EVALUATION TECHNIQUES FOR BENEFITS AND COSTS THAT ARE DIFFICULT TO QUANTIFY

The U.S. Nuclear Regulatory Commission (NRC) staff uses regulatory analyses to help understand the overall benefits and costs of the agency's regulations and requirements and to help determine whether other more efficient and cost-effective alternatives are available for implementing the proposed regulations. In addition, the agency prepares regulatory analyses for proposed NRC regulations and makes them available to the public as part of the public comment process for the proposed rule. Comments on the regulatory analysis may modify the methodology, assumptions, and calculations of the regulatory analysis; these modifications to the regulatory analysis could ultimately affect the NRC's decision concerning the recommended alternative.

One situation in which issues can arise is when the proposed regulatory alternative cannot be quantified with meaningful limits on uncertainty, such as those involving emergency preparedness, safeguards, and personnel requirements. In these situations, the challenge is to qualitatively consider factors adequately, but not to give them undue consideration. For example, if a proposed alternative is recommended despite monetized benefits falling significantly short of monetized costs (i.e., quantified costs are significantly higher than quantified benefits), the staff must explain, in detail, how the nonmonetized benefits would outweigh the quantitative analysis and the uncertainties in any qualitative evaluation and thus, how the regulatory action is justified. Reliance on a qualitative evaluation of factors should only be used after efforts to develop pertinent quantitative data have been unsuccessful.

This enclosure addresses situations in which the NRC staff relies upon a qualitative consideration of factors and describes techniques for evaluating qualitative benefits in comparison to quantitative costs. This enclosure begins with a discussion of various tools and methods for the qualitative consideration of factors and then describes how these tools and methods are used by other federal agencies and international bodies. Any updates to the NRC's cost-benefit guidance under the staff's proposal would include information on how and when to apply such tools so that they will be applied consistently.

Threshold or Break-Even Analysis

A common method for considering the relative significance of a cost or benefit that is difficult to quantify is a threshold or "break-even" analysis. This analysis allows decisionmakers to understand the significance of unquantified costs or benefits to the overall analysis by showing how small the value of the nonquantified benefit would need to be (or how large the nonquantified costs would need to be) before the proposed action would yield zero net benefits. For example, a proposed regulation that protects water quality costs $105 million annually and provides significant benefits in reducing pollution in rivers and streams. The benefits of the regulation would exceed its costs only if those effects could reasonably be valued at $105 million or more annually. Break-even analysis is an important tool that can provide insights to the NRC staff when quantification is speculative or impossible.

Bounding Analysis

A bounding analysis could be used when data is lacking or unknown to estimate the benefit of a potential program. In these cases, the NRC staff could use a parameter's limiting values as the lower and upper bounds. For instance, the effectiveness of a certain parameter could range from 0 to 100% for a given scenario. An analyst could evaluate the resulting probability and associated consequences at each of the conservative bounds (i.e., 0 and 100% effectiveness) to determine the range of severity of the accident. If the net benefit estimate is positive across this range, decisionmakers can have some confidence that the program is beneficial. The staff should carefully describe judgments or assumptions made in selecting appropriate bounding values.

Cost-Effectiveness Analysis

Cost-effectiveness analysis is similar to cost-benefit analysis with the exception that it does not attempt to place a value on the major benefits of the proposed regulatory action; instead, cost-effectiveness analysis compares the costs of alternative ways of producing the same or similar outcome (e.g., outputs or benefits). Health organizations[1] often use this type of analysis to find the option that meets a predefined objective at a minimum cost. The unit of measurement is usually nonmonetary, such as the number of events prevented, the number of lives saved, or cases of cancer reduced per unit cost.

Revision 4 to NUREG/BR-0058, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission," issued September 2004, states the following:[2]

> For certain proposed regulatory actions, the regulatory analysis may consist of only a cost-effectiveness analysis. For example, the NRC may be required to initiate a requirement and achieve a certain level of value based on court or Congressional mandates, or the NRC may require compliance or adequate protection actions. Under these circumstances, the issue is not to determine whether the impacts of the new requirement are justified, but rather to ensure that the requirement achieves the necessary level of value in an efficient and cost-effective manner given the other implementing mechanisms available. Similarly, there may be proposed actions with important values that cannot be assigned monetary values or with uncertainties that are substantial. If the alternatives yield similar values, cost-effectiveness analysis can be used to choose the most efficient alternative.

