"SUBSTANTIALLY COMPLETE CONTAINMENT" (SCC) ELICITATION REPORT

Prepared for

Nuclear Regulatory Commission
Contract NRC-02-88-005

Prepared by

Center for Nuclear Waste Regulatory Analyses
San Antonio, Texas

August 1992

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ABSTRACT

The Code of Federal Regulations (CFR), Title 10, Part 60 contains regulations set forth by actions of the Nuclear Regulatory Commission (NRC) with respect to disposal of high-level radioactive waste in a geologic repository. The performance objectives for the engineered barrier system include a requirement for "substantially complete containment" during the containment period which is qualitative and subject to interpretation. The following three factors make "quantification" difficult and will require the judicious application of advanced technologies: (1) minimum length of time for containment (300 to 1000 years); (2) size scale (20,000 to 80,000 containers); and (3) inaccessibility after permanent closure of the repository.

The NRC Division of High-Level Waste within the Nuclear Materials Safety and Safeguards (NMSS) Division initiated a technical feasibility study to evaluate potential quantitative criteria. The conduct of the feasibility study will not preclude the Nuclear Regulatory Commission (NRC) from pursuing any of the other options, including qualitative guidance or a "no action" option. The NRC contracted with the Center for Nuclear Waste Regulatory Analyses (CNWRA) to undertake an assessment of the feasibility of developing quantitative criteria for expressing the meaning of "substantially complete containment" (SCC) in 10 CFR 60.113. Following the completion of the SCC Quantitative Feasibility Study, a SCC Quantitative Alternatives Prioritization Study was initiated. The purpose of this study was to conduct an exercise where a selected number of NRC staff members participated in a structured elicitation process and presented their opinions on the four specified alternatives.

The objectives of the SCC Quantitative Alternatives Prioritization Study were: (1) to address selection of objectives to be fulfilled, (2) to identify and formulate criteria specific to the objectives and to the alternatives under consideration, and (3) to provide a coherent methodology specific to the prioritization of the identified alternatives. A prioritization exercise was instituted to elicit staff opinions with regard to the defined alternatives for quantitative criteria for reducing the uncertainty concerning "substantially complete containment."

Members of the NRC Staff constituted a prioritization panel and organized and conducted the prioritization exercise. The CNWRA contribution included the development of an elicitation procedure, the associated training for the prioritization panel and identification and description of support requirements related to the conduct of an alternatives prioritization analysis.

This report documents the elicitaion process and the results of the SCC Quantitative Alternatives Prioritization Study.

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ACKNOWLEDGMENTS

This report was prepared to document work performed by the Center for Nuclear Waste Regulatory Analyses (CNWRA) for the U.S. Nuclear Regulatory Commission (NRC) under Contract No. NRC-02-88-005. The activities reported here were performed on behalf of the NRC Division of High-Level Waste Management. The report is a product of the CNWRA and does not necessarily reflect the views or regulatory position of the NRC.

One of the authors of this report, Dr. L. R. Abramson, is affiliated with the NRC Office of Nuclear Regulatory Research, Probabilistic Risk Analysis Branch. Dr. Abramson's role of co-author of this CNWRA report is appropriate since he acted as normative expert during elicitation sessions, and his experience and knowledge have contributed significantly to the study. Special thanks are extended to NRC for Dr. Abramson's participation.

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1 INTRODUCTION

1.1 BACKGROUND

The Code of Federal Regulations (CFR), Title 10, Part 60, contains regulations set forth by the Nuclear Regulatory Commission (NRC), based on direction from the Nuclear Waste Policy Act (NWPA), as amended (U.S. Congress, 1987). In Part 60 of chapter I (U.S. NRC, 1990), the "Disposal of High-Level Radioactive Wastes in Geologic Repositories" is addressed. Two paragraphs in Part 60 are the principal focus of the current work on the isolation of high-level radioactive waste (HLW). They are 10 CFR 60.112, "Overall system performance objective for the geologic repository after permanent closure" and 10 CFR 60.113, "Performance of particular barriers after permanent closure." In 10 CFR 60.112, the performance objectives for the overall geologic repository system are provided. In 10 CFR 60.113, the performance objectives for engineered barrier system and geologic setting of the repository system are given.

The performance objectives for the engineered barrier system consist of two parts: (1) a "containment" requirement for HLW packages, and (2) a radionuclide release rate limit from the engineered barrier system. Taken together, these two parts are intended to control the release of radioactive materials to the geologic setting and to add confidence that the overall system performance objectives for the repository (i.e., 10 CFR 60.112) will be met.

The performance objectives for the engineered barrier system, as contained in 10 CFR 60.113, specify that:

> "(i) The engineered barrier system shall be designed so that assuming anticipated processes and events: (A) Containment of HLW will be substantially complete during the period when radiation and thermal conditions in the engineered barrier system are dominated by fission product decay; and (B) any release of radionuclides from the engineered barrier system shall be a gradual process which results in small fractional releases to the geologic setting over long times...."
>
> "(ii) In satisfying the preceding requirements, the engineered barrier system shall be designed, assuming anticipated processes and events, so that:
> (A) Containment of HLW within the waste packages will be substantially complete for a period to be determined by the Commission taking into account the factors specified in 60.113(b) provided, that such period shall be not less than 300 years nor more than 1000 years after permanent closure of the geologic repository; and
> (B) The release rate of any radionuclide from the engineered barrier system following the containment period shall not exceed one part in 100,000 per year of the inventory of that radionuclide calculated to be present at 1000 years following permanent closure, or such other fraction of the inventory as may be approved or specified by the Commission; provided that this requirement does not apply to any radionuclide which is released at a rate less than 0.1% of the calculated total release rate limit. The calculated total release rate limit shall be taken to be one part in 100,000 per year of the inventory of radioactive waste, originally emplaced in the underground facility, that remains after 1000 years of radioactive decay."

Although the requirement in the rule for limited release from the engineered barrier system in the post-containment period is clearly stated in numerical terms, the associated requirement for "substantially complete containment" during the preceding containment period is qualitative, subject to interpretation, and in need of clarification.

One reason why resolution of the meaning of this rule has not occurred is the extraordinarily long period of time for which the problem of containment must be confronted in a scientifically defensible way. The following three factors make quantification difficult and will require the judicious application of advanced technologies: (1) minimum length of time for containment (300 to 1000 years); (2) size scale (20,000 to 80,000 containers); and (3) inaccessibility after permanent closure of the repository.

To date, the Department of Energy (DOE) has attempted to define the performance implication of "substantially complete containment" in the Site Characterization Plan. The NRC staff found the representations at variance with the intent of the regulations as established in the statement of considerations for the containment rule and in the supporting document, Staff Analysis of Public Comments on Proposed Rule 10 CFR Part 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories," NUREG-0804, December 1983 (U.S. NRC, 1983). Considerations from NUREG-0804 are discussed elsewhere by Nair and Tschoepe (1990).

Pursuant to implementing the recommendation in SECY-88-285 (U.S. NRC, 1988) regarding clarification of the regulatory requirement for "substantially complete containment," the NRC Division of High-Level Waste Management Engineering Branch prepared a policy options paper (Bunting, 1989) and a proposed scope for a possible rulemaking effort (Bunting et al., 1989). The policy options paper, while considering several options, focussed on exploring a quantitative approach to the "substantially complete containment" requirement. As a result, it was recommended that a technical feasibility study be conducted for evaluating potential quantifiable criteria. The conduct of the feasibility study was not intended to preclude the Nuclear Regulatory Commission (NRC) staff from pursuing any of the other options, including qualitative guidance or "no action" option.

The NRC tasked the CNWRA to undertake an assessment of the feasibility of developing quantitative criteria for expressing the meaning of "substantially complete containment" (SCC) in 10 CFR 60.113. The purposes of the feasibility study were:

(i) To develop an understanding of the technical considerations required for demonstrating long-term waste package performance under anticipated conditions at the potential repository site;

(ii) To identify a methodology that can assist in classifying the type and nature of technical uncertainties and provide guidance for quantifying the uncertainties in a systematic manner for evaluating waste package performance; and

(iii) To assess the feasibility of representing "substantially complete containment" called for in regulations by quantitative criteria.

The feasibility study consisted of initially developing an understanding of the technical issues involved in assessing waste package performance and the development of guidelines based on quantitative methods to assess the types of uncertainties that could arise from the technical considerations. This part of the study was reported in two technical documents, namely:

- H. K. Manaktala, and C. G. Interrante, *Technical Considerations for Evaluating Substantially Complete Containment of High-Level Waste Within the Waste Package*, NUREG/CR-5638, December 1990 (Manaktala and Interrante, 1990); and

- Y.-T. Wu, A. G. Journel, L. R. Abramson, and P. K. Nair, *Uncertainty Evaluation Methods for Waste Package Performance Assessment*, NUREG/CR-5639, January 1991 (Wu et al., 1991).

The technical information developed in these two reports is appropriate regardless of how the uncertainty concerning SCC is reduced. Based on the study, it was concluded that quantitative containment criteria were feasible. The study resulted in the preparation of four alternative ways a quantitative criteria could be introduced in a regulatory framework. These alternatives were described in detail in the report

- P. K. Nair, and E. Tschoepe, III, *'Substantially Complete Containment' Feasibility Assessment and Alternatives Report*, CNWRA 90-007, September 1990. (Nair and Tschoepe, 1990)

Following the completion of the SCC Quantitative Feasibility Study, a SCC Quantitative Alternatives Prioritization Study was initiated. The purpose of this study was to conduct an exercise where a selected number of NRC staff members participated in a structured elicitation process and presented their opinions on the four specified alternatives. The subject of this report is the elicitation process and results of the SCC Quantitative Alternatives Prioritization Study.

1.2 INTRODUCTION

As a follow-up to the alternatives identified, the NRC tasked the CNWRA within the SCC Rulemaking/Guidance Activity under the EBS Program Element to support an SCC Quantitative Alternatives Prioritization Study. The objectives of the task were (1) to address selection of objectives to be used by the elicitation panel for developing opinions in decisions related to "Substantially Complete Containment" criteria with respect to 10 CFR Part 60, (2) to identify and formulate criteria specific to the objectives and to the alternatives under consideration, and (3) to provide a coherent methodology specific to the prioritization of the identified alternatives. A prioritization exercise was instituted to elicit staff opinions with regard to the defined alternatives for quantitative criteria for reducing the uncertainty about "substantially complete containment."

The rationale for conducting the prioritization exercise was based on several factors, each representing a different facet of the complex issue of how to resolve the uncertainty perceived in the language "substantially complete containment." The rule in 10 CFR Part 60 requiring "substantially complete containment" of radionuclides has technical and regulatory characteristics, and these two perspectives lead to different concepts regarding what the rule should require and how it should be expressed. In general, the perspectives on the meaning of the rule are different as they are expressed by various technical, regulatory, licensing, and legal staff members. These different perspectives are not necessarily compatible, and individual preferences may not be completely consistent.

The goals of the prioritization exercise, with respect to the "substantially complete containment" uncertainty, were to (1) clarify the goals and objectives set for the elicitation study; (2) reach agreement on the goals, objectives, and the associated attributes for the specified alternatives; (3) minimize

individual inconsistencies in understanding among the panel members; and (4) clarify reasons for differences between panel members. The exercise was not intended to formulate a consensus, but rather to identify and clarify ideas expressed by the staff through a structured elicitation process.

Members of the NRC Staff constituted a prioritization panel and organized and conducted the prioritization exercise. The CNWRA's contribution included the development of an elicitation procedure and the associated training for the prioritization panel and identification and description of support requirements related to the conduct of an alternatives prioritization analysis. The CNWRA developed a "Procedure for Decision Analysis for Evaluating the SCC Clarification Alternatives" in November 1990 [see Appendix A]. In addition to contributing to training the prioritization panel, CNWRA staff assisted NRC Staff by recording panelists' rationales during elicitation sessions. CNWRA also participated in a panel feedback meeting, as well as in presentations to Office of Nuclear Material Safety and Safegaurdes/Division of High-Level Waste Management (NMSS/HLWM) directors and, subsequently, to the Advisory Committee on Nuclear Waste (ACNW).

2 METHODOLOGY

2.1 INTRODUCTION

The prioritization exercise followed the procedure described in Appendix A. In broad outline, the steps included selection of the panel; identification of goals, objectives and attributes; training the panel on the decision analysis procedure; elicitation of individual panel members; analysis of the elicitations; and feedback of the results to the panel.

2.2 GOALS, OBJECTIVES, AND ATTRIBUTES

The overall purpose was to clarify the current SCC regulation in support of the staff's overall effort to get the regulatory framework in place for receipt and review of the DOE license application for construction authorization. The first step was to identify goals, objectives and attributes. A draft of the goals, objectives, and attributes was developed by the CNWRA and NRC staffs and was presented to the panel. The panel suggested a number of modifications and the final formulation is found in Appendix B.

There were three high-order goals:

GOAL 1. Provide authoritative guidance to DOE sufficient to ensure no misunderstanding of specific NRC regulatory requirements that would otherwise be likely to impair the submission of a high-quality application for a construction authorization.

GOAL 2. Provide authoritative interpretive positions regarding specific NRC regulatory requirements to the NRC technical staff so that associated technical capabilities will be available to review and process a high quality application for a construction authorization promptly without delays associated with regulatory uncertainty.

GOAL 3. Reduce, to the extent practical, opportunities for contentions during the licensing hearing regarding uncertainties about NRC's regulatory requirements so that, together with other measures to streamline the licensing process, a Commission decision on the construction authorization can be made within 36 months after receipt of the application (or as soon thereafter as is reasonably feasible).

In order to address the meaning of "substantially complete containment," a total of four objectives were derived from the high-order goals. Each objective was characterized by a set of attributes. For all objectives except the last, the attributes were divided according to whether they apply prior to (designated by P-) or after (designated by A-) the submittal of the license application. For the last objective, the attributes were of concern throughout the program and were therefore not divided by A- and P- designations. The objectives are listed below, followed by the attributes.

OBJECTIVE 1. To ensure compliance with DOE's repository program schedule and to ensure meeting the statutory deadline for license application review.

P1. Prevent schedule delays due to alternate interpretation of SCC.

A1. Prevent schedule delays due to alternate interpretation of SCC.

A2. Ensure completeness of information available to reviewer and decision-maker.

A3. Ensure ease of understanding of information available to reviewer and decision-maker.

A4. Reduce the scope for litigable issues.

OBJECTIVE 2. To provide a criterion for the containment requirement that the license applicant can be reasonably expected to comply with and clear enough so that NRC will be able to determine compliance.

P1. Ensure the feasibility of the design.

A1. Reduce uncertainty in determination of compliance with SCC.

A2. Ensure completeness of guidance and adequate level of detail in guidance.

A3. Ensure completeness of information available to reviewer and decision-maker.

A4. Retain flexibility for future options.

OBJECTIVE 3. To minimize the level of effort required for implementing the alternative and for evaluating the license application based on the alternative.

P1. Avoid introducing new uncertainties.

A1. Avoid introducing new uncertainties.

A2. Ensure ease of understanding of information available to reviewer and decision-maker.

A3. Allow applicant freedom of how compliance is demonstrated.

A4. Reduce the scope for litigable issues.

OBJECTIVE 4. To facilitate public acceptance of and confidence in the safe containment of HLW.

1. Prevent schedule delays.

2. Assurance of conservative design.

2.3 WEIGHING OBJECTIVES AND ATTRIBUTES

Before assessing the alternatives, it was necessary to assign weights to the objectives and attributes. The procedure chosen uses features of decision analysis in a way intended to maximize benefit to the decision-maker. Ranking to a common scale was used wherever possible, since the mathematical manipulations required during analysis are more intuitive and simpler, and more information can be obtained than for ranking by comparison. On the other hand, pair-wise comparison was used to advantage when it was not possible to construct a common scale as, for example, when comparing objectives and when comparing attributes to obtain weighting factors for each. Details of how the weighing was done are discussed in Section 4.2.

2.4 ASSESSING THE ALTERNATIVES

In applying the procedure, the weighing of the objectives and attributes was carried out before considering the alternatives. For this study, four alternatives were identified by Nair and Tschoepe (1990). The four alternatives are tied to three approaches to reduction of the uncertainty related to SCC:

- Change the existing regulation by way of a qualitative rule with probabilistic language (Alternative 1)
- Change the existing regulation by way of a quantitative rule (Alternatives 2 & 3)
- Do not change the regulation, but provide interpretation of SCC within a regulatory guidance document (Alternative 4)

The four alternatives are described in Figures 2-1 through 2-4 and discussed in detail by Nair and Tschoepe (1990).

To carry out the prioritization study, each of the four alternatives was assessed according to the degree to which it satisfied each of the attributes. The assessment scores were then weighed by the attribute weights to arrive at a final priority score for each alternative.

The procedure for calculating the scores for the alternatives is as follows. For each panel member, let w_{ij} be the weight for objective i and attribute j. It is assumed that the weights are normalized so that $\Sigma w_{ij} = 1$. Let a_{ijk} be the degree to which the panel member judges that alternative k satisfies the attribute j of objective i. The scores a_{ijk} lie between 1 and 10. The score for alternative k, S_k, is the weighted sum of the a_{ijk} scores:

$$S_k = \sum_i \sum_j a_{ijk} w_{ij}$$

The attributes were assumed to be preferentially independent and this justifies using the additive form of a value function for S_k.

The alternatives were ranked by comparing the priority scores produced by the panel (see Section 5).

