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NUREG/BR-0058
Revision 5

U.S. Nuclear Regulatory Commission Guidance on Performing Benefit-Cost Analyses

Office of Nuclear Reactor Regulation

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U.S. Nuclear Regulatory Commission Guidance on Performing Benefit-Cost Analyses

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ABSTRACT

The purpose of this NUREG is to provide guidance to the analyst to promote preparation of quality cost-benefit analysis documents and to implement the policies of the NRC. It provides standardized methods of preparation and presentation of cost-benefit analyses. Information on the objectives of the safety goal evaluation process and potential data sources for preparing a safety goal evaluation is also included. Consistent application of the methods provided here will result in more directly comparable analyses, thereby aiding decision-makers to evaluate and compare various cost-benefit actions.

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ABBREVIATIONS AND ACRONYMS

10 CFR	Title 10 of the *Code of Federal Regulations*
ACRS	Advisory Committee on Reactor Safeguards
ADAMS	Agencywide Documents Access and Management System
ALARA	as low as reasonably achievable
AOE	averted occupational exposure
AOSC	averted onsite costs
APE	averted public exposure
ASME	American Society of Mechanical Engineers
BPV	Boiler and Pressure Vessel Code (ASME)
BWR	boiling-water reactor
CatX	categorical exclusion
cSv	centisievert
CDF	core damage frequency
CFR	*Code of Federal Regulations*
COE	cost of enhancement
COL	combined licenses
CPCFB	conditional probability of containment failure or bypass
CRGR	Committee to Review Generic Requirements
DC	design certification
DCR	design certification rule
DOE	U.S. Department of Energy
EA	environmental assessment
EDO	Executive Director for Operations
EIS	environmental impact statement
E.O.	Executive Order
EPA	U.S. Environmental Protection Agency
ER	Environmental report
ESP	early site permits
ESRP	Environmental standard review plans
FR	*Federal Register*
FSAR	Final Safety Analysis Report
FY	fiscal year
GAO	Government Accountability Office
GDP	gross domestic product
GE	General Electric
GEIS	Generic Environmental Impact Statements

IPE	individual plant examination
IPEEE	individual plant examination of external events
IRRAS	Integrated reliability and risk analysis system
ISFSI	independent spent fuel storage installation
ISI	in-service inspection
ISR	in-situ recovery projects
IST	in-service testing
kWh	kilowatt-hours
LWR	light water reactor
MACCS	MELCOR accident consequence code system
MD	management directive
MELCOR	Methods for Estimation of Leakages and Consequences of Releases
ML	manufacturing license
NEPA	National Environmental Policy Act
NMSS	NRC Office of Nuclear Material Safety and Safeguards
NRC	U.S. Nuclear Regulatory Commission
NUREG	NRC technical report designation
NUREG/BR	NUREG brochure
NUREG/CR	NUREG contractor report
OM	Operations and Maintenance Code (ASME)
OMB	Office of Management and Budget
PRA	probabilistic risk assessment
PWR	pressurized-water reactor
SAMA	Severe Accident Mitigation Alternatives
SAMDA	Severe Accident Mitigation Design Alternatives
SARA	system analysis and risk assessment
SDA	standard design approval
SDC	standard design certifications
SECY	staff papers before the Commission
SEIS	Supplemental environmental impact statement
SNM	special nuclear material
SOC	statement of considerations
SRM	Staff Requirements Memorandum
SSC	systems, structures, and components
U.S.C	United States Code
UT	ultrasonic testing

1 INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) will use this guidance to evaluate proposed actions that may be needed to protect public health and safety, common defense and security, and the environment. These evaluations will aid the staff and the Commission (1) in determining whether the proposed actions are necessary, (2) in providing adequate justification for the proposed action, and (3) in documenting a clear explanation of why the proposed action was recommended. This guidance will establish the framework for (1) identifying the problem and associated objectives, (2) identifying alternatives for meeting the objectives, (3) analyzing the consequences of alternatives, (4) selecting a preferred alternative, and (5) documenting the analysis in an organized and understandable format. The resulting document is referred to as a cost-benefit analysis.

Although the NRC is not required to conduct cost-benefit analyses, it voluntarily began performing them in 1976. In preparing cost-benefit analyses, the NRC intends to ensure that decisions imposing burdens on licensees are based on adequate information regarding the costs and benefits associated with a reasonable set of alternatives, and to follow a systematic and disciplined process that is open and transparent. The ultimate objective of this process is to ensure that all burdens are justified and will achieve intended regulatory objectives. The NRC conducts cost-benefit analyses as part of the regulatory review of cost-justified substantial safety enhancements (i.e., backfit analysis), as well as regulatory and environmental analyses.

The cost-benefit analyses prepared by the NRC before 1983 were termed value-impact analyses and followed the value-impact guidelines in SECY-77-388A, "Value-Impact Guidelines," dated December 19, 1977 (Ref. 1). In February 1981, President Reagan issued Executive Order (E.O.) 12291 (Ref. 2) that directed executive agencies to prepare a cost-benefit impact analysis for all major rules and stated that cost-benefit actions should be based on adequate information concerning the need and consequences of proposed actions. Moreover, E.O. 12291 directed that actions were not to be undertaken unless they resulted in a positive net value to society. As an independent agency, the NRC was not required to comply with E.O. 12291. However, the Commission noted that its established cost-benefit review procedures included an evaluation of proposed and existing rules consistent with the cost-benefit impact analysis provisions of E.O. 12291. The Commission determined that clarifying and formalizing its existing value-impact procedures for the analysis of cost-benefit actions would enhance the effectiveness of NRC cost-benefit actions and further meet the spirit of E.O. 12291. The NRC issued the original version of these guidelines as NUREG/BR-0058, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission," in January 1983 (Ref. 3).

In December 1983, the NRC issued "A Handbook for Value-Impact Assessment," NUREG/CR-3568 (Ref. 4). The 1983 handbook outlined systematic procedures for performing value-impact assessments. The NRC issued Revision 1 to NUREG/BR-0058 in May 1984 (Ref. 5) to include appropriate references to NUREG/CR-3568.

In September 1993, President Clinton issued E.O. 12866 (Ref. 6). Section 1 of E.O. 12866 contained principles of regulation, and Section 6(a)(3) contained the elements of a cost-benefit analysis that are relevant to this guidance. E.O. 12866 revokes E.O. 12291. Except for certain planning functions in Section 4 of E.O. 12866, the NRC, as an independent agency, is not

required to comply with E.O. 12866, but in part because of the Commission's previously expressed desire to meet the spirit of Executive Orders related to cost-benefit reform and decisionmaking, the NRC voluntarily complies with E.O. 12866.

In November 1995, the NRC issued Revision 2 to NUREG/BR-0058 (Ref. 7) to reflect (1) the NRC's accumulated experience with implementing Revision 1 to NUREG/BR-0058 (Ref. 5), (2) changes in NRC regulations and procedures since 1984, particularly the backfit rule[1], and the "Policy Statement on Safety Goals for the Operation of Nuclear Power Plants," published in the *Federal Register* (51 FR 30028) on August 21, 1986 (Ref. 9), (3) advances and refinements in cost-benefit analysis techniques, (4) cost-benefit guidance for Federal agencies in E.O. 12866 and in issuances of the Administrative Conference of the United States (Ref. 6) and the Office of Management and Budget (OMB),[2] and (5) procedural changes designed to enhance the NRC's cost-benefit effectiveness.[3]

In January 1997, the NRC issued a "Regulatory Analysis Technical Evaluation Handbook," NUREG/BR-0184 (Ref. 15). This guidance expands upon policy concepts and provides data and methods to support the development of cost-benefit analyses.

In July 2000, the NRC issued Revision 3 of NUREG/BR-0058 to address the NRC's policy concerning the treatment of industry initiatives in cost-benefit analyses (Ref. 16).

In September 2004, the NRC issued Revision 4 of NUREG/BR-0058 (Ref. 17) to incorporate final criteria for the treatment of individual requirements in regulatory analyses, conforming changes based on OMB's Circular A-4 (Ref. 11), and additional discussion on the treatment of uncertainties in cost-benefit analyses.

In 2011, the accident at the Fukushima Dai-ichi nuclear power plant in Japan raised questions regarding how the NRC's regulatory framework considers offsite property damage and the associated economic consequences caused by a significant radiological release from an NRC-licensed facility. In response to these questions, on August 14, 2012, the staff issued SECY-12-0110, "Consideration of Economic Consequences within the U.S. Nuclear Regulatory Commission's Regulatory Framework" (Ref. 18) for Commission consideration. The purpose of SECY-12-0110 was to provide the Commission with information and options to address the extent, if any, that the NRC's regulatory framework should be modified when addressing the economic consequences of a significant radioactive release to the environment. In development of SECY-12-0110, the staff examined areas of the regulatory framework and the associated guidance and tools that consider economic consequences and identified potential changes to the framework.

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[1] Title 10, Section 50.109, of the *U.S. Code of Federal Regulations* (Ref. 8).

[2] The OMB's Regulatory Impact Analysis Guidance (Ref. 12) was based on E.O. 12291 (Ref. 2). Both E.O. 12291 and the Guidance were revoked by E.O. 12866 (Ref. 6).

[3] Certain regulatory actions are subject to the backfit rule (Ref. 8**Error! Reference source not found.**) and to the analysis and information requirements of the Committee to Review Generic Requirements (CRGR). The NRC intends that, for these actions, the analysis performed in accordance with the Guidelines will satisfy the documentation requirements of the backfit rule and the provisions of the CRGR Charter (Ref. 14) without a need to prepare separate submissions. As part of the regulatory analysis, the "substantial increase in overall protection" test required under the backfit rule is assessed using the safety goal screening criteria.

In the Staff Requirements Memorandum (SRM) in response to SECY-12-0110 dated March 20, 2013 (Ref. 19), the Commission affirmed the agency's current approach to the issue of land contamination from reactor accidents and approved the staff's plan for enhancing the currency and consistency of the existing framework through updates to cost-benefit guidance documents. The Commission also found that economic consequences should not be treated as equivalent in regulatory character to matters of adequate protection of public health and safety. The staff is issuing this revision of NUREG/BR-0058, in part, in response to SRM-SECY-12-0110.

This revision of NUREG/BR-0058 has been prepared to accomplish several objectives. First, this revision consolidates the NRC cost-benefit analysis guidance of NUREG/BR-0058, Revision 4, "Regulatory Analysis Guidelines of the U.S. NRC," and NUREG/BR-0184, "Regulatory Analysis Technical Handbook," into one document.

Second, the scope was increased to more fully cover all regulatory actions. Third, the document incorporates improvements in methods and technology including relevant best practices identified in the U.S. Government Accountability Office (GAO) Cost Estimating and Assessment Guide (Ref. 21**Error! Reference source not found.**) and recommendations from GAO report GAO-15-98 (Ref. 22). Fourth, NRC experience and improvements in uncertainty analysis as well as Commission direction on cost-benefit analysis made since the last revision of these documents have been incorporated.

1.1 Purpose

The purpose of this guidance is to aid the analyst in promoting preparation of high-quality regulatory decisionmaking documents[4] and to implement the provisions of the NRC guidelines. The guidance has several objectives.

First, the guidance expands upon current NRC policy to assist the analyst in understanding what the decisionmaker will likely need in the regulatory decision-making document.

Second, the guidance has been expanded to address the regulatory, backfit, and environmental analyses.

Third, the guidance has been updated to incorporate changes in policy and advances in methodology that have occurred since the 2004 NRC Regulatory Analysis Guidelines (Ref. 17**Error! Reference source not found.**). The NRC and other agencies have conducted considerable research on various aspects of regulatory decisionmaking. Also, NRC staff experience resulted in significant modifications to the regulatory decisionmaking documents. These advances have been incorporated in this guidance.

Fourth, the guidance has consolidated relevant information regarding regulatory analyses and backfits.

1.2 Scope of Regulatory Decisionmaking Documents

[4] Regulatory decision-making documents as used in this document refer to regulatory analyses, backfit analyses, and National Environmental Policy Act (NEPA) environmental analyses.

Most NRC regulatory actions require some form of analysis and supporting documentation. This section discusses the scope of the particular type of analysis termed a “regulatory decision-making document”.

1.2.1 Regulatory Analysis

According to NRC policy, all mechanisms proposed to be used by the NRC to establish or communicate generic requirements, guidance, requests, or staff positions that would affect a change in the use of resources by NRC licensees, must include an accompanying regulatory analysis.

A regulatory analysis is an integral part of NRC decisionmaking. It is necessary, therefore, that the regulatory process begin as soon as it becomes apparent that some type of regulatory action by the NRC to address an identified problem may be needed.

Many regulatory analyses will fall into the classifications of backfit regulatory analyses and/or Committee to Review Generic Requirements (CRGR) regulatory analyses. Regulatory analyses also assess the environmental impacts of proposed and final rulemaking actions and include a statement concerning the environmental impact in the Supplementary Information section of the preamble to each rulemaking.

1.2.2 Backfit Analysis and Issue Finality

It is the policy of the NRC to have an effective program that will ensure that proposed backfits to be imposed on nuclear power reactor licensees, new power reactor licensees,[5] and selected nuclear materials licensees are appropriately justified on the basis of the backfitting provisions of applicable NRC regulations and the Commission's backfitting policy and guidance. Additionally, NRC requires the staff to appropriately justify information requests to the licensees.

In Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.109, “Backfitting,” (Ref. 8) backfitting for a nuclear power reactor is defined as the modification of or addition to systems, structures, components, or design of a facility; or the design approval or manufacturing license for a facility; or the procedures or organization required to design, construct, or operate a facility; any of which may result from a new or amended provision in the Commission rules or the imposition of a regulatory staff position interpreting the Commission rules that is either new or different from a previously applicable staff position after certain date(s). For selected nuclear materials facilities, the backfitting definitions in 10 CFR 70.76 (Ref. 23), 72.62 (Ref. 64), and 76.76 (Ref. 40) are slightly different. The term "backfit" is not normally used in discussions relevant to new power reactors; the concept of "issue finality" is used rather than “backfit.” In this document, the NRC uses the terms “backfit” and “backfitting” to mean backfits as defined in 10 CFR 50.109, 10 CFR 70.76, 10 CFR 72.62, and 10 CFR 76.76 and issue finality matters under 10 CFR Part 52 (Ref. 47).

[5] The term “new power reactor licensees” refers to holders of early site permits (ESPs), standard design approvals (SDAs), combined licenses (COLs), manufacturing licenses (MLs), and applicants for design certifications (DCs); applicants for COLs if the application references an ESP, design certification rule (DCR), or SDA; and applicants for MLs if the application references a DCR or SDA.

The "issue finality" provisions in 10 CFR Part 52 are different from those in 10 CFR 50.109 in wording and structure. Issue finality applies to new licenses under 10 CFR Part 52 while backfit applies to existing licenses under 10 CFR Part 50. Issue finality under 10 CFR Part 52 and backfitting under 10 CFR 50.109 restrict the NRC's capability to impose new requirements or to take a different position from a previous NRC position. Namely, once the NRC issues under 10 CFR Part 52 an Early Site Permit, a Standard Design Certification, a Combined License, a Standard Design Approval, or a Manufacturing License, the NRC cannot modify, rescind, or impose new requirements, whether on its own motion, or in response to a petition from any person, unless the change satisfies specific requirements or conditions.[6]

Table -1 summarizes the affected entities and their applicable backfitting regulations.

Table 1-1 NRC Backfitting Requirements

Affected Entities	Backfitting / Issue Finality Regulation
Power Reactors	10 CFR 50.109
Power Reactors (licensed or approved under Part 52)	10 CFR Part 52
Early Site Permit (ESP)	10 CFR 52.39 (term of ESP) 10 CFR 52.31 (renewal)
Standard Design Certification Rule (DCR)	10 CFR 52.63 (term of DCR) 10 CFR 52.59 (renewal)
Combined License (COL)	10 CFR 52.83 (referenced NRC approvals) 10 CFR 52.98 (term of COL)
Standard Design Approval	10 CFR 52.145
Manufacturing License (ML)	10 CFR 52.171 (term of ML) 10 CFR 52.179 (renewal)
Licensees authorized to possess special nuclear material (SNM) above a critical mass	10 CFR 70.76, Subpart H
Independent Spent Fuel Storage Installation (ISFSI)	10 CFR 72.62
Gaseous Diffusion Plant	10 CFR 76.76

Ordinarily, any proposed action fitting the definition of a backfit will require the preparation of a backfit regulatory analysis. The only instances where a backfit regulatory analysis will not be required for a proposed backfit are the three exceptions identified at 10 CFR 50.109(a)(4) and 10 CFR 70.76(a)(4).[7] These exceptions are determinations by the Commission or NRC staff, as appropriate, that:

- a modification is necessary to bring a facility into compliance with a license or the rules or orders of the Commission, or into conformance with written commitments by the licensee; or

[6] See 10 CFR 52.39; 52.63; 52.83; 52.98; 52.145; 52.171; and Paragraph VI in Part 52, Appendices A through D for the specific requirements to be met in order to impose new requirements on a Part 52 licensee (Ref. 47).

[7] These exceptions apply to all NRC backfitting regulations. Issue finality provisions do not refer to these criteria as "exceptions;" instead these are just one of several criteria that would allow issue finality to be "violated."

- regulatory action is necessary to ensure that the facility provides adequate protection[8] to the health and safety of the public and is in accord with the common defense and security; or

- the regulatory action involves defining or redefining what level of protection to the public health and safety or common defense and security should be regarded as adequate.

When one of these exceptions is relied upon for not performing a backfit regulatory analysis, a written evaluation meeting the requirements of 10 CFR 50.109(a)(6), 10 CFR 70.76(a)(6), and Section IV.B(ix) of the CRGR Charter (Ref. 14) (for proposed actions within the scope of the CRGR) must be prepared.

A backfit regulatory analysis is similar to, and should generally follow the requirements for, a regulatory analysis.[9] There are certain requirements specific to a backfit regulatory analysis that are identified at 10 CFR 50.109(a)(3) and 10 CFR 50.109(c). These requirements are identified in Table 1-1 and at appropriate parts of the guidance. Table 1-1 also cites where in the CFR the requirement is located and indicates where in the regulatory analysis the discussion of each item should normally appear. The analyst must be sure to integrate the 10 CFR 50.109 requirements into the backfit regulatory analysis.

If the proposed backfit falls within the scope of the CRGR (as set out in Section III of the CRGR Charter), the information requirements identified in Section IV.B of the Charter and this guidance should be incorporated into the backfit regulatory analysis. (Inclusion of these items will, in effect, render the backfit regulatory analysis a CRGR regulatory analysis.) A proposed backfit involving a new or amended generic requirement or staff position to be imposed on one or more classes of nuclear power reactor licensees or materials licensees (to the extent directed by the Executive Director for Operations (EDO) or the Director of the NRC Office of Nuclear Material Safety and Safeguards (NMSS)) will ordinarily require CRGR review.

[8] The level of protection constituting "adequate protection" is that level which must be assured without regard to cost. It is to be determined on a case-by-case basis. The determination should be based on plant- and site-specific considerations and the body of the NRC's regulatory requirements.

[9] NRC's Final Policy Statement on the use of probabilistic risk assessment (PRA) in nuclear regulatory activities (Ref. 24) includes the statement that where appropriate, PRA should be used to support a proposal for additional regulatory requirements in accordance with 10 CFR 50.109 (Ref. 8).

Table 1-1 Checklist for specific backfit regulatory analysis requirements

CFR Citation[a] (Title 10)	Information Item to be Included in a Backfit Regulatory Analysis	Section of the Regulatory Analysis Where Item Should Normally be Discussed
50.109(a)(3)	Basis and a determination that there is a substantial increase in the overall protection of the public health and safety or the common defense and security to be derived from the backfit and that the direct and indirect costs of implementation for the affected facilities are justified in view of this increased protection.	Basis - Presentation of Results Determination - Decision Rationale
50.109(c)(1)	Statement of the specific objectives that the proposed backfit is designed to achieve.	Statement of the Problem and Objectives
50.109(c)(2)	General description of the activities that would be required by the licensee or applicant to complete the backfit.	Identification of Alternatives
50.109(c)(3)	Potential change in the risk to the public from the accidental offsite release of radioactive material.	Estimation and Evaluation of Values and Impacts
50.109(c)(4)	Potential impact on radiological exposure of facility employees.	Estimation and Evaluation of Values and Impacts
50.109(c)(5)	Installation and continuing cost associated with the proposed backfit, including the cost of facility downtime or construction delay.	Estimation and Evaluation of Values and Impacts
50.109(c)(6)	Potential safety impact of changes in plant or operational complexity, including the relationship to proposed and existing regulatory requirements.	Estimation and Evaluation of Values and Impacts
50.109(c)(7)	Estimated resource burden on the NRC associated with the proposed backfit and the estimated availability of such resources.	Estimation and Evaluation of Values and Impacts Availability - Implementation
50.109(c)(8)	Potential impact of differences in facility type, design, or age on the relevancy and practicality of the proposed backfit.	Presentation of Results Implementation
50.109(c)(9)	Whether the proposed backfit is interim or final and, if interim, the justification for imposing the proposed backfit on an interim basis.	Decision Rationale
50.109(e)	Consideration of how the backfit should be scheduled in light of other ongoing regulatory activities at the facility.	Implementation

[a] Similar provisions detailing what information is to be contained in a backfit analysis are contained in 10 CFR 70.76, 10 CFR 72.62, 10 CFR Part 76, and, for issue finality, 10 CFR Part 52.

1.2.3 National Environmental Policy Act Review

The National Environmental Policy Act (NEPA) requires Federal agencies to prepare a "detailed statement for major Federal actions significantly affecting the quality of the human environment" (Ref. 43). This statement is defined by NRC regulations as an environmental impact statement (EIS) (Ref. 44). The "essential purpose of NEPA is to insure that environmental factors are

given the same consideration as other factors in decisionmaking by federal agencies."[10] Additionally, an environmental assessment (EA) may be prepared to demonstrate that an EIS is not necessary[11] (Ref. 45**Error! Reference source not found.**). NRC regulations for implementing NEPA are in 10 CFR Part 51 (Ref. 44).

In addition to NRC licensing reviews deemed major Federal actions, the NRC must assess the environmental impact of each proposed and final rulemaking action and include a statement concerning the environmental impact in the Supplementary Information section of the preamble to each rulemaking. The NRC Regulations Handbook describes the procedural requirements for considering the environmental impact of a rulemaking action (Ref. 38).

1.3 Regulatory Relaxations

Preparation of a regulatory analysis for a proposed relaxation is generally required. However, the backfit rule requirements in 10 CFR 50.109 (Ref. 8) and the safety goal evaluation process set out in Section 2.4.1 of this guidance are not applicable to proposed relaxations.

For all regulatory analyses of proposed relaxations, information should be presented in the Decision Rationale section (see Section 2.3.5) indicating whether:

- The public health and safety and the common defense and security would continue to be adequately protected if the proposed reduction in requirements or positions were implemented.

- The cost savings attributed to the action would be substantial enough to justify taking the action.

- The proposed relaxation is optional or mandatory for affected licensees.

[10] James W. Spensley, Esq., *National Environmental Policy Act,* in *Environmental Law Handbook*, Fourteenth Edition (Ref. 45).

[11] *Id.*

2 REGULATORY ANALYSIS

The statutory mission of the NRC is to ensure that civilian uses of nuclear materials in the United States, in operation of nuclear power plants and related fuel cycle facilities or in medical, industrial, or research applications, are carried out with proper regard and provision for protection of the public health and safety, property, environmental quality, common defense and security, and in accordance with applicable antitrust laws. Accordingly, the principal purposes of a regulatory analysis are to help ensure the following:

- The NRC's regulatory decisions made in support of its statutory responsibilities are based on adequate information concerning the need for and consequences of proposed actions.

- Appropriate alternative approaches to regulatory objectives are identified and analyzed.

- No clearly preferable alternative is available to the proposed action.

- Proposed actions subject to the backfit rule (10 CFR 50.109), and not within the exceptions at 10 CFR 50.109(a)(4) (Ref. 8) and 76.76(a)(4) (Ref. 40), provide a substantial[12] increase in the overall protection of the public health and safety or the common defense and security and that the direct and indirect costs of implementation are justified in the view of this substantial increase in protection.

The regulatory analysis process should begin when it becomes apparent that some type of action to address an identified problem may be needed. Initial efforts should be focused on the nature, extent, and magnitude of the problem being addressed, why NRC action is required, and identification of alternative solutions. Detailed information-gathering and analysis activities should be focused on the most promising alternatives.

The regulatory analysis process is intended to be an integral part of the NRC's decisionmaking that systematically provides complete disclosure of the relevant information supporting a regulatory decision. The process is to be used neither to produce after-the-fact rationalizations to justify decisions already made, nor to unnecessarily delay regulatory actions. The conclusions and recommendations included in a regulatory analysis document are neither final nor binding, but are intended to enhance the soundness of decisionmaking by NRC managers and the Commission.

[12] The Commission has stated that "substantial" means important or significant in a large amount, extent, or degree (Ref. 26**Error! Reference source not found.**). Applying such a standard, the Commission would not ordinarily expect that safety-applying improvements would be required as backfits that result in an insignificant or small benefit to the public health and safety, regardless of costs. On the other hand, the standard is not intended to be interpreted in a manner that would result in disapprovals of worthwhile safety or security improvements having costs that are justified in view of the increased protection that would be provided. This approach is flexible enough to allow for qualitative arguments that a given proposed rule would substantially increase safety. The approach is also flexible enough to allow for arguments that consistency with national and international standards, or the incorporation of widespread industry practices, contributes either directly or indirectly to a substantial increase in safety. Such arguments concerning consistency with other standards, or incorporation of industry practices, would have to rest on the particulars of a given proposed rule. The Commission also believes that this approach of "substantial increase" is consistent with the Agency's policy of encouraging voluntary initiatives.