Cost-effectiveness analysis can provide a way to identify options that achieve the most effective use of the available resources without requiring monetization of all the relevant benefits and costs. Generally, cost-effectiveness analysis is designed to compare a set of regulatory actions with the same primary outcome (e.g., an increase in the acres of wetlands that are protected) or multiple outcomes that can be integrated into a single numerical index (e.g., units of health improvement). This approach provides useful information about the relative performance of regulatory alternatives.

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[1] World Health Organization (WHO) report entitled, "Making Choices in Health: WHO Guide to Cost-Effectiveness Analysis," issued 2003 (Geneva). This report is available at http://www.who.int/choice/ publications/p_2003_generalised_cea.pdf.

[2] Pages 33 and 34

When cost-effectiveness analysis is applied to public health and safety rulemakings, the NRC staff must select a measure of effectiveness that permits a comparison of proposed regulatory alternatives. For example, effectiveness measures could include the number of events prevented, the number of lives saved, or cases of cancer reduced per unit cost. This result then requires a value judgment on whether sufficient value is provided for the estimated costs. In any event, the regulatory analysis should explain and justify why an effectiveness measure was selected and how it was implemented.

Under the Office of Management and Budget (OMB) Circular A-4, "Regulatory Guidance," dated September 17, 2003, the conduct of a cost-effectiveness analysis should generally be done for rules in which the primary effectiveness metric is public health or safety. OMB Circular A-4 (Section D. Analytical Approaches) states the following:

> Both benefit-cost analysis [BCA] and cost-effectiveness analysis [CEA] provide a systematic framework for identifying and evaluating the likely outcomes of alternative regulatory choices. A major rulemaking should be supported by both types of analysis wherever possible. Specifically, [the staff] should prepare a CEA for all major rulemakings for which the primary benefits are improved public health and safety to the extent that a valid effectiveness measure can be developed to represent expected health and safety outcomes. [The staff] should also perform a BCA for major health and safety rulemakings to the extent that valid monetary values can be assigned to the primary expected health and safety outcomes. In undertaking these analyses, it is important to keep in mind the larger objective of analytical consistency in estimating benefits and costs across regulations and agencies, subject to statutory limitations…. If some of the primary benefit categories cannot be expressed in monetary units, [the staff] should also conduct a CEA. In unusual cases where no quantified information on benefits, costs, and effectiveness can be produced, the regulatory analysis should present a qualitative discussion of the issues and evidence.

Cost-utility analysis is a variant of cost-effectiveness analysis that measures the relative effectiveness of alternative interventions in achieving two or more given objectives and typically includes a quality of life component associated with morbidity using common health indices, such as quality-adjusted life years and disability-adjusted life years. Both cost-effectiveness analysis and cost-utility analysis provide measures of the relative effectiveness of analyzed alternatives in achieving a given objective (or two given objectives in the case of a cost-utility analysis).

Internal Rate of Return

Cost-beneficial calculations using the net present value (NPV) method to discount future benefits and costs to present value is the preferred method for the evaluation of alternatives. However, mathematical alternatives to NPV analysis are available and may be useful in combination with NPV. If an NPV has already been calculated, the calculation of alternative measures can likely be done as well.

The internal rate of return (IRR) is a potentially useful alternative measure, particularly in cases that have a lot of uncertainty about which discount rate is appropriate for use in the analysis. The IRR is the discount rate that would give an NPV of zero based on expected cash flows. However, the IRR produces unusual results in certain cases, as follows:

- the IRR cannot possibly be found at all (i.e., a discount rate that gives an NPV of zero does not exist);

- mathematically, more than one IRR may exist, and deciding which one to use is difficult; and

- the IRR does not distinguish between alternatives of different sizes. Using IRR as the sole criterion, a proposed alternative that has an NPV of $100,000 and an IRR of 25 percent may be preferable to an alternative that has an NPV of $1 million and an IRR of 20 percent. The alternative with the smaller NPV may be preferable even though it has a higher IRR.

