office of Management and Budget in Circular A-4, issued on September 17, 2003, endorses values between $1 million and $10 million, drawing on two journal articles and the analysis of EPA's Science Advisory Board. Other studies that have been published in peer-reviewed journals tend to fall within this range, but the probability of higher or lower values is not negligible. Since its 2002 annual Report to Congress on the Costs and

Benefits of Federal Regulations, OMB has used a standard of $5 million as the benefit of a fatality averted, when agencies have not supplied a different measure.[1] FDA and CPSC have long used this value. OMB has advised us, however, that the practices of other Federal agencies are consistent with higher values. According to OMB, the Food and Drug Administration "tends to use $5 million or $6.5 million, usually both," when conducting a sensitivity or uncertainty analysis. EPA has used values as high as $7 million in some analyses, and OMB states that the Department of Labor, including OSHA and the Mine Safety Health Administration, "follows the lead of EPA. Two of their recent analyses used $6.8 million." More recently, in its "Regulatory Impact Analysis for the Final Clean Air Visibility Rule" of June 2005, EPA employed a standard of $5.5 million in 1999 dollars, the mid-point of the range recognized by OMB.[2] The Department of Agriculture has recently used a range of $5 - $6.5 million in rulemaking, and OMB expects it to use this range in future analyses.

On January 8, 1993, we published a VSL of $2.5 million as guidance to the operating administrations for estimating the benefits of regulations and investments in safety.[3] This estimate has been adjusted for inflation by the implicit price deflator for GDP, most recently on January 29, 2002, yielding the current recommended value of $3.0 million in 2001 dollars. Its principal empirical basis, a survey by Ted R. Miller, which yielded a likely VSL of $2.2 million in 1988 dollars, has not been revised.[4] Additional information was obtained from a study by W. Kip Viscusi, who found most estimates to be clustered in the range of $3 million to $7 million.[5] The body of research surveyed was essentially identical to that reviewed by Miller. While Miller excluded 18 studies he considered methodologically invalid (out of 65) and attempted to correct for biases in an additional 15, Viscusi made no such adjustments and did not recommend a single value.

A major meta-analytical study was published by Viscusi with Joseph E. Aldy in 2003 estimating a median value of about $7 million 2000 dollars.[6] Mrozek and Taylor obtained lower VSL estimates of $1.5 to $2.5 million in 1998 dollars.[7] The range of $1 to $10 million cited by OMB was derived by EPA from these studies.[8] In 2000, Miller

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[1] See http://www.whitehouse.gov/omb/inforeg/regpol-reports_congress.html .

[2] See http://www.epa.gov/oar/visibility/pdfs/bart_ria_2005_6_15.pdf

[3] See http://ostpxweb.dot.gov/policy/Data/VSL93guid.pdf .

[4] Miller, T. R. (1990): "The Plausible Range for the Value of Life – Red Herrings among the Mackerel." *Journal of Forensic Economics*, 3, 17-40.

[5] Viscusi, W. Kip (1993): "The Value of Risks to Life and Health." *Journal of Economic Literature*, 31, 1912-46.

[6] Viscusi, W. Kip, and Joseph E. Aldy (2003): "The Value of a Statistical Life: A Critical Review of Market Estimates Throughout the World." *Journal of Risk and Uncertainty*, 27.1, 5 – 76. Draft at: http://yosemite.epa.gov/ee/epa/eermfile.nsf/vwAN/EE-0483-09.pdf/$File/EE-0483-09.pdf.

[7] Mrozek, Janusz R. and Laura O. Taylor (2002): "What Determines the Value of Life? A Meta-Analysis." *Journal of Policy Analysis and Management*, 21.2 253-270. Draft at: http://www2.gsu.edu/~ecolot/docs/meta.pdf.

[8] "The distribution of VSL is characterized by a confidence interval from $1 to $10 million, based on two meta-analyses of the wage-risk VSL literature. The $1 million lower confidence limit represents the lower end of the interquartile range from the Mrozek and Taylor (2002) meta-analysis. The $10 million upper confidence limit represents the upper end of the interquartile range from the Viscusi and Aldy (2003)

published a meta-analysis drawing on 68 studies he considered sound, including the original 47.[9] Miller's best estimate for VSL in the United States is $3.67 million in 1995 dollars. In 2004, Viscusi published a primary research study, based on wage premiums for increased job risks. This work, which used data from the BLS Census of Fatal Occupational Injuries, generated a VSL estimate for the full sample of $5.0 million in 2000 dollars.[10] A 2003 meta-analysis by Kochi *et al.* produced a mean estimate of $5.4 million in 2000 dollars.[11] (Studies by Bowland and Beghin[12] and Liu, Hammitt, and Liu[13] focused primarily on other countries.)

