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Repository Operational Criteria Analysis

Prepared by
J. P. Hageman, A. H. Chowdhury

Center for Nuclear Waste Regulatory Analyses

Prepared for
U.S. Nuclear Regulatory Commission

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ABSTRACT

The objective of the "Repository Operational Criteria (ROC) Feasibility Studies" (or ROC task) was to conduct comprehensive and integrated analyses of repository design, construction, and operations criteria in 10 CFR Part 60 regulations, considering the interfaces and impacts of any potential changes to those regulations. The study addresses regulatory criteria related to the preclosure aspects of the geologic repository. The study task developed regulatory concepts or potential repository operational criteria (PROC) based on analysis of a repository's safety functions and other regulations for similar facilities. These regulatory concepts or PROC were used as a basis to assess the sufficiency and adequacy of the current criteria in 10 CFR Part 60. Where the regulatory concepts were same as current operational criteria, these criteria were referenced. The operations criteria referenced or the PROC developed are given in this report. Detailed analyses used to develop the regulatory concepts and any necessary PROC for those regulations that may require a minor change are also presented. The results of the ROC task showed a need for further analysis and possible major rule change related to the design bases of a geologic repository operations area, siting, and radiological emergency planning.

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

Page

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

Page

TABLE OF CONTENTS (Cont'd)

Page

TABLE OF CONTENTS (Cont'd)

Page

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

Page

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

Page

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

Page

LIST OF TABLES

No. Page

EXECUTIVE SUMMARY

The Center for Nuclear Waste Regulatory Analyses (CNWRA) conducted a task entitled "Repository Operational Criteria (ROC) Feasibility Studies" (or ROC task) to determine the potential need for operational phase (preclosure) guidance development related to 10 CFR Part 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories." The ROC task consisted of a three-activity program: (l) development of regulatory concepts or potential repository operational criteria (PROC) for identification of the sufficiency and adequacy of the preclosure regulations in 10 CFR Part 60 by comparing current regulations with the regulatory concepts or PROC; (2) refinement of any needed PROC developed in Activity 1 and categorization of these criteria in terms of technical significance and requirement of further analysis; and (3) analysis of the more technically significant regulatory concepts of Activity 2 to develop the rationale for potential regulatory uncertainty reduction recommendations.

The ROC task has a goal to be comprehensive and integrated. Comprehensiveness was achieved by compiling a complete list of ROC Topics for analysis, within the scope of the ROC task. For all the Topics, a complete set of regulatory concepts or PROC was prepared to permit integration of various aspects among several ROC Topics, and integration of all the criteria (current and potential) was considered essential. If criteria were suggested (such as a different definition of "important to safety" or potential radiation accident siting or planning criteria), the impacts of such suggestions were addressed in each applicable ROC Topic.

This report presents the results of ROC task Activities 1 and 2, conducted to identify the sufficiency and adequacy of the current preclosure regulations in 10 CFR Part 60. The ROC task began with a review and assessment of the CNWRA "Repository Functional Analysis" (RFA) to determine its completeness and applicability to the ROC task. The RFA was a resource for initial consideration of repository operations, but it was not intended to cover the full scope of the ROC task. The ROC task included not only repository functions but also other areas such as definition of terms and preclosure site investigations related to operations. Thus, the scope of the ROC task was developed by a comprehensive listing of areas needed to analyze the sufficiency and adequacy of the current regulations relevant to the ROC task.

During Activity 1, a group of selected technical and regulatory analysts compiled a preliminary list of ROC Topics, which was then compared to several regulations (10 CFR Parts 2, 20, 50, 51, 60, 61, 72, and 100, and 30 CFR Part 57) relevant to geologic repository operations as a check of the comprehensiveness of the list. These ROC Topics were then expanded and subdivided by identification of their elements. Each ROC Topic was analyzed to develop regulatory concepts which were used to assess the adequacy and sufficiency of the current operational criteria or to develop PROC.

For Activity 2 the ROC Topics were reviewed, commented on, and categorized by technical significance and, thus, the need for further ROC analysis in Activity 3. These reviews and comments resulted in 43 ROC Topics, which were then categorized into four major areas: (1) Category 1: Routine Guidance; (2) Category 2: Specific Guidance; (3) Category 3: Minor

Rule Change (Category 1, 2, and 3 required no further ROC task action); and (4) Category 4: Major Rule Change.

Twenty-six ROC Topics were determined to be in Category 1, and only routine guidance was deemed necessary. The background information obtained for these Topics will be useful for further development of the routine-guidance documentation to be issued, such as the planned final "Format and Content Regulatory Guide" and "License Application Review Plan." One ROC Topic was placed in Category 2, eleven in Category 3, and five in Category 4. For those ROC Topics in Category 2 or 3, where special guidance or a minor rule change may be necessary, potential guidance or regulatory text was presented along with supporting rationale. In Category 4, four of the five Topics were related to the Design Basis Events major rulemaking, and the remaining one was related to the Radiological Emergency Planning major rulemaking. The results of the ROC task to date indicate that the current regulations in 10 CFR Part 60 are sufficient and adequate with the exception of those ROC Topics which may require a major rule change.

A summary of the conclusions reached for the ROC Topics is presented in section 2.3 of this report. These conclusions generally found 10 CFR Part 60 to be sufficient and adequate as currently written, with only a few exceptions for those Topics which may require minor rule changes (i.e., Category 3 ROC Topics). Those Topics which may require major rule changes will be further analyzed in Activity 3 of the ROC task.

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ABBREVIATIONS

ALARA	-	As low as is reasonably achievable
ASME	-	American Society of Mechanical Engineers
CFR	-	Code of Federal Regulations
CNWRA	-	Center for Nuclear Waste Regulatory Analyses
DCRDR	-	Detailed control room display review
DOE	-	Department of Energy
DOT	-	Department of Transportation
EBS	-	Engineered barrier system
EIS	-	Environmental Impact Statement
EPA	-	Environmental Protection Agency
EPZ	-	Emergency planning zones
ESF	-	Exploratory Studies Facility
FR	-	Federal Register
GROA	-	Geologic repository operations area
GTCC	-	Greater-than-class C radioactive waste
HLW	-	High-level radioactive waste
HVAC	-	Heating, ventilation, and air conditioning
IAEA	-	International Atomic Energy Agency
ISFSI	-	Independent spent fuel storage installation
LA	-	License application
LLW	-	Low-level radioactive waste
LSS	-	Licensing Support System
MRS	-	Monitored retrievable storage installation
MSHA	-	Mine Safety and Health Administration
NQA	-	Nuclear Quality Assurance
NRC	-	Nuclear Regulatory Commission
NWPA	-	Nuclear Waste Policy Act, as amended
OSHA	-	Occupational Safety and Health Administration
PROC	-	Potential repository operational criteria
QA	-	Quality assurance
RFA	-	Repository functional analysis
ROC	-	Repository operational criteria
SCP	-	Site Characterization Plan
SPDS	-	Safety parameter display system
SRP	-	Standard Review Plan
SSCIS	-	Structures, systems, and components important to safety
TP	-	Technical position

1 INTRODUCTION

1.1 PURPOSE AND SCOPE OF THIS REPORT

This report presents the results and conclusions of the technical effort performed for Activities 1 and 2 of the Repository Operational Criteria (ROC) Feasibility Studies, hereinafter referred to as the ROC task. The scope of the effort for Activities 1 and 2 included the following aspects:

- The ROC task was limited to the radiation safety considerations of design, construction, and operations of the high-level radioactive waste (HLW) geologic repository operations area (GROA) until the preclosure period ends and until the license to receive and possess radioactive material is terminated, and does not address postclosure performance.

- Areas applicable to the ROC task identified from the "Repository Functional Analysis" (RFA) (Ref. 1) and additional areas such as definitions, preclosure site investigations, design criteria, and construction criteria were considered in development of a list of ROC Topics for further analysis. The list of developed ROC Topics is presented in Section 2.2. This list was organized to present the ROC Topics in the same general order as the current regulatory format in Title 10, Code of Federal Regulations, Part 60 (10 CFR Part 60), "Disposal of High-Level Radioactive Wastes in Geologic Repositories."

- Regulatory concepts or potential repository operational criteria (PROC), used to evaluate, group, and categorize the ROC Topics, were developed to analyze the current preclosure regulations of 10 CFR Part 60. Any needed PROC and their supporting rationale were refined and documented and the Topics categorized as to the need for further ROC task actions. The rationale for those ROC Topics determined to need no changes in the current regulations of 10 CFR Part 60 was also documented in this report.

1.2 GENERAL DISCUSSION OF THE REPOSITORY OPERATIONAL CRITERIA (ROC) FEASIBILITY STUDIES

The ROC task had a goal to be comprehensive and integrated. Comprehensiveness was achieved by developing a complete list of Topics within the scope of the ROC task. Integration was achieved by presenting regulatory concepts and any necessary PROC addressing each ROC Topic. Integration of all the criteria (current and potential) was essential to best assure regulatory adequacy and sufficiency. If criteria were suggested (such as a different definition of "important to safety" or PROC for radiation accident siting and planning), the impacts of such suggestions were addressed in each related ROC Topic.

The ROC task was conducted by the Center for Nuclear Waste Regulatory Analyses (CNWRA) to provide a comprehensive and systematic approach to determine the need for additional guidance, regulatory concept development, or PROC for 10 CFR Part 60. The first draft of the ROC task was presented in a preliminary CNWRA Intermediate Milestone Report dated April 25, 1991 (unpublished report). The ROC task consisted of three activities, and this report addresses the first two. All three activities for the ROC task are given in the "CNWRA FY92-93 Operations Plans for the Division of High-Level Waste Management" (Ref. 2) and are outlined as follows.

- Activity 1 reviewed the "Repository Functional Analysis" (RFA) (Ref. 1), which identified "safety functions" associated with ROC and resulted in a comprehensive list of potential ROC Topics. An analysis of the ROC Topics [presented in CNWRA Intermediate Milestone Reports No. 20-3702-026-113 and -123, both dated March 27, 1991 (Ref. 3 and 4)] by comparing other relevant regulations and developing elements associated with each ROC Topic was performed. This established the bases for regulatory concepts and PROC for specific Topics or subtopics. The regulatory concepts or PROC were compared to the current regulations in 10 CFR Part 60 to assess the relative sufficiency and adequacy.

- Activity 2 categorized the Topics according to their technical significance and requirement for further ROC task analysis. The regulatory concepts or PROC were further analyzed and refined through a joint review effort with the U.S. Nuclear Regulatory Commission (NRC). Details of the Activity 2 work plan were presented in CNWRA Intermediate Milestone Report No. 20-3702-026-213, dated August 1, 1991 (Ref. 5).

- Activity 3 will analyze the more technically significant regulatory concepts along with the text of other applicable regulations and criteria to further develop the rationale and suggested recommendations for potential major rulemakings for 10 CFR Part 60.

2 SPECIFIC TECHNICAL AND REGULATORY TOPICS

The ROC task addressed both repository operational safety functions and other areas such as definition of terms, preclosure site limitations, license amendment, and license termination. To provide a systematic method of analysis, it was necessary to build upon the CNWRA "Repository Functional Analyses" (RFA) (Ref. 1) and develop a comprehensive list of subjects or topics, called ROC Topics, that would address the potential areas within the scope of the ROC task. Development of the ROC Topics was to assure that the ROC task was comprehensive and covered all criteria relevant to repository design, construction, and operations in order to assess the sufficiency and adequacy of relevant sections of 10 CFR Part 60.

Details of the process and rationale for developing the ROC Topics are addressed in the March 1991 CNWRA Intermediate Milestone Reports (Ref. 3 and 4). The Topic development process was performed by a group of analysts, who used their technical and regulatory experience to develop a comprehensive listing. The preliminary list of Topics was then compared to several regulations (10 CFR Parts 2, 20, 50, 51, 60, 61, 72, and 100, and 30 CFR Part 57) as a check for any additional Topics that could apply to the operation of a geologic repository. The initial list of ROC Topics was reported in the April 1991 CNWRA Intermediate Milestone Report (unpublished report) and later revised in Activities 2 and 3. The rationale for this approach was that it helped to assure the Topics would be comprehensive (i.e., cover all aspects of the ROC task) and it checked for completeness by comparison to several regulations relevant to geologic repository operations.

2.1 ROC TOPIC CATEGORIZATION

The ROC Topics were reviewed, commented on, refined, and categorized to identify and eliminate redundant or unnecessary items, resulting in 43 ROC Topics. The guidance used to categorize the ROC Topics was presented in the August 1991 CNWRA Intermediate Milestone Report (Ref. 5). This review process essentially provided a peer review of the preliminary results of the ROC task.

The 43 ROC Topics were categorized in four areas:

- *Category 1* - The current regulatory criteria are adequate and sufficient to ensure safety, and no further ROC task analysis is required; therefore, each of these ROC Topics will need only routine guidance developed. This guidance will be in relation to demonstration and determination of compliance and is anticipated to be achieved in planned documents such as the NRC's planned final "Format and Content Regulatory Guide" or "License Application Review Plan."

- *Category 2* - The current regulatory criteria are adequate and sufficient to ensure safety, but it may be desirable to provide additional guidance to assure compliance with a particular regulatory topic. The type of additional guidance is yet to be planned.

- *Category 3* - The current regulatory criteria are adequate and sufficient to ensure safety, but a minor rule change may be desirable to enhance a specific item in the current regulations.

- *Category 4* - The current regulatory criteria may need to be changed because the need for rulemaking has been documented by specific reservation in 10 CFR Part 60; a notice of proposed rulemaking has been issued; the need for rulemaking has been approved by the NRC's Executive Director for Operations; or there is significant likelihood of not providing sufficient or adequate criteria to assure radiation safety, retrieval, and GROA activities that impact containment and isolation. Analysis, development, and documentation of a coordinated regulatory basis are determined to be necessary and beneficial for the current regulatory criteria.

Of the 43 ROC Topics, 26 were placed in Category 1 - Routine Guidance, and only need to be addressed by routine guidance. These 26 ROC Topics are presented in section 4. Even though no further ROC task actions are necessary, the background information and details for these ROC Topics will be useful for routine guidance documentation, such as the NRC's planned final "Format and Content Regulatory Guide" and "License Application Review Plan."

One ROC Topic, presented in section 5, was determined to be in Category 2 - Special Guidance, and may have a need for some guidance such as a technical or staff position. Eleven ROC Topics, presented in section 6, were in Category 3 - Minor Rule Change, and may have a need for potential minor rulemaking. The ROC Topics placed in Categories 1, 2, and 3 do not require any further ROC task analysis. Five ROC Topics, presented in section 7, were determined to be in Category 4 - Major Rule Change. These Topics may have a need for potential major rulemaking and will receive further detailed analysis in ROC task Activity 3.

2.2 CROSS REFERENCE OF 10 CFR PART 60 TO THE ROC TOPICS

Table 1 gives a list of ROC Topics related to the corresponding sections of 10 CFR Part 60. The Topics in Table 1 were listed in the same general order as the current 10 CFR Part 60 format. If a regulatory citation included all the subsections of the citation, for example, 10 CFR 60.131(b)(1 through 10), the citation is simply listed as 10 CFR 60.131(b).

Table 1 - **RELATION OF CURRENT 10 CFR PART 60 REGULATIONS TO THE ROC TOPICS**

Section of 10 CFR Part 60	ROC Topic Title	Report Section
2	Definitions	7.4
9	Employee Protection	4.1
21 and 51	Planning and Description Requirements	4.2
21(c)(5), 21(c)(10), 31(a), 43(b)(1), 43(b)(3), 43(b)(6), 51(a)(2)(ii), 71, 75(b), 101(b), 113(b)(2), and 135(b)(4)	Inventory Control	4.3
21(c)(6), 32, 42, 43, Subpart H, and Subpart I	Licensing Conditions, Technical Specifications, or License Specifications	4.4
3, 4, 6, 7, 9(c)(1), 10(a), 15(a), 21, 22, 23, 24, 31, 32, 33, 41, 42, 43, 44, 45, 46, 51, 52, 63, 73(b), 73(c), and Subpart F	Licensing, License Amendment, and License Termination	6.1
42	Imposed Backfitting	4.5
2, 21(c)(1)(ii)(D), 21(c)(15)(vi), 51(a)(2), 51(a)(4), 101(a)(2), 102(b)(2), 111(a), 111(b)(2), 112, 113(a)(1), 133(a)(1), 133(a)(2), 133(c), 133(d), 133(e)(2), 133(f), 133(g)(3), 133(h), 134, 140(a)(2), and 142	Backfilling, Sealing, and Monument Erection	4.6
2, 21(c)(11), 21(c)(15)(vi), 52(a), 52(c)(1), 52(c)(2), 132(d), and 132(e)	Decommissioning	4.7
42(b)(1), 42(b)(2)	Violations	4.8
4, 10, 18, 21(c), 22, 24, 31(b)(1), 32(b), 44(b), 51(a), 71, 72, 73, and 152	Records and Reports	6.2
102(b)(3), 102(b)(4), 131, 132, 133, and 135(d)	Waste, Other Than HLW, for Disposal at the Repository	4.9

Table 1 - RELATION OF CURRENT 10 CFR PART 60 REGULATIONS TO THE ROC TOPICS (Cont'd)

Section of 10 CFR Part 60	ROC Topic Title	Report Section
102(d) and 111(b)	Extended Operations During a Post-Emplacement, Pre-retrieval, Preclosure "Prolonged Holding Period"	4.10
111(a)	Safety Performance Objectives	7.1
2, 21(c)(12), 46(a), 46(b), 111(a), 111(b), 112, 113, 131, 132, and 133	Retrieval, Removal, and Relocation	6.3
21(b)(3), 21(b)(4), 21(c)(8), 21(c)(13), 21(c)(15)(vii), 24, 31, 32, 41, 43(b)(5), 46(a)(3), 51(a)(2), 121, 122(a)(2), 122(c)(1), 122(c)(2), 122(c)(17), 122(c)(18), and 122(c)(19)	Land, Water, and Resource Ownership, Use, and Control	4.11
2, 21(c)(1), 21(c)(2), 21(c)(3), 113(a)(2), and 122	Potential-Site Disqualifying Conditions	4.12
2, 21(c)(1), 102(c), 122, 130, 141(a), 141(b), and 141(d)	Preclosure Site Investigations	5.1
122	Siting Criteria	7.3
131, 132, and 133	Design Bases and Criteria	7.2
21(a), 21(c)(12), 31(a), 31(c), 131(b)(10), 132(a), and 132(d)	Receipt and Shipment	4.13
21(c)(2), 21(c)(3), 21(c)(5), 21(c)(6), 21(c)(14), 21(c)(15), 31(a)(1), 31(a)(6), 111(a), 131(b)(4)(ii), 131(b)(5), 131(b)(8), 132(a), 132(e), 133(e), and 152	Preclosure Interfaces	4.14
31(a)(6), 44(a)(1)(ii), 44(b), 46(a)(5), and 152	Operating Procedures	4.15
131(b)(3), 131(b)(4)(ii), 133(a)(2), 135(b), and 135(c)(3)	Fire and Explosion Protection	4.16

Table 1 - RELATION OF CURRENT 10 CFR PART 60 REGULATIONS TO THE ROC TOPICS (Cont'd)

Section of 10 CFR Part 60	ROC Topic Title	Report Section
21(c)(1)(ii)(E), 21(c)(15)(v), 131(b)(4)(ii), 131(b)(5), 131(b)(6), and 131(b)(8)	Utilities, Communications, Emergency Lighting, and Instrumentation	4.17
21(c)(15)(iv), 21(c)(15)(v), 21(c)(15)(vi), 43(b)(6), 44, 74, 75, 111(a), 130, 131(a)(2), 131(a)(6), 131(b)(6), 132(a), 133(e)(1), 137, 140, 141, 142, 143, 152, and 161	Inspection and Testing	4.18
21(c)(15)(v), 131(a)(2), 131(b)(6), and 161	Maintenance	4.19
43(b)(6), 131(b)(3)(iv) and 131(b)(7)	Criticality Control	4.20
75(c)(3), 130, 131(b)(9), 132(a), 132(c), and 133(e)	Mining and Industrial Safety and Hazards	6.4
2, 21(b)(4), 21(c)(1)(ii)(C), 21(c)(1)(ii)(D), 21(c)(1)(ii)(E), 21(c)(2), 21(c)(14), 23(c), 43(b)(4), 46(a)(5), 46(a)(7), 51, 72(b), 74, 102, 113(b)(2), 122(a)(1), 130, 131, 132, 133, 135(a), 135(b)(3), 135(b)(4), 140(a)(2), 140(b), 140(d)(4), 142, 143, Subpart F, and Subpart G	Design of the GROA for Containment of HLW within the Waste Package and Limiting the Release Rate from the Engineered Barrier System (EBS)	6.5
15(c), 112, 133, 134, 140, 141(c), 141(d), and 142	Design of the GROA so that the Isolation Capabilities of the Seals for Shafts and Boreholes Are Not Adversely Affected	6.6
2, 15(c), 17(a)(2)(iii), 17(a)(2)(iv), 21(c)(1)(i)(F), 21(c)(1)(ii)(A), 21(c)(1)(ii)(C), 21(c)(1)(ii)(D), 21(c)(1)(ii)(F), 21(c)(2), 21(c)(5), 21(c)(6), 21(c)(15)(vi), 31(a)(1), 43(b)(3), 102(d), 111(a), 112, 130, 131, 132, 133, 134, 140(d)(1), 141, and 142	Design of the GROA To Not Adversely Affect Containment and Isolation	6.7

Table 1 - RELATION OF CURRENT 10 CFR PART 60 REGULATIONS TO THE ROC TOPICS (Cont'd)

Section of 10 CFR Part 60	ROC Topic Title	Report Section
2, 21(c)(3), 102(e)(1), 111, 131, 132, 133(a), 133(c), 133(e), and 135	Waste and Waste Package Protection and Waste Containment for Preclosure Reasons	4.21
21(c)(7), 21(c)(15)(v), 74(a)(3), 111(a), 131(a), 131(b)(5)(iii), and 132	Preclosure Radiation Monitoring	6.8
None	Computational and Software Capabilities	4.22
2, 15, 21(c)(1)(ii)(E), 21(c)(3), 46(a)(1), 111, 112, 113, 131(b), 133, 134, 140, 141, and 142(c)	Access and Emplacement Stability	6.9
111(a), 131(a)(1), 131(a)(4), 131(a)(6), 131(b)(9), 132(b), 132(c), 132(a)(2), and 133(g)	Ventilation	4.23
2, 43, 44, 74(a), 74(b), 111(b), 131(b)(1), 133(a), 133(b), 133(c), 133(d), 133(e), 133(f), 133(g), and 133(i)	Performance Confirmation for Preclosure Performance Objectives and Design Criteria	6.10
2, 15(c)(4), 15(d)(1), 17(a)(2)(v), 18(d), 21(c)(14), 24(b)(1), 31, 32(b), 42(b)(3), 74, 111(b), 131(b)(6), 131(b)(8), 132(c)(2), 137, 140, 141, 142, 143, 151, 152, and 153	Design, Construction, and Operation of the GROA Necessary To Ensure that Performance Confirmation for the Postclosure Performance Objectives Can Be Conducted	6.11
21(c)(4), 31(a)(3), 44, 71, 75, 150, 151, and 152	Quality Assurance	4.24
21(b)(3), 21(b)(4), 21(c)(8), 21(c)(10) 31(b), 41(c), 43(b)(5), 46(a)(3), 71(b), 75(c)(3), and 135(b)(4)	Preclosure Security and Safeguards	4.25
21(c)(15), 31(a)(4), 43(b)(6), 152, 160, 161, and 162	Personnel	4.26
Subpart I	Radiological Emergency Planning	7.5

2.3 SUMMARY OF CONCLUSIONS BY TOPIC

The conclusions for the ROC Topics and their subtopics are presented below. The order of presentation is the same as the order of the Topics following section 3 (e.g., 4.1 through 4.26, 5.1, and 6.1 through 6.11). There are no conclusions for the section 7 ROC Topics because these may require major rule changes and further analysis is required.

- **Employee Protection - Section 4.1 ROC Topic**

10 CFR Part 60 is sufficient and adequate because it is directly based on the statutory requirements for employee protection and has language that will provide for employee protection needed to ensure health and safety, common defense and security, and environmental protection.

- **Planning and Description Requirements - Section 4.2 ROC Topic**

Plans and descriptions are sufficiently and adequately addressed in 10 CFR 60.21 and 60.51 for a HLW repository. The general requirements in 10 CFR 60.21 and 60.51 appear to be similar to those for a nuclear power facility, a monitored retrievable storage installation (MRS), or an independent spent fuel storage installation (ISFSI) with regard to the types of plans and descriptions necessary in the license application. These requirements are meant to give general guidance to the applicant concerning the content of the application, and are not intended to be all-inclusive or to go into extensive detail for the plans and descriptions of all aspects of a geologic repository. The completion of the planned final "Format and Content Regulatory Guide" by the NRC should provide additional guidance necessary for the Department of Energy (DOE).

- **Inventory Control - Section 4.3 ROC Topic**

(1) What To Inventory. 10 CFR 60.71(b) and 60.43(b)(6) are broadly written to include all "specifications" about high-level waste that are necessary to ensure that preclosure and postclosure performance objectives are met and, thus, 10 CFR Part 60 was determined to be sufficient and adequate.

(2) Inventory Process. A physical inventory may be an implied part of an inventory control program, which is already required by 10 CFR 60.71(b) and 60.43(b)(6). Physical inventory may be considered to be a process or method of the inventory program used to help assure the reliability of the nuclear material control (inventory) and accounting program. Therefore, 10 CFR Part 60 appears sufficient and adequate. Also, 10 CFR Part 60 does not need to reference 10 CFR 74.31, because 10 CFR 74.31(a) specifically excluded its application to waste disposal.

- **Licensing Conditions, Technical Specifications, or License Specifications - Section 4.4 ROC Topic**

The license conditions and specifications of 10 CFR 60.42 and 60.43 are adequate and sufficient because they are generally written and could address any and all conditions or specifications that may be needed in a license to assure radiation safety, retrieval, containment, and isolation.

- **Imposed Backfitting - Section 4.5 ROC Topic**

It is possible for the NRC to impose backfitting during repository construction, operation, and closure because of statutory provisions.

- **Backfilling, Sealing, and Monument Erection - Section 4.6 ROC Topic**

(1) Preclosure Seals and Backfill. The design criteria for preclosure seals and backfill (those used during the preclosure period) are addressed sufficiently and adequately in 10 CFR Part 60. Backfilling is addressed in 10 CFR 60.111(b)(2) with regard to maintaining retrievability up to permanent closure, and in 10 CFR 60.142(a) and 60.142(c) with respect to performance confirmation monitoring of backfill and seals. More detailed criteria, with regard to preclosure sealing and preclosure backfilling, than are currently in 10 CFR Part 60 appear inappropriate, since the potential overlapping functions of preclosure and postclosure performance must be recognized. For instance, early backfilling could assist in stabilizing the underground openings and limiting additional fracturing. However, it could complicate inspection, monitoring, and retrieval. The relative weighing of advantages and disadvantages to preclosure seals and preclosure backfill during operations is likely to be site-specific and medium-specific, for example, fundamentally different in salt as compared to tuff.

(2) Monuments. Monument erection during permanent closure is sufficiently and adequately addressed in 10 CFR 60.51(a)(2) because it is broadly written. The design, location, and spacing of monuments are likely to be highly site-specific and, therefore, more detailed criteria would appear inappropriate.

- **Decommissioning - Section 4.7 ROC Topic**

(1) Decontamination or Dismantlement. Criteria in 10 CFR Part 60 for decontamination or dismantlement are adequate and sufficient. 10 CFR Part 60 requires DOE's license application to include plan(s) for decontamination or dismantlement of surface facilities [10 CFR 60.21(c)(15)(vi)]. These plans must be implemented before DOE can apply for an amendment to terminate the license [10 CFR 60.52(c)(2)]. Also required in the license application is a description of design considerations that are intended to facilitate decontamination or dismantlement of surface facilities [10 CFR 60.21(c)(11)] according to the design criterion set forth in 10 CFR 60.132(e).

Regarding total dismantlement of all surface facilities, the NRC believes that this may be unnecessary and overly restrictive. The NRC decided to allow decontamination *or* dismantlement. The site will have monuments erected to discourage illegal human occupancy and intrusion after permanent closure to protect public health and safety. The controlled area of the geologic repository is not intended to be prepared to such an extent that it can be released for unrestricted use after termination of the license. These requirements, therefore, for decontamination or dismantlement of surface facilities are adequate and sufficient.

(2) Removal of LLW from Decontamination or Dismantlement. Criteria in 10 CFR Part 60 regarding removal of LLW resulting from decontamination or dismantlement are adequate and sufficient. Removal of LLW is an integral part of decontamination or dismantlement and would be included in the NRC approved plans, and it will have to be completed before DOE can apply for an amendment to terminate the license [10 CFR 60.52(a)]. Also, LLW resulting from decontamination or dismantlement is secondary waste, and the criteria in 10 CFR 60.132(d) would apply. Before the NRC will approve the amendment to terminate the license, DOE will have to demonstrate that removal of the decontamination and dismantlement LLW has been made in conformance with the DOE's plan. It appears that removal of LLW resulting from decontamination or dismantlement is fully covered by the current regulatory language.

- **Violations - Section 4.8 ROC Topic**

(1) Enforcement of Regulations and Other Relevant Requirements. The current 10 CFR Part 60 concerns only violations that are serious enough to result in license amendment, suspension, modification, or revocation through the application of 10 CFR 60.42(b)(1). Existing statutes provide for civil and criminal penalties related to HLW disposal, which is a licensed activity of NRC. 10 CFR Part 60, in conjunction with the Congressional statutes, is sufficient and adequate for dealing with violations related to licensing actions.

(2) Employee Protection. See the section 4.1 ROC Topic.

- **Waste, Other Than HLW, For Disposal at the Repository - Section 4.9 ROC Topic**

(1) Disposal, Handling, and Storage of Radioactive Wastes, Other Than HLW. 10 CFR Part 60 adequately and sufficiently addresses safe handling, storage, and disposal of any radioactive wastes. The safe storage, handling, and disposal of any radioactive wastes, other than HLW, are subject to the same safety criteria as HLW. Note: Application of all the safety criteria to "other than HLW" may be necessary because these wastes are hazardous and will require safe handling. Some radioactive waste [such as greater-than-class C (GTCC)] may even be more hazardous than HLW because the GTCC waste may have a more concentrated and total radioactive material inventory than HLW that has decayed for numerous years.

(2) Nonradioactive Wastes. Some of the wastes at the GROA may be nonradioactive hazardous waste. This hazardous waste will not be controlled by the NRC because it is not within the statutory jurisdiction of NRC. Controls for handling hazardous materials that could cause "secondary effects" are addressed in the section 6.4 ROC Topic.

- **Extended Operations During a Post-Emplacement, Pre-Retrieval, Preclosure "Prolonged Holding Period" - Section 4.10 ROC Topic**

Criteria related to a prolonged holding period are sufficiently and adequately addressed by 10 CFR 60.111(b). Such a period is not disallowed by 10 CFR 60.102(d). Also, the concepts for a prolonged holding period are easily understood without a specific definition or time period explicitly stated.

- **Land, Water, and Resource Ownership, Use, and Control - Section 4.11 ROC Topic**

(1) Land Ownership, Use, and Control. Regulations for the activities pertinent to land ownership, use, and control are adequate and sufficient because they are broadly written to encompass any aspects of land ownership, use, and control. In this area, 10 CFR Part 60 has more detailed criteria than for other facilities regulated by other Parts of Title 10 of the Code of Federal Regulations.

(2) Water and Resource Ownership, Use and Control. Regulations for the purposes of the GROA pertinent to water and resource ownership, use, and control are adequate and sufficient because they are broadly written to encompass any aspects of water and resource ownership, use, and control. In this area, 10 CFR Part 60 has more detailed criteria than for other facilities regulated by other Parts of Title 10 of the Code of Federal Regulations.

- **Potential-Site Disqualifying Conditions - Section 4.12 ROC Topic**

(1) Human-Induced Hazard Considerations
(2) Natural Hazard Considerations

For both subtopics potential-site disqualifying conditions related to preclosure operations of a geologic repository are not recommended for addition to 10 CFR Part 60 because safety is assured by requiring that the design and operations (together with the site characteristics) assure that the performance objectives are met. Also, there appear to be several preclosure and postclosure potential-site disqualifying conditions in DOE's 10 CFR Part 960 regulations, which have been concurred in by NRC. This does not imply that some type of guidance on specific design/site limitations is unnecessary.

- **Receipt and Shipment - Section 4.13 ROC Topic**

(1) Siting Considerations. No operational criteria are recommended because the scope of the ROC study is limited to criteria needed for the operational aspects of the GROA. The concept concerning the impact on the public and the environment before the HLW reaches the GROA is related to an analysis of the environmental impact of the repository (outside the GROA), and to overall programmatic considerations for HLW storage, processing, and transportation.

(2) Treatment of Waste for Offsite Shipment. The text contained in 10 CFR 60.132(d) is clearly applicable to the treatment of radioactive waste generated at the GROA (secondary radioactive waste). This is sufficient and adequate to address safe treatment of any secondary radioactive waste generated at the site, and its final disposition, because it is broadly written.

(3) Preparation for Waste Transport or Receipt. 10 CFR Parts 60 and 71 contain sufficient and adequate criteria which address preparation of HLW for receipt or transport. 10 CFR Part 60 addresses operations that would be involved in HLW shipping, if necessary, as part of retrieval operations.

(4) Common Activities Related to Receipt and Shipment. Inspections are covered by the section 4.18 ROC Topic. Inventory control is covered by the section 4.3 ROC Topic. Use of personnel for receipt and shipment is covered by the section 4.26 ROC Topic.

- **Preclosure Interfaces - Section 4.14 ROC Topic**

(1) Integration of Design, Construction, and Operation. The current regulations sufficiently and adequately address integration of design, construction, and operation in 10 CFR 60.21(c)(2), 60.31(a)(1), and 60.31(a)(6) and in 10 CFR Part 50, Appendix B-III.

(2) Human Factors. The requirements for human factors engineering and reliability analysis are sufficiently and adequately addressed in 10 CFR 60.21(c)(2)(iv), 60.21(c)(3), 60.21(c)(6), 60.21(c)(14), and 60.131(b)(8) and in 10 CFR Part 50, Appendix B-III.

(3) Control-Room Facilities. Design criteria for a control room or control area are sufficiently and adequately addressed in 10 CFR 60.131(b)(8).

(4) External Interfaces. The criteria relevant to external interfaces are sufficiently and adequately addressed in 10 CFR Part 60 and its referenced regulations.

(5) Internal Interfaces. 10 CFR Part 60 has sufficient and adequate criteria for design of structures, systems, and components important to or associated with safety to ensure that interfaces are considered, by referencing 10 CFR Part 50, Appendix B.

- **Operating Procedures - Section 4.15 ROC Topic**

10 CFR Part 60 contains criteria regarding procedures in 10 CFR 60.31(a)(6) and more detailed criteria referenced by 60.152 in 10 CFR Part 50, Appendix B that are sufficient and adequate. Also, any operational procedure is an implied part of the design of a facility, and the existing design criteria are adequate for radiation safety.

- **Fire and Explosion Protection - Section 4.16 ROC Topic**

(1) Effects of Fires and Explosions. Fires and explosions have a high potential for producing damaging effects during preclosure operations. Preclosure issues are sufficiently and adequately addressed by the criteria of 10 CFR 60.131(b)(3).

(2) Effects of Suppression Systems. The preclosure impact of fire suppression systems is sufficiently and adequately addressed in 10 CFR 60.131(b)(3)(iv).

Within both subtopics, the use of "features important to isolation" refers to the effects that heat and/or suppression agents can have on the waste package or the geologic setting in which the waste package is emplaced. In a similar manner, the use of "other control features" refers to the effects that fire and explosion may have on those features needed to protect the workers and that may cause secondary effects.

Note: In regard to isolation, which is beyond the scope of the ROC analysis, the postclosure impact regarding fire and explosion suppression systems may need to be enhanced. This is because the use of suppression systems and the resulting impact on the engineered barriers or surrounding rock by some materials, including water that can alter geochemistry or corrode waste packages, may not be addressed. If, for example, a waste container were emplaced in an area that had been sprayed, the corrosion process might be enhanced as compared to an area free of the effects of fire or explosion suppressant.

- **Utilities, Communications, Emergency Lighting, and Instrumentation - Section 4.17 ROC Topic**

(1) Utility Service Testing. 10 CFR 60.131(b)(5)(ii) and 60.131(b)(8) are adequate and sufficient to ensure testing of those utilities important to safety. This is assumed to include utilities which support instruments that monitor structures, systems, and components important to safety (SSCIS) and emergency lighting associated with the safe operations of SSCIS.

(2) Utility Services. 10 CFR 60.131(b)(5), 60.131(b)(8), and 60.21(c)(1)(ii)(E) are adequate and suff. nt regarding utility syster . nd instrumentation and control systems.

- **Inspection and Testing - Section 4.18 ROC Topic**

(1) Inspection and Testing To Ensure Reliability and Safety. The current criteria in 10 CFR Part 60 are sufficient and adequate regarding inspection and testing to ensure reliability and safety.

(2) Inspection and Testing for Information Gathering for Performance Confirmation. The current criteria in 10 CFR Part 60, Subpart F, and 10 CFR 60.137 regarding inspection and testing for information gathering for performance confirmation are sufficient and adequate because they broadly address the performance confirmation criteria.

(3) Inspection and Testing Records. See the section 6.2 ROC Topic.

(4) Inspection and Testing by NRC or for NRC. The current criteria in 10 CFR Part 60 regarding inspection and testing by NRC or for NRC are sufficient and adequate because the applicable sections are broadly written.

(5) Access Engineering for Inspection and Testing. The current criteria in 10 CFR Part 60 regarding access engineering are sufficient and adequate because 10 CFR 60.131(b)(6), 60.131(a)(2), and 60.137 require that the SSCIS be designed to permit safe inspection and testing, that such activities be facilitated, and that the GROA be designed to permit performance confirmation.

- **Maintenance - Section 4.19 ROC Topic**

(1) Personnel, Planning, and Procedures. Criteria for training and certification of maintenance personnel, who are considered to be part of the operating personnel, are sufficiently and adequately addressed in 10 CFR 60.161, because they are broadly written. Maintenance plans for the GROA are adequately addressed in 10 CFR 60.21(c)(15)(v) because it is broadly written.

(2) Design to Permit and Facilitate Maintenance. The criterion in 10 CFR 60.131(b)(6), which requires designing to permit periodic inspection, testing, and maintenance as necessary to ensure continued functioning and readiness, is adequate and sufficient. Removal of the word "periodic" might make the regulation appear broader but is not essential. Design to facilitate maintenance is adequately and sufficiently addressed in 10 CFR 60.131(a)(2), which requires the design of equipment for ease of repair and replacement to limit the time required to perform work in the vicinity of radioactive materials.

(3) Facilities and Equipment for Maintenance. Facilities and equipment for maintenance are sufficiently and adequately addressed in 10 CFR 60.21(c)(15)(v) as part of the plans for maintenance because the choice of needed facilities and equipment is related to how to assure maintenance.

- **Criticality Control - Section 4.20 ROC Topic**

(1) Consistency with Other Regulations. The criteria for criticality control in 10 CFR Part 60 are sufficient and adequate because they are consistent with the intent of the regulations for other fixed site facilities and because similar concepts about fixed site criticality control are used in the other regulations, despite differing texts.

(2) Factors Considered for Criticality Control. 10 CFR Part 60 adequately addresses the preclosure period of a repository because the conditions for that time period are uniquely addressed, and methods used for criticality control are adequately addressed because of the reference to k_{eff}.

Note: Because of the longer time period for postclosure criticality control, the criteria in 10 CFR 60.131(b)(7) may need to be examined further.

- **Waste and Waste Package Protection and Waste Containment for Preclosure Reasons - Section 4.21 ROC Topic**

(1) Waste Package Design for Preclosure Containment and Retrieval. The criteria in 10 CFR Part 60 are adequate and sufficient to address the design of the waste package for preclosure containment and retrieval if the waste package is considered to be part of the GROA and is important to safety.

(2) Waste and Waste Package Protection for Preclosure Containment. Criteria related to the design of the GROA to ensure protection of the waste and waste package are adequately and sufficiently addressed by 10 CFR Part 60, since safe handling and storage imply protection by containment.

(3) Waste Package Protection for Retrieval. Criteria for the design of the GROA to ensure protection of the waste package for retrieval are adequately and sufficiently addressed by 10 CFR Part 60, since safe handling and storage apply to any preclosure activity.

(4) Containment Facilities. 10 CFR Part 60 adequately and sufficiently addresses waste containment prior to the insertion of unpackaged spent fuel or other HLW into waste packages because waste containment is part of repository operations and is thus required to meet the performance objectives for the preclosure period.

- **Computational and Software Capabilities - Section 4.22 ROC Topic**

10 CFR Part 60 sufficiently and adequately addresses the criteria for any associated computational and software capabilities for repository operations. Operational computer and software capabilities for accounting, monitoring, testing, projection, record-keeping, data analysis, and decision making are perhaps the current trend and future development for operations. However, they are not indispensable, and they address a method to achieve an

objective rather than what objective is to be achieved. The performance objectives and design criteria for the GROA are included in 10 CFR Part 60. Any structures, systems, equipment, and components used in the GROA must meet the appropriate performance objectives and design criteria. If the licensee chooses to apply robotics and automation, the selected components would include computer and software capabilities. These components must be in compliance with the applicable performance objectives and design criteria.

- **Ventilation - Section 4.23 ROC Topic**

(1) Underground Ventilation Separation. 10 CFR 60.133(g)(3) sufficiently and adequately addresses the need for separate ventilation for the underground facility. The existing design criteria are intended to provide further protection to the workers in the excavation area. Some leakages between the excavation and emplacement areas are likely. However, these leakages should be minor if separate ventilation is maintained. Therefore, the consequence of the leakages would be minimal and well within the performance objectives of 10 CFR 60.111(a).

(2) Ventilation Design. 10 CFR Part 60 has criteria that sufficiently and adequately address design of ventilation to control effluents and airborne exposures to workers and the public.

(3) Ventilation for Retrieval. 10 CFR Part 60 sufficiently and adequately addresses criteria for use of ventilation during retrieval.

- **Quality Assurance - Section 4.24 ROC Topic**

10 CFR Part 60 has sufficient and adequate criteria for quality assurance which are equivalent to the criteria established for nuclear power plants and for an MRS because 10 CFR Part 60 references 10 CFR Part 50, Appendix B. The current criteria are appropriate and are sufficient for quality assurance related to meeting the performance objectives.