Because of these limitations, the OMB Office of Information and Regulatory Affairs (OIRA) does not recommend that IRR be used as a criterion for choosing among mutually exclusive alternatives.[3] NRC guidance in NUREG/BR-0184, "NRC Regulatory Analysis Technical Evaluation Handbook," dated January 1997, is consistent with this position. Section 5.2, "Methods," of NUREG/BR-0184 states the following:

> To the extent possible, all attributes, whether values or impacts, are quantified in monetary terms and added together (with the appropriate algebraic signs) to obtain the net value in dollars. The net value calculation is generally favored over other measures, such as a value-impact ratio or internal rate of return.

Qualitative Assessment Supplemented with Decision Analysis Tools

Even with these alternative methods, the NRC staff may find that it is still not possible to quantify some costs and benefits in the regulatory analysis with any accuracy, and their inclusion in the quantitative cost-benefit analysis may in fact be more misleading than helpful. In such circumstances, the staff should include: (1) sensitivity analysis around key variables (recommended), or (2) a qualitative evaluation of those costs and benefits that cannot be quantified. The staff should exercise professional judgment in identifying the importance of the qualitative consideration of factors and should assess to the extent possible how the effect of these factors might change the ranking of alternatives based on estimated net benefits. If the qualitative consideration of factors is likely to be important, the regulatory analysis should include a thorough discussion on which of these factors are of sufficient importance to justify their consideration in the regulatory decision. This discussion should also include a clear explanation that supports designating these factors as important. In this case, the staff should also consider including a threshold analysis to help decisionmakers and other users of the analysis understand the potential significance of these factors in the staff's decision rationale.

[3] OMB/OIRA report entitled, "Economic Analysis of Federal Regulations under Executive Order 12866," January 11, 1996. This report is available at http://www.whitehouse.gov/ omb/inforeg_riaguide/.

A shortcoming of NUREG/BR-0058 is that a structured approach for presenting a combination of a quantitative evaluation and a qualitative evaluation in a consistent fashion is not provided. To address this limitation and to supplement the discussion of the qualitative consideration of factors, the NRC staff could use decision analysis tools to evaluate and choose among the alternatives analyzed through a systematic approach that may avoid the limitations of an unstructured presentation. This approach is a potential method for implementing the staff's proposal in this SECY paper.

Almost all decision analysis methodologies rely upon the construction of a decision matrix that employs numerical scores to communicate the merit of one alternative in comparison to others on a single scale. Scores are developed from the performance of alternatives in regard to an individual criterion and are aggregated into an overall score. Each alternative's individual scores may be simply summed or averaged, or a weighting mechanism could be used to favor some criteria more heavily than others. The goal of using a decision matrix is to transparently present the NRC staff's rationale based on the expressed scorings of alternatives and the weightings assigned to the evaluated criteria. Through the use of value functions,[4] this decision analysis method transforms the diverse results (e.g., quantified costs and benefits and qualitative costs and benefits) into a 0 to 100 utility scale that may be combined with weighting functions of the criteria to form a decision score for each alternative and that supplements the qualitative consideration of factors. This method allows individual decisionmakers or users of the regulatory analysis to assign their own scoring and weightings to assess whether they would have reached a different conclusion based on the justification provided.

Regulatory Uses of Decision Theory

Federal Agencies

A review of regulatory and guidance documents reveals several other Federal agency programs that using decision analysis tools and methods. The discussion below describes examples of such tools and methods. The focus of this information is different from Enclosure 2 of this SECY paper, which focuses on other federal agencies' regulatory decisions involving the qualitative consideration of factors (rather than the tools and methods employed to reach such decisions).

Federal Chief Information Officer Council Best Practices Committee

An inter-agency panel, the Federal Chief Information Officer Council Best Practices Committee, recommends the value measuring methodology,[5] which combines multicriteria assessment techniques with cost-benefit analysis techniques to arrive at an evaluation approach that values

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[4] One method to model preferences if founded on difference measures in which judgments about strength of preference is used to derive a value function.