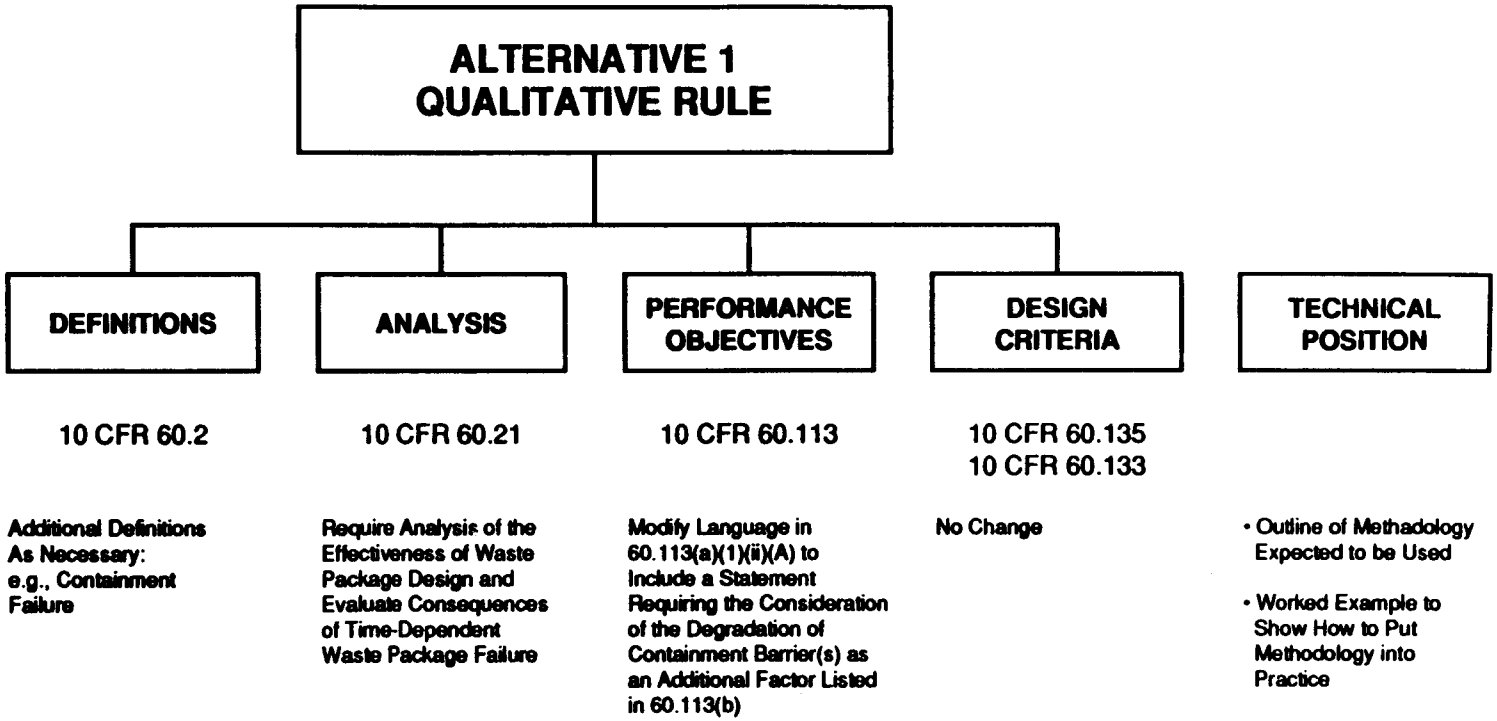


Figure 2-1. Presentation Alternative 1 - Qualitative Rule

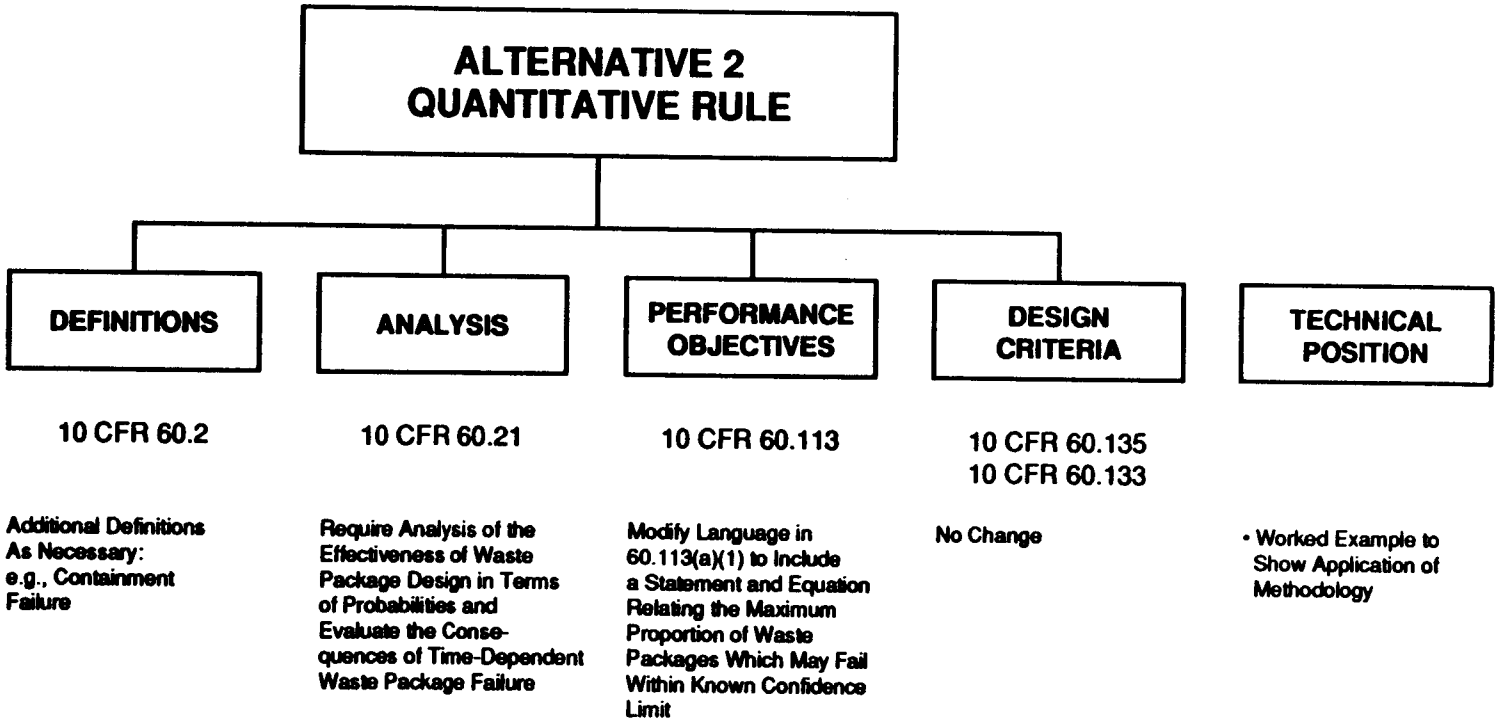


Figure 2-2. Presentation Alternative 2 - Quantitative Rule

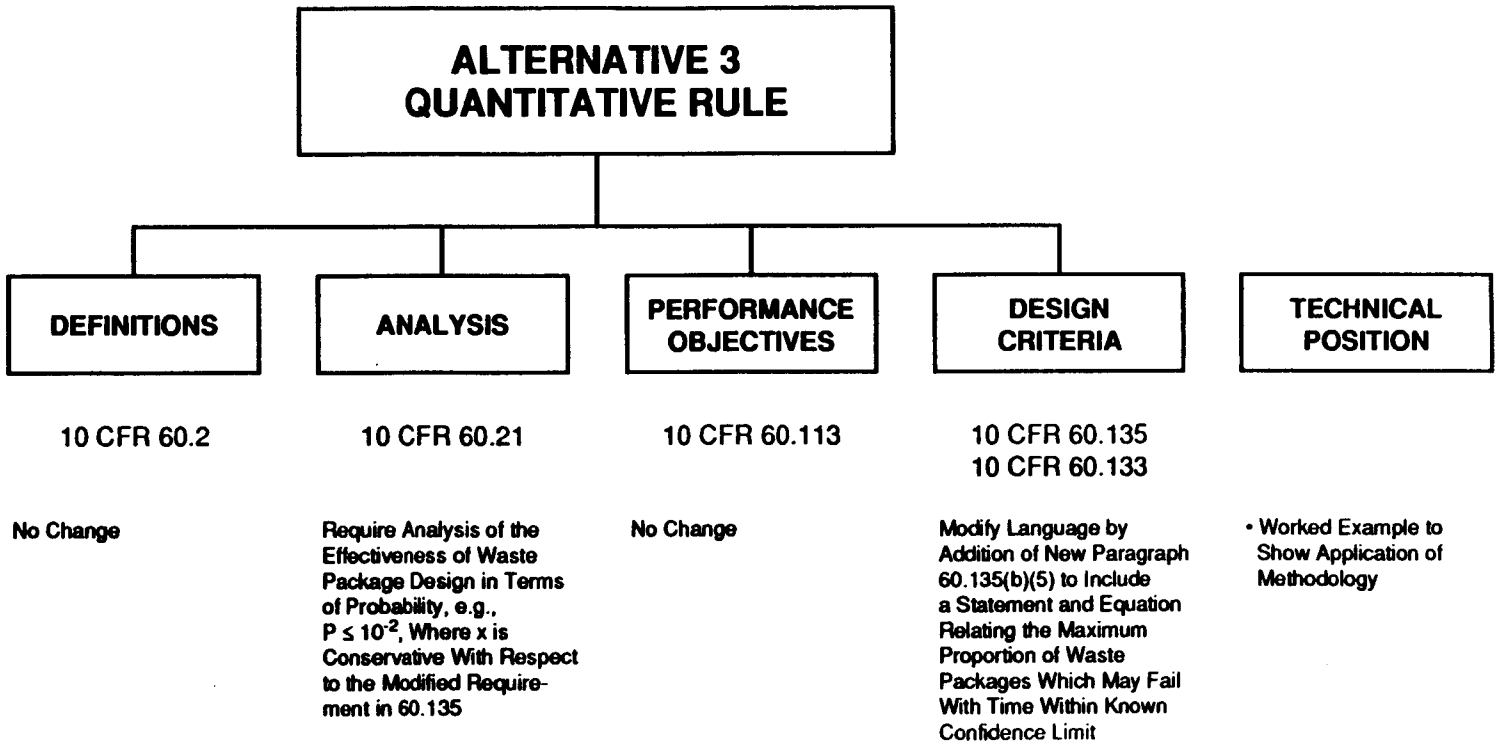


Figure 2-3. Presentation Alternative 3 - Quantitative Rule

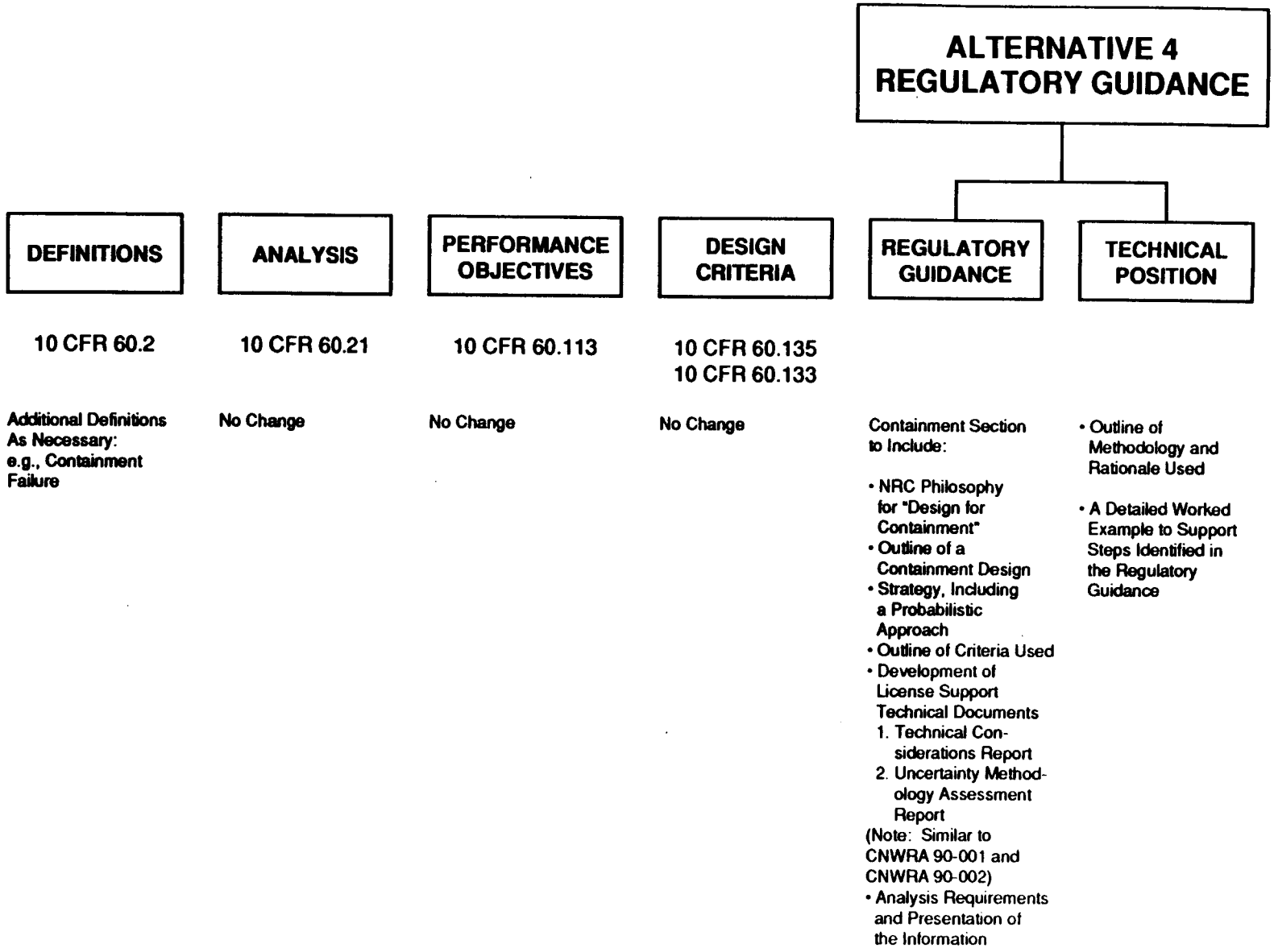


Figure 2-4. Presentation Alternative 4 - Regulatory Guidance

3 THE ELICITATION PROCESS

3.1 PANEL

The panel consisted of nine NRC staff members. These included three from the Offices of Licensing Support System Administrator and the General Counsel, four from the Office of Nuclear Material Safety and Safeguards, and two from the Office of Nuclear Regulatory Research. Five panel members were first line or higher supervisors and four were members of the technical staff. The panel members were chosen to represent a wide diversity of regulatory viewpoints as well as technical expertise. Participants are listed in alphabetical order, with their organization affiliations within NRC, as follows: S. Bahadur, Office of Nuclear Regulatory Research (RES)/Regulatory Development Branch (RDB); D. Brooks, Office of Nuclear Material Safety and Safeguards (NMSS)/ Divison of High Level Waste Management (HLWM); F. Cameron, Office of Licensing Support System Administrator (LSSA); M. Delligatti, NMSS/HLWM; R. Johnson, NMSS/HLWM; J. Moore, Office of the General Counsel (OGC); J. Philip, RES/Waste Management Branch (WMB); L. Roche, NMSS/Operations Branch (IMSB); and S. Treby, OGC. The panel had three meetings and individual elicitation sessions over a two-month period. The background and motivation for the study were discussed at the first meeting, and the decision analysis methodology was presented at the second meeting. This was immediately followed by individual elicitation sessions which took place over a one-week period. After analysis of the results, the final meeting was a feedback session in which the results were presented and discussed in detail with the panel. After the feedback session, the panel members were invited to change their assessments if desired, but no panel member felt the necessity of doing so.

3.2 ELICITATIONS

There were a number of guidelines for the elicitation process. These were discussed at the panel meetings and individually with each panel member. These include the following.

- Each panel member was assigned a randomly chosen number so that the results could be reported anonymously.

- Each elicitation session lasted between two and three hours. It was run by a facilitator who led the panel member through the list of questions. He was assisted by an NRC staff member who was familiar with the technical details of the alternatives. Also, a recorder from the CNWRA was present to record elicitation responses and their rationales. In addition, an NRC staff member was available to transform the pair-wise comparisons into weights using the Analytic Hierarchy Process (AHP) methodology.

- Significant inconsistencies in the responses of a panel member which were identified during the elicitation session were brought to the attention of the panel member at that time. The panel members were afforded an opportunity to make changes in their responses but they were not pressed to do so. Thus, some individual preferences may not have been consistent.

- For each response given, the panel member was asked to provide a rationale. These were recorded to provide insight into the reasons for the differences between the panel assessments.

- It was emphasized that the purpose of the elicitation was not to arrive at a consensus. Rather, it was to allow the individual panel members to express and explain their different points of view.

To begin the elicitation, each panel member was shown Figure 3-1, the SCC Clarification Alternatives Hierarchy. In Figure 3-1, the boxes correspond to the attributes associated with each of the four objectives. The facilitator then questioned the panel member and filled out the ranking form shown in Figure 3-2. The first step was to weigh the objectives (Level 2 in the hierarchy). This was done by asking the panel member to compare all pairs of objectives. For each pair, he was asked about the relative importance of the two objectives. The scale used was the nine-point scale in Table A-1 of Appendix A. For example, if Objective 1 (OBJ1) was judged to have weak importance over Objective 2 (OBJ2), this was coded as a '3' in the importance column. Similarly, if Objective 3 was judged to have strong importance over Objective 1, this was coded as a '5' in the importance column. This importance scale was then converted to a set of normalized weights (summing to 1), using the Analytic Hierarchy Process (AHP) methodology described in Appendix A. This conversion was carried out on a personal computer and the results were immediately fed back to the panel member to see if they reasonably reflected his judgments.

The second step was to weigh the relative importance of attaining the objective prior to or after submittal of the license application (Level 3 in the hierarchy). Thus, at this level of the hierarchy, there was only one pair of attributes to compare for each objective. The nine-point scale was converted to relative weights and fed back to the panel member in the same manner as for the Level 2 objectives.

The third step was to weigh the relative importance of the attributes on the lowest level (Level 4) of the Hierarchy. This was carried out in the same way as for the Level 2 objectives. This completed the first part of the elicitation.

For the second part of the elicitation, each panel member was asked to assess the degree to which each of the alternatives satisfied each of the 17 attributes on a 10-point scale. The only guidance given to the panel member was that a score of '1' should be assigned if the alternative did not satisfy the attribute at all, and a score of '10' should be assigned if the alternative completely satisfied the attribute. These results were entered into the form shown in Figure 3-4.

After the session, the relative weights from the ranking form in Figure 6 were combined in a weighed sum to yield a normalized set of weights for the attributes on the lowest level on the hierarchy. This summarized the panel member's judgment as to the relative importance of the objectives and attributes. Since there were 17 attributes, the average score for each attribute would be $1/17 = 0.059$. The actual weights always varied significantly from this average. As an example, one panel member had weights ranging from 0.001 to 0.395.

Using these normalized weights, the priority score for each alternative was calculated by weighing the scores from the scoring form in Figure 7 by the normalized weights. These priority scores were used to rank the alternatives as described in Section 5.

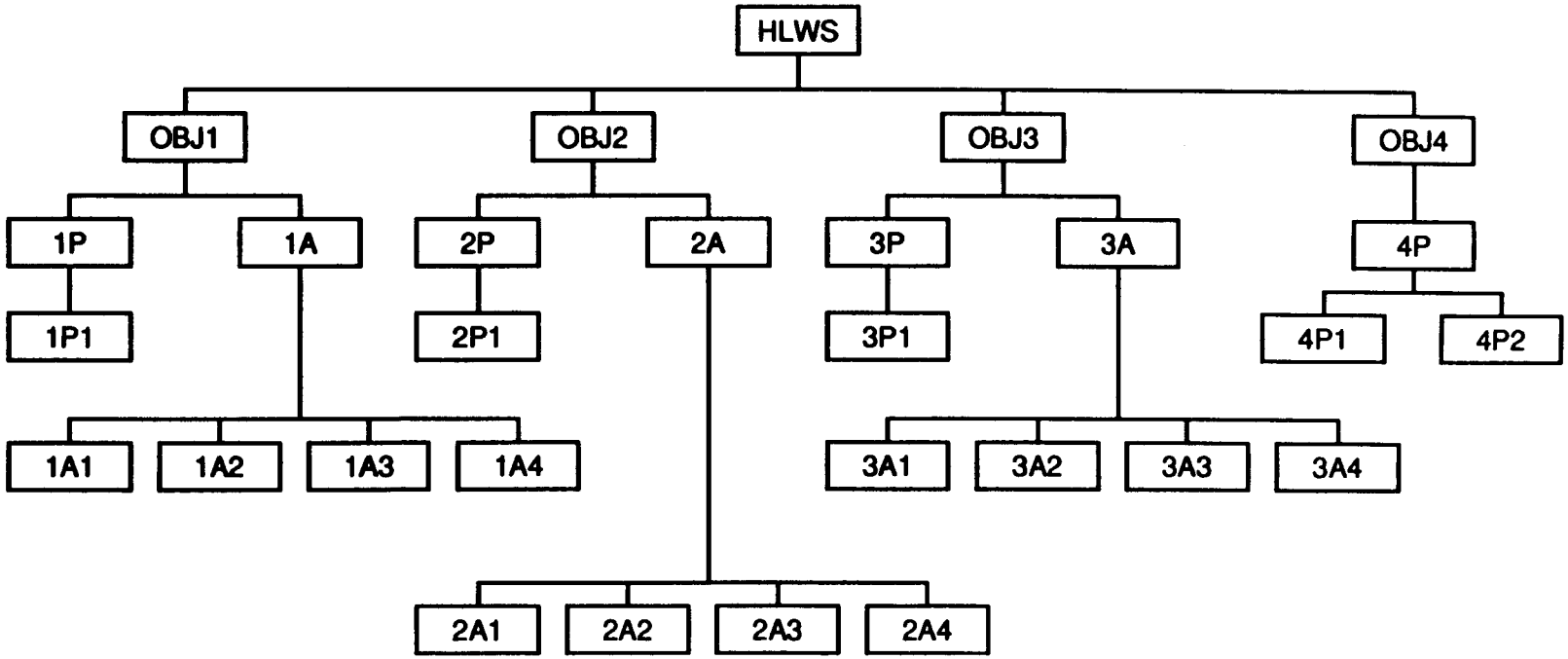


Figure 3-1. SCC Clarification Alternatives Hierarchy

SCC Clarification Alternatives Hierarchy Ranking Form

Name: _____ Date: _____

Directions: Check which choice in the pair is the more important and provide the ranking in the space at the right.

