Memorandum

U.S. Department of Transportation
Office of the Secretary of Transportation

Subject: Treatment of Value of Life and Injuries in Preparing Economic Evaluations

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To: Assistant Secretaries
Modal Administrators

Departmental guidance on the use of economic values for undertaking regulatory and investment analysis was contained in a memorandum jointly signed by General Counsel and the Assistant Secretary for Policy and International Affairs dated June 22, 1990. That guidance contained the following recommendation:

> "For the interim, those agencies that use a dollar value of life in economic analyses should use $1.5 million."

It was noted that upon completion of research work in progress, a revision to this interim value would be promulgated. That work has been completed and, in summary, the revised economic values and procedural guidance are as follows:

- There is widespread agreement that the collective willingness to pay (WTP) by society for reduced risks of fatalities and injuries should be the measure used by the Department to evaluate regulations and investments that improve transportation safety.

- The WTP number should be treated as a "threshold" by assigning monetary values to as many of each proposal's other benefits and costs as is practical, and then computing the net cost per fatality averted. If the calculated cost per life saved lies below the WTP threshold, then the proposal would pass the appropriate benefit-cost test or cost-effectiveness test as far as costs and benefits can be quantified.

- Under limited circumstances, computational procedures in investment analyses may require insertion of an explicit value for fatalities averted. In such limited cases, the WTP value can be used, but the accompanying text should avoid implying that the Department has set a dollar price on lives or injuries.

- Through 1993, we recommend using $2.5 million as the WTP value of a fatality averted. This value is based on a 1988 estimate updated using the latest available GDP deflator (3rd quarter, 1992). We expect to issue a memorandum early in each subsequent year, beginning in 1994, that will contain an updated recommended WTP value for use during the year.

- While the guidelines formulated in the attached memo should be followed as closely as possible, it is recognized that mitigating circumstances such as statutory, congressional or policy concerns may arise requiring some adjustments.

- The same set of values for fatality and injury reductions should be used throughout the Department. Although it is recognized that average income levels vary by transportation mode and that the concept of varying willingness to pay with income has been advanced, it is more appropriate public policy that the value of saving a life or preventing injury be independent of income.

- The best current estimates for the willingness to pay to avoid injury are shown below relative to the WTP value of a fatality averted. These estimates are derived from Miller, Brinkman, and Luchter, "Crash Costs and Safety Investment," 1988:

AIS Level Severity	Descriptor	Fraction of WTP Value of a Fatality Averted
AIS 1	Minor	0.0020
AIS 2	Moderate	0.0155
AIS 3	Serious	0.0575
AIS 4	Severe	0.1875
AIS 5	Critical	0.7625
AIS 6	Fatal	1.0000

- The above relationships to the full life WTP should be used with the understanding that values may change as the result of further research.

- In addition to a traveler's own valuations of reduced risks, reducing the number of accidental deaths and injuries would reduce a variety of other costs incurred by society in connection with fatalities and injuries. These include costs for emergency services, medical care, and property damage resulting from transportation accidents. Such savings may vary significantly among travel modes and circumstances of particular accidents. Thus, the savings in these costs likely to result from particular safety measures under consideration should be estimated and reported as a separate benefit, additional to the willingness to pay to avoid fatality and injury. Average or representative direct cost estimates may be used for different types or patterns of accidents and used in the economic analyses of regulations or investments.

- OMB requires the discounting of future costs and benefits to their present value to account for the fact that they are worth less in the future than they are today. Such analysis must use the discount rate specified by Circular A-94, currently 7 percent for constant dollar benefit-cost analysis of proposed investments and regulations, but may include a sensitivity analysis using higher and lower rates.

  The attached document discusses in greater detail the revised economic values and procedural guidance for undertaking economic analysis, and presents the rationale for the recommendations based on recent research. The values and procedures presented should be used by Departmental organizations in the conduct of regulatory or investment analyses except in exceptional circumstances (e.g. statutory requirements). Deviations from this guidance should be fully explained and justified.