The NRC performs regulatory analyses to support numerous NRC actions affecting reactor and materials licenses. Executive Order 12866 (Ref. 6) requires that a regulatory analysis be prepared for all significant regulatory actions.[13] The NRC requires regulatory analyses for a broader range of regulatory actions than "significant rulemakings" as defined in E.O. 12866. In general, each NRC office should ensure that all mechanisms used by the NRC staff to establish or communicate generic requirements, guidance, requests, or staff positions that would affect a change in the use of resources by its licensees include an accompanying regulatory analysis. This requirement applies to actions initiated internally by the NRC or from a petition to the NRC. These mechanisms include rules, bulletins, generic letters, cost-benefit guides, orders, standard review plans, branch technical positions, and standard technical specifications.

Regulatory analysis requirements for a given action may be waived or modified at the discretion of the Commission, the EDO or a Deputy Executive Director, or the responsible NRC office director. A factor that could influence this decision is the degree of urgency associated with the regulatory action. For example, urgent NRC bulletins and orders may need to be issued without regulatory analyses. In other regulatory applications, case-specific circumstances could justify the preparation of a more limited regulatory analysis. Such a regulatory analysis should be limited only in terms of depth of discussion and analysis, not in the reduction of the scope of the regulatory analysis and not in the need to justify the proposed action.

Generic actions[14] that may not need a regulatory analysis include notices, policy statements, and generic letters that only transmit information and do not present new or revised staff positions, impose requirements, or recommend action. Generic information requests issued under 10 CFR 50.54(f) require a specific justification statement and are reviewed by the CRGR when directed to one or more classes of nuclear power reactors, but do not require the type of regulatory analysis discussed in this guidance. New requirements affecting certified nuclear power plant designs will be justified through a notice and comment rulemaking process as specified at 10 CFR 52.63. Regulatory analyses are not necessary for requirements arising out of litigation, such as discovery in a licensing proceeding.

The analytical needs of regulatory analyses involving the relaxation of requirements can be markedly different. In these cases, the regulatory analysis should provide the level of assessment that will demonstrate with sufficient reasonableness, that the two following conditions are satisfied.

(1) The public health and safety and the common defense and security would continue to be adequately protected if the proposed reduction in requirements or positions were implemented.

[13] Significant regulatory actions are defined in E.O. 12866 to include actions that "are likely to result in a rule that may (1) have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities; (2) create a serious inconsistency or otherwise interfere with an action taken or planned by another agency; (3) materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or (4) raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in this Executive Order."

[14] In these Guidelines, the term "generic actions" refers to those actions that affect all, several, or a class of licensees.

(2) The cost savings attributed to the action would be substantial enough to justify taking the action.

For proposed regulatory actions that would relax or reduce current requirements, the backfit rule and the safety goal evaluation process and screening criteria are not applicable. However, for all proposed relaxations (including those affecting nuclear power plants), supporting documentation should be prepared that contains the basis for concluding that the two conditions previously identified will be satisfied. Further, it is appropriate in justifying a proposed relaxation to cite the results or insights from risk analyses that support relaxation, as well as the NRC's original bases for having established the existing requirement.

In general, actions that would relax or reduce requirements should give licensees the option of whether to take advantage of the change and should not be mandatory. However, calculation of the cost savings should be based on the assumption that all licensees will take advantage of the change.

2.1. Level of Detail

The appropriate level of detail to be included in a regulatory analysis varies, depending on the particular circumstances. The staff should consider the following five factors in determining the appropriate level of detail to include:

1. the complexity and policy significance of the particular problem being addressed
2. the magnitude and likelihood of benefit and costs
3. the relative amount by which projected benefits exceed costs[15]
4. the immediacy of the need for a regulatory action and time constraints imposed by legislation or court decisions
5. any supplemental direction provided by the Commission, the Office of the EDO, or an NRC office director.

The typical regulatory analysis is a two month effort. This is the level of effort believed sufficient for many regulatory analyses. Where larger levels of effort may be involved, this guidance suggests additional methods and references that can be used. These could entail major efforts, possibly up to a year.

The emphasis should be on simplicity, flexibility, and common sense, in terms of the type of information supplied and the level of detail provided. The level of treatment given to a particular issue in a regulatory analysis should reflect how crucial that issue is to the bottom line recommendation of the regulatory analysis. In all cases, regulatory analyses must be sufficiently clear and contain sufficient detail to enable the NRC decisionmakers and other interested parties to easily recognize the following:

[15] Proposed actions with values and impacts that are estimated to differ by a relatively small amount should normally be analyzed in greater detail than actions with values and impacts that differ by a substantial amount.

- the problem within the context of the existing regulatory framework
- the proposed regulatory action
- the conclusions reached and the associated bases
- the specific data and analytical methods used and the logic followed that led to the conclusion that the proposed new requirement was appropriate and justified
- the sources and magnitude of uncertainties that might affect the conclusions and the proposed new requirement
- the sensitivity of the conclusions to changes in underlying assumptions and considerations.

There may be instances when it would be beneficial for a regulatory analysis to include supplemental information (e.g., analyses and results that go beyond the guidance provided in these guidelines). This might be the case when, for example, the regulatory initiative is a "significant regulatory action," as defined in E.O. 12866 (Ref. 6), or of such policy import that a major controversy is likely to ensue. In OMB Circular A-4 (Ref. 11), additional regulatory analysis guidance is provided for such initiatives. Among other things, this additional guidance includes the use of a standardized accounting statement, cost-effectiveness analysis, incremental analyses of cost and benefits, and the calculation of internal rates of return. In addition, it calls for both a more expansive treatment of monetized health and safety benefits and the characterization of key attributes that are not readily quantified. This includes the use of shadow prices and willingness-to-pay measures to monetize attributes where no markets or imperfect markets prevail, and alternative health and safety measures that consider quality adjusted life years, equivalent lives, and non-fatal risks.[16] In reality, NRC initiatives rarely meet the high economic and policy thresholds of OMB Circular A-4, and so, for most NRC regulatory analyses, this level of analysis would not be required nor justified given the increased level of effort involved. Rather than provide more detailed guidance in this document, analysts are referred to OMB Circular A-4 when a specific regulatory action satisfies OMB's high threshold standards.

However, the variety of NRC licensees and disparate sets of available information can add complexity to these analyses. It should be recognized that there are many benefits of improved regulation that are not quantifiable. For example, increased confidence in the margin of safety may be a non-quantifiable benefit of a particular proposed regulatory requirement. As noted in Appendix A, qualitative factors can be significant elements of a regulatory analysis and should be appropriately considered by the analyst and decisionmaker.

In addition, the NRC regulates each phase of the nuclear fuel cycle, including nuclear fuel fabrication and dry storage of spent fuel as well as materials used for medical, industrial, and academic purposes.

[16] It is worth noting that the NRC's dollar per person-rem conversion factor does account for nonfatal risks.

2.2 Safety Goal Analysis

Assessing the risk of potential changes to public safety has always been a fundamental part of regulatory decision making. In the early development of regulations, this assessment was based on qualitative analysis, simple reliability principles and practices (such as worst-case analysis), defense-in-depth,[17] and the single-failure criterion. The frequency or probability of the hazard was not an explicit factor, primarily because the overall state-of-the-art of probabilistic risk assessment (PRA) technology was not sufficiently advanced and accepted. Because of the advancements made and an increased confidence in PRA, regulators have progressively relied more on the insights and results from risk assessment in management regulatory activities. The safety goals for the operation of nuclear power plants, which are in the "Policy Statement on Safety Goals for the Operation of Nuclear Power Plants," published in August 1986 by the NRC (Ref. 9), are a clear example of this change, and these goals established a guide for regulatory decisionmaking.

The safety goal evaluation is designed to answer when a regulatory requirement should not be imposed generically on nuclear power plants because the residual risk is already acceptably low. This evaluation is intended to eliminate some proposed requirements from further consideration independently of whether they could be justified by a regulatory analysis on their net value basis. The safety goal evaluation can also be used for determining whether the substantial added protection standard of 10 CFR 50.109(a)(3) is met (Ref. 8).

Additionally, note that the Commission's safety goals reflect a mean value for a class or for all U.S. nuclear power reactors. In this regard, the Commission specified in a staff requirements memorandum dated June 15, 1990, that "safety goals are to be used in a more generic sense and not to make specific licensing decisions" (Ref. 28**Error! Reference source not found.**).

The following discussion provides guidance on when a safety goal evaluation is required in a regulatory analysis and the sequence in performing the safety goal evaluation.

2.2.1 When a Safety Goal Evaluation is Needed

The NRC safety goal policy addresses a level of acceptable residual individual risk from operation of nuclear power reactors judged to be lower than the risk level associated with adequate protection. The risk level associated with adequate protection is that level above which continued operation would not be allowed. The safety goal evaluation, as discussed in this section, is applicable only to regulatory initiatives considered to be generic safety enhancement backfits subject to the substantial additional protection standard at 10 CFR 50.109(a)(3) (Ref. 8**Error! Reference source not found.**). A safety goal evaluation is not needed for new requirements within the exceptions at 10 CFR 50.109(a)(4)(i)-(iii). If the proposed safety goal screening criteria are satisfied, the NRC considers that the substantial additional protection standard is met for the proposed new requirement.

As discussed in Section 1.3 of this guidance, relaxations of requirements affecting nuclear power plants are not backfits and thus do not fall within the scope of the backfit rule.

[17] Defense-in-depth is the process implemented by the Atomic Energy Commission (later the NRC) to ensure that multiple levels of assurance and safety exist to minimize risk to the public from nuclear power plant operations.

Additionally, relaxations of requirements affecting nuclear power plants are not subject to the safety goal evaluation requirements. Nevertheless, a relaxation of requirements is subject to a regulatory analysis and specifically to the criteria appearing in Section 1.3 of this guidance. In justifying a proposed backfit under the backfit rule, the burden is on the NRC staff to make a positive showing that a generic safety problem actually exists and that the proposed backfit both addresses the problem effectively and provides a substantial safety improvement in a cost-beneficial manner.

2.2.2 Safety Goal Analysis Determination

The staff must first determine whether a regulatory action needs to consider safety goals. The discussion in Section 2.2.1 provides guidance for making this determination. If the proposed regulatory action meets safety goal screening criteria (see Section 2.4), the regulatory analysis should include the results of the safety goal evaluation. Figure 2-1 depicts the steps performed in a regulatory analysis including the safety goal evaluation. References to appropriate sections of the elements of a regulatory analysis are included. Depending on the results of steps C and D in Figure 2-1, the regulatory analysis can be terminated. In performing steps C and D, a PRA should be relied upon to quantify the risk reduction and corresponding values of the proposed new requirement. However, the NRC recognizes that not all regulatory actions are amenable to a quantitative risk assessment and that certain evaluations may be based directly on engineering or regulatory judgment or qualitative analysis. A more detailed description of the safety goal evaluation procedure is provided in Section 2.4.

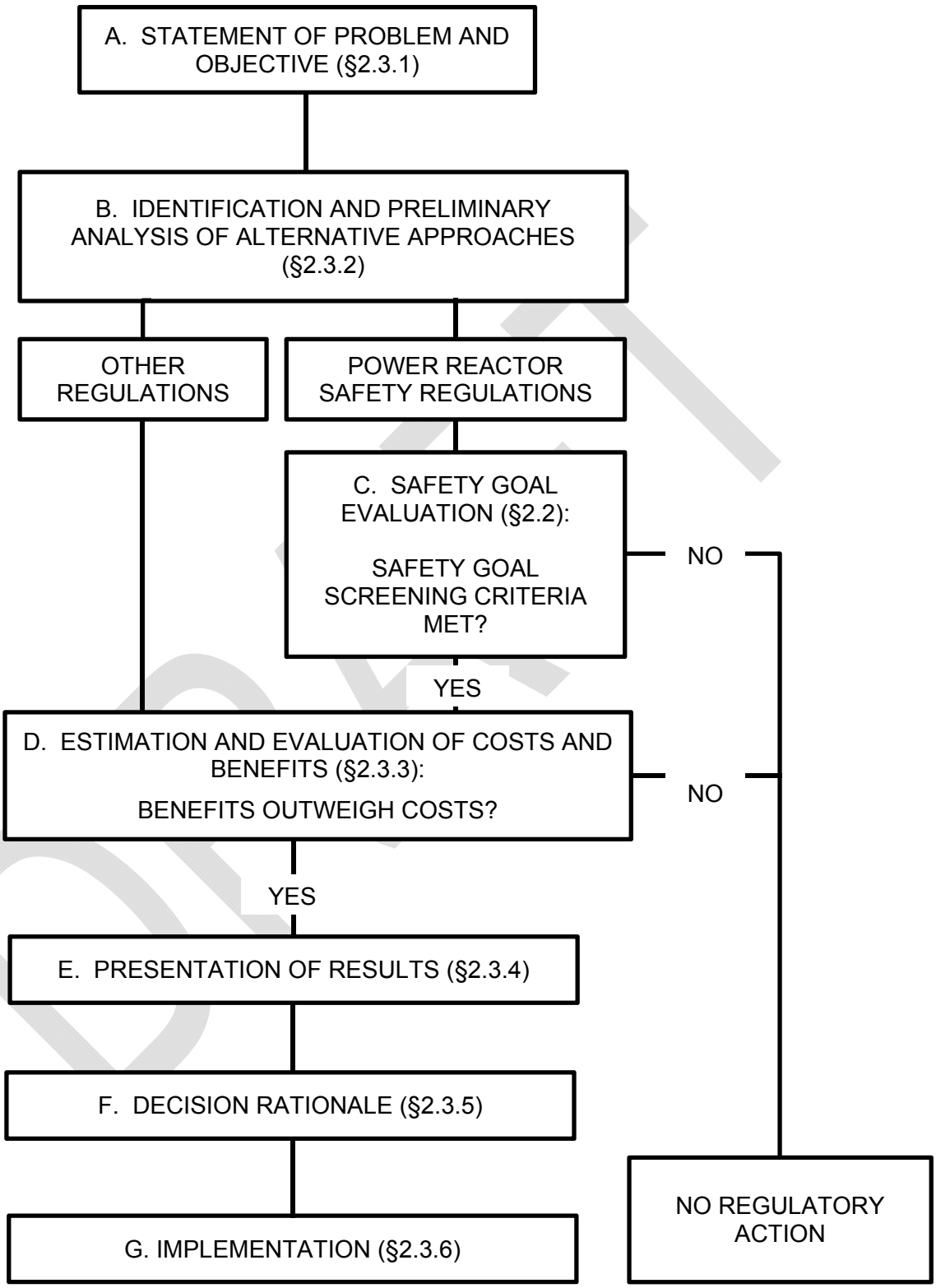


Figure 2-1 Elements of a Regulatory Analysis

DISCLAIMER: This is a working draft document for discussion purposes only. All information contained herein is subject to change upon further review by the U.S. Nuclear Regulatory Commission.

2.3 Elements of a Regulatory Analysis

This section presents the specific elements to be addressed in a regulatory analysis. The intent of this guidance is to ensure uniformity in the elements included in a regulatory analysis. A regulatory analysis consists of six elements:

(1) Statement of the problem and objective

(2) Identification and preliminary analysis of alternative approaches

(3) Estimation and evaluation of costs and benefits (incorporating a safety goal evaluation in appropriate cases)

(4) Presentation of results

(5) Decision rationale

(6) Implementation

A regulatory analysis should address each of these elements and should also include an executive summary, list of acronyms, and references.

Regulatory analyses are reviewed within the NRC and made publicly available. Reviewers include NRC technical staff and managers as well as formal groups such as the CRGR and the Advisory Committee on Reactor Safeguards (ACRS). Reviewers typically focus on the appropriateness of assumptions, the selection and elimination of alternatives, estimation techniques, evaluation methods, any limitations in the data used, and the decision rationale. To facilitate review by those non-NRC groups, the staff generally posts the analysis, with all the supporting documents, in ADAMS to allow public access to the analyses. A good analysis should be transparent with reproducible results. The basic assumptions, methods, data underlying the analysis, and discussion of the uncertainties associated with the estimates should be provided. Information obtained from outside the NRC, including that from parties interested in a proposed regulatory action, may be used in the regulatory analysis after the staff has validated the reasonableness of the information.

Because regulatory analyses are influential and have a specific role in the rulemaking process, minimum quality standards should be followed. The staff should provide documentation that the analysis is based on the best reasonably attainable scientific, technical, and economic information available. The staff should rely on peer-reviewed literature, when available, and provide the source for all original information. Further, the staff is encouraged to have the regulatory analysis peer reviewed, and be able to attest that the regulatory analysis satisfies the NRC's Information Quality Guidelines (Ref. 27**Error! Reference source not found.**).

Each of these elements are addressed in detail in the six sections below.

2.3.1 Statement of the Problem and Objective

This element allows the analyst to carefully establish the character of the problem, its background, boundaries, significance, and the objective.

The statement of the problem consists of several factors. A concise description of the problem or concern needs to be developed. Included in the description are 1) the basis for the problem statement (e.g., a series of equipment failures during operation or a major incident that reveals an inherent design weakness), and 2) the fundamental nature of the problem (e.g., inadequate design, inadequate inspection or maintenance, operator failure, failure to incorporate adequate human factors). Care should be taken to neither define the problem too broadly (making it difficult to target a regulatory action) nor too narrowly (risking non-solution of the problem when the regulatory action is implemented).

The scope of the problem should be discussed in terms of the affected entities to include their numbers, sizes, etc. The implications of taking no action (i.e., maintaining the status quo) should also be discussed.

Defining problem boundaries entails deciding the scope of the regulatory analysis. Systems, equipment, and operational activities at licensed facilities are highly interrelated, and there are typically numerous ways of viewing any particular problem. Consider, for example, the failure of a particular type of valve that serves two different safety-related coolant injection systems while also serving as a containment isolation valve. The problem resulting from failure of the valve can be viewed as a systemic problem for either of the injection systems or for the isolation valve system; or it could be viewed as part of a larger problem, such as inadequate maintenance or an inadequate quality assurance program.

Defining the appropriate boundaries can be complicated. It is important for the analyst to identify other proposed or ongoing NRC programs that may overlap or otherwise interface with the problem under consideration. The analyst should confer with those responsible for identified programs to determine appropriate boundaries. Interfacing programs should also be identified in the regulatory analysis document to facilitate communication between related programs.

The objective statement is a concise statement of the improvement sought by the proposed action. The objective should also be as specific as possible. For example, precluding a fire from disabling redundant safety systems or reducing the probability of component failure to some particular benefit would be acceptably specific. Some elaboration may be required to demonstrate how the objective would resolve the problem.

2.3.1.1 Background of the Problem

A background discussion of the problem should be included. The background discussion should include, as applicable:

- a brief history of the problem and the outcome of past efforts (if any) to resolve it
- any legislation or litigation[18] that directly or indirectly addresses the problem

[18] Litigation records could come from court cases, decisions by an Atomic Safety and Licensing or Appeal Board, or Commission decisions in cases under litigation.

- whether existing requirements have created or contributed to the problem and whether these requirements can be modified to achieve the regulatory objective more effectively

- the extent to which the immediate problem is part of a larger problem

- the relationship of the problem to other ongoing studies or actions[19]

- the objectives of the proposed new requirement and the relationship of the objectives to NRC's legislative mandates and authority, safety goals for the operation of nuclear power plants, and policy and planning guidance (e.g., the NRC's Strategic Plan (Ref. 33**Error! Reference source not found.**).

- the relationship of the problem to formal positions adopted by national and international standards organizations

- identification of any existing or proposed NRC (or Agreement State) regulatory actions that address the problem and their estimated effectiveness

- constraints or other cumulative impacts that work against solutions to the problem

- draft papers or other underlying staff documents supporting the requirements or staff positions.

2.3.2 Identification and Preliminary Analysis of Alternative Approaches

Identifying and evaluating alternative approaches to resolve problems is a key element in meeting the NRC's regulatory analysis policy.

Developing a set of alternative approaches needs to be done early in the analysis process to help maintain objectivity and prevent drawing premature conclusions.

The initial set of alternatives should be broad and comprehensive, but should also be sufficiently different to provide meaningful comparison and to represent the spectrum of reasonable possibilities. Alternatives that are minor variations of each other should be avoided. Taking no action should be viewed as a viable alternative except in cases where action has been mandated by legislation or a court decision. If a viable new alternative is identified after analysis has begun, it should be added to the list of alternatives and treated in the same manner as the original alternatives.

Once a broad and comprehensive list of alternatives has been developed, a preliminary analysis of the feasibility, benefits, and cost of each alternative is performed. Some alternatives may be eliminated based on clearly exorbitant costs in relation to benefits, technological infeasibility, severe enforcement or implementation problems, or other obvious considerations. Reduction of the list of alternatives at this point in the analysis will preserve resources needed to perform

[19] Reviewing issues associated with the problem in the context of other issues that apply to the same problem is important. These other issues may be among NRC's prioritized generic safety issues (Ref. 32**Error! Reference source not found.**) or other identified safety issues meriting NRC's attention.

detailed evaluation of benefits and costs of viable alternatives. The cost-benefit analysis document should list all alternatives identified and considered, and provide a brief rationale for eliminating certain alternatives during the preliminary analysis.

The level of analytical detail in the preliminary screening of alternatives need not be the same for all alternatives, particularly when one alternative can be shown to be clearly inferior or superior to the others. Rough estimates of benefits and costs should be made using simple analyses (in many cases, judgement may suffice). If several alternative actions are considered, comparisons can be based on the "expected-benefit" of each.

Using the rough estimates, and guidance provided by the Commission, the EDO, or the appropriate NRC office director, the significance of the problem should be estimated. This determination will usually result in a conclusion that a major or standard effort will be expended to resolve the problem. These two classifications are used to establish the level of detail to be provided in the regulatory analysis document and the amount of effort to be expended in performing the regulatory analysis. The significance of the problem will also help determine the priority assigned to its resolution.

Alternative regulatory documents that could be used to address regulatory concerns should also be identified at this time. The most common forms of documents include regulations, policy statements, orders, generic letters, and regulatory guides. Alternatives could include issuance of new documents or revision or deletion of existing ones. Other implementation means should be considered when appropriate (e.g., submission of proposed legislation to Congress).

Regulatory document alternatives should only be subjected to detailed regulatory analysis if preliminary assessment indicates significant differences in the benefits or costs among such alternatives. Otherwise, the means of implementing the proposed action should be discussed in the section of the regulatory analysis document covering implementation.

For alternatives that meet preliminary screening and that require a backfit analysis according to 10 CFR 50.109(a)(3) (Ref. 8**Error! Reference source not found.**), a general description of the activities that would be required by the licensee or license applicant to complete the backfit should be prepared at this point in the cost-benefit analysis process.

The alternative approaches that remain after the preliminary analysis is completed will be subjected to a detailed regulatory evaluation according to the guidance. Alternative instruments will be subjected to detailed regulatory analysis only if the preliminary analysis indicates that significant differences among these alternatives exist.

When appropriate, the analyst should consider including provision specifics for the preferred alternative. Adding the details allows the readers to track specific OMB supporting statements required by the Paperwork Reduction Act (Ref. 35**Error! Reference source not found.**). Adding provision details also aids the OMB desk officer and stakeholders. This detail can be provided in Section 2 of the regulatory analysis or perhaps as an appendix.

2.3.3 Estimation and Evaluation of Costs and Benefits

The analyst should make every effort to use quantitative attributes relevant to the cost-benefit analysis. The quantification should employ monetary terms whenever possible. Dollar benefits

should be defined in real or constant dollar benefits (i.e., dollars of constant purchasing power). If monetary terms are inappropriate, the analyst should strive to use other quantifiable benefits. However, despite the analyst's best efforts at quantification, there may be some attributes that cannot be readily quantified. These attributes are termed "qualitative" and handled separately from the quantitative ones (see Appendix A).

Estimates are made for those attributes that lend themselves to quantification using standard techniques. Obtaining the appropriate data may be more complicated when a major effort is being undertaken. In cases where a proposed action would result in significantly different attribute measures for different categories of licensees, separate estimates and evaluations should be made for each distinct category (e.g., older plants vs. newer plants) (see Appendix B).

If appropriate, qualitative considerations may also be evaluated. While these may be difficult to compare with the quantitative attributes, a consistent approach in their evaluation can result in a useful comparison among competing alternatives.

Depending upon the level of effort, either sensitivity or uncertainty analyses should be performed while quantifying the attributes to estimate the effect upon the results of variations in input parameters. Hypothetical best- and worst-case consequences may be estimated for sensitivity analyses. The output from the sensitivity analyses is used to determine the importance of various parameters and to approximate the uncertainties associated with the results. Actual uncertainty analyses should be more rigorous. A number of techniques are available, each with differences in usefulness of results and the amount of resources required. Uncertainty analyses should produce actual probability distributions for the overall results based on assumed distributions for selected input parameters. The differences between sensitivity and uncertainty analyses and their respective roles in cost-benefit analysis are discussed in Appendix C.

At this point, the above steps are repeated if there is another alternative to be evaluated. If not, results for all evaluated alternatives are put into a form for presentation in the cost-benefit analysis document.