Revision of DOT VSL Standard

DOT's previous method of updating VSL has imparted a downward bias over time for two reasons. First, the implicit GDP price deflator, an index of costs throughout the economy, has been used to adjust for inflation, while the Consumer Price Index more appropriately reflects individuals' standard for comparing values corresponding to WTP.[14] Second, there has been no adjustment for growth in real incomes, but research indicates that as people grow richer they are willing to pay more for safety. Estimates of income elasticity are based on studies conducted in several countries at different times, so that the incomes reflected in meta-analyses have multiple sources. The impact of differences between countries in per-capita income levels may not be identical to that of income growth over time in a single country. Although Miller (2000) focuses his meta-analysis on international comparisons (estimating a range of income elasticity from 0.92 to 1.00), he notes that three within-country studies yielded respective income elasticities of: near unity, 0.37 to 0.46, and 0.3 to 0.6. He suggests that the income elasticity of VSL between countries may be larger than within countries because the same cultural norms affect both rich and poor in a given community. Viscusi and Aldy obtain point estimates between 0.5

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meta-analysis." *Benefits of the Proposed Inter-State Air Quality Rule*, EPA 452-03-001, January 2004, cited in "Value of Statistical Life Analysis and Environmental Policy: A White Paper" (April 21, 2004) http://yosemite.epa.gov/ee/epa/eermfile.nsf/vwAN/EE-0483-01.pdf/$File/EE-0483-01.pdf.

[9] Miller, T. R. (2000): "Variations between Countries in Values of Statistical Life." *Journal of Transport Economics and Policy*, 34, 169-188.

[10] Viscusi, W. Kip (2004): "The Value of Life: Estimates with Risks by Occupation and Industry." *Economic Inquiry*, 42.1, 29-48. http://www.law.harvard.edu/faculty/viscusi/pubs/245_2004_EI-42-1.pdf.

[11] Kochi, Ikuho, Bryan Hubbell, and Randall Kramer (2003): "An Empirical Bayes Approach to Combining and Comparing Estimates of the Value of a Statistical Life for Environmental Policy Analysis." *Environmental and Resource Economics*, 34.3, July 2006. Draft at: http://www.epa.gov/air/sect812/appendixh51203.pdf.

[12] Bowland, B. J. and J. C. Beghin (2001): "Robust Estimates of Value of a Statistical Life for Developing Economies: An Application to Pollution and Mortality in Santiago." *Journal of Policy Modeling*, 23, 385-396.

[13] Liu, J., J.K. Hammitt, and J. Liu (1997): "Estimated Hedonic Wage Function and Value of Life in a Developing Country." *Economic Letters*, 57: 353-358.

[14] Thus, for example, in Circular A-4, OMB instructs analysts to use the GDP deflator to express monetized social benefits and costs in dollars of the same year. In deriving the social rate of time preference from the behavior of the average individual saver, however, it compares the rate of return on treasury notes with the annual growth in the CPI.

and 0.6 in a more comprehensive review of models and data sources. We will adopt the mean income elasticity of 0.55 from Viscusi and Aldy as both supported by research and consistent with the rationale Miller suggests.

We measure per-capita real income growth by the Wages and Salaries component of the Employment Cost Index, in constant dollars[15] deflated by the CPI-U, and derive its effect on VSL by the stated elasticity. The dollar values so estimated correspond to the price levels of the data used in the major studies cited. These VSLs are adjusted to 2007 prices by the CPI-U:

Mrozek and Taylor (2001)	$2.6 million
Miller (2000)	$5.2 million
Viscusi (2004)	$6.1 million
Kochi *et al.* (2003)	$6.6 million
Viscusi and Aldy (2003)	$8.5 million

The mean of these five values is $5.8 million, which we believe would appropriately reflect the conclusions of recent studies as well as the practice of other agencies. This figure should now be used in all Departmental analyses as the central value for estimating the monetary benefit of a unit reduction in the number of expected fatalities. Analyses should also recognize uncertainty by considering the impact of assuming alternative values, as discussed below. We intend to publish annual revisions to this guidance, based on recorded changes in wages and prices. These adjusted values will be rounded to the nearest $0.1 million.

Value of Preventing Injuries

Nonfatal injuries are far more common than fatalities, and safety measures affect the probability of these outcomes as well. In principle, the resulting losses in quality of life, including both pain and suffering and reduced income, should be estimated by potential victims' WTP for personal safety. Because detailed WTP estimates covering the entire range of potential disabilities are unobtainable, a standardized method is used to interpolate values of expected outcomes, scaled in proportion to VSL.