Level 2		Importance
OBJ1 _____	OBJ2 _____	_____
OBJ1 _____	OBJ3 _____	_____
OBJ1 _____	OBJ4 _____	_____
OBJ2 _____	OBJ3 _____	_____
OBJ2 _____	OBJ4 _____	_____
OBJ3 _____	OBJ4 _____	_____

Level 3 -- OBJ1		Importance
1P _____	1A _____	_____

Level 3 -- OBJ2		Importance
2P _____	2A _____	_____

Level 3 -- OBJ3		Importance
3P _____	3A _____	_____

Level 3 -- OBJ4	Importance
4P _____	1.0

Level 4 -- 1P	Importance
1P1	1.0

Level 4 -- 1A		Importance
1A1 _____	1A2 _____	_____
1A1 _____	1A3 _____	_____
1A1 _____	1A4 _____	_____
1A2 _____	1A3 _____	_____
1A2 _____	1A4 _____	_____
1A3 _____	1A4 _____	_____

Figure 3-2. SCC Clarification Alternatives Hierarchy Ranking Form

SCC Clarification Alternatives Hierarchy Ranking Form

Name: _____ Date: _____

Level 4 -- 2P		Importance
2P1		1.0

Level 4 -- 2A		Importance
2A1 _____	2A2 _____	_____
2A1 _____	2A3 _____	_____
2A1 _____	2A4 _____	_____
2A2 _____	2A3 _____	_____
2A2 _____	2A4 _____	_____
2A3 _____	2A4 _____	_____

Level 4 -- 3P		Importance
3P1		1.0

Level 4 -- 2A		Importance
3A1 _____	3A2 _____	_____
3A1 _____	3A3 _____	_____
3A1 _____	3A4 _____	_____
3A2 _____	3A3 _____	_____
3A2 _____	3A4 _____	_____
3A3 _____	3A4 _____	_____

Level 4 -- 4P		Importance
4A1 _____	4A2 _____	_____

Figure 3-2. SCC Clarification Alternatives Hierarchy Ranking Form (Cont'd)

SCC Clarification Alternatives Scoring

Name: _____ Date: _____

		Alternative Scores				
		Import.	ALT-1	ALT-2	ALT-3	ALT-4
1.	1P1					
2.	1A1					
3.	1A2					
4.	1A3					
5.	1A4					
6.	2P1					
7.	2A1					
8.	2A2					
9.	2A3					
10.	2A4					
11.	3P1					
12.	3A1					
13.	3A2					
14.	3A3					
15.	3A4					
16.	4P1					
17.	4P2					
TOTALS						
			ALT-1	ALT-2	ALT-3	ALT-4

Figure 3-3. SCC Clarification Alternatives Scoring Form

4 RESULTS

4.1 RANKING THE ALTERNATIVES

4.1.1 Introduction

This section presents the results of the priority scores assigned to the alternatives and the weights assigned to the objectives and attributes by each of the panel members. Of the nine panel members, seven preferred the quantitative alternatives over the qualitative alternatives. Of the four objectives, the panelists generally gave much higher weights to Objectives 2 and 4 (Feasibility and Public Acceptance, respectively) than to Objectives 1 and 3 (Compliance with Schedule and Minimize Level of Effort, respectively). For Objectives 1, 2, and 3, most panelists placed about equal weights on the pre- and post-licensing periods. For Objective 4, all but one panelist placed the preponderant weight on the assurance of conservative design. Details of these results are presented below. All weights are normalized so that the sum of the weights over the objectives is 1.00 for each panelist.

4.1.2 Objective and Attribute Weights

The panel assigned the greatest weights to Objective 2 (Feasibility) and Objective 4 (Public Acceptance). The median weight for Objective 2 was 0.42 and the median weight for Objective 4 was 0.30. Objective 1 (Schedule) had a median weight of 0.11, and Objective 3 (Minimize Level of Effort) had a median weight of 0.06. However, the spread of weights for each of the objectives was very wide, ranging from a minimum of 0.10 or less to a maximum of over 0.50 (Objective 3 had a maximum of 0.32). Histograms of the weights for the objectives are presented in Figures 4-1 through 4-4. These histograms illustrate the very wide spread of weights assigned by the panelists. The arrows indicate the weights assigned by the two members of the panel who preferred the qualitative rules. Discussions which follow describe examples of some of the other data.

The third level of the hierarchy dealt with pre- versus post-licensing time periods. The pattern of weights assigned by the panel were similar for Objectives 1 and 3. The weights were all centered at about 0.5, with considerable variability. A histogram of the post-licensing weights is presented in Figure 4-5. For Objective 2 (Feasibility), five of the nine panelists assigned weights between 0.40 and 0.60 for each of the two time periods. The median weight for the post-licensing period was 0.50. The post-licensing weights for Objectives 1 and 3 (Schedule and Minimize Level of Effort, respectively) were essentially the same for almost all of the panelists. Accordingly, to summarize the data, the post-licensing weights for Objectives 1 and 3 were averaged. For five of the panelists, the average post-licensing weights ranged between 0.45 and 0.55. The median weight was 0.50.

For Objective 4 (Public Acceptance), all but one panelist assigned a weight of at least 0.7 to Attribute 2 (Assurance of Conservative Design) as opposed to Attribute 1 (Prevent Schedule Delays). The median weight was 0.80, and a histogram of the weights is presented in Figure 4-6.

The most important attributes were 4P2 (Assurance of Conservative Design) and 2P1 (Ensure the Feasibility of the Design Prior to Submittal of the License Application). Of lesser importance was attribute 2A1 (Reduce Uncertainty in Determination of Compliance with SCC After Submittal of the License Application). In general, all other attributes were judged to be less important than these three. The median weight assigned to 4P2 was 0.21, and the median for 2P1 was 0.25 (recall that the sum of

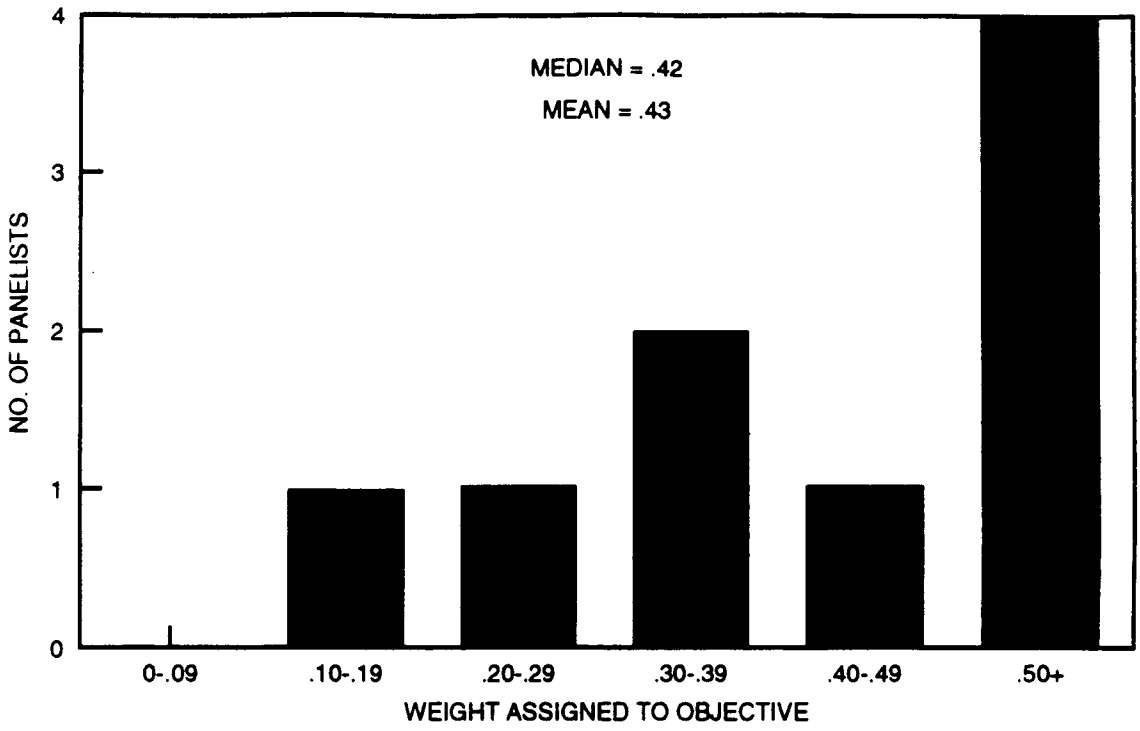


Figure 4-1. Objective Weights — Obj. 2 (Feasibility)

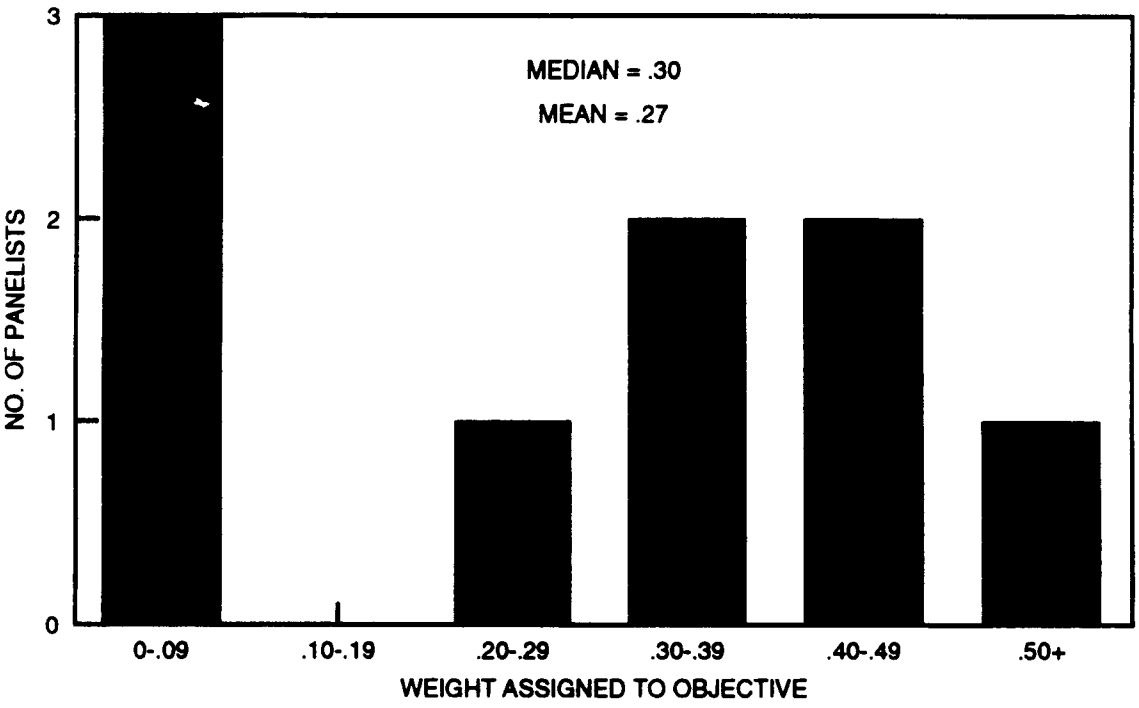


Figure 4-2. Objective Weights — Obj. 4 (Public Acceptance)

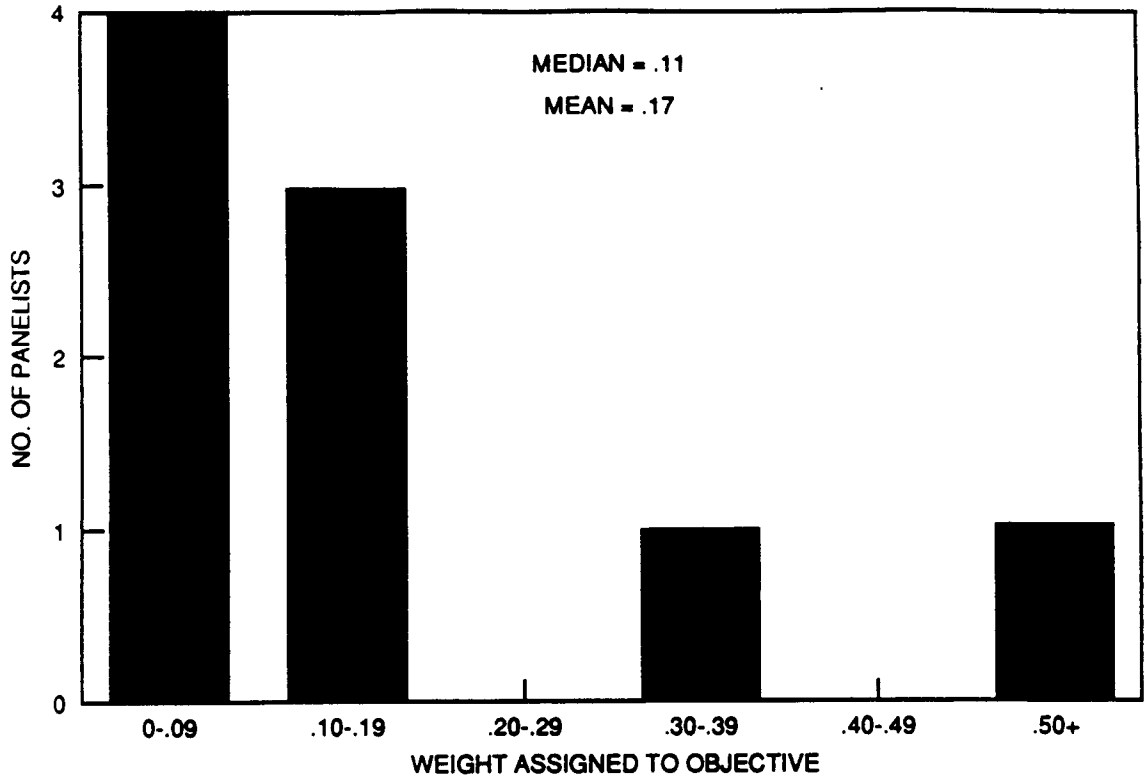


Figure 4-3. Objective Weights — Obj. 1 (Schedule)

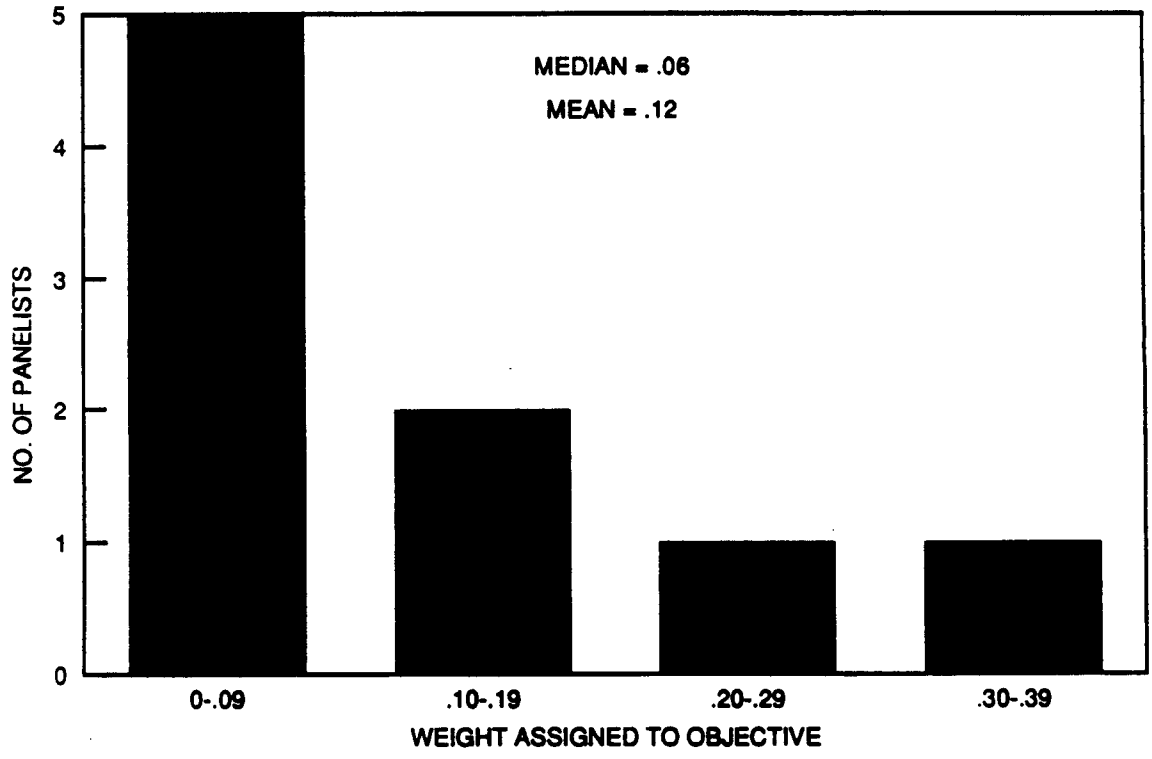


Figure 4-4. Objective Weights — Obj. 3 (Level of Effort)

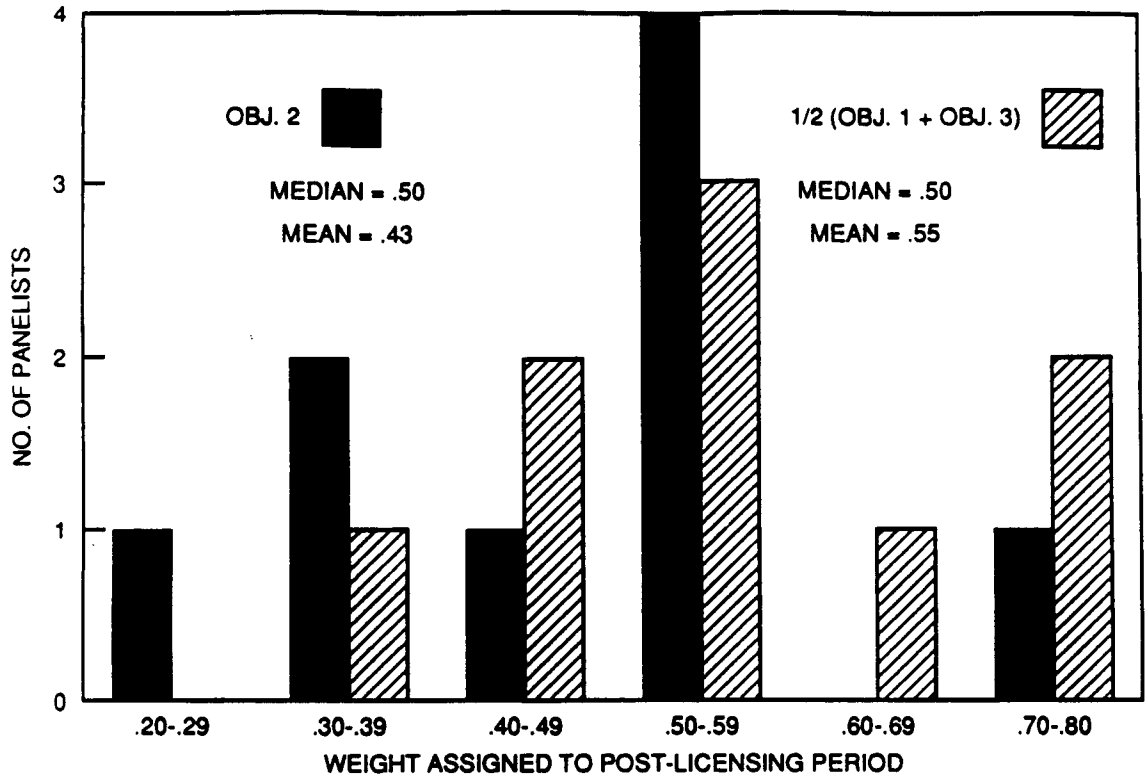


Figure 4-5. Post-Licensing Weights

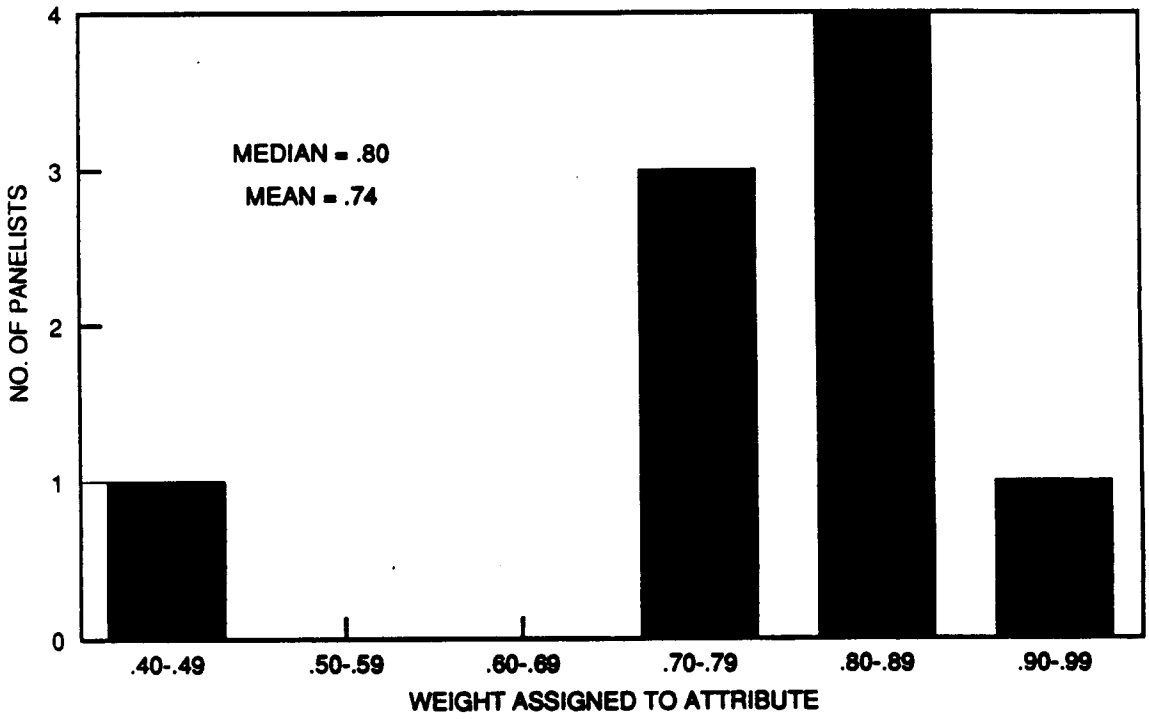


Figure 4-6. Obj. 4: Conservative Design Weights (versus Prevent Schedule Delays)

the weights over all 17 attributes was 1.00). For seven of the nine panelists, the total weight assigned for these two attributes was between 0.37 and 0.76. This gives a measure of the relative importance of these attributes. There was no significant difference between the weights assigned by all nine of the panelists. The differences in the ranks assigned by the panelists stemmed from the degree to which they judged the alternative satisfied the attributes, as described below.