Attachment

FATALITY AND INJURY RISK REDUCTION: DEPARTMENTAL GUIDANCE IN THE CONDUCT OF ECONOMIC EVALUATIONS

Reductions in fatalities and injuries are a major benefit of many of the Department's regulations and investments. The purpose of these guidelines is to provide more consistency within the Department on how the reduction in fatalities and injuries should be treated in the cost-benefit or cost effectiveness analyses of regulatory or public investment proposals. These guidelines are based on a careful review of the literature and recent research. In the absence of extenuating circumstances, these guidelines should be applied in the review of economic evaluations accompanying regulatory and investment proposals.

The Value of Improved Transportation Safety

There is widespread agreement that the collective willingness of society to pay for reduced risks of fatalities and injuries should be the measure used by the Department to evaluate regulations and investments that improve transportation safety. Society's valuation of safer transportation includes individual travelers' own willingness to pay (WTP) to reduce the risk of accidental death and injury they face in using the transportation system. It also includes any savings in medical, legal, and related expenses borne by the remainder of society that results when travelers' exposure to these risks is reduced.

Researchers have inferred estimates of individual travelers' willingness to pay for safety transportation from a variety of sources, including the additional compensation workers demand to accept more risky jobs, consumers' purchases and use of safety-enhancing devices (such as seat belts and smoke detectors), and structured interview techniques designed to elicit directly participants' willingness to pay for safer travel. In addition, detailed empirical estimates of medical, legal, and other accident-related costs have recently been developed, and can be used to assess the savings likely to be experienced by the remainder of society when accident risks are reduced. This guidance document outlines the use of these estimates to evaluate the potential benefits from regulations and investments that affect the safety performance of the nation's transportation system.

Willingness to Pay for Reduced Risks. Although the range of credible estimates of the value of preventing accidental fatalities is wide, those recommended in recent studies done by Miller and others at the Urban Institute for the FAA[1] and FHWA[2]

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[1] Federal Aviation Administration, Economic Values for Evaluation of Federal Aviation Administration Investment and Regulatory Programs, June 1989.

[2] The Urban Institute, The Costs of Highway Crashes, Final Report, June 1991.

establish a reasonable range for the value that should be used by the Department to evaluate regulations or investments that enhance transportation safety. The estimates of willingness to pay per accidental fatality averted reported in these two studies are $1.6 million and $2.2 million, when expressed in terms of 1988 dollars. More specifically, these amounts represent estimates of what users of the nation's transportation system would themselves collectively pay to reduce by one the number of fatalities expected to occur in transportation accidents during a given time period. WTP is based on observed willingness to pay modest amounts for small reductions in risk. For example, if 10 million passengers on an already safe mode were willing to pay an extra 20 cents in their fare to reduce the risk of accidental death per trip by .0000001, over the 10 million trips $2 million would be collected and one less life would be lost. The WTP would be $2 million per life, although no one would have directly expressed a willingness to pay that sum to save his/her life.

Some researchers -- most notably Professor Viscusi in a recent survey of his own and others' research on the subject prepared for FAA -- argue that the various studies establish a range of demonstrated willingness to pay values and that values well above the $2.2 million per accidental death prevented might be more appropriate for use in benefit-cost or cost-effectiveness analyses of proposed Department regulations and projects.

<u>DOT "Threshold" Value</u>. The figure of $2.2 million (in 1988 dollars) per accidental death averted recommended in the more recent study conducted by Miller for FHWA is the result of a more comprehensive review of available research than encompassed by the earlier study for FAA. The higher figure also reflects more systematic efforts by Miller to express estimates of willingness to pay to prevent accidental deaths reported in the research on a comparable basis. Although the adjusted WTP values still display considerably wider range of uncertainty than the $1.6-2.2 million range of the central values from the two reports cited earlier, the uncertainty extends much farther above the upper end of the $1.6-2.2 million range than below its lower end.

Recognizing this situation and the practical difficulty of using a range of WTP values in analyses, we recommend the Department use the higher figure of $2.2 million (in 1988 dollars) per accidental death prevented as the threshold value in evaluation of proposed regulations and investment projects.