- **Preclosure Security and Safeguards - Section 4.25 ROC Topic**

(1) Security and Safeguards. 10 CFR Part 60 is sufficient and adequate regarding preclosure security and safeguards because it requires certification and description of security and safeguards proposed by DOE.

Note: Requirements for other facilities, including those operated by DOE, in other Parts of Title 10 of the Code of Federal Regulations are much more detailed, and may require more detailed information in the license application.

(2) Sabotage Affecting Long-Term Performance. 10 CFR Part 60 is sufficient and adequate, since a description of DOE's physical security plan against radiological sabotage is a requirement.

(3) Application of Relevant Portions of 10 CFR Part 73. The current criteria in 10 CFR 60.21(b)(3) and 60.21(b)(4) are sufficient and adequate because DOE has experience with comparable facilities. The current criteria in 10 CFR 60.21(b)(4) are broadly written to address sabotage unique to a GROA.

(4) Security Plans. The current criteria in 10 CFR 60.21(b)(3) and 60.21(b)(4) are sufficient and adequate to require physical security plans.

- **Personnel - Section 4.26 ROC Topic**

(1) Personnel Qualification. 10 CFR Part 60 has addressed personnel qualification adequately and sufficiently in 10 CFR 60.21(c)(15)(iii) and Subpart H. These regulations are general and thus require qualifications and training requirements for all personnel conducting activities at the GROA.

Note: Training of offsite personnel for radiological emergencies will be addressed in the section 7.5 ROC Topic.

(2) Personnel Training Program, Facilities, and Equipment. 10 CFR Part 60 has adequate and sufficient criteria for a training program for the GROA and SSCIS because the requirement in 10 CFR 60.151 is general and includes training and certification of personnel for all operations, not just those important to safety.

(3) Organization, Administration, and Management. Criteria in 10 CFR Part 60 addressing organization, administration, and management are adequate and sufficient, because 10 CFR 60.21(c)(15)(i), 60.21(c)(15)(ii), 60.43(b)(6), and 10 CFR 50, Appendix B, require a description of the applicant's operating organization, delegation of responsibility and authority, and identification of key personnel.

(4) Use of Qualified Personnel. 10 CFR 60.162 adequately and sufficiently assures that the physical condition and the general health of personnel certified for operations important to safety will not endanger the public health and safety. This includes plant personnel.

- **Preclosure Site Investigations - Section 5.1 ROC Topic**

(1) Regulatory Organization. 10 CFR Part 60 has general guidance for assessment of the site for preclosure design. The regulatory criteria in 10 CFR 60.21(c)(1) require a description of the site assessments for design of the GROA investigations, which is general in nature, and would fully address any needed preclosure site investigations. However, experience to date suggests that the applicant may need more specific guidance in addition to the 10 CFR Part 60 criteria.

10 CFR 60.122 sets forth specific siting criteria applicable to the postclosure performance objectives, but does not address site investigation criteria for either preclosure surface or underground facilities.

(2) Human-Induced Hazard Considerations

(a) **Population Density and Proximity.** This subtopic will be considered in the section 7.3 ROC Topic.

(b) **Aircraft and Test-Missile Hazards.** Criteria for investigation and assessment of aircraft and missile hazards are not specifically addressed in 10 CFR Part 60. Guidance criteria may be needed because the location of a HLW repository, in areas of low population, may also be desirable for air and missile test ranges.

(c) **Induced Seismicity.** Criteria for investigation and assessment of induced seismicity for preclosure design are not specifically mentioned in 10 CFR Part 60, and guidance may be needed. Tunneling in hard rock can cause induced seismicity in the form of rock bursts and yielding of faults to regional strain. Induced seismicity can also result from fluid injection/withdrawal, construction of dams and reservoirs, and nuclear testing. Such induced earthquakes appear not to have exceeded magnitudes of 6.5 and, more likely, are much smaller in magnitude.

(d) **Industrial and Transportation Accident.** Criteria for investigation and assessment of industrial and transportation accidents for preclosure siting and design are not specifically mentioned in 10 CFR Part 60, and guidance may be needed. For large industrial facilities, which pose a secondary hazard, affected areas may extend to 40 or more miles. Highways and railways are not precluded from crossing the GROA. There is no specific mention of pipelines, which could carry potentially flammable or explosive materials.

(3) Natural Hazard Considerations

(a) **Seismic Magnitude and Frequency.** Investigations for seismic magnitude and frequency are specifically mentioned in 10 CFR 60.122 for postclosure objectives. However, no descriptions of required investigations are given; nor are the differences in acceleration expected at the surface and at depth discussed in 10 CFR Part 60. Because it is assumed that surface facilities must be located near HLW repository underground facilities, flexibility in siting criteria may be needed. Existing site investigation criteria for other nuclear facilities may be generally inappropriate because of this factor. Also, with respect to nuclear power plants, a repository has no similar pressure and high-temperature heat source capable of dispersing nuclear waste into the biosphere. However, because a statistically significant sample of seismic data is needed to assess recurrence rates of earthquakes, an investigative radius is proposed as potential guidance criteria. It must be sufficiently large to develop a statistically significant earthquake recurrence to enable development of a credible design specification. Faults that could produce 0.1g at the site must be investigated for their earthquake generation capability.

(b) **Soil and Rock Properties.** 10 CFR Part 60 does not specifically address investigation of soil and rock properties for preclosure concerns. Soil and rock properties related to foundations for HLW repository surface facilities are important. Consequently, potential guidance criteria may be needed.

(c) **Volcanism.** The large open areas of the Western U.S. that may be potentially suitable for repository siting are sometimes sites of volcanism. There is no mention of related preclosure site investigations in 10 CFR Part 60, perhaps because volcanism is so rare that the need for investigations is not obvious. Guidance criteria for investigation of volcanism may be required for some sites.

(d) **Fault Displacement.** A potential guidance criterion is suggested for the investigation of fault displacements that could affect the safety function of tunnels, shaft, ramps, or waste emplacement boreholes.

(e) **Groundwater.** 10 CFR 60.122(c)(20) applies only to postclosure performance objectives. Guidance criteria for groundwater conditions that require unusual engineering solutions for design of the GROA may be needed.

(f) **Surface Water.** 10 CFR 60.122 applies only to postclosure performance objectives. Flooding of the GROA is also a preclosure performance concern, and guidance criteria may be needed.

- **Licensing, License Amendment, and License Termination - Section 6.1 ROC Topic**

(1) Site Characterization, License Application, Updates, and Amendments. 10 CFR Part 60 is adequate and sufficient for addressing issues related to licensing, license updates and amendments, and license termination for a high-level radioactive waste repository. One potential exception may be in 10 CFR 60.24(a) where further specific guidance may be necessary. The need for further specific guidance will be determined at a future date.

(2) Use of References. 10 CFR Part 60 may be enhanced in regard to the use of references, as suggested by the NRC Staff. A change to 10 CFR 60.23 was suggested to clarify the subject of referencing to eliminate repetition and the reference to the "environmental report" versus the "environmental impact statement."

- **Records and Reports - Section 6.2 ROC Topic**

  (1) **Quality Assurance Records and Reports**
  (2) **License Activity Records and Reports**
  (3) **Nuclear Materials Records and Reports**
  (4) **Radiation Records and Reports**
  (5) **Licensing Support System Records**

For all five subtopics 10 CFR Part 60, in regard to criteria for records and reports, is adequate and sufficient for ensuring safety, except for minor criteria regarding public document rooms (see 10 CFR 60.22). 10 CFR Part 60 establishes criteria for reports and records which are equivalent to, and in most cases are identical to, those established for nuclear power plants and for other radioactive waste handling facilities.

- **Retrieval, Removal, and Relocation - Section 6.3 ROC Topic**

(1) Definitions Relevant to Retrieval

(a) **Retrieval and Removal Definitions.** The definition of retrieval in 10 CFR 60.2 includes the word "removing"; consequently, no separate formal definitions for "removal" and "retrieval" are required. The definition of retrieval in 10 CFR 60.2 may not appear wholly consistent with 10 CFR 60.21(c)(12). 10 CFR 60.21(c)(12) may imply that the term "retrieval" is limited to cases in which the geologic repository is proven to be unsuitable for disposal of radioactive waste. Many reasons can be envisioned for which removal following emplacement might be desired, ranging from simple visual inspection to identification of package manufacturing problems.

(b) **Definition of "substantially increase the difficulty of retrieving."** The phrase "substantially increase the difficulty of retrieving" is within the context of a particular site and design. Because of the site-specific and design-specific nature of "increased difficulty," engineering judgment should be sufficient to determine what constitutes a substantial increase in difficulty. NRC may present more guidance following the submittal of a license application and design.

(2) Ventilation Relevant to Retrieval. The current regulations concerning ventilation apply to retrieval because if retrieval were necessary, it would be a repository operation.

(3) "Facilitate" Versus "Not Preclude" Waste Retrieval. The criteria to maintain retrievability are sufficiently and adequately addressed in 10 CFR Part 60. Concerning the point on whether the repository is to be designed to permit waste retrieval, or only that the design must not preclude waste retrieval (i.e., not make retrieval impossible), the NRC intent appears to indicate that the GROA is to be designed for waste retrieval, not simply that retrieval is not precluded or made impossible. The degree of difficulty in retrieval does not appear to be an NRC concern as long as the design allows retrieval in a reasonable time frame. A concern to NRC is that there is a plan for retrieval and that the design allows for retrieval to be accomplished during a defined retrieval period.

(4) *Criteria To Be Satisfied During Retrieval.* 10 CFR Part 60 is adequately clear that all regulations applying to operations apply to retrieval because retrieval is a potential repository operation.

(5) *Emergency Retrieval.* No criteria appear to be needed for rapid or emergency retrieval because the repository design, site investigation, and performance confirmation are all aimed at ensuring a suitable site and repository design; and any need for retrieval on a rapid schedule is extremely unlikely and would be precluded prior to emplacement.

(6) *Demonstration of Retrievability.* The criteria to design for retrievability are in the present 10 CFR Part 60 regulations. Criteria concerning how and when to demonstrate retrieval will depend upon the site-specific and design-specific features for a particular repository and should be in the nature of guidance.

- **Mining and Industrial Safety and Hazards - Section 6.4 ROC Topic**

(1) *Secondary Effects and Design Considerations.* Ensuring that the design of the GROA addresses secondary effects of mining and industrial safety (or lack of safety) that could adversely affect radiation control is implied in 10 CFR 60.132(a) and 60.133(e)(1). This is implied when "safe handling" and "safety" are understood to mean that there should be protection against any worker injuries or events that would give rise to a radiation accident.

(2) *References to Safety Regulations.* The references to specific mining regulations in 10 CFR 60.131(b)(9) are outdated. The regulatory criteria could address safety regulations or standards that should not have a secondary effect on structures, systems, and components important to safety and radiation control, considering the design-specific characteristics of the GROA.

- **Design of the GROA for Containment of HLW within the Waste Package and Limiting the Release Rate from the Engineered Barrier System (EBS) - Section 6.5 ROC Topic**

(1) *Waste Package and EBS Components Handling and Emplacement.* An uncertainty in 10 CFR 60.131(b)(10) concerns the degree of specificity in "shaft conveyances," since regulations in 10 CFR Part 60 are intended to apply generically. 10 CFR Part 60 does not appear to address transfer of waste regarding potential adverse effects on containment.

(2) *Waste Package and EBS Components Inspection, Testing, and Repair.* 10 CFR Part 60 is sufficient and adequate regarding waste package inspection, testing, and maintenance (repair or replacement) to ensure postclosure containment. 10 CFR Part 60 is adequate and sufficient because the waste package is a component important to safety, and is addressed by 10 CFR Part 60 in 60.131(b)(6) and Subparts F and G.

(3) Waste Package and EBS Components Security and Identification. See the section 6.7 ROC Topic.

(4) Waste Package and EBS Components Environment. 10 CFR Part 60 is sufficient and adequate for criteria for the underground-facility waste-package environmental control and protection for postclosure containment. Also, see the section 6.7 ROC Topic.

(5) Coordination of Waste Package and EBS Components Design, Construction, Assembly, and Repair with the GROA. 10 CFR Part 60 has sufficient and adequate criteria concerning coordination of the GROA with the waste, waste package, and EBS regarding postclosure performance.

- **Design of the GROA so that the Isolation Capabilities of the Seals for Shafts and Boreholes are not Adversely Affected - Section 6.6 ROC Topic**

(1) Design and Construction that Impact Postclosure Performa[illegible]. The current regulations in 10 CFR Part 60 have requirements (10 CFR 60.112) for constr[illegible] (excavation, drilling, boring) of shafts (ramps) and boreholes in the GROA as well as for th[illegible] underground facility [10 CFR 60.133(e)(2), and 60.133(f)]. It is assumed that the present regulatory requirements on sealing for shafts and boreholes (10 CFR 60.134) would imply recognition of the significance of the rock surrounding the seals on performance of the overall seal system.

(2) Operations that Impact Postclosure Performance. See the section 6.7 ROC Topic.

(3) Permanent Closure Activities that Impact Postclosure Performance. See the section 6.7 ROC Topic.

- **Design of the GROA to not Adversely Affect Containment and Isolation - Section 6.7 ROC Topic**

(1) Design and Construction that Impact Containment and Isolation. 10 CFR Part 60 adequately and sufficiently regulates penetrations (i.e., shafts, ramps, and boreholes) into the geologic setting with regard to limiting alterations of the geologic setting that might adversely affect postclosure performance. 10 CFR Part 60 has adequate and sufficient criteria to address the impacts of the underground facility [10 CFR 60.133(a)(1) and 60.133(h)], and site characterization activities [10 CFR [illegible] 15(c)(1)] on postclosure isolation. Design criteria in the overall performance objectives [illegible] 10 CFR 60.112 are adequate and sufficient to ensure that construction activities related to the shafts and boreholes within the GROA do not compromise the isolation capability of the geologic repository. Operational criteria may be needed to enhance 10 CFR Part 60 to ensure that the design of the surface facilities in the geologic repository operations area do not adversely affect containment and isolation.

(2) Operations that Impact Containment and Isolation. 10 CFR Part 60 is sufficient and adequate with regard to ensuring that operational activities do not significantly degrade isolation capabilities within the geologic setting. Operations are assumed to be integral with design and, therefore, the design criteria are applicable to operations. In addition, the performance confirmation criteria are sufficient and adequate in requiring performance confirmation monitoring of the thermal, thermomechanical, hydrologic, and possible geochemical responses of the underground facility as a result of operations to ensure that postclosure performance within the geologic setting can be achieved.

(3) Permanent Closure Activities that Impact Containment and Isolation. 10 CFR Part 60 is adequate and sufficient because permanent-closure activities are considered to be a part of repository operations, and design criteria that require limiting adverse effects on the isolation within the geologic setting are applicable. In this context, the existing operational criteria are sufficient to cover permanent closure activities.

- **Preclosure Radiation Monitoring - Section 6.8 ROC Topic**

(1) Monitoring Direct Radiation Levels. 10 CFR Parts 60 and 20 provide adequate and sufficient criteria regarding monitoring personnel radiation exposure and measuring direct radiation levels in all working areas that may handle or store waste or the waste package.

(2) Monitoring Airborne Concentrations of Radioactive Materials (Restricted Area). 10 CFR Part 20, which is referenced by 10 CFR Part 60, provides criteria for the measurement of airborne concentrations of radioactive material in restricted and unrestricted areas.

(3) Radioactive Effluent Monitoring. 10 CFR Part 60 addresses effluent control and monitoring effluents from the underground facility. 10 CFR 20.1501 specifies under which conditions and events, including radiation accidents, monitoring of radionuclides should be performed.

(4) Radiation Alarms. 10 CFR Part 60 addresses criteria for radiation alarms adequately and sufficiently, in 10 CFR 60.131(a)(6). A minor change to enhance the grammar of 10 CFR 60.131(a)(6) may be needed.

(5) Radiation Surveys. 10 CFR Part 60 adequately and sufficiently addresses radiation surveys because it references 10 CFR Part 20, which has criteria for radiation surveys.

- **Access and Emplacement Stability - Section 6.9 ROC Topic**

(1) Design and Construction To Ensure Stability. The design of openings in the underground facility, which would include the excavation, backfill, and reinforcement, is sufficiently and adequately regulated in 10 CFR 60.133(e), 60.133(f), 60.133(i), and 60.142(c).

(2) Stability for Safe Operations such as Emplacement, Retrieval, and Closure. The criteria in 10 CFR 60.140 and 60.141 (Performance Confirmation Program) are adequate and sufficient to ensure that monitoring is conducted to detect any significant changes in design parameters and assumptions and in subsequent corrective measures as a result of operations within the repository.

- **Performance Confirmation for Preclosure Performance Objectives and Design Criteria - Section 6.10 ROC Topic**

(1) Definition of Performance Confirmation. The definition of "performance confirmation" may be enhanced in order to not appear to exclude addressing performance confirmation related to retrieval performance objective in 10 CFR 60.111(b).

(2) Preclosure Verification of Design for Safety. Verification of the GROA necessary to ensure that the design is adequate for radiation safety is sufficiently and adequately addressed in 10 CFR 60.74(a).

(3) Performance Confirmation Integration. See the section 6.11 ROC Topic.

(4) Performance Confirmation Plans. See the section 6.11 ROC Topic.

(5) Quality Assurance for Performance Confirmation. See the section 6.11 ROC Topic.

(6) Monitoring. See the section 6.11 ROC Topic.

- **Design, Construction, and Operation of the GROA Necessary to Ensure that Performance Confirmation for the Postclosure Performance Objectives can be Conducted - Section 6.11 ROC Topic**

(1) Performance Confirmation Integration. Integration of the performance confirmation program (with respect to postclosure performance objectives) with repository design, construction, and operations is adequately and sufficiently addressed in 10 CFR Part 60. It is clearly the responsibility of the applicant to ensure that design, construction, and operation of the GROA permit the performance confirmation program to be carried out.

(2) Performance Confirmation Plans. It may be an enhancement to 10 CFR Part 60 to require the applicant to provide a description of the performance confirmation program in the license application. At the present time there is no explicit requirement to submit such a description. 10 CFR Part 60 contains the notion that the performance confirmation program should be planned [see 10 CFR 60.111(b) and 60.140(d)(4)], but has no formal requirement for DOE to submit a performance confirmation program description. Since performance confirmation will be an integral and important part of the construction phase, it would seem appropriate for DOE to submit such a description in the license application for construction

authorization, for review by the NRC.

(3) Quality Assurance for Performance Confirmation. Quality assurance for performance confirmation has been adequately and sufficiently covered because 10 CFR 60.151 cites performance confirmation and 10 CFR 60.152 references 10 CFR Part 50, Appendix B.

(4) Monitoring. Criteria for inspection, calibration, and maintenance of performance confirmation monitoring equipment are adequate and sufficient because 10 CFR 60.151 cites performance confirmation and 10 CFR 60.152 references 10 CFR Part 50, Appendix B.

(5) Adverse Impacts. 10 CFR 60.140(d)(1) adequately and sufficiently addresses criteria related to adverse impact on repository performance when conducting the performance confirmation program. The requirement is understood not to prohibit useful tests that would have trivial impacts upon repository performance, while assuring that significant potentially adverse effects are taken into account in designing the performance confirmation program.

3 FORMAT OF THE INDIVIDUAL ROC TOPICS

Each ROC Topic presented in sections 4 through 6 follows the same format. Subsection 1 presents the conclusions for a given Topic or subtopic. Subsection 2 presents the regulatory concepts, referenced operational criteria or potential repository operational criteria (PROC), and rationale, all of which support the conclusions in subsection 1. Subsections 3 and 4 present background information that formed the bases to develop the regulatory concepts, identify the referenced operational criteria, and develop any necessary PROC and rationale in subsection 2.

Section 7 presents only a brief discussion of the five ROC Topics for which major rulemaking may be required, because they will receive more in-depth analysis in Activity 3 of the ROC task.

4 TOPICS FOR WHICH ROUTINE GUIDANCE IS RECOMMENDED

4.1 EMPLOYEE PROTECTION

There are no subtopics for this ROC Topic.

4.1.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

10 CFR Part 60 is sufficient and adequate because it is directly based on the statutory requirements for employee protection and has language that will provide for employee protection needed to ensure health and safety, common defense and security, and environmental protection.

4.1.2 Concepts, Operational Criteria, and Rationale

This subsection presents concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

Concept. Criteria for employee protection are needed to ensure health and safety, common defense and security, and environmental protection.

Operational Criteria. The operational criteria needed to address the concept are presented in 10 CFR 60.9.

Rationale for the Operational Criteria. 10 CFR 60.9 fully addresses this concept because it is based on the Energy Reorganization Act (Ref. 6), Section 210 (42 USCS 5851), requiring employee protection. 10 CFR 60.9 uses language that addresses what is needed to protect the employee to ensure health and safety, common defense and security, and environmental protection.

4.1.3 Elements Considered for Regulation

4.1.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

Elements related to this ROC Topic are indicated as follows:

- Protection of employees against discrimination for engaging in protected activities
- List of protected activities
- Assurance that employees have thorough knowledge of, and complete freedom to exercise, mechanisms for providing information to NRC

- Assurance that employees have thorough knowledge about their rights to provide information, participate in investigations, and provide testimony without fear of reprisal
- Denial, revocation, or suspension of license or imposition of a civil penalty due to employee discrimination
- Violation of an employee's right to protection which could jeopardize the license
- Posting of Form NRC-3 ("Notice to Employees")
- Location of a legible copy of Form NRC-3
- Posting 30 days after an application is docketed

4.1.3.2 Comments on and Discussion of the Elements Considered for Regulation

The wording in 10 CFR 60.9 appears to be based directly on the statutory language found in the Energy Reorganization Act (Ref. 6), Section 201 (42 USCS 5851) and is comparable to all other cited regulations.

4.1.4 Safety Functions and Regulatory Citations

4.1.4.1 Associated Safety Functions

No safety functions associated with this ROC Topic were identified from the "Repository Functional Analysis" (Ref. 1).

4.1.4.2 Relevant Regulatory Citations

The regulations in 10 CFR 30.7, 40.7, 50.7, 60.9, 61.9, 70.7, and 72.10 are relevant to this ROC Topic.

4.1.4.3 Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations

10 CFR Part 60 covers the concept of employee protection from discrimination related to an employee engaging in protected activities similar to the other regulations that also address employee protection (i.e., 10 CFR 30.7, 40.7, 50.7, 61.9, 70.7, and 72.10). The other cited regulations provide no additional guidance or directives as compared to 10 CFR Part 60. The provisions for employee protection presented in each of the regulations cited above appear to be based on the statutory language found in the Energy Reorganization Act (Ref. 6), Section 210 (42 USCS 5851), entitled "Employee Protection."

4.2 PLANNING AND DESCRIPTION REQUIREMENTS

There are no subtopics for this ROC Topic.

4.2.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

Criteria for plans and descriptions are sufficiently and adequately addressed in 10 CFR 60.21 and 60.51 for a HLW repository. The general requirements in 10 CFR 60.21 and 60.51 appear to be similar to those for a nuclear power facility, MRS, or ISFSI with regard to the types of plans and descriptions necessary in the license application. These requirements are meant to give general guidance to the applicant concerning the content of the application, and are not intended to be all-inclusive or to go into extensive detail for the plans and descriptions of all aspects of a geologic repository. The completion of the planned final "Format and Content Regulatory Guide" by the NRC should provide additional guidance necessary for DOE.

4.2.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

Concept. Criteria are needed to guide the licensee in its submittal of plans and descriptions of the GROA related to radiation control. These criteria should establish the minimum information necessary for the license application.

Operational Criteria. The operational criteria for this concept are presented in 10 CFR 60.21 and 60.51.

Rationale for the Operational Criteria. 10 CFR 60.21 and 60.51 describe the general requirements for what should be included in the license application and Safety Analysis Report.

An uncertainty was initially identified by CNWRA 90-003, Appendix B, page B-7 (Ref. 7) because 10 CFR 60.21 and 60.51 were thought to give insufficient detailed guidance for DOE to prepare a complete license application. However, the NRC staff recommendation for resolution of Uncertainty Reference Number 3, Appendix A, page 4, of the "Recommendations" report (Ref. 8) was for NRC to provide a "Format and Content Regulatory Guide." This format and content guide should provide the necessary guidance for a license application.

Also see the section 6.5 ROC Topic discussion regarding criteria for an updated description of the performance confirmation program in the Safety Analysis Report. These criteria establish minimum information necessary for the licensee to submit to ensure health and safety, common defense and security, and environmental protection.

4.2.3 Elements Considered for Regulation

4.2.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

Elements related to plans and descriptions required for design and construction include:

- Design and performance requirements for structures, systems, and components important to safety (SSCIS)
- Principal design criteria for the GROA
- Construction methods
- Personnel training
- Quality assurance
- Emergency plans

Elements related to plans and descriptions required for operations include:

- Receiving (arrival inspections, demurrage, carrier decontamination, unloading, etc.)
- Storage (surface, underground, retrieved waste, etc.)
- Transfer (intrafacility movements, loading, unloading, hoists, carriers, etc.)
- Emplacement (provisions for access/emplacement holes, plugs/shielding, etc.)
- Receipt and shipment (preparation, loading, inspection, etc.)
- Permanent closure of the repository (backfilling, sealing shafts, boreholes, etc.)
- Decommissioning [decontamination, dismantlement, monument erection, removal of decommissioning low-level waste (LLW), and other aspects of closure]
- Radiation protection [decontamination, effluent control, as low as is resonably achievable (ALARA), 10 CFR Part 20, 40 CFR Part 191, LLW handling, etc.]
- Preclosure radiological monitoring (controlled area, exposure value, etc.)
- Preclosure nonradiological monitoring (security and safeguards, natural conditions and events, industrial hazards and accidents, waste location, etc.)
- Preclosure interfaces (integration of design, construction, and operations, human factors, control room facilities, interfacility interfaces, and intrafacility interfaces)
- Other anticipated operations such as inspection and testing,

maintenance, personnel, operating procedures, quality assurance, fire protection, ventilation, criticality control, utilities, communication, access, and emplacement stability

Elements related to plans for the retrieval of radioactive wastes include:

- Details regarding the condition of the waste (waste identification including age and source)
- Details regarding the proposed techniques for retrieval of the waste (establishment of access)
- Details regarding the preparation of waste for transport (packaging, repackaging, rod consolidation, over-packing, shielding, etc.)
- Details regarding the facilities (equipment, personnel and procedures) required for proposed retrieval of the waste including the preparation of waste for transport
- Details regarding backfilling and sealing after waste removal
- Details regarding the preparation of vehicles to transport the waste for offsite shipment
- Alternative acceptable site where the waste will be stored
- Inventory control in order to comply with full retrieval

Elements related to emergency/contingency plans include:

- Organization for coping with radiation emergencies
- Activation of emergency organization
- Notification procedures
- Communications among principal response organizations
- Assessment action of radiation emergencies
- Development of emergency classifications and action levels
- Establishment of emergency planning zones (EPZ)
- Protective actions for plume exposure pathway
- Maintenance of emergency preparedness
- Emergency facilities and equipment
- Adequate staffing for emergency
- Training, including periodic drill exercises
- Recovery and re-entry plans

4.2.3.2 *Comments on and Discussion of the Elements Considered for Regulation*

The plans and descriptions listed in 10 CFR 60.21 and 60.51 are meant to provide general guidelines as to the information required in the license application. Subsequent Subparts within 10 CFR Part 60 give more specific detailed requirements. (For example, Subpart H deals specifically with training and certification of personnel and specific design criteria for the GROA are addressed in Subpart E). In essence, no further criteria are needed in 10 CFR 60.21 and 60.51, since they appear to provide an extensive list of general requirements for plans and descriptions that appear to be addressed in more detail in subsequent sections of 10 CFR Part 60.

4.2.4 Safety Functions and Regulatory Citations

4.2.4.1 Associated Safety Functions

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

- Plan overall HLW management physical system operations - 1
- Plan nuclear security and safeguards operations - 2.1
- Plan normal security and safeguards operations - 2.1.1
- Plan for security and safeguards contingencies - 2.1.2
- Plan waste preparation operations - 5.1
- Plan normal waste preparation operations - 5.1.1
- Plan for accident/emergency contingencies in waste preparation operations including any unforeseen loss or potential loss of containment in waste preparation facilities - 5.1.2
- Plan for emergency evacuation of workers and the public during waste preparation operations - 5.1.3
- Plan waste preparation facility decommissioning - 5.1.4
- Plan repository operations - 6.1
- Plan normal repository disposal operations - 6.1.1
- Plan for emergency repository operations contingencies including unforeseen loss or potential loss of containment - 6.1.2
- Plan for possible removal of waste from repository and alternative storage - 6.1.3
- Plan for emergency evacuation during disposal operations - 6.1.4
- Plan repository post-emplacement operations - 6.1.5
- Plan repository closure and decommissioning - 6.1.6
- Plan repository postclosure activities - 6.1.7

4.2.4.2 Relevant Regulatory Citations

- 10 CFR 50.34
- 10 CFR 60.21 and 60.51
- 10 CFR 72.24 and 72.28

4.2.4.3 *Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations*

10 CFR 60.21 provides an extensive list of general requirements for plans and descriptions to be included in the license application for disposal of high-level radioactive waste in a geologic repository. This list is similar in nature to the general information required in the content of application for a nuclear power reactor (10 CFR 50.34) and an ISFSI or MRS (10 CFR 72.24, and 72.28). The criteria in 10 CFR 60.21 appear to adequately address all the applicable safety functions listed in subsection 4.2.4.1.

- Plans for normal repository operations, such as construction and emplacement are addressed in 10 CFR 60.21(c)(2), 60.21(c)(15)(iv), and 60.21(c)(15)(v).
- Plans for repository closure and decommissioning are addressed in 10 CFR 60.21(c)(11) and 60.21(c)(15)(vi).
- Plans for security and safeguards operations are addressed in 10 CFR 60.21(b)(3) and 60.21(b)(4).
- Plans for removal of waste from the repository and alternative storage are addressed in 10 CFR 60.21(c)(12).
- Plans for coping with radiological emergencies are addressed in 10 CFR 60.21(c)(9).

10 CFR 60.21 contains many more general requirements for plans and descriptions than those indicated by the safety functions listed in subsection 4.2.4.1. Such additional requirements include descriptions of the site characteristics, design criteria, quality assurance program, and radioactive effluent monitoring program.

4.3 INVENTORY CONTROL

This ROC Topic has the following subtopics:

(1) What To Inventory
(2) Inventory Process

4.3.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) What To Inventory

10 CFR 60.71(b) and 60.43(b)(6) are broadly written to include all "specifications" about high-level waste that are necessary to ensure that preclosure and postclosure performance objectives are met and, thus, 10 CFR Part 60 was determined to be sufficient and adequate.

(2) **Inventory Process**

A physical inventory may be an implied part of an inventory control program, which is already required by 10 CFR 60.71(b) and 60.43(b)(6). Physical inventory may be considered to be a process or method of the inventory program used to help assure the reliability of the nuclear material control (inventory) and accounting program. Therefore, 10 CFR Part 60 appears sufficient and adequate. Also, 10 CFR Part 60 does not need to reference 10 CFR 74.31, because 10 CFR 74.31(a) specifically excluded its application to waste disposal.

4.3.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) **What To Inventory**

Concept. Criteria for the inventory program are needed to address all waste characteristics (type, amount, and specifications) that may impact repository performance.

Operational Criteria. The operational criteria to address this concept are presented in 10 CFR 60.43(b)(6) and 60.71(b).

Rationale for the Operational Criteria. The criteria in 10 CFR 60.43(b)(6) and 60.71(b) are broadly written and include all characteristics of the waste that need to be considered for inventory to assure preclosure and postclosure safety.

(2) **Inventory Process**

Concept. Criteria for records, reports, and administrative control for physical inventory control are needed for wastes not yet emplaced.

Operational Criteria. The operational criteria for records, reports, and administrative controls which are presented in 10 CFR 60.71 and 10 CFR 60.43(b)(6) appear to address this concept.

Rationale for the Operational Criteria. Physical inventory provides a mechanism for assessment and verification of the effectiveness of the nuclear material control and accounting (inventory) program already required by 10 CFR Part 60. It may be implied that a physical inventory is a part of any inventory program. Physical inventory may serve as a warning process for potential problems that may eventually lead to a radiological safety problem if the inventory control program fails. Once waste is emplaced with no foreseeable intent of recovery or movement, physical inventory may be impracticable, serve little purpose, and disturb emplaced barriers. If it is intended that after the waste is emplaced, performance confirmation of the emplacement hole seals will be conducted; this should verify that the waste remains in its final emplacement location. Also, conducting periodic physical inventories may be considered to be one method involved in implementing an inventory program.

4.3.3 Elements Considered for Regulation

4.3.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) What To Inventory

Elements of what to inventory are as follows:

- Disposal package inventory number
- High-level waste material characteristics
  - Type
    - Boiling water reactor spent fuel
    - Pressurized water reactor spent fuel
    - Processed waste
  - Amount
    - Number of spent fuel bundles
    - Number of glass logs
  - Age
    - Age after removal from reactor vessel
    - Effective full power hours of operation
    - Age after last criticality
  - Specifications
    - Thermal characteristics
    - Percent of burnup
    - Curie content
    - Percent of enrichment
    - Amount of fissionable products (U-235, Pu-238, etc.)
    - Spent fuel rod leakage or damage
    - Length, height, weight
    - Consolidated, unconsolidated
    - Radiation dose rate on contact, radiation dose rate at 3 ft. in air, etc.

(2) Inventory Process

Elements of an inventory process are as follows:

- Nuclear material control and accounting program
  - Material control procedure
  - Material accounting procedure

- Limitation of total inventory allowed for preclosure and postclosure safety
- Meet license specification for criticality,
- Meet license specification for radiation dose rates,
- Meet license specification for thermal loads,
- Meet license specification for rock/waste interactions, and
- Meet license specification for waste/geochemistry interactions

• Radioactive waste handling so inventory will track the characteristics of the waste
• Record filing and maintenance/procedure
  - Hardcopy records and maps
  - Computer records and maps
• Emplacement drift numbering/procedure
• Emplacement borehole numbering/procedure
• Disposal package labeling or identification/procedure
• Physical inventory (check of inventory process)

4.3.3.2 Comments on and Discussion of the Elements Considered for Regulation

(1) What To Inventory

For the elements given in subsection 4.3.3.1(1), regulatory requirements 10 CFR 60.21(c)(5), 60.71(b), and 60.135(b)(4) provide the bases for disposal packages control and 10 CFR 60.21(c)(5), 60.71(a), 60.71(b), 60.31(a)(1), 60.43(b)(3), 60.51(a)(2)(ii), and 60.113(b)(2) provide the bases for nuclear material type, amount, and specifications.

(2) Inventory Process

Other than the requirements for a description (1) of the kind, amount, and specification of radioactive material to be received and possessed and (2) of a nuclear material control and accounting program to be included in the license application, 10 CFR Part 60 does not explicitly require the implementation of a control and accounting program. However, a number of requirements, including 10 CFR 60.43(b)(1), 60.43(b)(3), 60.113(b)(2), and 60.71(b) implicitly require that inventory control should be exercised so that an accurate account of the kind, amount, age, and nature of the radioactive material received, possessed, and disposed of, and a complete history of the movement of the waste, from the shipper through all phases of storage and disposal, can be obtained. Inventory control can be carried out effectively through the implementation of a nuclear material control and accounting program as described in the license application. The above-mentioned four regulatory requirements are believed to provide guidance and incentive for DOE to utilize a control and accounting program for HLW inventory. There is, therefore, no need to include a separate requirement in 10 CFR Part 60 for such an application.

Processes listed in subsection 4.3.3.1(2), except the procedure for physical inventory, are required to ensure that the program for material control and accounting can function. 10 CFR 60.21(c)(5) indicates the need for a material control procedure and material accounting procedure, and limiting inventory for preclosure and postclosure safety is a license specification as required by 10 CFR 60.43(b)(1). The bases for a high-level radioactive waste packaging procedure, and emplacement drift and borehole numbering procedures can be inferred from 10 CFR 60.71(b). Utilization of a disposal package labeling or identification procedure ensures compliance with 10 CFR 60.135(b)(4). A record filing and maintenance procedure is related to 10 CFR 60.51(a)(2)(ii), 60.71(a), and 60.71(b). Physical inventory is a means to ensure the accounting program is working properly. A requirement for a physical inventory process is not found in 10 CFR Part 60.

4.3.4 Safety Functions and Regulatory Citations

4.3.4.1 Associated Safety Functions

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

(1) What To Inventory

- Account for and maintain inventories of nuclear materials in the waste management system - 2.10
- Inventory waste disposal package components in lag storage - 5.5.3
- Apply unique waste disposal package identification - 5.8.12
- Limit initial radionuclide inventory - 7.2.1.1
- Limit total quantity of emplaced waste - 7.2.1.1.1
- Control age of emplaced waste - 7.2.1.1.2

(2) Inventory Process

- Account for and maintain inventories of nuclear materials in the waste management system - 2.10
- Update inventory of waste disposal package components received for waste preparation operations - 5.3.4
- Update inventory of waste in lag storage - 5.4.3
- Inventory waste disposal package components in lag storage - 5.5.3

- Account for (maintain inventories of) nuclear materials during waste preparation for disposal - 5.11
- Maintain and secure waste preparation records and reports - 5.15
- Verify type, amount, and source of waste received - 6.2.1.4
- Update inventory of waste received for disposal - 6.2.6
- Update inventory of repository lag storage waste disposal packages - 6.4.3
- Verify identity of individual waste disposal package for intra-facility transfer - 6.5.2
- Update inventory of waste disposal packages for transfer operations - 6.5.6
- Verify and record identification of each waste disposal package and its intended emplacement opening/location - 6.6.3
- Verify and record identification of emplaced waste disposal package and emplacement opening location number - 6.6.10
- Update inventory of emplaced waste - 6.6.14
- Identify location of waste to be removed - 6.9.2
- Verify identity of waste to be removed from underground facility - 6.9.7
- Update inventory of emplaced waste during repository waste removal operations - 6.9.16
- Update inventory of geologic repository waste upon off-site shipment - 6.10.11

4.3.4.2 Relevant Regulatory Citations

- 10 CFR 60.21(c)(5), 60.21(c)(10), 60.31(a), 60.43(b)(1), 60.43(b)(3), 60.43(b)(6), 60.51(a)(2)(ii), 60.71, 60.75(b), 60.101(b), 60.113(b)(2), and 60.135(b)(4)
- 10 CFR 61.80(f) and 61.80(i)(2)(iv)
- 10 CFR 72.1, 72.72(a), 72.72(b), 72.72(d), 72.76, and 72.78
- 10 CFR 74.4, 74.31
- 10 CFR 75.35

4.3.4.3 Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations

(1) What To Inventory

Inventory control should include all the necessary information about the waste for all phases of storage and disposal [10 CFR 60.71(b)]. The idea is to ensure an appropriate level of understanding of the thermal loads [10 CFR 60.43(b)(3)], physical and chemical forms, and radioisotope contents [10 CFR 60.43(b)(1)] during preclosure and postclosure phases.

Independent spent fuel storage installations (ISFSI) and monitored retrievable storage installations (MRS) (10 CFR Part 72) are used only for interim storage until nuclear waste is transferred for permanent disposal. 10 CFR Part 72 does not require a description of the kind, amount, and specifications of radioactive materials to be received and possessed; but it does include a provision for the spent fuel storage capacity, such as 1900 metric tons at facilities not owned by the Federal Government on January 7, 1983 (10 CFR 72.1).

(2) Inventory Process

In 10 CFR Part 60, inventory control processes for radioactive wastes begin by requiring a description of the kind, amount, and specifications of the radioactive material proposed to be received and possessed [10 CFR 60.21(c)(5)] and a description of the nuclear material control and accounting program [10 CFR 60.21(c)(10)] in the license application. Upon review of an application, the NRC will determine whether there is reasonable assurance that the types and amounts of radioactive materials described in the application can be received, possessed, and disposed of in the GROA, of the design proposed, without unreasonable risk to the health and safety of the public [10 CFR 60.31(a) and 10 CFR 60.101(b)]. The application review may lead to an inclusion of certain license conditions in the license issued, as the NRC finds it necessary to protect the health and safety of the public, common defense and security, and environmental values.

Either the license specifications or conditions may include restrictions as to (1) the physical and chemical form and radioisotopic content of radioactive waste (limiting inventory for preclosure and postclosure safety) [10 CFR 60.43(b)(1)] and (2) the amount of waste permitted per unit volume of storage space considering the physical characteristics of both the waste and the host rock (limiting thermal effects) [10 CFR 60.43(b)(3)]. Inventory control will be required to ensure that these two license specifications are complied with throughout the period of repository operation. Moreover, DOE is required to maintain such records and make such reports in connection with the licensed activity as may be required by the conditions of the license [10 CFR 60.71(a)]. A good nuclear material control and accounting program will make sure that inventories related to license specifications are satisfied and their associated records are effectively maintained. The requirement on retention of records of the receipt, handling, and disposition of radioactive waste at a GROA to contain sufficient information to provide a complete history of the movement of the waste from the shipper through all phases of storage and disposal [10 CFR 60.71(b)] further suggests implementation of an inventory control (or nuclear material control and accounting) program as described in the license application. Unique identification of each waste package is required by 10 CFR 60.135(b)(4) to facilitate the application of the program and shall be consistent with the waste package's permanent written records. Upon permanent closure, recordkeeping is required by 10 CFR 60.51(a)(2)(ii).

A similar approach has been adopted for land disposal of low-level radioactive waste (10 CFR Part 61). A major difference is that 10 CFR Part 61 does not have many details on a nuclear material control and accounting program. 10 CFR 61.80(i)(2)(iv) does require a licensee to submit an annual report which includes a summary, by waste class, of activities and quantities of radionuclides disposed. One other difference is that 10 CFR Part 60 does not explicitly require records to be kept on discrepancies between material listed on the manifest and those received, as required by 10 CFR 61.80(f).

Major differences between 10 CFR Part 72 and 10 CFR Part 60 in terms of inventory control process are that:

(1) 10 CFR Part 72 requires physical inventory at least once a year [10 CFR 72.72(b)] while 10 CFR Part 60 does not.
(2) 10 CFR Part 72 does not require postclosure recordkeeping [10 CFR 72.72(a) and 10 CFR 72.72(d)] as 10 CFR Part 60 does [10 CFR 60.51(a)(2)(ii)].
(3) 10 CFR Part 72 requires submittal of a material status report regarding information concerning the special nuclear material contained in the spent fuel possessed, received, transferred, disposed, or lost by the licensee twice a year or pursuant to 10 CFR 75.35 [pertaining to implementation of the International Atomic Energy Agency (IAEA) Safeguards Agreements (10 CFR 72.76)], and 10 CFR Part 60 does not have such a requirement.
(4) 10 CFR 72.78 requires completion and distribution of a Nuclear Material Transaction Report on DOE/NRC Form-741 whenever spent fuel is transferred or received, while no similar requirement is included in 10 CFR Part 60.