4.1.3 Alternative Assessments

For each alternative, each of the panelists assigned a score between 1 and 10 expressing the degree to which each attribute was satisfied by the alternative. As a general rule, the scores assigned to quantitative alternatives 2 and 3 were identical or very close, and the scores assigned to the qualitative alternatives 1 and 4 were also very similar. Accordingly, the difference of the average scores for the quantitative and qualitative alternatives were used as a summary of the pattern of scores assigned to the alternatives. For any attribute, let S_i be the score assigned to alternative i (where $i \rightarrow 1$ through 4). The difference measure is defined by

$$D = (1/2)(S_2 + S_3) - (1/2)(S_1 + S_4)$$

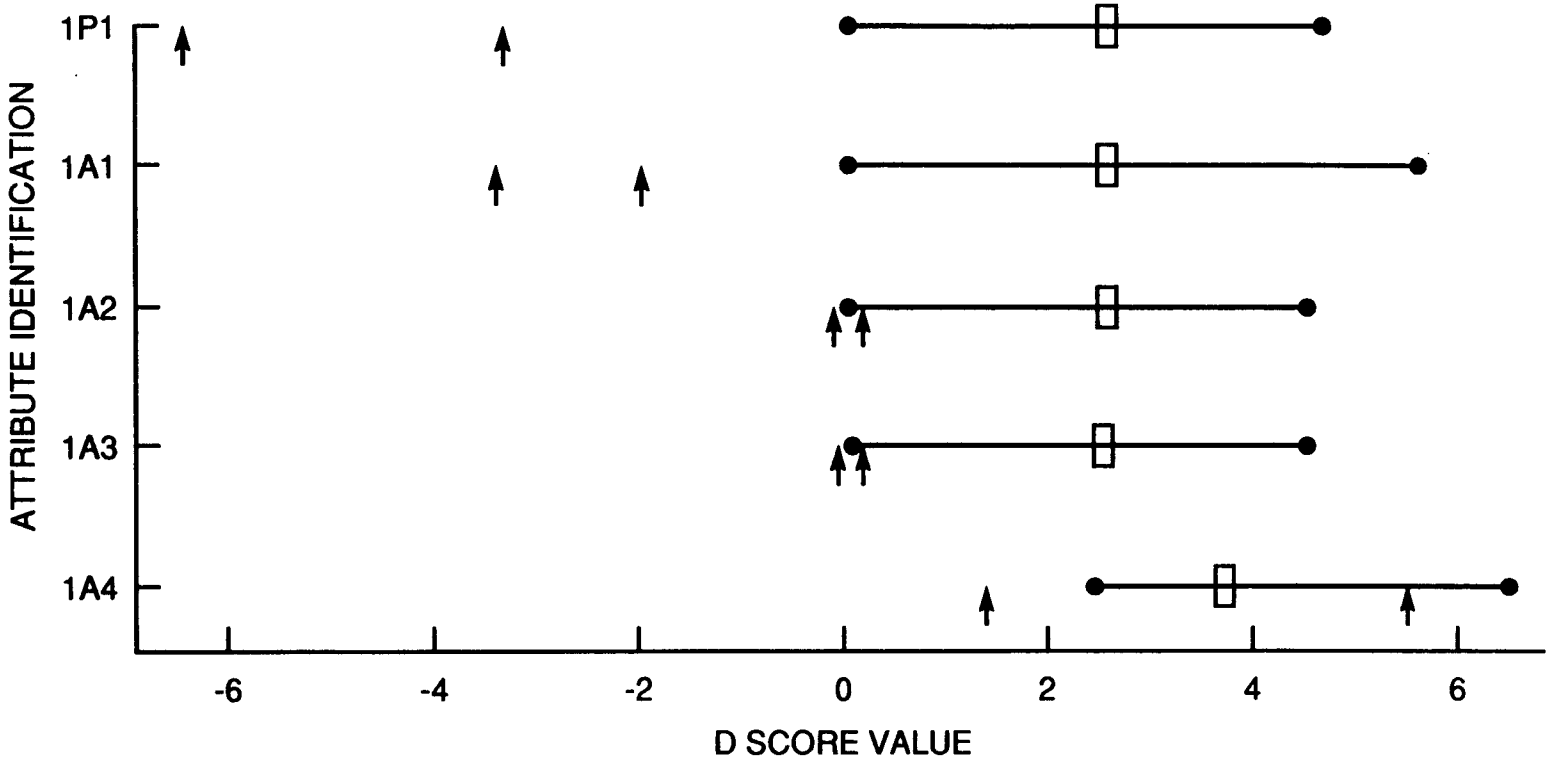
Thus, a positive value of D indicates that the panelist felt that the quantitative alternatives satisfied the attribute more than the qualitative alternatives.

Figures 4-7 through 4-10 summarize the D Scores for each of the 17 attributes, grouped by objectives. The D Scores were analyzed separately for panelists 2 and 3 and the other 7 panelists, since panelists 2 and 3 were the only panelists who generally preferred the qualitative alternatives to the quantitative alternatives. For each attribute displayed in Figures 4-7 through 4-10, the arrows indicate the D Score assigned by panelists 2 and 3. The horizontal line represents the range of D Scores for the other seven panelists, and the box represents their median.

For attribute 4P2 (Assurance of Conservative Design), the value of D was negative for panelists 2 and 3 and was 0 or positive for all the other panelists. The range of D was between -3.5 and 5.5. For attribute 2P1 (Feasibility), D ranged between -1.5 and 4.0, with four of the panelists assigning a negative value to D. For attribute 2A1 (Reduce Uncertainty in Determination of Compliance with SCC After Submittal of the License Application), all panelists scored a 0 or positive value for D.

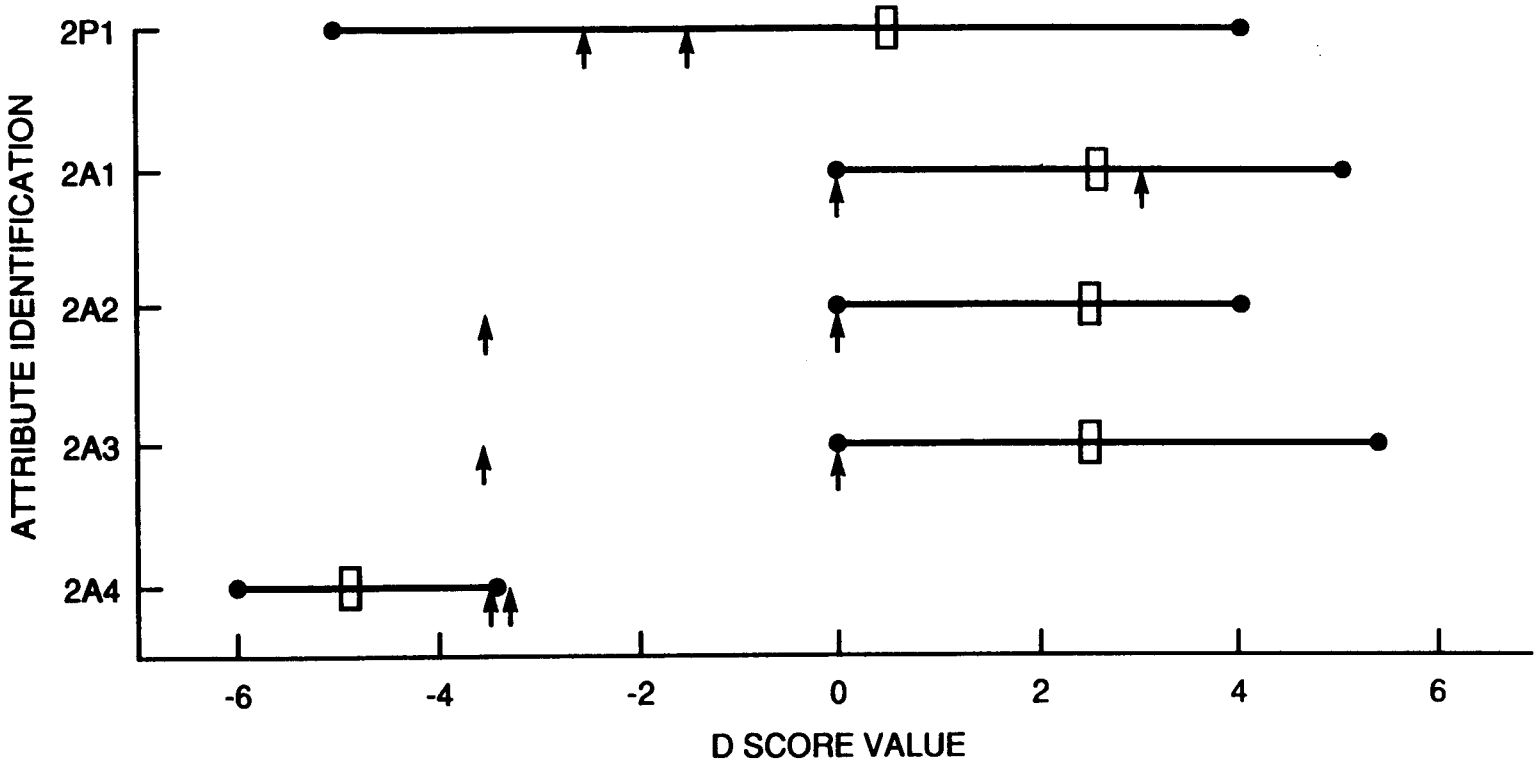
Figures 4-7 through 4-10 indicate that the D Scores for panelists 2 and 3 were generally significantly smaller than the scores for the other panelists, for all the attributes except for 2A4 (Retain Flexibility for Future Options). These figures indicate that the median score for the group of 7 panelists was between 1 and 3 for most attributes. Except for attributes 2A4 (Retain Flexibility for Future Options), 3P1 (Avoid Introducing New Uncertainties), and 3A3 (Allow Applicant Freedom of How Compliance is Demonstrated), the median D scores for these 7 panelists were all positive.

The priority score for each alternative was calculated by weighting the scores by the attribute weights. Using these scores, the alternatives were ranked for each panelist. Seven of the nine panelists ranked the quantitative alternatives (2 and 3) either first or second, and two panelists (numbers 2 and 3) rated the qualitative alternatives (1 and 4) first or second (both of these panelists were on the technical staff).



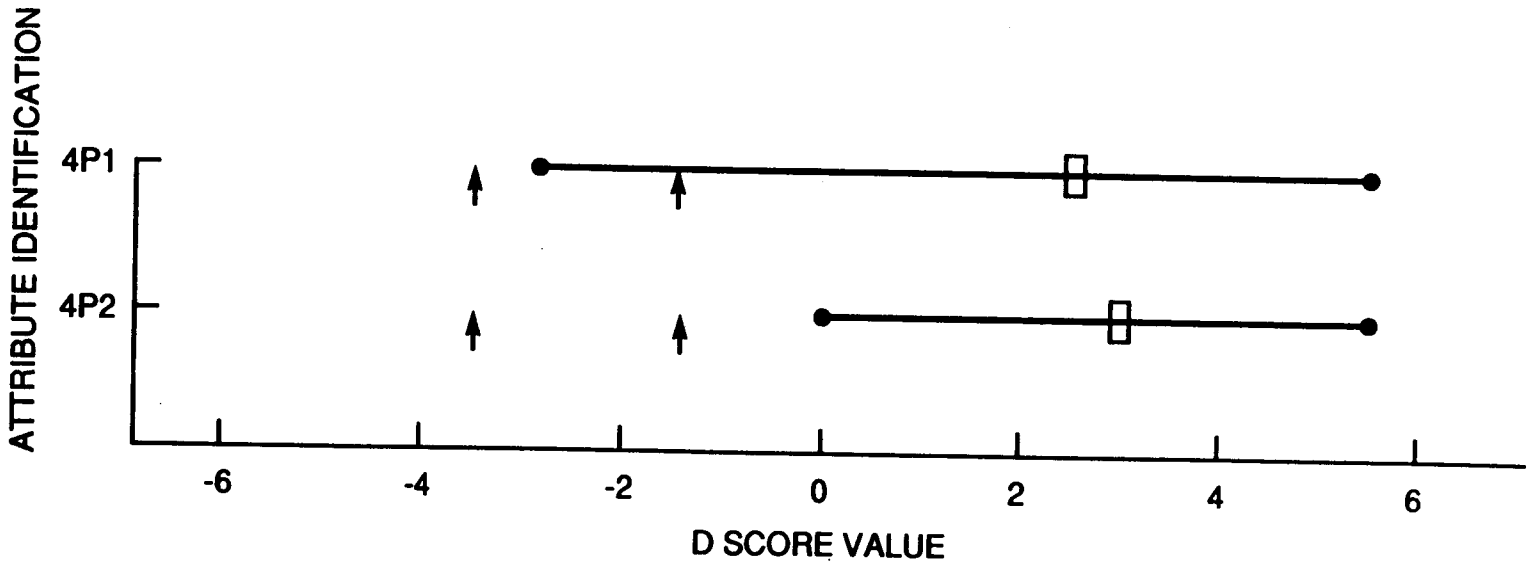
NOTES: 1. ARROWS INDICATE RESPONSES OF PANELISTS 2 AND 3.
2. BOX INDICATES MEDIAN FOR PANELISTS 1, 4-9.
3. HORIZONTAL LINE INDICATES RANGE OF D-SCORE FOR PANELISTS 1, 4-9.

Figure 4-7. D Scores for Attributes Related to Objective 1 (Schedule)



NOTES: 1. ARROWS INDICATE RESPONSES OF PANELISTS 2 AND 3.
2. BOX INDICATES MEDIAN FOR PANELISTS 1, 4-9.
3. HORIZONTAL LINE INDICATES RANGE OF D-SCORE FOR PANELISTS 1, 4-9.

Figure 4-8. D Scores for Attributes Related to Objective 2 (Feasibility)



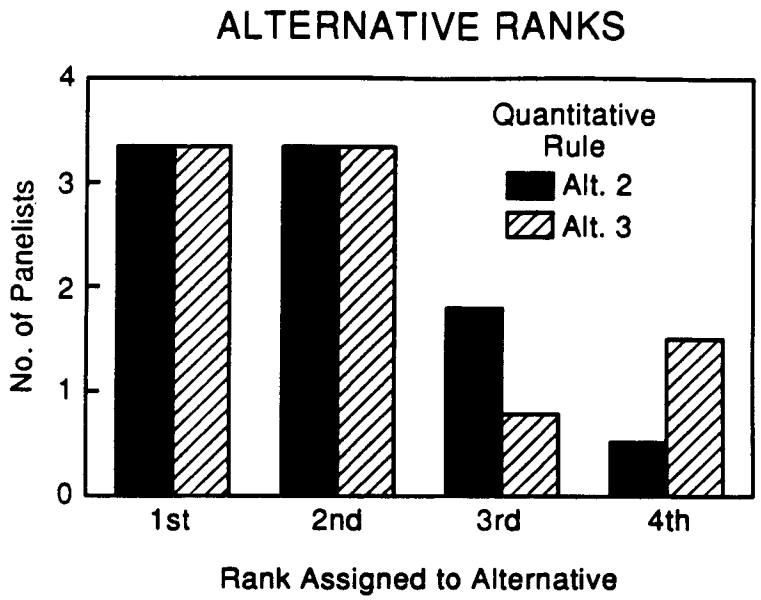
NOTES: 1. ARROWS INDICATE RESPONSES OF PANELISTS 2 AND 3.
2. BOX INDICATES MEDIAN FOR PANELISTS 1, 4-9.
3. HORIZONTAL LINE INDICATES RANGE OF D-SCORE FOR PANELISTS 1, 4-9.

Figure 4-10. D Scores for Attributes Related to Objective 4 (Public Acceptance)

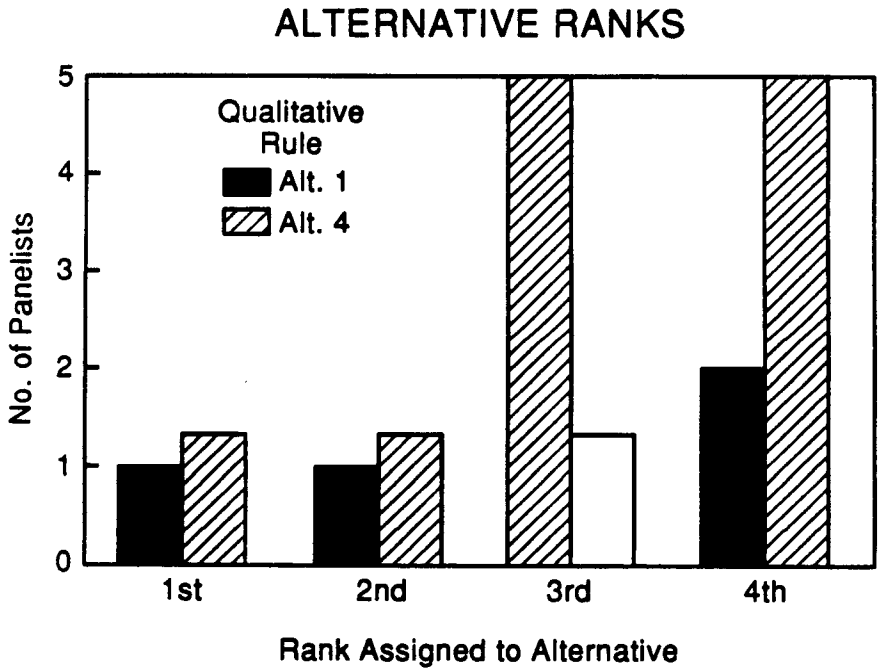
The ranks for the alternatives are displayed in Figure 4-11(a) and (b). For each alternative, this figure indicates the number of panelists who ranked it first, second, third or fourth. The fractional numbers reflect ties. Two of the seven panelists who preferred the quantitative rules preferred Alternative 2 to 3, two preferred Alternative 3 to 2, and three had no preference between alternatives 2 and 3. Five of these seven preferred Alternative 1 to Alternative 4. Of the two panelists who preferred the qualitative alternatives, one preferred Alternative 1 and the other preferred Alternative 4. Of these two panelists, one preferred Alternative 2 to 3, and the other had no preference.

4.2 RATIONALES

During the elicitation sessions, the rationales for each choice were elicited and recorded. A summary of the rationales for high and low assigned weights for the objectives is given in Table 4-1 and for the alternatives in Table 4-2. Selected portions of the verbatim transcript are presented in Appendix D, and these are keyed to the summary rationales in Tables 4-1 and 4-2.



