UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

May 1, 2017

Dr. Dennis C. Bley, Chairman
Advisory Committee on Reactor Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555

SUBJECT: PROPOSED REVISION TO NUREG-1530, "REASSESSMENT OF NRC'S DOLLAR PER PERSON-REM CONVERSION FACTOR POLICY"

Dear Dr. Bley:

This letter provides the U.S. Nuclear Regulatory Commission (NRC) staff's response to your letter dated March 20, 2017 (Agencywide Documents Access and Management System Accession No. ML17075A230), in which the Advisory Committee on Reactor Safeguards (ACRS or the Committee) provided its conclusions and recommendations concerning the proposed Revision 1 to NUREG-1530, "Reassessment of NRC's Dollar per Person-Rem Conversion Factor Policy." This proposed revision is currently under Commission review as part of SECY-17-0017, "Proposed Revision to NUREG-1530, 'Reassessment of NRC's Dollar per Person-Rem Conversion Factor Policy,'" dated January 30, 2017.

ACRS Conclusion and Recommendation 1

The staff's systematic process to derive a contemporary basis for the dollar per person-rem value is an important improvement to support NRC cost-benefit analyses. NUREG-1530, Revision 1, should be issued.

Staff Response to the ACRS Conclusion and Recommendation 1

The staff agrees with this conclusion and recommendation. Issuance of NUREG-1530, Revision 1 is currently under consideration by the Commission, as noted above.

ACRS Conclusion and Recommendation 2

A further revision to NUREG-1530 should be developed. That revision should characterize and quantify the uncertainty in the dollar per person-rem value.

Staff Response to the ACRS Conclusion and Recommendation 2

The staff disagrees with the Committee's recommendation to further revise NUREG-1530 to characterize and quantify the uncertainty in the dollar per person-rem value. The sensitivity analysis approach in the proposed revision to NUREG-1530 is an appropriate means of treating uncertainty associated with the dollar per person-rem value. This conclusion is based on (1) the nature of uncertainty about this "value parameter" and (2) the current state of knowledge and practice regarding how this uncertainty should be treated in quantitative risk and policy analyses, including cost-benefit and regulatory analyses. Additional information on the staff's rationale is provided in the enclosure.

Consistent with this rationale, the staff has included a sensitivity-study approach in the proposed revision to NUREG-1530 that is currently under Commission review, and does not have current plans to characterize and quantify the uncertainty in the dollar per person-rem value for use by the NRC in cost-benefit analyses. The staff will maintain awareness of efforts by other Federal agencies and will consider revising NUREG-1530 based on any new information, or as directed by the Commission.

The staff appreciates the ACRS's review of this important topic.

Sincerely,

/RA/

Victor M. McCree
Executive Director
for Operations

Enclosure:
As stated

cc: Chairman Svinicki
Commissioner Baran
Commissioner Burns
SECY

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TREATMENT OF UNCERTAINTY IN THE DOLLAR PER PERSON-REM CONVERSION FACTOR

The Nature of Uncertainty about the Dollar per Person-Rem Conversion Factor

Quantitative risk and policy analyses, including cost-benefit and regulatory analyses, rely on the use of models to develop insights that can be used to inform decisions involving complex systems. These models typically include a number of uncertain quantities. Conceptually, these uncertain quantities can be divided into two broad categories:

(1) Uncertain quantities that have an objectively true or factual value: For uncertain quantities that have a true value, objective information collection methods can, in principle, be used to determine, measure, or estimate the true value.

(2) Uncertain quantities that do not have an objectively true value but instead have a subjectively best or most appropriate value: For uncertain quantities that do not have a true value, subjective methods are used to determine the best or most appropriate value for use in a particular decision situation.

To address these uncertainties, the staff can gather additional information that will improve the state of knowledge in order to reduce or eliminate the uncertainty. Additionally, the staff can use analytical methods to prioritize and characterize the impact of these uncertainties on the decisions that the staff must make. The choice of which analytical method(s) to use to characterize the impact of uncertainty about a particular quantity depends on the nature of the uncertain quantity and the source(s) of uncertainty.