2.3.4 Presentation and Summary of Results

The following items must be included in the presentation of results section of the regulatory analysis document for each alternative:

- presentation of the net benefit (i.e., the algebraic sum of the attributes) using the discount rate procedures

- estimates for each attribute for each alternative

- presentation of any attributes quantified in non-monetary terms in a manner to facilitate comparisons among alternatives

- the distribution of benefits and costs on impacted entities

- discussion of key assumptions and results of sensitivity analyses or uncertainty analyses

Key assumptions are to be specifically stated so that readers of the regulatory analysis have a clear understanding of the analysis and the decisionmaker will be able to assess the confidence to place in the results. Sources and magnitudes of uncertainties in attribute estimates and the methods used to quantify sensitivity or uncertainty estimates should be discussed in all regulatory analyses.

For alternatives projected to result in significantly different attribute measures for different categories of licensees, separate evaluations should be made for each distinct category. In cases where significant differences exist, their distributions with respect to the various groups involved should be discussed.

The effects of the proposed action on other NRC programs should be assessed. These could include eliminating or creating a need for other programs; use of limited NRC resources resulting in postponement or rescheduling of other programs; modifying accident probabilities resulting in changes to priority of, or need for, other programs; or developing information with a bearing on other programs. Effects on other government agencies, if any, should also be assessed and reported.

In cases where uncertainties are substantial or where important benefits cannot be quantified, alternatives that yield equivalent benefits may be evaluated based on their cost-effectiveness. This methodology should also be used when the levels of benefits are specified by statute.

Having completed the cost-benefit analysis for one or more alternatives of the proposed action, the analyst should summarize the results for each alternative using a summary table.

The presentation provides a uniform format for recording the results of the evaluation of all quantitative attributes plus a comments section to discuss other attributes and special considerations. It displays the results for the net-value measure.

All dollar measures should be present valued and expressed in terms of the same year. This may require conversion of some dollar values from whatever years in which they have been expressed to one common year. The Gross Domestic Product (GDP) price inflation can be used to convert historical nominal dollars to dollars of one common year.

When recording estimates for an attribute, the analyst should reference Appendix B for further guidance.

2.3.5 Decision Rationale

This element of the regulatory analysis provides the basis for selection of the recommended alternative over the other alternatives considered. In selecting the preferred alternative, decision criteria are used and reported in the regulatory analysis document. This element gives the minimum set of decision criteria to be used, as well as other considerations.

The net-benefit calculation is a compilation of all of the attributes that can be quantified in monetary terms. Certain attributes are generally quantified in other than monetary terms (e.g., public health [accident], which is measured in person-rems of exposure) and converted to

monetary terms with an established conversion factor (see Appendix H). These attributes are included in the net-benefit calculation. To aid the decision maker, the net benefit is to be computed for each alternative.

In considering the net benefit, care must be taken in interpreting the significance of the estimate. An algebraically positive estimate would indicate that the action has an overall beneficial effect; a negative estimate would indicate the reverse. However, if the net benefit is only weakly positive or negative, it would be inappropriate to lean strongly either way because minor errors or uncertainties could easily change the sign of the net benefit.

If the net benefit is calculated to be strongly positive or negative, the result can be given considerable significance because the variations in the assumptions or data would be much less likely to affect the sign of the net benefit. Even so, other considerations may overrule the decision supported by the net benefit (e.g., qualitative factors such as those embodied in the "qualitative" attributes).

Non-quantifiable attributes can only be factored into the decision in a judgmental way; the experience of the decisionmaker will strongly influence the weight that they are given. These attributes may be significant factors in regulatory decisions and should be considered, if appropriate.

In addition to being the "best" alternative based on monetary and non-monetary considerations, the selected alternative must be within the NRC's statutory authority and, when applicable, consistent with NRC's safety goals and policy. A showing of acceptable costs of the proposed action on other existing and planned NRC programs and requirements is also necessary. This will ensure that there are no negative safety impacts in other areas, that NRC resources are being used responsibly, and that all actions are adequately planned and coordinated. Any other relevant criteria may be used with adequate documentation in the regulatory analysis.

2.3.6 Implementation

An implementation schedule for the proposed action must be prepared. The schedule must identify all major steps or actions to be taken by all affected parties (the NRC, Agreement States, licensees, and any others) and the dates or amounts of time allocated to accomplish each step. The schedule must be realistic and allow sufficient time for such factors as needed analyses, approvals, procurement, installation and testing, and training. Anticipated downtime of licensee facilities to implement the proposed action must be specifically identified. Availability and lead time required for acquisition and installation of new equipment and replacement parts must be addressed. For NRC planning purposes, short- and long-term actions are to be identified in such a way as to clearly differentiate the two.

The implementation section of the regulatory analysis document should also identify the proposed NRC process (e.g., rule, regulatory guide, policy statement) for implementing the proposed action and the reasons for selecting the proposed process. The relationship of the proposed action to other NRC programs, actions, and requirements, both existing and proposed, should be established. To the extent possible, the analyst should assess the effects of implementation of the proposed action on the priorities of other actions and requirements and the potential need to revisit other regulatory analyses.

2.4 Safety Goal Evaluation for Operation of Nuclear Power Plants

The safety goal evaluation is designed to answer when a regulatory requirement should not be imposed generically on nuclear power plants because the residual risk is already acceptably low. This evaluation is intended to eliminate some proposed requirements from further consideration independently of whether they could be justified by a regulatory analysis on their net value basis.

When performing a safety goal evaluation, the analyst should be aware of any previous or ongoing safety improvements that have the potential to impact the status quo risks associated with the issues being addressed. Because there is no formal process for accounting for the potential dependencies between issues, the analyst must resort to a "best effort" approach in accounting for preexisting or concurrent impacts. The analyst should make a thorough effort to identify any previous or ongoing safety improvements that may impact the issue being evaluated. For example, an analyst addressing proposed improvements in a diesel generator performance at power reactors should be aware of any diesel generator improvements already addressed in station blackout considerations. To the extent possible, the analyst should modify the risk equations of the representative plant to reflect the upgraded status quo from these other safety improvements. The analyst can then proceed to evaluate the difference between this new status quo and the proposed improvements being addressed.

2.4.1 Implementation Guidance

In summary, the safety goal evaluations are based upon the following broad guidelines:

- Safety goal screening criteria are to be applied only to safety enhancements and evaluated for the affected class of nuclear power plants. Safety goals are to be used as a reference point in ascertaining the need for safety enhancements. However, the safety goals are not requirements, and, with the Commission's approval, safety enhancements may be implemented without strict adherence to the Commission's safety goal policy statement.

- Safety Goal evaluations are to be performed in conjunction with the substantial additional protection criterion contained in the backfit rule and applied to 10 CFR 50.109 analyses associated with substantial safety enhancements wherein the costs of the implementation are justified in view of the safety improvement to be realized.

- Evaluations of proposed regulatory initiatives for consistency with safety goals should identify and integrate related issues under study. Integration of related issues is essential to the efficient application of staff and industry resources. The overall objective is to avoid piecemeal evaluation of issues.

The NRC philosophy for safety goal evaluations involves the concept of defense-in depth and a balance between preventions and mitigation. This traditional defense-in-depth approach and the accident mitigation philosophy require reliable performance of containment systems. The safety goal evaluation focuses on accident prevention, that is, on issues intended to reduce core damage frequency (CDF). However, to achieve a measure of balance between prevention and mitigation, the safety goal screening criteria established for these evaluations include a

mechanism for having greater consideration of issues, and associated accident sequences, with relatively poor containment performance.

Prevention of Core Damage Accidents – Comparison with Subsidiary Goal for Core Damage Mean Frequency of 10-4 per Reactor Year

For proposed regulatory actions to prevent or reduce the likelihood of sequences that can lead to core damage events, the change in the estimated CDF[20] per reactor year needs to be evaluated and addressed in the regulatory analysis. The objective is to ensure that emphasis is placed on preventing core damage accidents.

This calculation should be computed on a generic basis for the class of affected plants. The resulting change in CDF should be representative for the affected class of plants. The selection of the PRA model (or models) and the associated data base must be identified and justified as representative of the class. For example, if the class of affected plants is exclusively older boiling-water reactors (BWRs), one or more PRAs from individual plant examination submittals or that have otherwise been conducted for older BWRs should be selected. Table 2-1 lists PRAs available for use with staff risk assessment codes along with some basic attributes of each (e.g., plant type and year of initial commercial operation). As a minimum, the merit of the proposed new requirements should be explored and displayed using PRA data from multiple plants within the class. This will result in identification and assessment of the range of reduction in CDF, as well as an estimation of the representative change for the class. Uncertainties and limitations should be addressed qualitatively and, to the extent practical, quantitatively in the supporting documentation for the proposed regulatory action. This would include, for example, plant-to-plant variabilities within a class of plants.

Table 2-1 Nuclear power plants risk assessments

Plant	Type	Year Commercial	Analysis Level	External Events?	Program	References
Brunswick-1/2	GE BWRs	1977/75	1	No	Industry Reviewed	April 1988 NUREG/CR-5465 November 1989
Grand Gulf-1	GE BWR	1983	3	No	NUREG-1150	NUREG/CR-4551, V.6, September 1989 Brown et al. 1990 (Ref. 49)
Indian Point-2	W PWR	1974	3	Yes	Industry NRC Report	PASNY 1982 NUREG/CR-1410 and 1411, August 1980
					Reviewed	NUREG/CR-2934, December 1982
					Reviewed	NUREG/CR-0850, November 1981
LaSalle County-1	GE BWR	1984	3	Yes	Industry RMIEP, NRC	Call et al. 1985 (Ref. 10) NUREG/CR-4832, 1992 and 1993

[20] Core damage frequency is defined as the likelihood of an accident involving the loss of adequate cooling to reactor fuel elements up to and including major damage to a reactor core with consequent release of fission products, but not necessarily involving a breach of the reactor vessel.

Plant	Type	Year Commercial	Analysis Level	External Events?	Program	References
Peach Bottom-2 (Also train level)	GE BWR	1974	3	Yes	NUREG-1150	NUREG/CR-4551, V.4, August 1989 Payne et al. 1990 (Ref. 48)
Sequoyah-1	W PWR	1981	3	No	NUREG-1150	NUREG/CR-4551, V.5, April 1990 Gregory et al. 1990 (Ref. 50)
Surry-1	W PWR	1972	3	Yes	NUREG-1150	NUREG/CR-4551, V3, April 1990 Breeding et al. 1990 (Ref. 51)
Zion-I	W PWR	1973	3	No	NUREG-1150	NUREG/CR-4551, V.7, May 1990 Park et al. 1990 (Ref. 52)
AP-600	W PWR	*			*	Reviewed by NRC 1993
CESAR System 80+	CE PWR	*			*	Reviewed by NRC 1992
* Advanced reactor designs						

The risk assessments and analyses needed for safety goal evaluations should normally have the following characteristics:

- The analysis should explicitly define the class of affected plants and justify the use of specific PRAs to represent that class.
- The PRA should reflect the current state of PRA technology and include an analysis of uncertainties.
- The product of the analyses should be mean values and uncertainty estimates.
- The analysis should receive an independent review by staff knowledgeable and experienced in PRA, as well as reviews by the individual or group that identified the issue and the group that would be responsible for implementing the resolution.
- The analysis should be documented with sufficient detail to enable the analysis to be repeated. In addition, sufficient explanatory material should be provided to enable the reader to understand the significance of the calculations and to reconcile the various calculations with engineering judgment. Thus, the event or issue, its relationship to safety, the calculation approach, and all assumptions should be listed and justified, including choice of base PRA, choice of parameters, source of basic data, any mathematical approximations used, etc. The accident sequences affected should be described and explanations of why they are affected should be provided.

The documentation should not present calculation results with more significant figures that are appropriate. More than one significant figure in the mantissa is not appropriate in most cases. Note, however, that if intermediate results are presented, a reader attempting to use these

intermediate results in duplicating the calculation may not calculate exactly the same final results due to rounding errors.

In comparing the estimated resulting change in CDF for the affected class of plants, contributions from both internal and external events should be considered to extent that information is available and pertinent to the issue. However, the uncertainties associated with certain external event risk contributions (especially seismic) can be relatively large. Therefore, to supplement any available quantitative information, qualitative insights should be used for issues involving external events.

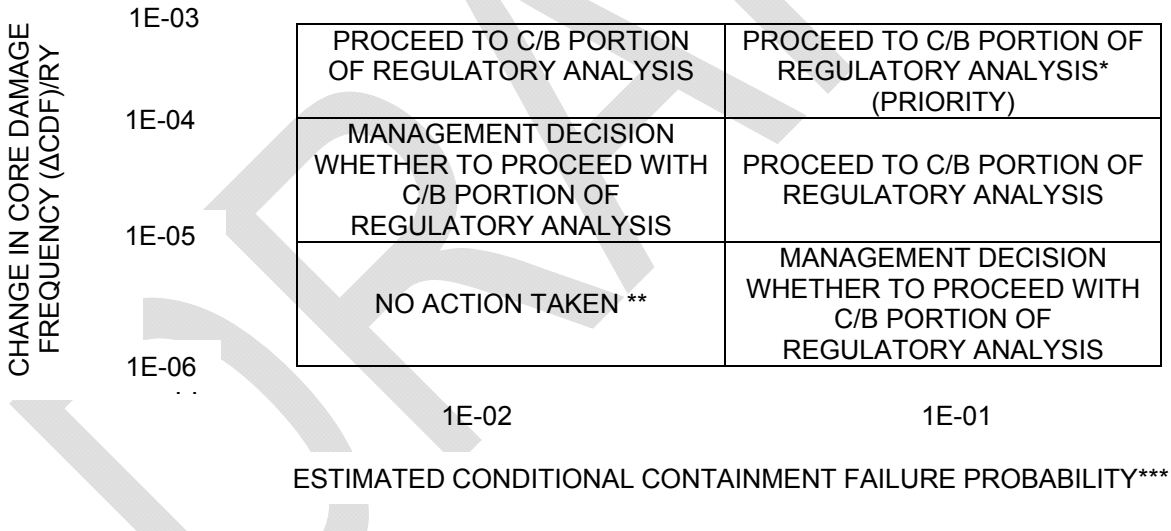
For the purpose of evaluating regulatory initiatives against safety goals, the magnitude of the change in CDF should be considered in concert with the determination of whether the substantial additional protection criterion of the backfit rule is met. Specifically, a single common criterion is to be used for determining whether a regulatory initiative involving a reduction in CDF (1) meets the substantial additional protection standard identified in the backfit rule (Ref. 8) and (2) is appropriate, considering the subsidiary safety goal[21] of 10^{-4} in mean CDF per reactor year.

In light of the inherent uncertainties of PRA analysis, a reduction in CDF will be considered to be clearly substantial if the reduction is equal to or greater than 10^{-4} per reactor year. If the reduction in CDF is 10 percent or more of the subsidiary safety goal of 10^{-4} in mean CDF per reactor year but less than 10^{-4}, consideration should be given to the probability of containment failure before a conclusion is reached on whether the reduction in CDF constitutes substantial additional protection. As illustrated in Figure 2-2, this means that, with certain exceptions as discussed later in this document, regulatory initiatives involving new requirements to prevent core damage should result in a reduction of at least $1x10^{-5}$ in the estimated mean value CDF (i.e., the CDF before the proposed regulatory change should exceed the CDF after the change by at least $1x10^{-5}$) in order to justify proceeding with further analyses. This safety goal screening criterion was selected to provide some assurance that the PRA and data limitations and uncertainties, as well as the variability's among plants, will not eliminate issues warranting regulatory attention. This does not mean that in all cases a proposed safety enhancement of at least $1x10^{-5}$ will subsequently prove to be justified for implementation after more detailed assessments are performed in accord with Section 2.5 of this guidance. In this regard, the effect of uncertainties should be considered and discussed.

[21] This goal has been determined by the staff to be a useful benchmark, but is not a Commission-approved safety goal.

After the significance has been determined as measured by the estimated reduction in CDF of the proposed new requirement for the affected class of plants, guidance on further staff action is as follows:

Estimated Reduction in CDF	Staff Action
>10^{-4}/reactor year	Proceed with the regulatory analysis on a high-priority basis
10^{-4}-10^{-5}/reactor year	The decision whether to proceed with the regulatory analysis is to be made by the responsible division director (see Figure 2-2).
<10^{-5}/reactor year	Terminate further analysis unless the office director decides otherwise based upon strong engineering or qualitative justification (see Figure 2-2).



* A determination is needed regarding adequate protection or compliance; as a result, a cost-benefit analysis may not be appropriate.

** Unless office director decides that the screening criteria do not apply (see Additional Consideration of Containment Performance)

*** Conditional upon core damage accident that releases radionuclides into the containment (see Additional Consideration of Containment Performance)

Figure 2-2 Safety Goal Screening Criteria

The evaluation of CDF reduction provides a calibration on the significance of the proposed regulatory action. If the initiative results in a small change in CDF (less than $1x10^{-5}$/reactor year), the regulatory analysis should in general proceed only if an alternative justification for the

proposed new requirement can be formulated. A class of accident sequencing involving the potential for early containment failure or containment bypass should receive further consideration even if the reduction in CDF is less than $1x10^{-5}$/reactor year. However, there may be other special circumstances that should be analyzed. The staff should forward the issue (and include sufficient supporting information) for office director review.

If it is not possible to develop adequate quantitative supporting information for the proposed new requirement, a qualitative analysis and perspective should be provided. To the extent practical, these points and insights should be related to the safety goal screening criteria. For example, how does the proposed initiative affect the CDF and to what extent? How should the risk and the expected improvement be measured or estimated?

The safety goal screening criteria are in terms of a mean for the class of plants. However, the range within the class of risk reduction is also important. Consequently, when performing safety goal evaluations, if specific plants are identified as "outliers," the situation should be noted for specific regulatory follow up (e.g., for evaluations regarding potential plant-specific backfits).

2.4.1.1 Additional Consideration of Containment Performance

The previous section focuses on accident prevention, that is, on issues intended to reduce CDF. To achieve a measure of balance between prevention and mitigation, the safety goal screening criteria established for safety goal evaluations include a mechanism for having greater consideration of issues, and associated accident sequences, with relatively poor containment performance. The measure of containment performance to be used in safety goal evaluations is the conditional probability of early containment failure or bypass (CPCFB)[22]. The safety goal screening criteria shown in Figure 2-2 are subdivided to require greater staff emphasis on the higher valued (i.e., greater than 0.1) CPCFBs. A CPCFB value of 0.1 is consistent with Commission guidance on containment performance for evolutionary designs. In effect, the use of the CPCFB reduces the priority of or eliminates the additional study of issues associated with those CPCFBs of less than 0.1.

The safety goal screening criteria provided in this guidance are based upon the recognition that the severe accident risk to the individual is dominated by the overall frequency of the following kinds of scenarios:

- those involving core damage and release into an intact containment with early containment failure occurring

[22] CPCFB in this context is the conditional probability of early containment failure or bypass given a core melt. In NUREG-1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," (Ref. 67), early containment failure is defined as "those containment failures occurring before within a few minutes of reactor vessel breach for pressurized water reactors (PWRs) and those failures occurring before or within 2 hours of vessel breach for BWRs. Containment bypass failures (e.g., interfacing-system loss-of-coolant accidents) are categorized separately from early failures" (Ref. 25). The definition recognizes the impacts of early failure and uses that as a baseline from which to assess containment performance, (e.g., CPCFB changes). In applying these screening criteria, the CPCFB definition may be extended, if appropriate, to up to 4 hours after vessel breach, to permit initiation of accident management and emergency preparedness actions. It is not a goal being sought because the staff recognizes the benefits of prolonging containment failure in those scenarios that risk early failure.

- those involving core damage and for which the containment system is breached as a result of accident phenomena either before or early in the core damage or melt progression

- those involving preexisting conditions that cause loss of containment integrity before core damage (e.g., large openings)

- those for which containment is bypassed entirely and which have high probability of causing core damage to occur (e.g., intersystem loss-of-coolant accident).

The NRC recognizes that in certain instances, the screening criteria may not adequately address certain accident scenarios of unique safety or risk interest. An example is one in which certain challenges could lead to containment failure after the time period adopted in the safety goal screening criteria, yet early enough that the contribution of these challenges to total risk would be non-negligible, particularly if the failure occurs before effective implementation of accident management measures. In these circumstances, the analyst should make the case that the screening criteria do not apply and the decision to pursue the issue should be subject to further management decision.

Furthermore, note that the safety goal screening criteria described in this guidance do not address issues that deal only with containment performance. Consequently, issues that have no impact on core damage frequency (ΔCDF of zero) cannot be addressed with the safety goal screening criteria. However, because initiatives have been relatively few and infrequent compared with accident preventive initiatives, mitigate initiatives will be assessed on a case-by-case basis with regard to the safety goals. Given the very few proposed regulatory initiatives that involve mitigation, this should have little overall impact from a practical perspective on the usefulness of the safety goal screening criteria.

2.4.1.2 Summary of Safety Goal Screening Criteria Guidance

Figure 2-2 graphically illustrates the safety goal screening criteria and provides guidance as to when the staff should proceed to the estimation and evaluation of the values and impacts portion of the regulatory analysis and when a management decision is needed.

Management with responsibility for preparation of a safety goal evaluation should review the results of the evaluation and the overall uncertainty and sensitivity of associated estimates. A judgment should be made whether substantial additional protection would be achievable and whether continuation of the regulatory analysis process is therefore warranted.

2.4.1.3 Regulatory Analysis

If the safety goal evaluation of the proposed regulatory action results in a favorable determination (i.e., any decision except no action), the analyst may presume the substantial additional protection standard of 10 CFR 50.109(a)(3) is achievable (Ref. 8). The initiative should then be assessed in accordance with Section 2.4.1 of this guidance (see Figure 2-1). If the net value calculation required by Section 2.4.1 is not positive, further activities and analyses should be terminated unless there is a qualitative justification for proceeding further.

The Commission has directed that NRC's regulatory actions affecting nuclear power plants be evaluated for conformity with NRC's Policy Statement on Safety Goals for the Operations of Nuclear Power Plants (Ref. 9). The Policy Statement sets out two qualitative safety goals and two quantitative objectives. Both the goals and objectives apply only to the risks to the public from the accidental or routine release of radioactive materials from nuclear power plants.

The qualitative safety goals in the Policy Statement are

- individual members of the public should be provided a level of protection from the consequences of nuclear power plant operation such that individuals bear no significant additional risk to life and health

- societal risks to life and health from nuclear power plant operation should be comparable to or less than the risks of generating electricity by viable competing technologies and should not be a significant addition to other societal risks.

The two quantitative objectives in the Policy Statement are to be used in determining achievement of the qualitative safety goals. The objectives are

- the risk to an average individual in the vicinity of a nuclear power plant of prompt fatalities that might result from reactor accidents should not exceed 0.1% of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population are generally exposed

- the risk to the population in the area near a nuclear power plant of cancer fatalities that might result from nuclear power plant operation should not exceed 0.1% of the sum of cancer fatality risks resulting from all other causes.

This guidance contains specific information implementing the quantitative objectives that the analyst should carefully follow.

This guidance states that a safety goal evaluation is needed for a proposed generic safety enhancement backfit to nuclear power plants that is subject to the substantial additional protection standard at 10 CFR 50.109(a)(3). Thus, proposals for a plant-specific backfit or for generic backfits within the exceptions at 10 CFR 50.109(a)(4)(i-ii) do not require a safety goal evaluation. This guidance also states that a safety goal evaluation is not needed for a proposed relaxation of a requirement affecting nuclear power plants.

This guidance states that a PRA should normally be used in performing a safety goal evaluation to quantify the risk reduction and corresponding values of a proposed new requirement.[23] NRC's Final Policy Statement on the use of PRA methods in nuclear regulatory activities (Ref. 24**Error! Reference source not found.**) contains the following statement:

> The Commission's safety goals for nuclear power plants and subsidiary numerical objectives are to be used with appropriate consideration of uncertainties in making regulatory judgments on the need for proposing and backfitting new generic

[23] SECY-95-079 contains a status update of NRC's PRA implementation plan (Ref. 30**Error! Reference source not found.**). SECY-95-280 contains a framework for applying PRA in reactor regulation (Ref. 31).

requirements on nuclear power plant licensees.

PRA data can be used in a safety goal evaluation. Table 2-1 contains a list of PRAs and their characteristics, which can potentially be used in performing safety goal evaluations.

If conducted, a safety goal evaluation should be included in Section 3 of the regulatory analysis document that covers "estimation and evaluation of cost benefit." The results of the safety goal evaluation should be included in Section 4 of the regulatory analysis document that covers "presentation of results."

2.4.2 New Power Reactors under 10 CFR Part 52

When analyzing risks from severe accidents as part of the environmental review under 10 CFR Part 52 for an early site permit or for a combined license as provided in NUREG-1555, the reviewer should compare the site-specific severe accident dose risks with the Commission's Safety Goals (Ref. 9). New reactor designs submitted for standard certification must comply with the PRA requirements in 10 CFR Part 52.

2.4.3 Substantial Safety Enhancement

A substantial safety enhancement has two aspects:

- the safety enhancement is real in the sense that most professionals would agree that the benefit exists and is not speculative, and
- the benefit is a relatively large increase.