(a)



(b)

Figure 4-11. Ranks Assigned by Panelists to the Four Alternatives

Table 4-1. Rationales for Weights Assigned to Objectives

OBJECTIVE #1: SCHEDULE	
WEIGHT	**RATIONALE**
High	Schedule is dictated by statute.
	Schedule slips have great impacts.
Low	Statutory schedule can be changed.
	Schedule can slip without great impact.
OBJECTIVE #2: FEASIBILITY	
WEIGHT	**RATIONALE**
High	DOE must have clear requirements.
	NRC must have clear criteria for review.
	Regulatory requirement must be achievable.
Low	Regulations are do-able.
OBJECTIVE #3: LEVEL OF EFFORT	
WEIGHT	**RATIONALE**
High	NRC must provide resources needed.
	NRC resources not unlimited.
Low	NRC resources not a major constraint.
	NRC will provide whatever resources required.
	Congress will provide needed resources.
OBJECTIVE #4: PUBLIC ACCEPTANCE	
WEIGHT	**RATIONALE**
High	Lack of public acceptance is adverse to program.
	Public confidence affected reactor licensing.
Low	NRC cannot greatly influence public acceptance.
	Lack of public acceptance has not hurt program.

Table 4-2. Rationales for Ranking Alternatives

ALTERNATIVE #1: QUALITATIVE RULE	
SCORE	**RATIONALE**
High	Retains some flexibility for future options.
	Ensures a feasible design.
Low	Results in schedule slips due to litigation and uncertainty.
	Results in level of effort increase due to litigation.
	Does not reduce uncertainty in SCC.
	Results in public confidence erosion due to schedule slips.
ALTERNATIVE #2: QUANTITATIVE RULE (PERFORMANCE OBJECTIVE)	
SCORE	**RATIONALE**
High	Decreases schedule slips caused by lack of clear NRC guidance or litigation.
	Reduces uncertainties.
	Decreases NRC level of effort needed for litigation and compliance determination (clearer DOE submittal).
	Facilitates public acceptance by reducing program slip and assurance of conservative design.
Low	Results in loss of NRC flexibility.
	Results in level of effort increase, due to rulemaking.
ALTERNATIVE # 3: QUANTITATIVE RULE (DESIGN CRITERIA)	
SCORE	**RATIONALE**
High	Decreases schedule slips resulting from lack of clear NRC guidance or litigation.
	Reduces uncertainties.
	Decreases NRC level of effort needed for litigation and compliance determination (clear DOE submittal).
	Facilitates public acceptance by reducing program slip and assurance of conservative design.

Table 4-2. Rationales for Ranking Alternatives (Cont'd)

ALTERNATIVE #3: QUANTITATIVE RULE (DESIGN CRITERIA) (Cont'd)	
SCORE	**RATIONALE**
Low	Results in less NRC flexibility.
	Requires greater rulemaking level of effort.
ALTERNATIVE #4: QUALITATIVE GUIDANCE	
SCORE	**RATIONALE**
High	Retains flexibility for future options.
	Allows DOE freedom in demonstrating compliance.
	Ensures a feasible design.
Low	Results in schedule slips due to litigation and uncertainty.
	Results in level of effort increase due to litigation and compliance determination.
	Does not reduce uncertainty in SCC.
	Results in public confidence erosion due to schedule slips.

5 CONCLUSIONS

5.1 SUMMARY OF RESULTS

The process of elicitation of expert opinion within NRC was used to provide insight into the difficult and complex issue of choosing an alternative to reduce the uncertainty concerning "substantially complete containment." Although it did not result in a consensus, it did serve to air the various perspectives on the issue, while maintaining anonymity of individual participants, thus allowing maximum freedom of discussion.

Although there was no consensus, the majority of the panel preferred the quantitative to the qualitative alternatives. There was little distinction in preference between the two quantitative alternatives or between the two qualitative alternatives. The two most important objectives were feasibility and public acceptance. The objectives of maintaining the schedule and minimizing the level of effort received very little weight. The panelists gave approximately equal weights to pre-licensing and post-licensing attributes. The two most important attributes were assurance of conservative design and ensuring feasibility of design prior to license application submittal.

5.2 LESSONS LEARNED

The elicitation process was judged to be a positive one by both the panelists and the involved staff members. However, some panel members felt uncomfortable because of the complexity of the judgments to be made, especially the pair-wise comparisons, and because it was sometimes difficult for them to come up with consistent assessments.

One drawback was that the process was rather time consuming. The total time spent on reviewing the materials and the meetings and elicitations averaged the better part of a week for each panel member. Several of the panelists who ranked the quantitative alternatives higher than the qualitative alternatives stated that their initial preference was for the qualitative alternatives rather than the quantitative alternatives. While this result was surprising to the panelists involved, it demonstrates the strength of this process. None of these panelists felt uncomfortable about their final conclusions.

It would have been useful to have a pilot elicitation to clarify the objectives and attributes. For example, a number of panelists would have preferred that attribute 3A3 (Allow Applicant Freedom of How Compliance is Demonstrated) be phrased in terms of maximizing instead of minimizing the NRC level of effort required.

The hybrid methodology developed for this exercise was judged to be successful, based on feedback from the panelists. Pair-wise comparisons were used to assess the relative importance of the objectives and attributes, while absolute scores were used to rate the degree to which the various alternatives satisfied each of attributes. In this way, the strength of each rating system was used to advantage. In particular, the panelists felt comfortable with scoring each alternative with respect to the attributes.

The weighting scales which were used during this process provided a composite, bottom-line assessment reflecting each individual's judgment. This composite assessment sometimes conflicted with

an individual participant's preconceived ideas about the choice of alternatives. Participants agreed that this bottom-line result accurately reflected their true opinions, since all attributes and objectives related to each of the four alternatives were assessed by each participant. Participants were given the option of reconsidering their responses after seeing the composite bottom-line result, but even those who were surprised by a conflict with a preconceived opinion opted not to revise their responses.

The weighting scales borrowed advantages of two commonly used techniques (pair-wise comparison and numerical scale rating), and, by combining them, minimized the disadvantages normally associated with exclusive use of one or the other. Pair-wise comparison was used in situations for which a common rating scale is not available, such as for determining the relative value of the objectives and for determining the relative degree to which various attributes contributed to one of the objectives. For comparison of the four alternatives as to their relative merits in meeting a given attribute, a common scale was constructed, since it was felt that the participant would have a reasonable feel for such comparison and it is the most direct rating system. The results were then mathematically combined into a composite result reflecting the individual's weighting of objectives, attributes, and alternatives.

It might have been instructive to perform a sensitivity analysis which would explore the sensitivity of the alternative rankings to the attribute weights and scores. This was not done for this study because its purpose was not to arrive at a *best* alternative but rather to identify and clarify the different staff perspectives on the alternatives. A sensitivity analysis would be appropriate for a study whose goal is to choose one of the alternatives as *best*.

6 REFERENCES

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APPENDIX A

PROCEDURE FOR DECISION ANALYSIS FOR EVALUATING THE SCC CLARIFICATION ALTERNATIVES

PROCEDURE FOR DECISION ANALYSIS FOR EVALUATING THE SCC CLARIFICATION ALTERNATIVES

A.1 PURPOSE

The purpose of this procedure is to describe decision analysis methods for evaluating the "substantially complete containment" (SCC) clarification alternatives based on a quantitative approach. The procedure involves analyzing the decision by attributes and ranking decision alternatives against weighted attributes and each other. It should be emphasized that the purpose of this decision analysis process is not to reach a consensus (although that would be a desirable result), but to systematically retrieve, organize, and present data representing various NRC perspectives to senior NRC management for consideration in choosing an appropriate alternative for clarification of "substantially complete containment."

A.2 BACKGROUND

Decision analysis techniques are used when decisions must be made for complex problems for which simple comparison of or ranking of alternatives cannot be readily done to reach a decision. Examples of problems for which decision analysis is appropriate are many, and they include those for which several objectives and many attributes exist, those for which conflicting objectives exist, and those requiring input from several people or groups whose objectives may conflict.

In decision analysis, a basic step is to assess various alternatives with respect to how well each meets an objective or set of objectives. Alternatives can be assessed with respect to one another in two basic ways: assessing each alternative according to a common scale and ranking by comparison of an alternative to each of the others. In cases where a common scale does not exist for all the alternatives, ranking should be done by comparison. When ranking by comparison, a mathematical consistency check can be made. Ranking by comparison has one disadvantage compared with assessment according to a common scale. When ranking by comparison, if all alternatives rate equally well (or equally poorly) as to meeting an objective, the degree to which an alternative meets the objective is not apparent from the relative ranking. Therefore, assessment according to a common scale will be done except in cases where a common scale does not exist for all the alternatives.

Two documents which have been used as guidelines for the development of this procedure are listed below.

- NRC NUREG/CR-3447: Research Prioritization Using the Analytical Hierarchy Process, August 1983, and
- CNWRA Technical Operating Procedure: TOP-015, Procedure for Decision Analysis, June 1990.

These guidelines have been amended and altered with subtle variations unique to the specific application. The resultant procedure presented here is intended as a specific guideline.

Many techniques are available to the decision-maker for special cases, and these may be found in the references cited below.

- Bonano, E. J,. et al, NUREG/CR-5411, *Elicitation and Use of Expert Judgment in Performance Assessment for High-Level Radioactive Waste Repositories*, Sandia National Laboratories, 1990.
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A.3 RESPONSIBILITY

A.3.1 Decision Analysis Process

The decision analysis process will be conducted by a NRC-selected coordinator/elicitor and a NRC-selected panel. The CNWRA will initially work with the coordinator/elicitor and the panel to ensure that all the necessary objectives and the associated attributes are covered. Also, the level and detailed description of each attribute will be examined for the purposes of clarity. The panel of participants will have input to review draft objectives and associated attributes, after which the CNWRA, in conjunction with the coordinator/elicitor, will issue a report with the revised objectives and associated attributes.

The recorder for elicitation sessions will be provided by the CNWRA, while the coordinator/elicitor will conduct the sessions. Once the panel has completed its deliberations, the CNWRA will assist the NRC in the analysis of the data and participate in a presentation to NRC senior management at the end of the decision analysis activity.

A.3.2 Key Personnel Acting as Organizational Contacts

NRC Technical Lead	Dr. Lee Abramson	(301) 492-3949
NRC Program Element Manager	Dr. Jerome Pearring	(301) 492-0508
CNWRA Principal Investigator	Dr. Prasad Nair	(512) 522-5150
CNWRA Program Element Manager	Dr. Prasad Nair	(512) 522-5150

A.4 DEFINITIONS

A.4.1 Basic Information

A.4.1.1 Decision Alternatives — Decision alternatives are the choices available to the decision maker as possible outcomes for a candidate.

A.4.1.2 **Decision Objectives** — Decision objectives are the goals of the decision. A decision may be based on one or more objectives. An objective has two characteristics: it identifies a concern about alternatives and it allows for the expression of preference, or choices among alternatives.

A.4.1.3 **Attributes** — Attributes are salient characteristics of the alternatives which provide measures of the extent to which a decision objective would be met by choosing an alternative. Each alternative is ranked according to how well it facilitates the attribute. When ranking to a common scale, an attribute has an associated scale which may be natural or constructed.

A.4.2 Process-Related Information

A.4.2.1 **Consistency Check** — A consistency check is a method for evaluating the results of the decision analysis in order to assure that the analysis is both repeatable and verifiable.

A.4.2.2 **Decision Analysis** — Decision analysis is a systematic and logical procedure for rational analysis of complex decision problems.

A.4.2.3 **Elicitation** — In the use of expert judgment, an elicitor assists the expert in expressing judgments and rationales during elicitation.

A.4.2.4 **Expert Judgment** — Expert judgment is judgment expressed by an individual whose credentials qualify her or him as an expert or authority on the given subject.

A.4.2.5 **Objectives Hierarchy** — An objectives hierarchy links objectives and attributes by their relative primacy and their relationship to each other.

A.4.2.6 **Rank** — Rank is the extent to which an attribute applies to an alternative. The rank of an alternative against an attribute will be reflected in the scale associated with that attribute. Ranking is the act of assigning a rank to an alternative for a specific attribute. During the consistency check, attributes are ranked in order of importance or degree of application to each alternative.

A.4.2.7 **Scale** — A scale is used when alternatives are ranked against attributes. There are two types of scales: natural scales (which exhibit common use and meaning) and constructed scales (which are developed to address a specific attribute or problem for which no natural scale exists). For example, the attribute of "cost" has a natural scale of dollars, while the attribute of "environmental damage" would use a constructed scale which would index relative damage by assigning numerical values ranging from "no damage" to "severe damage."

A.4.2.8 **Sensitivity Analysis** — Sensitivity analysis is an investigation of the decision. This investigation is made by systematically changing relative weights assigned to the attributes and comparing variations in the results of the decision analysis. A sensitivity analysis is used to determine the relative influence which an attribute or specific objective has on the final result of the decision analysis. For a sensitivity analysis, the weights assigned to attributes must be relative, and the total sum of the weights must not vary.

A.4.2.9 Weight — The weight assigned to an attribute indicates the relative importance of that attribute to the decision maker. Different attributes may be weighted differently or have different degrees of importance to the decision maker. For example, one attribute may be three times as important to the decision maker as another attribute, which may in turn be only half as important as another attribute. Weighting is the act of assigning weights to attributes. For the purpose of evaluating the SCC clarification alternatives, weighting will be done individually by participants by pair-wise comparison of objectives and pair-wise comparison of attributes.

A.4.3 Participants-Related Information

A.4.3.1 Decision Analyst — A decision analyst is an individual performing the decision analysis, who provides documentation of both the method and the decision process. A decision maker may use the assistance of decision analysts or may function individually as a decision analyst.

A.4.3.2 Decision Maker — The decision maker is the individual or organization responsible for the decision in question: the one making the actual decision.

A.4.3.3 Elicitor — An elicitor is the individual who presents the process of the decision analysis to an expert or a panel convened for input to the decision and then elicits appropriate responses from the expert or panel for use in the decision analysis. The elicitation of responses from the panel must be done without bias to the extent practical, and, as a result, it is preferable that the elicitor have training in such a process.

A.4.3.4 Normative Expert — A normative expert is one who is familiar with the substance of the decision being made as well as with the techniques of decision analysis and with theories and concepts of probability.

A.4.3.5 Panel — A panel is group of individuals chosen to participate in the decision analysis and from whom responses are elicited for the purpose of ranking.

A.4.3.6 Recorder or Secretary — The recorder or secretary is an individual who records elicited responses from a panel. By use of a recorder, the elicitor is not burdened with such recording, and the process of elicitation is often made more efficient as a result.

A.4.3.7 Substantive Expert - A substantive expert is one who has significant knowledge of the substance of the decision being made.

A.5 THE DECISION ANALYSIS PROCESS

A.5.1 Basic Features, Steps, and Options in the Process

The following outline gives the basic steps in the decision analysis for evaluating the SCC clarification alternatives.

A.5.1.1 Outline of Steps to be Used in the Decision Analysis Process

1. Define the general decision analysis process
2. Select the panel members
3. Introduce the panel to the problem
   a. Distribution of background material (reports, etc.)
   b. Distribution of draft objectives and attributes
4. Initial meeting of panel (November 19, 1990)
   a. Technical briefing on background
   b. Decision alternatives
   c. Overview of the decision analysis procedure
      i. Agreement on overall goals
      ii. General steps in the procedure
         A. Panelists rank alternatives as to how well they meet each attribute
         B. Panelists weigh of objectives and attributes with respect to importance
         C. Object is to get input, not necessarily consensus
   d. Panel discussion and critique of objectives and attributes
      i. Ground rules defined
      ii. Develop revised objectives and attributes (if necessary)
5. Panel to receive and study procedure
6. Second meeting of panel (December 6, 1990)
   a. Train panel on procedure for the particular decision analysis exercise
   b. Description of elicitation details
      i. Compare objectives with respect to (w.r.t.) one another and describe rationale for the selected ranking
      ii. Compare attributes w.r.t. meeting each objective and describe rationale for the selected ranking
      iii. Assess each alternative w.r.t. how well it meets a specific attribute
         A. Assess according to 0-10 scale
         B. Describe rationale for the assessments
         C. Review ranking of the alternatives to check consistency
         D. Revise assessments according to scale and rationales, if desired
         E. Do not bias assessments because objective or attribute is not considered important, as this information is captured separately when objectives and attributes are separately weighted
7. Elicitation of individual panel members (December 7-14, 1990)
8. Analyses of elicitations
9. Third meeting of panel (January 7, 1991)
   a. Feedback of results to panel
   b. Opportunity for change of opinion
   c. Determine need for re-elicitation (secret ballot)
10. Re-elicitations (if necessary)
11. Analyses of elicitations, including feedback from third meeting (and re-elicitations, if necessary)
12. Report of results

A.5.2 Discussion of Unique Features of the Procedure

This procedure uses features of decision analysis theory in a way intended to maximize benefit to the decision-maker. Ranking to a common scale is used wherever possible, since the mathematical manipulations required during analysis are more intuitive and simpler, and more information can be obtained than for ranking by comparison. On the other hand, pair-wise comparison is used to advantage when a common scale is not possible to construct, as, for example, when comparing objectives and attributes to obtain weighting factors for each.

A.5.3 Group Elicitation and Analysis

When a panel of participants is convened for decision analysis, pressure to conform and other group dynamics must be contended with. For this procedure, the group is first convened to come to agreement on ground rules, objectives, and attributes and for orientation on the problem. After that, the first round of elicitation is done individually so that effects of group dynamics are avoided. When results from the first round of elicitation are presented, the panel again convenes as a group and individuals are allowed to alter their first round judgments. If, after results from the second round are tabulated and they indicate no consensus, a decision is made by secret ballot of participants whether or not to re-elicit judgments individually before preparing the final report of results.

A.6 ELICITATION TRAINING AND ELICITATION

The purpose of elicitation training is to help the participants learn how to encode their knowledge and beliefs into quantitative forms. Elicitation training can significantly improve the quality of the participants' assessments by avoiding psychological pitfalls which can lead to biased and/or overconfident assessments. It is useful to schedule the training session early in the decision analysis process, e.g., immediately following the selection of issues and participants. The training should be carried out by a substantive expert who is knowledgeable about the issues to be assessed and a normative expert who is knowledgeable about decision theory and the practice of probability elicitation.
The elicitation sessions should be held as soon as possible following the discussion of issue analyses and the selection of elicitation variables such as objectives and attributes. An elicitation team should meet separately with each expert, to avoid pressure to conform and other group dynamics interactions which might occur if the expert judgments were elicited in a group setting.

The elicitation team should consist of a substantive expert, a normative expert, and a recorder. It is also useful to add as a fourth member the person who will prepare the final documentation. Individuals may perform more than one function to reduce the number of participants. For example, the normative expert or the recorder may also be familiar with the substance of the decision to double as a substantive expert, and the recorder and normative expert may team to prepare the final documentation.

After elicitation and documentation, the results of the decision analysis should be presented to the panel of participants as a group, at which time each may change any decisions previously made. If the results produced from this second round do not indicate a choice or if they appear inconsistent, a second elicitation may be appropriate. In some cases, a consensus may not be reached even after the second elicitation, in which case the results should be presented to the decision-maker as a complete set of information upon which to base the decision. In such cases, the rationales presented by the participants may influence the decision as much as the results of the decision analysis.

A.7 DEFINING THE PROBLEM AND ALTERNATIVE SOLUTIONS/CHOICES

The problem for which a decision is required should be stated clearly and concisely, so that all who are involved in the decision analysis process are equally and fully aware of the problem. The alternatives which may be chosen should be equally clear and concise when presented to the persons who will rank them. In some cases a large number of alternatives are available, with slight variations for each of several principle alternatives. It is not necessary to list all possible alternatives, but the principle alternatives, those for which clear differences in results are apparent, should be included. This will ensure that the spectrum of alternatives is covered without burdening the process with excess effort.

The four alternatives had been identified by Nair and Tschoepe (1990) prior to commencement of the elicitation exercise. However, the choice of objectives and attributes, made by panelists, reflected a statement of the problem and were not tied to the alternatives. Another way to proceed might be to choose the objectives and attributes first and then choose the alternatives.

A.8 DEFINING OBJECTIVES

The goal of the decision is to meet one or more objectives by virtue of choosing an alternative. Each objective should be clearly stated and as independent as possible of the other objectives. Meeting one objective should not necessarily equate to meeting another objective.

A.9 DEFINING ATTRIBUTES ASSOCIATED WITH OBJECTIVES

For each objective, one or more attributes may be stated which connect the objective to the alternatives. Attributes should be written to clearly bring out particular facets of an objective with respect to the alternatives. As such, the set of attributes for a given objective should be as complete as possible without repetition. If two attributes express essentially the same aspect, then that aspect intrinsically receives an inadvertent additional weighting and the decision analysis process may be adversely affected.

A.10 CONSTRUCTING SCALES

When assessing to a common scale, it is best to use a natural scale whenever possible, since such a scale by definition has a common use and meaning (e.g., dollars, time, etc.). Scales should have the same relative direction for all attributes, so that a high assessment is understood as an assessment of how well an alternative meets the attribute and a low assessment is understood as an assessment of how poorly the alternative fares.