The inclusion of the above-mentioned four items in 10 CFR Part 60 will depend largely on whether they have positive impacts on inventory control. The information required in Items (2), (3), and (4) could be generated fairly easily if a nuclear material control and accounting program is effectively implemented. The reports called for in items (2), (3), and (4) are a result of an effective program, rather than proof of an effective inventory program. Moreover, the same results can be achieved through 10 CFR 60.75(b), which requires DOE to make available to the NRC for inspection, upon a reasonable notice, records kept by DOE pertaining to activities under 10 CFR Part 60.

Implementation of the control and accounting program required by 10 CFR Part 60 would fulfill all the safety functions listed in subsection 4.3.4.1.(2).

After a significant time of decay, the spent fuel at a repository can be classified as special nuclear material of low strategic significance based on the definition in 10 CFR 74.4. Operations involved in waste disposal are, however, excluded from "special nuclear material" accounting program requirements of 10 CFR 74.31; therefore, 10 CFR Part 60 does not need to reference 10 CFR Part 74 for its nuclear material control and accounting program.

4.4 LICENSING CONDITIONS, TECHNICAL SPECIFICATIONS, OR LICENSE SPECIFICATIONS

There are no subtopics for this ROC Topic.

4.4.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

The license conditions and specifications of 10 CFR 60.42 and 60.43 are adequate and sufficient because they are generally written and could address any and all conditions or specifications that may be needed in a license to assure radiation safety, retrieval, containment, and isolation.

4.4.2 Concepts, Operational Criteria, and Rationale

This subsection presents concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

Concept. License conditions and license specifications need to address any and all potential aspects of assurance of radiation safety, retrieval, containment, and isolation.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.21(c)(6), 60.32, 60.42, and 60.43.

Rationale for the Operational Criteria. Specifically, 10 CFR 60.42(a) states: "A license issued pursuant to this part shall include such conditions, including license specifications, as the Commission finds to be necessary to protect the health and safety of the public, common defense and security, and environmental values." This criterion fully addresses the concept above because it is a very broad and inclusive statement that could address any and all potential license conditions or specifications that are necessary.

4.4.3 Elements Considered for Regulation

4.4.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

Some of the elements to be considered as potential license conditions or specifications are as follows:

- Personnel training and certification
- Environmental monitoring

- Physical security and safeguards
- Emergency plans
- Surface facilities
  - Radioactive waste handling facilities
  - Radioactive waste treatment and packaging facilities
  - Waste package
  - Storage or lag facilities
  - Radiation control facilities
  - Monitoring instruments and limiting control devices
  - Ventilation
- Underground facilities
  - Emplacement layout
  - Ventilation
  - Roof support
- Transporters among surface facilities
- Radioactive waste handling equipment
- Radioactive waste treating and packaging equipment
- Ventilation equipment
- Operations (of structures, systems, and components important to safety)
- Inspection and monitoring of spent fuel and high-level radioactive waste in storage
- Inspection and calibration operations
- Underground facility construction
- Maintenance of radioactive waste treatment and handling systems
- Operating procedures for control of effluents in surface facilities
- Procedures for environmental monitoring
- Inspection and maintenance procedures
- Construction procedures
- Personnel for operation of systems and components important to safety
- Limits on release of radioactive materials
- Waste handling and storage limits
- Lowest performance level of equipment for safe operations
- Restriction for thermal loads
- Restriction for design and construction of waste package
- Construction progress report
- Data deviation report
- Design deficiency report
- Report for principal radionuclides releases

4.4.3.2 *Comments on and Discussion of the Elements Considered for Regulation*

License conditions and specifications serve the purpose of providing further details that complement the regulations for the protection of the health and safety of the public, common defense and security, and environmental values. There may be many levels of license conditions and license specifications that may be associated with a particular facility. Only a portion of the elements that may be included as conditions of a license are listed above. Because the list of elements could be almost boundless as a lower level of detail is sought, a more general approach seems preferable.

4.4.4 Safety Functions and Regulatory Citations

There are no subtopics for this ROC Topic, since licensing conditions and technical specifications cover nearly every aspect of geological repository operations.

4.4.4.1 *Associated Safety Functions*

No safety functions associated with this ROC Topic were identified from the "Repository Functional Analysis" (Ref. 1).

4.4.4.2 *Relevant Regulatory Citations*

- 10 CFR 50.6, 50.47(b), 50.54(p)(1), 50.54(p)(3), 50.54(q), and 50.55(c), and Part 50, Appendix E
- 10 CFR 60.21(c)(6), 60.32, 60.42, 60.43, and Part 60, Subpart H and Subpart I
- 10 CFR 72.44(b)(4), 72.44(b)(5), 72.44(e), 72.44(f), 72.190, 72.192, and 72.194

4.4.4.3 *Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations*

License conditions, technical specifications, or license specifications are an integral part of a license as required in 10 CFR Parts 50, 60, 61, and 72. These terminologies are not presented consistently throughout Title 10. In 10 CFR Part 50, license conditions and technical specifications are listed separately; and no license specifications are listed. In 10 CFR Part 61, only license conditions are required to be included in the license. Under 10 CFR Part 60, technical specifications are not mentioned. Although license specifications are listed separately in 10 CFR 60.43, they are cited in 10 CFR 60.42. Moreover, these specifications are derived from the analyses and evaluations included in the license application; therefore, they are equivalent to technical specifications. In 10 CFR Part 72, technical specifications are listed directly as a part of the license conditions and no license specifications are given.

Despite the inconsistency, the license specifications and conditions are listed to provide further details related to assurance of public health and safety. There may be three areas to be covered by the license conditions and specifications; they are (1) providing provisions that are not appropriate to be listed anywhere else, for example, consideration of license suspension, modification, or revocation; (2) providing specific limits, values, and sometimes processes that are generally design-specific and cannot be included in the regulation; and (3) ensuring completeness of certain regulatory requirements which otherwise may not be complete.

Depending upon the nature of the application, the specific conditions and specifications required for the license should be different among 10 CFR Parts 50, 60, 61, and 72. A number of conditions and specifications included in other Parts of Title 10 may not be relevant to repository design, construction, and operation. Some specific considerations are discussed in the following paragraphs.

Conditions for Construction Authorization. The conditions of construction authorization or a construction permit are found in 10 CFR Parts 50 and 60, while they are not included in 10 CFR Parts 61 and 72. In general, the construction authorization conditions as presented in 10 CFR 60.32 focus on provisions for submitting reports regarding construction progress, site data different from design bases data, severe deficiencies in design and construction, results of research and development programs, and provisions for limiting changes in design and procedures. A significant difference relevant to construction authorization between 10 CFR Parts 50 and 60 is that a construction permit in 10 CFR Part 50 is subject to the same conditions to which a license is subject [10 CFR 50.55(c)] while that in 10 CFR Part 60 is not. It is also notable that the conditions for a license to operate a repository are not as comprehensive as those in 10 CFR Part 50 for a reactor or a reprocessing plant; thus, subjecting the construction authorization to license conditions may not improve the quality of repository construction. Also, license specifications in the requirements of 10 CFR 60.43 are part of license conditions as well. They are intended for HLW receipt, possession, and disposal and may not be appropriate to be included in the conditions of construction authorization.

Emergency Plan(s) Implementation. 10 CFR 50.54(q) is a license condition that requires the licensee to follow and maintain emergency plans which meet the standards in 10 CFR 50.47(b) and the requirements in Appendix E of 10 CFR Part 50. 10 CFR 72.44(f) is a license condition that requires a licensee to follow and maintain in effect an emergency plan that is approved by the NRC. No similar license condition is included in 10 CFR Part 60. A license condition may be needed when 10 CFR Part 60, Subpart I is added.

Security Plan Implementation. In 10 CFR 50.54(p)(1), a license requires safeguards and contingency plan procedures in accordance with Appendix C of 10 CFR Part 73. In 10 CFR 50.54(p)(3), a license condition requires providing for the development, revision, and implementation of its safeguards contingency plan. A license condition in 10 CFR 72.44(e) is similar. The license condition in 10 CFR 60.43(b)(5) includes controls (1) to be applied (to control operational radiation exposure) to the restricted area during the preclosure period; (2) to avoid disturbances to the controlled area during the preclosure period that may affect isolation after closure; and (3) to avoid disturbances to the areas outside the controlled area during the preclosure period that may affect isolation within the controlled area after closure. All of these controls, which may include security-type activities, can only apply during the preclosure period because once the license is terminated, the license conditions and specifications of 10 CFR 60.43 would no longer be applicable.

Certified Personnel. In 10 CFR Part 72, license conditions include requirements for having an NRC-approved training and certification program in effect prior to the receipt of spent-fuel and high-level radioactive waste for storage [10 CFR 72.44(b)(4)] and having certified personnel to operate, or be in direct visual supervision of, the operation of equipment and controls that are important to safety [10 CFR 72.44(b)(5)]. 10 CFR Part 72 also has requirements for training and certification of personnel included in Subpart I (10 CFR 72.190, 72.192, and 72.194). Similar to 10 CFR Part 72, Part 60 has included a subpart (Subpart H) for training and certification of personnel. Subpart H has to be complied with according to the license condition specified in 10 CFR 60.42(b)(3). Therefore, criteria are similar for two regulations: (1) for having training and certification programs and (2) for having certified personnel to operate or be in direct visual supervision of the operation of systems and components that are important to safety.

Technical Specifications. Several technical specifications are found in 10 CFR Parts 50 and 72 but not in 10 CFR Part 60. These are, for example: (a) functional and operating limits, (b) limiting conditions, (c) design features, (d) release limits on radioactive materials for effluents, (e) operating procedure for effluents control, and (f) report of principal radionuclide releases. These technical details may not be appropriate for a geologic repository, which is a first-of-a-kind facility.

4.5 IMPOSED BACKFITTING

There are no subtopics for this ROC Topic.

4.5.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

It is possible for the NRC to impose backfitting during repository construction, operation, and closure because of provisions in the Atomic Energy Act (Ref. 9).

4.5.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusion presented above.

Concept. Criteria to allow NRC to impose backfitting for design, construction, and operation are required.

Operational Criteria. The operational criteria needed to allow the NRC to impose backfitting are presented in the Atomic Energy Act (Ref. 9).

Rationale for the Operational Criteria. In accordance with the Atomic Energy Act (Ref. 9), the NRC has the authority and obligation to require backfits when necessary for the adequate protection of public health and safety. Backfitting rules in 10 CFR Parts 50, 72, etc., limit the discretion of the NRC staff to impose backfitting. This is necessary for programs with numerous licensees, that may be administered by many different members of the NRC staff, to ensure consistent criteria are applied. This will be entirely different for HLW disposal with only one licensee. Still, there is authority in both the Atomic Energy Act (Ref. 9) and 10 CFR Part 60 to accomplish backfitting in order to protect public health and safety.

Two court cases discussing backfitting (Refs. 10 and 11) give some insight to clarify that the Atomic Energy Act (Ref. 9) does allow the NRC to impose backfitting and license conditions.

> The Atomic Energy Act (42 USCS No. 2011 et seq.) provides ample authority for the NRC to impose customized requirements designed to minimize risk to public health and safety, and there is no constitutional problem with doing so. The Atomic Energy Act does not preclude prudent risk-reduction measures, provided it is rational to conclude that risk will be reduced. Consequently, The Commission can impose special requirements for plants in densely populated areas. (1985, CL1) 21 NRC 1043 (Ref. 10).

> The NRC did not act in an arbitrary or capricious manner or in violation of law in approving restart of an undamaged reactor, despite the 1979 accident which severely damaged another reactor at the power plant site. The Commission imposed 155 conditions on the licensee to insure that reactor could be operated consistent with public health and safety. Re. Three Mile Island Alert, Inc. (1985, CA3) 771 F2d 720 (Ref. 11).

According to 10 CFR 60.42, the NRC can require backfitting where necessary. A cost/benefit analysis is not required with respect to any backfit that is needed to assure adequate protection to the public. Where a backfit is an increment above and beyond what is required for adequate protection, the backfit is subject to a cost/benefit analysis.

4.5.3 Elements Considered for Regulation

4.5.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

Associated elements relevant to the regulatory criteria for NRC imposed backfitting are as follows:

- Assessing information to determine if backfitting should be imposed by the NRC during site characterization, design, construction, or operation to include:
  - Review of pertinent new or amended provisions in NRC rules to determine if imposed backfitting is necessary as a result of these provisions
  - Review of pertinent regulatory staff positions which interpret NRC rules to determine if imposed backfitting is necessary as a result of any statements in these positions
  - Review of data derived by the applicant/licensee during the site-characterization or construction stages to determine if imposed backfitting is necessary based on these data and operations
  - Review of systems, structures, and components of a facility in light of new and amended provisions, regulatory staff positions, and data provided by the applicant/licensee to determine if imposed backfitting is necessary to modify these systems, structures, or components
  - Review of design data in light of new and amended provisions, regulatory staff positions, and data provided by the applicant/licensee to determine if imposed backfitting is necessary to modify design procedures or facility design
  - Review of new and amended provisions, regulatory staff positions, and data provided by the applicant/licensee to determine if imposed backfitting is necessary to modify construction or operations procedures
  - Review of advancements in science and technology that may improve facility performance
  - Specifying to the applicant/licensee the backfitting to be imposed
- Specifying to the applicant/licensee the objectives of the backfitting
- Defining the most advantageous schedule for implementing the imposed backfitting in light of both the ongoing regulatory activities at the facility and the availability of needed NRC resources required during the proposed backfit
- Describing activities required of the applicant/licensee to complete the imposed backfitting
- Reviewing related information provided to the NRC by the applicant/licensee (including cost/benefit analyses associated with the backfitting)
- Assessing effectiveness of the imposed backfitting to enhance health and safety after the backfit is completed

4.5.3.2 Comments on and Discussion of the Elements Considered for Regulation

10 CFR Part 60 does not have any specific treatment of NRC-imposed backfitting. It may be necessary for the NRC to require backfitting (1) as early as the site characterization phase or during construction or operation because of natural features or conditions found that may affect design procedures or repository design or (2) during operation because of the occurrence of unanticipated behavior of engineered components. In addition, changes in technology could also make backfitting necessary.

Imposition of backfitting by the NRC should not be required in order for the applicant/licensee to modify site characterization plans and activities due to the anticipated discovery of problematic natural features or conditions during site characterization.

Modification of techniques for site characterization activities need not be subject to imposed backfitting because the information gained by those activities is being collected to initially establish or to alter design, construction, or operation of a repository. The applicant/licensee may also implement self-imposed modifications to design, construction, or operation without NRC-imposed backfitting; documentation of these modifications would be required.

4.5.4 Safety Functions and Regulatory Citations

There were no subtopics for this ROC Topic because of the narrow subject of this topic.

4.5.4.1 Associated Safety Functions

No safety functions associated with this ROC Topic were identified from the "Repository Functional Analysis" (Ref. 1).

4.5.4.2 Relevant Regulatory Citations

- 10 CFR 50.109
- 10 CFR 60.42
- 10 CFR 72.62

4.5.4.3 Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations

There are no specific references in 10 CFR Part 60 to NRC-imposed backfitting during any phase of the development, construction, or operation of a high-level radioactive waste repository.

10 CFR Part 60 does not address the concept of imposition of backfitting by the NRC. Backfitting criteria in 10 CFR Part 60 would explicitly make it possible for the NRC to impose backfitting because of (1) characteristics of the natural system which could be found during site characterization, construction, or operation that may have an effect on repository design; (2) unanticipated behavior of engineered components noted during operation; or (3) advances in the sciences or engineering.

10 CFR 72.62 addresses backfitting in a time frame after the (operating) license has been issued. 10 CFR Part 72 defines "backfitting" as the addition, elimination, or modification of (1) structures, systems, or components of an ISFSI or MRS or (2) procedures or organization required to operate such a facility. It requires backfitting if that action is necessary to assure adequate protection to occupational or public health and safety; to bring the ISFSI or MRS facility into compliance with a license, rules, or orders of the NRC; or to bring the facility into conformance with written commitments from a licensee. It does not specify that backfitting need be considered in relation to modifications to facility design, but concentrates on an operations time frame.

10 CFR 50.109 addresses a broader time period during which imposition of backfitting by the NRC should be considered. 10 CFR 50.109 indicates that backfitting may be imposed (1) after the date of issuance of the construction permit for the facility, (2) six months before the date of docketing of the operating license, (3) after the date of issuance of the operating license, or (4) after the date of issuance of the design approval. It defines "backfitting" as the modification of or addition to systems, structures, components, or design of a facility; or the design approval or manufacturing license for a facility; or the procedures or organization required to design, construct, or operate a facility. 10 CFR Part 50 requires backfitting if that action is necessary to ensure that the facility will provide adequate protection to public health and safety in accord with the common defense and security. It outlines information appropriate for consideration by the NRC in relation to a proposed backfit, and specifies that the NRC's Executive Director for Operations is responsible for implementation of 10 CFR 50.109.

From the above discussion, it is clear that both 10 CFR Parts 50 and 72 provide information on certain aspects of NRC-imposed backfitting that are not explicit in 10 CFR Part 60. 10 CFR Part 50 indicates a time frame broader than that specified in 10 CFR Part 72, for consideration of backfitting, clearly allowing for NRC imposition of backfitting during the construction time frame so that design procedures and facility design could be more effectively influenced.

4.6 BACKFILLING, SEALING, AND MONUMENT ERECTION

This ROC Topic has the following subtopics:

(1) Preclosure Seals and Backfill
(2) Monuments

4.6.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) Preclosure Seals and Backfill

The design criteria for preclosure seals and backfill (those used during the preclosure period) are addressed sufficiently and adequately in 10 CFR Part 60. Backfilling is addressed in 10 CFR 60.111(b)(2) with regard to maintaining retrievability up to permanent closure, and in 10 CFR 60.142(a) and 60.142(c) with respect to performance confirmation monitoring of backfill and seals. More detailed criteria, with regard to preclosure sealing and preclosure backfilling, than are currently in 10 CFR Part 60 appear inappropriate, since one needs to recognize the potential overlapping functions of preclosure and postclosure performance. For instance, early backfilling could assist in stabilizing the underground openings and limiting additional fracturing. However, it could complicate inspection, monitoring, and retrieval. The relative weighing of advantages and disadvantages to preclosure seals and preclosure backfill during operations is likely to be site-specific and medium-specific, for example, fundamentally different in salt as compared to tuff.

(2) Monuments

Monument erection during permanent closure is sufficiently and adequately addressed in 10 CFR 60.51(a)(2) because it is broadly written. The design, location, and spacing of monuments are likely to be highly site-specific and, therefore, more detailed criteria would appear inappropriate.

4.6.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) Preclosure Seals and Backfill

Concept. Criteria are needed to ensure that performance of preclosure seals and backfill is maintained.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.111(b)(2), 60.133(a)(2), 60.133(d), 60.133(g)(3), 60.142(d), and 60.142(c).

Rationale for the Operational Criteria. The design of preclosure seals and backfill (those used during the preclosure period to control flooding, water and gas intrusion, separate ventilation in the underground facility, etc.), which excludes postclosure seals of shafts and boreholes (those used for postclosure containment and isolation), is adequately regulated by 10 CFR 60.133(a)(2), 60.133(d), and 60.133(g)(3) because they are part of the underground facility and consequently part of the engineered barrier system (EBS). The regulations currently do not preclude decisions to allow backfilling prior to the end of the retrieval period. 10 CFR 60.111(b)(2) ensures that if it is used, the retrievability option will still be maintained.

The "Repository Functional Analysis" report (Ref. 1) made the observation, on page 29, that although backfill emplacement is widely recognized throughout the regulation, no criteria are provided relative to either requirements or constraints on its performance. Consequently, the functional constraints on backfill were assigned a sufficiency category 3, meaning that recognition or criteria may need to be strengthened. However, based on the preceding rationale, backfill is a part of the underground facility and consequently a part of the EBS. Thus, criteria that specify requirements or constraints on performance of the underground facility and EBS [e.g., 10 CFR 60.133(a)(1) and 60.133(h)] also apply to backfill.

Note: A slight discrepancy was found in 10 CFR 60.112 with regard to the phrase "shafts, boreholes and their seals." The lack of a comma between "boreholes" and "and" may imply that the criteria apply only to seals for boreholes. Everywhere else in the regulations [10 CFR 60.2, 60.102(b)(2), 60.134, 60.142(a), and 60.142(d)] the context "shafts, boreholes, and their seals" is used, and implies postclosure seals for both shafts and boreholes. The latter context is assumed to be correct.

(2) Monuments

Concept. Criteria are needed for monuments for repository closure.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.51(a)(2).

Rationale for the Operational Criteria. These criteria fully address this concept because they are broadly written. Types of monuments which will be used to best discourage intrusion after closure depend on the available technology and are site-specific.

4.6.3 Elements Considered for Regulation

4.6.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

Elements relevant to backfilling, sealing, and monument erection are as follows:

- Seals (for ventilation control)
  - Seal materials
  - Host rock at and near seal locations
  - Seal-rock interface
  - Rock reinforcement/support at and near seal locations
- Seals (dams) (for groundwater and/or surface water control)

  - Seal (dam) materials
  - Host rock at and near seal (dam) locations
  - Seal-rock interface
  - Grout (emplaced in host rock and/or along seal-rock interface)
  - Rock reinforcement/support at and near seal locations
- Backfill
  - Backfill materials
  - Host rock at backfill locations
  - Rock reinforcement/support in backfilled excavations
- Monuments
  - Monument materials (concrete, steel)
- Rock excavation
- Monitoring of rock excavation procedures and effects
- Inspection of excavations
- Reinforcement and/or support installation
- Deformation monitoring
- Visual inspection
- Maintenance (e.g., scaling, placement of additional reinforcement and/or support)
- Site preparation for seal/dam emplacement:
  - Inspection
  - Scaling, or more complete or in-depth removal of surficial rock
  - Support removal (controversial: may be dangerous and may allow rock deformation and hence enhanced permeability)
- Seal/dam emplacement
- Inspection/testing of emplaced seals/backfills/dams
  - Physical and chemical properties
  - Thermal interactions
- Hydraulic testing for grouting design
- Grouting
- Grout inspection/testing
- Corrective grouting (if needed)
- Continued seal/dam inspection/monitoring/maintenance
- Preparation for backfill emplacement
  - Inspection of excavations to be backfilled
  - Removal of utilities
  - Scaling of loose rock
  - General cleanup
  - Floor scraping/excavation
- Backfill emplacement
- Control/monitoring of backfill emplacement
- Inspection/testing of emplacement backfill
  - Compaction testing
- Monument erection

- Thermally induced effects on the sealing and backfilling performance during the operations period
  - Thermal expansion/swelling
  - Permeability changes
  - Thermal stresses across the interface between seal and host rock, which may reduce the hydraulic conductivity of the interface but enhance the hydraulic conductivity of some of the discontinuities of the host rock
  - Induced effects resulting from thermally driven water, steam, and/or air flows
  - Hydraulic conductivity changes of the seal system
  - Physical/geochemical changes of seals and backfill
- Surface weathering and degradation of stockpiled backfill, seals, and monuments, and weathering of boreholes, shafts, and seals

4.6.3.2 Comments on and Discussion of the Elements Considered for Regulation

10 CFR 60.133(g)(3) requires that ventilation of excavation and waste emplacement areas be separated. This requirement could possibly be met without the use of ventilation seals. The installation of air doors or heavy curtains, along with establishment of a higher pressure in the excavation area, could be enough to prevent intrusion of radioactive materials from a release into the waste emplacement area, and thus satisfy the intent of this requirement. However, 10 CFR Part 60 does not appear to have as broad an application for the term "seal" and, therefore, 10 CFR 60.133(g)(3) could be interpreted to require that there be no leakage from the construction area into the emplacement area. In this case, ventilation seals may be necessary. 10 CFR 60.133(g)(3), along with 30 CFR 57.8535 and possibly 30 CFR 57.22217, 57.22218, and 57.22219, appears to be adequate in regulating the use of any ventilation seals. The section 4.23 ROC Topic deals specifically with ventilation.

Since potential seals and/or dams for control of flooding, gas and water intrusion, and radioactive materials would be included as part of the definition of the underground facility, 10 CFR 60.111(a), 60.133(a)(2), 60.133(c), and 60.133(d) appear to adequately regulate them during the preclosure period.

The surrounding rock at locations where seals and dams are likely to be installed is also an essential component in determining the sealing effectiveness of the overall sealing structure, as discussed in the section 6.5 and 6.6 ROC Topics. Bypass flow through the rock in which seals or dams are emplaced is a common source of poor sealing performance. Bypass flowpaths can result from overstressing of the rock, from excessive damage caused by uncontrolled excavation (blasting), from lack of adequate support or reinforcement, and from progressive deterioration with time. 10 CFR 60.133(e)(2) and 60.133(f) appear to adequately cover the design of openings, which would be construed as including the reinforcement/support, to reduce the potential for deleterious rock movement or fracturing and creation of preferential pathways for groundwater travel. Satisfying the above two criteria indirectly ensures that the design will take into account this aspect of sealing performance.

It should be emphasized that placement of backfill and seals during the operations period may have conflicting implications in terms of preclosure performance for some geologic settings as follows:

- Complicate waste monitoring and inspection
- Complicate retrieval
- Reduce air flow near/past emplaced waste, which:
  - Reduces risk of radiological releases
  - Reduces heat removal from emplaced waste area (as compared to the heat removal resulting from active ventilation). Note: This would result in higher temperatures in access or emplacement openings that have been sealed or backfilled, and subsequent increases in thermomechanical stresses.
- Complicate inspection of emplacement holes, emplacement rooms, and possibly access excavations
- Assist in stabilizing the backfilled excavations (to a greater or lesser extent, depending upon the type and quality of the backfill), which may reduce the risk of deleterious rock movements
- Affect water flow through and near the repository
- Allow long term *in situ* observation of backfill and seal performance, and of the performance of backfilled and sealed excavations

10 CFR Part 60 does not require backfilling of emplacement rooms and access openings in the underground facility during the operations period up to permanent closure. Likewise, seals are not required for emplacement rooms or access openings in the underground facility, with the exception of shafts and boreholes. The use of such seals and backfill during the operations period is likely to be highly dependent on the geologic setting in which the waste is emplaced. One would have to weigh their use against the potential conflicting implications for preclosure performance stated above. 10 CFR Part 60 appears adequate in requiring that the retrievability option be maintained if seals and backfills are used during the operations period [10 CFR 60.133(c) and 60.111(b)(2)]. Also, 10 CFR 60.142(a), 60.142(c), and 60.142(d) appear to sufficiently require that test sections be established to determine the effectiveness of backfilling and sealing before any permanent placement begins. This testing would include determining the thermal interactions on seals and backfills as listed in subsection 4.6.3.1.

Construction of surface monuments is covered in 10 CFR 60.51(a)(2).

4.6.4 Safety Functions and Regulatory Criteria

This ROC Topic covers backfilling and sealing with regard to the preclosure period, which includes permanent closure. The erection of monuments during permanent closure is addressed. Effects of sealing and backfilling on postclosure performance objectives are discussed in the sections 6.5 and 6.6 ROC Topics; that is, so that the release rate from the EBS, following the containment period, to the geologic setting is not significantly degraded and so that the isolation capabilities of the shafts, boreholes, and their seals are not significantly degraded. Also, the NRC staff has developed a Technical Position (TP) on Postclosure Seals (Ref. 12), which deals with regulatory concerns and guidance for assessing performance of these seals after permanent closure.

4.6.4.1 Associated Safety Functions

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

- Emplace emplacement opening packing or backfill (if required) - 6.6.7
- Remove underground facilities (plumbing, HVAC (heating, ventilation, and air conditioning), etc.) and equipment (as appropriate) - 6.11.1.2
- Examine performance capability of seals/backfills and monitoring equipment previously emplaced - 6.11.1.5
- Repair/replace previously emplaced seals and/or backfill and monitoring equipment (as required) - 6.11.1.6
- Emplace emplacement opening/location packing, backfill and/or cover (or plug as required) - 6.11.1.7
- Verify readiness for final closure - 6.11.1.8
- Seal and/or backfill drifts and rooms (if required) - 6.11.1.9
- Emplace drift seal(s) (if required) - 6.11.1.10
- Backfill and close shafts, ramps, and other access openings and emplace seals - 6.11.2.3
- Emplace closure seals for boreholes and other openings - 6.11.2.4
- Erect surface monuments/markers - 6.11.3.6
- Maintain chemical and physical properties of waste emplacement packing/backfill/seal(s) during closure - 6.25
- Maintain chemical and physical properties of closure backfill/seals during closure - 6.26
- Emplacement opening/location backfill emplacement equipment (if required) - 6.41.5.2.5
- Repository backfill material processing facility (if required) - 6.41.9.1.1
- Repository seal material processing facility (if required) - 6.41.9.1.2

- Backfill bulk materials and material processing equipment (if required) - 6.41.9.2.1
- Backfill emplacement equipment (if required) - 6.41.9.2.2
- Seal bulk materials and material processing equipment (if required) - 6.41.9.2.3
- Seal emplacement equipment - 6.41.9.2.4
- Trained and certified personnel for backfill material processing - 6.41.9.4.1
- Trained and certified personnel for backfill emplacement - 6.41.9.4.2
- Trained and certified personnel for seal material processing - 6.41.9.4.3
- Trained and certified personnel for seals emplacement - 6.41.9.4.4
- Procedure(s) for backfill material processing (if required) - 6.41.9.5.1
- Procedure(s) for backfill emplacement - 6.41.9.5.2
- Procedure(s) for seal material processing (if required) - 6.41.9.5.3
- Procedure(s) for seal emplacement - 6.41.9.5.4

4.6.4.2 Relevant Regulatory Citations

- 10 CFR 60.2, 60.21(c)(1)(ii)(D), 60.21(c)(15)(vi), 60.51(a)(2), 60.51(a)(4), 60.101(a)(2), 60.102(b)(2), 60.111(a), 60.111(b)(2), 60.112, 60.113(a)(1), 60.133(a)(1), 60.133(a)(2), 60.133(c), 60.133(d), 60.133(e)(2), 60.133(f), 60.133(g)(3), 60.133(h), 60.134, 60.140(a)(2), and 60.142
- 30 CFR 57.8535, 57.20010, 57.22217, 57.22218 and 57.22219

4.6.4.3 Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations

10 CFR Part 60 primarily discusses seals with regard to isolation during the postclosure period. For example, 10 CFR 60.134 gives criteria to ensure that the design, material selection, and placement methods of seals for shafts and boreholes do not compromise the ability of the repository to meet the performance objectives following permanent closure. Seals will also likely be used to satisfy a number of preclosure design objectives, including the control of water intrusion, gas intrusion, flooding, and separation of ventilation areas. Seals could also be used to close off emplacement drifts or emplacement rooms in the underground facility upon completion of waste emplacement. This would provide additional protection against possible radiation exposures during the preclosure period as well as enhanced isolation following permanent closure. 10 CFR Part 60 does not require that seals for emplacement rooms and/or drifts be used in the underground facility, but does not rule them out. Permanent closure of the repository currently only requires that shafts and boreholes be sealed.

The safety functions dealing with providing seal processing facilities, seal emplacement equipment, sealing procedures, etc., are implied by 10 CFR 60.134 as a result of the requirement for shaft and borehole sealing.

The "underground facility" is defined in 10 CFR 60.2 as the underground structure, including openings and backfill materials, but excluding shafts, boreholes, and their seals. It is reasonable to assume that seals and/or dams used in the underground facility during the preclosure period, whether they are temporary or permanent, would be part of the underground structure and, therefore, would be included in the definition of "underground facility." Likewise, since the EBS includes the underground facility, these preclosure seals as well as preclosure backfill, would be part of the EBS. Seals for shafts and boreholes are discussed separately in 10 CFR 60.134.

In this context, 10 CFR Part 60 does address sealing during repository operations to the extent that 10 CFR 60.133(a)(2) requires: "The underground facility shall be designed so that the effects of credible disruptive events during the period of operations, such as flooding . . . will not spread through the facility." In addition, 10 CFR 60.133(d) requires: "The design of the underground facility shall provide for control of water and gas intrusion." 10 CFR 60.111(a) requires: "The geologic repository operations area shall be designed so that until permanent closure has been completed, radiation exposures and radiation levels, a releases of radioactive materials to unrestricted areas will at all times be maintained within the limits . . ." Finally, 10 CFR 60.133(g)(3) requires that the underground facility ventilation be designed to "separate ventilation in excavation and waste emplacement areas."

The Mine Safety and Health Standards (30 CFR Part 57) include requirements on dams (30 CFR 57.20010), on seals (30 CFR 57.8535), and for methane controls (30 CFR 57.22217, 57.22218, and 57.22219). 30 CFR Part 57 uses the terminology "seals" for ventilation control and "dams" for water control. This usage is not consistent with 10 CFR Part 60, in which the term "seals" is used in the context of containment/isolation of radionuclides from the EBS.

Backfilling has far fewer performance objectives or functions (if any) than sealing during the preclosure period. Depending on the type and quality of the backfill, it could be used in assisting the stability of openings through the design for retrieval as well as reducing the risk of radiological releases during the preclosure period. As a result of this, 10 CFR Part 60 primarily addresses backfill in the postclosure sense.

10 CFR 60.111(b)(2) appears to adequately ensure that the retrievability option will be maintained even if the NRC allows backfilling part or all of the GROA prior to the end of the retrievability period.

10 CFR 60.142 requires design and testing of backfills and seals during early development stages and up to the period of permanent closure. The regulations are somewhat generic concerning the types of tests that would be conducted, but imply testing of

such phenomena as thermal interactions and changes in chemical and physical properties due to thermal loading to ensure that design requirements for the seals and backfills can be met. These criteria appear to directly address safety functions which deal with performance of backfill and seals.

It appears that 10 CFR 60.140(a)(2), 10 CFR 60.51(a)(4), and 10 CFR 60.21(c)(1)(ii)(D) adequately require the results of tests on components of the EBS including seals and backfills to ensure that they are functioning as intended for permanent closure.

Permanent closure is defined in 10 CFR 60.2 as "final backfilling of the underground facility and the sealing of shafts and boreholes." This definition along with the criterion 10 CFR 60.142(c) implies that backfilling of the underground facility is a requirement to meet permanent closure. Thus, safety functions dealing with providing backfill equipment, facilities, etc., would be required, even though some of these safety functions appear conditional (i.e., they have in parentheses "if required").

The criteria dealing with monument erection are addressed in 10 CFR 60.21(c)(15)(vi) and 60.51(a)(2), which require plans and a detailed description of measures to be employed for permanent closure such as construction of monuments to regulate and prevent activities that could impair the long-term isolation. The design and spacing of surface monuments are likely to be highly site-specific, so the regulation needs to allow flexibility with regard to these aspects.

4.7 DECOMMISSIONING

This ROC Topic has the following subtopics:

(1) Decontamination or Dismantlement
(2) Removal of LLW from Decontamination or Dismantlement

4.7.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) Decontamination or Dismantlement

Criteria in 10 CFR Part 60 for decontamination or dismantlement are adequate and sufficient. 10 CFR Part 60 requires DOE's license application to include plan(s) for decontamination or dismantlement of surface facilities [10 CFR 60.21(c)(15)(vi)]. These plans must be implemented before DOE can apply for an amendment to terminate the license [10 CFR 60.52(c)(2)]. Also required in the license application is a description of design considerations that are intended to facilitate decontamination or dismantlement of surface facilities [10 CFR 60.21(c)(11)] according to the design criterion set forth in 10 CFR 60.132(e).

Regarding total dismantlement of all surface facilities, the NRC believes that this may be unnecessary and overly restrictive [see NUREG-0804 (Ref. 13), page 26]. The

NRC decided to allow decontamination *or* dismantlement. The site will have monuments erected to discourage illegal human occupancy and intrusion after permanent closure to protect public health and safety. The controlled area of the geologic repository is not intended to be prepared to such an extent that it can be released for unrestricted use after termination of the license. Therefore, these requirements for decontamination or dismantlement of surface facilities are adequate and sufficient.

(2) Removal of LLW from Decontamination or Dismantlement

Criteria in 10 CFR Part 60 regarding removal of LLW resulting from decontamination or dismantlement are adequate and sufficient. Removal of LLW is an integral part of decontamination or dismantlement and would be included in the NRC approved plans, and it will have to be completed before DOE can apply for an amendment to terminate the license [10 CFR 60.52(a)]. Also, LLW resulting from decontamination or dismantlement is secondary waste, and the criteria in 10 CFR 60.132(d) would apply. Before the NRC will approve the amendment to terminate the license, DOE will have to demonstrate that removal of the decontamination and dismantlement LLW has been made in conformance with the DOE's plan. It appears that removal of LLW resulting from decontamination or dismantlement is fully covered by the current regulatory language.

4.7.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) Decontamination or Dismantlement

Concept. Criteria are needed to assure the repository is designed for decontamination or dismantlement for closure.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.21(c)(11), 60.21(c)(15)(vi), 60.52(c)(2), and 60.132(e).

Rationale for the Operational Criteria. The criteria listed above address this concept because they are broadly written to provide that closure activities for a disposal facility will ensure radiation safety. Closure of the repository and termination of the license may require the decontamination or dismantlement of the surface facilities to ensure radiation safety.

(2) Removal of LLW from Decontamination or Dismantlement

Concept. Safe removal of decontamination or dismantlement LLW for license termination is needed.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.21(c)(15)(vi), 60.52(c)(2), and 60.132(d).

Rationale for the Operational Criteria. The criteria listed above fully address this concept because they require that this waste be removed or disposed of in a safe and acceptable manner. The LLW generated during closure of the repository must be removed to ensure radiation safety.

4.7.3 Elements Considered for Regulation

4.7.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) Decontamination or Dismantlement

Elements to be considered in decontamination or dismantlement for closure are as follows:

- Plan for decontamination of surface facilities
- Facility and equipment decontamination
- Decontamination materials
- Containers for contaminated materials
- Facilities designed to facilitate decontamination (cleanable surfaces)
- Radiation control facilities
- Storage or lag facilities
- Waste handling facilities
- Decontamination equipment
- Waste handling equipment
- Waste transfer vehicle
- Monitoring equipment
- Radiation control equipment
- Decontamination of waste handling facility
- Decontamination of waste storage or lag facilities
- Decontamination of waste handling equipment
- Decontamination of waste transfer vehicles
- Radiation control
- Facility decontamination procedure
- Equipment decontamination procedure
- Decontamination equipment operating procedure
- Radiation control procedure
- Records management procedure
- Trained decontamination personnel
- Trained health physicist

- Limits for decontamination (Refs. 14 and 15)
- Removal of buildings to possibly help deter illegal occupancy and return the area to its original surface conditions
- Plans for dismantlement of surface facilities
- Waste handling equipment and facilities
- Waste storage facilities
- Ventilation facilities above surface
- Facilities designed to allow dismantlement
- Waste transfer vehicle
- Dismantlement of waste handling facility
- Dismantlement of waste transfer vehicles
- Dismantlement of waste storage facilities
- Radiation control for dismantlement
- Procedures for facility dismantlement
- Radiation control procedures for dismantlement
- Records management procedures for dismantlement
- Return of the area to the natural state

(2) Removal of LLW from Decontamination or Dismantlement

Elements to be considered in removal of decontamination or dismantlement LLW from closure are as follows:

- Plan for removal of LLW from decommissioning
- Packing and shipment facilities for contaminated materials
- Temporary storage facilities for contaminated materials
- Packing and shipment equipment for contaminated materials
- Consolidation of contaminated equipment and materials
- Transfer of contaminated equipment and materials
- Radiation control
- Contaminated material handling procedures
- Procedures for contaminated material packing and shipping (meeting disposal and shipping requirements)
- Radiation control procedures
- Records management procedures
- Trained personnel for contaminated material handling and shipping
- Trained health physicist

4.7.3.2 Comments on and Discussion of the Elements Considered for Regulation

(1) Decontamination or Dismantlement

The requirements for decontamination or dismantlement are similar to, but different from, those for decommissioning of nonwaste disposal facilities. The requirements currently available in 10 CFR Part 60 for decontamination or dismantlement address these differences. 10 CFR Part 60 regulations on decontamination or dismantlement for a repository cover all the elements and specific guidance or limits necessary for decontamination and dismantlement.

(2) Removal of LLW from Decontamination or Dismantlement

Removal of LLW is an integral part of, or conclusion to, decontamination or dismantlement and would be included in the NRC-approved plans for decontamination or dismantlement of surface facilities. The removal will have to be completed before the DOE can apply for an amendment to terminate the license [10 CFR 60.52(a)]. One important consideration for the NRC to approve the amendment is that the final disposition of radioactive wastes has been made in conformance with the DOE's plan, as amended and approved as part of the license [10 CFR 60.52(c)(1)]. This waste is secondary waste and is addressed by 10 CFR 60.132(d).

4.7.4 Safety Functions and Regulatory Citations

4.7.4.1 Associated Safety Functions

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

(1) Decontamination or Dismantlement

- Plan repository closure and decommissioning - 6.1.6
- Decontaminate underground facilities and equipment (if required) - 6.11.1.1
- Decontaminate surface facilities (as necessary) - 6.11.3.1
- Dismantle and dispose of unneeded surface facilities (when decontamination is complete) - 6.11.3.3
- Facility for repository equipment decontamination - 6.41.9.1.3
- Decontamination equipment and materials - 6.41.9.2.5
- Trained and certified decontamination personnel - 6.41.9.4.6
- Procedure(s) for decontamination - 6.41.9.5.6

(2) Removal of LLW from Decontamination or Dismantlement

- Plan repository closure and decommissioning - 6.1.6
- Consolidate and transfer contaminated equipment and materials - 6.11.3.4
- Dispose of contaminated equipment and materials in repository during closure operations (as authorized) - 6.11.3.5
- Contaminated material processing and package facility (if required) - 6.41.9.1.6
- Contaminated material processing and packaging equipment (if required) - 6.41.9.2.8
- Trained and certified personnel for contaminated material packaging and shipping - 6.41.9.4.8
- Procedure(s) for decontaminated material packaging and shipping during closure and decommissioning - 6.41.9.5.9

4.7.4.2 Relevant Regulatory Citations

- 10 CFR 60.2, 60.21(c)(11), 60.21(c)(15)(vi), 60.52(a), 60.52(c)(1), 60.52(c)(2), 60.132(d), and 60.132(e)
- 10 CFR 61.28(a)(3)(i)
- 10 CFR 72.54(b)(1), 72.54(b)(2), and 72.54(b)(3)

4.7.4.3 Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations

The discussion in this section on the topic regarding decommissioning will be presented more coherently by treating the topic as a whole rather than by subtopics.