In the 1985 Backfit Rule statement of consideration, reiterated in the 1993 SRM (Ref. 26), the Commission said:

> Substantial means "important or significant in a large amount, extent, or degree." Under such a standard the Commission would not ordinarily expect that safety improvements would be required as backfits that result in an insignificant or small benefit to public health and safety or common defense and security, regardless of costs. On the other hand, the standard is not intended to be interpreted in a manner that would result in disapprovals of worthwhile safety or security improvements having costs that are justified in view of the increased protection that would be provided (50 FR 38097, 38102, September 20, 1985).[24]

As a result, backfitting has more stringent criteria than regulatory analysis because the change must meet the following two sequential criteria:

1. substantial increase in safety or security

[24] In a 1993 staff requirements memorandum SECY-93-086 (Ref. 26), the Commission said that it continues to believe that these words embody a sound approach to the "substantial increase" criterion and that this approach is flexible enough to allow for qualitative arguments that a given proposed rule would substantially increase safety. Additionally, in the context of 10 CFR Part 70 licensing actions as documented in SRM-SECY-98-185 (Ref. 108), the Commission supported the requirement that "any new backfit pass a cost-benefit test without the 'substantial' increase in safety test. The Commission believes that modest increase in safety at minimal or inconsequential cost should be justified on a cost-benefit basis."

2. cost of the safety or security increase is justified in light of the increase in safety or security (i.e., cost-beneficial).

2.5 Relationship to Other Procedural Requirements

This section discusses the relationship of regulatory analyses to other statutory requirements applicable to the NRC. The documentation required by the Regulatory Flexibility Act (Ref. 36**Error! Reference source not found.**) is typically included as an appendix to the regulatory analysis; documentation required by the Paperwork Reduction Act (Ref. 35), though not appended to the regulatory analysis, must be developed and approved concurrently. The remaining procedural requirements discussed here typically involve issues closely related to those examined in the regulatory analysis.

2.5.1 Paperwork Reduction Act

The Paperwork Reduction Act (Ref. 35**Error! Reference source not found.**) contains procedural requirements designed to minimize and control the burdens associated with collections of information by Federal agencies from individuals, businesses and other private entities, and state and local governments. The NRC's internal procedures for complying with the Paperwork Reduction Act and preparing justifications for OMB approval of information collections are in NRC Management Directive 3.54, "NRC Collections of Information and Reports Management," issued May 2006 (Ref. 37), and in the NRC Regulations Handbook (Ref. 38).

Whenever a proposed regulatory action involves information collections subject to OMB approval, an OMB clearance package must be prepared for the rulemaking. While the OMB clearance package need not be included as part of the rulemaking package that is submitted to the EDO or Commission for approval, the clearance package must be approved by the NRC Clearance Officer for submittal to OMB before the rule can be submitted to the Office of the *Federal Register* for publication.

Agencies are required to obtain OMB approval for collections of information when under any of the following conditions: (1) the information collection involves 10 or more persons by means of identical questions or reporting or recordkeeping requirements, or (3) the collection is addressed to all or a substantial majority of an industry, even if that majority involves fewer than 10 persons (Ref. 39).

OMB's criteria for approval of information collections are contained in 5 CFR 1320.5(d) (1). To obtain OMB approval for information collections, an agency must demonstrate that the collection of information (1) is the least burdensome necessary for the proper performance of the agency's functions to comply with legal requirements and achieve program objectives, (2) is not duplicative of information otherwise available to the agency, and (3) has practical utility. The agency should minimize its cost of collection, processing, and using the information, but not by shifting disproportionate costs or burdens onto the public. Agencies should consult with interested agencies and members of the public in an effort to minimize the burden of the information collection to the public. OMB clearance packages are to identify any significant burdens placed on a substantial number of small businesses or entities.

In the event that OMB disapproves an information collection, independent regulatory agencies such as the NRC, may override the disapproval or stay of effectiveness of approval of a collection of information by a majority vote of the Commissioners. Procedures for Commission override of OMB disapproval are contained in NRC MD 3.54.

2.5.2 Regulatory Flexibility Act

The Regulatory Flexibility Act (Ref. 36) requires Federal agencies to prepare a regulatory flexibility analysis if a proposed rule will have significant economic impact on a substantial number of small entities. The analysis is to describe the impact of the proposed rule on small entities (Ref. 41). The size standards used by the NRC to qualify a licensee as a small entity, codified at 10 CFR 2.810 (Ref. 42**Error! Reference source not found.**), are as follows:

- A small business is a for-profit concern and is a concern that provides a service or a concern not engaged in manufacturing with average gross receipts of $7.0 million or less over its last 3 completed fiscal years

- A manufacturing concern with an average number of 500 or fewer employees based upon employment during each pay period for the preceding 12 calendar months.

- A small organization that is a not-for-profit organization that is independently owned and operated and has annual gross receipts of $7.0 million or less.

- A small governmental jurisdiction that is a government of a city, county, town, township, village, school district, or special district with a population of less than 50,000.

- A small educational institution is one that is (1) supported by qualifying small government jurisdiction or (2) not state or publicly supported and has 500 or fewer employees.

The NRC Regulations Handbook (Ref. 38) sets out procedural requirements for preparation of regulatory flexibility analyses. The NRC public website provides a summary of these procedures. If a proposed rule would likely have a significant economic impact on a substantial number of small entities, a draft regulatory flexibility analysis must be prepared consistent with the NRC procedural requirements. The regulatory flexibility analysis is normally included as an appendix to the regulatory analysis document and as an insert to the proposed rule. The regulatory flexibility analysis need not repeat information discussed in the body of the regulatory analysis; such information may be incorporated by reference. If the NRC determines that the proposed rule would not have a significant economic impact on a substantial number of small entities, a certification to this effect must be included in the proposed rule and repeated in the final rule. The regulatory analysis must contain sufficient information concerning the potential impact of the proposed rule on small entities to support this certification.

2.5.3 National Environmental Policy Act

When a generic or programmatic EIS has been prepared under NEPA that provides the technical basis for a proposed regulatory action, a brief summary of the EIS will be an acceptable substitute for the information and analysis requirements identified in Sections 4.1-4.4

of this guidance. The EIS may be referenced at other appropriate points in the regulatory analysis to avoid duplicating existing written material.

When a regulatory analysis and an EIS or EA are being prepared for a proposed regulatory action, preparation of the two documents should be coordinated as much as possible. For example, the alternatives evaluated in the regulatory analysis should correspond as much as possible to the alternatives evaluated in the EIS or EA.

2.5.4 Information Requests Under 10 CFR 50.54(f)

Procedures for NRC information requests directed to production and utilization facility licensees appear at 10 CFR 50.54(f) (Ref. 8**Error! Reference source not found.**). The regulation requires NRC to prepare a written statement justifying the reasons for the information request, except when the information is needed to verify licensee compliance with the current licensing basis for the facility. The written statement is to establish that the burden imposed on the licensee is justified in view of the potential safety significance of the issue. All justification statements must be approved by the EDO or his or her designee prior to issuance of the information request.

Section IV(B)(xi) of the CRGR Charter (Ref. 14) contains additional guidance for information requests affecting multiple nuclear power plants. The CRGR Charter specifies that when a written justification is required, the written statement is to include the following:

- A problem statement that describes the need for the information in terms of the potential safety benefit
- The licensee actions required and the estimated cost to develop a response to the information request
- An anticipated schedule for NRC use of the information
- A statement affirming that the request does not impose new requirements on the licensee.

NRC Management Directive (MD) 8.4 (Ref. 25) discusses plant-specific information requests directed at individual nuclear power plants.

Written statements prepared according to the proceeding requirements to justify information requests are not regulatory analyses within the scope of this guidance. Nevertheless, the written justification will have many of the elements of a regulatory analysis. The elements of a regulatory analysis discussed in Section 2.5 of this guidance can appropriately be included in an information request justification. An information request justification will normally be a more concise document than a regulatory analysis.

3 BACKFITTING AND ISSUE FINALITY

3.1 General

Over the years, issues with regard to what constitutes a backfit and questions on agency policy and practices have been raised inside and outside the agency. This guidance is intended to address these issues and promote a clearer understanding of the backfit rule and both the generic and plant-specific backfit policies and associated processes that have been adopted by the NRC.

The Commission revised the backfit rule (Ref. 8) in 1985 to provide more specific guidance for backfitting decisions and to provide for management control and accountability of backfits. Although the 1985 rule was superseded, it is included as Appendix A in NUREG-1409 (Ref. 20) because its statement of considerations provides background information on the development of current practice.

The 1985 backfit rule and the NRC Manual Chapter (Ref. 25), which implemented the rule, were vacated by the U.S. Court of Appeals in 1987. The court stated that the rule was ambiguous about whether economic costs would be considered in ensuring or redefining adequate protection of the public health and safety. In 1988, a revised backfit rule was published to clearly state that economic costs cannot be considered (1) when a modification is necessary to bring a facility into compliance with Commission rules or written licensee commitments, (2) when regulatory action is necessary to ensure adequate protection of public health and safety, or (3) when the regulatory action involves defining or redefining the adequate protection standard (Ref. 46). The court upheld the 1988 revised rule, which is included as Appendix B in NUREG-1409.

Backfits are expected to occur as part of the regulatory process to ensure the safety of power reactors and radioactive materials. It is important for sound and effective regulation, however, that backfitting be conducted by a controlled and defined process. The NRC backfitting process is intended to provide for a formal, systematic, and disciplined review of new or changed positions before imposing them.

The backfit process enhances regulatory stability by ensuring that changes in regulatory staff positions are justified and suitably defined. For example, even if not needed to meet the standard of adequate protection or to ensure compliance, backfitting is proper if a substantial safety benefit is realized and the costs are justified by the safety benefit.

3.2 Discussion

3.2.1 Nature and Types of Backfits

3.2.1.1 Background

Backfitting is defined in 10 CFR 50.109 (Ref.8) as the modification of or addition to systems, structures, components, or design of a facility; or the design approval or manufacturing license for a facility; or the procedures or organization required to design, construct, or operate a facility; *and* may result from a new or amended provision in Commission rules or the imposition of a regulatory staff position that is either new or different from a previously applicable staff position *and* effective after specific dates keyed to the effective date of the backfit rule.

Note that the backfit rule and the definition of backfitting apply to cases of compliance and cases of adequate protection as well as to cases of cost-justified substantial safety improvement. They are all backfits but require different types of justification as discussed further in Section 3.2.1.5 of this guidance.

Backfitting applies to nuclear power reactors and certain radioactive material provisions. The scope of the backfitting rules include all design and hardware aspects of systems, structures, and components as well as supporting activities reflected by procedures and organization.

The rule is intended to encompass only positions or requirements that bring about improvements in safety. Therefore, NRC actions that merely request information and do not impose changes (specifically in hardware, procedures, or organization) are not covered under the backfit rule, but may be addressed under 10 CFR 50.54(f). The use of 10 CFR 50.54(f) requires an analysis of the burden to be imposed on responders, but this analysis has a limited scope and depth relative to that required for a backfit analysis.

The backfit rule applies to actions that impose positions or requirements on licensees; it does not apply to requested actions that are optional or voluntary. Generally, it does not apply to relaxations. However, if requirements are reduced but not mandatory, the backfit rule would apply if licensees are required to make the changes in order to achieve a greater level of safety.

The backfit rule does not apply to specific requirements imposed by statute. For example, if a statute requires a revision to license fee schedules, the backfit rule does not apply.

The backfit rule does not apply to purely administrative matters. For example, a change in the number of copies of safety analysis reports that licensees must submit to the NRC would not be covered by the backfit rule.

Different standards apply to the imposition of more stringent safety requirements for standard design certifications (SDCs) or early site permits issued under 10 CFR Part 52 (Ref. 47). For example, during the pendency of the statements of consideration (SOC), backfits of the SOC are permitted only for the sake of compliance or adequate protection. Those standards are not covered in this guidance.

In its amended (Ref. 46) form, the rule requires a backfit analysis, including consideration of associated implementation costs, for all proposed backfits with the following exceptions:

- modifications necessary to bring a facility into compliance with its license or into conformance with written commitments by the licensee
- actions necessary to ensure adequate protection
- actions that involve defining or redefining what constitutes adequate protection

For these exceptions, instead of a backfit analysis, the rule requires a documented evaluation including a statement of the objectives of and the reasons for the backfit and the basis for invoking the exception. For additional background see NUREG-1409 (Ref. 20).

3.2.1.2 Backfit Determination

A backfit involves a modification to the plant, design approval, manufacturing license, procedures, or organization. In addition, (1) a new or revised staff position or requirement must be involved, that is, there must be a change in content or applicability of the previously applicable regulatory staff position (in the direction of increased safety requirements) and (2) this change must be issued after specified dates or milestones.

3.2.1.3 Applicable Regulatory Staff Position

A requirement or position already specifically imposed on or committed to by a licensee is called an applicable regulatory staff position. There are several different types of positions, such as:

- legal requirements, as in explicit regulations, orders, and plant licenses and in amendments, conditions, and technical specifications

- written licensee commitments such as those contained in the final safety analysis report, licensee event reports, and docketed correspondence, including responses to NRC bulletins, generic letters, inspection reports, notices of violation, and confirmatory action letters.

NRC staff positions are documented explicit interpretations of more general regulations and are contained in documents such as the Standard Review Plan, branch technical positions, regulatory guides, generic letters, and bulletins.

For the purpose of this guidance, a change in the applicable regulatory staff position will be subsequently referred to as a new or revised position.

3.2.1.4 Justification for Imposing Backfits

3.2.1.5 Basic Backfit Justification (Backfit Rule)

The NRC staff is responsible for identifying plant-specific and generic backfits and for determining if proposed new or revised positions would constitute a backfit. Staff positions are not communicated to licensees unless the NRC official communicating that position determines whether the position is a backfit. At any point during the process, it may be decided to drop the position because further work is not likely to show (a) that the resulting safety benefit is required for compliance or adequate protection or (b) that the action would provide substantial additional overall protection and the direct and indirect costs of implementation would be justified.

(a) Documented Evaluation (Compliance and Adequate Protection)

In the case of ensuring compliance with existing requirements or commitments, a backfit analysis is not required. Instead, if a finding is made that the action is necessary to ensure compliance, then a documented evaluation of the type discussed in 10 CFR 50.109(a)(6) (Ref. 8**Error! Reference source not found.**) is prepared. The documented evaluation includes a statement of the objectives of and the reasons for the action and the basis for invoking the compliance exception.

Similarly, in the case of a backfit needed to ensure adequate protection of public health and safety, a backfit analysis is not required. A documented evaluation of the type discussed in 10 CFR 50.109(a)(6) is prepared and a finding is made that the action is necessary for adequate protection. The documented evaluation includes a statement of the objectives of and the reasons for the backfit and the basis for invoking the adequate protection exception. The concept of what constitutes adequate protection is an evolving standard. It is expected that this standard will continue to change to keep up with new information and with improvements in nuclear power technology.

For either the compliance case or the adequate protection case, if immediately effective regulatory action is needed, the required documented evaluation may follow the issuance of the regulatory action.

(b) Cost-Justified Substantial Safety Enhancement

For backfits providing a cost-justified substantial safety enhancement, the staff must develop a backfit analysis of the type discussed in 10 CFR 50.109(a)(3) and 10 CFR 50.109(c) to document a finding that there is a substantial safety benefit to be achieved and that the costs are justified by the benefit. The backfit analysis considers how the backfit should be scheduled in light of other ongoing regulatory activities at the facility. Information should include the following factors as may be appropriate:

- statement of the specific objective that the proposed backfit is designed to achieve
- general description of the activity that would be required by the licensee or applicant in order to complete the backfit
- potential for change in the risk to the public from the accidental offsite release of radioactive material
- potential impact of radiological exposure to facility employees
- installation and continuing costs associated with the backfit, including the cost of facility downtime or the cost of construction delay (i.e., resource burden on licensees)
- the potential safety impact of changes in plant or operational complexity, including the relationship to proposed and existing regulatory requirements
- the estimated resource burden on the NRC associated with the proposed backfit and the availability of such resources
- the potential impact of differences in facility type, design, or age on the relevancy and practicality of the proposed backfit
- whether the proposed backfit is interim or final and, if interim, the justification for imposing the proposed backfit on an interim basis

For this type of backfit, there first must be a substantial increase in overall protection (or common defense and security), even for requirements that might bring about a net-cost savings. If there is a substantial increase, then the cost justification must be considered. The backfit rule requires the NRC to consider the cost of facility downtime or construction delay as costs associated with the backfit.

Averted onsite costs can arise when it is estimated that the backfit will save money for licensees, such as by reducing forced outage rates. These savings are not treated as a benefit (safety

enhancement). They are, however, considered as a negative cost, that is, an offset against other licensee costs. Averted offsite costs can result from an estimated decrease in accident frequency or severity. These reduce enhancement).

For this type of backfit, the backfit rule does not require a strict quantitative showing that benefits exceed costs, but rather "that there is a substantial increase in the overall protection of the public health and safety or the common defense and security to be derived from the backfit and that the direct and indirect costs of implementation for that facility are *justified* in view of this increased protection" (emphasis added) (Ref. 20). Qualitative factors can be considered. Many of the factors to be addressed in the analysis may not be easily quantified, and the backfit rule permits consideration of other relevant and material factors.

3.2.1.6 Backfit Analyses Basics

For generic backfits, item IV(b)(5) of the CRGR Charter (Ref. 14) specifies preparation of backfit analyses for CRGR review packages. A typical way of meeting the requirements for CRGR review packages is to address each backfit analysis factor (which also is specifically listed in the CRGR Charter), making reference to the regulatory analyses if it contains the necessary cost-benefit information. An example of this approach is provided in Appendix E in NUREG-1409 (Ref. 20).

Regulatory analyses generally contain a cost-benefit analysis; however, as discussed earlier, it would not be appropriate (or permissible) for an adequate protection or compliance backfit to consider the cost in deciding on imposition of the backfit (except for deciding which among several acceptable alternatives to prescribe).

3.2.1.7 Further Justification (Staff Procedures)

In addition to backfit analyses and regulatory analyses, NRC procedures contain further justification requirements.

For generic backfits, Section IV.B of the CRGR Charter (Ref. 14) contains a number of other factors to be addressed in all CRGR review packages for new generic requirements or positions. For example, item IV.B(iv) specifies the proposed method of implementation and the concurrence (with any comments) of the Office of the General Counsel.[25] Item IV.B(ix) specifies the necessary findings and standards for relaxations in requirements, which are not addressed in the backfit rule. Finally, Section 11.D of the charter exempts compliance and adequate protection cases from the backfit analysis factors and specifies the documented evaluations needed in accordance with the backfit rule.

For plant-specific backfits, NRC Management Directive 8.4 (Ref. 25) specifies some of the same additional factors as the CRGR Charter, but only for backfits that are not compliance or adequate protection backfits. The manual chapter further specifies that a proposed plant-specific backfit must be considered for generic backfitting. For more information on plant-specific backfits, see NUREG-1409 (Ref. 20).

[25] Section IV.B(iv) of the CRGR Charter also requires the concurrence of the NRC Office of the General Counsel (and any comments) and the concurrence of affected program offices or an explanation of their non-concurrence in the proposed method of implementation. These concurrences and related information can be included in the transmittal memorandum to the CRGR and need not be included in the CRGR regulatory analysis (Ref. 14).

3.2.2 Information Requests

Informal oral information requests are not considered to be backfitting, and they should not be used by the staff or accepted by licensees for the purpose of imposing backfits. When written requests cite 10 CFR 50.54(f) (Ref. 8), requiring a response under oath or affirmation, a statement of the reasons for the request must be prepared and must be approved by the EDO or his designee (regional administrators, office directors and their deputies) except when the information is needed to verify compliance with the current licensing basis. As specified in the rule, this is done to ensure that the burden imposed on respondents is justified in view of the potential safety significance of the issue to be addressed. As further specified in NRC Management Directive 8.4 (Ref. 25) for plant-specific requests, such justification is not needed when seeking information of the type routinely sought for licensing reviews of plants under construction or when there is reason to believe that there is not adequate protection.

Some information requests promulgate new or revised staff positions and request that licensees, in their responses, state whether they will adopt the new positions. Even though these actions do not impose backfits, as a matter of internal staff practice they are identified as backfits and justified accordingly before they are issued, as required by NRC procedures.

4 NATIONAL ENVIRONMENTAL POLICY ACT

4.1 General

As previously discussed in Section 1.2.3, NEPA requires Federal agencies to prepare a detailed statement for major Federal actions significantly affecting the quality of the human environment (Ref. 43). This statement is defined by NRC regulations as an EIS (Ref. 44). A "major Federal action" is defined by the Council on Environmental Quality as an "action with effects that may be major and which are potentially subject to Federal control and responsibility" (Ref. 53). Many NRC licensing and regulatory actions meet this definition. NRC regulations implementing NEPA are in 10 CFR Part 51. The "essential purpose" of the Act is to ensure that the environmental effects of agency actions are considered along with other factors during the agency's regulatory decisionmaking process[26] (Ref. 38).

NRC NEPA reviews include categorical exclusion (CatX) (10 CFR 51.22), EAs (10 CFR 51.30), or EISs (10 CFR 51.70 to 10 CFR 51.81 and 10 CFR Part 51, Appendix A to Subpart A). As a matter of policy, the Commission has identified licensing actions requiring an EIS (10 CFR 51.20).

In some cases, EISs have been prepared to avoid duplicating the environmental reviews for similar licensing actions and allow reviewers to focus specifically on those environmental issues that are important to a specific regulatory action. The NRC calls these EISs "Generic Environmental Impact Statements" (GEIS). Site-specific environmental issues are then considered in a supplement to the GEIS, known as a Supplemental EIS (SEIS). Operating reactor license renewal, reactor decommissioning, and in-situ recovery projects (ISR) use the GEIS/SEIS model.

When a GEIS has been prepared that forms the basis for a proposed regulatory action, a brief summary of the EIS will be an acceptable substitute for the information and analysis requirements identified in Sections 2.3.1–2.3.3 of this document. The EIS may be referenced at other appropriate points in the regulatory analysis to avoid duplicating existing written material. When a regulatory analysis and an EIS or EA are being prepared for a proposed regulatory action, preparation of the two documents should be coordinated as much as possible. For example, the alternatives examined in the regulatory analysis should correspond as much as possible to the alternatives examined in the EIS or EA.

4.2 Cost-Benefit Analyses in 10 CFR Part 51

Under 10 CFR 51.71(d), NRC staff is required, unless excepted in 10 CFR 51.71 or 10 CFR 51.75, to include in the draft environmental impact statement a preliminary analysis that considers the economic, technical, and other benefits and costs of the proposed action and alternatives (Ref. 44). The following sections describe how cost-benefit analyses are conducted in NEPA reviews for NRC reactor and material licensing actions.

[26] *Id.*, note 2.

4.2.1 Requirements

By regulation, applicants for NRC licenses are required to include the consideration of the economic, technical, and other benefits and costs of the proposed action and its alternatives in environmental reports (ER). NRC regulation 10 CFR 51.45(c) states, "Except for an environmental report prepared at the early site permit stage, or an environmental report prepared at the license renewal stage under 10 CFR 51.53(c), the analysis in the environmental report should also include consideration of the economic, technical, and other benefits and costs of the proposed action and its alternatives. Environmental reports prepared at the license renewal stage under 10 CFR 51.53(c) need not discuss the economic or technical benefits and costs of either the proposed action or alternatives except if these benefits and costs are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation" (Ref. 44**Error! Reference source not found.**).

This regulatory requirement does not apply to ERs prepared at the license renewal stage under 10 CFR 51.53(c) unless benefits and costs are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation (10 CFR 51.71(d)). For early site permits (ESP) under 10 CFR Part 52, (Ref. 47) the draft EIS must not include an assessment of the economic, technical, or other benefits (for example, need for power) and costs of the proposed action or an evaluation of alternative energy sources, unless these matters are addressed in the early site permit ER (10 CFR 51.75(b)). When cost benefit analyses are required, they will, to the fullest extent practicable, quantify the various factors considered. To the extent that there are important qualitative considerations or factors that cannot be quantified, those considerations or factors will be discussed in qualitative terms. Environmental standard review plans (ESRP) in NUREG-1555 (Ref 54) provides guidance to the staff on the identification and tabulation of costs and benefits resulting from construction and operation of new nuclear power plants (see ESRP Chapter 10.4, Benefit-Cost Balance and ESRP Chapters 10.4.1 and 10.4.2, Ref 55).

The ESRPs explain that the reviewer may rely on an independent analysis of benefits and costs by State or regional authorities, rely on the applicant's analysis, or prepare an independent assessment. If a review of the applicant's analysis is conducted, the reviewer should ensure that the applicant's assumptions, data, and methods have been accepted by all appropriate ESRP reviewers. If reviewers have relied on an independent analysis, the review in this ESRP should be modified accordingly. The scope of the review directed by this plan should include the plant average annual electrical-energy generation in kilowatt-hours (kWh), enhanced reliability of the electrical distribution system, technical benefits such as development of technology, the quantities of other products (e.g., steam) produced, and other benefits (e.g., increased regional productivity, tax revenues, or new or improved recreational facilities) that have been identified. Benefits should be identified for the applicant's proposed project and for any alternatives identified as appropriate and practical to mitigate predicted environmental impacts.

4.2.2 Costs and Benefits for the Proposed Action and Each Alternative

The discussion of costs and benefits will include both the costs of each alternative and a qualitative discussion of environmental impacts. Assumptions and uncertainties in the analyses should be provided and discussed.