Table 1 identifies:

(1) the principal types of uncertain quantities used in nuclear power plant probabilistic risk assessments (PRAs) or NRC cost-benefit analyses organized by whether the uncertain quantity has a true value,

(2) examples of each type of uncertain quantity, and

(3) the analytical methods judged to be the most appropriate for treatment of uncertainty regarding each type of quantity.

The information in Table 1 is based primarily on a taxonomy of uncertain quantities that has been widely used in quantitative risk and policy analyses across multiple domains and applications for nearly 30 years.[1]

[1] Morgan, M.G., and M. Henrion, *Uncertainty: A Guide to Dealing with Uncertainty in Quantitative Risk and Policy Analysis.* Cambridge University Press, New York, NY, 1990.

Table 1. Principal Types of Uncertain Quantities in Quantitative Risk and Policy Analyses

Type	Example(s)	Uncertainty Treatment Method(s) (See note below)
Uncertain quantities with a true value that can be objectively determined		
Empirical parameter (random variable)	• Initiating event frequency • Component failure rate • Cancer risk coefficient • Cost parameters	• Probabilistic analysis (e.g., Monte Carlo N-Particle Transport Code (Monte Carlo) simulation) • Parametric sensitivity analysis • Switchover analysis
Uncertain quantities with a most appropriate value that must be subjectively determined		
Value parameter	• Value of statistical life (VSL) • Dollar per person-rem conversion factor • Discount rate	• Parametric sensitivity analysis • Switchover analysis
Model domain parameter	• Geographic region • Time horizon or mission time	• Parametric sensitivity analysis • Switchover analysis
Note: When more than one example and more than one uncertainty treatment method are identified, the uncertainty treatment methods are assumed to apply to the type of uncertain quantity and not necessarily to specific examples.		

In concept, the dollar per person-rem conversion factor represents the amount of money (in U.S. dollars) that our society is willing to pay for each incremental reduction in radiological dose (in person-rem) to reduce the risk of premature death from radiation exposure. As shown in Table 1, both the dollar per person-rem conversion factor and the value of statistical life (VSL) are value parameters. Value parameters are used to model the values or preferences of the decisionmaker(s) or the people they represent, or both, and, therefore, they do not have an objectively true value. Instead, there is only a subjectively most appropriate value. This value is subjectively determined and depends on (1) the decisionmaker(s) or the people they represent, or both, and (2) the decision situation or context. Moreover, uncertainty about value parameters arises from the uncertainty concerning these values or preferences. Thus, the uncertainty about the best or most appropriate value to use for the dollar per person-rem conversion factor ultimately stems from the uncertainty concerning how much society values incremental reductions in radiological dose to reduce the risk of premature death from radiation exposure.

Treatment of Uncertainty about the Dollar per Person-Rem Conversion Factor

As discussed above, Table 1 identifies methods that are judged to be the most appropriate for treatment of uncertainty about each type of quantity. As shown, probabilistic methods are generally applied to an empirical parameter or random variable. Empirical parameters include the initiating event frequencies and component failure rates used in nuclear power plant PRA models and the cancer risk coefficient used to calculate the dollar per person-rem conversion factor. For such models, probability distributions can be specified to model the uncertainty about the true value of the parameter. Monte Carlo sampling methods can then be used in integrated uncertainty analyses to propagate the uncertainties about these input parameter values to estimate uncertainty about PRA model output quantities (e.g., core damage frequency, change in core damage frequency, conditional probability of early containment failure or bypass). This is consistent with the state of practice in PRAs.

Table 1 identifies two analytical methods suitable for value parameters:

(1) Parametric sensitivity analysis. The impact of uncertainty about a parameter value is assessed by specifying a range of plausible alternative parameter values and then calculating model output quantities for each alternative parameter value. This is done to evaluate the impact on the model output and decision to variation in the assumed value of one or more input parameters. Sensitivity analyses can be performed by varying the assumed value of only one parameter at a time or by varying the assumed values of combinations of parameters at a time.