Relative value coefficients for preventing injuries of varying severity and duration are based on the Abbreviated Injury Scale (AIS), which categorizes injuries into levels ranging from AIS 1—minor to AIS 5—critical[16]. Research to determine these values is described in reports, by Miller, Brinkman, and Luchter[17] and by Rice, MacKenzie &

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[15] See http://www.bls.gov/web/ecconst.pdf . A new basis for the Employment Cost Index was introduced in 2001, and the old index was discontinued in 2005. This guidance uses the former SIC-based index for 1988-2005 and projects the 2006 index by the 2006/2005 growth in the new NAICS-based index.

[16] Factors derived for the AIS are typically applied at the injured person level based on the maximum AIS level injury sustained in an accident. The factors recommended here represent the average value for the universe of injuries that fall within each injury category under AIS.

[17] Miller, Ted R., C. Philip Brinkman, and Stephen Luchter (1988): "Crash Costs and Safety Investment," Proceedings of the 32nd Annual Conference, Association for the Advancement of Automotive Medicine, Des Plaines, IL.

Associates.[18] The technique relies on a panel of experienced physicians to relate injuries in each AIS level to the loss of quality and quantity of life involved, a scaling termed Quality-Adjusted Life-Years, or QALYs. In Circular A-4, OMB discusses the possible use of integrated measures such as QALYs to aggregate disabilities for cost-effectiveness analysis. Besides the psychic disutility represented by lost QALYs, lost market earnings and household productivity have been estimated and assigned to AIS categories.

The Department's 1993 guidance memorandum, following Miller, Brinkman, and Luchter, recommended the following schedule of coefficients for each category of injuries. NHTSA has conducted research to revise these estimates. We will review new values when they become available and publish them for use throughout the Department. In the interim, these values may be used. They are to be multiplied by the current value of preventing a fatality to obtain the values of preventing injuries of the relevant types.

Relative Disutility Factors by Injury Severity level (MAIS)[19]

MAIS Level	Severity	Fraction of VSL
MAIS 1	Minor	0.0020
MAIS 2	Moderate	0.0155
MAIS 3	Serious	0.0575
MAIS 4	Severe	0.1875
MAIS 5	Critical	0.7625
MAIS 6	Fatal	1.0000

These factors have two direct applications in analyses. The first is as a basis for establishing the value of nonfatal injury prevention in benefit/cost analysis. The total value of preventing injuries and fatalities can be combined with the value of other economic benefits not measured by VSLs and compared to costs to determine either a benefit/cost ratio or an estimate of net benefits or costs, the method recommended by OMB.

OMB circular A-4 also requires that evaluations of major regulations include cost-effectiveness analysis, in which the cost of a government action is compared with a non-monetary measure of benefit. The values in the above table may be used to translate nonfatal injuries into fatality equivalents which, when added to fatalities, can be divided into costs to determine the cost per equivalent fatality. This ratio may also be seen as a

[18] Rice, Dorothy P., and Ellen J. MacKenzie & Associates (1989): *Cost of Injury in the United States: A Report to Congress.* San Francisco: Institute for Health and Aging, University of California, and Injury Prevention Center, the Johns Hopkins University.

[19] MAIS (Maximum Abbreviated Injury Scale) refers to the highest level injury received by an accident victim.

"break-even" VSL, the value that would have to be assumed if benefits of a proposed action were to equal its costs. It would illustrate whether the costs of the action can be justified by a VSL that is well within the accepted range or, instead, would require a VSL that approaches the upper limit of plausibility. Because the values assigned to prevention of injuries and fatalities are derived in part by different methodologies, it may be useful to understand their relative importance in drawing conclusions. Consequently, we recommend that in analyses where both types of benefit are present, the estimated values of injuries and fatalities prevented be stated separately, as well as in the aggregate.

Implementation of this Guidance

As directed in Circular A-4, future benefits, including the benefits of preventing fatalities and injuries, are to be discounted to present values using alternative discount rates of 3 percent and 7 percent. These discounted values are to be compared with the costs of Departmental actions, discounted at the same rates. All costs and benefits should be expressed in dollars of a common base year.

The potential damage associated with accidents includes both the personal disutility of death or injury and a variety of purely economic losses (to both the victims and others), including property damage, traffic delay, lost productivity, and the costs of police, investigation, medical, legal, and insurance services. In general, the benefit of preventing economic losses to society, apart from victims and their families, should also be accounted for in analyses.

The literature is relatively unambiguous that VSL includes lost after-tax earnings,[20] as do values derived for QALYs.[21] Although VSL and related injury values based on QALYs already incorporate productivity losses, for presentation purposes, it is permissible to decompose these values into a component related to pain, suffering and lost quality of life and a separate productivity component. Avoiding these losses, whether aggregated or decomposed, should be treated as the entire benefit to potential victims of accidents and their families. In contrast, reductions in property damage, medical expenses,[22] traffic delay, and other costs associated with fatal accidents should be treated as added social benefits not included in the potential victims' benefits measured by VSL.