Applicant prepared ERs should include the following information (major costs and benefits), as appropriate. It may not be necessary for the evaluation of potential impacts from the proposed action to require all the information requested below:

- Qualitative discussion of environmental enhancement or degradation (including air, water, soil, biotic, as well as socioeconomic factors such as noise, traffic congestion, overuse of public works and facilities, and land access restrictions);
- Changes to public health and safety;
- Capital costs or benefits of the proposed action and alternatives, including land and facilities;
- Operating and maintenance costs;
- Post-operation restoration (not applicable when the alternative is restoration);
- Post-operation monitoring requirements;
- Other costs or benefits of the alternative (e.g., changes to tax revenue, recreational value, and impacts to transportation corridors, as appropriate);
- Incremental changes in regional productivity;
- Changes to recreational values; and
- Other costs or benefits.

NRC staff prepared EISs should consider the major costs and benefits for each alternative to the proposed action and be presented in the EIS (10 CFR 51.71) (Ref. 44). The costs and benefits should not be limited to a simple financial accounting of project costs for each alternative. Costs and benefits should also be discussed for qualitative subjects (i.e., environmental degradation or enhancement). Extensive or detailed analysis should be presented in an appendix to the EIS to avoid diverting attention away from primary issues such as public health and safety. The cost-benefit analysis is not simply a mathematical formula from which to justify economic parameters; other applicable qualitative factors should be discussed and weighed in the decision.

Qualitative environmental costs and benefits can be compared to the discussion of environmental impacts within the environmental report. Standard project costs can be reviewed utilizing standard cost estimating databases. Socioeconomic costs and benefits can be reviewed and compared against similar projects as applicable. The reviewer should also verify that analyses were performed in accordance with appropriate cost benefit guidance. Future costs and benefits should be discounted to present worth as discussed in "Economic Analysis of Federal Regulations Under Executive Order 12866" (Ref. 6**Error! Reference source not found.**). The methods used for discounting should be explained, and applied consistently to both costs and benefits. NUREG-1727, NMSS Decommissioning Standard Review Plan (Ref 55), provides guidance on determining costs and benefits for decommissioning projects as well as providing guidance on determining as low as reasonably achievable (ALARA) and prohibitive costs related to ALARA. The cost-benefit analysis provides input to determine the relative merits of various alternatives; however, the NRC must ultimately base its decision on public health and safety issues.

4.3 Environmental Justice

The Commission's "Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions," (69 FR 52040; August 24, 2004) (Ref. 56) confirmed that the legal basis for NRC's analysis of environmental justice matters, including impacts of a proposed licensing or regulatory action on minority or low-income communities, is NEPA. While NRC supports the general goals of Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," (Ref. 57) NRC will meet these goals through the normal and traditional NEPA review process. Office guidance on how to incorporate environmental justice in the NEPA review process can be found in NMSS NUREG-1748 "Environmental Review Guidance for Licensing Actions Associated with NMSS Programs" (August 22, 2003) (Ref. 34), "Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan" (NUREG-1555) (Ref. 53) , and NRR LIC-203, Rev. 3, "Procedural Guidance for Preparing Environmental Assessments and Considering Environmental Issues" (June 24, 2013) ML12234A708, (Ref. 59) . [Refer to the NRC Regulations Handbook NUREG/BR-0053, Rev. 6, September 2005] (Ref. 38).

4.4 Public and Occupational Health Impact Analyses

The EIS should include information on current background levels, historical exposure levels for the proposed action, and a summary of any public health studies performed in the region sufficient to establish baseline information for the analysis of impacts to public and worker health.

The analysis should consider potential pathways for the transfer of radioactive and nonradioactive materials from the proposed action and alternatives to the environment and ultimately to living organisms. The analysis should identify all pathways necessary to calculate public and occupational exposure.

The following information should be presented in the applicant's ER, as applicable. It may not be necessary for the evaluation of potential impacts from the proposed action to require all the information requested below:

- Major sources and levels of background radiation exposure, including natural and man-made sources; express levels in mSv/yr (mrem/yr);
- Current sources and levels of exposure to radioactive materials;
- Major sources and levels of chemical exposure; express levels in appropriate units;
- Historical exposures to radioactive materials;
- Occupational injury rates and occupational fatality rates; and
- Summary of health effects studies.

4.4.1 Reactors – SAMA/SAMDA Analyses

4.4.1.1 Severe Accident Mitigation Alternatives (SAMA)

Severe nuclear accidents are those that are more severe than design-basis accidents because they could result in substantial damage to the reactor core, whether or not there are serious offsite consequences. In the license renewal generic GEIS, the staff assesses the impacts of severe accidents, using the results of existing analyses and site-specific information to

conservatively predict the environmental impacts of severe accidents for each nuclear power plant.

In accordance with 10 CFR 51.53(c)(3)(ii)(L), (Ref. 44) license renewal applicants are to consider alternatives to mitigate severe accidents if the staff has not previously evaluated SAMA for the applicant's plant in an environmental impact statement or related supplement or in an environmental assessment. The purpose of this consideration is to ensure that changes at nuclear power plants prior to and during the license renewal term (e.g., hardware, procedures, and training) with the potential for improving severe accident safety performance are identified and evaluated. Section 4.4.1.2 discusses the use of SAMA for new reactor applications.

SAMA evaluations are conducted using a four-step approach. In the first step, the applicant quantifies the level of risk associated with potential reactor accidents using a plant-specific PRA. In the second step, the applicant examines the major risk contributors and identified possible ways (SAMA) of reducing that risk. Common ways of reducing risk are changes to components, systems, procedures, and training. In the third step, the applicant estimates the benefits and the costs associated with each of the proposed SAMA. Estimates are made of how much each alternative could reduce risk. Those estimates are monetized per applicable NRC regulatory analysis guidance. The cost of implementing the proposed SAMA is also estimated. In the fourth step, the cost and benefit of each of the proposed SAMA are compared to determine whether the alternative is cost-beneficial, meaning the benefits of the SAMA were greater than the cost (a positive cost-benefit ratio). The potentially cost-beneficial SAMA are then evaluated to determine if they are within the scope of license renewal, i.e., are they subject to aging management. This evaluation considers whether the systems, structures, and components (SSCs) associated with these SAMA: (1) perform their intended function without moving parts or without a change in configuration or properties and (2) that these SSCs are not subject to replacement based on qualified life or specified time period. If the cost-beneficial SAMA do not relate to adequately managing the effects of aging during the period of extended operation, they need not be implemented as part of license renewal in accordance with 10 CFR 54, "Requirements for renewal of operating licenses for nuclear power plants" (Ref. 60).

The cost-benefit analysis involves determining the net value for each alternative. If the net value of an alternative is negative, the cost of implementing the SAMA is larger than the benefit associated with the SAMA and it is not considered cost-beneficial. Two sets of estimates should be developed, one at a 3 percent discount rate and one at a 7 percent discount rate. A sensitivity study using the 3 percent discount rate is performed as well as additional analyses to evaluate the impact of parameter choices and uncertainties on the results of the SAMA assessment.

The NRC staff reviews the SAMA analysis prepared by the applicant and determines whether the methods used and the implementation of those methods follows the guidance of NEI 05-01 (Ref. 61).

4.4.1.2 Severe Accident Mitigation Design Alternatives (SAMDA)

SAMDAs are a subset of the SAMA review. The purpose of the evaluation of SAMAs is to determine whether there are SAMDAs or procedural modifications or training activities that can be justified to further reduce the risks of severe accidents.

In Title 10 of the Code of Federal Regulations (CFR), specifically 10 CFR 52.79(a)(38) (Ref. 47**Error! Reference source not found.**), the NRC requires that applicants for combined licenses (COLs) include "a description and analysis of design features for the prevention and mitigation of severe accidents" in the Final Safety Analysis Report (FSAR). In 10 CFR 52.47(a)(23), the NRC requires that applications for a reactor design certification include "a description and analysis of design features for the prevention and mitigation of severe accidents…." In addition, 10 CFR 52.47(a)(27) requires a description of a "plant-specific PRA and its results," and in 10 CFR 52.47(b)(2) the NRC requires an applicant-prepared ER that contains the information required by 10 CFR 51.55 (Ref. 44).

In an ER submitted as part of a design certification application, an applicant identifies candidate SAMDA based on a review of alternatives for other plant designs, including those considered in license renewal environmental reports, and on consideration of plant-specific enhancements. The candidate alternatives are then screened to identify candidates for detailed evaluation.

After screening, the design certification applicant calculates the maximum attainable benefit associated with completely eliminating all risk for the design under review. This methodology involves determining the net value for a SAMDA according to the following formula:

$$\text{Net Value} = (\text{APE} + \text{AOC} + \text{AOE} + \text{AOSC}) - \text{COE}$$

where:

- APE = present value of averted public exposure ($)
- AOC = present value of averted offsite property damage costs ($)
- AOE = present value of averted occupational exposure costs ($)
- AOSC = present value of averted onsite costs ($); this includes cleanup, decontamination, and long-term replacement power costs
- COE = cost of enhancement ($).

If the net value of a SAMDA is negative, the cost of implementing the SAMDA is larger than the benefit associated with the SAMDA, and it is not considered to be cost-beneficial. To assess the risk reduction potential for SAMDAs, the applicant assumes that each design alternative would work perfectly to completely eliminate all severe accident risk from the events that are evaluated. This assumption is conservative because it maximizes the benefit of each design alternative. The applicant estimates the public exposure benefits for the design alternative on the basis of the reduction of risk expressed in terms of whole body person-rem per year received by the total population within a 50-mile radius of the generic reactor site.

In 10 CFR 52.47(a)(27), the NRC requires that an applicant for design certification perform either a plant-specific or site-specific PRA. The aim of this PRA is to seek improvements in the reliability of core and containment heat removal systems that are significant and practical. The set of potential design improvements considered for the proposed design certification includes those from generic, technology appropriate, reactor SAMA reports.

The NRC staff evaluates the risk reduction potential of design improvements for proposed designs based on risk reduction estimates for screened design alternatives, in conjunction with an assessment of the potential impact of uncertainties on the results. The NRC staff performs averted cost estimates using two sets of parameters (best estimate and high estimate) for the

parameters used in the calculations of the occupational dose after accident and during decontamination and cleanup, and for the replacement power costs. The NRC staff's maximum estimate is based on the use of "high or upper bound" estimated parameters and the proposed design's power rating.

4.4.2 Materials

The applicant/licensee should describe existing public and occupational health issues, as appropriate. The following information should be presented in the ER. It may not be necessary for the evaluation of potential impacts from the proposed action to require all the information requested below:

- Physical layout of the site, including the location and orientation of radioactive materials that are expected to be present;
- Location and characteristics of radiation sources and liquid and gaseous radioactive effluent;
- Measured radiation dose rates, airborne radioactivity concentrations, and waterborne radioactivity concentrations at specific locations where environmental radiological monitoring data exist;
- Calculated radiation dose rates, airborne radioactivity concentrations, and waterborne radioactivity concentrations at specific locations important to dose calculations where environmental radiological monitoring data are not available, including a description of the methodology;
- Calculated total effective dose equivalent to an average member of the critical group or calculated average annual concentration of radioactive material in gaseous and liquid effluent; including all models, assumptions, and input data in order to determine compliance with 10 CFR 20 (Ref. 62) and 40 CFR 190 (Ref. 63);
- Calculated dose to the workforce including all models, assumptions, and input data in order to determine compliance with 10 CFR 20;

The list of reasonably foreseeable (i.e., credible) accidents (e.g., design basis events for 10 CFR 72 (Ref. 64) licenses, credible consequence events for 10 CFR 70 (Ref. 23**Error! Reference source not found.**) licenses, etc.) identified as having a potential for releases to the environment and the analysis of the dose consequences from these accidents.

5 COST-BENEFIT ANALYSIS

5.1 General

The discussions presented in this chapter apply to both reactor and material licensing and regulatory actions.

Cost-benefit analysis can:

- help the analyst and decision-maker clearly define and think through the problem
- provide a logical structure for the combination of issues contributing to a decision
- clearly display beneficial and detrimental aspects of a decision
- provide a record of the decision rationale, helping to provide documentation, defensibility, and reproducibility
- focus debate on the specific issues of contention, thereby assisting resolution
- provide a framework for the sensitivity testing of data and assumptions
- consider all factors affecting an issue
- clarify results in the face of closely valued alternatives and/or large uncertainties

5.1.1 Methods

As stated earlier, the regulatory analysis process is comprised of six steps. These steps are:

- a statement of the problem and NRC objectives for the proposed regulatory action
- identification and preliminary analysis of alternative approaches to the problem
- estimation and evaluation of the values and impacts for selected alternatives, including consideration of the uncertainties affecting the estimates
- the conclusion of the evaluation of values and impacts and, when appropriate, the safety goal evaluation
- the decision rationale for selection of the proposed regulatory action
- a tentative implementation schedule and implementation instrument for the proposed regulatory action

The cost-benefit portion of a regulatory analysis encompasses the third and fourth steps of the process. Cost benefit analysis identifies and estimates the relevant costs and benefits likely to

result from a proposed NRC action. The methodology is a systematic definition and evaluation of those costs and benefits.

Attributes are the principal components of a cost-benefit assessment that are used to characterize the consequences of a proposed action. The attributes affected by any given proposed action will vary, however, and the analyst will have to determine the appropriateness of each attribute. Attributes, whether costs or benefits, can have either positive or negative algebraic signs, depending on whether the proposed action has a favorable or adverse effect. The sign conventions are as follows: favorable results are positive; adverse results are negative. Each attribute measures the change from the existing condition due to the proposed action. Attributes are discussed in detail in Sections 5.2 and 5.3.

To the extent possible, all attributes, whether a cost or benefit, 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 cost-benefit ratio or an internal rate of return.

The net-value method calculates a numerical value that is intended to summarize the balance between the favorable and unfavorable consequences of the proposed action. The basic perspective of the net-value measure is national economic efficiency. All cost and benefits are added together and the total is intended to reflect the aggregate effect of the proposed action on the economy. The net-value measure does not, and is not intended to, provide any information about the distribution of values and impacts within the national economy. The cost and benefits to all affected parties are simply added together.

Significant differences may exist between recipients of benefits and those who incur costs. The distribution of costs and benefits on various groups should be presented and discussed.

To calculate a net value, all attributes must be expressed in dollars. For instance, person-rems of averted exposure, a measure of safety value, is converted to dollars via a dollar per person-rem conversion factor.

5.1.2 Attribute considerations for Material Licensees

The attribute quantification procedure for cost benefit analysis for materials licensees is different for the following six attributes:

1. Public Health (Accident)
2. Public Health (Routine)
3. Occupational Health (Accident)
4. Occupational Health (Routine)
5. Offsite Property
6. Onsite Property.

The quantification of these attributes may involve both frequencies and population doses associated with accident scenarios. Non-reactor facilities tend to be much simpler in system configuration than power reactors and the potential consequences to the public from accidents compared to power reactors is much smaller. This simplifies the scope of the accident analysis and accident frequency and population dose data; however there is less data available than for power reactors. See Appendix H for additional guidance.

5.2 Identification of Attributes

For every cost-benefit analysis to be performed, those attributes that could be affected by the proposed action must be identified. Once identified, the attributes may be quantified using the techniques presented in Appendix B.

5.2.1 Public Health (Accident)

This attribute measures expected changes in radiation exposures to the public due to changes in accident frequencies or accident consequences associated with the proposed action. Expected changes in radiation exposure from a nuclear power reactor accident should be measured over a 50-mile[27] appropriate distance from the licensed facility.[28] In most cases, the effect of the proposed action would be on public exposure. A decrease in public exposure (given in person-rems) assumes a positive sign. Therefore, this decrease multiplied by the monetary conversion factor ($/person-rem) will give a positive monetary value.

It is possible that a proposed action could increase public exposure due to potential accidents. In this case, the increase in public exposure (person-rems) assumes a negative sign. When this increase is multiplied by the monetary conversion factor ($/person-rem), the resulting monetary term is interpreted as negative.

5.2.2 Public Health (Routine)

This attribute accounts for changes in radiation exposures to the public during normal facility operations (i.e., non-accident situations). It is expected that this attribute would not be affected as often in reactor regulatory analyses as in non-reactor ones. When used, this attribute would employ an actual estimate; accident probabilities are not involved.

Similar to the attribute for public health (accident), a decrease in public exposure would be positive. Therefore, the product of a decrease in exposure and the monetary conversion factor (assumed to be the same factor as that for public health [accident]) would be taken as positive. The product of an increase in public exposure and the monetary conversion factor would be taken as negative.

[27] While the NRC's metrication policy statement calls for the use of dual units, it also states that "all event reporting and emergency response communications between licensees, the NRC, and State and local authorities will be in the English system of measurement." Hence, the use of the English unit, "miles", in this case.

[28] Because of the nature of nuclear fabrication facilities, a 50-mile radius is not automatically required (Ref. 34)

5.2.3 Occupational Health (Accident)

This attribute measures health effects, both immediate and long-term, associated with site workers as a result of changes in accident frequency or accident mitigation. A decrease in worker radiological exposures is taken as positive; an increase in worker exposures is considered negative.

As is the case for public exposure, the directly calculated effects of a particular action are given in person-rem. A monetary conversion factor must be used to convert the effect into dollars. To review current NRC policy, see NUREG-1530 (Ref. 29).

5.2.4 Occupational Health (Routine)

This attribute accounts for radiological exposures to workers during normal facility operations (i.e., non-accident situations). For many types of proposed actions, there will be an increase in worker exposures; sometimes this will be a one-time effect (e.g., installation or modification of equipment in a hot area), and sometimes it will be an ongoing effect (e.g., routine surveillance or maintenance of contaminated equipment or equipment in a radiation area). Some actions may involve a one-time increase with an offsetting lowering of future exposures.

Because this attribute represents an actual estimate of health effects, accident probabilities are not relevant. As is true of other types of exposures, a net decrease in worker exposures is taken as positive; a net increase in worker exposures is taken as negative. This exposure is also subject to the dollar per person-rem conversion factor (see NUREG-1530) (Ref. 29).

5.2.5 Economic Consequences (Offsite Property)

This attribute measures the expected total monetary effects on offsite property resulting from the proposed action. Changes to economic consequences can take various forms, both direct (e.g., land, food, and water) and indirect (e.g., tourism). This attribute is typically the product of the change in accident frequency and the property consequences resulting from the occurrence of an accident (e.g., costs of interdiction measures such as decontamination, cleanup, and evacuation). A reduction in economic consequences is taken as positive; an increase in economic consequences is considered negative.

5.2.6 Onsite Property

This attribute measures the expected monetary effects on onsite property, including replacement power (specifically for power reactors), decontamination, and refurbishment costs, from the proposed action. This attribute is typically the product of the change in accident frequency and the onsite property consequences given that an accident were to occur. A reduction in expected onsite property damage is taken as positive; an increase in onsite property damage is considered negative.

5.2.7 Industry Implementation

This attribute is an impact which accounts for the projected net economic effect on the affected licensees to install or implement mandated changes. Costs will include procedural and administrative activities, equipment, labor, materials, and shutdown costs, including the cost of

replacement power in the case of power reactors. Additional costs above the status quo are considered negative; cost savings would be considered positive.

5.2.8 Industry Operation

This attribute measures the projected net economic effect due to routine and recurring activities required by the proposed action on all affected licensees. If applicable, replacement power costs (power reactors only) directly attributable to the proposed action will be included. Additional costs above the status quo are taken to be negative; cost savings are taken to be positive.

Costs falling in this category, and those associated with NRC operational considerations, generally occur over long periods of time (the facility lifetime). These costs are particularly sensitive to the discount factor used.

5.2.9 NRC Implementation

This attribute measures the projected net economic effect on the NRC to place the proposed action into operation. Costs already incurred, including all pre-decisional activities performed by the NRC, are viewed as "sunk" costs and are not to be included. Additional costs above the status quo are taken to be negative; cost savings are taken to be positive.

The NRC may seek compensation (e.g., license fees) from affected licensees to provide needed services; any compensation received should not be subtracted from the cost to the NRC because the NRC is the entity consuming real resources (e.g., labor and capital) to meet its responsibilities. Any fees provided by licensees are viewed as transfer payments, and as such are not real costs from a societal perspective.

5.2.10 NRC Operation

This attribute measures the projected net economic effect on the NRC after the proposed action is implemented. Additional inspection, evaluation, or enforcement activities would be examples of such costs. Additional costs above the status quo are taken to be negative; cost savings are taken to be positive. As with industry operation costs, NRC operation costs generally occur over long periods of time and are sensitive to the assumed discount factor.

The NRC may seek compensation from the licensee to provide needed services; any compensation received should not be subtracted from the cost to the NRC.

5.2.11 Other Government

This attribute measures the net economic effect of the proposed action on the federal government (other than the NRC) and state and local governments resulting from the action's implementation or operation. Additional costs above the status quo are taken to be negative; cost savings are taken to be positive.

The government entities may seek compensation from the licensee to provide the needed services; any compensation received should not be subtracted from the cost to the government units.

5.2.12 General Public

This attribute accounts for direct, out-of-pocket costs paid by members of the general public as a result of implementation or operation of a proposed action. Examples of these costs could include items such as increased cleaning costs due to dust and construction-related pollutants, property value losses due to the action, or inconveniences (e.g., testing of evacuation sirens). Increases in costs from the status quo are taken to be negative; decreases in costs from the status quo are taken as positive.

This attribute is not related to the attribute associated with economic consequences due to accidents. The general public attribute measures real costs that will be paid due to implementation of the proposed action, subject to the uncertainties involved in estimation. These costs exclude taxes as they are simply transfer payments with no real resource commitment from a societal perspective. Any costs which are reimbursed by the applicant or licensee should be accounted for here and not duplicated under industry costs.

5.2.13 Improvements in Knowledge

This attribute accounts for the potential value of new information, especially from assessments of the safety of licensee activities. Some NRC actions have as their goal the improvement in the state of knowledge for such factors as accident probabilities or consequences, with an ultimate objective of facilitating safety enhancement or reduction in uncertainty. This attribute is qualitative in nature.

Quantitative measurement of improvements in knowledge depends largely on the type of action being investigated. The value of assessments directed at a fairly narrow problem (e.g., reducing the failure rate of a particular component) may be quantifiable in terms of safety or monetary equivalent. If this is the case, such cost and benefits should be treated by other attributes and not included under this attribute. In order to avoid double counting, potential benefits from the assessments that are difficult to identify or are otherwise not easily quantified, should be addressed under this attribute.

5.2.14 Regulatory Efficiency

This attribute attempts to measure regulatory and compliance improvements resulting from the proposed action. These may include changes in industry reporting requirements and the NRC's inspection and review efforts. Achieving consistency with international standards groups may also improve regulatory efficiency for both the NRC and the groups. This attribute is qualitative in nature.

In some instances, changes in regulatory efficiency may be quantifiable, in which case the improvements should be accounted for under other attributes, such as NRC implementation or industry operation. In order to avoid double counting, regulatory efficiency actions that are not quantifiable should be addressed under this attribute.

5.2.15 Antitrust Considerations

The NRC has a legislative mandate under the Atomic Energy Act (Ref. 65) to uphold U.S.

antitrust laws. This qualitative attribute is included to account for antitrust considerations for those proposed actions that have the potential to allow violation of the antitrust laws.

If antitrust considerations are involved, and it is determined that antitrust laws could be violated, then the proposed action must be reconsidered and, if necessary, redefined to preclude such violation. If antitrust laws would not be violated, then evaluation of the action may proceed based on other attributes. The decision as to whether antitrust laws could be violated must rely on a criterion of reasonable likelihood, since it is difficult to anticipate the consequences of a regulatory action with absolute certainty.

5.2.16 Safeguards and Security Considerations

The NRC has a legislative mandate to maintain the common defense and security and to protect and safeguard national security information in its regulatory actions. This attribute includes such considerations.

In applying this attribute, it must be determined whether the existing level of safeguards and security is adequate and what effect the proposed action has on achieving an adequate level of safeguards and security. If the effect of the proposed action on safeguards and security is quantifiable, then this effect should be included among the quantitative attributes. Otherwise the contribution of the action will be evaluated in a qualitative way and treated under this attribute.

5.2.17 Environmental Considerations

Section 102(2) of the National Environmental Policy Act (NEPA) (Ref. 43) requires federal agencies to take various steps to enhance environmental decision-making. NRC's procedures for implementing NEPA are set forth in 10 CFR 51 (Ref. 44). Many of the NRC's regulatory actions are handled through use of a generic or programmatic EIS, EA, or CatX. If these processes are used, no further cost-benefit analysis is necessary because such analyses are part of the NEPA process. However, a summary of the salient results of the environmental analysis should be included in the regulatory analysis document. NEPA reviews are handled separately from the cost-benefit analysis described in this guidance. It could be the case that mitigation or other measures resulting from the environmental review may result in cost increases that should be accounted for in the cost-benefit analysis. Alternatives examined in an EIS or EA should correspond as closely as possible to the alternatives examined in the corresponding cost-benefit analysis.

5.2.18 Other Considerations

The above set of attributes is believed to be comprehensive for most cost-benefit analyses. It is recognized that any particular analysis may also identify unique attributes. Any such attributes should be appropriately described and factored into the analysis.

5.3 Quantification of Attributes

The following sections provide specific guidance in estimating the values of each attribute. However, before looking at specific attributes, there are several generic concepts that need to be explored.

Cost and benefits estimates are performed relative to a baseline case, which is typically the no-action alternative. In establishing the baseline case, an assumption should be made that all existing NRC and Agreement State requirements and written licensee commitments are already being implemented and that values and impacts associated with these requirements are not part of the incremental estimates prepared for the regulatory analysis. Similarly, the effects of formally proposed concurrent regulatory actions that are viewed as having a high likelihood of implementation need to be incorporated into the baseline before calculating the incremental consequences of the regulatory action under consideration.