<u>Should Taxes be Included</u>? Some of the studies cited recommend that the income and other taxes that victims of transportation accidents would have been expected to pay over their remaining lifetimes be included as part of society's willingness to pay to prevent their deaths. Including tax payments that accident victims would have made is intended to measure society's pecuniary interest in their continued survival, and thus to represent another benefit of reducing the number of transportation fatalities. However, each of the levels of government to which accident victims would have

remitted taxes over their remaining lifetimes would also have made corresponding expenditures on their behalf, which would have reduced society's purely financial interest in prolonging their lives. The difference between lost taxes and avoided governmental expenditures is likely to be small, could possibly be negative and is certain to be controversial. We recommend that DOT analyses not include taxes saved as part of the benefits of saving lives.

Updating the Value of Saving Lives

The primary purpose for updating the recommended WTP value from 1988 dollars is to compensate for the declining value of the dollar caused by economy-wide price inflation. For this purpose, a broad-based index of price movements encompassing the entire U.S. economy, such as the implicit price deflator for the Gross Domestic Product (GDP), appears most suitable (the Consumer Price Index is widely thought to be excessively sensitive to fluctuations in housing prices for use as a measure of general inflation in prices for consumption goods and services). The GDP implicit price deflator rose about 14% from its average value during 1988 through the third quarter of 1992; hence, when expressed in approximately today's dollars, the recommended unit value per fatality prevented would be 14% higher than the $2.2 million recommended previously, or approximately $2.5 million.

Annual updating of this WTP value should be sufficiently frequent to capture the effects of current price escalation on transportation system users' willingness to pay for reduced fatality risks, and should avoid the confusion of differing values appearing in different analyses in the same year. We currently recommend using $2.5 million as the WTP value of a fatality averted. This value is derived from a 1988 estimate adjusted by the increase in the GDP price deflator through the third quarter of 1992. We will prepare and issue an updated memo early in each subsequent year recommending a WTP value to be used for that year.

Reduced Direct Costs of Accidents. In addition to travelers' own valuations of reduced risks of transportation fatalities, reducing the number of accidental deaths and injuries would lower a variety of other costs incurred by society. These include costs for emergency services, medical care, and property damage resulting from transportation accidents. While reducing these costs represents one of the benefits of regulations or investment projects that result in safer travel, the resulting savings may vary significantly among travel modes and circumstances surrounding the accidents that these measures are expected to prevent. Thus the savings in these costs likely to result from particular safety measures under consideration should be estimated and reported as a separate benefit, rather than including their average value per fatality or injury as part of society's total willingness to pay for averting each accidental death or injury, as recommended in the studies conducted for FAA and FHWA.

Analysis Using a Threshold Value

Because no single WTP value can reliably be established as the "true" or "correct" one, analysts should avoid if possible treating the value of saving a life as a hard and fast single number like the price of a piece of equipment. If possible, the WTP number should be treated as a "threshold" by assigning monetary values to as many of each proposal's other benefits and costs as is practical, and then computing the net cost per fatality averted. If the calculated cost per life saved lies below the WTP threshold, then the proposal would pass the appropriate benefit-cost test or cost-effectiveness test as far as costs and benefits can be quantified. For example, the simplified result of benefit-cost analysis might be:

Total Expected Cost of Proposal	$57.4 million
Less Property Damage & Other Direct Savings -	$ 5.8 million
Net Cost of Proposal	$51.6 million
Number of Lives Saved by the Proposal --------	30
Net Cost per Fatality Averted	$ 1.7 million

The net cost per fatality averted in the example lies below the threshold, so the proposal passes the benefit-cost test without ever explicitly using WTP in the computations. The text accompanying such analyses should be something like, "The proposal satisfies the benefit-cost test because the net cost per fatality averted is less than the reasonable estimate of people's willingness to pay value of $2.5 million indicated by economic research."

Under limited circumstances, computational procedures in investment analysis may require insertion of an explicit value for fatalities averted. In such cases, the WTP value can be used, but the accompanying text should avoid implying that the Department has set a dollar price on lives or injuries. Rather than saying something like, "The Office of the Secretary has set the value of life at $2.5 million dollars ...," the preferable language would be more like, "Economic research indicates that $2.5 million per statistical life saved is a reasonable estimate of people's willingness to pay for safety."