While we use a single VSL for all fatalities, our QALY methodology for aggregating the benefits of preventing injuries reflects the relative valuation of all injury types that occur within each specific MAIS category. In some cases, prevention of transportation accidents will benefit travelers with narrowly defined injury types that are a subset of the overall MAIS category to which they belong. If special studies or analyses become available

[20] After-tax earnings represent roughly 85 percent of total earnings.

[21] Gold, M. R., J. E. Siegel, L. B. Russell, M. C. Weinstein (1996): *Cost-effectiveness in Health and Medicine*. Oxford University Press, New York.

[22] Technically a small portion of medical expense – that paid for by the individual – is also included in VSL estimates. NHTSA estimates that about 15% of these costs are paid by individuals, leaving the far greater portion, 85%, paid through societal mechanisms such as insurance, tax supported welfare programs, and charity.

which indicate that these specific types of injuries have consequences that differ markedly from the average injury in that category, analysts may rely on these studies to determine an injury-specific factor and substitute this for the average MAIS factor in the table.

Recognizing Uncertainty

It must be emphasized that the value we adopt here does not establish a threshold dividing justifiable from unjustifiable actions. Any estimate of the cost of preventing a fatality that lies within the plausible range of VSL can only suggest greater or lesser degrees of confidence in regulatory or investment decisions. Such decisions must be taken by duly empowered officials informed of the limitations of the knowledge available to them.

To assist decision-makers in understanding the sensitivity of their conclusions to uncertainty and changes in underlying assumptions, analysts should present supplementary calculations using alternative VSLs both higher and lower than $5.8 million. Although VSLs within the range of $1 million to $10 million (or even more extreme values) can not be ruled out, it would be preferable to show values that are more likely to be accepted as realistic. Therefore, we are instructing analysts to provide supplementary benefit calculations based on VSLs of $3.2 and $8.4 million.

OMB has announced that for major rules involving annual economic effects of $1 billion or more, a formal quantitative analysis of the relevant uncertainties should be provided. This can be accomplished by a Monte Carlo simulation model that estimates the probabilities of randomly selected hypothetical outcomes, using empirically or judgmentally estimated probability distributions for uncertain parameters. Even for actions involving smaller impacts, it may be useful to estimate the probability that a given decision will be justified by its net benefits. Whether Monte Carlo techniques or discrete high and low values are employed, it is essential to consider the range of uncertainty in all determinants of costs and benefits, not just in VSL.

Information on the probability distribution of VSL is very limited, but all sources acknowledge that estimates are widely scattered. The range of $1 million to $10 million discussed in footnote 8 comprises only the half of observations closest to the median in two separate studies. Kochi *et al.* estimate a standard deviation of VSL of $2.4 million, but this range should expand with the passage of time and the growing values of the determinants of VSL. We are now recommending that analysts use a standard deviation of $2.6 million in mathematical uncertainty analysis, together with the mean VSL of $5.8 million. Since the bell-shaped normal distribution includes both positive and unrealistically negative values, we also recommend the use of distributions restricted to a positive range, such as the Weibull or lognormal distribution.

Policy Statements

The argument is sometimes advanced that reliance on WTP estimates to guide regulatory policy may produce inequitable outcomes by justifying more effective and costly protection for the wealthy. This possibility, which may be condemned by some on moral grounds, may also tempt others to introduce scientific evidence of greater or lesser validity to support a higher level of safety in special cases. We must emphasize that, in accepting

WTP as a theoretical basis for VSL, the Department is not approving different treatment of groups affected by its safety policies. The same standard is to be applied to all individuals at risk, regardless of age, location, income, or mode of travel. In many cases, prevention of transportation accidents will benefit travelers in randomly distributed groups, but some Departmental actions may be designed specifically to protect infants, disabled passengers, or the elderly. In these cases, no adjustment is to be made to the values used to estimate benefits, but analysts should call the attention of decision-makers to the special character of the beneficiaries.

More generally, science can do no more in this area than inform policy judgments; it can not dictate the correct conclusions. Analysts must be prepared to assist decision-makers in understanding the risks associated with both action and inaction and in assigning probabilities to these risks if possible. Where arguments can be made that an action should be taken, even if it can be justified only by the high benefits associated with a VSL in the upper part of the range, or conversely, that an action should be rejected, even if apparently justified by a low VSL, these arguments are not properly within the realm of economics. Nevertheless, analysts must also be prepared to assist decision-makers in stating reasons for their decisions that are consistent with the principles developed here.

Finally, responsible analysis requires that regulations and other actions be disaggregated into their major elements so that the net benefits of including each in the final decision can be weighed. Circular A-4 explicitly mandates evaluation of regulations with and without separable provisions. DOT analysts are therefore instructed to present the costs and benefits of rules in each practically feasible configuration, so that decision-makers will be aware of the options available to them and of the potential consequences.