The treatment of voluntary incentives on the part of industry also has important implications on the baseline and therefore, the incremental consequences of the proposed action. Section 5.3.1 of this guidance discusses the treatment of voluntary activities by affected licensees when establishing a baseline reference. Basically, analysts should give no credit for voluntary actions in making base case estimates. However, for completeness and sensitivity analysis purposes, the analyst should also display results with credit being given for voluntary actions by licensees.

5.3.1 Treatment of Industry Initiatives

Industry initiatives are typically actions performed by licensees that form the bases for either continued compliance with the regulations or obviate the need for new regulations. It must be clear to the public that substituting industry initiatives for NRC regulatory action can provide effective and efficient resolution of issues, will in no way compromise plant safety, and does not represent a reduction in the NRC's commitment to safety and sound regulation. The NRC and the industry are jointly responsible for the long-term success of using industry initiatives as substitutes for NRC regulatory action.

Industry initiatives can generally be put into one of the following categories: (1) those put in place in lieu of, or to complement, a regulatory action to ensure that existing requirements are met, (2) those used in lieu of, or to complement, a regulatory action in which a substantial increase in overall protection could be achieved with costs of implementation justifying the increased protection, and (3) those that were initiated to address an issue of concern to the industry but that may or may not be of regulatory concern. Issues related to adequate protection of public health and safety are deemed the responsibility of the NRC and should not be addressed through industry initiatives.

The presence of industry initiatives is potentially very important in the estimation of cost and benefits, and, as such, its treatment in the regulatory analysis must be explicitly considered. All consequences of a proposed regulatory change are measured relative to the baseline, which is how things would be if the proposed regulation were not imposed. If industry initiatives which complement or substitute for a proposed regulatory action exist, the future role of these industry initiatives must be determined. This determination would affect the baseline, which in turn would affect the calculation of incremental costs and benefits. For example, if "full credit" is given to the industry initiatives (i.e., it is assumed that complementary industry initiatives will continue in the future), the incremental values attributable to the proposed regulation are diminished. Alternatively, if "no credit" is given, the incremental values assigned to the proposed rule are increased.

For the purpose of the regulatory analysis, cost-benefit results are to be calculated based, to the extent practical, on varied assumptions concerning the future role of industry initiatives. Initially, two sets of cost-benefit estimates are to be derived: one based on no credit and the other based on full credit for industry initiatives. These results will have equal weight and will be presented for sensitivity analysis purposes. If the overall value-impact result does not tilt from an overall net cost to an overall net benefit (or vice versa), there is no need to proceed further and the final results would be reported as a range of values that reflect the sensitivity of these results to this assumption. However, if the results are highly sensitive to that level of variation, such that the overall cost benefit conclusion shifts or the final recommendation changes, the analyst would proceed to develop a "best-estimate" base case.

Under this best-estimate base case, the staff will evaluate the specific industry initiatives in question to determine how much credit to give to the industry initiatives. The NRC is currently developing guidelines designed to increase the NRC's assurance that industry initiatives will be effective long-term alternatives to regulatory actions. Clearly, the more an industry initiatives satisfies these guidelines, the more credit one should give to the industry initiative. Before these guidelines are formally approved, the staff should rely on relevant features and characteristics of the industry initiatives to assess the weight or amount of credit to attach to any given industry initiative. Relevant characteristics would include the following:

- Costs associated with the industry initiative (if the dominant costs are fixed costs that have already been expended or the future recurring costs to maintain the industry initiative are minimal, it is more likely the industry initiative will continue in the future).

- The extent to which written commitments exist (if written commitments exist it is more likely a license will continue that commitment in the future, and the NRC could, if necessary, respond to licensees not adhering to the industry initiative).

- The degree to which the industry initiative is noncontroversial and standard industry practice (if the industry initiative is noncontroversial and standard industry practice, as a function of consistency with provisions of industry codes and standards, the participation rate among relevant licensees, how long the program has been operating, or its effectiveness, the more likely it will continue without the rule change).

- The scope and schedule for industry initiatives that are still pending (for industry initiatives that are still works in progress, the more well defined the scope and the sooner the initiative is expected to be in place, the more likely it will be available in the future).

Based on such an assessment, the regulatory analysis should contain, to the extent practical, a best estimate of the cost and benefits of the regulation under consideration. These results would serve as the basis for the staff's recommendations to the Commission. Careful attention is needed when PRA techniques are used to give partial or no credit to industry initiatives, because risk estimates from PRAs are based on existing conditions which typically include credit for any industry initiative that may be in place. When the PRA is modified to eliminate or reduce credit for industry initiatives, the reviewer needs to assure that these changes are properly reflected in the details of the PRA model.

5.3.2 Attributes Valuation

When placing valuation to the identified impacted attributes, the cost benefit analysis should be transparent and the results should be easily reproducible. The analysis should clearly set out the assumptions, methods, and data underlying the analysis and discuss the uncertainties associated with the estimates. A qualified third party reading the analysis should be able to understand the basic elements of your analysis and the way in which estimates were developed.

Based on OMB's guidance in Circular A-94 (Ref 13), a 7% real (i.e., inflation adjusted) discount rate be used for a best estimate. For sensitivity analysis, a 3% discount rate should be used. However, for certain regulatory actions involving a timeframe exceeding 100 years (e.g., decommissioning and waste disposal issues), OMB Circular A-94 stipulates the following:

> The regulatory analysis should display results to the decision-maker in two ways. First, on a present worth basis using a 3 percent real rate, and second, by displaying the cost and benefits at the time in which they are incurred with no present worth conversion. In this latter case, no calculation of the resulting net value should be made.

When choosing the appropriate time horizon for estimating costs and benefits, the analyst should consider how long the regulation being analyzed is likely to have resulting effects. The time horizon begins when the regulatory action is implemented and ends when those effects are expected to cease. Ideally, the analyst should use the remaining operating license term across impacted entities and add an appropriate decommissioning period.

There are four attributes for which a benefit is normally calculated: public health (accident), occupational health (accident), offsite property, and onsite property. All four of these attributes usually rely on estimation of the change in probability of occurrence of an accident as a result of implementation of the proposed action. (Changes in the consequence of the accident [i.e., dose or cost] would also affect these attributes.)

Four attributes involve radiation exposure: 1) public health (accident), 2) public health (routine), 3) occupational health (accident), and 4) occupational health (routine). In quantifying each measure, the analyst should assess the reduction (or risk averted) relative to the existing condition. For accident-related exposures, the measure will be probabilistically weighted (i.e., the potential consequence is multiplied by its probability of occurrence). The non-accident terms (e.g., routine occupational exposure) are given in terms of annual expected effect. Both types of terms would be integrated over the lifetime of the affected facilities to show the total effect. Each of the attributes involving radiation exposure can be characterized in terms of person-rem, either averted by or resulting from implementation of the proposed action.

The four attributes associated with radiation exposure require a dollars per person-rem conversion factor to be expressed monetarily. The remaining quantitative attributes are normally quantified monetarily in a direct manner. When quantified monetarily, attributes are to be discounted to present value. This operation involves an assumption regarding the remaining lifetime of a facility. If appropriate, the effect of license renewal should be included in the facility lifetime estimate. The total dollar figures capture both the number of facilities involved (in the case of generic rulemaking) and the economic lifetime of the affected facilities.

"Qualitative" attributes do not lend themselves to quantification. To the degree to which the considerations associated with these attributes can be quantified, they should be; the quantification should be documented, preferably under one or more of the quantitative attributes. However, if the consideration does not lend itself to any level of quantification, then its treatment should take the form of a qualitative evaluation in which the analyst describes as clearly and concisely as possible the precise effect of the proposed action.

To estimate values for the accident-related attributes in a regulatory analysis, the analyst can draw from detailed risk/reliability assessments or statistically-based analyses.

However, the analyst will sometimes find limited factual data or information sufficiently applicable only for providing a quantitative perspective, possibly requiring extrapolation. These may often involve non-reactor licensees since detailed risk/reliability assessments and/or statistically-based analyses are less prevalent than for power reactor licensees. Two examples illustrate this type of quantitative evaluation.

In 1992, the NRC performed a regulatory analysis for the adoption of a proposed rule (57 FR 56287; November 27, 1992) concerning air gaps to avert radiation exposure resulting from NRC-licensed users of industrial gauges. The NRC found insufficient data to determine the averted radiation exposure. To estimate the reduction in radiation exposure should the rule be adopted, the NRC assumed a source strength of one curie for a device with a large air gap, which produces 1.3 rem/hr at a distance of 20 inches from a Cs-137 source. Assuming half this dose rate would be produced, on average, in the air gap, and that a worker is within the air gap for four hours annually, the NRC estimated the worker would receive 2.6 rem/yr. The NRC estimated that adopting the proposed air-gap rule would be cost-effective if 347 person-rem/yr were saved. At the estimated average savings of 2.6 person-rem/yr for each gauge licensee, incidents involving at least 133 gauges would have to be eliminated. Given the roughly 3,000 gauges currently used by these licensees, the proposed rule would only have to reduce the incident rate by roughly 4%, a value the NRC believed to be easily achievable. As a result, the NRC staff recommended adoption of the air-gap rule.

In 1992, the NRC responded to a petition from General Electric (GE) and Westinghouse for a rulemaking to allow self-guarantee as an additional means for compliance with decommissioning regulations. An NRC contractor estimated the default risks of various types of financial assurance mechanisms, including the proposed self-guarantee. The contractor had to collect data on failure rates both of firms of different sires and of bank, savings and loans, and other suppliers of financial assurance mechanisms. The contractor estimated a default risk of 0.13% annually for the GE-Westinghouse proposal, with a maximum default risk of only 0.055% annually for third-party guarantors, specifically a small savings and loan issuing a letter of credit. Based on these findings, the NRC initiated a proposed rulemaking which would allow self-guarantee for certain licensees. The final rule was issued December 29, 1993 (58 FR 68726).

5.3.2.1 Public Health (Accident)

Evaluating the effect on public health from a change in accident frequency due to proposed regulatory actions is a multi-step process. For each affected facility, the analyst first estimates the change in the public health (accident) risk associated with the action and reports this as person-rem avoided exposure. Reduction in public risk is algebraically positive; increase is

negative (viewed as a negative reduction). Next the analyst converts person-rems to their monetary equivalent (dollars) and discounts to present value. Finally, the analyst totals the change in public health (accident) as expressed in discounted dollars over all affected facilities. The steps are as follows:

(1) Estimate reduction in accident frequency per facility (see Appendix H).

(2) Estimate reduction in public health (accident) risk per facility.

(3) Convert value of public health (accident) risk avoided (person-rems) per facility to monetary equivalent (dollars) via monetary valuation of health effects.

$$Z_{PHA} = RD_{PA}$$

where Z_{PHA} = monetary value of public health (accident) risk avoided per facility-year before discounting ($/facility-year)
D_{PA} = avoided public dose per facility-year (person-rem/facility-year)
R = monetary equivalent of unit dose ($/person-rem)

(4) Discount to present value per facility (dollars).

(5) Total over all affected facilities (dollars).

$$V_{PHA} = NW_{PHA}$$

where V_{PHA} = discounted monetary value of public health (accident) risk avoided for all affected facilities ($)
W_{PHA} =monetary value of public health (accident) risk avoided per facility after discounting ($/facility)
N = number affected facilities

If individual facility values rather than generic values are used, the formulations can be replaced with

$$V_{PHA} = \sum_i N_i W_{PHA_i}$$

where i = facility (or group of facilities) index.

5.3.2.1.1 Estimation of Accident-Related Health Effects

For the standard analysis, the analyst would employ data developed in existing risk studies which include offsite effects, if possible. Such studies provide population dose factors that can be applied to accident release categories to yield dose estimates as follows:

$$\textit{Avoided Public Dose [DPA] (person-rem/facility-yr)} = \sum_{\textit{Release Category}} \left[\textit{Reduction in Release Category Frequency} \left(\frac{events}{facility-yr}\right)\right] X \left[\textit{Population Dose Factor for Release Category} \left(\frac{person-rem}{event}\right)\right]$$

If the risk assessment being used by the analyst to estimate public health (accident) employs its own unique accident release categories with corresponding population dose factors, then these should be used.

Tables 5-1 and 5-2 provide screening information from NUREG-1150 that can be used for performing standard analyses.

Table 5-1 Expected population doses for power reactor release categories

Plant Type	Release Category	Accident Progression Characteristics						Population Dose	
		CF Time	PDS	SP Bypass	RB Bypass	CCI	CF Mode	Total (Person-Rem)	% Long Term
PWR	RSUR1	CFatVB	LOSP	Not Applicable		Dry	Rupture	6.15E+6	63
	RSUR2	Late CF					Leak	2.30E+6	88
	RSUR3	No CF					No CF	2.50E+2	67
	RSUR4	Bypass	Bypass				Bypass	4.29E+6	80
	RZ1	CFatVB	LOCA			Shallow	Rupture	5.77E+6	65
	RZ2	Late CF				Flooded	Leak	1.31E+5	38
	RZ3	No CF					No CF	3.31E+2	67
	RZ4	Bypass	Bypass			Dry	Bypass	4.80E+6	76
	RSEQ1	CFdurCD	LOSP			Dry	CatRup	1.31E+7	50
	RSEQ2	CFatVB						5.77E+6	56
	RSEQ3	Late CF	LOCA			Flooded	Rupture	1.33E+5	42
	RSEQ4	No CF					No CF	4.06E+2	71
	RSEQ5	Bypass	Bypass			Dry	Bypass	4.94E+6	76
BWR	RPB1	CFatVB	LOSP	Early/Late	Sm/None	Dry	DWMth	5.25E+6	80
	RPB2		ATWS					5.32E+6	
	RPB3	CFdurCD		None	Large		WWvent	3.26E+6	84
	RPB4	Late CF	LOSP	Early/Late			DWrup	1.13E+6	92
	RPB5	No CF		None	Sm/None	Shallow	No CF	8.27E+3	62
	RPB6	CFatVB		Early/Late	Large	Dry	DWMth	1.11E+7	
	RLAS1	CFdurCD	Tran	Early/Late	Sm/None	Dry	WWawrup	5.25E+6	80
	RLAS2	CFatVB				Shallow	WWaw-lk	3.21E+6	81
	RLAS3						DWrup	4.66E+6	82
	RLAS4	CFdurCD				Dry	WWvent	5.92E+6	73
	RLAS5	Late CF			Sm/None	Shallow		1.75E+6	82
	RLAS6				Large	Dry	CF-Ped	4.18E+6	73
	RLAS7	No CF		None	None	Shallow	No CF	3.33E+2	65

Plant Type	Release Category	Accident Progression Characteristics						Population Dose	
		CF Time	PDS	SP Bypass	RB Bypass	CCI	CF Mode	Total (Person-Rem)	% Long Term
	RGG1	CFatVB	STSB	Early/Late	Early/Late	Flooded	Rupture	5.77E+6	75
	RGG2	CFdurCD		None	None			2.74E+6	90
	RGG3	Late CF		Late Only	Late Only			2.35E+6	80
	RGG4	CFdurCD		Early/Late	Early/Late	No CCI		2.70E+6	93
	RGG5	No CF		None	None		No CF	1.18E+2	59

Note: The initials RSUR, RZ, and RSEQ refer to Surry, Zion, and Sequoyah release categories respectively followed by the release category number.

The initials RPB, RLAS, and RGG refer to Peach Bottom, LaSalle, and Grand Gulf release categories respectively followed by the release category number.

Key:

CF Time = Containment failure (CF time)
- CFatVB = CF at vessel breach (VB)
- CFdurCD = CF during core damage (Before VB, if it occurs)
- LateCF = CF during core concentration interactions (CCI)
- No CF = no CF
- Bypass = bypass of containment (usually throughout duration of accident)

PDS = Plant damage state (PDS)
- LOSP = loss of offsite power
- LOCA = loss of coolant accident
- Bypass = bypass of containment (interfacing systems LOCA or steam generator tube rupture)
- ATWS = anticipated transient without scram
- Tran = Transient
- STSB = short-term station blackout

CCI = Type of molten core concrete interactions (CCI)
- Dry = CCI occurs in a dry cavity
- Shallow = CCI occurs in a wet cavity (nominally 5 ft. of water)
- Flooded = CCI occurs in a deeply flooded cavity (nominally 14 ft. of water)
- No CCI = There is no CCI (the debris is coolable with replenishable water or no VB)

CF Mode = Containment failure mode
- CatRup = Catastrophic rupture failure
- Rupture = Rupture failure of containment
- Bypass = bypass of containment
- Leak = Leak failure of containment
- NoCF = no CF
- WWawrup = Rupture above the wetwell water level
- WWaw-lk = Leak above the wetwell water level
- DWRup = Rupture in the drywell
- WWvent = Venting of the wetwell
- CF-Ped = Rupture in the drywell wall, caused by late failure of the reactor pedestal
- DWMth = Melt-through of the drywell wall by direct contact of the molten core

Plant Type	Release Category	Accident Progression Characteristics						Population Dose	
		CF Time	PDS	SP Bypass	RB Bypass	CCI	CF Mode	Total (Person-Rem)	% Long Term

SP Bypass = Suppression pool (SP) bypass
- Early/Late = SP is bypassed from the time of VB throughout the accident
- None = SP is never bypassed
- Late Only = SP is only bypassed late in the accident (during CCI)

RB Bypass = Reactor building (RB) bypass
- Sm/None = Nominal or small leakage from the RB
- Large = Large leakage .from the RB or bypass of the RB (fur Grand Gulf, all containment failures were assumed to be above the RB)

Should the nature of the issue require that the reduction in accident frequency be expressed as a single number, a single population dose factor, preferably one that had been probabilistically weighted to reflect those for all accident release categories, is generally needed. For this approach, the calculation of avoided public dose becomes:

$$\begin{matrix}\textit{Avoided Public Dose} \\ \textit{[DPA]} \\ \textit{(person-rem/facility-yr)}\end{matrix} = \left[\begin{matrix}\textit{Reduction in} \\ \textit{Accident Frequency} \\ \left(\frac{events}{facility-yr}\right)\end{matrix}\right] \times \left[\begin{matrix}\textit{Population Dose} \\ \textit{Factor} \\ \left(\frac{person-rem}{event}\right)\end{matrix}\right]$$

Mubayi et al. (1995) (Ref. 66) have calculated population doses weighted by the frequencies of the accident release categories for the five power reactors analyzed in NUREG-1150 (Ref. 67). These are listed in Table 5.4 based on Version 1.5.11.1 of the MACCS computer code (Chanin et al. 1993) (Ref. 68). The population doses have been calculated as the sum of those for emergency response and long-term protective action, defined as follows:

- For early consequences, an effective emergency response plan consisted of evacuation of all but 0.5% of the population within a ten-mile radius at a specified speed and delay time following notification of the emergency.

- For long-term relocation and banning of agricultural products, the interdiction criterion was 4 rem to an individual over five years (2 rem in year one, followed by 0.5 rem each successive year).

For regulatory analyses involving nuclear power plants, doses should be estimated over a 50-mile radius from the plant site (see Section 5.2.1). Doses for other distances can be considered in sensitivity analyses or special cases, and are available in NUREG/CR-6349 (Ref. 66).

It is possible that the proposed action will affect public health (accident) through a mitigation of consequences instead of (or as well as) through a reduction in accident frequency. Should this be the case, the previous general formulations are replaced with the following:

$$Avoided\ Public\ Dose = \sum_{\substack{Release \\ Categories}} [Release\ Category\ Frequency\ x\ Category\ Population\ Dose\ Factor]_{\substack{Status \\ Quo}}$$

$$- \sum_{\substack{Release \\ Categories}} [Release\ Category\ Frequency\ x\ Category\ Population\ Dose\ Factor]_{\substack{After \\ Action}}$$

or

$$Avoided\ Public\ Dose = [Accident\ Frequency\ x\ Population\ Dose\ Factor]_{\substack{Status \\ Quo}} - [Accident\ Frequency\ x\ Population\ Dose\ Factor]_{\substack{After \\ Action}}$$

Table 5-2 Weighted population dose factors for the five NUREG-1150 power reactors

Reactor	Type	Person-rem Within 50 miles from the Plant
Zion	PWR	1.95×10^5
Surry	PWR	1.60×10^5
Sequoyah	PWR	2.46×10^5
Peach Bottom	BWR	2.00×10^6
Grand Gulf	BWR	1.93×10^5
Average		1.99×10^5

Beyond the standard analysis lies the major effort. In parallel with the more involved effort to identify and quantify affected parameters in appropriate accident sequences would be an equivalent effort to quantify population dose factors and possibly even specific health effects. Such effort at the "consequence end" of the risk calculation would increase the likelihood of obtaining representative results. Non-representative results can arise through the use of inappropriate or inapplicable dose calculations just as readily as through inappropriate logic models and failure data.

Several computer codes exist for estimation of population dose. Most for reactor applications have been combined under MACCS (Ref. 69 and Ref. 70). Three codes for non-reactor applications are GENII (Napier et al. 1988) (Ref. 74), CAP-88 (Beres, 1990) (Ref. 75), and COMPLY (EPA 1989) (Ref. 76). There have also been recent upgrades to MELCOR itself for modeling severe accidents in light water reactors, including estimation of severe accident source terms and their sensitivities/uncertainties (Ref. 71).

The GENII code package determines individual and population radiation doses on an annual basis, as dose commitments, and as accumulated from acute or chronic radionuclide releases to air or water. It has an additional capability to predict very-long-term doses from waste management operations for periods up to 10,000 years.

The CAP-88 code package is generally required for use at the U.S. Department of Energy (DOE) facilities to demonstrate compliance with radionuclide air emission standards where the maximally exposed offsite individual is more than 3 km from the source [40 CFR 61.93(a)] (Ref.

77). The code contains modules to estimate dose and risk to individuals and populations from radionuclides released to the air. It comes with a library of radionuclide-specific data and provides the most flexibility of the U.S. Environmental Protection Agency (EPA) air compliance codes in terms of ability to input site-specific data. A personal computer version of the CAP-88 code package (Parks. 1992) (Ref. 78) was released in March 1992 under the name CAP88-PC and is also approved for demonstrating compliance at DOE facilities.

The COMPLY code is a screening model intended primarily for use by NRC licensees and federal agencies other than DOE facilities. It is approved for use by DOE facilities where the maximally exposed offsite individual is less than 3 km from the emissions source (40 CFR 61.93(a)J). The code consists of four screening levels, each of which requires increasingly detailed site-specific data to produce a more realistic (and less conservative) dose estimate. COMPLY runs on a personal computer and does not require extensive site-specific data.

5.3.2.1.2 Monetary Valuation of Accident-Related Health Effects

In order to place all costs and benefits on a common basis, a conversion factor is needed that reflects the monetary value of a unit of radiation exposure. This conversion factor is subject to periodic NRC review. The basis for selection of this value is set out in NUREG-1530 (Ref. 29). This dollar per person-rem value is to be used for routine and accidental emissions for both public and occupational exposure. Unlike early NRC practice, offsite property consequences are separately valued and are not part of this person-rem value. Monetary conversion of radiation exposure using the dollar per person-rem value is to be performed for the year in which the exposure occurs and then the monetized value is discounted to present value for purposes of evaluating costs and benefits.

5.3.2.1.3 Discounting Monetized Value of Accident-Related Health Effects

The present value for accident-related health effects in their monetized form can be calculated as follows:

$$W_{PHA} = C \; x \; Z_{PHA}$$

where W_{PHA} = monetary value of public health (accident) risk avoided per facility after discounting ($/facility)

$C = [\exp(-rt_i) - \exp(-rt_f)]/r$

t_f = years remaining until end of facility life

t_i = years before facility begins operating

Z_{PHA} = monetary value of public health (accident) risk avoided per facility-year before discounting ($/facility-year).

If a facility is already operating, t_i will be zero and the equation for C simplifies to

$$C = \frac{1 - e^{-rt_f}}{r}$$

Should public health (accident) risk not be discounted in an analysis, r effectively becomes zero in the preceding equations. In the limit as r approaches zero, $C = t_f - t_i$ (or, $C = t_f$ when $t_i = 0$). This new value of C should be used to evaluate W_{PHA} in the undiscounted case.

The quantity W_{PHA} must be interpreted carefully to avoid misunderstandings. It does not represent the expected reduction in public health (accident) risk due to a single accident. Rather, it is the present value of a stream of potential losses extending over the remaining lifetime of the facility. Thus, it reflects the expected annual loss due to a single accident (this is given by the quantity Z_{PHA}); the possibility that such an accident could occur, with some small probability, at any time over the remaining facility life; and the effects of discounting these potential future losses to present value. Since the quantity Z_{PHA} only accounts for the risk of an accident in a representative year, the result is the expected loss over the facility life, discounted to present value.

5.3.2.2 Public Health (Routine)

As with the public health (accident), the evaluation of the effect on public health from a change in routine exposure due to proposed regulatory actions is a multi-step process. Reduction in exposure is algebraically positive; increase is negative (viewed as a negative reduction).