The result of a benefit-cost analysis using an explicit WTP will typically be the net benefit of the proposal. For the above example, the result might be:

Benefits (in losses averted)	
30 lives saved at $2.5 million WTP	$75.0 million
Property Damage & Other Direct Costs	$ 5.8 million
Total Benefit of the Proposal	$80.8 million
Cost of the Proposal	$57.4 million
Net Benefit of the Proposal	$23.4 million

With a substantial positive net benefit, the proposal passes the benefit-cost test. In reviewing the benefit-cost analysis, OST would not question the use of a WTP value below the threshold. Despite its computational neatness the explicit inclusion of WTP can cause difficulties as discussed below.

What if Costs Exceed the Threshold? Cases may arise in which estimated costs exceed estimated benefits based on WTP figures for the current year. While such proposals would appear to fail the threshold, it is recognized that extraordinary circumstances such as legislative mandates or significant public concerns may override a strict cost-benefit test.

Restrictions on Raising or Lowering the WTP Threshold. The same set of values for fatalities and injury reductions should be used throughout the Department. Although it is recognized that average income levels vary by transportation mode and that the concept of varying willingness to pay with income has been advanced, it is more appropriate public policy that the value of saving a life or preventing injury be independent of income.

Generally no change in values should be made for groups affected that are younger or older than the average on which these estimates were based i.e., span of remaining life 39 years. Although there may be some conceptual basis for differentiating, making distinctions for different age groups implies a false degree of precision in the WTP numbers and extends them beyond the data on which they are based.

Value of Reducing Injuries

Virtually all measures that are expected to reduce the number of transportation fatalities -- whether they are regulations or investments in public infrastructure -- also reduce the expected incidence of injuries suffered by those involved in transportation mishaps. As with fatalities themselves, the value to society of reducing the incidence of injuries is represented by its collective willingness to pay for their less frequent occurrence. Unfortunately, however, reliable empirical estimates of individuals' willingness to pay to reduce their exposure to injury risks have proven considerably more difficult to develop than have comparable estimates of the value of reduced fatality risk. In their absence, Miller and others have recommended converting injuries of varying severity levels to their "fatality equivalent," based on such measures as the duration of time for which an injury victim is incapacitated relative to that resulting from premature death. A number of studies have used the Abbreviated Injury Scale (AIS), which categorizes injuries into levels ranging from AIS 1 -- minor, to AIS 5 -- critical. (There is also an AIS 6, called "maximum" that refers to injury that is almost always fatal and rarely used as an injury descriptor.)

Current research attempting to determine willingness to pay for the prevention of injuries is described in reports, by Miller, Brinkman

and Luchter[3] and by Rice, MacKenzie & Associates[4] as well as the two reports already cited. The research technique on willingness to pay to avoid injury relies on a panel of experienced physicians to relate injuries in each AIS level to the loss of quality and quantity of life involved. Avoiding a minor injury involving only a few days of discomfort equates to only a tiny fraction of a WTP for saving a life, while preventing a severe injury with permanent disability could be deemed nearly equivalent to preventing death.

The best current estimates for the willingness to pay to avoid injury are shown below in respect to WTP. These are derived from Miller, Brinkman, and Luchter, "Crash Costs and Safety Investment," 1988:

AIS Level Severity	Descriptor	Fraction of WTP Value
AIS 1	Minor	0.0020
AIS 2	Moderate	0.0155
AIS 3	Serious	0.0575
AIS 4	Severe	0.1875
AIS 5	Critical	0.7625
AIS 6	Fatal	1.0000

As noted earlier, reducing the number of injuries in accidents will also lower a number of other costs associated with accidents. These include the costs for emergency services, medical care and property damage. The savings in these costs resulting from particular safety measures under consideration should be estimated and reported as a separate benefit, rather than included in the average value of society's willingness to pay to avert an injury. The direct costs of accidents will vary according to the pattern and severity of injuries associated with the accident. Average or representative direct cost estimates may be used for different types or patterns of accidents and used in the economic analyses of regulations or investments.