[5] Federal Chief Information Officer Council Best Practices Committee report entitled, "Value Measuring Methodology, How-To-Guide," Washington, DC, USA, October 2002. This report is available at http://www.fgdc.gov/policyandplanning/50states/valuemeasuring_methodology_howtoguide_oct_2002.pdf/view. The value measurement methodology is an approach used in the United State for e-commerce projects of national significance sponsored by the Federal Government.

both monetary and nonmonetary aspects of alternatives under investigation. This approach includes the determination of factors and criteria for inclusion, and then it uses a scoring system (with or without weighting) to reflect the relative importance of each one in the overall assessment. In this manner, a single number score for each alternative can be developed. Scoring is usually done using a scale, such as a scoring scale that runs from 0 to 5. Symmetrical scales are also widely used.

Although the scaling approach is subject to debate, it can convert all impacts to a common range of values, and it preserves the relative standing for each factor considered under the different alternatives when scores and scales are combined.

U.S. Army Corps of Engineers

Historically, the U.S. Army Corps of Engineers (USACE) has used essentially a single-measure approach to civil works projects. The USACE has primarily used net national economic development benefits as the single measure to choose among different alternatives. The USACE employs a principles and guidelines method that uses a complex analysis of each alternative to determine the benefits and costs in terms of dollars and other nonmonetized measures (e.g., environmental quality and safety); the alternative with the highest net national economic development benefit (i.e., with no environmental degradation) is usually selected.

U.S. Environmental Protection Agency

The U.S. Environmental Protection Agency (EPA) uses a variety of modeling tools to support its current decisionmaking processes. Several EPA guidance documents introduce decision analytical tools and recommend their use. EPA's "Multi-criteria integrated resource assessment" (MIRA) is a process that directs stakeholders to organize scientific data, establishes links between the results produced by the research community, and organizes applications in the regulatory community. MIRA has been proposed as an alternative framework to existing decision analysis approaches at the EPA. MIRA uses tradeoff analysis based on the analytical hierarchy process (AHP) to determine the relative importance of decision criteria.[6]

U.S. Department of Energy

Several U.S. Department of Energy (DOE) guidance documents introduce decision analysis tools and recommend their use. Guidance also focuses on how to select a decisionmaking tool from among five recommended evaluation methods.[7] These methods include an analysis of the pros and cons, the Kepner-Tregoe decision analysis, the AHP, the multiattribute utility theory, and a cost-benefit analysis.

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[6] Kiker, G.A., et al., "Application of Multicriteria Decision Analysis in Environmental Decision Making," *Integrated Environmental Assessment and Management*, 1(2):95–108, 2005.

[7] The DOE guidance document, "Guidebook to Decision-Making Methods," WSRC-IM-2002-00002, December 2001, discusses how to select a decisionmaking tool from among five recommend evaluation methods. This document is accessible at https://www.google.com/url?q=http://www.everyspec.com/DOE/DOE-PUBS/WSRC-IM-2002-00002_36284/&sa=U&ei=c_KzU7fEBfLJsAS264HICg&ved=0CAUQFjAA&client=internal-uds-cse&usg=AFQjCNEiFAxRPK-HjHLwPt3Q2HJBulhObg

International Community

The NRC staff performed a limited review of how selected international organizations qualitatively consider factors in cost-benefit analyses. The following discussion was considered pertinent to this issue. The focus of this information is different from Enclosure 2 of this SECY paper, which focuses on other federal agencies' regulatory decisions involving the qualitative consideration of factors (rather than the tools and methods employed to reach such decisions).

Australian Government Civil Aviation Safety Authority

The Australian Government Civil Aviation Safety Authority uses value management as part of its cost-benefit analysis to identify which nonquantified attributes are the most highly valued and to select the best way to realize these valued benefits.[8]

Norway and the Republic of Botswana

Norway and the Republic of Botswana (based on the Norwegian methodology) use a systematic methodology to assess the relevant advantages (benefits) and disadvantages (costs) of the alternative alignments that road infrastructure projects will generate, regardless of the unit of measurement or whether these alignments are measurable in monetary units.[9] Analysts use the following three properties assigned on a scale of three (e.g., from small, medium, and large) to evaluate and analyze the nonmonetized impacts:

- value—the perceived value of the item;
- magnitude—the extent of benefit or damage caused; and
- significance—a balanced evaluation of the incremental advantages and disadvantages as compared to the baseline.