When a natural scale is unavailable, a scale must be constructed to index relative value ranging from an indication of none to maximum. For the purpose of evaluating the SCC clarification alternatives, a scale of 0-10 will be used to assess alternatives.

Since there is no natural scale for ranking the objectives and attributes, these are compared in pairs with a qualitative scale ranging from an indication of equal importance between two choices to absolute importance of one choice over another. The qualitative judgments are translated into a numberical scale as shown in Table A-1. While this scale (ranging from 1-9) is certainly not the only way to translate qualitative judgments into a numerical scale, it has been found to yield reasonable

Table A-1. Scale of Relative Importance

Intensity of Relative Importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Weak importance of one over another	Experience and judgment slightly favor one activity over another
5	Essential or strong importance	Experience and judgment strongly favor one activity over another
7	Demonstrated importance	An activity is strongly favored, and its dominance is demonstrated in practice
9	Absolute importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values between the two adjacent judgments	Use when compromise is needed

weights for the judged alternatives when used in conjunction with the computationally efficient analytical hierarchy process. (See Section A.11.2 for an example.)

A.11 RANKING

Before ranking, it is very important that each individual participant asked to perform the ranking have a common understanding of the objectives, alternatives, attributes, and ranking scales. Before

assessing alternatives, each participant will be asked to make pair-wise comparisons of the objectives as well as the attributes associated with each objective in order of preference. The results will be used to weight objectives, and attributes by degree of importance. When assessing alternatives, each alternative should be judged only with respect to how well it correlates with the attribute of interest. How well it correlates with other attributes must be excluded, and participants' biases for or against the attribute and its associated objective should not enter into the assessment of alternatives. The participants will have had an opportunity to judge each attribute and objective separately before alternatives are assessed.

It should be noted that each participant's judgments will be questioned during the elicitation process, to ensure that the response recorded accurately portrays the participant's opinions.

A.11.1 Assessing to a Common Scale

Each alternative should be assessed individually to indicate the judgment of how well it meets each individual attribute. Ideally the common scale would be natural, to avoid error in interpreting the scale. Since a scale is to be constructed, it will be based on a scale of 0 (none) to 10 (maximum). When assessing to a common scale has been completed, a check for consistency will be done by arranging the alternatives in order of preference along with the ranking of each, to see if re-assessment is in order to most accurately reflect the participant's judgment. Rationales for decisions should be recorded by the recorder at the time the assessment is done.

For three of the objectives, attributes are categorized by time of importance; that is, attributes are classified as either pertinent prior to submittal of the license application or after submittal of the license application (see Appendix B). Participants will be asked to directly weight the importance of each of these two time periods with respect to each objective (e.g., pre-submittal = 0.6 and after submittal = 0.4). This will provide an additional measure of weighting which will be reported with the results of the analysis. Ranking by comparison is not used here for the case when only two items are to be compared since the mathematics in such a case does not allow sufficiently fine distinctions.

A.11.2 Ranking by Comparison

Each objective should be compared in a pair-wise fashion to each other objective individually to indicate the judgment of how it compares to each of the other objectives in meeting the goals. The same process should next be used for comparing attributes to one another. The results will be used to weight objectives and attributes by degree of importance. Consider the following hypothetical ranking of objectives as an example. For the given four objectives, A, B, C and D, A and B may be considered equally important to a participant, but A may have strong importance when compared to C, A may be considered absolutely more important than D. Additionally, B may have demonstrated importance when compared to C and B may be considered slightly favored (weak importance in Table 8-1) over D. Finally, D may be considered slightly favored over C.

Using the scale of relative importance in Table A-1, the relative importance assigned to each of A, B, C and D are given in the following example Table A-2, where the comparisons are done in terms of which element dominates, expressed as an integer. If element I dominates over element J, then the dominance integer is entered in row I and column J, and the reciprocal is entered in row J and column I.

Procedures for mathematical manipulation by matrix algebra to determine normalized weights are described in Saaty, T. L., *The Analytic Hierarchy Process*, McGraw-Hill, 1980.

Although the example given is for weighting objectives, the pair-wise comparison process will be used also for weighting attributes, since there is also no common scale by which to rank them.

A normalized weight will be assigned to each of the objectives and attributes to reflect each participant's evaluation as a result of this exercise.

A.11.3 Recommended Practice

While there is merit to either assessing by a common scale or by relative importance in the decision analysis process, it is recommended that the former be used in evaluating alternatives and the latter for weighting the objectives and attributes.

Table A-2. Example Showing Relative Importance in the Matrix

Attribute of Interest	A	B	C	D	Normalized Weights
A	1	1	5	9	.4801
B	1	1	7	3	.3604
C	1/5	1/7	1	1/3	.0556
D	1/9	1/3	3	1	.1039

APPENDIX B

OBJECTIVES AND ASSOCIATED ATTRIBUTES FOR EVALUATING THE SCC CLARIFICATION ALTERNATIVES

OBJECTIVES AND ASSOCIATED ATTRIBUTES FOR EVALUATING THE SCC CLARIFICATION ALTERNATIVES

B.1 INTRODUCTION

This appendix presents a description of the systematic basis on which the selection of an alternative can be made from among the ones described in the technical feasibility study report (Nair and Tschoepe, 1990). A hierarchy of a goal, objectives, and attributes by which to assess the alternative is presented.

B.2 PURPOSE AND GOALS

The purpose of clarifying the current regulation dealing with SCC is to meet the statutory Nuclear Waste Policy Act (NWPA) requirement that the NRC reach a decision on the construction authorization within 36 months after receipt of the DOE license application. The Commission has testified before Congress that it would support the requirement in the NWPA, provided that DOE submitted a high-quality application.

Based on this purpose, a high-order set of goals can be defined. The goals are:

GOAL 1. Provide authoritative guidance to DOE sufficient to ensure no misunderstanding of specific NRC regulatory requirements that would otherwise be likely to impair the submission of a high-quality application for a construction authorization.

GOAL 2. Provide authoritative interpretive positions regarding specific NRC regulatory requirements to the NRC technical staff so that associated technical capabilities will be available to review and process a high quality application for a construction authorization promptly without delays associated with regulatory uncertainty.

GOAL 3. Reduce, to the extent practical, opportunities for contentions during the licensing hearing regarding uncertainties about NRC's regulatory requirements so that, together with other measures to streamline the licensing process, a Commission decision on the construction authorization can be made within 36 months after receipt of the application (or as soon thereafter as is reasonably feasible).

B.2.1 Objectives

With respect to the ambiguity concerning the meaning of SCC, the following objectives may be derived from the set of high-order goals. The objectives address different elements of the goals and, taken together, address the entirety of the goals.

B.2.1.1 Objective 1

To ensure compliance with DOE's repository program schedule and to ensure meeting the statutory deadline for license application review.

Note: Ensures that guidance can be made during the time available for guidance development. Timeliness is an important consideration to NRC from two perspectives: (i) the requirement outlined in the NWPA [Federal Register 10134(e)] that federal agencies must either comply with DOE's repository program schedule or explain the reason for delay to the Secretary and to Congress, and (ii) the NWPA mandates that the Commission "... shall issue a final decision approving or disapproving the issuance of a construction authorization not later than the expiration of 3 years after the date of submission of such application, except that the Commission may extend such deadline by not more than 12 months if, not less than 30 days before such deadline, the Commission complies with the reporting requirements established in subsection (e)(2) ..." [reference Federal Register 10134(d)].

B.2.1.2 Objective 2

To provide a criterion for the containment requirement that the license applicant can be reasonably expected to comply with and clear enough so that NRC will be able to determine compliance.

Note: This objective is aimed at do-ability of the chosen alternative. The objective is to ensure that the criterion is one with which compliance is reasonably possible. The alternative which is chosen must have a high probability of acceptance by the applicant and must result in required actions which are feasible. In addition, the alternative should result in providing clarity, which speaks to the minimization of any new uncertainties. It should be possible at the time of implementing the alternative to see a path toward a known destination of compliance.

B.2.1.3 Objective 3

To minimize the level of effort required for implementing the alternative and for evaluating the license application based on the alternative.

Note: The level of effort in this context means the expenditure of NRC resources that would be needed. Such resource expenditure could be for NRC staff or for contractors, and it could be incurred during guidance development before license application or during compliance assessment after a license application has been submitted.

B.2.1.4 Objective 4

To facilitate public acceptance of and confidence in the safe containment of HLW.

Note: This objective is included to ensure that the design which complies with the SCC requirement will be good to a degree sufficient to satisfy all interested parties (State, Indian tribes, individuals, etc.). This objective had been revised to read "To ensure a safe design to protect the public health and safety," but the original language was reinstated for the following reason. If DOE complies with the requirements of NRC, which are conservatively based on EPA requirements, a safe design will be ensured. This objective is not aimed at ensuring that DOE complies with NRC requirements, however; it is instead concerned with public acceptance and confidence in NRC decisions regarding disposal of high-level nuclear waste.

Associated with each objective is a set of attributes, which are given below.

B.2.2 Attributes for Objective 1

To ensure compliance with DOE's repository program schedule and to ensure meeting the statutory deadline for license application review.

B.2.2.1 Attributes

B.2.2.2 Prior to Submittal of the License Application

P1. Prevent Schedule Delays Due to Alternate Interpretation of SCC

Pursuing the alternative will reduce the uncertainty in the interpretation of SCC so that no delays in the applicant's schedule will occur due to the need for periodic NRC guidance. Pursuing the alternative will ensure that guidance provided by NRC to the applicant concerning the containment requirement is as complete as necessary and contains an adequate level of detail so that no delays in the schedule occur as a result. Pursuing the alternative will not introduce any new regulatory or technical uncertainties, thereby ensuring that the time required for prelicensing guidance will not cause a delay in DOE's schedule.

B.2.2.3 After Submittal of the License Application

A1. Prevent Schedule Delays Due to Alternate Interpretation of SCC

Pursuing the alternative will reduce the uncertainty in the interpretation of SCC so that the requirement on NRC for a construction authorization decision within the three-year allowable time period can be met. Pursuing the alternative will ensure that guidance provided by NRC to the applicant concerning the containment requirement is as complete as necessary and contains an adequate level of detail so that no delays in the schedule occur as a result. Pursuing the alternative will not introduce any new regulatory or technical uncertainties, thereby ensuring that the required schedule for compliance determination activities can be met. Pursuing the alternative will ensure that the applicant's compliance demonstration method is consistent with that expected by NRC so that no delays in the schedule occur as a result.

A2. Ensure Completeness of Information Available to Reviewer and Decision-Maker

Pursuing the alternative will ensure that the information on the applicant's design for containment, which is available to the Reviewer and Decision-Maker, will be as complete as necessary for timely presentation and license review.

A3. Ensure Ease of Understanding of Information Available to Reviewer and Decision-Maker

Pursuing the alternative will ensure that the information on the applicant's design for containment, which is available to the Reviewer and Decision-Maker, will be easy to understand, thus ensuring that NRC's review will be completed within the allotted time.

A4. Reduce the Scope for Litigable Issues

Pursuing the alternative will reduce the scope for litigable issues and, thereby, ensure meeting the statutory deadline required of NRC during the licensing hearing process.

B.2.3 Attributes for Objective 2

To provide a criterion for the containment requirement that the license applicant can be reasonably expected to comply with and clear enough so that NRC will be able to determine compliance.

B.2.3.1 Attributes

B.2.3.2 Prior to Submittal of the License Application

P1. Ensure the Feasibility of the Design

Pursuing the alternative will ensure that the applicant has freedom as to how compliance is demonstrated and can submit a feasible design which complies with the NRC requirements/guidance.

B.2.3.3 After Submittal of the License Application

A1. Reduce Uncertainty in Determination of Compliance with SCC

Pursuing the alternative will reduce the uncertainty in the interpretation of SCC, and it will not introduce any new regulatory or technical uncertainties, so that compliance determination is straightforward. As a result, the rule/guidance will be sufficiently clear so that NRC has a firm regulatory basis to determine compliance.

A2. Ensure Completeness of Guidance and Adequate Level of Detail in Guidance

Pursuing the alternative will ensure that guidance provided by NRC to the applicant concerning the containment requirement is as complete as necessary and contains an adequate level of detail so that compliance determination is feasible.

A3. Ensure Completeness of Information Available to Reviewer and Decision-Maker

Pursuing the alternative will ensure that the information on the applicant's design for containment, which is available to the Reviewer and Decision-Maker, will be as complete as necessary, thereby providing clarity for compliance determination activities. Pursuing the alternative will portray to NRC the technical uncertainties on predicted containment performance, contributing to the rationale for NRC's decision on compliance determination.

A4. Retain Flexibility for Future Options

Pursuing the alternative will allow NRC sufficient flexibility for any future options concerning containment which NRC might choose to pursue to make compliance demonstration and/or determination feasible.

B.2.4 Attributes for Objective 3

To minimize the level of effort required for implementing the alternative and for evaluating the license application based on the alternative.

B.2.4.1 Attributes

B.2.4.2 Prior to Submittal of the License Application

P1. Avoid Introducing New Uncertainties

Pursuing the alternative will not introduce any new regulatory or technical uncertainties, thereby minimizing the level of effort required by NRC for pre-licensing guidance activities. Guidance provided by NRC to the applicant concerning the containment requirement, as a result of pursuing the alternative, will be unlikely to require re-evaluation which might otherwise affect the level of effort for compliance determination.

B.2.4.3 After Submittal of the License Application

A1. Avoid Introducing New Uncertainties

Pursuing the alternative will not introduce any new regulatory or technical uncertainties, thereby minimizing the level of effort required by NRC for compliance determination activities. Pursuing the alternative will ensure that guidance provided by NRC to the applicant concerning the containment requirement is as complete as necessary and contains an adequate level of detail so that the level of effort for compliance determination is not increased.

A2. Ensure Ease of Understanding of Information Available to Reviewer and Decision-Maker

Pursuing the alternative will ensure that the information in the applicant's design for containment, which is available to the Reviewer and Decision-Maker, will be easy to understand, thus reducing associated NRC expenditure of resources.

A3. Allow Applicant Freedom of How Compliance is Demonstrated

Pursuing the alternative will allow the applicant freedom of how compliance is to be demonstrated, minimizing NRC level of effort required.

A4. Reduce the Scope for Litigable Issues

Pursuing the alternative will reduce the scope for litigable issues, thereby reducing the level of effort required.

B.2.5 Attributes for Objective 4

To facilitate public acceptance of and confidence in the safe containment of HLW.

B.2.5.1 Attributes

1. Prevent Schedule Delays

Pursuing the alternative will ensure that no delays in the applicant's repository program schedule will occur due to the need for periodic NRC guidance, thus contributing to public confidence in NRC's regulatory ability and authority.

Pursuing the alternative will ensure that NRC is able to meet the three-year time period for deciding on issuance of construction authorization, thus contributing to public confidence in NRC's regulatory ability and authority.

2. Assurance of Conservative Design

Pursuing the alternative will contribute to assurance that the applicant will produce a conservative design, contributing to public acceptance and confidence for the safe containment of HLW. Aspects of the design which should be retained to ensure conservatism should include the following: (i) the multiple barriers approach; (ii) allowance for final finding on SCC at the time of decision on permanent closure; (iii) consistency with release limits for the period after containment; and (iv) maintaining the relationship to EPA standards. Pursuing the alternative will ensure that NRC and other parties will be aware of uncertainties in performance predictions made by the license applicant, contributing to the rationale for NRC's decision on compliance determination and increasing public confidence in and acceptance of NRC's decision. Pursuing the alternative will ensure that adequate Quality Assurance procedures are adopted and followed by the license applicant, thereby contributing to public acceptance and confidence in NRC's licensing decisions concerning the safe disposal of HLW.

APPENDIX C

ALTERNATIVES

- Flexibility in alternative approaches may be more appropriate than a strictly quantitative procedure to demonstrate compliance, and such flexibility may be lost with adoption of a quantitative rule.

The following points provide offsetting factors to be considered in light of the disadvantages:

- Quantitative criteria can be designed to leave enough flexibility in the definition of acceptable thresholds to allow for a final decision which is responsive to the latest data available. Just as the containment period is not yet a fixed value, the probability of failure of a proportion of waste packages by the end of the containment period and the value for the proportion of failed waste packages could be constrained to be in an interval to be ultimately decided by the Commission.

- Any guidelines proposed by NRC would be carefully peer-reviewed. In addition, the current process of public comment and debate on any rulemaking or technical position on the subject will adequately expose the pros and cons. Documentation and rationale descriptions can be time-tested over a long period.

From the above discussion, it can be concluded that the advantages of adoption of a quantitative criterion for SCC outweigh the disadvantages.

C.2 ATTRIBUTES OF A QUANTITATIVE CRITERION

In order to maintain flexibility for the NRC, while assisting the license applicant in designing safe waste packages, any quantitative criterion based rule should have the following attributes:

- It should be easy to interpret and unambiguous.

- It should allow for a pass-fail criterion.

- It should reflect the state-of-the-art in both scientific knowledge and uncertainty.

- Its demonstration should be achievable with presently available or easily developed methodology and data, including the use of expert judgement.

- It should allow flexibility to use data up to licensing hearing time and beyond, up until permanent closure of the repository.

- It should allow flexibility for possible later rule modification.

A quantitative criterion developed by Nair and Tschope (1990) and meeting the attributes discussed in this section is described below:

The probability that the proportion K of waste packages failing during the period $(0, T_o)$ does not exceed K_o should be greater than r_o.

Probability $\{K \leq K_o\} > r_o$, where

K_o is the maximum allowable proportion of waste packages failing in

time T_o;
r_o is the minimum acceptable probability that $K \leq K_o$; and
T_o is the containment period.

The quantitative criterion expressed above attempts to capture the postclosure performance of the waste packages in a broad yet concise manner. In establishing a robust rule, the above quantitative criterion should also imply that the probability of failure of waste packages, $K > K_o$, is controlled and is very small. This approach will ensure the application of the philosophy of designing *for* containment. It will also enable the designer to account for a multiple of waste packages in varying environmental and loading conditions.

The definition of a waste package failure plays an important part in evaluating the consequence of the failures. Assuming that the waste package degradation is progressive with time and at some time in the future (say $>>$ 1,000 years) all of the waste package material is ineffective toward performing any containment functions, a reasonable definition can be developed where the credit for a minimum containment period is established such that a significant part of the waste package is intact at the end of the minimum containment period. Regardless of the definition chosen, it should be possible for the applicant to compute partial or fractional releases from the waste package for satisfying at least part of the post-containment, gradual release rate requirement. The quantitative approach presented in terms of proportions of waste packages is equally applicable to proportions of radionuclides in a single or multiple waste packages, if failure is defined in terms of the proportion of radionuclides released. The approach facilitates a logical transition from the containment requirement to the gradual release requirement. It also provides a basis to analyze consequences of premature compromise of the containment function.

C.3 PRESENTATION ALTERNATIVES

There are several presentation alternatives to implementing quantitative criteria. Three basic approaches to reduction of the uncertainty related to SCC are identified as follows:

- Change the existing regulation by way of a qualitative rule with probabilistic language
- Change the existing regulation by way of a quantitative rule
- Do not change the regulation but provide interpretation of SCC within a regulatory guidance document (Regulatory Guide or Technical Position).

These three approaches provide the basis for a broad scope of alternatives that could be pursued to accomplish the task of expressing the technical details needed to clarify the SCC issue. For each of these particular cases complementary Technical Position (TP) (or Regulatory Guide) reports are recommended. For each case, the content and scope of the associated TP will be different. The purpose of the TPs is to provide guidance on the implementation of the defined approach.

The choice of which alternative is pursued will determine where explanatory text will reside. The alternatives that involve changing the existing regulation, either with a qualitative or a quantitative rule, would require that some text in 10 CFR Part 60 be replaced and/or supplemented with new text. Under the current rule, the following portions of 10 CFR Part 60 (U.S. NRC, 1990) contain text relevant to the issue of SCC:

- 10 CFR 60.2 *Definitions*

- 10 CFR 60.21 *License Applications*
- 10 CFR 60.113 *Performance of Particular Barriers after Permanent Closure*
- 10 CFR 60.133 *Additional Design Criteria for the Underground Facility*
- 10 CFR 60.135 Design *Criteria for the Waste Package and Its Components*
- 10 CFR 60.140(a)(2) Performance Confirmation Program *General Requirements*
- 10 CFR 60.143 *Monitoring and Testing Waste Packages*

C.3.1 Areas of Change

C.3.1.1 Definitions - 10 CFR 60.2

There is a need for precise definitions for containment and failure of containment in order to adequately pursue an assessment of compliance with a rule on SCC. If any change to 10 CFR Part 60 is contemplated to aid in the understanding of SCC, the change in such definitions is the minimum required.