The steps are as follows:

1. Estimate reductions in public health (routine) risk per facility for implementation (D_{PRi}) and operation (D_{PRO})

2. Convert each reduction in public health (routine) risk per facility from person-rems to dollars via monetary evaluation of health effects.

$$G_{PRI} = RD_{PRI} \qquad G_{PRO} = RD_{PRO}$$

where G_{PRI} = monetary value of per-facility reduction in routine public dose required to implement the proposed action, before discounting ($/facility)

G_{PRO} = monetary value of annual per-facility reduction in routine public dose to operate following implementation of the proposed action, before discounting ($(facility-year)

D_{PRI} = per-facility reduction in routine public dose required to implement the proposed action (person- rem/facility)

D_{RPO} = annual per-facility reduction in routine public dose to operate following implementation of the proposed action (person-rem/facility-year)

R =monetary equivalent of unit dose ($/person-rem)

3. Discount each reduction in public health (routine) risk per facility (dollars)

4. Sum the reductions and total over all facilities (dollars):

$$V_{PHR} = N\,(H_{PRI} + H_{PRO})$$

where V_{PHR} = discounted monetary value of reduction in public health (routine) risk for all affected facilities ($).

H_{PRI} = monetary value of per-facility reduction in routine public dose required to implement the proposed action, after discounting ($/facility)

H_{PRO} = monetary value of per-facility reduction in routine public dose to operate following implementation of the proposed action, after discounting ($/facility).

N =number of affected facilities.

Note the algebraic signs for D_{PRI} and D_{PRO}. A reduction in exposure is positive; an increase is negative. The dose for implementation (D_{PRI}) would normally be an increase and therefore negative.

If individual facility values rather than generic values are used, the formulations can be replaced with

$$V_{PHR} = \sum_i N_i\,(H_{PRI} + H_{PRO})$$

where i = facility (or group of facilities) index.

5.3.2.2.1 Estimation of Change in Routine Exposure

A proposed NRC action can affect routine public exposures in two ways. It may cause a one-time increase in routine dose due to implementation of the action (e.g., installing a retrofit). It may also cause a change (either increase or decrease) in the recurring routine exposures after the action is implemented.[29] For the standard analysis, the analyst may attempt to make exposure estimates, or obtain at least a sample of industry or community data for a validation of the estimates developed. Baker (1995) (Ref. 79) provides estimates of population and individual dose commitments for reported radionuclide releases from commercial power reactors operated during 1991. Tichler et al. (1995) (Ref. 80) have compiled and reported releases of radioactive materials in airborne and liquid effluents from commercial Light Water Reactors (LWRs) during 1993. Data on solid waste shipments are also included. This report is updated annually.

5.3.2.2.2. Monetary Valuation of Routine Exposure

As with public health (accident) monetary valuation for public health (routine) employs the

[29] The equations included in this Guidance apply a discounting term to doses associated with both implementation and operational impacts. In practice, the implementation dose may be of such short duration that discounting is not necessary. Its inclusion here is in recognition that, in some cases, implementation may extend over a longer period than one year.

monetary conversion factor contained in NUREG-1530 (Ref. 29).

5.3.2.3 Occupational Health (Accident)

Evaluating the effect on occupational health from a change in accident frequency due to proposed regulatory actions is a multi-step process. Reduction in occupational risk is algebraically positive; increase is negative (viewed as a negative reduction).

The steps are follows:

1. Estimate reduction in accident frequency per facility

2. Estimate reduction in occupational health (accident) risk per facility due to the following.

   - "immediate" doses

   - long-term doses

3. Per facility, convert value of occupational health (accident) risk avoided (person-rems) to monetary equivalent (dollars) via monetary evaluation of health effects, due to the following (see Occupational Health (Accident)) (Ref. 29):

- "immediate" doses $Z_{IO} = RY_{IO}$

- long-term doses $Z_{LTO} = RY_{LTO}$

where Z_{IO} = monetary value of occupational health (accident) risk avoided per facility-year due to "immediate" doses, before discounting ($/facility-year)

Z_{LTO} = monetary value of occupational health (accident) risk avoided per facility-year due to long-term doses, before discounting ($/facility-year).

Y_{IO} = avoided occupational "immediate" dose per facility-year (person-rem/facility-year).

Y_{LTO} = avoided occupational long-term dose per facility-year (person-rem/facility-year).

R = monetary equivalent of unit dose ($/person-rem).

4. Discount to present value per facility (dollars).

5. Total over all affected facilities (dollars) using

$$V_{OHA} = N (W_{IO} + W_{LTO})$$

where V_{OHA} = discounted monetary value of occupational health (accident) risk avoided for all affected facilities.

W_{IO} = monetary value of occupational health (accident) risk avoided per facility due to "immediate" doses, after discounting ($/facility)

W_{LTO} = monetary value of occupational health (accident) risk avoided per facility due to long-term doses, after discounting ($/facility)

N =number of affected facilities.

If individual facility values rather than generic values are used, the formulations can be replaced with

$$V_{OHA} = \sum_i N\,(W_{IO_i} + W_{LTO_i})$$

where i = facility (or group of facilities) index.

5.3.2.4Occupational Health (Routine)

As with occupational health (accident), the evaluation of the effect on occupational health from a change in routine exposure due to proposed regulatory actions is a multi-step process. Reduction in exposure is algebraically positive increase is negative (viewed as a negative reduction).

The steps are as follows:

1. Estimate reductions in occupational health (routine) risk per facility for implementation (D_{0R1}) and operation (D_{ORO}).

2. Convert each reduction in occupational health (routine) risk per facility from person-rems to dollars via monetary evaluation of health effects:

$$G_{ORI} = RD_{ORI} \qquad G_{ORO} = RD_{ORO}$$

where G_{ORI} = monetary value of per-facility reduction in routine occupational dose to implement the proposed action, before discounting ($/facility)

G_{ORO} = monetary value of annual per-facility reduction in routine occupational dose to operate following implementation of the proposed action, before discounting ($/facility-year)

D_{ORI} = per-facility reduction in routine occupational dose to implement the proposed action (person- rem/facility)

D_{ORO} = annual per-facility reduction in routine occupational dose to operate following implementation of the proposed action (person-rem/facility-year)

R = monetary equivalent of unit dose ($/person-rem).

3. Discount each reduction in occupational health (routine) risk per facility (dollars).

4. Sum the reductions and total over all facilities (dollars):

$$O_{OHR} = N\left(H_{ORI} + H_{ORO}\right)$$

where V_{OHR} = discounted monetary value of reduction in occupational health (routine) risk for all affected facilities ($)

H_{ORI} = monetary value of per-facility reduction in routine occupational dose required to implement the proposed action, after discounting ($/facility)

H_{ORO} = monetary value of per-facility reduction in routine occupational dose to operate following implementation of the proposed action, after discounting ($/facility)

N = number of affected facilities.

Note the algebraic signs for D_{ORI} and D_{ORO}. A reduction in exposure is positive; an increase is negative. The dose for implementation (D_{ORI}) would normally be an increase and therefore negative.

If individual facility values rather than generic values are used, the formulas can be replaced with

$$V_{OHR} = \sum_i N_i \left(H_{ORI_i} + H_{ORO_i}\right)$$

where i = facility (or group of facilities) index.

5.3.2.4.1 Estimation of Change in Routine Exposure

A proposed NRC action can affect routine occupational exposures in two ways. It may cause a one-time increase in routine dose due to implementation of the action (e.g., installing a retrofit). It may also cause a change (either increase or decrease) in the recurring routine exposures after the action is implemented. A new coolant system decontamination technique, for example, may cause a small implementation dose but may result in a decrease in annual exposures from maintenance thereafter.

For the standard analysis, the analyst may attempt to make exposure estimates, or obtain at least a sample of industry or other technical data for a validation of the estimates developed. There are two components in the development of an exposure estimate: estimating the radiation field (rem/hour) and estimating the labor hours required. The product is the exposure (person-rem). In developing operational estimates, the annual frequency of the activity is also required.

General estimates of radiation fields can be obtained from a number of sources. For power reactors, Chapter 12 of the Final Safety Analysis Report (FSAR) for the plant will contain a

partitioning of the power plant into estimated radiation zones (Ref. 6). Both summary tables and plant layout drawings are usually provided. Some FSARs provide exposure estimates for specific operational activities. The analyst must be cautioned that the FSAR values are calculated, not measured. Actual data from operating facilities, as might be obtained from facility surveys, would have greater accuracy. Generic estimates of dose rates for work on specific Pressurized Water Reactor (PWR) and BWR systems and components are provided by Beal et al. (Ref. 83). These are used by Sciacca in NUREG/CR-4627 (Ref. 84) along with labor hours and occupational exposure estimates for specific repair and modification activities. Appropriate references" are cited.

Work in a radiation zone inevitably requires extra labor due to radiation exposure limits and lower worker efficiency. Such inefficiencies arise from restrictive clothing, rubber gloves, breathing through filtered respirators, standing on ladders or scaffolding, or crawling into inaccessible areas. In addition, paid breaks must be allowed for during a job. Basically, there are five types of adjustment factors identified for work on activated or contaminated systems. LaGuardia et al. (Ref. 85) identify the following five time duration multipliers:

1. Height (i.e., work conducted at elevations, e.g., on ladders or scaffolds) = 10-20% of basic time duration

2. Respiratory Protection = 25 – 50% of basic time duration

3. Radiation Protection = 10 – 40% of basic time duration

4. Protective Clothing = 30% of adjusted time duration

5. Work Breaks = 8.33% of total adjusted time duration.

Sciacca provides information from which to estimate relevant labor productivity factors, whose values can vary with the status of the plant and work environment at the time of the action.

Keeping these factors in mind, the analyst can proceed with the estimation of implementation and operational doses. The implementation dose would be

$$D_{ORI} = - F_R \times W_I$$

where D_{ORI} = per-facility reduction in routine occupational dose required to implement the proposed action (person-rem/facility-year)

F_R = radiation field in area of activity (rem/hour)

W_I = work force required for implementation (labor-hours/facility).

As mentioned earlier, implementation dose normally involves an increase, hence the negative sign in the equation.

The operational dose is the change from the current level; its formulation is

$$D_{ORO} = (F_R\ W_O\ A_F)_S - (F_R\ W_O\ A_F)_A$$

where D_{ORO} = annual per-facility reduction in routine occupational dose to operate following implementation of the proposed action (person-rem/facility-year)

F_R=radiation field in area of activity (rem/hour)

W_o =work force required for activity (labor-hours/facility-activity)

A_F = number of activities (e.g., maintenance, tests, inspections) per year (activities/year)

S = status quo (current conditions)

A = after implementation of proposed action.

Again, note the algebraic sign for D_{ORO} as mentioned earlier, an operational dose reduction is positive; an increase is negative.

For a major effort beyond the standard analysis, the best source of data to estimate both the implementation and operational exposures would be a thorough survey of health physicists at the affected facilities. This survey could be screened for bias and potential inflated value by a knowledgeable third party.

5.3.2.4.2. Monetary Valuation of Routine Exposure

The analyst should use the dollar per person-rem conversion factor discussed in NUREG-1530 for the monetary valuation of routine exposures.

5.3.2.4.3 Nonradiological Occupational Costs

In some cases, it will be possible to identify nonradiological occupational costs associated with a proposed action. When possible, these should be identified and included in the regulatory analysis. One source of data on the incidence of occupational injuries for various industries is the report *Occupational Injuries and Illnesses in the United States by Industry,* published annually by the Department of Labor's Bureau of Labor Statistics (BLS). Data from this report can be accessed from the BLS Home Page on the Internet (URL: http://www.bls.gov/home.htm) (Ref. 86).

Occupational injury data should be converted to a dollar valuation. The value of an injury should include medical costs and the value of lost production (RWG 1996, Section 5). The value of loss production is normally estimated using employee wage rates. Pain and suffering costs attributable to occupational injury can be identified qualitatively, but would not normally be quantified in dollar terms. Potential information sources for occupational injury valuation data are the National Center for Health Statistics (URL: http://www.cdc.gov/nchs/index.htm) (Ref. 87) and the publication *Accident Facts* published annually by the National Safety Council based in Itaska, Illinois (Ref. 87).

5.3.2.5 Offsite Property

Estimating the effect of the proposed action upon offsite property involves three steps:

1. Estimate reduction in accident frequency.

2. Estimate level of property damage.

3. Calculate reduction in risk to offsite property as

$$V_{FP} = N\Delta FD$$

where V_{FP}= monetary value of avoided offsite property damage ($)
N = number of affected facilities
ΔF = reduction in accident frequency (events/facility-year)
D = present value of property damage occurring with frequency F ($-year).

It is possible that the proposed action mitigates the consequences of an accident instead of, or as well as, reducing the accident frequency. In that event, the value of the action is

$$V_{FP} = (NFD)_S - (NFD)_A$$

where F = accident frequency (events/facility-year)
S = status quo (current conditions)
A = after implementation of proposed action.

Reduction in offsite property damage costs (i.e., costs savings) is algebraically positive; increase (i.e., cost accruals) is negative (viewed as negative cost savings).

The computer code MACCS has been developed to estimate power reactor accident consequences using currently available information. MACCS was employed for the consequence analyses in NUREG-1150 (Ref. 67).

Cost values within 50 miles are to be used in the regulatory analysis: Alternative values reflecting shorter and longer distances from the plan may be used for sensitivity analyses or special cases.

The present value for offsite property damage can be calculated as

$$D = C \times B$$

where D = present value of offsite property damage ($-year)
$C = [\exp(-rt_i) - \exp(-rt_f)]/r$
t_f = years remaining until end of facility life
t_i = years before facility begins operating
r = real discount rate (as fraction not percent)
B = undiscounted cost of offsite property damage.

If a facility is already operating, t_i will be zero and the equation for C simplified to

$$C = \left[1 - \exp(-rt_f)\right] / r$$

Should offsite property damage not be discounted in an analysis (e.g., when the time frame is sufficiently short to mitigate the need for discounting), r effectively becomes zero in the preceding equations. In the limit as r approaches zero, $C = t_r = t_i$ (or, $C = t_f$ when $t_i = 0$). This new value for C should be used to evaluate D in the undiscounted case.

The quantity D must be interpreted carefully to avoid misunderstandings. It does not represent the expected offsite property damage due to a single accident. Rather, it is the present value of a stream of potential losses extending over the remaining lifetime of the facility. Thus, it reflects the expected loss due to a single accident (this is given by the quantity B); the possibility that such an accident could occur, with some probability, at any time over the remaining facility life; and the effects of discounting these potential future losses to present value. When the quantity D is multiplied by the annual frequency of an accident, the result is the expected loss over the facility life, discounted to present value.

At a more detailed level, but still within the scope of a standard analysis, the analyst can identify the affected facilities, then calculate the proper sum effect rather than relying on generic values. The following steps are required:

1. Identify affected facilities.
2. Identify reductions in accident frequency per facility.
3. Calculate value of property damage per facility.
4. Calculate avoided property damage value per facility.
5. Sum avoided property damage over affected facilities.

For a major effort beyond the standard analysis, it is recommended that the estimates be derived from information more site-specific than that used by Strip (Ref. 88). For power reactors, the MACCS code with the most recent data available should be used. This degree of effort would be relatively costly to conduct, both in terms of computer costs and data col- lection and interpretation costs. However, it would provide the highest degree of reliability.

Burke et al. (Ref. 89) examined the offsite economic consequences of severe LWR accidents, developing costs models for the following:

- population evacuation and temporary sheltering, including food, lodging, and transportation
- emergency phase relocation, including food, housing, transportation, and income losses
- intermediate phase relocation, beginning immediately after the emergency phase
- long-term protective actions, including decontamination of land and property and land

area interdiction

- health effects, including the two basic approaches (human capital and willingness-to-pay).

5.3.2.6 Onsite Property

Onsite property damage cost savings (i.e., averted onsite costs) needs to be included in the cost-benefit analysis. In the net-value formulation it is a positive attribute.

Estimating the effect of the proposed action on onsite property involves three steps:

1. Estimate reduction in accident frequency.

2. Estimate onsite property damage.

3. Calculate reduction in risk to onsite property as

$$V_{OP} = N\Delta FU$$

where Y_{OP} = monetary value of avoided onsite property damage ($)
N = number of affected facilities
ΔF = reduction in accident frequency (events/facility - year)
U= present value of property damage occurring with frequency F ($-year).

Reduction in onsite property damage costs (i.e., costs savings) is algebraically positive; increase (i.e., cost accruals) is negative (viewed as negative cost savings).

For the standard analysis, it is convenient to treat onsite property costs under three categories: (1) cleanup and decontamination, (2) long-term replacement power, and (3) repair and refurbishment.

Long-Term Replacement Power
TBD – Appendix G
Repair and Refurbishment
TBD – Appendix G
Total Onsite Property Damage Costs
TBD – Appendix G

5.3.2.7 Industry Implementation

This section provides procedures for computing estimates of the industry's incremental costs to implement the proposed action. Estimating incremental costs during the operational phase that follows the implementation phase is discussed in Section 5.3.2.8. Incremental implementation costs measure the additional costs to industry imposed by the regulation; they are costs that would not have been incurred in the absence of that regulation. Reduction in the net cost (i.e., cost savings) is algebraically positive; increase (i.e., cost accrual) is negative (viewed as negative cost savings). Both the NRC and Agreement State licensees should be addressed, as appropriate.

In general, there are three steps that the analyst should follow in order to estimate industry implementation costs:

1. Estimate the amount and types of plant equipment, materials, and/or labor that will be affected by the proposed action.

2. Estimate the costs associated with implementation.

3. If appropriate, discount the implementation costs, and then sum.

In preparing an estimate of industry implementation costs, the analyst should also carefully consider all cost categories that may be affected as a result of implementing the action. Example categories include

- land and land-use rights
- structures
- hydraulic, pneumatic, and electrical equipment
- radioactive waste disposal
- health physics
- monitoring equipment
- personnel construction facilities, equipment, and services
- engineering services
- recordkeeping
- procedural changes
- license modifications
- staff training/retraining
- administration
- facility shutdown and restart
- replacement power (power reactors only)
- reactor fuel and fuel services (power reactors only)
- items for averting illness or injury (e.g., bottled water or job safety equipment). Note that

transfer payments should not be included.

Note that transfer payments should not be included.

For the standard analysis, the analyst should use consolidated information to estimate the cost to industry for implementing the action.

Step 1 - Estimate the amounts and types of plant equipment, materials, and/or labor that will be affected by the proposed action, including not only physical equipment and craft labor, but professional staff labor for design, engineering, quality assurance, and licensing associated with the action. If the action requires work in a radiation zone, the analyst should account for the extra labor required by radiation exposure limits and low worker efficiency due to awkward radiation protection gear and tight quarters.

When performing a sensitivity analysis, but not for the best estimate, the analyst should include contingencies, such as the most recent greenfield construction project contingency allowances supplied by Robert Snow Means Co., Inc. (Ref. 90). They suggest adding contingency allowances of 15% at the conceptual stage, 10% at the schematic stage, and 2% at the preliminary working drawing stage. The Electric Power Research Institute (Ref. 91) offers guidelines for use in estimating the costs for "new and existing power generating technologies." EPRI suggests applying two separate contingency factors, one for "projects" to cover costs resulting from more detailed design, and one for "process" to cover costs associated with uncertainties of implementing a commercial-scale new technology.

Step 2 - Estimate the costs associated with implementation, both direct and indirect. Direct costs include materials, equipment, and labor used for the construction and initial operation of the facility during the implementation phase. Indirect costs include required services. The analyst should identify any significant secondary costs that may arise. One-time component replacement costs and associated labor costs should be accounted for here. For additional information on cost categories, especially for reactor facilities, see Schulte et al. (Ref. 92) and United Engineers and Constructors, Inc. (Refs. 93, 94, and 95).

Step 3 - If appropriate, discount the costs, and then sum. If costs occur at some future time, they should be discounted to yield present values. If all costs occur in the first year or if present value costs can be directly estimated, discounting is not required. Generally, implementation costs would occur shortly after adoption of the proposed action.

When performing cost-benefit analyses for non-reactor facilities, the analyst will encounter difficulty in finding consolidated information on industry implementation costs comparable to that for power reactors. Comprehensive data sources such as Sciacca (Ref. 84) and the references from which he drew his information are generally unavailable fur non-reactor facilities. The types of non-reactor facilities are quite diverse. Furthermore, within each type, the facility layouts typically lack the limited standardization of the reactor facilities. These combine to leave the analyst pretty much "on his own" in developing industry implementation costs for non-reactor facilities. Specific data may be best obtained through direct contact with

knowledgeable sources for the facility concerned, possibly even the facility personnel themselves.

For a major effort beyond the standard analysis, the analyst should obtain very detailed information, in terms of the cost categories and the costs themselves. The analyst should seek guidance from NRC contractors or industry sources experienced in this area (AE firms, etc.). The incremental costs of the action should be defined at a finer level of detail. The analyst, should refer to the code of accounts in the Energy Economic Data Base (Ref. 95) or Schulte et al. (Ref. 92) to prepare a detailed account of implementation costs.

5.3.2.7.1 Short-Term Replacement Power

5.3.2.7.2 Premature Facility Closing

Several nuclear power plants have been voluntarily shut down prior to the expiration of their operating licenses. Normally, a decommissioning cost of approximately $0.3E+9 (1993 dollars) would be associated with an end-of-life shutdown. However, if a proposed regulatory requirement is expected to result in a premature shutdown, this cost is shifted to an earlier time with an associated net increase in its present value. For example, if a plant with an estimated t years of remaining life is prematurely closed, the net increase in present value, for a real discount rate of r, becomes ($0.3E+9) [1- 1/(1+r)^t].

$$Premature\ facility\ closing\ cost = Decommissioning\ cost\ x\ \left[1 - \frac{1}{(1+r)^t}\right]$$

Thus, a plant closed 20 years early will incur an additional cost of $0.2E+8 for a 7% real discount rate.

5.3.2.8 Industry Operation

This section provides procedures for estimating industry's incremental costs during the operating phase (i.e., after implementation) of the proposed action. The incremental costs measure the additional costs to industry imposed by the proposed action; they are costs that would not have been incurred in the absence of the action. Reduction in the net cost (i.e., cost savings) is algebraically positive; increase (i.e., cost accrual) is negative (viewed as negative cost savings). Both NRC and Agreement State licensees should be addressed, as appropriate.

In general, there are three steps that the analyst should follow in order to estimate industry operation costs:

1. Estimate the amount and types of plant equipment, materials, and/or labor that will be affected by the proposed action.

2. Estimate the associated costs.

3. Discount the costs over the remaining lifetimes of the affected facilities, then sum.

Costs incurred for operating and maintaining facilities may include, but are not limited to, the

following:

- maintenance of land and land-use rights
- maintenance of structures
- operation and maintenance of hydraulic, pneumatic, and electrical equipment
- scheduled radioactive waste disposal and health physics surveys
- scheduled updates of records and procedures
- scheduled inspection and test of equipment
- scheduled recertification/retraining of facility personnel
- associated recurring administrative costs
- scheduled analytical updates.

For the standard analysis, the analyst should proceed as follows:

1. Estimate the amount and types of plant equipment, materials, and/or labor that will be affected by the proposed regulation, including professional staff time associated with reporting requirements and compliance activities. Possible costs on a facility's capacity factor should be considered. The analyst may consult with engineering and costing experts, as needed. The analyst could seek guidance from NRC contractors, architect engineering firms, or utilities.

2. Estimate the associated operation and maintenance costs. The analyst should consider direct and indirect effects of the action; for example, the action could have an impact on plant labor, which, in tum, could affect administrative costs.

3. Discount the total costs over the remaining lifetime of the affected facilities.

Much of the discussion on industry implementation costs for non-reactor facilities applies here for operation costs. Again, the analyst will generally not find consolidated cost information comparable to that for power reactors facilities. However, the analyst may again need to rely on "engineering judgement," although specific data may be available through direct contact with cognizant industry/contractor personnel.

For a major effort beyond the standard analysis, the analyst should seek specific guidance from contractor or industry sources experienced in this area. The user may wish to use contractors who have developed explicit methodo10gies for estimating operating and maintenance costs. The following references can provide useful information for industry operation costs: Budwani (Ref. 96); Carlson et al. (Ref. 97); Clark and Chockie (Ref. 98); Eisenhauer et al. (Ref. 99); NUS Corporation (Ref. 100); Phung (Ref. 101); Roberts et al. (Ref. 102); Stevenson (Ref. 103) and United Engineers and Constructors, Inc. (Refs. 94, 95 and 104).

5.3.2.9 NRC Implementation

Once a proposed action is defined and the Commission endorses its application, the NRC will incur costs to implement the action. Implementation costs refer to those "front-end" costs necessary for the proposed action. All costs associated with pre-decisional activities by the NRC are viewed as "sunk" costs and are excluded from the NRC implementation costs. Reduction in the net cost (i.e., cost savings) is algebraically positive; increase (i.e., cost accrual) is negative (viewed as negative cost savings).

Implementation costs to the NRC may arise from developing procedures, preparing guidance, and taking other actions to assist in or assure compliance with the proposed action.

The analyst should determine whether the proposed action will be implemented entirely by the NRC or in cooperation with one or more Agreement States. Implementation costs shared by Agreement States may reduce those of the NRC.

NRC implementation costs include only the incremental costs resulting from adoption of the proposed action. Examples of these costs are as follows:

- developing guidelines for interpreting the proposed action and developing enforcement procedures
- preparing handbooks for use by the NRC staff responsible for enforcement and handbooks for use by others responsible for compliance
- supporting and reviewing a licensee's change in technical specifications
- conducting initial plant inspections to validate implementation.

Sciacca (1992) assist the analyst in calculating these and "other" implementation costs. Implementation costs may include labor costs and overhead, purchases of equipment, acquisition of materials, and the cost of tasks to be carried out by outside contractors. Equipment and materials that would be eventually replaced during operation should be included under operating costs rather than implementation costs.