The definition of decommission as stated in 10 CFR Parts 50 and 72 is "to remove (as a facility) safely from service and reduce residual radioactivity to a level that permits release of the property for unrestricted use and termination of license." This definition is not applicable to land disposal of low-level radioactive waste (10 CFR Part 61) and disposal of high-level radioactive wastes in geologic repositories (10 CFR Part 60), since the surface areas directly above the waste disposal horizons will not be released for unrestricted use even after the license is terminated and since the objective of such disposal is to leave high-level waste underground at the site. Consequently, the word "decommission" does not appear in 10 CFR Part 61. Instead, the language of "decontamination and/or dismantlement of surface facilities" is used in 10 CFR 61.28(a)(3)(i), and "decontamination or dismantlement of surface facilities" is used in 10 CFR Part 60, except for 10 CFR 60.132(e). Although the term "decommissioning" appears in the title of the requirement 10 CFR 60.132(e), the text of the requirement refers strictly to "decontamination or dismantlement." Since no definition for decommission is provided in 10 CFR 60.2, decommissioning in 10 CFR 60.132(e) implicitly means decontamination or dismantlement.

Because after "decommissioning" a property can be released for unrestricted use, the required standard for decommissioning might need to be more stringent than that for decontamination or dismantlement where the area will not be released for unrestricted use. Several requirements in 10 CFR Part 72, such as 10 CFR 72.54(b)(1), 72.54(b)(2), and 72.54(b)(3), that are intended for public health and safety protection are not included in either 10 CFR Part 60 or Part 61.

One of the prerequisites for DOE to apply for an amendment to terminate the license is that decontamination or dismantlement of surface facilities at the repository has been completed based on the plan as amended and approved as part of the license. An adequate plan which the NRC will approve for decontamination or dismantlement of surface facilities should at least include all the functions listed in subsection 4.7.4.1. To this end, all functions listed in subsection 4.7.4.1 are covered by the current regulatory requirements in 10 CFR Part 60.

4.8 VIOLATIONS

This ROC Topic has the following subtopics:

(1) Enforcement of Regulations and Other Relevant Requirements
(2) Employee Protection (see the section 4.1 ROC Topic)

4.8.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) Enforcement of Regulations and Other Relevant Requirements

The current 10 CFR Part 60 concerns only violations that are serious enough to result in license amendment, suspension, modification, or revocation through the application of 10 CFR 60.42(b)(1). The Atomic Energy Act (Ref. 16) provides for civil and criminal penalties related to HLW disposal, which is a licensed activity of NRC. 10 CFR Part 60, in conjunction with the Atomic Energy Act (Ref. 16), is sufficient and adequate for dealing with violations related to licensing actions.

(2) Employee Protection

See the section 4.1 ROC Topic.

4.8.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) **Enforcement of Regulations and Other Relevant Requirements**

Concept. Criteria for civil and criminal penalties for violations are needed for contractors, subcontractors, and individuals.

Operational Criteria. The operational criteria related to enforcement actions for violations are in 10 CFR 60.42(b)(1) and the Atomic Energy Act (Ref. 16).

Rationale for the Operational Criteria. The above criteria and statute state that NRC's enforcement realm includes the licensee and contractors, subcontractors, and individuals. NRC enforcement philosophy in practice has been directed toward the licensee. Provisions of the Atomic Energy Act, (Ref. 16), whether they are in the regulations of 10 CFR Part 60 or not, apply to licensed activities. Consequently, injunctions and court orders may be obtained and civil penalties may be imposed without direct inclusion of these provisions in 10 CFR Part 60.

(2) **Employee Protection**

See the section 4.1 ROC Topic.

4.8.3 Elements Considered for Regulation

4.8.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) **Enforcement of Regulations and Other Relevant Requirements**

Some of the elements associated with enforcement of regulatory violations are as follows:

- License suspension
- License revocation
- License modification
- Civil penalties of contractors, subcontractors, and individuals in violation of a regulation
- Criminal conviction and punishment of individuals who commit willful violations

(2) **Employee Protection**

See the section 4.1 ROC Topic.

4.8.3.2 *Comments on and Discussion of the Elements Considered for Regulation*

(1) Enforcement of Regulations and Other Relevant Requirements

In order for the enforcement of regulations in 10 CFR Part 60 to be effective and complete, violations need to be addressed. Lower level violations that are not severe enough to require license suspension, revocation, or modification may be addressed by imposing civil or criminal penalties on the contractors, subcontractors, and individuals who are responsible for construction and operation activities. 10 CFR Part 60 directly addresses higher level violations in 10 CFR 60.42(b)(1), and lower level violations are addressed in the Atomic Energy Act (Ref. 16).

(2) Employee Protection

See the section 4.1 ROC Topic.

4.8.4 Safety Functions and Regulatory Citations

4.8.4.1 *Associated Safety Functions*

No safety functions associated with either subtopic for this ROC Topic were identified from the "Repository Functional Analysis" (Ref. 1).

4.8.4.2 *Relevant Regulatory Citations*

- 10 CFR 30.63
- 10 CFR 40.81
- 10 CFR 50.110
- 10 CFR 55.71
- 10 CFR 60.42(b)(1), 60.42(b)(2)
- 10 CFR 61.83
- 10 CFR 70.71
- 10 CFR 72.84

4.8.4.3 *Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations*

(1) Enforcement of Regulations and Other Relevant Requirements

10 CFR Part 2 provides general rules of practice for domestic licensing proceedings. It governs the conduct of all proceedings, other than export and import licensing proceedings, for: (1) granting, suspending, revoking, amending, or taking other action with respect to any license, construction permit, or application to transfer a license; (2) imposing

civil penalties under section 234 of the Atomic Energy Act of 1974 (Ref. 16); and (3) public rulemaking. This part is applicable to actions governed by Title 10, including 10 CFR Part 60.

Enforcement of (1) rules, regulations, and orders issued thereunder and (2) terms, conditions, and limitations issued thereunder is an integral part of, and essential to, safe operation. Regulations provide requirements for a licensee to follow, and enforcement provides a means to ensure compliance with all the regulations. Enforcement clauses are contained in almost all parts of Title 10 (e.g., 10 CFR 30.63, 40.81, 50.110, 55.71, 61.83, 70.71, and 72.84). The clauses related to enforcement are essentially the same, if not identical. It is notable that DOE is not excluded from the enforcement clauses for its operation of an MRS. All similar enforcement clauses are not directly included in 10 CFR Part 60, but are part of the Atomic Energy Act (Ref. 16).

License condition 10 CFR 60.42(b)(1) gives the NRC the right to revoke, suspend, modify, or amend a license issued for cause, as provided by the Atomic Energy Act (Ref. 16). It is believed that revocation, suspension, modification, or amendment of a license is intended for serious (higher level) violations of regulations because these are directed toward the DOE in license condition 10 CFR 60.42(b)(2). DOE, as an organization, will be held responsible for such violations; and as a result, DOE's construction authorization or license for operation may be revoked, suspended, or modified. By enforcing license condition 10 CFR 60.42(b)(1), higher level violations will be addressed.

Relatively less serious (lower level) violations may not need to result in license revocation, suspension, and modification. Further, enforcement applied below the DOE level may be another important aspect. Repository construction and operation are going to be conducted by DOE's contractors and subcontractors. Enforcement clauses dealing with contractors, subcontractors, and individuals below the DOE organization level are not directly included in 10 CFR Part 60. However, the provisions of Sections 186, 223, 232, and 234 (42 USCS 2236, 2273, 2282, and 2284) of the Atomic Energy Act (Ref. 16), addressing civil and criminal penalties, are enforceable by both the NRC and DOE if lower level violations occur.

(2) Employee Protection

See the section 4.1 ROC Topic.

4.9 WASTE, OTHER THAN HLW, FOR DISPOSAL AT THE REPOSITORY

This ROC Topic has the following subtopics:

(1) Disposal, Handling, and Storage of Radioactive Wastes, Other than HLW
(2) Nonradioactive Wastes

4.9.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) Disposal, Handling, and Storage of Radioactive Wastes, Other than HLW

10 CFR Part 60 adequately and sufficiently addresses safe handling, storage, and disposal of any radioactive wastes. The safe storage, handling, and disposal of any radioactive wastes, other than HLW, are subject to the same safety criteria as HLW.

Note: Application of all the safety criteria to "other than HLW" may be necessary because these wastes are hazardous and will require safe handling. Some radioactive waste [such as greater-than-class C (GTCC)] may even be more hazardous than HLW because the GTCC waste may have a more concentrated and total radioactive material inventory than HLW that has decayed for numerous years.

(2) Nonradioactive Wastes

Some of the wastes at the GROA may be nonradioactive hazardous waste. This hazardous waste will not be controlled by the NRC because it is not within the jurisdiction of NRC. Criteria for disposal of nonradioactive hazardous wastes are beyond the jurisdiction of NRC under the Atomic Energy Act (Ref. 16) and the Energy Reorganization Act (Ref. 6). Controls for handling hazardous materials that could cause "secondary effects" are addressed in the section 6.4 ROC Topic.

4.9.2 Concepts, Operational Criteria, and Rationale

This subsection presents concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) Disposal, Handling, and Storage of Radioactive Wastes, Other Than HLW

Concept. Criteria are needed for disposal, handling, and storage of radioactive waste, other than HLW.

Operational Criteria. The operational criteria needed to address this concept are specifically presented in 10 CFR 60.132(d). Also, all the operational criteria in 10 CFR 60.131, 60.132, and 60.133 are applicable to wastes other than HLW because of the concepts presented in 10 CFR 60.102(b)(3) and 60.102(b)(4).

Rationale for the Operational Criteria. The references cited above fully address this concept because they require storage, handling, and disposal of all radioactive wastes to be done in such a manner as to ensure safety. The safe handling of secondary radioactive wastes from the operation of the geologic repository is adequately and sufficiently covered by 10 CFR 60.132(d). Other radioactive waste (other than HLW) generated offsite is addressed by concepts presented in 10 CFR 60.102(b)(3) and 60.102(b)(4). Storage in 10 CFR 60.102(b)(4) is being used in a very specific context of the exercise of NRC authority, and refers specifically to the term "storage" as used in the Energy Reorganization Act (Ref. 6), Section 202(3) [42 USCS 5842(3)], which says that NRC has licensing jurisdiction over "facilities used primarily for the receipt and storage of high-level radioactive waste." In this context "storage" includes all facility operations.

(2) Nonradioactive Wastes

See subsection 4.9.1(2).

4.9.3 Elements Considered for Regulation

4.9.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) Disposal, Handling, and Storage of Radioactive Wastes, Other than HLW

Elements to be considered in disposal, handling, and storage of radioactive wastes, other than HLW, are as follows:

- GTCC wastes
- Secondary wastes generated onsite
- LLW generated onsite
- Transuranic waste
- Contaminated gloves and coveralls
- Contaminated materials generated by hot cell operations
- Fuel-handling grapples
- Contaminated air filters
- Contaminated equipment
- Fuel-assembly frames
- Radiographic sources
- Spent resin of ion-exchange units in waste treatment
- Solid wastes generated by waste treatment
- Spent cartridge filters resulting from waste treatment

(2) Nonradioactive Wastes

See subsection 4.9.1(2).

4.9.3.2 *Comments on and Discussion of the Elements Considered for Regulation*

(1) Disposal, Handling, and Storage of Radioactive Wastes, Other than HLW

10 CFR 60.132(d) specifically stipulates the safety requirements for the treatment, conversion, transportation, and disposal of all types of radioactive wastes generated onsite. Furthermore, 10 CFR 60.102(b)(3) and 60.102(b)(4) provide the safety and other regulatory requirements for storage, which includes disposal and handling.

(2) Nonradioactive Wastes

See subsection 4.9.1(2).

4.9.4 Safety Functions and Regulatory Citations

4.9.4.1 *Associated Safety Functions*

(1) Disposal, Handling, and Storage of Radioactive Wastes, Other than HLW

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

- Process secondary waste for packaging (as required) - 5.8.3
- Process GTCC waste for packaging (as authorized) - 5.8.4
- Containerize secondary waste (if required) - 5.8.10
- Facility to prepare for disposal those secondary wastes generated during packaging of high-level waste - 5.35.5.1.6
- Facility to package Greater-Than-Class C (GTCC) waste for disposal (if applicable) - 5.35.5.1.7
- Containers for secondary wastes (if required) - 5.35.5.2.2
- Equipment for preparation of secondary waste for disposal - 5.35.5.2.9
- Equipment for packaging of GTCC waste for disposal (if applicable) - 5.35.5.2.10
- Dispose of contaminated equipment and materials during closure operations (as authorized) - 6.11.3.5

(2) **Nonradioactive Wastes**

The following are safety functions for disposal, handling, and storage of nonradioactive (hazardous) waste identified from the "Repository Functional Analysis" (Ref. 1).

- Continuously monitor conditions that may impact personnel safety (radiological and nonradiological) during repository operations - 6.8.1
- Monitor environmental conditions to provide warning of potentially hazardous conditions or events during repository operations (e.g., air contamination, seismic event) - 6.8.1.2

4.9.4.2 Relevant Regulatory Citations

- 10 CFR 60.102(b)(3), 60.102(b)(4), 60.131, 60.132, 60.133, and 60.135(d)
- 10 CFR 72.128(b)

4.9.4.3 Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations

(1) **Disposal, Handling, and Storage of Radioactive Wastes, Other than HLW**

This subtopic is related to the design criteria for the GROA for radioactive wastes other than HLW. 10 CFR 60.102(b)(3) and 60.102(b)(4) address what criteria apply if the GROA is used for the "storage or disposal" of any radioactive wastes other than HLW. All 10 CFR Part 60 criteria would apply. In addition, the safety concerns for the radioactive secondary wastes generated onsite are addressed by 10 CFR 60.132(d). The safety provisions in 10 CFR 60.132(d) are similar to those in 10 CFR 72.128(b).

The associated safety functions of this subtopic have been addressed in 10 CFR 60.102(b)(3), 60.102(b)(4), 60.132(d), and 60.135(d). The safety functions for the provision of facility, container, equipment, and processes for the disposal of secondary wastes generated in the GROA are covered by the current 10 CFR 60.132(d) and 60.135(d). The safety functions concerning the disposal of GTCC wastes in the GROA are covered by 10 CFR 60.102(b)(3) and 60.102(b)(4). Also, contaminated equipment and materials resulting from the operation of this HLW repository are radioactive wastes generated at the GROA.

(2) **Nonradioactive Wastes**

See subsection 4.9.1(2).

4.10 EXTENDED OPERATIONS DURING A POST-EMPLACEMENT, PRE-RETRIEVAL, PRECLOSURE "PROLONGED HOLDING PERIOD"

There are no subtopics for this ROC Topic.

4.10.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

Criteria related to a prolonged holding period are sufficiently and adequately addressed by 10 CFR 60.111(b). Such a period is not disallowed by the discussion in 10 CFR 60.102(d). Also, the concepts for a prolonged holding period are easily understood without a specific definition or time period explicitly stated.

4.10.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

Concept. Criteria should allow a prolonged holding period for a repository (as related to performance confirmation or other reasons).

Operational Criteria. The operational criteria required to address this concept of a prolonged holding period, if necessary for performance confirmation, are presented in 10 CFR 60.111(b) and discussed in 10 CFR 60.102(d).

Rationale for the Operational Criteria. 10 CFR 60.111(b) fully addresses this concept because it does allow for changing the schedule for the retrieval period, which is linked to the performance confirmation program. Also, 10 CFR 60.102(d) supports this concept because a prolonged holding period is not disallowed. DOE would consider the potential advantages and disadvantages of a prolonged holding period under the current criteria for confirmation of the postclosure performance of a repository. If it is determined that implementation of the prolonged holding period might lead to enhancement of public health and safety, then it may be reasonable to have a prolonged holding period.

4.10.3 Elements Considered for Regulation

4.10.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

Active and passive institutional controls are required before closure of the repository. Prevention of human intrusion during a prolonged holding period may include passive institutional controls imposed by land ownership and control as well as active controls for security. Use of active institutional controls (e.g., security guards) is a possibility for preventing human intrusion. In 10 CFR 61.59(b), it is stated that after closure, institutional controls should not be relied upon to be an effective deterrent to intrusion for more than a

100-year time period. This statement is consistent with the concept presented in 40 CFR 191.14(a) that performance assessments relating to isolation of wastes from the accessible environment shall not consider contributions from active institutional controls for more than 100 years after disposal. The following elements are important in relation to security during a prolonged holding period:

- Security barriers
- Guards and other active security staff
- Monitoring equipment
- Local transportation routes

Long-term monitoring and testing to better ascertain the behavior of the natural and engineered systems of a repository can be considered the principal reasons for implementing a prolonged holding period. However, with regard to long-term postclosure monitoring NUREG-0804 (Ref. 13), page 34, states:

> The Commission considers such measures unnecessary and unlikely to provide useful information on the performance of a geologic repository. The multiple barrier approach the Commission has adopted will result in containment of substantially all of the radioactive materials within the waste packages for centuries after permanent closure, the feasibility of obtaining reliable data on subsurface conditions over a period of centuries is questionable, and the practicality of taking remedial action after sealing of the shafts is doubtful. Moreover, the emplacement of remote subsurface monitoring instruments and the provision of data transmission capabilities could provide additional pathways for release that would make it more difficult to achieve isolation. Rather, the Commission has adopted an approach where the retrievability option is maintained until a performance confirmation program can be completed that will allow the Commission to decide, with reasonable assurance, that permanent closure of the facility, with no further active human intervention with the emplaced wastes, will not cause an unreasonable risk to public health and safety.

The following elements involve inspections and maintenance of facilities during a prolonged holding period:

- Inspection and maintenance of surface facilities required to be functional during the extended holding period
- Inspection and maintenance of subsurface facilities required to be functional and accessible during the extended holding period

The following elements are important in relation to radiological protection activities during a prolonged holding period:

- Inspection and maintenance of markers which designate the restricted area
- Guards and other active security staff
- Inspection and maintenance of surface and subsurface facilities, equipment, and procedures related to radiation control
- Radiation monitoring
- Inspection and maintenance of monitoring equipment, recording and data-gathering equipment, and protective housings
- Inspection and maintenance of warning system devices
- Inspection and maintenance of emergency radiological systems
- Training and certification of personnel in radiation control
- Training and certification of personnel in use of procedures for monitoring
- Training and certification of personnel in use of warning systems and emergency contingency plans

In light of the potential scenarios related to terrorism or sabotage which could result in release of radionuclides or disturbance of the geologic setting, it becomes necessary to provide additional security and safeguards during a prolonged holding period. The following elements are important in relation to potential terrorism and sabotage during a prolonged holding period:

- Inspection and maintenance of security safeguard systems for surface and subsurface facilities
- Inspection and maintenance of security back-up systems
- Inspection of vehicles and materials brought into the surface or subsurface facilities
- Security checks for personnel having access to the surface and subsurface facilities
- Preparation and updating of security contingency plans
- Training and certification of guards and other active security staff
- Secure transportation routes for guards and other active security staff
- Training and certification of personnel in use of the procedures for implementation of the security contingency plans

The following elements are important to records maintenance during a prolonged holding period:

- Inspection and maintenance of permanent records storage facility
- Assessment or development of new materials suitable for permanent records, if required
- Controlled access to permanent records
- Development of procedures governing functions of the permanent records storage facility

* Training and certification of personnel to use the procedures governing the functions of the permanent records storage facility

4.10.3.2 Comments on and Discussion of the Elements Considered for Regulation

As currently written, a prolonged holding period and the activities that would be required during this period are addressed in 10 CFR Part 60. Most activities that would normally occur during waste emplacement and before backfilling and permanent closure of a repository would be necessary during this prolonged holding period. An important aspect of a prolonged holding period would be monitoring of the natural and engineered systems to assess the long-term performance of the systems, which would be part of performance confirmation.

4.10.4 Safety Functions and Regulatory Citations

4.10.4.1 Associated Safety Functions

Many of the safety functions included in the "Repository Functional Analysis" (Ref. 1) address activities that would normally occur after waste emplacement and before waste retrieval or permanent closure of a repository. These safety functions would be applicable during a period of extended operations. No associated safety functions are directly associated with this ROC Topic because none of the safety functions address a time frame specific to a "prolonged holding period."

4.10.4.2 Relevant Regulatory Citations

* 10 CFR 60.102(d) and 60.111(b)
* 10 CFR 61.59(b)
* 40 CFR 191.14(a) and 191.14(b)

4.10.4.3 Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations

None of the safety functions included in the "Repository Functional Analysis" (Ref. 1) specifically addresses the conduct of operations during the time frame specified to be a prolonged holding period.

"Prolonged holding period" in the context of this ROC Topic means an extended, but unspecified, time between emplacement of waste and either retrieval of waste or permanent closure of the repository. Certain operations could continue, and monitoring and acquisition of data for assessing the long-term performance of the natural and engineered barrier systems could be conducted during the prolonged holding period.

A prolonged holding period is a concept which, if implemented, could provide a longer time frame for performance confirmation monitoring and analyses. It would extend the time for conduct of virtually all activities that normally occur after waste emplacement and before waste retrieval or permanent closure of the repository.

None of the current federal regulations makes specific reference to the potential length of a prolonged holding period for a repository or to activities during such a period. However, most of the criteria used for anticipated repository operations would continue to be applicable during a prolonged holding period if such a period were employed by DOE. 10 CFR 60.111(b) does give allowance on a case-by-case basis for changing the period of time during which any plans for retrieval must be initiated. This additional time could be used for collection of performance confirmation data or other purposes and still allow retrieval if it should extend beyond 50 years after the start of waste emplacement operations. This prolonged holding period is thus allowed, but is not intended to be centuries in length.

NRC does allow for the concept of a reasonable holding period linked to performance confirmation. In NUREG-0804 (Ref. 13) on page 10, NRC states: "It should be noted that DOE may elect to maintain a retrievability capability for a longer period than the Commission has specified . . ." The link for the period of retrievability with the performance confirmation program is explicitly stated on page 49 of NUREG-0804 (Ref. 13). Also, NRC questions having a performance confirmation program needing to be conducted for centuries after emplacement [see page 34 of NUREG-0804 (Ref. 13)].

10 CFR 60.102(d) discusses the period of operations and states:

> A period of operations follows the issuance of a license by the Commission. The period of operations includes the time during which emplacement of wastes occurs, any subsequent period before permanent closure during which the emplaced wastes are retrievable; and permanent closure, which includes sealing of shafts.

10 CFR 61.59(b) is concerned with institutional control and could be considered related to a prolonged holding period and to the postclosure period. 40 CFR 191.14(a) relates specifically to active institutional controls, and provides guidance for a 100-year time frame for dependence on active controls, which is not considered in 10 CFR Part 60.

10 CFR Part 61 is not directly related to this ROC Topic because this regulation is concerned with near-surface disposal low-level waste. However, 10 CFR 61.59(b) is concerned with institutional control which may be considered to be somewhat related. 40 CFR 191.14(b) discusses monitoring after disposal, which could occur during a prolonged holding period. 40 CFR 191.14(a) relates specifically to active institutional controls, and provides guidance on a 100-year time limit for dependence on active controls which are not addressed in 10 CFR Part 60, but is consistent with the concept conveyed in 10 CFR 60.111(b).

4.11 LAND, WATER, AND RESOURCE OWNERSHIP, USE, AND CONTROL

This ROC Topic has the following subtopics:

(1) Land Ownership, Use, and Control
(2) Water and Resource Ownership, Use, and Control

4.11.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) Land Ownership, Use, and Control

Regulations for the activities pertinent to land ownership, use, and control are adequate and sufficient because they are broadly written to encompass any aspects of land ownership, use, and control. In this area, 10 CFR Part 60 has more detailed criteria than for other facilities regulated by other Parts of Title 10 of the Code of Federal Regulations.

(2) Water and Resource Ownership, Use and Control

Regulations for the purposes of the GROA pertinent to water and resource ownership, use, and control are adequate and sufficient because they are broadly written to encompass any aspects of water and resource ownership, use, and control. In this area, 10 CFR Part 60 has more detailed criteria than for other facilities regulated by other Parts of Title 10 of the Code of Federal Regulations.

4.11.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) Land Ownership, Use, and Control

Concept. During construction and operation, criteria are needed to assure (1) that the GROA and the controlled area are located on lands that are acquired lands under the jurisdiction and control of the DOE or on lands permanently withdrawn and reserved for its use and (2) that appropriate controls outside of the controlled area are established.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.21(b)(3), 60.21(b)(4), 60.21(c)(8), 60.21(c)(15)(vii), 60.31(a)(2), 60.43(b)(5), 60.46(a)(3), 60.51(a)(2), 60.121(a)(1), 60.121(a)(2), 60.121(b), 60.122(a)(2), 60.122(c)(1), 60.122(c)(2), and 60.122(c)(19).

Rationale for the Operational Criteria. The listed criteria assure that this concept is met because they are broadly written to require any necessary controls. Also, these criteria assure that during construction and operation, necessary land use and control of the

GROA, the controlled area, and areas outside the controlled areas have the objective to assure public health and safety.

(2) Water and Resource Ownership, Use, and Control

Concept. During construction and operation, criteria are needed to address water and resource rights, and their use and controls for repository postclosure performance.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.21(c)(13), 60.21(c)(15)(vii), 60.31(a)(2), 60.121(b), 60.121(c)(1), 60.121(c)(2), 60.122(a)(2), 60.122(c)(17), and 60.122(c)(18).

Rationale for the Operational Criteria. The listed criteria fully address this concept because they are comprehensive and broadly written and provide reasonable assurance that the performance objectives can be met. Also, they are written so that during construction and operation, control of water and natural resources within the GROA, the controlled area, and areas outside the controlled area are consistent with the purposes of operations (of the GROA) and waste isolation.

4.11.3 Elements Considered for Regulation

4.11.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) Land Ownership, Use, and Control

Elements relevant to land ownership, use, and control are as follows:

- Land records of the boundary of the secured area, both the controlled area and the surrounding area which is under DOE's control
- Establishment of a secure boundary for the controlled area to prevent inadvertent access and provide instant notification of unauthorized entry
- Monuments to identify the controlled area after permanent closure
- Description of the controls that the applicant will apply to restrict access and to regulate land use at the site and adjacent areas
- Physical security plan and personnel to control the secure boundary
- Plans and procedures to provide access to authorized visitors and enable quick identification of unauthorized visitors

- Plans for future land use of the GROA and surrounding areas and analysis of their impact on waste isolation performance

(2) **Water and Resource Ownership, Use, and Control**

Elements relevant to water and resource ownership, use, and control are as follows:

- Water usage monitoring system in or adjacent to the controlled area
- Segregation of water sources for use in actual repository operations and use for human consumption or related auxiliary purposes
- Plans for future development of the land area within and around the GROA which would affect the distribution of surface water
- Identification of mineral resources within the site
- Estimates of undiscovered mineral resources within the site
- Estimates of value of resources within and near the GROA
- Impact analysis of mining or exploration of the natural resources within or near the GROA on the GROA isolation performance

4.11.3.2 Comments on and Discussion of the Elements Considered for Regulation

(1) **Land Ownership, Use, and Control**

Controls applied to restrict access and to avoid disturbance to the controlled area and areas outside the controlled area, where conditions may affect isolation within the controlled area, will be terminated after permanent closure. Land ownership will not terminate. After the repository is permanently closed, new measures for land use controls as specified in the license amendment for permanent closure [10 CFR 60.51(a)(2)] and approved by the NRC will be in effect. No specific criteria have been provided in the regulation for the land use controls. Other measures such as construction of monuments and preservation of records are also required in 10 CFR 60.51(a)(2) after permanent closure to provide necessary information for reference for the potential future intruding societies. These are passive control measures and are expected to reduce significantly the likelihood of inadvertent intrusion into a geologic repository as discussed in NUREG-0804, Section 2.6, pages 15-18 (Ref. 13).

(2) **Water and Resource Ownership, Use, and Control**

The estimates of the value of natural resources which are listed as elements for resource control may be very difficult to produce. Of particular concern are: (1) methods for estimating undiscovered resources "by reasonable inference based on geological and geophysical evidence," (2) methods for evaluating future value of such resources, (3) methods for evaluating "natural resources without current markets, but which would be marketable given credible projected changes in economic or technological factors," and (4) methods for comparing the estimated value of any resources within the site to comparible sites.

4.11.4 Safety Functions and Regulatory Citations

4.11.4.1 Associated Safety Functions

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

(1) **Land Ownership, Use, and Control**

- Plan normal security and safeguards operations - 2.1.1
- Physical barriers to operations area(s) access - 2.20.1.2
- Equipment for security and safeguards - 2.20.2
- Maintain government control of controlled area land and resource use - 7.4.3
- Maintain government control of adjacent area land and resource use - 7.4.4
- Monitor for drilling or excavation in or adjacent to the controlled area - 7.4.7

(2) **Water and Resource Ownership, Use, and Control**

- Prevent unauthorized access to (and activities in) operations areas - 2.8
- Repository surface-subsurface water distribution facilities and equipment - 5.35.1.3.6
- Mine water control (if required) - 6.41.1.2.5
- Mine water handling in access openings (if required) - 6.41.1.2.5.2
- Repository surface-subsurface water distribution facilities and equipment - 6.41.1.3.1.6
- Limit quantity and rate of fluids contacting waste form - 7.2.2.5
- Impede movement of fluids to the waste disposal package - 7.3.5
- Establish a controlled area - 7.4.1
- Designate the boundaries of the controlled area - 7.4.2

4.11.4.2 *Relevant Regulatory Citations*

- 10 CFR 60.21(b)(3), 60.21(b)(4), 60.21(c)(8), 60.21(c)(13), 60.21(c)(15)(vii), 60.24, 60.31, 60.32, 60.41, 60.43(b)(5), 60.46(a)(3), 60.51(a)(2), 60.121, 60.122(a)(2), 60.122(c)(1), 60.122(c)(2), 60.122(c)(17), 60.122(c)(18), and 60.122(c)(19)

4.11.4.3 *Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations*

(1) Land Ownership, Use, and Control

The safety functions associated with land ownership, use, and control relate to either physical delineation of the land or establishment of security and control mechanisms. They address both the controlled area and the land surrounding it. The common factor in all the safety functions identified is the prevention of human intrusion.

The citations within 10 CFR Part 60 are all supportive of the primary regulation, 10 CFR 60.121. The analogous land control citations within 10 CFR Parts 61 and 72 are not as direct as the provisions of 10 CFR 60.121. Given the nature of the waste involved and the time period addressed by 10 CFR Part 60, this is understandable. The security requirements of 10 CFR 60.21(b)(3) and (b)(4), while not as detailed as in 10 CFR Part 72, do require security and safeguards for the GROA as is required at "comparable surface facilities (of DOE)."

License condition 10 CFR 60.43(b)(5) requires that controls "be applied to restricted access and to areas outside the controlled area where conditions may affect isolation within the controlled area." A license amendment is required [10 CFR 60.46(a)(3)] if DOE wants to remove or reduce controls applied to restrict access to or avoid disturbance of the controlled area or areas outside the controlled area where conditions may affect isolation within the controlled area.

A regulatory uncertainty was raised on page B-69 of Appendix B of CNWRA 90-003 (Ref. 7). It stated:

> The implied interpretation that land use and control need not be established until construction authorization has been granted needs clarification. The NRC review and approval of the construction authorization (license) application will provide the only opportunity to evaluate a demonstration of adequate land ownership and control.

The NRC's "Recommendations" report (Ref. 8) regarding Reference Uncertainty Number 23 is quoted from pages 31 and 32 of Appendix A.

The regulatory policy is clear--namely, that DOE must exercise control in a manner that is sufficiently timely for the Commission to make the licensing determinations set out in 10 CFR 60.31 and 10 CFR 60.41. With reference to 10 CFR 60.31, this calls for the Commission to consider whether the site complies with the land ownership and control requirements of 10 CFR 60.121, and, based on the consideration of this and other factors, to determine whether there is reasonable assurance of safety.

DOE is required to describe the controls it ". . . will apply to restrict access and to regulate land use" [10 CFR 60.21(c)(8)]; it is not, however, required to document its having actually acquired the necessary land interests. The license application shall be ". . . as complete as possible in the light of information that is reasonably available at the time of docketing," but other information not available at the construction authorization stage may be submitted before issuance of a license (10 CFR 60.24). Thus, if DOE has described the needed controls, but has not as yet acquired them, the circumstances must be such that the Commission has reasonable assurance of safety. This will involve a review of both the controls deemed to be necessary and DOE plans for exercising those controls (including, as appropriate, acquisition or withdrawal of lands for DOE use). To the extent that the Commission finds conditions relating to such controls to be necessary to protect health and safety, these will be included in the construction authorization (10 CFR 60.32).

As a practical matter, it should be borne in mind that Congress might be reluctant to authorize a permanent withdrawal of public lands for DOE's use until the Nuclear Regulatory Commission (NRC) has issued a construction authorization (or license). The regulation recognizes and accommodates this consideration.

(2) Water and Resource Ownership, Use, and Control

The license application must contain "an identification of natural resources of the geologic setting," in accordance with 10 CFR 60.21(c)(13). The text of this citation goes into detail concerning evaluation of the value of the resources whose exploitation "could affect the ability of the geologic repository to isolate radioactive wastes." Such natural resources, if found to be feasible for economic extraction in the present or foreseeable future [10 CFR 60.122(c)(17)(i)(1)] or of greater value than those representative of the geologic setting [10 CFR 60.121(c)(17)(ii)], will constitute adverse conditions. Analyses will need to be provided in the license application to demonstrate that the isolation capability of the geologic repository will not be compromised as a result of mining such natural resources [10 CFR 60.122(a)(2)(ii) and 10 CFR 60.122(a)(2)(iii)].

The license application must also contain "plans for any uses of the geologic repository operations area for purposes other than disposal of radioactive wastes, with an analysis of the effects" on performance, per 10 CFR 60.21(c)(15)(vii). Other potentially adverse conditions which will require appropriate land and water ownership, use, and control are 10 CFR 60.122(c)(1) and 10 CFR 60.122(c)(2).

4.12 POTENTIAL-SITE DISQUALIFYING CONDITIONS

This ROC Topic has the following subtopics:

(1) Human-Induced Hazard Considerations
(2) Natural Hazard Considerations

4.12.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

For both subtopics potential-site disqualifying conditions related to preclosure operations of a geologic repository are not recommended for addition to 10 CFR Part 60 because safety is assured by requiring that the design and operations (together with the site characteristics) assure that the performance objectives are met. Also, there appear to be several preclosure and postclosure potential-site disqualifying conditions in DOE's 10 CFR Part 960 regulations, which have been concurred in by NRC. This does not imply that some type of guidance on specific design/site limitations is unnecessary.

4.12.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above. The concepts for both subtopics were the same.

Concept. No potential-site disqualifying conditions related to preclosure operations of a geologic repository are recommended to be added to 10 CFR Part 60.

Operational Criteria. NRC regulations do not directly address or recommend having any potential-site disqualifying conditions related to preclosure operations.

Rationale for the Operational Criteria. No potential-site disqualifying conditions related to preclosure operations are recommended because of the concept that unfavorable site characteristics affecting operations may be mitigated by engineering measures. The overall goal of the preclosure performance objectives and the design criteria is to achieve adequate radiation safety. A major part of assurance of adequate radiation safety is meeting the radiation criteria of 10 CFR Part 20 and the Environmental Protection Agency (EPA) standards. Meeting these radiation limits requires the following, as stated in 10 CFR 60.21(c)(1), and 60.21(c)(3):

A description and assessment of the site at which the proposed geologic repository operations area is to be located with appropriate attention to those features of the site that might affect geologic repository operations area design and performance. The description of the site shall identify the location of the geologic repository operations area with respect to the boundary of the accessible environment.

A description and analysis of the design and performance requirements for structures, systems, and components of the geologic repository which are important to safety. This analysis shall consider (i) the margins of safety under normal conditions and under conditions that may result from anticipated operational occurrences, including those of natural origin; and (ii) the adequacy of structures, systems, and components provided for the prevention of accidents and mitigation of the consequences of accidents, including those caused by natural phenomena.

Site Versus Potential Site. The term "site" (which is defined in 10 CFR Part 60 as "the location of the controlled area") can be considered to be a term that can only be associated with the postclosure period because of the definition of "controlled area" in 10 CFR 60.2. Also, it is conceivable that a "controlled area" may not be established until the "outer boundary of the underground facility" is established. In this light, it would seem more appropriate to this discussion to use the term "potential site." Here a "potential site" means a potentially acceptable site or a candidate site, as appropriate, until such time as the "controlled area" has been established; at that time, the "site" and the "controlled area" are the same. Also, it may be advantageous to clarify the point of a "disqualifying condition" of a potential site. Here a "disqualifying condition" means a condition that, if present at a potential site, would eliminate that potential site from further consideration.

Preclosure and Postclosure Risks. It is acknowledged that in certain respects the material being handled on the surface is in its most hazardous and most vulnerable state. For example:

- The spent fuel will not have had a relatively long decay period.
- The spent fuel will have its highest levels of fission products and latent heat during the operational phase.
- Workers and members of the public will be the "closest" to the waste (no geological shield/container that is hundreds of feet thick).

However, the relative hazards or risks from the waste may be the greatest during the postclosure period because of the much longer time of exposure (e.g., drinking and eating contaminated water and food, and breathing contaminated air continuously in the area if leakage reaches the accessible environment) with the possibility of no remediation. During operations, exposure will be kept ALARA. If an accidental release occurs, remedial actions will be taken to minimize worker and public exposure. So even though the waste may be judged to be most hazardous and vulnerable during the preclosure phase, the human risk can be far greater in the postclosure phase and should thus receive the greatest consideration. However, the relative risk is not the main concern; rather, the main concern is the requirement that preclosure operational radiation safety is assured. The assurance of safety can be accomplished with adequate design criteria for the GROA.

Engineering Measures and Other Regulations. The previous statement is not intended to imply that engineers can design for everything. Rather, it is intended to be consistent with the concept that "Where unfavorable physical characteristics of the site exist, the proposed site may nevertheless be found acceptable if the design of the facility includes appropriate and adequate compensating engineering safeguards," as stated in 10 CFR 100.10(d). Also, 10 CFR 72.102(b) appears to indicate that sites of large capable faults should be avoided, not that sites possessing these kinds of faults shall be disqualified without further consideration. Other regulations, e.g., 10 CFR Part 100, describe investigations to be made in the event that faults are found in a site area, but do not disqualify the site if they are found. The site/design combination can be deemed acceptable if the engineers can design, for a given site, the GROA that meets the preclosure performance objectives. A license c[illegible] be issued only if the preclosure and postclosure performance objectives are met for a given [illegible]

Other NRC regulations could be considered to be potential-site disqualifying conditions. In addition, there appear to be potential-site disqualifying criteria in 10 CFR Part 60 related to the postclosure period; for example, the groundwater travel-time regulation in 10 CFR 60.113(a)(2). Also, there are disqualifying con[illegible] related to preclosure operations in DOE's 10 CFR Part 960 regulations, which were prep[illegible] accordance with the Nuclear Waste Policy Act (NWPA) (Ref. 17), Section 112(a) [42 USC 10132(a)]. For example, 10 CFR 960.5-2-9(d) indicates that a repository would be disqualified if the nature and rates of the fault movement are such that engineering measures beyond reasonably available technology would be required.

NRC regulatory philosophy does not appear to eliminate potential sites from the perspective of preclosure performance because engineering solutions may make a potential site acceptable, even though a potential site condition could be rated as adverse. For example, in 10 CFR 100.10(d) it is stated: "Where unfavorable physical characteristics of the site exist, the proposed site may nevertheless be found acceptable if the design of the facility includes adequate compensating engineering safeguards."

A potential site could be disqualified if the *entire* site is an area of severe liquefaction, in a flood plain, subject to landslide, in a severe karst region, on the slope of an active volcano like Mt. St. Helens, etc. Several conditions could disqualify a potential site (if representative of the entire site), or they could be considered as adverse conditions related to preclosure performance. Examples of adverse conditions are:

- Flooding 60.122(c)(1)
- Landslides 60.122(c)(3)

- Karst (subsidence) 60.122(c)(3) and 60.122(c)(11)
- Volcanic activity (e.g. Mt. St. Helens) 60.122(c)(3) and 60.122(c)(15)

These adverse conditions in 10 CFR 60.122(c) address only postclosure performance but would address the specific examples just listed and many other examples when applied to evaluation of an entire potential site. It appears that adding more adverse conditions to 10 CFR Part 60 specifically for potential-site disqualification based on preclosure operations could be considered redundant. In this context, disqualification is addressed of an entire potential site, perhaps of several square miles in area.

Different from the above examples is the location of a particular facility in an area of relatively high risk within a site. An example would be location of the Exploratory Studies Facility (ESF) in a wash or at a specific location within a potential site. A specific facility location is often called a "construction site" or "building site." Some "site limitations" may be applied to specific facility locations or "building sites," such as location of the ESF in a wash. Certainly, if specific locations at a potential site are areas that are contraindicative to sound design engineering (flood plains, nearby faults, etc.), then these specific locations should be avoided as building sites. It is important that good engineering/design judgment and technical guidance be used in building-site selection, but additional regulatory criteria in 10 CFR Part 60 are not needed due to the site/design-specific nature of such guidance.

The limitation for a construction site or building site may need to be conveyed in guidance in the form of meetings with DOE, NRC's planned final "Format and Content Regulatory Guide" or "License Application Review Plan," reference to existing regulatory guides, reference to design/construction standards, or other site-specific guidance. This is recommended because of the very design/site-specific nature of a GROA's building site, and because detailed guidance for concerns about building sites is readily available in existing standards.

Summary of Considerations. A listing of some of the considerations for and against having preclosure-related, potential-site disqualifying conditions in 10 CFR Part 60 are summarized in Table 2.

Since cost is not an NRC concern for ensuring safety, Considerations 2 and 3 do not appear to be sufficient reasons for having preclosure-related, potential-site disqualifying conditions added to 10 CFR Part 60. Even though NRC has no regulatory authority to have DOE self-enforce 10 CFR Part 960, DOE was required to obtain concurrence on the criteria for site disqualifying conditions, and NRC has reviewed and concurred with the use of 10 CFR Part 960. Placing almost duplicative criteria in an NRC regulation seems unnecessary. It seems reasonable that DOE will receive a great deal of public scrutiny to adhere to its own regulations. Furthermore, DOE must meet the operational safety performance and design criteria in 10 CFR Part 60 that are judged to be adequate.

Therefore, for all the reasons discussed above, it was concluded that potential-site disqualifying conditions do not need to be added to 10 CFR Part 60. It is not implied that some type of guidance on specific design/site limitations is unnecessary.