C.3.1.2 Additional Factors

The approaches involving changing the existing regulation would introduce new definitions in 10 CFR 60.2, and they may involve a probabilistic assessment as part of the analyses of barrier performance in the license application under 10 CFR 60.21. Changing the existing regulation might be done either in 10 CFR 60.113 (which is under the general heading of Performance Objectives) or in 10 CFR 60.135 (which is under the general heading of Design Criteria for the Waste Package). In these two cases there are certain implications associated with the choice of where new language would appear in 10 CFR Part 60 (U.S. NRC, 1990) as well as with the Regulatory Guidance choice of simply interpreting SCC outside the structure of 10 CFR Part 60. The implications and rationale for the various alternatives are discussed in Section C.3.2.

C.3.2 Qualitative Rule - Alternative 1

The potential changes to the various sections of 10 CFR Part 60 (U.S. NRC, 1990) to support clarification of 60.113 with a more qualitative rule are identified in Figure 1. For a qualitative rule, a change in language would most appropriately appear in 10 CFR 60.113, since the issue of SCC is most accurately categorized as performance of the engineered barrier after permanent closure. Also needed would be a clear definition of containment failure in 10 CFR 60.2 so that the license applicant could demonstrate compliance for a particular design for containment. Any proof of compliance with a probabilistic methodology in the case of a qualitative rule would require additional guidance outside 10 CFR Part 60, and that is indicated by presentation of an acceptable methodology and a worked example in a Technical Position (TP) Report.

Presentation in a qualitative rule has the following advantage:

- It does not constrain the requirement to specific probability numbers, even in a generic sense. This allows for regulatory flexibility in light of anticipated advances in technical state

of the art in both the ability to produce improved containment and the ability to predict such containment performance.

There are, however, disadvantages associated with the adoption of a qualitative rule.

- It does not provide a quantitative basis to indicate how one is to judge the adequacy of the predicted performance with respect to standard for containment.

- With the probabilistic approach in a TP, there is a risk that the applicant may adopt a different approach which they feel is appropriate but which may be unacceptable to NRC.

Note that, even with the qualitative rule, the probabilistic approach could be presented in some other format than strictly in a TP. For example, the probabilistic approach could be included in a revision to 10 CFR 60.21 as a requirement in the assessment of performance for the license application.

C.3.3 Quantitative Rule - Alternatives 2 & 3

For the quantitative rule change, two alternatives are considered as shown in Figures 2 and 3. For these alternatives, it is important to consider the location of the modified or additional text within 10 CFR Part 60 (U.S. NRC, 1990). For Alternative 2 (Figure 4), probability based quantitative language would be added to 10 CFR 60.113, whose subject deals with performance objectives. Also, assessment of waste package effectiveness required in 10 CFR 60.21 would be expanded to require that the assessment be made in terms of probabilities. In contrast, Alternative 3 (Figure 3) recommends the inclusion of the probability based quantitative language in 10 CFR 60.135, whose subject is the waste package design criteria. With this second alternative, the quantification would be treated as a design criterion and not as a performance objective. The rationale for incorporating a quantified rule in 10 CFR 60.113 (Alternative 2) is that the Commission can prescribe a more flexible performance objective in terms of a specified number of waste package failures, i.e., nonzero values. If the NRC determines that a nonzero value for K_o would be appropriate, particularly for unanticipated conditions as part of the system requirement in 10 CFR 60.112, it would have the flexibility to do so. Technological advances and site characterization could, in the future, justify such a Commission decision. The current rule does not allow such flexibility.

In making changes to 10 CFR 60.135 (Alternative 3) a tacit assumption of a performance objective of zero waste package failures during containment is made and the focus in the quantitative language in 10 CFR 60.135 would be to ensure less than one failure with a high level of confidence. Changes and additions to the definitions in 10 CFR 60.2 and clarification of analyses needs in 10 CFR 60.21 would be required. In either of the two quantitative alternatives, the implication will be to design a robust waste package, such that the containment of radionuclides during the containment period can be attained at a prescribed level of confidence. For both the quantitative alternatives, Technical Position reports would be prepared with an example to clearly show how the methodology is intended to be applied.

The quantitative rule has the following advantage:

- With the probabilistic approach in the rule, there is less risk that DOE will adopt a different approach which they feel is appropriate but which may be unacceptable to NRC.

A quantitative rule has the following disadvantages:

- Greatest change in rule probably means greatest expenditure of resources/effort and time to implement it.

- Reduces freedom of license applicant in choice of how to comply with the requirement.

- May reduce flexibility to adopt options available in the future.

A comparison between the two quantitative Alternatives 2 and 3 is outlined below.

Advantage of Alternative 2

- There may be a distinct advantage of putting the specific probability language in 60.113, which is under the heading of "Performance of Particular Barriers after Permanent Closure" (instead of 10 CFR 60.135, which is located in the section of 10 CFR Part 60 entitled Design "Criteria for the Waste Package and Its Components"). While both passages carry the force of law, the Performance Objectives have been considered by some to be overriding in any case of apparent conflict or inconsistency with Design Criteria. With the language located in 60.135, it might be viewed by DOE only as a design requirement and not as a performance requirement.

Advantage of Alternative 3

- The containment provision, since it deals specifically with the waste package, would logically seem more appropriately located in a section dealing more specifically with the waste package. By this logic, it would appear to be more appropriate to locate a quantitative rule for containment under Design Criteria (10 CFR 60.135) than under Performance Objectives (10 CFR 60.113).

C.3.4 Regulatory Guidance - Alternative 4

For the case in which regulatory guidance is chosen as the presentation option, no probabilistic or quantitative language would be introduced in 10 CFR Part 60. Options to consider if regulatory guidance is chosen as the method of presentation include changes or additions to certain definitions (such as containment failure) and providing a worked example along with a discussion of preferred methodology in a comprehensive guidance document (see Figure 4). The guidance document in this case would capture the development of a quantifiable methodology along the lines described in the other alternatives.

Use of regulatory guidance as the vehicle to present a quantitative containment criterion has the following advantages:

- Since a rulemaking will not be undertaken, this alternative requires minimal resources (effort, time, expenditures) to implement.

- No new regulatory uncertainties are introduced.

- Guidance to applicant is consolidated into a single reference.

- The applicant retains maximum freedom of how compliance with containment requirements is to be demonstrated, with maximum flexibility for choosing any future options.

APPENDIX D

RATIONALES

RATIONALES

This appendix contains text taken directly from the comments recorded during the elicitation sessions as participants provided rationales for their decisions. This is intended to prevent interpretive errors which could have arisen by paraphrasing the comments. The comments are organized by general subject and have been reduced to avoid repetition.

The comments and rationales which follow express a range of opinions, varying from one panel participant to the next. As a result, a group of comments within a general subject will not necessarily express a consistent viewpoint.

D.1 RATIONALES FOR DECISIONS — COMPARISON OF OBJECTIVES

D.1.1 Objective 1—Ensure Compliance with the Schedule

D.1.1.1 High Weight: Schedule is Dictated by Statute

In order to have a chance of meeting the three-year statutory deadline, we need to have all the information at the start when our clock starts ticking. So we want the application to be complete at the time that it's docketed. DOE's repository program schedule takes the back seat to NRC's review schedule after docketing.

We are working within the framework of the law, so we must keep the schedule in mind because of that, but we also must keep public confidence highest in consideration. However, I assume that, if we have a justifiable assumption, we will be able to change the guidance.

D.1.1.2 High Weight: Schedule Slips Have Great Impacts

Objective 1 (ensure compliance with the schedule) is the most important objective, because any time we lose sight of this objective, historically, the impact has always been great. We are bound by the statute to meet the schedule, and we assume that our regulations are do-able.

Schedule (Objective 1) is more important than Objective 3 (minimize the level of effort), because it goes to the credibility of the program. If the schedule keeps slipping, people will lose confidence. Even though the statutory deadline is important, in the end public acceptance must be behind the whole thing or we are going to have problems. The technical community will look at it and if they do not have confidence, there will be problems.

From an agency standpoint, if we help them meet the schedule, public acceptance would follow. Allocation of resources also would likewise follow. Reduced cost means fewer agency problems.

D.1.1.3 Low Weight: Statutory Schedule Can Be Changed

Schedules are always changing, and that is not really that important. If necessary, we can always even go back to Congress to change the statutory deadline.

D.1.1.4 Low Weight: Schedule Can Slip Without Great Impact

We will have no excuse once we receive an application given to us within our requirements. Before receipt of the application, whatever it takes to get a complete application we should do regardless of schedule.

Slipping the schedule has historically occurred without many consequences.

Objective 1 is not as important as do-ability and public acceptance because, although, from the point of view of management this could be important, in the overall context of a HLW repository a slippage of schedule of 1 or 5 years compared to hundreds of years is not important. Statutory deadlines can always be changed.

A schedule pushed too hard may appear like a compromise of safety.

D.1.1.5 Miscellaneous

We must have a single tune before developing anything about guidance. This would be the root cause of delay. Second in importance with respect to potential schedule delays would be reducing the scope of litigable issues. Having cleared the interpretation of SCC, we must have enough documentation to make sure of no misperception outside of NRC which would cause litigation and schedule delays. There will be much public participation and we must make sure litigable issues are contained.

D.1.2 Objective 2—Feasibility of Design and Compliance Determination

D.1.2.1 High Weight: DOE Must Have Clear Requirements

To consider meeting a schedule, first DOE must know what to do, and they need guidance (criteria) which must be followed to meet the schedule. Without a criterion and do-ability having been established, the cost of doing will be very high.

Objective 2 (feasibility of compliance and determination of compliance) is clarity in terms of how the license applicant is going to determine how the standard is met and how NRC will evaluate. Public confidence, Objective 4, is going to flow from Objective 2.

Objective 2, do-ability, is the most important because the criteria must be well defined to avoid the licensee not knowing what is expected and NRC not being able to review the application. Also, you will be able to tell the public why you want what you want.

With respect to feasibility of compliance and compliance determination, if the applicant does not have a clear idea of what to do before the application is submitted, this will be a big problem.

First, we must make sure the applicant knows clearly what he must comply with, therefore the reduction of uncertainty is the most important. Retaining flexibility is least important, because this can be done by many other ways. The options must be pretty much crystallized by the time the application is received, and changes should not be an option. We must spend as much effort to avoid foot dragging and revision; you may never get to a conclusion. If you know you're going to see it (the application) again, it encourages inefficiency. We want to lock in on a position and come to a conclusion.

To meet a schedule, if information we get is not clear, we will incur larger schedule delays than if we had an alternate interpretation of SCC. If you have an alternative interpretation, you open the scope

for litigable issues. You want to eliminate the schedule delays due to alternate interpretations but also want to limit scope of litigable issues. You're dealing with an expert, and if the information is there, the expert can work with that information, but without the information, you must first get the information and schedule delays will result. It takes more time to litigate issues than to explain things to an expert.

D.1.2.2 High Weight: NRC Must Have Clear Criteria for Review

Above all things we need to establish criteria that we can review against. If we can not establish criteria for review, public acceptance will not matter.

With fespect to feasibility reducing uncertainty in determination of compliance with SCC is the most important, because it contributes most and it would then be not so much of a problem to determine compliance.

The more the uncertainty, the more the debate, both internally and externally, about determination of compliance. Second in importance is completeness of guidance, because if we have not been sufficient in the guidance we have given them we will still get into debates about compliance determination.

If we're not clear on what we want from the rule, there's a high probability that the schedule would be impacted. Reducing the scope of litigable issues is, however, most important to meeting the statutory deadline.

D.1.2.3 High Weight: Regulatory Requirement Must Be Achievable

Objective 2 (feasibility of design and compliance determination) is the most important objective, because credibility in the program is dependent on a good valid workable methodology, even if more time is required in the schedule.

Do-ability comes next in importance (to public acceptance) because you have to show that you can really achieve it technically. For example, considering the long time periods, it will be difficult to prove that it will work. It will have to be shown and others outside the NRC and DOE who must be convinced that the repository will be good enough so that the consensus will be that NRC has a good basis for SCC. If the criterion for SCC that we provide can reasonably be met and we can determine compliance with it (Objective 2 is satisfied), then all the other objectives will be satisfied.

D.1.2.4 Low Weight: Regulations Are Feasible

Completeness is more important than ease of understanding. The assumption is that, if all the information is there, a technically qualified individual will be able to understand it. Ease of understanding has implications related to wordsmithing.

D.1.3 Objective 3—Minimize Level of Effort Required

D.1.3.1 High Weight: NRC Must Provide Resources Needed/NRC Resources Not Unlimited

Minimizing the level of effort is more important than feasibility, because our resources are not infinite and we have only so many resources to apply to each activity and the level of effort must meet the resources available.

D.1.3.2 Low Weight: NRC Resources Not a Major Constraint

Objective 3 is not as important as do-ability and public acceptance because primarily we have to do what is right, the cost is not nearly as high a priority and will not be a deciding factor. We would do the thing which is right, and therefore the level of effort should not be the criteria.

D.1.3.3 Low Weight: NRC Will Provide Whatever Resources Required

If the issue gets on the front burner, then the resources will flexibly be shifted to the need. Resources will not, however, be a major constraint, because it's something that we can control by realignment of resources.

Prior to receipt of the license application, we may need to expend a lot of time and resources, but we will gain that back after the license application. The key is that the resources that have to be spent to provide public confidence are well worth it and we should not cut corners.

D.1.3.4 Low Weight: Congress Will Provide Needed Resources

The level of effort is flexible in that, if it is demonstrated that we need the resources, we can go to Congress and get them.

D.1.3.5 Miscellaneous

Concerning the level of effort required to evaluate the application, most important is to reduce the scope of litigable issues, which minimizes resources necessary to evaluate matters of controversy. Emphasis on completeness and adequate level of detail of guidance seems to say we are going to describe what the applicant has to do so that we can determine that the applicant complies. In other words, it puts more of a burden on our resources. You minimize the level of effort that you have to use to evaluate the application by reducing the number of issues. If we had worked out in advance the details of how we are going to determine compliance, it might be easier, but it would probably not make that big a difference.

Towards the objective of reducing the level of effort to determine compliance, reducing the litigable issues is most important. Next most important is to avoid introducing new uncertainties.

D.1.4 Objective 4—Facilitate Public Acceptance and Confidence

D.1.4.1 High Weight: Lack of Public Acceptance is Adverse to Program

Objective 4, public acceptance, is most important. The public must accept that this repository will be safe, that we know what is involved, and that they are presented with evidence that it will be safe. Their acceptance will be passed politically upward to allow a political climate to build a repository. Experience tells us that if the public does not accept it, then everything goes out.

Second most important (to do-ability) is the public acceptance and confidence, because each time in waste management history public acceptance is what either kills the program or makes it possible.

Conservative design is more important than schedule delays because the public will always like a conservative design, and we will always get public acceptance with public perception of a conservative

design. Schedule delays will not affect public confidence nearly as much. We are very seldom criticized for not doing timely things but we are always criticized for not doing quality things.

D.1.4.2 High Weight: Public Confidence Affected Reactor Licensing

At first glance, the most important objective would appear to be feasibility of compliance and determination thereof (objective 2), because if you meet objective 2 you're going to meet the other 3 objectives. However, public acceptance must be considered the most important objective, following the reactor example. Regardless of the level of sophistication of the technology, it was public confidence that affected reactor licensing the most (we're not building reactors any more). But this is a different ball game because a repository is mandated by law, so one will be built, and it's therefore not at the same degree of experience as for reactors.

D.1.4.3 Low Weight: NRC Cannot Greatly Influence Public Acceptance

The public may not think our requirements, no matter how conservative, are acceptable. They may even be more distrustful of NRC if we are prescriptive with numbers in the rule.

Meeting the schedule is more important than public acceptance. As long as we do our task that's all we can do. There's not much we can do to influence public acceptance. Public acceptance is really DOE's job (public relations that people believe it's safe). As an independent regulator we're not in a popularity contest. From the industry's point of view, schedule is more important. The lack of public acceptance over the years has had no affect on our program, so objective 4 is not as important.

Concerning public acceptance, conservative design is most important. It shows we are not just rushing into something, but we are trying to do it with a conservative and effective design. There is not a need to have the repository so fast. Waste can be stored in casks at the power plants, and, in the future, there may be a better technology to contain and we may understand fracture flow better. Also, by postponing the repository, you lower the temperature and reduce the problems tremendously.

D.1.4.4 Low Weight: Lack of Public Acceptance Has Not Hurt Program

Conservative design and redundancy may not contribute to public confidence so much as our show of decisiveness.

D.2 RATIONALES FOR DECISIONS — CHOICE OF ALTERNATIVES

The responses of panelists indicated that they tended to group together the four alternatives into two groups. One group consisted of the quantitative rules, Alternatives 2 and 3, and the other group included the qualitative approaches, either rulemaking (Alternative 1) or guidance (Alternative 4). Panelists' responses concerning choice of alternatives have, therefore, been similarly grouped below. Notes are included to indicate cases for which a response applies to only one alternative and the language of the response does not clearly indicate such is the case.

D.2.1 Alternatives #1 (Qualitative Rule) and #4 (Qualitative Guidance)

D.2.1.1 High Score: Retains Flexibility for Future Options

Alternative 1 is the best with good TP guidance and examples but the burden would still be on DOE. However, this rule could be litigated because it does not have the number quantified in a rule. DOE would have a little more leeway with a qualitative rule. With Alternative 1 we are putting more qualifying words in the rule than with Alternative 4 and we're giving them a strong TP so that they will, I assume, address those words and they will be able to fill out the application with more completeness. The fact that the guidance is in the rule (for Alternative 1) may give a slightly higher comfort factor than for Alternative 4.

Alternative 4: The difference between what pre-licensing can do and what a rule can do is what is largely coloring this participant's opinion. I am putting a lot on pre-licensing guidance, which should be a very powerful tool even before we start our licensing review. A rulemaking locks you in, and you can not do more with it. If we disagree with the content of the application, we will not accept their application. Although we have never done this before, I am assuming that what is in the application will have been in the Format and Content Guide (F & CG) and what is in NRC's current documents policy. The LARS is saying that our prelicensing reviews are aimed at making that determination. We have flexibility during license review if we're not bound by a rule, so Alternative 4 is best. The license application review is documenting that what is in the application is what NRC and DOE have agreed to all along. If we have a big sufficiency problem it goes into a report, and a sufficiency problem would be a basis for not docketing the application. The prelicensing consultations and guidance have some teeth as a result. Even though no force of law is in prelicensing guidance, the assumption is that agreement would be reached. We have a robust process, more so than with previous applications. Such guidance could be modified more easily with less resources and less perception by the public that NRC is changing the rules. It is recognized that some things DOE will be responsive to and others will be long drawn out battles. The schedule is to do this in the 10 year pre-application period, which should be enough time. Everything to be considered in the 18 month review should go pretty smoothly as a result. Prescribing the probabilistic methodology departs from Commission policy on Probabilistic Risk Assessments (PRAs) in making a licensing decision.

Alternative 4: ASSUMPTION—Alternative 4 will be quantitative guidance, but the amount of guidance is not specified. Guidance could ask for a probabilistic analysis, but NRC would specify via a worked example a quantifiable methodology to analyze the number of packages to fail. The applicant must still demonstrate that he has complied with some quantified number for K sub o, and DOE may argue for a value for K_o. We give them the methodology for our guidance. It may, in other words, be that we do not specify the number and DOE may have to specify the number. DOE must show a probabilistic analysis and the burden would be on DOE to determine the number and justify that it would be in compliance with the rule.

Part 60 has gone beyond that by accepting EPA standards in a probabilistic approach. Part of that acceptance was to have deterministic standards as well. There is more comfort factor with a little bit of each (probabilistic and deterministic approach). Putting a probabilistic approach in the rule limits flexibility and indicates a change in Commission policy. We probably need more experience before such a change. If the Commission is not excited about PRAs for reactors, why should we jump into a probabilistic approach for a repository, where much less information is available? Maybe 8 or 10 years from now we will have enough information to put it into a rule. If you go probabilistic with SCC, you will undoubtedly go probabilistic for other aspects of compliance. In other words, it will set a precedent which the Commission will feel compelled to do. It would in effect be a decision to go probabilistic for compliance determination.

D.2.1.2 High Score: Ensures a Feasible Design

There is an implicit assumption that a technically explicit rule (such as Alternatives 2 and 3) can, in fact, be done.