The above relationships to the full life WTP should be used with the understanding that values may change as the result of further research. If it is determined that certain numbers of injuries in the various AIS levels will be prevented by a proposed safety measure, those numbers can be multiplied by the appropriate

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

[4] Dorothy P. Rice, Ellen J. MacKenzie & Associates; Cost of Injury in the United States, A Report to Congress produced by the University Of California, San Francisco and The Johns Hopkins University for National Highway Traffic Safety Administration and Centers for Disease Control, 1989.

fraction to convert them into "equivalent lives saved." Thus the fatality and injury prevention benefits of a proposal can be treated as a single number, either implicitly as a threshold or multiplied by WTP and inserted explicitly.

With either technique, there are complications in dealing with injuries that should be recognized:

- Different accident types in different modes tend to have different patterns of associated injuries. In most cases the less severe injury levels tend to be more numerous, but the pattern may vary. (For the first few decades of flight, aviation crashes tended to be "all or nothing." People either were killed or walked away. Only in the last decade or two have improvements in overall safety and in aircraft crashworthiness reduced fatalities and changed the pattern to include significant numbers of injuries.)

- Different safety measures may prevent different patterns of injuries. Accident prevention measures will, of course, prevent injuries in the pattern associated with the type of accident, but crashworthiness or occupant protection measures may affect one injury level more greatly than others. It would be possible for a measure to reduce fatalities and the more serious injuries, but do little to reduce less serious injuries. In fact, a safety measure could have the effect of shifting casualties down to less serious levels and actually <u>increase</u> the numbers in lower AIS categories. (Advances in emergency services and trauma medicine have saved lives, but increased the number of survivors with long-term serious disabilities.)

- Injury data are often spotty and rarely reported in AIS levels. There is no injury equivalent to the complete NHTSA Fatal Accident Recording System (FARS) data on highway fatalities. Injuries are often reported as whether there was time lost, whether the victims were carried from the scene, whether they required subsequent hospitalization, etc. Minor injuries may not be reported at all. Virtually every economic analysis of the value of reducing injuries will have to make assumptions and approximations to convert available accident statistics into AIS levels and <u>then</u> to equivalent lives.

These complications mean that there can be no simple "cost of injury" number usable for transportation as a whole or for any mode. Each analysis that takes into account the benefit of injury prevention will have to establish on a case-by-case basis what patterns of injuries are occurring and what patterns of injuries will be prevented by the measure in question.

Discounting Future Safety Benefits

Discounting Future Lives Saved. As with the other benefits resulting from transportation investment projects or regulations, the value of preventing accidental deaths and injuries during future years should be discounted to reflect the fact that expected future benefits are valued less highly by society than immediate benefits. The usual technique for dealing with this in evaluation is to apply a discount rate that measures the percent per year the future valuation decreases. Dollar benefit values should be assigned to lives saved and injuries prevented but these values should then be discounted to "present values" using the appropriate discount rate.

Costs are likewise subject to the same discounting. A cost expected several years in the future takes on less importance than one that must be paid today. In cases where benefits are completely paid for at the time they are enjoyed, the anticipated costs of a proposed regulation or investment project can be converted to an equivalent annual installment and compared to the expected annual reduction in fatalities without the need for discounting. Nevertheless, many safety measures involve near- term expenditures that lead to longer-term benefits, often a stream of benefits spread out over many years. Comparisons of the cost and benefits are needed to make sound regulatory decisions and any valid comparison of dissimilar cost and benefit streams requires collapsing them to present values using a discount rate. The same is true if costs and benefits would be discounted at a different rate.

Discount Rates. The Office of Management and Budget revised Circular A-94 provides guidance on the discount rate to be used for cost benefit analyses of Federal programs and regulation impact analyses. The Circular specifies a discount value of 7 percent for constant dollar benefit-cost analyses of proposed investments and regulations. The analyses should also show the sensitivity of the discounted net present value to variations in the discount rate.