4.12.3 Elements Considered for Regulation

4.12.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) Human-Induced Hazard Considerations

Elements of human-induced hazard conditions that may be relevant to site-limiting criteria are as follows:

- Aircraft and test-missile hazards (bombing ranges, airport glide paths, test ranges)
- Induced seismicity
- Population density and proximity (individuals working or living next to a site; a large city near a site)

(2) Natural Hazard Considerations

Elements of natural hazard considerations that may be relevant to site-limiting criteria are as follows:

- Seismic magnitude and frequency
- Soil and rock properties (e.g., liquefaction)
- Volcanism
- Fault displacement
- Groundwater
- Surface water

4.12.3.2 Comments on and Discussion of the Elements Considered for Regulation

Technical subtopics under this ROC Topic for required investigations are virtually identical, although the context of analysis is different.

(1) Human-Induced Hazard Considerations

(a) Aircraft and Test-Missile Hazards

Air hazards to surface facilities in the preclosure time period are not specifically addressed for a HLW geologic repository. Neither design requirements nor

Table 2 - SOME CONSIDERATIONS FOR HAVING AND NOT HAVING PRECLOSURE-RELATED, POTENTIAL-SITE DISQUALIFYING CONDITIONS IN 10 CFR PART 60

Considerations Related to ***Having*** Potential-Site Disqualifying Conditions in 10 CFR Part 60	Considerations Related to ***Not Having*** Potential-Site Disqualifying Conditions in 10 CFR Part 60
1. NRC has "de facto" potential-site disqualifying conditions for other nuclear facilities.	A. Adequate design of the preclosure facilities could ensure adequate safety for potential-site conditions.
2. Potential-site disqualifying conditions may reduce the costs of unnecessary site investigations by early elimination of a potential site.	B. If the design cannot ensure adequate safety for potential-site conditions (the preclosure performance objectives cannot be met), NRC should *not* issue a construction permit.
3. Potential-site disqualifying conditions may reduce costs by not requiring unnecessarily rigorous design considerations for a potential site with a condition that is difficult to compensate for.	C. The primary function and purpose of a geological repository is long-term isolation. Therefore, considering this coupled with points A and B above, emphasis on potential-site disqualifying conditions which are only or primarily related to preclosure operations may not appear warranted.
	D. Several potential-site disqualifying conditions given in 10 CFR Part 960 (which received concurrence by NRC) are applicable by DOE to any potential site until construction.

limiting siting criteria are discussed. Remote areas, which satisfy exclusion areas dependent on population density and distance from population centers, are sometimes sites for airports or bombing ranges where aircraft activity is relatively high. The secondary hazard from an aircraft impact, either domestic or military, on the surface facilities of a HLW geologic repository could be assessed by the NRC. If found to be of serious concern, studies for a specific site could be required to determine if the probability of radionuclide releases would be sufficiently low to meet 40 CFR Part 191 criteria. Details of required studies could be codified to assist applicants for licenses. Such criteria could become site-limiting only if alternate operating procedures for such adjacent activities could not be arranged. This becomes a matter of national priorities, and such laws as may be passed by Congress take precedence under such circumstances. Therefore, the presence of such hazards is not an *a priori* reason for site limits.

(b) Induced Seismicity

Seismicity is known to be induced by several mechanisms. Principal among them are underground nuclear testing, water injection (including hydrofracturing) into geologic material at depth, construction of large deep reservoirs, and rock burst activity and fault movement consequent to mining operations. Such seismicity is at a level that unusual design measures are not required. Therefore, site-limiting criteria are not appropriate.

(2) Natural Hazard Considerations

(a) Seismic Magnitude and Frequency

Above-ground facilities used for temporary storage at a HLW repository may pose less of a hazard to the environment because there may be less waste material than in an ISFSI or MRS. These facilities require more flexibility in siting than an ISFSI or MRS, even if investigative costs are high because they must be sited with or near a HLW repository for which siting alternatives may be severely limited. Therefore, 10 CFR Part 72 criteria may be excessively stringent for surface facilities of a geologic HLW repository.

(b) Soil and Rock Properties

Soil and rock properties applicable to foundations or subsurface operations for the preclosure time period are not addressed by 10 CFR Part 60. However, 10 CFR 60.122(c)(12) and 60.122(c)(14) that deal with earthquakes could be related to surface facility foundations. Also, 10 CFR 60.122(c)(21) states that "Geomechanical properties that do not permit design of underground openings that will remain stable through permanent closure" are potentially adverse conditions. Although 10 CFR 60.122 is for postclosure, the language suggests that it could also be a preclosure concern, although not a potential-site disqualifying condition.

(c) Volcanic Activity

10 CFR 60.122(c)(3) and 60.122(c)(15) address generally a geologic repository and volcanic activity. These are only applicable to postclosure considerations, but the same general concepts for preclosure would be addressed by 10 CFR 60.21(c)(1).

(d) Fault Displacement

10 CFR 60.122(c)(3), 60.122(c)(11), 60.122(c)(12), 60.122(c)(13), and 60.122(c)(14) generally address fault displacement. 10 CFR Part 72 for an MRS or ISFSI precludes construction if adequate protection could not be provided. These are only applicable to postclosure considerations, but the same general concepts for preclosure would be addressed by 10 CFR 60.21(c)(1).

(e) Groundwater Conditions

10 CFR 60.122(c)(6), 60.122(c)(7), and 60.122(c)(9) generally address a geologic repository and groundwater conditions. These are only applicable to postclosure considerations, but the same general concepts for preclosure would be addressed by 10 CFR 60.21(c)(1).

(f) Surface Water Conditions

10 CFR 60.122(c)(3) and 60.122(c)(6) generally address a geologic repository and surface water conditions. These are only applicable to postclosure considerations, but the same general concepts for preclosure would be addressed by 10 CFR 60.21(c)(1).

4.12.4 Safety Functions and Regulatory Citations

4.12.4.1 Associated Safety Functions

No safety functions associated with either subtopic for this ROC Topic were identified from the "Repository Functional Analysis" (Ref. 1).

4.12.4.2 Relevant Regulatory Citations

- 60.2, 60.21(c)(1), 60.21(c)(2), 60.21(c)(3), 60.113(a)(2), and 60.122
- 10 CFR 72.90(d), 72.90(f), 72.91(c), 72.94, 72.96, 72.98(c)(3), and 72.102
- 10 CFR 100.10(d) and Part 100 Appendix A-II

- 10 CFR 960.3-1-5, 960.4-2-7(c)(5), 960.5-1(a)(3), 960.5-2-4(d), 960.5-2-8(a), 960.5-2-9(b)(2), 960.5-2-9(d), 960.5-2-10(d), and 960.5-2-11(d)

4.12.4.3 Comments and Comparison and Contrast of Safety Functions and Regulatory Citations

Note: 10 CFR Parts 50, 60, and 61 do not contain potential-site disqualifying conditions (interpreted as go/no-go criteria). 10 CFR Part 72 and the DOE's 10 CFR Part 960 regulations, however, contain such criteria. 10 CFR Part 100's population exclusion area can be limiting.

Regulations in 10 CFR Parts 50 and 60 are little concerned with potential-site disqualifying conditions but are concerned with what to do to prove that a site is qualified. 10 CFR Part 72 addresses some issues of disqualification, primarily political (where and where not to site) and avoidance of sites that lie within the range of strong near-field ground motion from historical earthquakes on large, capable faults, per 10 CFR 72.102(b). There are references in 10 CFR Parts 50 and 72 to 10 CFR Part 100, the siting regulation for nuclear power plants, in particular its Appendix A, which consider geologic hazards. 10 CFR Part 100 is not very concerned with disqualifying conditions, but details what is to be done to determine the design level for earthquake shaking. The design level may be relatively high, but a potential site would not be disqualified.

10 CFR Part 100 should not be used as the siting criteria for surface facilities of a HLW repository because it was developed for nuclear power plants which have an active heat and pressure source capable of disseminating radionuclides into the atmosphere. HLW repositories do not have such an active heat and pressure source.

Conceptual designs of HLW repository surface facilities may have many functional similarities to MRS/ISFSI design. However, 10 CFR 72.96, 72.102(a)(1), and 72.102(b) may not directly, or appropriately, apply to a HLW repository because there may be only a few sites technically suitable for a HLW repository. Therefore, the site limitations of 10 CFR 72.96, 72.102(a)(1), and 72.102(b) that may eliminate the need for 10 CFR Part 100 type investigations may serve as an undue limitation for a HLW repository's surface facilities.

10 CFR Part 960 attempts to define disqualifying conditions. Where 10 CFR 60.122(c)(11) finds "structural deformation . . . during the Quaternary Period" as potentially unfavorable, 10 CFR Part 72 prohibits siting at geologically unsuitable sites; and 10 CFR Part 960, in effect, prohibits siting where Quaternary Period fault movement has taken place or, in practice, where it cannot be proved to have not taken place. Under 10 CFR Part 100, the licensee would be required to prove that the nuclear facility could safely operate should similar fault movement occur. Under 10 CFR Part 960, the site would appear to be disqualified if Quaternary Period faulting were present. In practice, guidance for determining the presence of Quaternary Period faulting is usually taken from 10 CFR Part 100. This means that the

extensive investigations of 10 CFR Part 100 are likely to be performed to determine if a site is suitable under 10 CFR Part 960 or if the performance objectives of 10 CFR Part 60 can be met. Wherever there is lack of detail in one Title 10 regulation, practice has resorted to using the detail present in another Title 10 regulation as guidance.

While 10 CFR Part 60 has no preclosure potential-site disqualifying conditions, it does have postclosure criteria in the form of groundwater travel time and radionuclide migration rates. Currently, 10 CFR 60.122 is considered applicable to postclosure performance only. 10 CFR 60.122(c)(1), 60.122(c)(2), 60.122(c)(3), 60.122(c)(12), 60.122(c)(13), 60.122(c)(14), 60.122(c)(18), and 60.122(c)(20) are primarily related to environmental extremes at the surface, e.g., earthquakes, landslides, and flooding. Because of minimal 10 CFR Part 60 guidance regarding preclosure potential-site disqualifying conditions, it is likely that 10 CFR Part 100 for nuclear power plants may be considered by applicants to provide applicable preclosure guidance for surface facilities of a HLW repository.

(1) Human-Induced Hazard Considerations

(a) Aircraft and Test-Missile Hazards

10 CFR 72.91(c) requires that "Appropriate methods must be adopted for evaluating the design basis external man-induced events, based on the current state of knowledge about such events." This could be reasonably assumed to include aircraft and missile hazards. 10 CFR Part 60 contains more general criteria in 10 CFR 60.21(c)(1), 60.21(c)(2), and 60.21(c)(3).

(b) Induced Seismicity

10 CFR 960.5-2-4(d) states that a disqualifying condition exists if atomic defense activities in proximity to the site are expected to conflict irreconcilably with repository siting, construction, operation, closure, or decommissioning. A basis for this concern could have included instigation of fault rupture for sites potentially too close to underground nuclear testing. 10 CFR 960.5-2-11(d) disqualifies a site if, based on rates of fault movement or other ground motion, it is likely that engineering measures beyond those reasonably available will be required. The term "other ground motion" would encompass induced seismicity.

10 CFR 72.94, regarding human-induced events, requires that such events and the conditions leading to them be investigated and those important to design be identified. Among such events would be induced seismicity from any cause. 10 CFR 60.122(c)(2) lists as an unfavorable postclosure condition "potential for foreseeable human activity to adversely affect the groundwater flow system, such as groundwater withdrawal, extensive irrigation, subsurface injection of fluids, underground pumped storage, military activity or construction of large scale surface water impoundments." Although this section directly addresses effects on the groundwater flow system, injection, large-scale impoundments, and

certain military activities are also potential sources for induced seismicity and might also be a preclosure concern.

(2) Natural Hazard Considerations

(a) Seismic Magnitude and Frequency

The requirements in 10 CFR 72.102 avoid areas such as Attica, New York, because of local seismic activity for siting east of the Rocky Mountains implies that many areas west of the Rocky Mountains which have experienced similar seismic activity would be unsuitable. However, 10 CFR Part 72 also stipulates that 10 CFR Part 100 be used west of the Rocky Mountains and excludes only areas of historic strong motion from large earthquakes and vicinities near large, capable faults. This might permit siting in areas of seismic activity similar to Attica (where event magnitude is controversial) provided that adequate levels of seismic design are implemented.

(b) Soil and Rock Properties

10 CFR 960.5-2-9(b)(2) states that "A host rock with characteristics that would require minimal or no artificial support for underground openings to ensure safe repository construction, operation, and closure" is a favorable condition. There are also references to mining regulations which stipulate in a more quantitative manner what must be done if rock strength is not high enough to maintain safety to miners. These criteria are difficult to interpret as qualifying or disqualifying considering 10 CFR 960.3-1-5, although remediation under poor conditions might exclude a site on an economic basis. 10 CFR 72.102(d) states that "Site-specific investigations and laboratory analyses must show that soil conditions are adequate for the proposed foundation loading."

(c) Volcanic Activity

10 CFR 60.122(c)(3) lists volcanic activity of such a magnitude that large-scale surface water impoundments could be created as a potentially adverse condition. 10 CFR Part 100, Appendix A-II, states that it does not address investigations of volcanic phenomena and that they would be determined on a case-by-case basis. 10 CFR 960.4-2-7(c)(5) essentially repeats the statement in 10 CFR 60.122(c)(3). Also tectonic or igneous activity could be associated with volcanism. 10 CFR 960.5-2-11(d) states that if the expected nature of fault movement or other ground motion is likely to require engineering measures that are beyond reasonably available technology, the site may be disqualified. Although predictive capabilities regarding volcanic activity are available, 10 CFR Part 60 does not specifically address direct effects of volcanism during the preclosure period and does not provide an explicit rationale for dealing with them or dismissing them. There is no clear statement of the preclosure implications of on-site or nearby volcanic activity, nor of the nature and extent of investigations required in the regulations for HLW disposal or nuclear power plants. Investigations of volcanic activity have been required for the Trojan and WPPSS nuclear power plants in the Pacific Northwest and

for the Hanford reservation in western Washington (a formerly proposed HLW repository site). More general criteria are given in 10 CFR 60.21(c)(1), 60.21(c)(2), and 60.21(c)(3).

(d) Fault Displacement

10 CFR 72.102(b) states that areas of large, capable faults are to be avoided. Other regulations, e.g., 10 CFR Part 100, describe investigations to be made in the event that faults are found in a site area, but it does not disqualify the site if they are found. 10 CFR 960.5-2-9(d) states that a repository would be disqualified if the nature and rates of fault movement indicate that engineering measures beyond reasonably available technology would be required.

(e) Groundwater Conditions

10 CFR 60.122(c)(2), 60.122(c)(3), 60.122(c)(5), 60.122(c)(6), 60.122(c)(7), 60.122(c)(9), 60.122(c)(20), 60.122(c)(22), and 60.122(c)(23) discuss groundwater conditions that would be considered potentially adverse. Only 10 CFR 60.122(c)(20), which states that "Rock or groundwater conditions that would require complex engineering measures in the design and construction of the underground facility or in the sealing of boreholes and shafts," appears potentially applicable to preclosure. 10 CFR 72.98(c)(3) states that "Consideration of present and projected future uses of land and water within the region . . ." must be investigated, but does not limit siting based on groundwater criteria. 10 CFR 960.5-2-10(d) states that a disqualifying condition is ". . . based on expected ground-water conditions, it is likely that engineering measures that are beyond reasonably available technology will be required for exploratory-shaft construction or for repository construction, operation, or closure."

(f) Surface Water Conditions

As defined in 10 CFR 960.5-2-8(a) the site shall be located such that, considering the surface characteristics and conditions of the site and surrounding area, including surface-water systems and the terrain, the requirements specified in 10 CFR 960.5-1(a)(3) can be met during repository siting, construction, operation, and closure." According to 10 CFR 960.3-1-5, if a qualifying condition cannot be met, a site is disqualified.

10 CFR 60.122(c)(1) states that an adverse condition is, "Potential for flooding of the underground facility whether resulting from the occupancy and modification of floodplains or from the failure of existing or planned man-made surface water impoundments." This statement could apply to preclosure as well as postclosure time periods.

10 CFR 72.90(d) states, "Proposed sites with design basis external events for which adequate protection cannot be provided through ISFSI or MRS design shall be deemed unsuitable for the location of the ISFSI or MRS." 10 CFR 72.90(f) states, "The facility must be sited so as to avoid to the extent possible the long-term and short-term adverse impacts associated with the occupancy and modification of floodplains."

4.13 RECEIPT AND SHIPMENT

This ROC Topic has the following subtopics:

(1) Siting Considerations
(2) Treatment of Secondary Waste for Offsite Shipment
(3) Preparation for Waste Transport or Receipt
(4) Common Activities Related to Receipt and Shipment

4.13.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) Siting Considerations

No operational criteria are recommended because the scope of the ROC study is limited to criteria needed for the operational aspects of the GROA. The concept concerning the impact on the public and the environment before the HLW reaches the GROA is related to an analysis of the environmental impact of the repository (outside the GROA), and to overall programmatic considerations for HLW storage, processing, and transportation.

(2) Treatment of Waste for Offsite Shipment

The text contained in 10 CFR 60.132(d) is clearly applicable to the treatment of radioactive waste generated at the GROA (secondary radioactive waste). This is sufficient and adequate to address safe treatment of any secondary radioactive waste generated at the site, and its final disposition, because it is broadly written.

(3) Preparation for Waste Transport or Receipt

10 CFR Parts 60 and 71 contain sufficient and adequate criteria which address preparation of HLW for receipt or transport. 10 CFR Part 60 addresses operations that would be involved in HLW shipping, if necessary, as part of retrieval operations.

(4) Common Activities Related to Receipt and Shipment

Inspections are covered by the section 4.18 ROC Topic. Inventory control is covered by the section 4.3 ROC Topic. Use of personnel for receipt and shipment is covered by the section 4.26 ROC Topic.

4.13.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) **Siting Considerations**

Concept. Criteria are needed to address the impact on the public and the environment of transporting waste to and from the repository.

Operational Criteria. None.

Rationale for the Operational Criteria. No operational criteria are recommended because the scope of the ROC study is limited to criteria needed for the operational aspects of the GROA. The concept concerning the impact on the public and the environment before the HLW reaches the GROA is related to an analysis of the environmental impact of the repository (outside the GROA) and to overall programmatic considerations for HLW storage, processing, and transportation.

(2) **Treatment of Secondary Waste for Offsite Shipment**

Concept. Criteria are required for treatment of onsite generated waste.

Operational Criteria. Operational criteria to address this concept are presented in 10 CFR 60.132(d).

Rationale for the Operational Criteria. 10 CFR 60.132(d) applies to radioactive waste generated onsite and requires that the radioactive waste be processed for disposal at the GROA or for safe transport to a disposal site elsewhere.

(3) **Preparation for Waste Transport or Receipt**

Concept. Criteria are needed to assure safe offsite shipment of waste.

Operational Criteria. Operational criteria required to address this concept are presented in 10 CFR 60.21(c)(12), 60.31(a), 60.31(c), 60.132(a), and 60.132(d) and in 10 CFR Part 71.

Rationale for the Operational Criteria. The criteria cited above fully address this concept because they are broadly written and apply to waste handling. Retrieval could also involve removal of the waste from the site. There are several regulations in 10 CFR Part 71 and referenced Department of Transporation (DOT) regulations dealing with *receipt* and *shipment* of radioactive material that must be followed to ensure safety.

(4) **Common Activities Related to Receipt and Shipment**

Inspections are covered in the section 4.18 ROC Topic. Inventory control is covered in the section 4.3 ROC Topic. Use of personnel for receipt and shipment is covered in the section 4.26 ROC Topic.

4.13.3 Elements Considered for Regulation

4.13.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) Siting Considerations

In considering a facility's receipt and offsite transportation of radioactive wastes, siting considerations would include:

- Identification of those radiological health concerns of the facility associated with normal transport and accidents associated with the receipt and offsite shipping of waste, e.g.,
  - Population density along available routes
  - Local police, fire, and emergency response facilities
- Identification and investigation of those vulnerable characteristics of the proposed site, including routes to be used for shipping, e.g.,
  - Route conditions
  - Route alternatives
  - Expected rate of movement vs. locale
  - Environmental influences, i.e., weather impact on accidents and releases

(2) Treatment of Secondary Waste for Offsite Shipment

Elements required for the preparation of waste for transport include:

- Secondary waste consisting of wastes generated onsite, e.g., contaminated gloves, apparel, scrap from rod consolidation, air filters, etc.
- Facilities and equipment for the packaging and shipping of contaminated materials, e.g., packing materials, casks, barrels, containers, tape, radiation detection equipment, ventilation, hot cells, etc.
- Facilities and equipment to treat or modify waste into a form suitable for transport, e.g., solidifiers, compactors, liquid removal systems, and separation of hazardous and radioactive waste if necessary

(3) Preparation for Waste Transport or Receipt

Elements required for the preparation of waste for offsite shipment or receipt include:

- Facilities, e.g., holding yards, demurrage areas, and docks for loading/unloading shipping casks
- Equipment used for loading/unloading shipping casks or vehicles for offsite shipment or receipt, e.g.,
  - Adequate shipping casks to contain the radioactive wastes during transport (repair facilities or replacement casks)
  - Adequate transport vehicles (railcars, trucks, etc.) to move the radioactive wastes to an alternate storage site
  - Handling devices, e.g., overhead cranes, mechanical manipulators, grapplers, modified forklifts, etc.
- Personnel and procedures for preparation for offsite shipment or receipt of waste
- Adequate interfaces of offsite shipping system and the GROA

Elements required for the handling of waste include:

- Radiation control facilities, e.g., air handling systems, hot cells, exhaust systems, and monitoring systems
- Handling devices, e.g., overhead cranes, mechanical manipulators, grapplers, modified forklifts, etc.
- Support equipment, e.g., survey, decontamination effluent collection, effluent monitoring, etc.
- Personnel and procedures

(4) Common Activities Related to Receipt and Shipment

Elements for inspection are covered in the section 4.18 ROC Topic. Elements for inventory control are covered in the section 4.3 ROC Topic. Elements for use of personnel for receipt and shipment are covered in the section 4.26 ROC Topic.

4.13.3.2 Comments on and Discussion of the Elements Considered for Regulation

(1) Siting Considerations

Siting and site investigation are discussed in detail in the sections 4.12 and 5.1 ROC Topics; however, one aspect of site investigation for a facility to be addressed by this ROC Topic was analyzed herein. In addition to the site where construction would be undertaken, considerations are needed for facilities where radioactive waste would be transported so that the radiological risk outside the GROA can be assessed for each facility. However, the scope of 10 CFR Part 60 contains only criteria for the GROA.

(2) **Treatment of Secondary Waste for Offsite Shipment**

Analysis of this subtopic has indicated that the regulatory text in 10 CFR Part 60 regarding treatment of secondary waste is sufficient if the NRC's intent is to require treatment of wastes generated onsite only.

(3) **Preparation for Waste Transport or Receipt**

Analysis of this subtopic has indicated that 10 CFR Part 60 contains few specific criteria with respect to facilities, equipment, and operations required for (1) receipt of waste and (2) preparation of the shipping cask and transporter for shipment offsite, including repair and replacement of shipping casks, and vehicle preparation. Analysis of this subtopic has further indicated that 10 CFR Part 60 contains few specific criteria with respect to facilities, equipment, and operations involving the insertion or removal of waste into/from shipping casks and the loading or unloading of casks onto/from vehicles. All of these considerations are addressed by safe handling of the waste at the GROA.

(4) **Common Activities Related to Receipt and Shipment**

Elements for inspection are covered in the section 4.18 ROC Topic. Elements for inventory control are covered in the section 4.3 ROC Topic. Elements for use of personnel for receipt and shipment are covered in the section 4.26 ROC Topic.

4.13.4 Safety Functions and Regulatory Citations

4.13.4.1 Associated Safety Functions

(1) **Siting Considerations**

No safety functions associated with siting considerations were identified from the "Repository Functional Analysis" (Ref. 1).

(2) **Treatment of Secondary Waste for Off-site Shipment**

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

- Contaminated material processing and package facility (if required) - 6.41.9.1.6
- Contaminated material processing and packaging equipment (if required) - 6.41.9.2.8

(3) Preparation for Waste Transport or Receipt

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

- Prepare waste disposal package for off-site shipment (if required) - 5.8.15
- Limit personnel radiation exposure during normal waste preparation operations - 5.16.1
- Limit radiation level of waste contained in waste preparation operations - 5.16.2
- Repository holding facility and yard for off-loaded railcars/trucks during disposal package component receiving - 5.35.2.1.5 (see also 6.41.2.1.4)
- Equipment for receiving waste disposal package components during waste preparation receiving operations - 5.35.2.2
- Equipment for off-loading waste disposal package components from transportation vehicle - 5.35.2.2.2
- Equipment for waste packaging - 5.35.5.2
- Equipment for the movement of waste, waste disposal package components, and assembled waste disposal packages in the waste packaging process - 5.35.5.2.4
- Equipment for waste repackaging (if required) - 5.35.5.2.8
- Off-load transportation package from transportation vehicle upon receipt (if required) - 6.2.2
- Remove waste from transportation package in receiving - 6.2.4
- Inspect and test waste received for disposal to verify condition and content - 6.2.5
- Prepare waste for off-site shipment during repository waste handling operations (as required) - 6.10
- Repair/replace shipping cask (as necessary) for off-site shipment - 6.10.2
- Prepare shipping cask for shipment - 6.10.3
- Assemble transportation package (shipping cask with waste) in preparation for off-site shipment - 6.10.7
- Load transportation package onto transportation vehicle for off-site shipment (if required) - 6.10.8
- Repository facilities for complete external inspection/survey of off-site transportation vehicle (e.g., railcar and truck) - 6.41.2.1.1
- Repository demurrage area for railcars/trucks carrying waste - 6.41.2.1.2
- Repository facility for off-loading transportation package/waste from transportation vehicle - 6.41.2.1.3

- Radiation-controlled repository facility for removing waste from transportation package - 6.41.2.1.5
- Radiation-controlled repository facility for waste inspection and test in receiving operations - 6.41.2.1.6
- Repository facility for loading waste for intra-facility transfer from receiving - 6.41.2.1.7
- Ventilation and air conditioning for repository waste receiving facilities - 6.41.2.1.8
- Facility for maintenance of repository waste receiving facility and equipment - 6.41.2.1.9
- Equipment for repository waste receiving operations - 6.41.2.2
- Repository equipment for off-loading transportation package/waste from off-site transportation vehicle - 6.41.2.2.2
- Repository equipment for removing waste from transportation package in receiving operations - 6.41.2.2.3
- Repository equipment for waste inspection and test during receiving - 6.41.2.2.4
- Radiation-controlled facility for assembling transportation package - 6.41.8.1.6
- Monitoring equipment for waste in preparation for off-site shipment - 6.41.8.2.6
- Equipment for assembling transportation package - 6.41.8.2.7
- Trained and certified personnel for off-site shipment operations - 6.41.8.4
- Trained and certified personnel for preparation of shipping cask for waste off-site shipment operations - 6.41.8.4.1
- Trained and certified personnel for waste handling (e.g., load/off-load) in off-site shipment operations - 6.41.8.4.2
- Trained and certified personnel for inspecting and testing waste disposal package in preparation for off-site shipment - 6.41.8.4.3
- Trained and certified personnel for refurbishment of waste disposal package in preparation for off-site shipment - 6.41.8.4.4
- Trained and certified personnel for off-site shipment unsafe/emergency conditions - 6.41.8.4.5
- Procedure(s) for waste off-site shipment operations - 6.41.8.5
- Procedure(s) for preparation of shipping cask for waste off-site shipment - 6.41.8.5.1
- Procedure(s) for waste handling (e.g., load/off-load) in off-site shipment operations - 6.41.8.5.2
- Procedure(s) for inspecting and testing waste disposal package in preparation for off-site shipment - 6.41.8.5.3

- Procedure(s) for refurbishment of waste disposal package in preparation for off-site shipment - 6.41.8.5.4
- Procedure(s) for waste off-site shipment radiological unsafe/emergency conditions - 6.41.8.5.5
- Procedure(s) to ensure fitness for duty of personnel certified for waste off-site shipment operations - 6.41.8.5.6

(4) Common Activities Related to Receipt and Shipment

Inspection is covered by the section 4.18 ROC Topic. Inventory control is covered by the section 4.3 ROC Topic. Use of personnel for receipt and shipment is covered by the section 4.26 ROC Topic.

4.13.4.2 Relevant Regulatory Citations

- 10 CFR 60.21(a), 60.21(c)(12), 60.31(a), 60.31(c), 60.131(b)(10), 60.132(a), and 60.132(d)
- 10 CFR 72.34, 72.108, and 72.128(b)

4.13.4.3 Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations

(1) Siting Considerations

10 CFR 72.34 requires the submission of an environmental report. This is similar to 10 CFR 60.21(a), which requires an Environmental Impact Statement (EIS) to be prepared in accordance with the NWPA (Ref. 17).

10 CFR 72.108 contains a requirement to evaluate the proposed ISFSI or MRS with respect to potential impact on the environment of the transportation of spent fuel or high-level waste within the region, and no similar requirement is in 10 CFR Part 60. The environmental report required by 10 CFR 72.34 and 60.21(a) may contain information regarding the transportation of radioactive waste. The siting criteria contained in 10 CFR 72.108 require the specific consideration of facility impact with respect to the transportation of radioactive waste on the region. Also, 10 CFR Part 60 contains no siting criteria for preclosure activities, as per the NRC's Federal Register Statement (Ref. 18). Siting considerations are analyzed in the sections 4.12 and 5.1 ROC Topics, but site considerations related to transportation are addressed in this ROC Topic.

The environmental report required by 10 CFR 72.34 would contain information regarding transportation of radioactive waste and its impact on the environment. It appears that 10 CFR 72.108 may be a redundant requirement. It may be that the intent of 10 CFR 72.108 is not specifically covered by 10 CFR 72.34 because 10 CFR 72.108 addresses specifically the radiological health and safety impact on the public in regard to the *facility* and not just transportation of waste in general.

(2) Treatment of Secondary Waste for Offsite Shipment

The safety functions are generally covered by 10 CFR 60.132(d). Review of pertinent regulatory citations revealed that 10 CFR 60.21(c)(12) requires plans for alternate storage of wastes should the repository prove to be unsuitable. 10 CFR 60.132(d) requires that radioactive waste treatment facilities be designed to process any radioactive wastes generated at the GROA into a form suitable for disposal at the GROA, or permit safe transportation and conversion to a form suitable for disposal at an alternative site in accordance with any applicable regulations. 10 CFR 72.128(b) and 60.132(d) both require radioactive waste treatment facilities. Provisions must be made for the treating or packaging of site-generated low-level wastes in a form suitable for storage or disposal onsite or transfer to a disposal site.

(3) Preparation for Waste Transport or Receipt

The associated safety functions for receipt or shipment are addressed in 10 CFR 60.132(a) by generally requiring safe handling of waste. Review of pertinent regulatory citations revealed that 10 CFR Part 60 contains no specific criteria regarding offsite shipment of HLW, while requirements for offsite shipment of secondary storage are addressed. 10 CFR 60.21(c)(12) requires plans for alternate storage of wastes should the repository prove to be unsuitable, but does not specifically address offsite shipment. Also, 10 CFR 60.132(a) requires that surface facilities allow safe handling and storage, but does not specifically address offsite shipment of HLW. 10 CFR Part 60 does require (1) plans for alternate storage, and (2) safe handling of waste, which is related to loading or unloading waste for offsite shipment or receipt. Criteria that address loading or unloading are also found in 10 CFR 60.131(b)(10), which addresses shaft conveyances.

(4) Common Activities Related to Receipt and Shipment

Inspections are covered in the section 4.18 ROC Topic. Inventory control is covered in the section 4.3 ROC Topic. Use of personnel for receipt and shipment is covered in the section 4.26 ROC Topic.

4.14 PRECLOSURE INTERFACES

This ROC Topic has the following subtopics:

(1) Integration of Design, Construction, and Operation
(2) Human Factors
(3) Control Room Facilities

(4) External Interfaces
(5) Internal Interfaces

4.14.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) Integration of Design, Construction, and Operation

The current regulations sufficiently and adequately address integration of design, construction, and operation in 10 CFR 60.21(c)(2), 60.31(a)(1), and 60.31(a)(6) and in 10 CFR Part 50, Appendix B-III.

(2) Human Factors

The requirements for human factors engineering and reliability analysis are sufficiently and adequately addressed in 10 CFR 60.21(c)(2)(iv), 60.21(c)(3), 60.21(c)(6), 60.21(c)(14), and 60.131(b)(8) and in 10 CFR Part 50, Appendix B-III.

(3) Control-Room Facilities

Design criteria for a control room or control area are sufficiently and adequately addressed in 10 CFR 60.131(b)(8).

(4) External Interfaces

The criteria relevant to external interfaces are sufficiently and adequately addressed in 10 CFR Part 60 and its referenced regulations.

(5) Internal Interfaces

10 CFR Part 60 has sufficient and adequate criteria for design of structures, systems, and components important to or associated with safety to ensure that interfaces are considered, by referencing 10 CFR Part 50, Appendix B.

4.14.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) Integration of Design, Construction, and Operation

Concept. Criteria are needed that integrate the design, construction, and operation of a repository.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.21(c)(2), 60.31(a)(1), and 60.31(a)(6) and in 10 CFR Part 50, Appendix B-III, which is referenced by 10 CFR 60.152.

Rationale for the Operational Criteria. The above cited criteria fully address this concept because they require the integration of design, construction, and operation relevant to safety. Also, it is understood that the design process must consider construction and operational processes, to ensure functionality.

(2) **Human Factors**

Concept. Criteria are needed to require a program to begin during design and follow into operations until permanent closure, for human factors engineering and reliability analysis.

Operational Criteria. The operational criteria to address this concept are presented in 10 CFR 60.21(c)(2)(iv), 60.21(c)(3), 60.21(c)(6), 60.21(c)(14), and 60.131(b)(8) and in 10 CFR Part 50, Appendix B-III.

Rationale for the Operational Criteria. The above cited criteria are judged to adequately address the concept because human factors engineering is generally understood to be a method required to assure full compliance with the regulatory requirements in 10 CFR 60.131(b)(8). The criteria to perform a reliability analysis of the design are contained in 10 CFR 60.21(c)(2)(iv), 60.21(c)(3), 60.21(c)(6), 60.21(c)(14) and 10 CFR Part 50, Appendix B-III.

Examples of where the application of human factors engineering is suggested for criteria similar to 10 CFR 60.131(b)(8) are in Standard Review Plan (SRP) 18.1 and 18.2 of NUREG-0800 (Ref. 19). SRP 18.2 on page 18.2-A5 states, "The control room instrumentation required (see General Design Criteria 13 and 19 of Appendix A-II to 10 CFR 50) provides the operators with the information necessary for safe reactor operation under normal, transient, and accident conditions. . . . The SPDS (safety parameter display system) shall be designed to incorporate accepted human factors principles so that the displayed information can be readily perceived and comprehended by SPDS users." Also, NUREG-0800 (Ref. 19) in SRP 18.1 on page 18.1-2 states, "A human factors engineering evaluation of designs, at operating reactors, of the remote shutdown capability provided to meet 10 CFR Part 50, Appendix A-II, Criterion 19 and 10 CFR Part 50, Appendix R is not specifically required. However, the staff recommends that the scope of the DCRDR (detailed control room design review) include a human factors engineering evaluation of the remote shutdown capability." Criteria 13 and 19, Appendix A-II, 10 CFR Part 50, have similar texts and concepts as compared to 10 CFR 60.131(b)(8), even though it is more generally written.

Note: Human factors are explicitly addressed in 10 CFR 50.34(f)(2)(ii) and 50.34(f)(2)(iii).

(3) **Control Room Facilities**

Concept. Criteria are needed so that a control room or area, as appropriate, will be designed to permit occupancy and actions to be taken to control and monitor safety during a radiation accident and to provide safe operation.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.131(b)(8).

Rationale for the Operational Criteria. The criteria in 10 CFR 60.131(b)(8) fully address the concept because they are generally written to address control and monitoring of the structures, systems, and components important to safety, and address normal operations and accident conditions.

Note: Specific criteria for a central control room are in 10 CFR 50.34(f)(2), 50.54(m)(2), and 72.122(j).

(4) **External Interfaces**

Concept. The GROA should be designed to ensure safety where external interfaces are required. These external interfaces include utilities, communications, offsite emergency services, transportation, the public, and NRC.

Operational Criteria. Operational criteria to address this concept are presented in 10 CFR 60.131(b)(5)(iii), 60.131(b)(4)(ii), 10 CFR 20.2201, 20.2202, 20.2203, 20.2204, and 20.2206, and 10 CFR Part 21. These regulations also address communications with NRC. External communications with other outside agencies would only be required for emergencies, and this is addressed in 10 CFR 60.131(b)(5)(iii).

Rationale for the Operational Criteria. The above cited criteria fully address this concept because they are broadly written to address the numerous external interfaces which must be included in the GROA design.

(5) **Internal Interfaces**

Concept. Criteria are needed for addressing internal interfaces to ensure safe operation of structures, systems, and components important to safety.

Operational Criteria. The operational criteria to address this concept are presented in 10 CFR 60.21(c)(2) and 60.21(c)(5). The internal interface of utilities is addressed by 10 CFR 60.131(b)(5). 10 CFR 60.132(a) addresses the interface of the wastes and the surface facility, and 10 CFR 60.133(e) addresses the interface of the underground openings and operation therein. Consideration of overall interfacing of the features of the GROA that are important to safety is given in 10 CFR Part 50, Appendix B-III, which is referenced by 10 CFR 60.152.

Rationale for the Operational Criteria. The above cited criteria fully address the concept because they consider interfaces of equipment important to safety in order to ensure that overall waste handling and storage are conducted safely.

4.14.3 Elements Considered for Regulation

4.14.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) Integration of Design, Construction, and Operation

Elements associated with integration of design, construction, and operation are as follows:

- Development of the access (e.g., ramps, shafts, and drifts for the GROA)
- Development of exploratory shaft facilities
- Selection of designs, materials, parts, and equipment
- Assessment of the compliance to regulatory requirements of the final design
- Establishment of quality standards for all design documents
- Establishment of procedures for the review, approval, release, distribution and revision of design documents
- Establishment of change control procedures
- Start-up testing
- Construction inspections to assure meeting of design specifications
- Worker training and supervision
- Plant mock-ups for training
- Systems engineering
- Human factors engineering
- Configuration management
- Reliability analysis
- Scenario development and fault-tree analysis
- Application of operational experience
- Equipment and system maintainability
- Preventive and predictive maintenance

(2) **Human Factors**

Elements associated with human factors (the man/machine interfaces) are as follows:

- Human error analysis and preventions
- Instrumentation control and display
- Performance-shaping factors
- Alarming and announcing systems recognition
- Operational monitoring, control, and communication interfaces
- Hazard and safety protection implementation
- Environmental factors in operating areas
- Efficient movement of people and equipment
- Maintenance accessibility
- Presentation of technical information on safety and control systems
- Use of tools, parts, and test equipment
- Personnel training and retraining
- Emergency response procedures
- Facility and equipment design
- Quantitative measurement of human performance

(3) **Control Room Facilities**

Elements of control room facilities are as follows:

- Control room facilities with built-in multiple fission product barriers
- Control room operation for control and monitoring under normal, off-normal, and radiation accident conditions and events
- Continuous monitoring capabilities
- Utilities, facilities, essential services, and operations important to or associated with safety

(4) **External Interfaces**

Elements of external interfaces are as follows:

- Solidified waste/repository
- Waste package supplier/repository
- Nuclear power plant utilities/repository
- MRS or ISFSI/repository
- Waste transport operator/repository
- Repository/low-level waste repository

- Repository/offsite emergency facilities
- Repository/offsite utilities
- Offsite emergency services/onsite services
- Offsite utilities/onsite utilities
- Offsite fire-fighting services/onsite fire-fighting
- Offsite medical care facilities/onsite medical care facilities
- Offsite environmental protection facilities and personnel/onsite environmental protection facilities and personnel
- Onsite/offsite environmental monitoring
- Cask receiving equipment/cask
- Cask unloading equipment/cask
- Cask transfer equipment/cask
- Inspection equipment/waste and waste package
- Offsite solidified waste/onsite compatibility testing
- Communications
- Visitors' facilities and tours
- Access road receipt and shipment requirements

(5) **Internal Interfaces**

- Surface/subsurface facilities
- Surface facilities/waste handling and consolidation processes
- Surface/subsurface equipment maintenance
- Waste receiving/storage facilities
- Hot cells layout/radiation shielding
- Waste transport/storage facilities
- Cask preparation/storage facilities
- Waste water treatment/decontamination
- Cask receiving/shipping bays
- Waste emplacement/retrieval operations
- Land use plan/the GROA
- Local communities and traffic
- Management of emergency response
- Emergency power/utility services
- Onsite, fire, medical, and security services
- Management for monitoring and testing for safety
- Waste carriage between facilities
- Waste inventory/monitoring systems
- Onsite transport equipment
- Waste emplacement equipment
- Shield plug installer/remover
- Waste retrieval system
- Cask preparation/decontamination station
- Waste container transporter

- Repository/offsite emergency facilities
- Repository/offsite utilities
- Offsite emergency services/onsite services
- Offsite utilities/onsite utilities
- Offsite fire-fighting services/onsite fire-fighting
- Offsite medical care facilities/onsite medical care facilities
- Offsite environmental protection facilities and personnel/onsite environmental protection facilities and personnel
- Onsite/offsite environmental monitoring
- Cask receiving equipment/cask
- Cask unloading equipment/cask
- Cask transfer equipment/cask
- Inspection equipment/waste and waste package
- Offsite solidified waste/onsite compatibility testing
- Communications
- Visitors' facilities and tours
- Access roads/receipt and shipment requirements

(5) Internal Interfaces

- Surface/subsurface facilities
- Surface facilities/waste handling and consolidation processes
- Surface/subsurface equipment maintenance
- Waste receiving/storage facilities
- Hot cells layout/radiation shielding
- Waste transport/storage facilities
- Cask preparation/storage facilities
- Waste water treatment/decontamination
- Cask receiving/shipping bays
- Waste emplacement/retrieval operations
- Land use plan/the GROA
- Local communities and traffic
- Management of emergency response
- Emergency power/utility services
- Onsite, fire, medical, and security services
- Management for monitoring and testing for safety
- Waste carriage between facilities
- Waste inventory/monitoring systems
- Onsite transport equipment
- Waste emplacement equipment
- Shield plug installer/remover
- Waste retrieval system
- Cask preparation/decontamination station
- Waste container transporter

- Cask receiving/surface facilities
- Unloading hot cell/empty container storage
- Cask preparation/transfer tunnel
- Surface storage vault/out transfer bay
- Unloading hot cell/cask shipping bay
- Maintenance cell for decontamination station
- Container welding station/unloading hot cell
- Glove box unit/equipment maintenance station
- Air exhaust systems/consolidation hot cell
- Fuel handling grapple/loading or unloading hot cell/waste packages
- Bridge cranes/cask receiving and shipping bay
- Spent fuel condition/consolidation hot cell
- Weld inspection/packaging hot cell
- Inspection/waste preparation
- Control systems/any operations
- Low-level waste/onsite disposal
- Radiation control of the above

4.14.3.2 *Comments on and Discussion of the Elements Considered for Regulation*

(1) Integration of Design, Construction, and Operation

In order to ensure safety, the design, construction, and operation must be integrated. It is possible to design a "perfect facility" and have poor construction result in a radiation accident. Likewise, it is possible to design and construct a "perfect facility" and have an operator cause a radiation accident. 10 CFR Part 60 explicitly addresses integration of design, construction, and operation of SSCIS by reference to 10 CFR Part 50, Appendix B. Also, good engineering judgment assures integration of design, construction, and operation. Application of good engineering judgment is a method used in design and not a parameter to be governed by regulatory criteria.