Alternative 4: Alternative 4 could be almost as good as Alternatives 2 and 3, because a state of the art regulatory guide which is agreeable to all parties and is acceptable could do almost as good as Alternatives 2 and 3, and DOE will have no question as to how to demonstrate compliance. If we come out with a regulatory guide which does not have much quantitative guidance in it, there will be an application from DOE which is whatever they think is best and we will have to spend much effort. We are not sure really what they are going to come up with. DOE will assume what is best in light of having the onus put on DOE and the resolution of differences may never occur. If we do not give them enough guidance, we will not know what level "good enough" is.

Alternative 4: DOE will likely follow the guidance whether it's in a rule or not. ASSUMPTION is that DOE is very likely to take our guidance and follow it as if it were a rule whether or not it is in a rule, but there is some level of uncertainty that DOE could take a different approach. Experience is that DOE almost always follows the regulatory guide, even though it does not have the force of law.

D.2.1.3 High Score: Allows DOE Freedom in Demonstrating Compliance

The probabilistic method is great, but we may not be able to get the numbers and justify them, which would require much NRC effort and resources. It would be preferable to have DOE to put in the numbers.

By going with a rule change, the regulator takes on much of the burden for analyses and justifying numbers. DOE should have the burden to design their system and have flexibility in how to allocate certain things as well as to argue that their design meets our requirements. The more prescriptive we are, the more we take the burden from DOE. Pre-consultation should allow us an opportunity to tell DOE when they go astray. The assumption is that DOE would check it out thoroughly, but, if they do not, we would object. At any time that we would call them with objections to them submitting the application, it puts them on notice that when they submit the application that we will not accept it.

D.2.1.4 Score Low: Results in Schedule Slips Due to Litigation and Uncertainty

It is assumed that a prescriptive rulemaking, regulatory guidance, and/or a technical position would have gone through the public process by the time the application is received. If you allow the applicant the freedom of how to determine compliance, then it will take more time for NRC to determine compliance because NRC will have to verify that the applicant's method is acceptable. It does matter that the applicant not have such great freedom. Freedom may well be counter productive to reviewing the application.

Alternative 4: Rulemaking efforts are always labor intensive, and, if iterations are necessary, you have to go through the two-year rulemaking period. Guidance is not nearly so resource intensive as rulemaking. Guidance (Alternative 4) is best because, from a schedule viewpoint, you could work out differences with strong technical rationales.

Alternative 4: With Alternative 4, all the guidance will not have the force of law and would not reduce the uncertainty, and we will be open to a lot of contentions which will delay the hearings.

D.2.1.5 Score Low: Results in Level of Effort Increase Due to Litigation and Compliance Determination

Alternative 4 would be open to litigation quite a bit. In the present state, the rule does not provide a good criteria for SCC. Not only would DOE not know but NRC staff would also not know well how to determine compliance.

Before the application has been docketed, Alternative 1 requires less level of effort than 2 or 3 because of less probability for litigation during that period of time. There's potential for litigation with Alternative 1, but not all that much.

The level of guidance envisioned for Alternative 4 is something along the lines shown in the report 3. In other words, the amount of guidance will be as much as is needed; say a TP, etc. Guidance will change as time goes on, very likely, and will be an active process on the part of NRC.

If we give DOE freedom without giving them sufficient guidance, it might require additional analysis and effort on our part because they possibly have not done the best job that they could.
Alternative 1: After the application is received, all the last 3 alternatives would take less resources than the first, because the guidance is good and so the application associated with any of the last three alternatives would avoid introducing any new uncertainties.

With Alternative 4, DOE could come in with a twist which could increase the resources required of NRC. Just the fact that it is guidance, it could be fuzzier or looser than if it were a rule. Alternative 4 will not do much to reduce the scope of litigable issues.

The rulemaking associated with Alternatives 1 through 3 requires more level of effort than for Alternative 4.

D.2.1.6 Score Low: Does Not Reduce Uncertainty in SCC

During the period of time before the application is docketed, with Alternative 1 we will probably be constantly changing the guidance. The assumption is that Alternative 1 does not include a quantitative numerical guidance in a TP or Regulatory Guide.

D.2.1.7 Score Low: Results in Public Confidence Erosion Due to Schedule Slips

With Alternative 1, there is greater likelihood that DOE and NRC will disagree and the public will perceive that we are hiding something or do not know what we're doing and just involved in conflict. With a good regulatory guide or rule which is acceptable to experts, the public will accept it.

If DOE has the burden to design and justify the design, people will have more confidence in it than if DOE is saying that they're just doing what the rule said. The National Academy of Science (NAS) has also been concerned about our inflexibility in rules. They feel the regulatory framework is just not realistic. Going one step farther, in a rule, would be taking it too far and would reduce confidence of the technical community in a perceived conservative design. Conservative design is more

important than delays. A conservative design will help to demonstrate robustness of design and public acceptance will follow.

D.2.2 Quantitative Alternatives #2 (Performance Objective) and #3 (Design Criteria)

D.2.2.1 High Score: Decreases Schedule Slips Caused By Lack of Clear Guidance and Litigation

To prevent schedule delays due to an alternate interpretation of SCC, Alternatives 2 and 3 are the best.

There is a reduced chance of litigation because the rule is better than only guidance (Alternative 4). If DOE follows the rule in Alternatives 2 and 3, which have already gone through the public process, there should be very little chance for litigation.

Alternatives 2 and 3 would not introduce new uncertainties; a new rule would follow a careful study which would not introduce new uncertainties. These (Alternatives 2 and 3) would be by far the best for preventing schedule delays.

Alternative 2 or 3 would prevent schedule delays the best, because, if we have enough information and a defensible probabilistic approach with consensus on the numbers, then we should not have any delay. There will be no alternate interpretations. This analysis does not say whether it's achievable or not. Also, we may have to expend more resources to do it, but the delay would be least. We could expend resources simultaneously in a crash program and so time may not necessarily be the most even though expenditure of resources may be great.

D.2.2.2 High Score: Reduces Uncertainties

There is a higher level of confidence if guidance is in the rule. With quantitative rules when changes are made you are basically stating what completeness means, and therefore DOE would have to go off the bank to not be complete. The more prescriptive you are, the less likely the application would be incomplete. Alternative 3 is rated a little higher than Alternative 2 because by putting it into the design criteria, which is where the waste package is being designed, there's more specificity there as they affect what the barriers are than there is in the performance objectives. DOE knows more clearly what the requirements are, so we are more likely to get it. It is possible with a change of language that new uncertainties would be introduced. After doing an SRA, it's possible that something that you did not anticipate could get into the rule. The more quantitative you get, there is less of a chance for new uncertainty. By putting the guidance into the rule, it specifies it to the degree that it lessens the degree that it could be litigated. Everyone will have it and see it up front.

Alternatives 2 and 3 are best because they are both prescriptive with least uncertainty of interpretation.

D.2.2.3 High Score: Decreases NRC Level of Effort Needed for Litigation and Compliance Determination (Clearer DOE Submittal)

Alternatives 2 and 3 will more likely result in us getting what we are looking for in the application. In a prescriptive rule NRC is telling DOE more precisely what we want to get in the

application. We have already decided what we are going to get in the application if we are prescriptive in a rule.

The more freedom the applicant has, the more our level of effort. With a quantitative rule, the applicant has less freedom, and the less our level of effort.

D.2.2.4 High Score: Facilitates Public Acceptance By Reducing Program Slip and Assurance of Conservative Design

A prescriptive rule should assure a conservative design. If DOE meets the requirement of our rule the design will be conservative.

A thorough ventilation of the issues through the rulemaking process would give the public a lot more confidence that it was conservative rather than allowing "wiggle room" for DOE with the perception attached to guidance.

Alternatives 2 and 3 have less possibility for litigation after the application has been received, because we have had all the litigation before the application is submitted. What's the potential that the litigation for these rules would go on for 20 years before we would get the rule? Litigation is the only factor which would affect the schedule, in terms of discriminating between any of the alternatives. But litigation would not likely impact the schedule in the 'prior' period, only in the period after receipt of the application. Alternatives 2 and 3 have the potential for greatest impact on schedule before submittal, if the litigation goes to court. Alternatives 2 and 3 have the highest potential for eroding public confidence if litigation erodes public confidence, which has historically been the case.

Litigation could potentially increase public confidence. In practice, this has not happened in the past.

With Alternatives 2 and 3 there would be high-visibility rulemaking affecting confidence: we would be changing the rule and it would appear that we do not know what we're doing.

D.2.2.5 Score Low: Results in Loss of NRC Flexibility

SCC is a piece of the puzzle. There was concern by NRC that EPA was too prescriptive, and it may be inconsistent for us to be prescriptive only for one part of the puzzle. If we put in the numbers, the burden of compliance is lifted from DOE, and they have more resources to do it.

If we went to a quantitative rule (we have never done anything like this before), we would be putting values in a rule early on before we really understand what may even be remotely achievable for any site (in this case Yucca Mountain). Actually plugging in numbers, given all the things we do not know about, is almost setting us up for another rule change in the future if we find that the number we put in early is wrong. A number put in the rule early puts the burden on us. Our rule is supposed to be generic. Can we do it generically? If we assume that we will put the numbers in, we may have to change them later because it's too stringent when we apply a generic rule to Yucca Mountain. The number may be so low that the applicant may never be able to comply with it. We do not have a good enough handle on it to go to a rulemaking. Compliance with such a rule chosen early on may not be achievable at any site. Alternatives 2 and 3 have a lot of risks associated with them. One such risk is that it would affect the schedule. If the rule is not implementable, amendment later would affect the schedule. If you have guidance via Alternative 4, you will have the flexibility to fit the rule to the site.

D.2.2.6 Score Low: Results in Level of Effort Increase, Due to Rulemaking

Alternatives 2 and 3 are about the same. They would put the burden on us. Since the rule tells DOE what to do, all they have to do is follow the recipe. It would require a lot of time to do it in the first place, and if it has to be redone it would require even more time. NRC would have to show that the numbers demonstrated by DOE comply with the rule. The greatest level of effort would be for Alternatives 2 and 3, because we would have to do rulemaking and choose the numbers to put in the rule and provide the technical basis for the numbers.

D.2.2.7 Miscellaneous

Alternative 3 ranks higher than Alternative 2 because, if you put the guidance in the design criteria, you're not affecting whether or not the design is meeting the performance objectives. It is better to put guidance in the design criteria rather than in the performance objectives. For Alternative 3, you could still get an argument that "we can show you we designed to this." Note that there are many ways to demonstrate the performance objective, but in the design criteria DOE must show how they specifically met the design criteria. If it's a possibility that there will be a litigable issue over design, you will not reduce the scope as much by Alternative 2 as with 3. If a rule change is in the design criteria, SCC language would still appear in performance objectives. One assumption is that, under Alternative 2 (performance objective location for guidance), you give them leeway to design to meet the performance objectives. Another assumption is that, if you put the guidance in Alternative 3 (design criteria), essentially you have met the performance objective if you have met the design criteria. In performance objectives, Alternative 2 gives more flexibility to NRC as to what design met the performance objectives than Alternative 3. Is there a realistic distinction between Alternative 2 and Alternative 3? How feasible technically will it be for DOE to come in with different designs to meet the performance objectives?

A design requirement could be more prescriptive than a performance requirement, but the assumption is that the requirement would be the same, just located in a different place in 10 CFR Part 60.

D.3 NEED FOR FLEXIBILITY

Once we take away the flexibility and we're locked into an option, then, if we're wrong, we're blown out of the water. The longer we retain flexibility, the greater the chance the guidance will be good.

The "after receipt of application" period is clearly more important than before the application is received because it is a statutorily-based time period. We are constrained in time and resources. We have very little flexibility after the license application has been submitted. We have a finite pool of resources. In contrast there is a lot of flexibility in pre-licensing. As a result, reducing the scope for litigable issues is more important than any of the others. If there are fewer issues to be debated we will have a greater probability of meeting the schedule. If there is disagreement between DOE and NRC on the meaning of SCC, it could mean additional tests and analyses which could affect the schedule. For a first of a kind program you must be able to adjust guidance to make sure it is implementable. We as well as DOE have got to have a flexible program because these things have not been done before. What seems like a good idea now may not work as well in practice.

Future things could change and force us to change, but we must concentrate more on what is now on hand. Flexibility could be within our control, but it could be outside our control. For example, Congress could tell NRC to make changes.

Any alternative would not eliminate flexibility, and it's not as important as reducing the uncertainty. If you could not get the flexibility, it would still be preferable to reduce the uncertainty than retain flexibility. If we expect something, it's fair to avoid the "get me another rock" syndrome. Also, if we give complete guidance, we will know what we want to see. If we tell them how to comply, the level of effort will be less since we will not have to review a new and different approach. To reduce effort, you need to get a clear and concise submission, which will reduce the level of effort. Freedom to demonstrate compliance could be diametrically opposed to reducing the level of effort.

If there is no alternate interpretation of SCC and information is complete, even though you may have an accepted contention, it should be fairly easy and efficient to resolve. Allowing the applicant freedom could actually cause NRC to expend more resources; i.e., it could be a negative influence. The applicant may come in with something that we have not considered. If there's a range of options to demonstrate compliance we will have to consider that range of options. The more flexibility DOE has on demonstrating compliance the more time will be spent by our staff.

Flexibility is next most important (to reducing uncertainty in determination of compliance with respect to do-ability). If you have a good rule and have reduced uncertainties, completeness of information and guidance should not be a problem. And, if there is a problem, the flexibility is available to modify the position as necessary. Flexibility would have been a good choice as an attribute for other objectives too.

We need flexibility but, more importantly, we want a complete application, so we need to give DOE as much information as possible. You want to have complete information, but you do not want a rule so prescriptive that you need to make, for example, a showing that only, say, 2 drops can get through. Flexibility is much more important.

Allowing the applicant freedom of how compliance is demonstrated is the next best way of saving resources (next to reducing the scope of litigable issues) required to evaluate the application because you put the burden of compliance on the applicant as opposed to the staff devising a way to determine compliance.

Minimizing resources is more important before the application comes in, because you will have no flexibility to maneuver after the license application comes in. At that point you have to have everything set up and ready to go. It's not clear that you can just throw more people at the problem of compliance determination, so you will have had to have done the planning in the pre-application period.

Of least importance is flexibility, because the more flexible we are the less clear we will be in the recipe for compliance determination. In fact, we do not want to be flexible. Flexibility is not going to make compliance determination easier to defend.

The more freedom DOE has, the harder our job will be.

From the aspect of flexibility, changes are most likely to be needed in quantitative guidance. Alternative 2 may be less flexible by putting numbers in the performance criteria. There's less baggage

with Alternative 3 than with Alternative 2, because only the design objectives (not performance objectives) would be affected.

From past practice it appears that the public never thinks we are tough enough. Is there any difference in public perception whether or not the guidance is in a rule? Does the public want our flexibility reduced so that they have a clear understanding of what our job is and what guidance we are giving? Maximizing our flexibility (Alternative 4) gives a moving target and results in least public confidence, even though the overall guidance would be the same for any of the four alternatives. On the other hand, rule changes also tie our hands with respect to what we can require. With respect to public confidence, schedules will take a back seat to safety.

The applicant must have freedom of how to demonstrate compliance, because NRC otherwise would take on the burden of compliance to show that the method will comply with NRC requirements. If NRC is less prescriptive, it lies with DOE to demonstrate that the method complies with NRC requirements. If we are very rigid, we are very likely to need to defend the rule. But this would occur during rulemaking, so such contention would have to occur before the application is received. If we give them the numbers in a prescriptive rule, DOE will have to address a narrow range to comply with. Completeness of information from DOE as a result will be less than it would have been if the rule had been less prescriptive.

D.4 ACCEPTANCE REVIEW VERSUS LICENSING REVIEW

In relation to the licensing review, the acceptance review is important only in that the license review can not proceed until the acceptance review is complete. The license application review (LAR) would probably be fairly extensive in that we would need to know that "it's all in there." The acceptance review means the information to determine whether or not it's correct is in there, in other words whether or not the LA is complete.

We were supposed to ensure completeness of information before we accept the application. ASSUMPTION is that we will not accept it unless the application is complete, but there may be some little gap during evaluation of the application that we discover after the application has been docketed. The acceptance review only ensures that the application is complete and acceptable for docketing, even though it may be technically wrong or not acceptable. If we do our job with guidance before the application comes in, there should be no surprises due to alternate interpretation of SCC. It is expected that a common interpretation of SCC will be had by DOE and NRC before docketing.

We must first of all have clear in our minds what we expect of DOE, and, if we proceed without having a clear concept, we will have problems. If we reduce uncertainty in determination of compliance, everything else falls into place. An efficient review requires that we reduce the uncertainty as much as we can.

D.5 RATIONALES FOR DECISIONS — IMPORTANCE OF PERIOD PRIOR TO DOCKETING LICENSE APPLICATION VERSUS AFTER

We will have more people involved in reviewing in the "after" period and resources spent will be greater then.

The period of time after the application has been docketed is more important, weakly, because it's statutorily mandated. The statute could be changed however. Pre-application, there is plenty of time to do the work.

For Objective 1 (meeting the schedule), the period after we receive the application is much more important than before. It's a much more forgiving process before the license application comes in, because there is no hard and fast 3-year deadline to meet and no focused visibility on NRC before the application is submitted.

It's critical that, when we get to the hearing, people know that the standard is clear and the information is there. In order for DOE to give us something that is clear and to the point, they have to know what they are supposed to design and they have to be able to do it.

To minimize effort to implement the alternative over time, the period before receipt of the application is more important. Therefore, it is more important to spend staff time and spend it efficiently in the front. (This response is not to be misconstrued that more resources should be expended after the application comes in. The preferred choice would be an alternative that would be resource-intensive before rather than resource-intensive after. Spending resources efficiently is not the same as to minimize resources, which could be incorrectly construed as "do not do rulemaking but just give guidance.")

The less uncertainties after the application comes in, the less resources NRC will have to expend reviewing the application or in hearing time. Less contentions or less complex contentions will require less technical and legal staff and licensing board staff. Even though the application is easy to understand, there could still be a dispute over whether it is the right approach or whether the facts demonstrate compliance. Litigable issues are going to cost quite a bit. If you can reduce the scope of contentions with fewer or less complex contentions there's a big possibility of saving resources.

There's much more importance on the "post-receipt of application" than on the "before," for public acceptance.

Time should not be an obstacle to preclude us from giving good guidance. We have to put in more level of effort before the application is received, to avoid problems which otherwise would occur after the application is submitted. The ramification of not giving DOE our best shot in time is that we could be held responsible for holding up the schedule. If you have a good alternative, which is understood by all parties, it will reduce schedule delays. To control NRC resources most effectively, it is more important to control them in the period before the license application is received. If we give good guidance before the license submittal in sufficient time for DOE to look at it, and if DOE works on a good defensible position, we would have no problem to look at it during review.

The period of time after the application is received is more important than before, because meeting the three-year period is most important. To do so you must have a complete record and reduce the issues litigable. As long as the record is complete you can determine compliance regardless of how prescriptive the regulation is. Least important is whether interpretation of SCC is very prescriptive or very flexible.

It is more important to prevent the delay during the period after the application is submitted (to meet the statutory deadline) than afterwards, because we have never done this and we will have many good reasons for delay and we can share responsibility with DOE for delays before the application is

docketed. Afterwards, we will have less rationale for a delay and we have the sole responsibility for the delay.

D.6 RATIONALES FOR DECISIONS — GENERAL COMMENTS

Assumption is that content of guidance is the same for each of 4 alternatives; the only difference is the location of the guidance.

This exercise appears to be something that could be generically applied to any rulemaking at NRC, in that the degree of rulemaking (from technically explicit through gradations to no rulemaking) could be applied to a number of rulemaking issues.

The same guidance, even the same words, would be in each of the alternatives; the difference is in where the guidance would appear. The primary difference among the 4 alternatives is how binding the guidance would be. DOE's not going to change the technical program they are pursuing; it would more or less stay the same no matter which alternative we pursue. The only effect would be how they take their results to argue compliance with our requirements. They will not run tests significantly longer or shorter as a result of us choosing any of these alternatives. Most of DOE's time will be spent on testing, etc., as opposed to preparing documents for the application. With Alternative 4, there would still remain a potential for schedule delays, because it's not binding, and DOE may not follow the guidance. But that would not impact DOE's schedule. The assumption is that the guidance would be as complete as it could be, regardless of the alternative. Each of these alternatives are about the same. The guidance would still be there. DOE is likely to follow any guidance we issue, within the constraints of what we issue as being logical, etc.