(2) Switchover analysis. The impact of uncertainty about a parameter value is assessed by calculating the value of an input parameter at which the model output quantity exceeds a specified value. Typically, the output value that would indicate a different decision is the preferred course of action as compared to the preferred decision based on results of a base case analysis. Once this “switchover value” is identified, the analyst and decisionmaker(s) can evaluate the degree to which it is plausible for the value of an uncertain parameter of interest to meet or exceed the switchover value to determine whether the decision is sensitive to uncertainty about that parameter.

Although these two methods can also be used for treatment of uncertainty about empirical quantities, it is widely recognized that probabilistic methods (e.g., Monte Carlo sampling) represent the most systematic and rigorous approach to quantifying and characterizing the impact on model output quantities of uncertainty about input empirical parameters.

The dollar per person-rem conversion factor is calculated as the product of a value parameter (VSL) and an empirical parameter (cancer risk coefficient). This product, however, still conceptually represents a value parameter that necessitates a fundamentally different treatment of uncertainty. In principle, it is possible to specify a subjective probability distribution for the value parameter such as the VSL or dollar per person-rem conversion factor. However, Morgan and Henrion (1990) argue that it is generally inappropriate to represent uncertainty about value parameters using probability distributions. Their rationale for this position is based on two elements:

(1) Value parameters tend to be among the uncertain quantities that people are most unsure about and, therefore, contribute most to uncertainty about which decision alternative is optimal or preferred.

(2) Probabilistic treatment of the uncertainty about a value parameter may hide the impact of this uncertainty and prevent decisionmakers from seeing the implications of possible alternative value judgments on the decision at hand.

For these reasons, parametric sensitivity analysis or switchover analysis is considered the most appropriate analytical method for treating uncertainty about value parameters. Therefore, the staff has recommended that the Commission continue to support the use of sensitivity studies to assess the uncertainty about the dollar per person-rem conversion factor and that further analysis to characterize and quantify the uncertainty in the dollar per person-rem value is unnecessary.

Practices of Other Federal Agencies

The staff also notes that its practices in this area are consistent with that of other Federal agencies.

Although the U.S. Environmental Protection Agency (EPA) fitted a distribution to VSL values from a meta-analysis of 26 published studies, both EPA and its Science Advisory Board—Environmental Economics Advisory Committee (SAB-EEAC) specifically state that the analyst should not use the meta-analysis distribution in VSL uncertainty analyses. Appendix B, “Mortality Risk Valuation Estimates,” to the EPA’s report titled “Guidelines for Preparing Economic Analyses,” issued 2010, states the following:

(1) The EPA recommends that the central estimate, updated to the base year of the analysis, be used in all benefits analyses that seek to quantify mortality risk reduction benefits. This approach was vetted and endorsed by the Agency when the 2000 *Guidelines for Preparing Economic Analyses* were drafted. It remains EPA’s default guidance for valuing mortality risk changes although the Agency [EPA] has considered and presented alternatives.

(2) Until updated guidance is available, the Agency [EPA] determined that a single, peer-reviewed estimate applied consistently best reflects the SAB-EEAC advice received to date. Therefore, the VSL that was vetted and endorsed by the SAB should be applied in relevant analyses while the Agency [EPA] continues its efforts to update its guidance on this issue.

Furthermore, the U.S. Department of Transportation (DOT) states in its report titled “Guidance on Treatment of the Economic Value of a Statistical Life (VSL) in U.S. Department of Transportation Analyses—2016 Adjustment” that the VSL “values we adopt here do not establish a threshold dividing justifiable from unjustifiable actions; they only suggest a region where officials making these decisions can have relatively greater or lesser confidence that their decisions will generate positive net benefits.” Similar to the NRC, DOT encourages the use of probabilistic methods (e.g., Monte Carlo simulation) to synthesize the many uncertain quantities that determine net benefits as part of integrated uncertainty analyses. However, DOT’s 2016 guidance also states the following:

> While the individual estimates of VSL reported in the studies cited [here] are often accompanied by estimates of confidence intervals, we [DOT] do not, at this time, have any reliable method for estimating the overall probability distribution of the average VSL that we have calculated from these various studies. Consequently, alternative VSL values can only illustrate the conclusions that would result if the true VSL actually equaled the higher or lower alternative values.