(2) Human Factors

Consideration of human factors in the design, construction, and operation of the GROA may not be explicitly covered as it is in 10 CFR 50.34(f)(2). Human factors are important to the safe operation of a complex facility that handles a large volume of hazardous materials. Application of human factors is akin to good engineering judgement for integration of design and operations. Therefore, human factors would also be an implied integral part of facility design.

(3) **Control Room Facilities**

10 CFR Part 60 has criteria for the design of control systems for a GROA in 10 CFR 60.131(b)(8). These criteria for control and monitoring systems would address the elements associated with a control room.

(4) **External Interfaces**

10 CFR Part 60 has criteria addressing interfaces with offsite utilities, external disposal and transport of site-generated low-level waste, and emergency facilities. The repository should to the extent practicable be self-sufficient; but there are external interfaces, such as HLW transportation, local population safety, and external communication with local agencies. These are addressed by NRC regulations, the EIS, or DOT regulations.

(5) **Internal Interfaces**

Elements associated with the internal interfaces have been covered in the current 10 CFR Part 60 in 60.21(c)(2), 60.21(c)(15), 60.131(b)(5), 60.132(a), 60.132(e), and 60.152 (that references 10 CFR Part 50, Appendix B-III). There are sufficient specific criteria in 10 CFR Part 60 and the referenced 10 CFR Part 50, Appendix B, to require that the design of the GROA consider the integration of the various facilities at the site to ensure safe operations.

4.14.4 Safety Functions and Regulatory Citations

4.14.4.1 Associated Safety Functions

(1) **Integration of Design, Construction, and Operation**

No safety functions that addressed integration of design, construction, and operations of a repository were identified from the "Repository Functional Analysis" (Ref. 1).

(2) **Human Factors**

No safety functions that specifically addressed human factors were identified from the "Repository Functional Analysis" (Ref. 1).

(3) **Control Room Facilities**

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

- Prevent unauthorized access to (and activities in) operations areas - 2.8
- Account for access and egress of authorized visitors - 2.8.1
- Control temporary individual authorizations for access to operations areas and specific facilities - 2.8.2
- Detect and respond to intrusions and other unauthorized activities - 2.8.3
- Control configuration of operational security and safeguards facilities, equipment, software and procedures - 2.[illegible]
- Manage the configuration of waste preparation facilities, equipment, software and procedures - 5.13
- Perform configuration management for waste disposal operations system elements - 6.12
- Surface general purpose (non-waste handling) facilities and equipment for repository operations - 6.41.1.1

(4) External Interfaces

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

- Prevent theft, sabotage, or terrorism in waste management facilities - 2.9
- Prepare waste disposal package for off-site shipment (if required) - 5.8.15
- Implement worker evacuation plan as appropriate during waste preparation operations - 5.16.7.5 (*sic* 5.16.2.5)
- Implement worker/public evacuation plan as appropriate in event of accidental release during waste preparation operations - 5.17.3.4
- Prepare waste for off-site shipment during repository waste handling operations (as required) - 6.10

(5) Internal Interfaces

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

- Dispatch waste from lag storage - 5.4.6
- Dispatch waste disposal package components from lag storage - 5.5.6
- Implement worker evacuation plan as appropriate during waste preparation operations - 5.16.7.5 (*sic* 5.16.2.5)

- Dispatch waste disposal package from repository lag storage - 6.4.5
- Coordinate transfer of individual waste disposal package - 6.5.1.3
- Prepare waste for inter-facility transfer during waste removal operations - 6.9.12
- Remove underground facilities (plumbing, HVAC, etc.) and equipment (as appropriate) - 6.11.1.2
- Ensure operability of repository general purpose (non-waste handling) facilities and equipment - 6.29
- Ensure the stability of repository general purpose (non-waste handling) surface facilities under local foundation conditions - 6.30
- Ensure the ability of repository general purpose (non-waste handling) facilities and equipment to perform their intended functions under naturally induced conditions and events (e.g., weather, seismic activity) - 6.31
- Ensure the ability of repository general purpose (non-waste handling) surface facilities and equipment to perform their intended functions under conditions and events induced by human activity - 6.32

4.14.4.2 Relevant Regulatory Citations

- 10 CFR 20.2201, 20.2202, 20.2203, 20.2204, and 20.2206
- 10 CFR 50.34(f)(2), 50.34(f)(3), 50.47(b)(2), 50.47(b)(3), 50.54(m)(2), and Part 50, Appendix A-II, Criterion 13 and Criterion 19, Appendix B-III, and Appendix R
- 10 CFR 60.21(c)(2), 60.21(c)(3), 60.21(c)(5), 60.21(c)(6), 60.21(c)(14), 60.21(c)(15), 60.31(a)(1), 60.31(a)(6), 60.111(a), 60.131(b)(4)(ii), 60.131(b)(5), 60.131(b)(8), 60.132(a), 60.132(e), 60.133(e), and 60.152
- 10 CFR 72.120, 72.122(d), 72.122(e), 72.122(g), 72.122(j), 72.122(k), and 72.146
- 40 CFR Part 191, Subpart A

4.14.4.3 Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations

(1) Integration of Design, Construction, and Operation

10 CFR 72.120 requires application of all design criteria to design, construction, and operations (testing, maintenance, and performance) for SSCIS. The integration of design, construction, and operation has also been explicitly specified in 10 CFR Part 60 by

reference to 10 CFR 50, Appendix B-III. 10 CFR 50.34(f)(2)(ii) requires establishment of a program, to begin during construction and follow into operation, for integrating and expanding current efforts to improve plant procedures. 10 CFR 60.21(c)(2) addresses integration of construction and the design of GROA.

QA related to design control for construction and operation has been addressed in 10 CFR 50.34(f)(3); 10 CFR Part 50, Appendix B-III; and 10 CFR 72.120(a) and 72.146. Design control for the structures, systems, and components important to safety, to waste isolation, and to related activities is covered through the application of 10 CFR Part 50, Appendix B, as referenced in 10 CFR 60.152.

(2) Human Factors

The consideration for human factors is not explicit in 10 CFR Parts 60 and 72. 10 CFR Part 50 has addressed human factors as part of design, construction, and operational requirements, as stipulated in 10 CFR 50.34(f)(2)(ii) and 50.34(f)(2)(iii).

(3) Control Room Facilities

Design criteria for a control system (or control room) for the GROA have been addressed in 10 CFR 60.131(b)(8). Requirements for a control room and for protection of the control room staff against radiation releases have been stipulated in 10 CFR 50.34(f)(2)(iii, iv, xi, xii, xvii, xviii, xxii, and xxviii), 50.54(m)(2)(iii), and Part 50, Appendix A-II, Criterion 19. 10 CFR 72.122(j) has similar requirements for a control room, or control area, if appropriate for the ISFSI or MRS design. For a passive storage facility where ambient cooled monolithic storage containers are used, a control room or area would not seem appropriate.

(4) External Interfaces

Several safety considerations for the interfaces between the GROA and other offsite facilities are specified in 10 CFR Part 60. The protection measures and offsite support in the event of an emergency, such as that stipulated in 10 CFR 50.47(b)(2) and (3), have been covered by the combined application of 10 CFR 60.131(b)(4)(ii), 60.131(b)(5)(ii), and 60.131(b)(5)(iii). The interface with HLW receipt may be considered covered through the application of 10 CFR 60.21(c)(5), the EIS, and the 10 CFR Part 71 regulations.

10 CFR Part 72 addresses (1) shared facilities [72.122(d)], (2) proximity to other sites [72.122(e)], (3) offsite emergency facilities and services [72.122(g)], and (4) shared or offsite utilities [72.122(k)]. 10 CFR Part 60 has addressed similarly (3) and (4) above in 60.131(b)(4)(ii) and 60.131(b)(5)(iii). Item (1) is not addressed by 10 CFR Part 60 because it is assumed under the current statutory environment that the repository will not rely on or share offsite facilities, other than those mentioned above. 10 CFR Part 60 has addressed the concern regarding the proximity to other sites and the cumulative effects of their combined

operations to not constitute an unreasonable risk to the public. 10 CFR 60.111(a) references applicable EPA standards (40 CFR Part 191, Subpart A), which have a 0.025 rem limit for public exposure. This limit is based on four nuclear facilities in the same proximity. By referencing the EPA standards, 10 CFR Part 60 addresses the same concerns expressed in 10 CFR 72.122(e).

(5) Internal Interfaces

Plans for using the GROA for activities other than HLW disposal have been addressed in 10 CFR 60.21(c)(15)(vii). 10 CFR Part 60 is similar to 10 CFR Parts 50 and 72 in regard to requiring the onsite facilities and operations interface to ensure safe operations. These regulations directly address design interfaces of structures, systems, and components important to safety, by reference to 10 CFR Part 50, Appendix B-III, second paragraph.

4.15 OPERATING PROCEDURES

There are no subtopics for this ROC Topic.

4.15.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

10 CFR Part 60 contains criteria regarding procedures in 10 CFR 60.31(a)(6) and more detailed criteria referenced by 60.152 in 10 CFR Part 50, Appendix B that are sufficient and adequate. Also, any operational procedure is an implied part of the design of a facility, and the existing design criteria are adequate for radiation safety.

4.15.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

Concept. Criteria applicable to operating procedures are necessary for radiological control operations and for operations important to safety.

Operational Criteria. The operational criteria required to address this concept are presented in 10 CFR 60.31(a)(6) and 10 CFR Part 50, Appendix B, which is referenced by 10 CFR 60.152.

Rationale for the Operational Criteria. The criteria in 10 CFR 60.31(a)(6) and 10 CFR Part 50, Appendix B, fully address the concept for preparation, review, maintenance, and storage of operational procedures because 10 CFR 60.31(a)(6) is broadly written and the more detailed criteria of 10 CFR Part 50, Appendix B, have been used successfully for several years for facilities that have similar or more demanding procedure requirements as compared to a potential repository.

4.15.3 Elements Considered for Regulation

4.15.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

The elements relevant to operating procedures cut across many activities that are expected to be ongoing at the GROA. For clarity, they can be divided into two categories: (1) procedures "important to safety" and (2) procedures necessary for radiological control.

Procedures are written instructions pertaining to (1) operation of equipment, (2) use of certain systems, (3) notification activities, and (4) any other operational activities that are needed to assure a safe environment, such as the following:

- Radiation monitoring and survey activities
- Inspection activities
- Emergency response actions
  - Notification of State and local organizations when alarms have indicated that a radiation accident is underway
  - Implementation of evacuation plans, etc.
- Low-level waste control
- Other radiological control activities
- Mining and industrial safety that may have secondary effects on radiation control

4.15.3.2 Comments on and Discussion of the Elements Considered for Regulation

General criteria are needed regarding operating procedures that are necessary for radiological control as well as for SSCIS. This is required so that procedures are prepared to assure radiation safety at all levels.

4.15.4 Safety Functions and Regulatory Citations

Procedures will be required for several diverse types of operations, but the criteria for any procedures would generally contain the same elements.

4.15.4.1 Associated Safety Functions

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

- Procedure(s) to screen/qualify candidate security and safeguards trainees - 2.20.5.1

- Procedure(s) to train and certify security and safeguards personnel - 2.20.5.2
- Procedure(s) to monitor personnel reliability - 2.20.5.3
- Procedure(s) to conduct periodic training exercises - 2.20.5.4
- Procedure(s) to periodically recertify security and safeguards personnel - 2.20.5.5
- Contingency procedure(s) for the event of loss or theft of special nuclear material - 2.20.5.6
- Procedure(s) for security and safeguards facility and equipment maintenance - 2.20.5.8
- Procedure(s) for waste disposal package components handling in receiving operations - 5.35.2.5.1
- Procedure(s) for waste disposal package components receiving facility and equipment maintenance - 5.35.2.5.5
- Procedure(s) for waste lag storage operations - 5.35.3.5
- Procedure(s) for waste handling in lag storage - 5.35.3.5.1
- Procedure(s) for inspection of waste received for lag storage - 5.35.3.5.2
- Procedure(s) for waste lag storage unsafe/emergency conditions - 5.35.3.5.3
- Procedure(s) for waste lag storage facility and equipment maintenance - 5.35.3.5.4
- Procedure(s) for waste packaging operations - 5.35.5.5
- Procedure(s) for waste handling in repository lag storage - 6.41.3.5.1
- Procedure(s) for inspection of waste disposal package received for repository lag storage - 6.41.3.5.2
- Procedure(s) for waste lag storage radiological unsafe/emergency conditions during repository operations - 6.41.3.5.3
- Procedure(s) for waste lag storage facility and equipment maintenance during repository operations - 6.41.3.5.4
- Procedure(s) for waste transfer conveyance operations - 6.41.4.5.1
- Procedure(s) for waste transfer equipment maintenance - 6.41.4.5.3
- Procedure(s) for waste transfer network maintenance - 6.41.4.5.4
- Procedure(s) to ensure fitness for duty of personnel certified for waste transfer operations - 6.41.4.5.5
- Procedure(s) for waste emplacement - 6.41.5.5.1
- Procedure(s) for monitoring during repository operations - 6.41.6.5
- Procedure(s) for removal of waste from emplacement opening/location - 6.41.7.5.1
- Procedure(s) for waste removal radiological unsafe/emergency conditions - 6.41.7.5.2
- Procedure(s) for waste off-site shipment operations - 6.41.8.5
- Procedure(s) for backfill material processing (if required) - 6.41.9.5.1

- Procedure(s) for backfill emplacement - 6.41.9.5.2
- Procedure(s) for seal material processing (if required) - 6.41.9.5.3
- Procedure(s) for seal emplacement - 6.41.9.5.4
- Procedure(s) for decontamination - 6.41.9.5.6
- Procedure(s) for contaminated material processing and packaging during closing and decommissioning - 6.41.9.5.8

4.15.4.2 Relevant Regulatory Citations

- 10 CFR 50.2, and Part 50, Appendix B
- 10 CFR 60.31(a)(6), 60.44(a)(1)(ii), 60.44(b), 60.46(a)(5), and 60.152
- 10 CFR 61.12(k)
- 10 CFR 72.146, 72.150, 72.152, 72.158, 72.160, 72.162, 72.166, and 72.170

4.15.4.3 Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations

The safety functions identified the need for procedures that cross a wide spectrum of activities including security and safeguards, normal operations, off-normal conditions and events, emergencies (accidents), monitoring, emplacement activities, waste retrieval, and offsite shipment of waste. A review of the regulations revealed the following pertinent regulatory citations regarding procedures:

- 10 CFR Part 50, Appendix B-III, requires that measures shall be established so that applicable regulatory requirements and the design basis, as defined in 10 CFR 50.2 and as specified in the license application, for those structures, systems, and components to which this appendix applies, are correctly translated into specifications, drawings, procedures, and instructions.
- 10 CFR 60.44(a)(1)(ii) and 60.44(b) permit DOE to make changes in the procedures as described in the application.
- 10 CFR 60.46(a)(5) requires a license amendment for any substantial change to the design or operating procedures from that specified in the license.
- 10 CFR 60.152 requires DOE to implement a QA program based on the criteria of Appendix B of 10 CFR Part 50, as applicable, and appropriately supplemented by additional criteria as required.
- 10 CFR 61.12(k) requires specific technical information regarding the radiation safety program. The program description must include procedures, instrumentation, facilities and equipment.

- 10 CFR 72.146, regarding design control, has two criteria:
  - The licensee shall establish measures to ensure that applicable regulatory requirements and the design basis are correctly translated into specifications, drawings, procedures, and instructions.
  - The licensee shall establish written procedures among participating design organizations for the review, approval, release, distribution, and revision of documents involving design interfaces.
- 10 CFR 72.150 requires the licensee to prescribe activities affecting quality by documented instructions, procedures, or drawings of a type appropriate to the circumstances and that these instructions, procedures, and drawings be followed. The instructions, procedures, and drawings must include appropriate quantitative or qualitative acceptance criteria for determining that important activities have been satisfactorily accomplished.
- 10 CFR 72.152 requires the licensee to establish measures to control the issuance of documents such as instructions, procedures, and drawings, including changes, which prescribe all activities affecting quality. These measures must assure that documents, including changes, are reviewed for adequacy, approved for release by authorized personnel, distributed, and used at the location where the prescribed activity is performed. These measures must ensure that changes to documents are reviewed and approved.
- 10 CFR 72.158 requires the licensee to establish measures to ensure that special processes, including welding, heat treating, and nondestructive testing, are controlled and accomplished by qualified personnel using qualified procedures in accordance with applicable codes, standards, specifications, criteria, and other special requirements.
- 10 CFR 72.160 requires the licensee to establish and execute a program for inspection of activities affecting quality by (or for) the organization performing the activity to verify conformance with the documented instructions, procedures, and drawings for accomplishing the activity.
- 10 CFR 72.162 requires the licensee to establish a test program to ensure that all structures, systems, and components important to safety will perform satisfactorily. The test procedures must include provisions for assuring that all prerequisites for the given test are met, that adequate test instrumentation is available and used, and that the test is performed under suitable environmental conditions. The licensee shall document and evaluate the test results to ensure that test requirements have been satisfied.

- 10 CFR 72.166 requires the licensee to establish measures to control, in accordance with work and inspection instructions, the handling, storage, shipping, cleaning, and preservation of materials and equipment to prevent damage or deterioration. When necessary for particular products, special protective environments, such as inert gaseous atmosphere, specific moisture content, and temperature levels must be specified and provided.
- 10 CFR 72.170 requires the licensee to establish measures to control materials, parts, or components that do not conform to the licensee's requirements in order to prevent their inadvertent use or installation. These measures must include, as appropriate, procedures for identification, documentation, segregation, disposition, and notification to affected organizations.

Design control as discussed in 10 CFR Part 50, Appendix B, includes procedures and instructions as part of design for structures, systems, and components important to safety. 10 CFR Part 60 requires adherence to 10 CFR Part 50, Appendix B. Therefore, 10 CFR Part 60 addresses all the same criteria in 10 CFR 72.146 through 72.170 regarding procedures for SSCIS and related activities. 10 CFR Part 60, in 60.31(a)(6), 60.44(a)(1)(ii), 60.44(b), and 60.46(a)(5), addresses procedures necessary for radiological protection and changes to those procedures.

4.16 FIRE AND EXPLOSION PROTECTION

This ROC Topic has the following subtopics:

(1) Effects of Fires and Explosions
(2) Effects of Suppression Systems

Within both subtopics, the use of "features important to isolation" refers to the effects that heat and/or suppression agents can have on the waste package or the geologic setting in which the waste package is emplaced. In a similar manner, the use of "other control features" refers to the effects that fire and explosion may have on those features needed to protect the workers and that may cause secondary effects.

4.16.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) Effects of Fires and Explosions

Fires and explosions have a high potential for producing damaging effects during preclosure operations. Preclosure issues are adequately and sufficiently addressed by the criteria of 10 CFR 60.131(b)(3).

(2) **Effects of Suppression Systems**

The preclosure impact of fire suppression systems is sufficiently and adequately addressed in 10 CFR 60.131(b)(3)(iv).

Note: In regard to isolation, which is beyond the scope of the ROC analysis, the postclosure impact regarding fire and explosion suppression systems may need to be enhanced. This is because the use of suppression systems and the resulting impact on the engineered barriers or surrounding rock by some materials, including water that can alter geochemistry or corrode waste packages, may not be addressed. If, for example, a waste container were emplaced in an area that had been sprayed, the corrosion process might be enhanced as compared to an area free of the effects of fire or explosion suppressant.

4.16.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) **Effects of Fires and Explosions**

Concept. Criteria are needed so that: (1) the GROA is designed to minimize the potential for fires and explosions; (2) the GROA is designed to include fire and explosion detection, alarm, and suppression systems to operate under anticipated conditions and events; and (3) SSCIS are designed to function during and after fires and explosions.

Operational Criteria. Operational criteria needed to address this concept are presented in 10 CFR 60.131(b)(3) and 60.133(a)(2).

Rationale for the Operational Criteria. 10 CFR 60.131(b)(3) and 60.133(a)(2) fully address this concept because the SSCIS are required to be designed to function safely under events including credible fires and explosions. The entire GROA is also required to be designed to be fire and explosion retardant, since prevention is the best solution to fire and explosion control.

(2) **Effects of Suppression Systems**

Concept. Criteria are needed to ensure that the GROA is designed so that the operation or failure of the fire and explosion suppression systems will not have an adverse effect on the features important to safety.

Operational Criteria. Operational criteria needed to address this concept are presented in 10 CFR 60.131(b)(3)(iv).

Rationale for the Operational Criteria. 10 CFR 60.131(b)(3)(iv) addresses this concept in relation to the effects of fire suppression systems on items important to safety because the suppression systems (water, CO_2, or other material) may have an adverse effect if activated. For example, water may contribute to criticality, or CO_2 or nitrogen used for fire or explosion suppression could asphyxiate control room operators.

Note: In regard to isolation, the suppression systems may alter geochemistry for an unsaturated zone, or another fire suppressant may accelerate corrosion of a waste package or alter geochemistry. In the context of postclosure performance, criteria may be needed to ensure that the presence and possible use of suppression/control systems will not jeopardize the geological setting, the waste package, or the EBS. This is discussed further in the section 6.7 ROC Topic.

4.16.3 Elements Considered for Regulation

4.16.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) Effects of Fires and Explosions

Elements relevant to the effects of fires and explosions are as follows:

- Worker safety
- Damage to SSCIS
- Damage to control features not important to safety
- Damage to electrical equipment
- Damage to geologic setting
- Damage to waste packages
- Damage to EBS
- Damage to surrounding rock

(2) Effects of Suppression Systems

Elements of the effects of suppression systems are as follows:

- Any components such as valves, conduits, storage vessels, pumps, etc., associated with delivery of an extinguishing agent to a fire
- Any sensors, monitors, controllers, and alarms used to trigger fire/explosion suppression systems or to notify personnel of hazardous conditions

- Any combination of personnel associated with suppression systems, maintenance of those systems, or application of suppression media to fires (e.g., fire crews must have precise knowledge of fire-fighting methods in relation to the various areas of the repository, and these individuals must be physically and mentally able to perform their intended functions)
- Release of water leading to criticality
- Release of any suppression medium that can cause a failure of equipment important to safety
- Release of suppression medium that is detrimental to worker safety or other control features of the GROA that may lead to secondary effects
- Release of suppression medium that significantly degrades the postclosure performance of a repository
- Failure of an intended release of suppression medium that adversely impacts the SSCIS, workers, other control features, and the postclosure isolation features

4.16.3.2 Comments on and Discussion of the Elements Considered for Regulation

(1) Effects of Fires and Explosions

In regard to the effects of fires and explosions on SSCIS, 10 CFR 60.131(b)(3) addresses the elements relevant to SSCIS. A fire or explosion significantly increases the potential for secondary effects as a consequence of the heat produced, the toxic gas generated, and the oxygen consumed. Any one or combination of these factors can adversely affect the performance of other control features as well as jeopardize the safety of the workers. Secondary effects are discussed in the section 6.4 ROC Topic.

(2) Effects of Suppression Systems

In the context of preclosure considerations, 10 CFR Part 60 is adequate by virtue of the wording of 10 CFR 60.131(b)(3). The potential adverse effects of fires and explosions on features important to isolation are discussed in the section 6.7 ROC Topic. Water may have two detrimental effects. First, it may promote the corrosion of waste packages; and second, it may serve to degrade the geologic media. Therefore, the use of water in both the construction and operational phases of the repository should be analyzed for its potential effect. This, of course, may impact the ability to provide fire protection at least insofar as the choice of extinguishing agent. Water run-off in extinguishing surface fires could threaten the geologic media via access openings or faults. Likewise, runoff in extinguishing underground fires could threaten personnel as well as the integrity of the repository or waste packages.

4.16.4 Safety Functions and Regulatory Citations

4.16.4.1 Associated Safety Functions

(1) Effects of Fires and Explosions

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

- Repository surface-subsurface water distribution facilities and equipment - 5.35.1.3.6
- Aqueous and nonaqueous surface fire protection facilities and equipment for disposal operations - 6.41.1.1.1
- Aqueous and nonaqueous underground fire protection facilities and equipment - 6.41.1.2.4
- Repository surface-subsurface water distribution facilities and equipment - 6.41.1.3.1.6

(2) Effects of Suppression Systems

No safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

4.16.4.2 Relevant Regulatory Citations

- 10 CFR Part 50, Appendix R
- 10 CFR 60.131(b)(3), 60.131(b)(4)(ii), 60.133(a)(2), 60.135(b), and 60.135(c)(3)
- 30 CFR Part 57, Subpart C

4.16.4.3 Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations

(1) Effects of Fires and Explosions

10 CFR Part 60 makes no attempt to separately address the surface and underground facilities of the GROA in regard to fire/explosion prevention or control. The only unique recognition given resides as the reference to MSHA regulations that are applied to the underground facility. 10 CFR 60.131(b)(3)(iii) requires that SSCIS remain functional during and after credible fires or explosions in the GROA. The functionality of SSCIS is also supplemented by 10 CFR 60.131(b)(3)(ii), which emphasizes the use of noncombustible and heat-resistant materials. When compared to 10 CFR Part 72, 10 CFR Part 60 gives a similar treatment of fires and explosions protection.

Note: Criteria pertaining to the effects of fires or explosions on features important to postclosure isolation in 10 CFR 60.135(b) and 60.135(c)(3), which require that the waste package design consider any handling hazards, i.e., fire and explosion hazards, and that the design not contain combustibles.

Protection against the adverse effects of fires and explosions on other control systems is addressed by 10 CFR 60.131(b)(3)(ii), 60.131(b)(3)(iii), 60.131(b)(4)(ii), and 60.133(a)(2). 10 CFR 60.131(b)(3)(ii) specifies the use of noncombustible and heat-resistant materials to the extent practicable. 10 CFR 60.131(b)(3)(iii) requires the GROA to be designed for fire and explosion detection systems and alarms. In addition to the text within 10 CFR 60.131(b)(3), the MSHA regulations invoked by reference include criteria for fire and explosion protection. The relevant sections of 30 CFR Part 57, Subpart C, are directed toward equipment and procedures that typically are not classified as SSCIS. It should be noted that the MSHA regulations apply to both surface and underground features of a mine.

10 CFR Part 50, Appendix R, provides a comprehensive format for fire protection which is much more detailed than that contained within 10 CFR Part 60. While comprehensive, 10 CFR Part 50 is not "application" or "design" specific. Instead, it is generally applicable to any facility wherein fire suppression and control are required to ensure radiation safety. This level of detail may be more appropriate for regulatory criteria guidance for a GROA.

(2) Effects of Suppression Systems

The effects of suppression systems failure or activation on SSCIS are addressed in 10 CFR 60.131(b)(3)(iv). As written, 10 CFR 60.131(b)(3)(iv) requires that the GROA be designed to protect SSCIS against the adverse effects of either the operation or failure of the fire suppression systems. The effects of fire suppression systems on other control features, not important to safety, are not explicit, but would be inherent in the design of SSCIS. The functionality of these other control features may have secondary effects from inadvertent operation or failure of the fire suppression systems. Secondary effects are discussed in the section 6.4 ROC Topic. In regard to impacts on isolation, which are discussed in the section 6.7 ROC Topic, 10 CFR Part 60 contains specific criteria that address the potential adverse effects on isolation.

4.17 UTILITIES, COMMUNICATIONS, EMERGENCY LIGHTING, AND INSTRUMENTATION

This ROC Topic has the following subtopics:

(1) Utility Service Testing
(2) Utility Services

4.17.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) Utility Service Testing

10 CFR 60.131(b)(5)(ii) and 60.131(b)(8) are adequate and sufficient to ensure testing of those utilities important to safety. This is assumed to include utilities which support instruments that monitor SSCIS and emergency lighting associated with the safe operations of SSCIS.

(2) Utility Services

10 CFR 60.131(b)(5), 60.131(b)(8), and 60.21(c)(1)(ii)(E) are adequate and sufficient regarding utility systems and instrumentation and control systems.

4.17.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) Utility Service Testing

Concept. Criteria are needed for utility services, including redundant and back-up systems important to safety, to have appropriate testing of those components to ensure safety.

Operational Criteria. The operational criteria required to address this concept are presented in 10 CFR 60.131(b)(4)(ii) and 60.131(b)(6).

Rationale for the Operational Criteria. The above cited criteria fully address this concept because these criteria are broadly written to address testing of utilities and services to assure safe (and timely) response. All forms of testing are addressed, including on-line operability testing of auxiliary and redundant systems important to safety, because the type or frequency of testing is unspecified.

(2) Utility Services

Concepts. Design criteria are needed for utility and communication systems important to safety and for instrumentation and control systems to monitor behavior of systems important to safety. Also, instrumentation and control systems important to safety need to be listed.

Operational Criteria. The operational criteria required to address this concept are presented in 10 CFR 60.131(b)(5), 60.131(b)(8), and 60.21(c)(1)(ii)(E).

Rationale for the Operational Criteria. The above cited criteria fully address the above concept because they broadly address utility systems/services and instrumentation and control systems needed to assure radiological health and safety. Utility systems encompass water, electric, gas, telephone, and emergency lighting systems. 10 CFR 60.131(b)(5)(ii) is adequate and sufficient to ensure redundancy for those utilities important to safety. This may be assumed to include instruments that monitor SSCIS and emergency lighting associated with the safe operations of SSCIS. 10 CFR 60.21(c)(1)(ii)(E) requires that structures, systems, and components important to safety be identified (listed) in an analysis which must be included in the Safety Analysis Report.

4.17.3 Elements Considered for Regulation

4.17.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) Utility Service Testing

The following are elements of utilities that may be important to safety, and are therefore candidate utilities that may need testing:

- Electrical power supplies important to safety
- Power supply to control rooms or instrumentation important to safety
- Power supply to forced cooling of high-level waste (forced cooling could be by ventilation fans or water pumps and coolers)
- Electric power supply used to move waste between storage location and transfer cask
- Electric power used to emplace waste in an exact location
- Water supplies important to safety
- Water used for forced cooling of high-level waste
- Gas utilities used to operate SSCIS
- Phone and other communication systems

(2) Utility Services

Utilities are listed above. The following are elements of instrumentation and control systems related to such utility services which may be important to safety, and therefore may need to be listed in the Safety Analysis Report.

- Instrumentation and control systems for equipment important to safety
- Monitoring instrumentation used to provide data to control system used to operate equipment important to safety

- Control system used to operate equipment important to safety
- Control-room area and control panels

4.17.3.2 Comments on and Discussion of the Elements Considered for Regulation

(1) Utility Service Testing

Utility services important to safety are commonly designed with features that require periodic on-line testing to verify the functionality of each subsystem. Periodic on-line testing of all utility systems important to safety may be required to ensure that these systems will operate at full capacity individually and in concert with other utility services under anticipated and off-normal conditions and events. This testing mav be important for utility systems and their redundant or backup components important to safety.

(2) Utility Services

It is important to provide utilities, instrumentation, and control systems "important to safety" and list them so that a determination can be made as to the completeness of the design analysis, and whether the design criteria have been met.

4.17.4 Safety Functions and Regulatory Citations

4.17.4.1 Associated Safety Functions

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

(1) Utility Service Testing

- Ensure the ability of waste preparation facilities and equipment important to safety to perform their intended functions under naturally induced conditions and events (e.g., weather, seismic) - 5.32
- Utilities for waste preparation operations - 5.35.1.3
- Interface with utilities from off-site sources - 5.35.1.3.1
- On-site utility distribution facilities and equipment for waste preparation operations - 5.35.1.3.2
- Standby electrical power sources and power distribution facilities and equipment for waste preparation operations important to safety - 5.35.1.3.3
- Uninterruptable power source(s) (e.g., for repository instrumentation, alarms, communications, and lighting important to safety) - 5.35.1.3.4

- Interface with communications from/to off-site sources for waste preparation operations - 5.35.1.4.1
- On-site repository utility and communications distribution facilities and equipment - 6.41.1.3.1
- Interfaces with utilities from off-site sources - 6.41.1.3.1.1
- Repository on-site normal electrical power distribution facilities and equipment - 6.41.1.3.1.2
- Standby electric power sources and power distribution facilities and equipment for repository operations important to safety - 6.41.1.3.1.3
- Uninterruptable power source(s) (e.g., for repository instrumentation, alarms, communications, and lighting important to safety) - 6.41.1.3.1.4
- Repository surface-subsurface water distribution facilities and equipment - 6.41.1.3.1.6
- Interfaces with communications from/to off-site sources - 6.41.1.3.1.8

(2) Utility Services

- Ensure the ability of waste preparation facilities and equipment important to safety to perform their intended functions under conditions and events induced by human activities - 5.33
- Waste preparation generic system elements - 5.35
- Repository surface-subsurface water distribution facilities and equipment - 5.35.1.3.6 (see also 6.41.1.3.1.6)
- Repository sewage collection, treatment, and disposal facilities and equipment - 5.35.1.3.7 (see also 6.41.1.3.1.7)
- Communications for waste preparation operations - 5.35.1.4
- Interface with communications from/to off-site sources for waste preparation operations - 5.35.1.4.1
- On-site communication network facilities and equipment for waste preparation operations - 5.35.1.4.2
- On-site repository utility and communications facilities and equipment - 6.41.1.3.1
- Interfaces with utilities from off-site sources - 6.41.1.3.1.1
- Emergency lighting for repository surface-subsurface common facilities - 6.41.1.3.1.5
- On-site repository communications network facilities and equipment - 6.41.1.3.1.9
- Facilities and equipment to verify geologic repository design data and assumptions - 6.41.1.3.2

4.17.4.2 *Relevant Regulatory Citations*

- 10 CFR 60.21(c)(1)(ii)(E), 60.21(c)(15)(v), 60.131(b)(4)(ii), 60.131(b)(5), 60.131(b)(6), and 60.131(b)(8)
- 10 CFR 72.122(i)

4.17.4.3 *Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations*

(1) Utility Service Testing

A regulatory uncertainty was raised on page B-136 of Appendix B of CNWRA 90-003 (Ref. 7). It stated: "Additional guidance is needed regarding on-line operability testing of auxiliary and redundant systems. On-line operability testing should be explicitly required for redundant, auxiliary, and backup elements of the utility systems. This uncertainty needs to be addressed to ensure adequacy of design and operation of systems important to safety under normal and accident conditions." But it is not stated in 10 CFR 60.131(b)(6) what the periodic schedule should be for testing or if the "testing" is operability testing or exercising. It is clear that any periodic schedule or type of testing would apply to all systems important to safety, as necessary to ensure safety. Also, just because a system is a redundant system does not mean it is not important to safety. In fact, systems important to safety are often designed with redundant and backup components to ensure operability under anticipated and off-normal conditions and events.

Comments in NRC's "Recommendations" report (Ref. 8) for Uncertainty Reference Number 37 on page 54 of Appendix A are paraphrased as follows: The question is whether existing regulations provide adequately for on-line operability testing of auxiliary and redundant utility systems. Those primary systems that are "important to safety" must be subject to necessary testing, so as to satisfy the requirement in 10 CFR 60.131(b)(5)(i) for design so that essential safety functions can be performed. The redundant and backup system, if important to safety, would be equally subject to the on-line operability testing requirements, as necessary. 10 CFR 60.21(c)(15)(v) addresses the "plans for . . . periodic testing of structures, systems, and components" of the GROA. Structures, systems, and components important to safety will be included in the plans.

(2) Utility Services

10 CFR 60.131(b)(8) discusses instrumentation and control systems to monitor behavior of systems important to safety. According to 10 CFR 72.122(i), a listing of instrumentation and control systems "important to safety" must appear in the Safety Analysis Report; and there is a similar requirement in 10 CFR 60.21(c)(1)(ii)(E).

4.18 INSPECTION AND TESTING

This ROC Topic has the following subtopics:

(1) Inspection and Testing To Ensure Reliability and Safety
(2) Inspection and Testing for Information Gathering for Performance Confirmation
(3) Inspection and Testing Records (see the section 6.2 ROC Topic)
(4) Inspection and Testing by NRC or for NRC
(5) Access Engineering for Inspection and Testing

4.18.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) Inspection and Testing To Ensure Reliability and Safety

The current criteria in 10 CFR Part 60 are sufficient and adequate regarding inspection and testing to ensure reliability and safety.

(2) Inspection and Testing for Information Gathering for Performance Confirmation

The current criteria in 10 CFR Part 60, Subpart F (60.140 through 60.143), and 10 CFR 60.137 regarding inspection and testing for information gathering for performance confirmation are sufficient and adequate because they broadly address the performance confirmation criteria.

(3) Inspection and Testing Records

See the section 6.2 ROC Topic.

(4) Inspection and Testing by NRC or for NRC

The current criteria in 10 CFR Part 60 regarding inspection and testing by NRC or for NRC are sufficient and adequate because the applicable sections are broadly written.

(5) Access Engineering for Inspection and Testing

The current criteria in 10 CFR Part 60 regarding access engineering are sufficient and adequate because 10 CFR 60.131(b)(6), 60.131(a)(2), and 60.137 require that the SSCIS be designed to permit safe inspection and testing, that such activities be facilitated, and that the GROA be designed to permit performance confirmation.

4.18.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) Inspection and Testing To Ensure Reliability and Safety

Concept. Criteria are needed to require performance of inspections and testing as necessary to ensure reliability and safety.

Operational Criteria. The operational criteria required to address this concept are presented in 10 CFR 60.21(c)(15)(v), 60.131(a)(6), 60.131(b)(6), and 60.161.

Rationale for the Operational Criteria. The above cited criteria fully address the concept because those elements considered necessary for inspection and testing to ensure reliability and safety are broadly written.

Note: The word "periodic" in 10 CFR 60.21(c)(15)(v) and 60.131(b)(6) may be understood to not require a fixed interval of occurrence. Therefore, a broad application of the current criteria to having inspections that ensure safety and reliability seems appropriate, since some inspections may need to be random from time to time to assure reliability and safety. NRC's "Recommendations" report (Ref. 8) regarding Uncertainty Reference Number 38, page 55, Appendix A, concludes that periodic can mean "occurring repeatedly from time to time."

(2) Inspection and Testing for Information Gathering for Performance Confirmation

Concept. Criteria are needed so that the GROA is designed to allow for conducting safe inspections for performance confirmation.

Operational Criteria. The operational criteria required to address this concept are presented in 10 CFR 60.137, 60.140, 60.141, 60.142, and 60.143.

Rationale for the Operational Criteria. The concept associated with inspections and testing for performance confirmation is addressed by 10 CFR 60.137, 60.140, 60.141, 60.142, and 60.143 because the performance confirmation criteria are very broad in scope and address testing interference.

(3) Inspection and Testing Records

See the section 6.2 ROC Topic.

(4) **Inspection and Testing by NRC or for NRC**

Concept. Criteria are needed to allow for a need for unforeseen inspections and testing.

Operational Criteria. The operational criteria required to address this concept are presented in 10 CFR 60.44, 60.74, and 60.75.

Rationale for the Operational Criteria. The regulations in 10 CFR 60.44, 60.74, and 60.75 fully address this concept because they are broadly written.

(5) **Access Engineering for Inspection and Testing**

Concept. Criteria are needed so that the GROA will be designed to permit safe inspections and testing.

Operational Criteria. The operational criteria required to address this concept to permit testing are presented in 10 CFR 60.131(a)(2), 60.131(b)(6), and 60.137 and in the requirements that require safety during operations, such as 10 CFR 60.43(b)(6), 60.44, 60.111(a), 60.132(a), and 60.133(e)(1).

Rationale for the Operational Criteria. The concept is fully addressed by the criteria cited above because designing to permit safe inspection and testing is equivalent to access engineering. Since inspection is a part of normal operations, designing for safe operations addresses designing for safe inspections.

4.18.3 Elements Considered for Regulation

4.18.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) **Inspection and Testing To Ensure Reliability and Safety**

Elements to be considered in this subtopic are as follows:

- Inspection of SSCIS and their instrumentation
- Inspection of supporting equipment (e.g., electrical equipment, fire protection, ventilation, lighting, monitoring, and alarms)
- Inspection frequency - periodic and nonroutine
- Inspection to verify original function
- Inspection to verify operationally induced flaws (e.g., wear, environmental degradation, and aging)
- Operational inspections (e.g., inspections of personnel, inspections of operating procedures, and evaluations of

emergency simulation)

- Startup testing prior to receipt of HLW
- Testing of personnel before employment
- Inspection for changes in ambient conditions (e.g., groundwater level and rock stability)

(2) **Inspection and Testing for Information Gathering for Performance Confirmation**

Elements to be considered in this subtopic are as follows:

- Design of the GROA so information gathering is possible
- Gathering of information about the environment to ensure that design limits are properly based
- Gathering of information about the man-made facilities to ensure that performance objectives are being met
- Gathering of information as necessary about the geologic setting to ensure that performance objectives can be met

(3) **Inspection and Testing Records**

See the section 6.2 ROC Topic.

(4) **Inspection and Testing by NRC or for NRC**

After the repository design is completed and in operations some additional inspections not planned for may be necessary. These additional inspections may be site, design, or operations specific. For this reason, it is difficult to present specific examples of these types of inspections. Allowance for these types of inspections appears to be addressed in 10 CFR 60.74 and 60.75.

(5) **Access Engineering for Inspection and Testing**

Elements to be considered for this subtopic are as follows:

- Design to facilitate access for inspections where radiation is present
- Design to allow someone or something to inspect a SSCIS
- Allowance for space for inspection equipment
- Allowance for functional verification to be permitted under normal operations, if possible
- Consideration for what inspections may be needed during the design process
- Installation of permanent inspection and testing devices, if

- Consideration of the frequency of inspection, as compared to importance, environment, degree of use, fragility, etc.