Three steps are necessary for estimating NRC implementation costs:

1. Determine what steps the NRC must take to put the proposed action into effect.
2. Determine the requirements for NRC staff, outside contractors, materials, and equipment.
3. Estimate the costs of the required resources, discount if appropriate, then sum.

Implementation is likely to affect a number of NRC branches and offices. For example, the Office of Nuclear Regulatory Research (RES) may develop a regulatory guide, the Office of Nuclear Reactor Regulation (NRR) may review any licensee submissions, and the NRC

Regional Offices may inspect against some portion of the guide in operating facilities. In developing estimates for the implementation costs, the analyst is encouraged to contact all of the NRC components likely to be affected by the proposed action.

For the standard analysis, the analyst should identify the major tasks that must be performed to get the proposed rule implemented, major pieces of equipment (if any) that must be acquired, and major costs of materials. Major tasks are then assessed to estimate the approximate level of effort (in professional staff person-hours) necessary to complete them. The number of person-hours for each task is multiplied by the appropriate NRC labor rate and then summed over all of the tasks. The NRC's labor rates are determined using the methodology in Abstract 5.2, "NRC Labor Rates," of NUREG/CR-4627, "Generic Cost Estimates, Abstracts from Generic Studies for Use in Preparing Regulatory Impact Analyses," (Ref. 84).

Similarly, the costs to complete tasks that would be contracted out also need to be estimated. In order to obtain a reasonably good approximation of contractor costs, the analyst should contact the NRC component that would be responsible for contracting for the tasks. Finally, the costs of major pieces of equipment and quantities of materials are added to the labor and contract costs.

When other data are unavailable, the analyst may assume as an approximation that for a non-controversial amendment to an existing rule or regulation implementation will require the following: a total of one professional NRC staff person-year with no additional equipment, and no additional materials. For a new rule or regulation, it is much more difficult to supply a rough but reasonable estimate of the implementation cost, because the level of effort and types and quantities of machinery and materials can vary dramatically. One recourse would be to use as a proxy the implementation costs for a recently adopted regulatory requirement that is similar to the proposed measure. The relative similarity of the two requirements should be judged with respect to the effort required to implement the proposed measure.

For a major effort beyond the standard analysis a more detailed and complete accounting would be expected. The analyst can request the responsible NRC office to provide available information, such as paper submittals or records of initial inspections.

5.3.2.10 NRC Operation

After a proposed action is implemented, the NRC is likely to incur operating costs. These are the recurring costs that are necessary to ensure continued compliance. For example, adding a new regulation may require that NRC perform periodic inspections to ensure compliance. The analyst should determine whether operations resulting from the proposed action will be conducted entirely by the NRC or in cooperation with one or more Agreement States. Reduction in the net cost (i.e., cost savings) is algebraically positive; increase (i.e., cost accrual) is negative (viewed as negative cost savings).

There are three steps for estimating NRC operating costs:

1. Determine the activities that the NRC must perform after the proposed action is implemented.

2. Estimate NRC staff labor, contractor support and any special equipment and material required.

3. Estimate the costs of the required resources, discount (usually over the remaining lifetimes of the affected facilities, as for industry operation costs) to yield present value, then sum.

In determining the required post-implementation activities, the analyst should carefully examine the proposed action, asking such questions as the following:

- How is compliance with the proposed action to be assured?
- Is periodic review of industry performance required?
- What is an appropriate schedule for such review?
- Does this action affect ongoing NRC programs, and, if so, will it affect the costs of those programs?

Since recurring costs attributable to the proposed action may be incurred by several NRC branches and offices, the analyst is encouraged to contact all of the NRC components likely to be affected.

For the standard analysis, the analyst should obtain estimates of the number of full-time equivalent professional NRC staff person-hours that would be required to ensure compliance with the proposed rule.[30] Major recurring expenditures for special equipment and materials, and for contractors, should be added. Since operating costs are recurring, they must be discounted usually over the remaining lifetimes of the affected facilities.

A major effort beyond the standard analysis would proceed along the lines described above, except that greater detail would be provided to account for acquisitions of special equipment and materials.

5.3.2.11 Other Government

This attribute measures costs to the federal government (other than the NRC) and state (including Agreement State) and local governments. The discussion parallels that for NRC implementation and operation. Reduction in the net cost (i.e., cost savings or an averted cost) is algebraically positive; increase (i.e., cost accrual) is negative (viewed as negative cost savings).

Implementation costs to the federal (non-NRC) government and to state and local governments may arise from developing procedures, preparing aids, supporting license amendments, and taking action to assure compliance with the proposed action. For example, placing roadside evacuation route signs for the possibility of a radioactive release from a nearby power reactor would require expenditures from selected government agencies. As another example, requiring criminal investigation checks for nuclear reactor personnel may require resources of the Federal Bureau of Investigation. When estimating the implementation costs, the analyst should be

[30] The NRC's labor rates are determined using the methodology in Abstract 5.2, "NRC Labor Rates," of NUREG/CR-4627, "Generic Cost Estimates, Abstracts from Generic Studies for Use in Preparing Regulatory Impact Analyses." (Ref. 84).

aware that they may differ between Agreement and non-Agreement States. Such differences should be taken into account in preparing cost estimates.

Three steps are needed to estimate the other government implementation costs:

1. Determine what steps the other governments must take to put the proposed action into effect.

2. Determine the requirements for government staff, outside contractors, materials, and equipment.

3. Estimate the costs of the required resources, discount if appropriate, then sum.

Implementation is likely to affect a number of government branches and offices. In developing estimates for the implementation costs, the analyst is encouraged to contact all of the government components likely to be affected by the proposed action.

For the standard analysis, the analyst should identify the major tasks that must be performed to get the proposed rule implemented, major pieces of equipment (if any) that must be acquired, and major costs of materials. Major tasks are then assessed to estimate the approximate level of effort (in professional staff person-hours) necessary to complete them. The number of person-hours for each task is multiplied by the appropriate labor rate and then summed over all of the tasks.

Similarly, the costs to complete tasks that would be contracted out also need to be estimated. In order to obtain a reasonably good approximation of in-house and contractor costs, the analyst should contact the government agencies that would be responsible for carrying out or contracting for the tasks. Finally, the costs of major pieces of equipment and quantities of materials are added to the labor and contract costs.

After a proposed action is implemented, the federal (non-NRC) government and state and local governments may incur operating costs. These are the recurring costs that are necessary to ensure continued compliance. For example, adding a new regulation may require that other government agencies in addition to the NRC perform periodic inspections to ensure compliance. The analyst should determine whether operations resulting from the proposed action will be conducted entirely by the NRC or in cooperation with one or more other government agencies.

The three steps for estimating the other government operating costs are

1. Determine the activities that the other governments must perform after the proposed action is implemented.

2. Estimate government staff labor, contractor support, and any special equipment and material required.

3. Estimate the costs of the required resources, discount (usually over the remaining lifetimes of the affected facilities, as for NRC operation costs) to yield present value, then sum.

In determining the required post-implementation activities, the analyst should carefully examine the proposed action, asking such questions as the following:

- Does compliance with the proposed action require non-NRC cooperation?
- Is periodic review of industry performance required beyond that of the NRC?
- What is an appropriate schedule for such review?
- Does this action affect ongoing government programs, and, if so, will it affect the costs of those programs?

Since recurring costs attributable to the proposed action may be incurred by several government branches and offices, the analyst is encouraged to contact all components likely to be affected.

For the standard analysis, the analyst should obtain estimates of the number of full-time equivalent professional staff person-hours that would be required to ensure compliance with the proposed rule. Each person-hour should be costed at the appropriate labor rate may be used as a substitute if no more specific value is available. Major recurring expenditures for special equipment and materials, and for contractors, should be added. Since operating costs are recurring, they must be discounted, usually over the remaining lifetimes of the affected facilities.

A major effort beyond the standard analysis would proceed along the lines described above, except that a more detailed and complete accounting would be expected. The analyst could request the responsible government agencies to provide available information.

5.3.2.12 General Public

This attribute measures costs incurred by members of the general public, other than additional taxes, as a result of implementation of a proposed action. Taxes are viewed simply as transfer payments with no real resource commitment from a societal perspective. Reduction in the net cost (i.e., cost savings) is algebraically positive; increase (i.e., cost accrual) is negative (viewed as negative cost savings).

Typically, costs to the general public cover such items as increased cleaning due to dust and

construction-related pollutants, property value losses, or inconveniences, such as testing of evacuation sirens. Care must be taken not to double count for general public and other government costs. If a cost could be assigned to either group, it should be assigned where more appropriate, the analyst_ remembering not to account for it again in the other attribute.

The two steps to estimate costs to the general public are as follows:

1. Identify the adverse impacts incurred by the general public to implement the proposed action.

2. Estimate the costs associated with these adverse impacts, discount if appropriate, then sum.

This attribute is not expected to be one commonly affected by regulatory actions. However, if relevant, the standard analysis would require the analyst to identify the major activities to implement the proposed action that will result in adverse impacts to the general public. Public records or analogous experience from other communities could be used as information sources to estimate the costs to the general public.

5.3.2.13 Improvements in Knowledge

This attribute relates primarily to proposals for conducting assessments of the safety of licensee activities. At least four major potential benefits are derived from the knowledge produced by such assessments:

- improvements in the materials used in nuclear facilities

- improvement or development of safety procedures and devices

- production of more robust risk assessments and safety evaluations, reducing uncertainty about the relevant processes

- improvement in regulatory policy and regulatory requirements.

To the extent that the effects of regulatory actions can be quantified, they should be treated under the appropriate quantitative attributes. On the other hand, if the effects from the assessments are not easily quantified, the analyst still has the burden of justifying the effort and providing some indication of its effect. If necessary, this justification would be expressed qualitatively under this attribute. An effort should be made to identify the types of cost and benefits that are likely to accrue and to whom.

Consider the following statement:

> This assessment effort has a reasonable prospect of reducing our uncertainty regarding the likelihood of containment failure resulting from hydrogen burning. Such an accident may be a significant source of risk. The knowledge from the proposed assessments would enable us to assess more accurately the overall accident risk posed by nuclear reactors, and this in tum should benefit the public

through better policy decisions.

While this statement describes why the proposed assessment is needed, no information is provided for evaluating the merits of the proposed assessment.

Providing answers to the following questions would help to fill this information gap:

- What are the likely consequences of a hydrogen-burning accident?
- To what extent would the proposed assessment reduce the uncertainty in the likelihood of a hydrogen-burning accident?
- Given our current information, what is the contribution of hydrogen burning to overall accident risk?

The above questions are specific to a particular topic. For the broader problem of providing a cost-benefit analysis of an assessment proposal, it is recommended that the analyst be responsive to the following list of more general questions:

- What are the objectives?
- If the assessment is successful in meeting its objectives, what will be the social benefits?
- Is there a time constraint on the usefulness of the results?
- Who will benefit from the results, by how much, and when?
- What is the likelihood that the assessment will fail to meet its objectives within the time and budget constraints?
- What will be the social costs (and benefits) if the assessment is not successful, or if the assessment is not undertaken?

5.3.2.14 Regulatory Efficiency

Regulatory efficiency is an attribute that is frequently difficult to quantify. If it can be quantified, it should be included under one or more of the other quantifiable attributes. If quantification is not practical, regulatory efficiency can be treated in a qualitative manner under this attribute. For example achieving consistency with international standards groups may increase regulatory efficiency for both the NRC and the groups. However, this increase may be difficult to quantify.

If necessary, this justification would be expressed qualitatively under this attribute. An effort should be made to identify the types and recipients of cost and benefits likely to accrue: If the proposed NRC action is expected to have major effects on regulatory efficiency, then a proper evaluation of these effects may require a level of effort commensurate with their magnitude. This may mean expending resources to obtain the judgments of experts outside of the NRC if the necessary expertise is not available in-house.

Whether the assessment is performed by a panel of experts or by the analyst, the following are questions that might be considered in order to focus on that assessment:

- Does this action conflict with any other NRC/federal/state directives?
- Are there any nuclear facilities for which (or conditions under which) this action might have unexpected or undesirable consequences?
- Do you foresee any major enforcement problems with this action or regulation?
- What sort of adjustments might industry undertake to avoid the regulation's intended effects?
- How will the regulation impact productivity in the nuclear/electric utility industries?
- How will this action affect facility licensing times?
- How will this action affect the regulatory process within the NRC (and/or other regulatory agencies)?

5.3.2.15 Antitrust Considerations

This qualitative attribute is not expected to be one commonly affected by regulatory actions. However, the NRC does have a legislative mandate in Section 105 of the Atomic Energy Act to uphold the antitrust laws (Ref. 65). Thus, this attribute can be relevant for those proposed actions which may potentially violate the antitrust laws. If applicable, antitrust considerations should be explored with the NRC Office of the General Counsel early in the analysis to preclude analyzing an issue clearly in conflict with these laws. If antitrust considerations are involved, and it is determined that antitrust laws would be violated, then the proposed action must be reconsidered and, if necessary, redefined to preclude such violation.

5.3.2.16 Safeguards and Security Considerations

Safeguards and security considerations include protection of the common defense and security and safeguarding restricted data and national security information. In more practical terms, this means providing adequate physical security and safeguards systems to prevent the diversion of certain types of fissionable and radioactive materials, the perpetration of acts of radiological sabotage, and the theft by unauthorized individuals of restricted data or national security information.

The NRC has a legislative mandate in the Atomic Energy Act to assure the objectives mentioned above (Ref. 65). Through its regulations and regulatory guidance, the NRC has established a level of protection deemed to satisfy the legislative mandate. As is the case for adequate protection of the health and safety of the public, this level of protection must be maintained without consideration of cost.

While quantification of safeguards and security changes may be difficult, the analyst should attempt quantification when feasible. If this process is impossible, the analyst may proceed with a qualitative analysis under this attribute.

5.3.2.17 Environmental Considerations

Section 102 of the National Environmental Policy Act (NEPA) requires federal agencies to consider environmental impacts in the performance of their regulatory missions (Ref. 43) NRC's regulations implementing NEPA are in 10 CPR Part 51 (Ref. 44). Any documentation prepared to satisfy NEPA and Part 51 should be coordinated with any regulatory analysis documentation covering the same or similar subject matter as much as possible.

Environmental impacts can have monetary effects (e.g., environmental degradation, mitigation measures, environmental enhancements), which could render potential alternative actions unacceptable or less desirable than others. Therefore, at a minimum, such effects should be factored into the cost benefit analysis, at least to the extent of including a summary of the results of the environmental analysis.

Many of the NRC's regulatory actions are subject to categorical exclusions as set forth in 10 CFR 51.22. In these cases, detailed environmental analyses are not performed, and there will be no environmental consideration to factor into the regulatory analysis. In some cases, a generic or programmatic EIS is prepared. If such is the case, portions of the EIS may be referenced in lieu of performing certain elements of the regulatory analysis. In the remaining cases, it may be that the regulatory analysis alternative being considered will initiate the requirement for review of environmental effects. For purposes of the regulatory analysis document, the preferred approach to be used in this situation is to perform a preliminary environmental analysis, identifying in general terms anticipated environmental consequences and potential mitigation measures. The results of this preliminary analysis should be quantified under the appropriate quantitative attributes, if possible, or addressed qualitatively under this attribute, if not quantified.

5.3.2.18 Other Considerations

There may be other considerations associated with a particular proposed action that are not captured in the preceding descriptions. Possible examples might include the way in which the proposed action meets specific requirements of the Commission, EDO, or NRC office director that requested the regulatory analysis; the way in which the proposed action would help achieve NRC policy; or advantages or detriments that the proposed action would have for other NRC programs and actions. If quantifiable, the effect should be included in essentially the same way as in the quantitative attributes. Because such considerations would be expected to be unusual, some additional discussion in the regulatory analysis document should be provided.

The analyst needs to give thoughtful consideration to the possible effects of the proposed action. Some of the effects may not be immediately obvious. The analyst may wish to consult with other knowledgeable individuals to aid in the identification of all significant effects. These considerations need to be presented clearly to facilitate the reader's understanding of the issues.

When quantification of effects is not feasible, the analyst may still be able to provide some indication of the magnitude to facilitate comparison among alternatives, and comparison with quantifiable attributes. Comparative language (greater than, less than, about equal to) can be very helpful in achieving this objective, as the analyst can make the necessary judgements.

Consultation with experts or other knowledgeable individuals may be required.

5.4 Labor Rates

When determining the appropriate industry labor rates the analyst should use data from the National Wage Data available on the Bureau of Labor Statistics Web site (www.bls.gov). Depending on the industry and the occupation (e.g., manufacturing, health and safety, etc.), an appropriate mean hourly labor rate should be selected. The labor rate should be increased using a multiplier of 1.5 to account for benefits (pension, insurance premiums, and legally required benefits). Because exact hourly rates may be difficult to obtain and may not be sufficiently recent, nationwide mean hourly rates should be used.

The NRC's labor rates are determined using the methodology in Abstract 5.2, "NRC Labor Rates," of NUREG/CR-4627, "Generic Cost Estimates, Abstracts from Generic Studies for Use in Preparing Regulatory Impact Analyses." (Ref. 84) This methodology considers only variable costs (including salary and benefits) that are directly related to the implementation, operation, and maintenance of the amendments. The NRC's labor rates are distributed annually.

5.5 Economic Discounting and Calculation of Present Value

To evaluate the economic consequences of proposed regulatory actions, the costs incurred or saved over a period of years must be summed.

This summation cannot be done directly because an amount of money available today has greater value than the same amount at a future date. There are several reasons for this difference in value:

- the present amount of money can be invested and the total amount increased through accumulated interest
- certain consumption today is superior to contingent consumption in the future
- the option of present or future consumption is superior to future consumption alone.

A method known as "discounting" is used to compare amount of money expended at different times. The result of discounting is called the "present value," the amount of money that must be invested today to achieve a specified sum in the future. To perform the discounting procedure, the analyst must know three parameters:

- the discount rate
- the time period over which discounting is to be performed
- the amount of money or value that is to be discounted.

5.6 Discount Rate

The appropriate discount rate to use is often a controversial issue in the application of cost-benefit analysis. The discount rates specified in the most recent version of OMB Circular A-4 (Ref. 11) are to be used in preparing regulatory analyses. Circular A-4 currently specifies use of a real discount rate (r) of 7% per year. A discount rate of 3% should be used for sensitivity analysis to indicate the sensitivity of the results to the choice of discount rate.

When the time horizon associated with a regulatory action exceeds 100 years, the 7% real discount rate should not be used. Instead the net value should be calculated using the 3% real discount rate. In addition, the results should be displayed showing the cost and benefits at the time they are incurred with no discounting.

OMB Circular A-94 (Ref. 13) defines the term "discount rate" as the interest rate used in calculating the present value of expected yearly benefits and costs. When a real discount rate is used, yearly benefits and costs should be in real or constant dollars. Circular A-94 defines "real or constant dollar values" as economic units measured in terms of constant purchasing power. A real value is not affected by general price inflation. Real values can be estimated by deflating nominal values with a general price index generally the GDP deflator discussed in Section 5.5.2.

5.7 Discrete Discounting

The following formula is used to determine the present value (PV) of an amount (FV) at the end of a future time period:

$$PV = \frac{FV}{(1+r)^{t_f}}$$

Where r = the real annual discount rate (as fraction, not percent)
t = the number of years in the future in which the costs occur.

For example, to determine how much $750 to be received 25 years (t) hence is worth today, using a 7% real discount rate (r), the formula yields

$$PV = \frac{\$750}{(1+\ .07)^{25}} = \$750\ x\ 0.184 = \$138$$

To find the present value of a stream of costs and revenues, the analyst should record the costs and revenues occurring in each year. Then, for each year, the net cost is determined by simply adding algebraically the costs and revenues for that year. After this has been done for each year, the net cost in each year is discounted to the present. The sum of these present values is the present value of the entire stream of costs and revenues. A sample use of this formula in cost benefit analysis would be in determining the PV of implementation costs for industry and the NRC which occur in the future.

The above formula is used for discounting single amounts backward in time. However, some of the costs encountered in cost benefit analysis recur on an annual basis. These include not only industry and NRC operating costs, but also the monetized values of the annual per-facility reductions in routine public and occupational dose due to operation (see Sections 5.2.2 and 5.2.4). Such costs can be discounted by the use of the following annuity formula (only if they are the same amount for each time period):

$$PV = \frac{C_A \, x \, [(1+r)^t - 1]}{r \, x \, (1+r)^t}$$

where C_A = identical annual costs
r = the real discount rate (as fraction, not percent)
t = the number of years over which the costs recur.

For example, if the increase in annual industry costs is $1,000, due to increased maintenance expenses, with a 7% real discount rate for 20 years, starting at the present time, the present value of these costs is:

$$PV = (\$1{,}000)x \, \frac{(1+.07)^{20} - 1]}{.07 \, (1+.07)^{20}} = \$10{,}600$$

In most cases, operating costs will start to be incurred at some date in the future, after which the real costs will be constant on an annual basis for the remaining life of the facility. To discount the costs in this situation, a combination of the above two methods or formulas is needed. For example, given the same $1,000 annual cost for a 20-year period at a 7% real discount rate, but starting five years in the future, the formula to calculate the PV is:

$$PV = (\$1{,}000)x \, \frac{(1+r)^{t_2} - 1]}{r \, (1+r)^{t_1} \, (1+r)^{t_2}}$$

where:

r = 7% discount rate (i.e., 0.07 per year)
t_1= 5 years
t_2 = 20 years for annuity period

Therefore,

$$PV = (\$1{,}000)x \, \frac{(1+.07)^{20} - 1]}{.07 \, (1+.07)^{5} \, (1+.07)^{20}} = \$7{,}560$$

Additional background on discrete discounting can be found in the EPRI Technical Assessment Guide (Ref. 91), DOE Cost Guide (Ref. 110), and Wright (Ref. 111).

5.8 Continuous Discounting

Discrete discounting, as discussed above, deals with costs and revenues that occur at discrete instances over a period of time. For most regulatory analyses, discrete discounting and present value factors can be used. Technically, discrete discounting does not correctly account for consequences that occur constantly, but the difference is viewed as minimal, and the additional effort is generally not warranted in a standard regulatory analysis.

Continuous discounting should be used in regulatory analyses beyond the standard analysis when costs and revenues occur continuously over a period of time, such as those which must be weighed by an accident frequency over the remaining life of a facility. The accident frequency is a continuous variable, although the real cost of the accident consequences is constant.

The formula for continuous discounting is derived from the discrete discounting formula as follows. Assume that in one period (t), the time will be subdivided into n intervals. The formula for discrete discounting, with a real discount rate of r, is $1/(1 + r/n)^n$. As we subdivide the time period into an infinite number of intervals in the limit, we would abandon discrete intervals altogether and so set the limit as

$$\lim_{n\to\infty} \frac{1}{(1+\frac{r}{n})^n} = e^{-r}$$

For t periods, instead of one period as above, the formula becomes e^{-rt}, where r and t are defined over the same time period.

The monetized values for the reductions in public and occupational dose due to accidents, as well as the avoided onsite and offsite property damage costs, require continuous discounting. To calculate the present value for the public health (accident) and offsite property attributes, when the monetary value or cost C_o can occur with a frequency f, Strip (1982) provides the following formula:

$$\int_{t_i}^{t_f} C_0 f e^{-rt} dt = C_0 f [e^{-rt_i} - e^{-rt_f}]/r$$

where t_i = time of onset of accident risk
t_f = time of end of accident risk.

For public (accident) risk, the product $C_o f$ is replaced by Z_{PHA} representing the monetary value of avoided risk before discounting ($/facility-yr [see Section 5.3.2.1.3]). As an example, assume the monetary value of avoided public risk due to an accident is 1.0×10^4 per facility-year ($C_o f = \$1.0 \times 10^4$). The facility is operational ($t_i = 0$) with a remaining lifetime of 25 years ($t_f = 25$). For an annual discount rate of 7% (r = 0.07 per year) the present value of avoided risk (monetized) becomes

$$PV = \frac{\left(\frac{\$10{,}000}{yr}\right) x\ [e^{-(0.07)(0)} - e^{-(0.07)(25)}]}{0.07/yr} = \$118{,}000\ per\ facility$$

To determine the present value of a reduction in offsite property risk, the frequency (f in the general equation above) is replaced with the frequency reduction (Δf). As an example, let the frequency reduction (Δf) be 1.0E-5/facility-yr and the cost (C_o) be $1.0E+9. The annual discount rate is 7% (r = .07/yr), and the reduction in accident frequency takes place 5 years in the future ($t_i = 5$) and will remain in place for 20 years ($t_f = 5 + 20 = 25$). The present value of the avoided

off site property damage becomes

$$PV = \frac{(\$1.0\ x\ 10^{9})\left(\frac{1.0\ x\ 10^{-5}}{yr}\right) x\ [e^{-(0.07)(5)} - e^{-(0.07)(25)}]}{0.07/yr} = \$75{,}800\ per\ facility$$

To calculate present values for the occupational health (accident) and onsite property attributes, the continuous discounting formula must be modified. The modifications account for the fact that 1) some components of severe accident costs are not represented by constant annual charges as noted in Section 5.7) the single-event present values must be reintegrated because the accident costs and risks would be spread over a period of time (e.g., over the remaining plant life- time for replacement power costs and over the estimated 10 years for cleanup and decontamination following a severe accident, for onsite property damage). Section 5.3.2.1.3 and Appendix G (Total Onsite Property Damage Costs) address these modifications and provide estimation guidelines for regulatory initiatives that affect accident frequencies in current and future years.

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