The magnitude of the incremental change is presented on a scale of five, ranging from a large negative to a large positive magnitude (e.g., large negative, medium negative, small negative, (none), small positive, medium positive, and large positive). An assessment of the significance of the evaluated impacts is done by combining the value and the magnitude of the impact, as shown in Figure 1. Figure 1 illustrates that the larger the perceived value of the factor, the more serious the adverse impacts. For example, if the value is large and if the magnitude of the negative impact is large, the resulting significance is a "very large negative," which is shown as

[8] Australian Government Civil Aviation Safety Authority report entitled, "Cost-Benefit Analysis Methodology Procedures Manual," Version 1.1, November 2010. This report is available at http://www.casa.gov.au/wcmswr/_assets/main/manuals/regulate/acm/257rfull.pdf.

[9] Republic of Botswana, Ministry of Works, Transport and Communications report entitled, "Planning and Environmental Impact Assessment of Road Infrastructure," Guideline No. 5, September 2001.

four minuses. The guidelines caution that, although value and magnitude can be combined to assess significance, "[they] should not be used too enthusiastically."[10]

Four minuses and four pluses are reserved for extreme impacts in which assets of National importance are affected or will be enhanced in a very significant way. The span from four minuses to four pluses should not be used to differentiate among alternatives whose impact significance does not greatly differ. Analysts should describe small differences in writing.

Similar to other methods described, this method serve as a basis for ranking different alternatives in regard to their total viability and requires that the assessment clearly show how quantitative and qualitative results were considered in the selection of the best alternative.

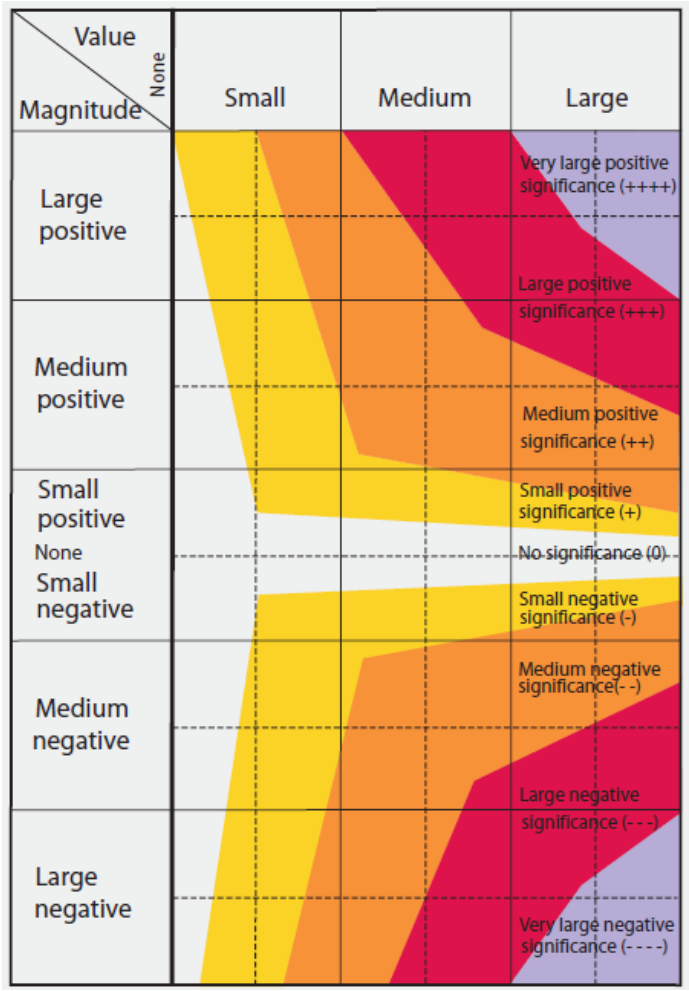

Figure 1 Significance of nonquantified impacts by combining

[10] See page 41 of the Republic of Botswana, Ministry of Works, Transport and Communications report entitled, "Planning and Environmental Impact Assessment of Road Infrastructure."

their values and magnitudes