4.18.3.2 Comments on and Discussion of the Elements Considered for Regulation

(1) Inspection and Testing To Ensure Reliability and Safety

10 CFR Part 60 requires inspection and testing for SSCIS and personnel that operate SSCIS and monitoring equipment, per 10 CFR 60.131(b)(6), 60.161, and 60.131(a)(6). 10 CFR Part 60 also requires a startup plan which includes preoperational testing to verify original functions, per 10 CFR 60.21(c)(15)(vi). 10 CFR 60.131(b)(6) may appear to limit inspection to "periodic" inspections. An uncertainty about "periodic inspections" is discussed in two reports: CNWRA 90-003 (Ref. 7) on page B-138 of Appendix B and NRC's "Recommendations" report (Ref. 8) regarding Uncertainty Reference Number 38 on page 55 of Appendix A. NRC states in its "Recommendations" report (Ref. 8):

> Designing for non-periodic maintenance is included in 10 CFR 60.131(b)(6). Although the term "periodic" often implies the occurrence of an event at regular intervals it can also refer to events occurring infrequently or from time to time. In the context of 10 CFR 60.131(b)(6), the term "periodic" is meant to cover inspections that are performed on a non-routine basis. It would be illogical to design for inspection, testing, and maintenance only at fixed intervals, if testing on other occasions is also necessary. The design should accommodate the need for special maintenance on modifications to the facility. Furthermore, the regulations provide an alternative adequate basis for this design element, in that 10 CFR 60.130 declares that omissions do not relieve the Department of Energy (DOE) from any obligation to provide safety features needed to achieve its performance objectives.

(2) Inspection and Testing for Information Gathering for Performance Confirmation

The elements for this subtopic appear to be addressed in 10 CFR 60.137 and 60.140-143.

(3) Inspection and Testing Records

See the section 6.2 ROC Topic.

(4) **Inspection and Testing by NRC or for NRC**

The elements for these types of inspections appear to be addressed in 10 CFR 60.74 and 60.75.

(5) **Access Engineering for Inspection and Testing**

The elements required for access engineering appear to be addressed by 10 CFR 60.131(a)(2), 60.131(b)(6), and 60.137.

4.18.4 Safety Functions and Regulatory Citations

4.18.4.1 Associated Safety Functions

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

(1) **Inspection and Testing To Ensure Reliability and Safety**

- Screen/qualify candidate security and safeguards trainees - 2.2
- Train and certify security and safeguards personnel - 2.3
- Monitor personnel reliability - 2.4
- Periodically recertify security and safeguards personnel -2.6
- Procedure(s) to screen/qualify candidate security and safeguards trainees - 2.20.5.1
- Procedure(s) to train and certify security and safeguards personnel - 2.20.5.2
- Procedure(s) to monitor personnel reliability - 2.20.5.3
- Procedure(s) to periodically recertify security and safeguards personnel - 2.20.5.5
- Verify transportation vehicle condition and absence of sabotage devices (e.g., explosives) upon receipt of waste disposal package components - 5.3.1
- Inspect and test waste disposal package components - 5.3.3
- Inspect, test and maintain waste disposal package component receiving facilities and equipment - 5.3.7
- Inspect, test and maintain waste lag storage facilities and equipment - 5.4.7
- Inspect, test and maintain waste disposal package components lag storage facilities and equipment - 5.5.7
- Inspect and/or test waste disposal package - 5.8.7
- Inspect, test and maintain waste disposal packaging facilities and equipment - 5.8.16

- Perform periodic inspection, test and maintenance of waste preparation facilities and equipment - 5.12
- Stop releases at the source during waste preparation operations - 5.16.7.1
- Limit spread of contamination during waste preparation operations - 5.16.7.2
- Facilities for external inspection of complete off-site transportation vehicle (e.g., railcar, truck) during waste disposal package component receiving - 5.35.2.1.1
- Facility for receiving, inspection and test of waste disposal package components during disposal package component receiving - 5.35.2.1.4
- Equipment for external inspection of complete off-site transportation vehicle (e.g., railcar, truck) - 5.35.2.2.1
- Trained and certified inspection and testing personnel for waste disposal package components receiving operations - 5.35.2.4.2
- Procedure(s) for inspection and test of waste disposal package components in receiving operations - 5.35.2.5.2
- Monitoring equipment for waste in lag storage - 5.35.3.2.4
- Trained and certified personnel for inspection of waste received for lag storage - 5.35.3.4.2
- Procedure(s) for inspection of waste received for lag storage - 5.35.3.5.2
- Trained and certified personnel for inspection of waste disposal package components received for lag storage - 5.35.4.4.3
- Procedure(s) for inspection of waste disposal package components received for lag storage - 5.35.4.5.2
- Waste disposal package inspection and test facility - 5.35.5.1.4
- Equipment for waste disposal package inspection and test during/following packaging - 5.35.5.2.7
- Trained and certified inspection and testing personnel for waste packaging operations - 5.35.5.4.2
- Procedure(s) for inspection and testing waste disposal packages during and following waste packaging operations - 5.35.5.5.2
- Inspect waste upon receipt at the repository - 6.2.1
- Verify railcar/truck condition and absence of sabotage devices (e.g., explosives) upon receipt - 6.2.1.1
- Survey transportation package external dose rate upon receipt - 6.2.1.2
- Inspect physical condition of waste upon receipt - 6.2.1.3
- Verify type, amount, and source of waste received - 6.2.1.4
- Inspect and test waste received for disposal to verify condition and content - 6.2.5

- Inspect, test and maintain waste receiving operations facilities and equipment - 6.2.9
- Inspect, test and maintain repository lag storage facilities and equipment - 6.4.6
- Ensure integrity of waste disposal package prior to transfer - 6.5.3
- Inspect, test and maintain receiving operation facilities and equipment - 6.5.11
- Ensure integrity of waste disposal package at start of emplacement - 6.6.1
- Verify and record identification of each waste disposal package and its intended emplacement opening/location - 6.6.3
- Verify integrity of waste disposal package and, if used, emplacement opening backfill during waste emplacement operations - 6.6.9
- Verify and record identification of emplaced waste disposal package and emplacement opening location number - 6.6.10
- Inspect, test and maintain receiving operations facilities and equipment - 6.6.17
- Continuously monitor conditions that may impact personnel safety (radiological & non-radiological) during repository operations - 6.8.1
- Inspect, test, and maintain monitoring facilities and equipment - 6.8.3
- Verify identity of waste to be removed from underground facility - 6.9.7
- Determine condition of waste disposal package prior to removal from underground facility during waste removal operations - 6.9.8
- Survey waste disposal package external dose rate prior to removal from underground facility during waste removal operations - 6.9.9
- Inspect, test and maintain waste removal operations facilities and equipment - 6.9.20
- Inspect and test waste in preparation for off-site shipment - 6.10.5
- Conduct external inspection/survey of complete off-site transportation vehicle - 6.10.9
- Inspect, test, and maintain receiving operations facilities and equipment - 6.10.12
- Decontaminate underground facilities and equipment (if required) - 6.11.1.1
- Install, calibrate, and test subsurface postclosure monitoring equipment (as applicable) - 6.11.1.4, 6.11.2.1

- Emplace closure seals for boreholes and other openings - 6.11.2.4
- Inspect, test, and maintain closure and decommissioning facilities and equipment - 6.11.4
- Repository facilities for complete external inspection/survey of off-site transportation vehicle (e.g., railcar, truck) - 6.41.2.1.1
- Repository facility for off-loading transportation package/waste from transportation vehicle - 6.41.2.1.3
- Radiation-controlled repository facility for waste inspection and test in receiving operations - 6.41.2.1.6
- Repository equipment for waste inspection and test during receiving - 6.41.2.2.4
- Trained and certified personnel for inspection and testing of waste in repository receiving - 6.41.2.4.2
- Procedure(s) for inspection and testing of waste (upon repository receipt) - 6.41.2.5.2
- Trained and certified personnel for inspection of waste received for repository lag storage - 6.41.3.4.2
- Procedure(s) for inspection of waste disposal package received for repository lag storage - 6.41.3.5.2
- Equipment for waste emplacement facility, equipment and process inspection and testing - 6.41.5.2.10
- Trained and certified personnel for waste emplacement facility, equipment and process inspection and testing - 6.41.5.4.2
- Procedure(s) for inspection and testing of waste emplacement facilities, equipment and process - 6.41.5.5.3
- Equipment for inspection of removed waste disposal package - 6.41.7.2.6
- Trained and certified personnel for waste removal facility, equipment and process inspection and testing - 6.41.7.4.2
- Procedure(s) for waste removal facility, equipment, and process inspection - 6.41.7.5.3
- Trained and certified personnel for inspection and testing waste disposal package in preparation for off-site shipment - 6.41.8.4.3
- Procedure(s) for inspection and testing waste disposal package in preparation for off-site shipment - 6.41.8.5.3
- Trained and certified personnel for emplaced backfill and seal inspection and testing - 6.41.9.4.5
- Procedure(s) for inspection and testing of emplaced backfill and seals - 6.41.9.5.5

(2) **Inspection and Testing for Information Gathering for Performance Confirmation**

- Verify transportation vehicle condition and absence of sabotage devices (e.g., explosives) upon receipt of waste disposal package components - 5.3.1
- Inspect and test waste disposal package components - 5.3.3
- Inspect and/or test waste disposal package - 5.8.7
- Equipment for inspecting waste disposal package components upon receipt - 5.35.2.2.3
- Procedure(s) for inspection and test of waste disposal package components in receiving operations - 5.35.2.5.2
- Waste disposal package inspection and test facility - 5.35.5.1.4
- Procedure(s) for inspecting and testing waste disposal packages during and following packaging operations - 5.35.5.5.2
- Verify railcar/truck condition and absence of sabotage devices (e.g., explosives) upon receipt - 6.2.1.1
- Survey transportation package external dose rate upon receipt - 6.2.1.2
- Inspect physical condition of waste upon receipt - 6.2.1.3
- Verify type, amount, and source of waste received - 6.2.1.4
- Ensure integrity of waste disposal package prior to transfer - 6.5.3
- Ensure integrity of waste disposal package at start of emplacement - 6.6.1
- Verify and record identification of each waste disposal package and its intended emplacement opening/location - 6.6.3
- Verify integrity of waste disposal package and, if used, emplacement opening backfill during waste emplacement operations - 6.6.9
- Verify and record identification of emplaced waste disposal package and emplacement opening location number - 6.6.10
- Verify identity of waste to be removed from underground facility - 6.9.7
- Determine condition of waste disposal package prior to removal from underground facility during waste removal operations - 6.9.8
- Install, calibrate and test subsurface postclosure monitoring equipment (as applicable) - 6.11.1.4
- External inspection/survey facilities for complete off-site transportation vehicle - 6.41.8.1.8
- Equipment for external inspection/survey of off-site waste transportation vehicle - 6.41.8.2.9

(3) **Inspection and Testing Records**

See the section 6.2 FOC Topic.

(4) **Inspection and Testing by NRC or for NRC**

No safety functions addressing requirements for inspection and testing by NRC or for NRC were identified from the "Repository Functional Analysis" (Ref. 1).

(5) **Access Engineering for Inspection and Testing**

No safety functions addressing designing to permit inspections or testing were identified from the "Repository Functional Analysis" (Ref. 1).

4.18.4.2 Relevant Regulatory Citations

- 10 CFR 50.34(a)(6)(iii), 50.49, 50.55a(g), 50.59, 50.70, Part 50 Appendix A-II, Criterion 18, and Appendix B
- 10 CFR 60.21(c)(15)(iv), 60.21(c)(15)(v), 60.21(c)(15)(vi), 60.43(b)(6), 60.44, 60.74, 60.75, 60.111(a), 60.130, 60.131(a)(2), 60.131(a)(6), 60.131(b)(6), 60.132(a), 60.133(e)(1), 60.137, 60.140, 60.141, 60.142 60.143, 60.152, and 60.161
- 10 CFR 61.24(g), 61.81, and 61.82
- 10 CFR 72.24(p), 72.44(c)(3), 72.48(a)(1)(iii), 72.82, 72.122(f), 72.144(b), 72.160, 72.162, 72.164, 72.168, and 72.176

4.18.4.3 Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations

(1) **Inspection and Testing To Ensure Reliability and Safety**

Several safety functions deal with conducting inspections, tests, verifications, or analyses (generally referred to as inspections) to ensure reliability of personnel, waste handling equipment, security and safeguards, waste form, waste containers, packaging, backfill, and seals. 10 CFR Part 60 addresses all these functions in 10 CFR 60.131(a)(6), 60.131(b)(6), 60.140, 60.141, 60.142, 60.143, and 60.161, except security and safeguards. Security and safeguards are addressed by the section 4.25 ROC Topic. Procedures to conduct inspections to ensure reliability are a normal part of repository operations and are addressed by the section 4.15 ROC Topic.

The criteria in the other regulations, dealing with inspections to ensure reliability, are comparable to 10 CFR Part 60, except that 10 CFR Part 50 has extensive requirements for electrical equipment important to safety (in 10 CFR 50.49 and Appendix A-II, Criterion 18). This appears reasonable considering the need for reliance on electrical power for forced cooling of the reactor core or spent fuel. If no equipment important to safety would release radioactive material on a loss of electrical power, the electrical power might not be safety-related. On the other hand, some equipment, such as pumps or instruments, requires power to function and would fail to an unsafe condition on loss of power. A repository appears to be fundamentally different from a nuclear plant if forced cooling of the HLW is not required. This fundamental difference would not require such an emphasis on inspecting and testing of electric equipment.

10 CFR Part 60 appears to be as thorough as 10 CFR 72.144(b), 72.160, 72.162, 72.164, 72.168, and 72.176 (regarding inspection and testing for Quality Assurance (QA) purposes) because 10 CFR 60.152 references Appendix B of 10 CFR Part 50.

Startup testing criteria, as addressed in 10 CFR 60.21(c)(15)(iv), 72.24(p), and 50.34(a)(6)(iii), appear to be similar.

10 CFR 50.55a(g) references the ASME (American Society of Mechanical Engineers) Codes for inspection and testing of pipes, vessels, pumps, and valves. 10 CFR Part 60 does not (and should not need to) reference the ASME Codes because a repository is fundamentally different from a nuclear power plant.

(2) Inspection and Testing for Information Gathering for Performance Confirmation

10 CFR 60.44 appears to be similar in content to 10 CFR 50.59 and 72.48(a)(1)(iii). 10 CFR 60.140-143 appears to have much more thorough and detailed requirements for testing to collect performance confirmation information than all of the other regulations, including 10 CFR 61.24(g) and 72.44(c)(3). There appear to be no other criteria comparable to 10 CFR 60.137 in 10 CFR Part 50 or Part 72.

(3) Inspection and Testing Records

See the section 6.2 ROC Topic.

(4) Inspection and Testing by NRC or for NRC

10 CFR 60.74 and 60.75 appear to be similar to, or more thorough than, the sections of the other regulations that address this subtopic (10 CFR 50.70, 72.82, 61.81, and 61.82).

(5) Access Engineering for Inspection and Testing

10 CFR 50.55a(g)(3) requires the SSCIS to be "designed and be provided with access to enable performance of inservice examination." Both 10 CFR 72.122(f) and 10 CFR 60.131(b)(6) require that the SSCIS be designed to permit (allow access for)

periodic inspection and testing. Also, 10 CFR 60.137 requires the design of the GROA to permit (allow access for) performance confirmation testing.

4.19 MAINTENANCE

This ROC Topic has the following subtopics:

(1) Personnel, Planning, and Procedures
(2) Design To Permit and Facilitate Maintenance
(3) Facilities and Equipment for Maintenance

4.19.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) Personnel, Planning, and Procedures

Criteria for training and certification of maintenance personnel, who are considered to be part of the operating personnel, are sufficiently and adequately addressed in 10 CFR 60.161, because they are broadly written. Maintenance plans for the GROA are adequately addressed in 10 CFR 60.21(c)(15)(v) because it is broadly written.

(2) Design to Permit and Facilitate Maintenance

The criterion in 10 CFR 60.131(b)(6), which requires designing to permit periodic inspection, testing, and maintenance as necessary to ensure continued functioning and readiness, is adequate and sufficient. Removal of the word "periodic" might make the regulation appear broader but is not essential. Design to facilitate maintenance is adequately and sufficiently addressed in 10 CFR 60.131(a)(2), which requires the design of equipment for ease of repair and replacement to limit the time required to perform work in the vicinity of radioactive materials.

(3) Facilities and Equipment for Maintenance

Facilities and equipment for maintenance are sufficiently and adequately addressed in 10 CFR 60.21(c)(15)(v) as part of the plans for maintenance because the choice of needed facilities and equipment is related to how to assure maintenance.

4.19.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) **Personnel, Planning, and Procedures**

Concept. Criteria for maintenance plans, procedures, and training of maintenance personnel are needed to ensure reliability and safety of facilities and equipment within the geologic repository operations area.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.21(c)(15)(v) and 60.161.

Rationale for the Operational Criteria. These criteria fully address the above concept because they are broadly written. The criteria in 10 CFR 60.21(c)(15)(v) include plans for conducting maintenance on structures, systems, and components of the GROA. 10 CFR 60.161 addresses the training of all operating personnel, which would include maintenance personnel.

(2) **Design To Permit and Facilitate Maintenance**

Concept. Criteria to permit and facilitate the performance of maintenance on structures, systems, and components important to safety to ensure their continued functioning and readiness are needed.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.131(b)(6), 60.131(a)(2), and 60.21(c)(15)(v).

Rationale for the Operational Criteria. These cited criteria, for design for maintenance, are broadly written and require that maintenance necessary to ensure radiation health and safety is performed. Also, if the maintenance is performed in a radiation area, the design must facilitate maintenance.

(3) **Facilities and Equipment for Maintenance**

Concept. Criteria are needed to ensure that maintenance facilities and equipment are sufficient to provide continued functioning and readiness of structures, systems, and components in the geologic repository operations area.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.21(c)(15)(v).

Rationale for the Operational Criteria. 10 CFR 60.21(c)(15)(v) fully addresses the concept above because it requires plans for maintenance, which includes any facilities, equipment, and materials needed for such maintenance.

4.19.3 Elements Considered for Regulation

4.19.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) Personnel, Planning, and Procedures

Elements related to maintenance personnel are as follows:

- Maintenance engineer, technician, and supervisor
- Maintenance quality control group, planning and scheduling groups, operation liaison group, repair group, and inspection group

Elements related to maintenance plans are as follows:

- Preventive maintenance plans
- Routine and nonroutine maintenance plans
- Scheduling plans

(2) Design to Permit and Facilitate Maintenance

Elements related to design features are as follows:

- Availability of lay-down area
- Accessibility
- Ease of maintenance to reduce radiation exposure time and prevent damage to other equipment
- Design to account for human factors
- Environmental conditions to perform maintenance
- Equipment, spares, and materials needed for routine, preventive, and nonroutine maintenance to ensure continued function and readiness

(3) Facilities and Equipment for Maintenance

Elements related to facilities and equipment necessary for maintenance are as follows:

- Suitable working area that is well-shielded, air-conditioned, lighted, and designed for ease of repair

- Machine shop for both contaminated and uncontaminated equipment maintenance. Such facilities should include maintenance equipment such as repair tools, lifting equipment, and spares
- Maintenance facilities and equipment provided solely by a contractor off-site

4.19.3.2 Comments on and Discussion of the Elements Considered for Regulation

(1) Personnel, Planning, and Procedures

Since maintenance is a part of operations, the training and certification program for operating personnel (10 CFR 60.161) would address maintenance personnel. (See the section 4.26 ROC Topic.) Maintenance planning and scheduling should cover all normal conditions to ensure continued function and readiness of all the facilities that are important to safety. 10 CFR 60.21(c)(15)(v) includes maintenance plans as part of the normal activities of the geologic repository operations, including maintenance operation. (See the section 4.2 ROC Topic.) Maintenance procedures are discussed in the section 4.15 ROC Topic.

(2) Design to Permit and Facilitate Maintenance

10 CFR 60.131(b)(6) requires the design of structures, systems, and components important to safety to permit periodic maintenance. An uncertainty about "periodic maintenance" is discussed in CNWRA 90-003 (Ref. 7) on page B-138. In the NRC "Recommendations" report (Ref. 8), Uncertainty Reference Number 38, Appendix A, page 55, this uncertainty is resolved.

10 CFR 60.131(a)(2) appears to adequately ensure the design of equipment for ease of repair and replacement, and design of facilities to limit the time required to perform work in the vicinity of radioactive materials.

(3) Facilities and Equipment for Maintenance

Plans for maintenance as required in 10 CFR 60.21(c)(15)(v) would be assumed to include any facilities, equipment, and materials that would be required to conduct such maintenance activities in the geologic repository operations area.

4.19.4 Safety Functions and Regulatory Citations

4.19.4.1 Associated Safety Functions

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

(1) **Personnel, Planning, and Procedures**

- Trained and certified personnel for security and safeguards facility and equipment maintenance - 2.20.4.2
- Procedure(s) for security and safeguards facility and equipment maintenance - 2.20.5.8
- Trained and certified personnel for waste disposal package components receiving facility and equipment maintenance - 5.35.2.4.4
- Procedure(s) for waste disposal package components receiving facility and equipment maintenance - 5.35.2.5.5
- Trained and certified personnel for waste lag storage facility and equipment maintenance - 5.35.3.4.4
- Procedure(s) for waste lag storage facility and equipment maintenance - 5.35.3.5.4
- Facility for maintenance of waste preparation waste lag storage facility and equipment - 5.35.4.1.4
- Trained and certified personnel for waste disposal package components lag storage facility and equipment maintenance - 5.35.4.4.5
- Procedure(s) for waste disposal package components lag storage facility and equipment maintenance - 5.35.4.5.5
- Trained and certified personnel for waste packaging facility and equipment maintenance - 5.35.5.4.4
- Procedure(s) for waste packaging facilities and equipment maintenance - 5.35.5.5.4
- Trained and certified personnel for repository waste receiving facility and equipment maintenance - 6.41.2.4.4
- Procedure(s) for repository waste receiving facility and equipment maintenance - 6.41.2.5.5
- Trained and certified personnel for repository lag storage facility and equipment maintenance - 6.41.3.4.4
- Procedure(s) for waste lag storage facility and equipment maintenance during repository operations - 6.41.3.5.4
- Trained and certified personnel for waste transfer facility and equipment maintenance - 6.41.4.4.3

- Trained and certified personnel for waste transfer network maintenance - 6.41.4.4.4
- Procedure(s) for waste transfer equipment maintenance - 6.41.4.5.3
- Procedure(s) for waste transfer network maintenance - 6.41.4.5.4
- Trained and certified personnel for waste emplacement facility and equipment maintenance - 6.41.5.4.4
- Procedure(s) for waste emplacement facility and equipment maintenance - 6.41.5.5.4
- Trained and certified personnel for waste removal facility and equipment maintenance - 6.41.7.4.4
- Procedure(s) for waste removal facilities and equipment maintenance - 6.41.7.5.4
- Trained and certified personnel for off-site waste shipment facility and equipment maintenance - 6.41.8.4.6
- Procedure(s) for waste off-site shipment facility and equipment maintenance - 6.41.8.5.7
- Trained and certified personnel for closure and decommissioning facilities and equipment maintenance - 6.41.9.4.12
- Procedure(s) for closure and decommissioning equipment maintenance - 6.41.9.5.12

(2) Design Permit and Facilitate Maintenance

No safety functions were identified from the "Repository Functional Analysis" (Ref. 1) that directly require "design" of the GROA.

(3) Facilities and Equipment for Maintenance

- Facilities for maintenance of security and safeguards facilities and equipment - 2.20.1.4
- Equipment, spares and materials for security and safeguards facilities and equipment maintenance - 2.20.2.9
- Surface facilities, equipment, spares and material for general purpose waste preparation facility and equipment maintenance during waste preparation operations - 5.35.1.7
- Facility for maintenance of waste disposal package component receiving facility and equipment - 5.35.2.1.8
- Equipment, spares, and materials for receiving facility and equipment maintenance waste disposal package components - 5.35.2.2.7

- Facility for maintenance of waste preparation waste lag storage facility and equipment - 5.35.3.1.4
- Equipment, spares, and materials for waste lag storage facilities and equipment maintenance - 5.35.3.2.7
- Facility for maintenance of waste preparation waste lag storage facility and equipment - 5.35.4.1.4
- Equipment, spares, and materials for waste disposal package components lag storage facilities and equipment maintenance - 5.35.4.2.6
- Facility for waste packaging facility and equipment maintenance - 5.35.5.1.8
- Equipment, spares, and materials for waste packaging facility and equipment maintenance - 5.35.5.2.13
- Repository surface facilities and equipment for vehicle service and maintenance - 6.41.1.1.4
- Surface facilities, equipment, spares, and material for repository general purpose facility and equipment maintenance during disposal operations - 6.41.1.1.7 and 6.41.1.2.10
- Facility for maintenance of repository waste receiving facility and equipment - 6.41.2.1.9
- Repository equipment for off-site transportation vehicle maintenance (e.g., railcars, trucks) - 6.41.2.2.1
- Equipment, spares and material for maintenance of receiving operations facilities and equipment - 6.41.2.2.8
- Facility for maintenance of repository waste lag storage facility and equipment - 6.41.3.1.4
- Equipment, spares and material for maintenance of repository lag storage operations facilities and equipment - 6.41.3.2.7
- Repository facility for maintenance of waste transfer facilities and equipment - 6.41.4.1.4
- Equipment, spares and material for maintenance of waste transfer equipment - 6.41.4.2.5
- Facility for maintenance of waste emplacement facilities and equipment - 6.41.5.1.6
- Equipment, spares and material for maintenance of emplacement facilities and equipment - 6.41.5.2.11
- Facility for maintenance of waste removal facilities and equipment - 6.41.7.1.6
- Equipment, spares and material for maintenance of emplacement facilities and equipment - 6.41.7.2.10
- Repository facility for maintenance of waste off-site shipment facilities and equipment - 6.41.8.1.12
- Equipment, spares and material for maintenance of off-site shipment facilities and equipment - 6.41.8.2.12

- Facility for maintenance of repository closure and decommissioning facilities and equipment - 6.41.9.1.11
- Equipment, spares and material for maintenance of closure and decommissioning equipment - 6.41.9.2.13

4.19.4.2 Relevant Regulatory Citations

- 10 CFR 50.34(b)(6)(iv), 50.34a(c)(1), Part 50, Appendix A-I, Criterion 4, and Appendix A-III, Criterion 22
- 10 CFR 60.21(c)(15)(v), 60.131(a)(2), 60.131(b)(6), and 60.161
- 10 CFR 72.120(a), 72.122(b)(1), 72.122(f), and 72.126(a)(5)

4.19.4.3 Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations

(1) Personnel, Planning, and Procedures

The need for trained and certified maintenance personnel is addressed by the safety functions listed in subsection 4.19.4.1(1). Training and certification of personnel are covered by 10 CFR 60.161. This regulation specifically addresses operating personnel, which would also include maintenance personnel. The section 4.26 ROC Topic discusses personnel requirements and training.

10 CFR 60.21(c)(15)(v) requires information on plans for conducting normal activities, including maintenance of the structures, systems, and components of the GROA. A similar requirement is addressed in 10 CFR 50.34(b)(6)(iv) for a nuclear power reactor. The section 4.2 ROC Topic discusses additional planning requirements.

10 CFR 50.34a(c)(1) requires a description of the maintenance and use of equipment installed in radioactive waste systems to be included in an application for a license to operate a nuclear power reactor, unlike 10 CFR 60.21(c)(15)(v), which is a more general requirement.

(2) Design to Permit and Facilitate Maintenance

10 CFR 60.131(b)(6) requires structures, systems, and components important to safety to be designed to permit periodic maintenance as necessary to ensure their continued functioning and readiness. 10 CFR 72.122(f) similarly requires systems, structures, and components that are important to safety to be designed to permit maintenance.

10 CFR Part 50, Appendix A-III, Criterion 22, requires design techniques that prevent loss of the protection function as it applies to maintenance operation. 10 CFR 72.122(b)(1) and 10 CFR Part 50, Appendix A-I, Criterion 4, also have requirements for SSCIS to ensure that they are designed to accommodate the effects of, and to be compatible

with, site characteristics and environmental conditions associated with normal operations and maintenance. There do not appear to be such explicit criteria addressed in 10 CFR Part 60.

Design of equipment to facilitate ease of repair and replacement (maintenance) in the vicinity of radioactive materials is discussed in 10 CFR 60.131(a)(2) with regard to radiological protection. A similar requirement is given in 10 CFR 72.126(a)(5).

The design criteria as stated in 10 CFR 72.120(a) establish the design, fabrication, construction, testing, maintenance, and performance requirements for structures, systems, and components important to safety.

(3) Facilities and Equipment for Maintenance

The safety functions require facilities, equipment, spares, and materials to be provided for maintenance. These functions are at a much lower level of detail than the regulations in 10 CFR Part 60. It is reasonable to assume that such facilities, equipment, and materials would be addressed in plans for maintenance of structures, systems, and components important to safety [10 CFR 60.21(c)(15)(v)].

4.20 CRITICALITY CONTROL

This ROC Topic has the following subtopics:

(1) Consistency with Other Regulations
(2) Factors Considered for Criticality Control

4.20.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) Consistency with Other Regulations

The criteria for criticality control in 10 CFR Part 60 are sufficient and adequate because they are consistent with the intent of the regulations for other fixed site facilities and because similar concepts about fixed site criticality control are used in the other regulations, despite differing texts.

(2) Factors Considered for Criticality Control

10 CFR Part 60 adequately addresses the preclosure period of a repository because the conditions for that time period are uniquely addressed, and methods used for criticality control are adequately addressed because of the reference to k_{eff}.

Note: Because of the longer time period for postclosure criticality control, the criteria in 10 CFR 60.131(b)(7) may need to be examined further.

4.20.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) Consistency with Other Regulations

Concept. The intent of 10 CFR Part 60, in regard to the preclosure period, needs to be consister.: with the intent of other applicable regulations relevant to criticality control for a fixed site facility.

Operational Criteria. The operational criteria needed to address this concept are in 10 CFR 60.131(b)(7) and are consistent with the intent of other regulations.

Rationale for the Operational Criteria. The preclosure criteria in 10 CFR Part 60 related to criticality are consistent with the intent of other regulations relevant to criticality control for a fixed facility because the methods used for criticality control are optional. The stipulation of k_{eff} addresses all the factors to be used for criticality control; a criticality monitoring system is not required for dry storage, and criticality is controlled under anticipated and off-normal conditions and events unless two unlikely (off-normal) independent and concurrent or sequential changes have occurred.

(2) Factors Considered for Criticality Control

Concept. Consideration of factors such as geometry, enrichment, poisons, and neutron moderation and reflection is needed to ensure that criticality has a sufficiently low probability of occurrence during the approximately 100-year preclosure period.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.131(b)(7).

Rationale for the Operational Criteria. The criteria in 10 CFR 60.131(b)(7) fully address this concept because all the factors affecting criticality are used in calculation of k_{eff}, and 10 CFR Part 60 has a safety margin in the design requirements of all systems used for the preclosure period.

Note: In regard to postclosure criticality control, which is beyond the scope of the ROC analysis, the double contingency principle may not be adequate because of the much longer duration: 10,000 years versus 100 years for the operational period. It is essential to assure that the waste does not go critical during the postclosure perio ecause criticality would most likely void the overall performance assessment for the repository, due to changes in the thermal and isotope inventory assumptions.

4.20.3 Elements Considered for Regulation

4.20.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) Consistency with Other Regulations

The elements of 10 CFR Part 60 that may be different from 10 CFR Parts 50, 71, or 72 are:

- Application of the double contingency principle
- Quantitative (5 percent) margin of safety for k_{eff}
- Criticality monitoring in the storage area
- Specification of methods to control criticality
- Criticality calculational bias or error

(2) Factors Considered for Criticality Control

Criticality depends on the relative magnitudes of the neutron production and loss mechanisms. Criticality can be described in terms of its effective multiplication factor (k_{eff}), which is a ratio of neutron generation rate over neutron loss rate. When a system is critical, production rate is equal to the loss rate and $k_{eff} = 1$. A number of methods are used for calculating k_{eff} (Refs. 20 through 24), and the factors of concern are as follows:

- *Geometry.* For example: consolidated or original fuel bundle configuration (the original configuration was designed to ensure criticality, a k_{eff} greater than one, and consolidation reduces k_{eff}).
- *Fuel Ratio.* For example: percent of U-235, U-233, or Pu in spent or fresh fuel.
- *Neutron Reflection.* For example: water, carbon, deuterium, and some heavy metals.
- *Neutron Moderation.* For example: water, hydrogen, deuterium, carbon, and beryllium.
- *Poisons.* For example: presence or lack of poisons (e.g., xenon, boron, cadmium, and gadolinium).

All of these factors must exist in combination with the proper ratio in order to have criticality. These factors are a concern for both surface storage and waste disposal underground. Criticality should not occur during anticipated and off-normal conditions and events during the preclosure period, and under anticipated and unanticipated processes and events during the postclosure period.

4.20.3.2 *Comments on and Discussion of the Elements Considered for Regulation*

(1) Consistency with Other Regulations

Generally, the intent of 10 CFR Part 60 is consistent with 10 CFR Parts 50 and 72, even though on the surface the text of 10 CFR Part 60 seems different.

10 CFR Part 60 regulates nuclear criticality safety of systems involved in processing, transporting, handling, storage, retrieval, emplacement, and isolation of radioactive waste regardless of the methods used or factors considered. 10 CFR Parts 50 and 72 only suggest potential methods for criticality control. 10 CFR Part 60 allows any method of criticality control by stipulating the acceptable value of k_{eff}. Thus, it functions as a performance standard rather than providing specific design criteria.

10 CFR 60.131(b)(7) requires at least a 5-percent margin of safety (after allowance) for the bias in the method of calculation of k_{eff} and the uncertainty in the experiments leading to validation of these calculational methods, which is more conservative than 10 CFR Parts 50, 71, and 72.

10 CFR Part 60 does not require criticality monitoring, since it is assumed all storage will be dry storage. This is consistent with 10 CFR 72.124(c). 10 CFR Parts 50 and 71 are silent on criticality monitoring.

10 CFR Parts 50 and 71 do not invoke the double contingency principle; but this principle appears applicable to "all fuel cycle licenses," per NRC Information Notice No. 89-24 (Ref. 25). Also, since spent-fuel storage is safety related, Criterion 2 of 10 CFR Part 50, Appendix A, applies. This is explicitly stated in section 9.1.2 of the "Standard Review Plan for Review of Safety Analysis Reports for Nuclear Power Plants" (Ref. 19). 10 CFR Part 50, Appendix A-I, Criterion 2, addresses design consideration for "sufficient margin for the limited accuracy [of] . . . data" and for the "appropriate combinations of the effects of normal and accident conditions." This would be similar to what is explicitly stated in 10 CFR 60.131(b)(7) and 10 CFR 72.124.

Regarding spent-fuel transportation, experience shows that anticipated carrier accidents could lead to large physical and thermal shocks and to total immersion in water. Since these accident conditions may occur during transportation, transportation is fundamentally different from a fixed site facility; and thus their appropriate regulations are different.

(2) **Factors Considered for Criticality Control**

The elements summarized in Section 4.20.3.1 (2) above are factors affecting criticality of HLW. All these factors are included in 10 CFR Part 60 by referencing k_{eff}.

Since water is a key factor in criticality, fire protection systems that use water should be designed so that their activation or failure does not cause criticality. Fire protection is addressed in 10 CFR 60.131(b)(3)(iv) to "protect . . . against adverse effects of either the operation or failure of the fire suppression systems." Also, failure of utilities that carry water should not cause criticality. This is addressed in 10 CFR 60.1 (b)(7) if the utility system that carries water is "for processing, transporting, handling, storage, retrieval, emplacement, and isolation." Also, even if the utility system is not for any of the above (e.g., drinking water or rain-water collection), the design has to ensure that criticality is not possible even if a water conduit failed as a single event.

The GROA and the waste package should not allow criticality during the preclosure period of a repository under design basis events.

The probability for criticality should also be very unlikely for the 10,000-year postclosure period. In order to achieve this, criticality should not occur under "anticipated and unanticipated processes and events." It can be argued that the latter criterion is reasonable, since criticality would produce a large localized radiation and thermal pulse and would produce a new inventory of plutonium and fission products, which it is assumed would not have been considered in the postclosure performance assessment.

4.20.4 Safety Functions and Regulatory Citations

4.20.4.1 Associated Safety Functions

(1) **Consistency with Other Regulations**

No safety functions that address consistency with other regulations were identified from the "Repository Functional Analysis" (Ref. 1).

(2) **Factors Considered for Criticality Control**

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

- Consolidate spent fuel rods (as required) - 5.8.1
- Package waste in waste disposal package - 5.8.5
- Repackage waste (if required) - 5.8.9
- Containerize secondary waste (if required) - 5.8.10

- Prevent nuclear criticality during waste preparations - 5.19
- Ensure operability of waste preparation equipment important to safety - 5.30
- Repository surface-subsurface water distribution facilities and equipment - 5.35.1.3.6
- Verify railcar/truck condition and absence of sabotage devices (e.g., explosives) upon receipt - 6.2.1.1
- Prevent nuclear criticality during waste disposal operations - 6.19
- Aqueous and non-aqueous underground fire protection facilities and equipment - 6.41.1.2.4
- Repository surface-subsurface water distribution facilities and equipment - 6.41.1.3.1.6

4.20.4.2 Relevant Regulatory Citations

- 10 CFR Part 50, Appendix A-I, Criterion 2, Appendix A-VI, Criterion 62, and Appendix A-VI, Criterion 63
- 10 CFR 60.43(b)(6), 60.131(b)(3)(iv) and 60.131(b)(7)
- 10 CFR 71.24(b), 71.55(b), and 71.55(e)
- 10 CFR 72.74 and 72.124

4.20.4.3 Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations

(1) Consistency With Other Regulations

10 CFR Part 50, Appendix A-VI, Criterion 62, addresses prevention of criticality in fuel storage and handling systems by physical systems or processes, preferably by use of geometrically safe configurations. Part 60 does not state any preferred methods to prevent criticality. 10 CFR 60.131(b)(7) is similar to 10 CFR 72.124; but, again, 10 CFR Part 60 does not address methods for criticality control, while 10 CFR 72.124(b) addresses methods for criticality control. 10 CFR 72.124(b) states that these methods are to be used "when practicable."

Reports of accidental criticality or loss of special nuclear material are addressed in 10 CFR 72.74, while there is no direct mention of this requirement in 10 CFR Part 60. 10 CFR 60.43(b)(6) does require administrative controls for reporting necessary to assure that activities at the facility are conducted in a safe manner and in conformity with the other license specifications.

10 CFR Part 60 is similar to 10 CFR Part 72 in stating "at least two unlikely, independent, and concurrent or sequential changes have occurred in the conditions essential to nuclear criticality safety." This is called "the double contingency principle" as

discussed in NRC Information Notice No. 89-24, "Nuclear Criticality Safety" (Ref. 25). 10 CFR Part 50, Appendix A-VI, Criterion 62, does not place a similar limitation on preventing criticality as 10 CFR Parts 60 and 72 do.

10 CFR Parts 60 and 72 are similar, in that 10 CFR 72.124 addresses "margins of safety" in data and calculations used to assess criticality control, and 10 CFR 60.131(b)(7) addresses "allowance for the bias" in calculations and experiments used to validate the methods of calculation. 10 CFR Part 50, Appendix A-VI, Criterion 62, does not address these calculational aspects.

10 CFR Part 60 is more specific and conservative than 10 CFR Parts 72 and 50 by requiring a k_{eff} at least 5 percent below unity. 10 CFR 72.124 and 10 CFR Part 50, Appendix A-VI, Criterion 62, do not state a margin for k_{eff}, which could be 1 percent or less, as compared to the 5 percent in Part 60.

10 CFR 72.124(c) requires a criticality monitoring system if the waste is stored or handled beneath water shielding, but not if dry storage is used. It is assumed a repository will use dry storage. Storage-area monitoring is required by 10 CFR Part 50, Appendix A-VI, Criterion 63; but it is not stated if this must be a "criticality monitoring" system. Also, it is not stated if the monitoring is required if the storage area is wet or dry. In any case, the radiation level and heat-removal monitoring capability required by Criterion 63 should detect a loss of criticality control.

10 CFR Part 71, on transportation of radioactive material, does not use the double contingency principle. 10 CFR 71.55(b) and 71.55(e) even require that three hypothetical changes occur and that the material must still remain subcritical. These three are as follows:

- The material is the most reactive *credible* configuration (geometry and chemical form).
- Water moderation occurs to the most reactive *credible* extent.
- There is reflection by water on all sides, as close as is *credible*.

It is assumed these hypothetical events may occur simultaneously or sequentially for a transportation accident.

(2) Factors Considered for Criticality Control

In 10 CFR 72.124(b), methods of criticality control are based on geometry and/or poisons; but 10 CFR Part 60 does not specifically state anything about methods used to effect criticality control. 10 CFR Part 50, unlike Part 72, only addresses geometrically safe configuration to control criticality. 10 CFR 71.24(b) includes several specific methods to be regulated to ensure subcriticality. These are as follows:

- Packaging must not incorporate lead shielding more than 5 cm thick, tungsten shielding, or uranium shielding
- Beryllium or deuterium must not be present in a package.
- Total mass of graphite must not exceed 150 times the total mass of U-235 and plutonium.
- Certain hydrocarbons, with a higher hydrogen density than water, must not be present in a package.
- The fissile contents must contain no U-233 and less than 1 percent total plutonium, with special considerations in 10 CFR 71.24(b)(7).
- Limits on U-235 are based on uniformity of distribution or lattice arrangement.

4.21 WASTE AND WASTE PACKAGE PROTECTION AND WASTE CONTAINMENT FOR PRECLOSURE REASONS

This ROC Topic has the following subtopics:

(1) Waste Package Design for Preclosure Containment and Retrieval
(2) Waste and Waste Package Protection for Preclosure Containment
(3) Waste Package Protection for Retrieval
(4) Containment Facilities

4.21.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) Waste Package Design for Preclosure Containment and Retrieval

The criteria in 10 CFR Part 60 are adequate and sufficient to address the design of the waste package for preclosure containment and retrieval if the waste package is considered to be part of the GROA and is important to safety.

(2) Waste and Waste Package Protection for Preclosure Containment

Criteria related to the design of the GROA to ensure protection of the waste and waste package are adequately and sufficiently addressed by 10 CFR Part 60, since safe handling and storage imply protection by containment.

(3) Waste Package Protection for Retrieval

Criteria for the design of the GROA to ensure protection of the waste package for retrieval are adequately and sufficiently addressed by 10 CFR Part 60, since safe handling and storage apply to any preclosure activity.

(4) **Containment Facilities**

10 CFR Part 60 adequately and sufficiently addresses waste containment prior to the insertion of unpackaged spent fuel or other HLW into waste packages because waste containment is part of repository operations and is thus required to meet the performance objectives for the preclosure period.

4.21.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) **Waste Package Design for Preclosure Containment and Retrieval**

Concept. Criteria are needed for design of the waste package to maintain containment within the waste package during the preclosure period, and for design of the waste package for retrieval, if necessary.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.111, 60.131(a), and 60.131(b).

Rationale for the Operational Criteria. The criteria cited above fully address this concept because the waste package is an engineered feature of the GROA and the waste package should be "important to safety."

(2) **Waste and Waste Package Protection for Preclosure Containment**

Concept. Criteria are needed so that the GROA is designed to protect the waste and waste package to ensure containment during the preclosure period under anticipated and off-normal conditions and events.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.111(a), 60.131(a), 60.131(b), 60.132(a), 60.133(a)(1), and 60.133(e).

Rationale for the Operational Criteria. The above citations from 10 CFR Part 60 require safe handling and storage, and this would require protection of the waste and waste package to ensure preclosure containment.

(3) **Waste Package Protection for Retrieval**

Concept. Criteria are needed so the GROA is designed to protect the waste package to ensure that it can be retrieved, if necessary.

Operational Criteria. The operational criteria to address this concept are presented in 10 CFR 60.111(b), 60.132(a), 60.133(a), and 60.133(e).

Rationale for the Operational Criteria. The citations from 10 CFR Part 60 address the concept above because they require design for retrieval; protection of the waste package during handling would be an implicit part of the design for retrieval.

(4) Containment Facilities

Concept. Criteria are required for containment of HLW from the time it arrives at the GROA until it is placed in a waste package.

Operational Criteria. The operational criteria required to address this concept are presented in 10 CFR 60.111(a), 60.132(a), 60.132(b), 60.132(c), and 60.132(d). If structures, systems, and components which are used for handling or storing unpackaged waste are identified to be important to safety, 10 CFR 60.131(b) also applies.

Rationale for the Operational Criteria. The criteria in 10 CFR 60.111(a), 60.132(a), 60.132(b), 60.132(c), 60.132(d) and possibly all of 10 CFR 60.131(b) fully address the concept because receiving, storing, and packaging HLW are part of operations in the surface facility of the GROA. Any activity to be performed in the surface facility should meet the performance objective of 10 CFR 60.111(a), and the design of the surface facility should meet the design criteria required in all parts of 10 CFR 60.132.

4.21.3 Elements Considered for Regulation

4.21.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) Waste Package Design for Preclosure Containment and Retrieval

Some of the elements to be considered for waste package design for preclosure containment and retrieval are as follows:

- Classification, identification, and inventory for pre- and post-consolidation fuel assemblies
- Emplacement hole environment during the preclosure period
- Subsurface work environment during emplacement (e.g., dust, oxygen, temperature, and humidity, etc.)
- Environment of waste handling and transport equipment
- Environment inside the surface storage vault
- Potential environmental hazards during the preclosure period
- Emplacement hole liner
- Emplacement hole/waste package identification systems

- Waste cask/transporter
- Waste package retrieval systems
- Emplacement hole environment monitoring systems
- Emplacement hole liner design and installation
- Provisions for off-normal and accident conditions
- Waste package quality assurance procedures
- Subsurface work environment during and after emplacement

(2) **Waste and Waste Package Protection for Preclosure Containment**

Some of the elements to be considered for waste and waste package protection for preclosure containment are as follows:

- Waste handling building and overhead bridge cranes
- Radiation-shielded surface storage vaults
- Emplacement hole liners
- Emplacement hole identification systems
- Waste package identification systems
- Storage-vault identification system
- Surface storage racks
- Grapple for waste package or waste
- Fuel rod consolidation
- Decontamination system
- Shield plugs
- Shipping cask lifting strongback
- Overhead bridge cranes
- Overhead roofs and ceilings
- Waste package transfer machine
- Waste manipulators
- Fuel assembly transfer/storage cart
- Consolidation system frame assembly
- Traversing carriage for compacted fuel assemblies
- Container weld inspection station
- Provisions for the waste protection under off-normal and accident conditions
- Waste-container quality evaluation procedures
- Waste-container and package inspectors
- Waste package handling procedures
- Fuel-assembly protection procedures
- Fuel consolidation procedures
- Surface storage operational procedures
- Pre-emplacement transfer procedure for waste packages
- Operator for waste loading/unloading
- Computer analysts and data-processing experts for waste

handling, identification, and inventory
- Waste characterization and classification
- Waste consolidation operators
- Waste container transfer equipment operators
- Preclosure security and safeguards
- Surface storage vaults
- Waste package transfer/storage cart
- Cask/transporter for emplacement
- Cask emplacement mechanism
- Waste package emplacement mechanism
- Emplacement hole environmental monitoring

(3) Waste Package Protection for Retrieval

Some elements to be considered for waste package protection for retrieval are as follows:

- Emplacement hole mouth protection systems
- Emplacement hole cover removal mechanism
- Backfill removal procedures
- Emplacement hole stability
- Emplacement hole layout
- Emplacement hole liner
- Emplacement hole environment
- Emplacement hole environment monitoring
- Casks for retrieved containers
- Transporter for retrieved containers
- Container inspection procedures
- *in situ* container repair
- Container retrieval equipment
- Container storage facilities
- Retrieved container handling procedures
- Over-boring equipment, if necessary
- Storage vaults for retrieved waste packages
- Cask-positioning mechanism for retrieval
- Removal of physical impediments for retrieval
- Retrieved waste transfer/storage procedures
- Retrieved waste package inspection procedures

(4) Containment Facilities

Prior to insertion of HLW into a waste package, it must be contained. Various facilities could accomplish this task, for example:

- Containment buildings
- Containment rooms
- Containment/storage casks

4.21.3.2 *Comments on and Discussion of the Elements Considered for Regulation*

(1) Waste Package Design for Preclosure Containment and Retrieval

The waste package is assumed to be part of the GROA. The waste package is also assumed to be a SSCIS. Considering these assumptions, the elements for the design of the waste package to assure preclosure containment have been addressed by 10 CFR 60.111(a), 60.131(a), 60.131(b), and 60.135. Similarly, the elements for the design requirements of the waste package for retrieval are addressed in 10 CFR 60.111(b), 60.131, and 60.135.

(2) Waste and Waste Package Protection for Preclosure Containment

The design requirements for the protection of the waste and waste package prior to and during emplacement and confinement have not been explicitly specified. However, applying the criteria of 10 CFR 60.21(c)(3), 60.132(a), 60.133(e), 60.135(a), 60.135(b), and 60.135(c), the concerns for waste confinement, waste, and waste package protection are addressed.

(3) Waste Package Protection for Retrieval

It appears that the combined application of 10 CFR 60.111(b), 60.131, 60.132(a), and 60.133(c) addresses the elements associated with the design requirements and performance objectives of waste retrieval which implicitly include protection of the waste package to ensure retrievability.

(4) Containment Facilities

Containment has been required for the nuclear fuel cycle industry. 10 CFR Part 60 defines containment where it can apply to preclosure aspects of the GROA, but it is only applied to the period immediately following permanent closure, except in 10 CFR 60.135(b)(3). However, unpackaged spent fuel or other HLW located at the GROA must be contained as well. It is important for emplaced waste to be contained after closure and for unpackaged waste to be contained during the operational period.

4.21.4 Safety Functions and Regulatory Citations

4.21.4.1 Associated Safety Functions

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

(1) Waste Package Design for Preclosure Containment and Retrieval

- Maintain waste disposal package functional capability during preparation for disposal - 5.8.13
- Ensure integrity of waste disposal package prior to transfer - 6.5.3
- Ensure integrity of waste disposal package at the start of emplacement - 6.6.1
- Withstand external loads on waste disposal package - 7.1.1.2.5
- Control condition of waste disposal package material when emplaced - 7.1.2.1.1
- Control thermal environment of waste disposal package - 7.1.2.2.7

(2) Waste and Waste Package Protection for Preclosure Containment

- Protect waste disposal package components from damage during receiving - 5.3.6
- Maintain waste disposal package functional capability during preparation for disposal - 5.8.13
- Ensure integrity of waste disposal package at the start of emplacement - 6.6.1
- Protect waste disposal package from damage during repository operations - 6.20
- Withstand external loads on waste disposal package - 7.1.1.2.5
- Control condition of waste disposal package material when emplaced - 7.1.2.1.1
- Control thermal environment of waste disposal package - 7.1.2.2.7

(3) Waste Package Protection for Retrieval

- Maintain waste disposal package functional capability during preparation for disposal - 5.8.13
- Ensure integrity of waste disposal package at the start of emplacement - 6.6.1

- Verify access entry point location before providing access to waste in underground facility during waste removal operations - 6.9.4
- Remove physical impediments to waste disposal package removal from underground facility (e.g., debris, cover or plug) - 6.9.6
- Protect waste disposal package from damage during repository operations - 6.20
- Withstand external loads on waste disposal package - 7.1.1.2.5
- Control condition of waste disposal package material when emplaced - 7.1.2.1.1
- Control thermal environment of waste disposal package - 7.1.2.2.7

(4) **Containment Facilities**

- Radiation-controlled repository facility for removing waste from transportation package - 6.41.2.1.5
- Radiation-controlled repository facility for waste inspection and test in receiving operations - 6.41.2.1.6

4.21.4.2 Relevant Regulatory Citations

- 10 CFR 60.2, 60.21(c)(3), 60.102(e)(1), 60.111, 60.131, 60.132, 60.133(a), 60.133(c), 60.133(e), and 60.135,
- 10 CFR 72.3, 72.122(h), and 72.128

4.21.4.3 Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations

(1) **Waste Package Design for Preclosure Containment and Retrieval**

The safety functions focus on the physical well-being of the waste and waste package to protect the workers and public from the waste. 10 CFR 60.135(b)(3) and 60.135(a)(2) cover the safety functions related to the design of the waste package for preclosure protection. Design of the waste package for retrieval operations has been covered in 10 CFR 60.111(b), 60.135(a), and 60.135(b)(3). Requiring that the waste package be designed to address physical properties, mechanical strength, mechanical stress, synergistic interactions, containment during retrieval, and labeling for retrievability all address that the waste package must be designed for retrieval. The waste package is part of the EBS, and the EBS is a part of the GROA. The GROA has to meet the requirements of 10 CFR 60.111(b) and therefore, the waste package must also meet this performance objective. The criterion for the integrity and structural stability of the waste package and the provisions for the protection of health and safety of workers during retrieval operations to provide containment is in 10 CFR 60.135(b)(3).

Comparing 10 CFR 72.122(h)(5), it appears that 10 CFR 60.135(b)(3) does address the specific design requirements for waste protection by packaging.

(2) Waste and Waste Package Protection for Preclosure Containment

The associated safety functions identified above have specified concerns related to protecting the integrity of the waste and waste package during and immediately after the onsite processing and emplacement of waste into the geologic repository.

If it is assumed that safe handling of the waste and waste package provides "protection" to ensure preclosure containment, the regulations in 10 CFR 60.131(a), 60.131(b)(1), 60.131(b)(2), 60.131(b)(3), 60.131(b)(6), 60.131(b)(7), 60.131(b)(10), 60.132(a), 60.133(a), and 60.133(e) do address the protection of the waste and waste package. If it is assumed that the design to allow safe storage encompasses the protection of the spent-fuel cladding during storage against undue degradation that leads to gross ruptures or operations safety problems, then 10 CFR 60.131(a) addresses the same concerns expressed in 10 CFR 72.122(h)(1).

(3) Waste Package Protection for Retrieval

The safety functions regarding operations for protection of the waste package for retrievability have been addressed in 10 CFR 60.111, 60.133(c), and 60.133(e), since the waste package is part of the GROA.

(4) Containment Facilities

The safety functions identified the need to (1) provide a radiation control facility for removing or inserting waste from/to a shipping cask and for inspecting waste, and (2) reestablish containment in the event of a containment loss. A review of the relevant regulations revealed the following:

- 10 CFR Part 50 prescribes containment criteria throughout the regulation in great detail.
- 10 CFR 60.2 defines containment as the confinement of radioactive waste within a designated boundary.
- 10 CFR 60.102(e)(1) describes a concept of the containment that applies only to the postclosure period, i.e., the first several hundred years following permanent closure.
- 10 CFR 72.3 defines confinement systems as those systems, including ventilation, that act as barriers between areas containing radioactive substances and the environment.

- 10 CFR 72.122(h) describes that spent-fuel cladding must be protected during storage against degradation that leads to gross ruptures or the fuel must be otherwise confined such that degradation of the fuel during storage will not pose operational safety problems with respect to its removal from storage. These requirements may be fulfilled by overpacking consolidated fuel rods o unconsolidated assemblies or other means as appropriate.
- 10 CFR 72.128 requires that spent-fuel and high-level radioactive waste storage, and other systems that might contain or handle radioactive materials associated with spent fuel or high-level radioactive waste, be designed to ensure adequate safety under normal and accident conditions. These handling and storage systems must be designed with confinement structures and systems.

10 CFR Part 60 addresses containment for the period following permanent closure and during the operations period in 10 CFR 60.135(b)(3). 10 CFR Part 60 addresses the safety functions associated with GROA design for containment of unpackaged HLW in 10 CFR 60.111(a) 60.131(a), 60.131(b), 60.132(a), 60.132(b) and 60.132(c).

4.22 COMPUTATIONAL AND SOFTWARE CAPABILITIES

There are no subtopics for this ROC Topic.

4.22.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

10 CFR Part 60 sufficiently and adequately addresses the criteria for any associated computational and software capabilities for repository operations. Operational computer and software capabilities for accounting, monitoring, testing, projection, record-keeping, data analysis, and decision making are perhaps the current trend and future development for operations. However, they are not indispensable, and they address a method to achieve an objective rather than what objective is to be achieved. The performance objectives and design criteria for the GROA are included in 10 CFR Part 60. Any structures, systems, equipment, and components used in the GROA must meet the appropriate performance objectives and design criteria. If the licensee chooses to apply robotics and automation, the selected components would include computer and software capabilities. These components must be in compliance with the applicable performance objectives and design criteria.

4.22.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

Concept. There should be no criteria specified for operational computational and software capabilities.

Operational Criteria. There are none.

Rationale for No Operational Criteria. No specific operational criteria for computational and software capabilities are proposed because all the operational criteria in 10 CFR Part 60, applicable to a particular aspect of the repository, would apply to operational computers and software, if used. The current criteria for any feature of the GROA would apply to the computational and software capabilities associated with that particular feature. Separate criteria for operational computational and software capabilities are not required because criteria for operational computational and software capabilities would address how to accomplish an objective rather than what objectives are to be met. In view of the potential hazards, repetitions of maneuvering, and mechanical energy or power requirements for many of the tasks involved in the handling, storage, processing, packaging, emplacement, and retrieval of the wastes, operational computational and software capabilities (including robotics and automation) may be helpful and useful for their accomplishment. Operational computational and software capabilities may be essential and, in many cases, an integral part of operations. However, they are not indispensable and all of the tasks can be accomplished mechanically, manually, or electrically.

4.22.3 Elements Considered for Regulation

4.22.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

Some of the elements that may be relevant to the use of computers and software at a repository are as follows:

- Fuel assemblies handling in hot cells
- Waste transfer and transporting
- Fuel assemblies consolidation operations
- Waste inspection and characterization processes
- Waste emplacement operations
- Waste unloading operations
- Bridge crane operations
- Fuel assemblies transfer operations
- Surface storage operations
- Cask receiving and shipping operations
- Waste packaging operations
- Waste retrieval operations
- Waste identification and inspection systems
- Radiological operations
- Positioning, aligning, and emplacing operations
- Waste removal operations

- Records management
- Monitoring
- Security and safeguards
- Inventory control
- Robotic systems
- Communication and information systems

4.22.3.2 *Comments on and Discussion of the Elements Considered for Regulation*

Criteria for the use of computational and software capabilities for repository design, construction, or operation would address methods of how objectives for the repository may be met. When computers or software are used they must meet the same criteria for the feature of the GROA for which they are used. For example, if a computer/software package operates equipment "important to safety," the computer and its software must meet all the design criteria and the QA requirements because the computer and software would be components important to safety.

4.22.4 Safety Functions and Regulatory Citations

4.22.4.1 *Associated Safety Functions*

The following safety functions were identified from the "Repository Functional Analysis" (Ref.1).

- Computational capability for security and safeguards (e.g., monitor intrusion, access/egress control) - 2.20.2.3
- Software for security and safeguards - 2.20.3
- Software for waste disposal package components receiving operations - 5.35.2.3
- Computational capability for waste lag storage operations - 5.35.3.2.5
- Software for waste lag storage (e.g., inventory, process control, management) - 5.35.3.3
- Computational capability for waste packaging operations - 5.35.5.2.11
- Software for waste packaging operations (e.g., inventory, process control, monitoring) - 5.35.5.3
- Computational capability for repository waste receiving operations - 6.41.2.2.6
- Software for repository waste receiving operations (e.g., inventory, process control, monitoring) - 6.41.2.3
- Computational capability for waste lag storage operations - 6.41.3.2.5
- Software for waste lag storage (e.g., inventory, process control, monitoring) during repository operations - 6.41.3.3
- Computational capability for repository waste transfer - 6.41.4.2.3

- Software for repository waste transfer operations (e.g., inventory, monitoring) - 6.41.4.3
- Computational capability for waste emplacement operations - 6.41.5.2.8
- Software for waste emplacement operations (e.g., inventory, process control, monitoring) - 6.41.5.3
- Software for monitoring during repository operations - 6.41.6.3
- Computational capability for waste removal operations - 6.41.7.2.8
- Software for waste removal operations (e.g., inventory, process control, monitoring) - 6.41.7.3
- Computational capability for off-site shipment operations - 6.41.8.2.10
- Waste off-site shipment operations software (e.g., inventory, process control, management) - 6.41.8.3
- Computational capability for closure and decommissioning - 6.41.9.2.10
- Closure and decommissioning software (e.g., inventory, process control, monitoring) - 6.41.9.3

4.22.4.2 Relevant Regulatory Citations

- 10 CFR 61.80(c)

4.22.4.3 Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations

The associated safety functions address computational and software capabilities for repository operations. The current regulations have not specifically covered these considerations. The needs for computational and software capabilities are not the objectives to be met but are, rather, a particular technique that can be applied to meet an objective.

It is envisioned that during the emplacement period, the nuclear material accounting and records system may use computational and software capabilities. Though no regulations exist in the current 10 CFR Part 60 concerning computer and software capabilities, 10 CFR 61.80(c) has stipulated that records stored in electronic media *may* be used. Conceptually, any such requirements are not objectives, but rather are how specific objectives may be met.

Criteria for computational and software criteria for robotics, electronic operations, and other automation in both surface and subsurface facilities are not in 10 CFR Part 60. These criteria are not covered in other regulations because they would be essentially concerned with *how* to meet specific operational objectives rather than with what objectives are to be met.

Computational and software capabilities may be needed to enhance the communications with other nuclear waste facilities, the utilities of nuclear power plants, the MRS, transportation systems, and governmental and regulatory agencies. The computational and software capabilities may also provide needed information and analyses for the development of future databases and/or expert systems related to HLW repository operation. All these concerns are again related to *how* to meet the necessary objectives.

4.23 VENTILATION

This ROC Topic has the following subtopics:

(1) Underground Ventilation Separation
(2) Ventilation Design
(3) Ventilation for Retrieval

4.23.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) Underground Ventilation Separation

10 CFR 60.133(g)(3) sufficiently and adequately addresses the need for separate ventilation for the underground facility. The existing design criteria are intended to provide further protection to the workers in the excavation area. Some leakages between the excavation and emplacement areas are likely. However, these leakages should be minor if separate ventilation is maintained. Therefore, the consequence of the leakages would be minimal and well within the performance objectives of 10 CFR 60.111(a).

(2) Ventilation Design

10 CFR Part 60 has criteria that sufficiently and adequately address design of ventilation to control effluents and airborne exposures to workers and the public.

(3) Ventilation for Retrieval

10 CFR Part 60 sufficiently and adequately addresses criteria for use of ventilation during retrieval.

4.23.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) **Underground Ventilation Separation**

Concept. Criteria are needed for separate ventilation systems for the excavation and waste emplacement areas.

Operational Criteria. The operational criteria required to address this concept are presented in 10 CFR 60.133(g)(3).

Rationale for the Operational Criteria. The criteria in 10 CFR 60.133(g)(3) fully address the concept because they are generally written. The concept of separate ventilation is to provide further radiation safety for the workers in the excavation area. The separate ventilation for the excavation area and the waste emplacement area could require separate ventilation systems for each area. 10 CFR 60.133(g)(3) implies allowance for leakage of air from one system to another. Since 10 CFR 60.111(a) has to be met in the emplacement area, the leakage of air from the emplacement area to the excavation area will have no consequence.

(2) **Ventilation Design**

Concept. The ventilation systems should be designed to control effluents and protect the workers.

Operational Criteria. The operational criteria to address this concept are presented in 10 CFR 60.111(a), 60.131(a)(1), 60.131(a)(4), 60.131(a)(6), 60.132(b), 60.132(c), and 60.133(g).

Rationale for the Operational Criteria. The above cited criteria fully address the above concept because they are written to address control and monitoring of airborne contamination in the facilities and emitted from the facilities.

(3) **Ventilation for Retrieval**

Concept. The criteria for emplacement period ventilation should apply to the retrieval period.

Operational Criteria. The operational criteria to address the concept are presented in 10 CFR 60.111(a).

Rationale for the Operational Criteria. 10 CFR 60.111(a) addresses the safety performance objectives which apply during times through permanent closure or "until permanent closure has been completed," which includes a retrieval period, if necessary.

4.23.3 Elements Considered for Regulation

4.23.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) Underground Ventilation Separation

Elements relevant to underground ventilation include:

- Structures
  - Shafts/ramps
  - Access drifts
  - Emplacement drifts
- Systems
  - Control system - damper movers, air door movers, and speed controllers
  - Waste emplacement ventilation system
  - Development (i.e., excavation) ventilation
- Components
  - Air doors
  - Seals
  - Seal materials
  - Host rock at and near seal locations
  - Seal-rock interface
  - Ducts
  - Dampers
  - Regulators
  - Bulkheads
- Equipment
  - Blowers (fans)
  - HEPA filters
  - Electric motors
  - Automatic shutoff
  - Air conditioning
- Operations
  - Maintenance
  - Inspection
- Procedures
  - Operations
  - Maintenance
  - Inspection

(2) **Ventilation Design**

Elements relevant to ventilation design are the same as above.

(3) **Ventilation for Retrieval**

Elements related to ventilation for retrieval are the same as those above.

4.23.3.2 Comments on and Discussion of the Elements Considered for Regulation

(1) **Underground Ventilation Separation**

One way to satisfy the intent of the design objective expressed by 10 CFR 60.133(g)(3) is to have separate ventilation systems, and to maintain a higher air pressure in the excavation area than in the waste emplacement area.

Air flow in any underground facility will be dominated by air flow in drifts. However, in unsaturated media, air also flows through discontinuities in the rock. Before waste is emplaced, air flow is governed primarily by the ventilation system and its controls. Soon after waste is emplaced, thermal effects will start to influence air-flow patterns. The thermal gradient will likely induce some air flow from heated areas (e.g., the waste emplacement area) toward unheated areas (the excavation area). Since some air may flow through the unsaturated media, the specific design must address this aspect for separating the ventilation systems for the two areas.

(2) **Ventilation Design**

The elements for ventilation are not unique and are generally addressed by 10 CFR Part 60.

(3) **Ventilation for Retrieval**

The elements for ventilation design for repository emplacement operations would appear to apply to retrieval.

4.23.4 Safety Functions and Regulatory Citations

4.23.4.1 Associated Safety Functions

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

(1) **Underground Ventilation Separation**

- Isolate underground waste operations air from construction areas during concurrent operations - 6.28
- Underground ventilation and air conditioning - 6.41.1.2.6
- Ventilation and air conditioning for underground waste operations - 6.41.1.2.6.1

(2) **Ventilation Design**

- Limit releases of radionuclides to the general environment during waste preparation operations - 5.17
- Ventilation and air conditioning for general purpose surface waste preparation facilities - 5.35.1.5
- Ventilation and air conditioning for waste lag storage facilities - 5.35.3.1.3
- Ventilation and air conditioning for waste packaging facilities - 5.35.5.1.9
- Monitor repository conditions that affect radiological health and safety or isolation during repository operations - 6.8
- Limit releases of radionuclides to the general environment during waste disposal operations - 6.17
- Ventilation and air conditioning for underground caretaker and waste retrieval operations - 6.41.1.2.6.2
- Ventilation and air conditioning for underground facility closure operations - 6.41.1.2.6.3
- Ventilation and air conditioning for repository waste receiving facilities - 6.41.2.1.8
- Ventilation and air conditioning for repository waste lag storage facilities - 6.41.3.1.3
- Ventilation and air conditioning for repository waste transfer facilities - 6.41.4.1.3
- Ventilation and air conditioning for waste emplacement facilities (surface and subsurface) - 6.41.5.1.5, 6.41.7.1.4
- Ventilation and air conditioning for waste off-site shipment facilities and equipment - 6.41.8.1.10
- Ventilation and air conditioning for material package and shipment facilities (surface and subsurface) - 6.41.9.1.8

(3) **Ventilation for Retrieval**

- Ventilation and air conditioning for underground caretaker and waste retrieval operations - 6.41.1.2.6.2

4.23.4.2 *Relevant Regulatory Citations*

- 10 CFR 60.111(a), 60.131(a)(1), 60.131(a)(4), 60.131(a)(6), 60.131(b)(9), 60.132(b), 60.132(c), 60.133(a)(2), and 60.133(g)
- 30 CFR 57.4760

4.23.4.3 *Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations*

(1) Underground Ventilation Separation

10 CFR 60.133(g)(3) requires that the underground facility ventilation system be designed to separate ventilation of the excavation and waste emplacement areas. Interpretation of "separate the ventilation" could mean the ventilation air is separate, ventilation systems are separate, ventilation dampers and controls are separate, areas ventilated are separate, or all of the above. The interpretation of separate ventilation systems seems the most logical.

If it is presumed that the basic intent of the design objective is separating the ventilation systems for the waste emplacement and excavation areas, this would help to ensure that any air which might contain radioactive material (i.e., air in the waste emplacement area) would not directly enter into the excavation area. This would provide assurance of worker radiological safety in the excavation area.

With the introduction of air doors, heavy curtains, and ventilation seals, some leakage from one area to the other could occur. If air leakage is *from* the waste emplacement area *to* the excavation area, assuming airborne contamination is present, excavation area worker radiological safety would not be provided. However, if leakage were *from* the excavation area *to* the emplacement area, then the best intent of having two separate systems would be effective. Therefore, it can be argued that it is necessary to have separate ventilation systems, especially systems that permit leakage in only one direction (i.e., from the excavation area to the emplacement area).

The issue of fan reversibility should be discussed because, at first reading, there appears to be a potential conflict in applicable regulations. According to 10 CFR 60.133(g)(3), "The (underground facility) ventilation system shall be designed to separate the ventilation of excavation and waste emplacement areas." The objective here is to prevent flow of radionuclides from the waste emplacement area to the excavation area in the unlikely event of rupture or leakage of a waste package. This can likely be accomplished by the following: (1) suitable arrangement of drifts, control doors, separate ventilation systems, and ventilation control devices and (2) maintenance of a higher air pressure at all times in the excavation area than in the waste emplacement area.

However, mining regulations referenced in 10 CFR 60.131(b)(9) require mechanical ventilation to be reversible (see 30 CFR 57.4760) to control the underground spread of fire, smoke, and toxic gases in the event of fire. 10 CFR 60.133(a)(2) also requires the underground facility to be designed so that the effects of credible disruptive events, such as fires, will not spread through the facility. 30 CFR Part 57 does allow for two alternative means to control the impact of the spread of fire, smoke, and toxic-gases: control doors or effective evacuation procedures. If the underground facility ventilation is designed to meet the intent of 10 CFR 60.133(g)(3) by maintaining lower air pressures for the waste emplacement than for the excavation areas at all times, reversible fans, which may be required or desirable by 30 CFR Part 57 and 10 CFR 60.133(a)(2), may cause the smoke or effects of the fire to flow from the excavation area to the emplacement area. But fires are unlikely events, and releases from the waste package are an even more unlikely events. The design should consider protecting the workers for each event. Under emergency conditions, worker safety is the utmost concern, and it appears that reversible fans would be permitted by the regulations provided that suitable measures can be taken to protect against inadvertent or accidental reversal.

(2) **Ventilation Design**

The design criteria for ventilation are similar among the various regulations, and the safety functions all appear to be addressed.

(3) **Ventilation for Retrieval**

The criteria for ventilation in 10 CFR Part 60 apply to anticipated operations. Waste retrieval is an anticipated operation. The current criteria in 10 CFR 60.133(g) for ventilation address the safety function for providing subsurface ventilation for retrieval operations.

4.24 QUALITY ASSURANCE

There are no subtopics for this ROC Topic.

4.24.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

10 CFR Part 60 has adequate and sufficient criteria for quality assurance which are equivalent to the criteria established for nuclear power plants and for an MRS because 10 CFR Part 60 references 10 CFR Part 50, Appendix B. The current criteria are appropriate and are sufficient for quality assurance related to meeting the performance objectives.

4.24.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

Concept. Criteria are needed for QA for features of the repository that are important to safety and isolation and features associated therewith. The QA programs should have criteria similar to that of other nuclear facilities that handle spent fuel or other HLW.

Operational Criteria. The operational criteria required to address this concept are presented in 10 CFR 60.21(c)(4), 60.31(a)(3), 60.150, 60.151, and 60.152.

Rationale for the Operational Criteria. The criteria cited above fully address the concept because an application of the criteria of 10 CFR Part 50, Appendix B (incorporated by reference into 10 CFR Part 60), to the design, construction, and operation of nuclear power plants has a well established history of successful implementation and has comprehensive guidance for implementation of QA programs through the ASME Standard NQA (Nuclear Quality Assurance)-1 (Ref. 26) and ASME Standard NQA-2 (Ref. 27).

4.24.3 Elements Considered for Regulation

4.24.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

The quality assurance program applies to: (1) structures, systems, and components important to safety, (2) design and characterization of barriers important to waste isolation, and (3) activities related to (1) or (2) such as site characterization, facility and equipment construction, facility operation, performance confirmation, permanent closure, and decontamination and dismantling of surface facilities.

4.24.3.2 Comments on and Discussion of the Elements Considered for Regulation

10 CFR 60.151 is written to have very broad applicability for QA; and by referencing 10 CFR Part 50, Appendix B, 10 CFR 60.152 helps to ensure the QA program criteria will be adequate and sufficient.

4.24.4 Safety Functions and Regulatory Citations

4.24.4.1 Associated Safety Functions

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

- Implement a quality assurance program for security and safeguards - 2.13
- Implement a quality assurance program for waste preparation operations - 5.14
- Implement a quality assurance program for waste disposal operations - 6.13

4.24.4.2 Relevant Regulatory Citations

- 10 CFR 50.4(b)(7), 50.34(a)(7), 50.54(a)(3), 50.55(f)(3), 50.70, 50.71, Part 50, Appendix A-I, Criterion 1, and Appendix B
- 10 CFR 60.21(c)(4), 60.31(a)(3), 60.44, 60.71, 60.75, 60.150, 60.151 and 60.152
- 10 CFR 72.24(n), 72.40(a)(7) 72.48, 72.70, 72.82, 72.122(a), and 72.140 through 72.176

4.24.4.3 Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations

The associated safety functions are comparable, suggesting a broad application of QA requirements, while one specifically addressed security and safeguards QA. 10 CFR 60.150-60.152, with the referenced 10 CFR Part 50, Appendix B, is equivalent to 10 CFR 72.140-72.176. Each contains the eighteen criteria for a quality assurance program. Originally applicable to nuclear power plants and fuel reprocessing plants, 10 CFR Part 50, Appendix B, provides examples of design control and test control applications which are specific to power plants, while corresponding portions of 10 CFR Part 72 provide ISFSI/MRS oriented examples. The licensee should be able to easily discern these cases and substitute equivalent criteria applicable to a repository. 10 CFR 50.34(a)(7) and 10 CFR Part 50, Appendix A-I, Criterion 1, establish the basic requirement for a quality assurance program, and are equivalent to 10 CFR 60.31(a)(3), 60.152, 72.40(a)(7), 72.122(a), and 72.140(c). Access and office facilities for NRC inspectors are required by 10 CFR 50.70, 60.75, and 72.82. 10 CFR 50.4(b)(7), 50.34(a)(7), 50.54(a)(3), 50.55(f)(3), and 50.71 involve submittal of quality assurance related documents and changes. Equivalent criteria are identified in 10 CFR 60.21(c)(4), 60.44, 60.71, 72.24(n), 72.48, and 72.70.

Overall, the quality assurance associated regulations in 10 CFR Parts 50, 60, and 72 appear entirely consistent.

4.25 PRECLOSURE SECURITY AND SAFEGUARDS

This ROC Topic has the following subtopics:

(1) Security and Safeguards
(2) Sabotage Affecting Long-Term Performance
(3) Application of Relevant Portions of 10 CFR Part 73
(4) Security Plans

4.25.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) Security and Safeguards

10 CFR Part 60 is sufficient and adequate regarding preclosure security and safeguards because it requires certification and description of security and safeguards proposed by DOE.

Note: Requirements for other facilities, including those operated by DOE, in other Parts of Title 10 of the Code of Federal Regulations are much more detailed, and may require more detailed information in the license application.

(2) Sabotage Affecting Long-Term Performance

10 CFR Part 60 is sufficient and adequate, since a description of DOE's physical security plan against radiological sabotage is a requirement.

(3) Application of Relevant Portions of 10 CFR Part 73

The current criteria in 10 CFR 60.21(b)(3) and 60.21(b)(4) are sufficient and adequate because DOE has experience with comparable facilities. The current criteria in 10 CFR 60.21(b)(4) are broadly written to address sabotage unique to a GROA.

(4) Security Plans

The current criteria in 10 CFR 60.21(b)(3) and 60.21(b)(4) are sufficient and adequate to require physical security plans.

4.25.2 Concepts, Operational Criteria, and Rationale

This section presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) Security and Safeguards

Concept. Criteria are needed to ensure that the GROA will be designed, constructed, and operated to address the relevant portions of 10 CFR Part 73 or similar criteria.

Operational Criteria. Operational criteria needed to address the concept are presented in 10 CFR 60.21(b)(3) and 60.21(b)(4).

Rationale for the Operational Criteria. The criteria in 10 CFR 60.21(b)(3) and 60.21(b)(4) address this concept because DOE has experience with comparable facilities

[60.21(b)(3)] and, where unique features of a GROA exist, 10 CFR 60.21(b)(4) is broadly written to address sabotage.

(2) Sabotage Affecting Long-Term Performance

Concept. Criteria for security and safeguards to prevent or detect sabotage of the postclosure performance features of a repository are needed.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.21(b)(4).

Rationale for the Operational Criteria. 10 CFR 60.21(b)(4) addresses this concept because requiring a description of the physical security plan for sabotage can ensure radiological protection from sabotage of HLW.

(3) Application of Relevant Portions of 10 CFR Part 73

Concept. Criteria are needed so that the GROA will be designed, constructed, and operated to address the relevant portions of 10 CFR Part 73 regarding sabotage.

Operational Criteria. The operational criteria needed to address this concept are presented in text similar to 10 CFR 60.21(b)(3) and 60.21(b)(4).

Rationale for the Operational Criteria. The criteria in 10 CFR 60.21(b)(3) and 60.21(b)(4) address this concept because DOE has experience with comparable facilities (60.21(b)(3)) and, where unique features of a GROA exist, 10 CFR 60.21(b)(4) is broadly written to address sabotage.

(4) Security Plans

Concept. Criteria are needed for a description of the measures for physical protection, including design features for compliance with appropriate sections of 10 CFR Part 73.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.21(b)(3) and 60.21(b)(4).

Rationale for the Operational Criteria. Information required by 10 CFR 60.21(b)(3) and 60.21(b)(4) fully addresses this concept because these sections require a description of physical protection measures, which would include design features for the GROA.

4.25.3 Elements Considered For Regulation

4.25.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) Security and Safeguards

Some of the elements relevant to promoting the common defense and security are as follows:

- Facilities and equipment for security, including computer, guard stations, armory, security personnel vehicles, surveillance equipment (video monitoring, etc.), communications network, software for security and safeguards, system to maintain and secure security and safeguards records and reports
- Physical barriers to access controlled areas and facilities within fences, walls, and locks
- Training facilities for security and safeguards, procedures for training and certifying personnel for security and safeguards, and procedures to screen/qualify candidate security and safeguards trainees
- Procedures to monitor personnel reliability, conduct periodic training exercises, periodically recertify security and safeguards personnel, conduct investigations and issue long-term authorizations for access to operations areas and specific facilities, and issue temporary individual authorizations for access to operations areas and specific facilities
- Facilities for maintenance of security and safeguards facilities and equipment
- Procedures for interacting with law enforcement agencies in support of security of the controlled area
- Procedures for training security personnel, ensuring integrity of security personnel, controlling access to on-site HLW storage, and handling information which might be used by saboteurs
- Procedures for background (criminal history) checks of employees and visitors and procedures for training of same
- Emergency response equipment and storage (armory with appropriate weapons to deter armed saboteurs and terrorists), controlled access to emergency response equipment storage armory
- Procedures and equipment for detecting potential sabotage and saboteurs, contingency procedures for the event of loss or theft of special material, and procedures to account for and maintain inventories of nuclear materials in the waste management system

- Equipment and procedures to verify transportation vehicle condition and absence of sabotage devices (e.g., explosives) during receiving of waste package components

(2) Sabotage Affecting Long-Term Performance

Some of the elements relevant to sabotage affecting long-term performance are as follows:

- Procedures for controlling access to or avoiding disturbance of the controlled area and the areas outside the controlled area where conditions may affect isolation within the controlled area and procedures for emergency response for the preceding conditions
- Procedures and equipment for detecting potential sabotage and saboteurs
- Waste package or waste package component storage facilities, and any equipment necessary to maintain proper storage conditions (e.g., physical security controls for entrance to facility and possible sabotage via environment, personnel access control devices, interlocks, and alarms for environmental parameter bounds)
- Emplacement borehole equipment intended to provide physical security against tampering by unauthorized persons (fail-safe design, emplacement borehole locks, transporter locks, personnel access control devices, and interlocks)
- Procedures for controlling the storage, handling, testing, transporting, and emplacing of waste packages and their components with respect to security considerations (multiple point control of waste access and sequential control of processes)

(3) Application of Relevant Portions of 10 CFR Part 73

The elements relevant to this subtopic would include the detailed security requirements in accordance with pertinent portions of 10 CFR Part 73.

(4) Security Plans

The elements of a security plan should address those elements listed above.

4.25.3.2 Comments on and Discussion of the Elements Considered for Regulation

(1) Security and Safeguards

The elements indicate that many aspects of preclosure security and safeguards are not covered in detail by requirements in 10 CFR Part 60. The security and safeguards criteria in 10 CFR 60.21(b)(3) and 60.21(b)(4), by referencing "comparable surface facilities," may be inadequate, considering the repository will be a first-of-a-kind facility and security for sabotage affecting long-term performance is a wholly unique area.

(2) Sabotage Affecting Long-Term Performance

The elements show that waste package security and protection should include environmental aspects of security so that sabotage of the package environment (with subsequent long-term performance degradation) would not go undiscovered before or after a package is emplaced.

(3) Application of Relevant Portions of 10 CFR Part 73

The sections in 10 CFR Part 73 that deal with sabotage would be related to a geologic repository. These criteria would have to be carefully reviewed to ensure that security related to sabotage of long-term containment and isolation features of a repository would be adequately addressed.

(4) Security Plans

A description of the security plan could address all the elements above.

4.25.4 Safety Functions and Regulatory Citations

4.25.4.1 Associated Safety Functions

The following safety functions were identified from the CNWRA "Repository Functional Analysis" (Ref. 1).

(1) Security and Safeguards

- Screen/qualify candidate security and safeguards trainees - 2.2
- Train and certify security and safeguards personnel - 2.3
- Monitor personnel reliability - 2.4
- Conduct periodic training exercises - 2.5
- Periodically recertify security and safeguards personnel - 2.6

- Conduct investigations and issue long-term authorizations for access to operations areas and specific facilities - 2.7
- Prevent unauthorized access to (and activities in) operations areas - 2.8
- Account for access and egress of authorized visitors - 2.8.1
- Control temporary individual authorizations for access to operations areas and specific facilities - 2.8.2
- Detect and respond to intrusions and other unauthorized activities - 2.8.3
- Prevent theft, sabotage, or terrorism in waste management facilities - 2.9
- Account and maintain inventories of nuclear materials in the waste management system - 2.10
- Maintain and secure security and safeguards records and reports - 2.12
- Implement a quality assurance program for security and safeguards - 2.13
- Ensure operability of security and safeguards equipment important to safety - 2.14
- Ensure fitness for duty of personnel certified for security and safeguards operations that are important to safety - 2.15
- Control configuration of operational security and safeguards facilities, equipment, software and procedures - 2.16
- Ensure the stability of security and safeguards facilities important to safety under local foundation conditions - 2.17
- Ensure the ability of security and safeguards facilities and equipment to perform their intended functions under naturally induced conditions and events (e.g., weather, seismic activity) - 2.18
- Ensure the ability of security and safeguards facilities and equipment to perform their intended functions under conditions and events induced by human activity - 2.19
- Security and safeguards generic system elements - 2.20
- Facilities for security and safeguards - 2.20.1
- Facilities for security and safeguards operations (e.g., administrative, investigatory, computer, guard stations, armory) - 2.20.1.1
- Physical barriers to operations area(s) access - 2.20.1.2
- Training facilities for security and safeguards - 2.20.1.3
- Facilities for maintenance of security and safeguards facilities and equipment - 2.20.1.4
- Equipment for security and safeguards - 2.20.2
- Operations area surveillance equipment for security and safeguards - 2.20.2.1

- Detection equipment for unauthorized entry of emplacement opening/location - 2.20.2.2
- Computational capability for security and safeguards (e.g., monitor intrusion, access/egress control) - 2.20.2.3
- Communications network for security and safeguards - 2.20.2.4
- Vehicles, armaments, and personal equipment for security and safeguards - 2.20.2.5
- Equipment for preparation and retention of security and safeguards records and reports - 2.20.2.6
- Training equipment for security and safeguards - 2.20.2.7
- Equipment for security and safeguards unsafe/emergency conditions - 2.20.2.8
- Equipment, spares, and materials for security and safeguards facilities and equipment maintenance - 2.20.2.9
- Software for security and safeguards - 2.20.3
- Trained and certified personnel for security and safeguards - 2.20.4
- Trained and certified personnel for security and safeguards unsafe/emergency conditions - 2.20.4.1
- Trained and certified personnel for security and safeguards facility and equipment maintenance - 2.20.4.2
- Procedure(s) for security and safeguards - 2.20.5
- Procedure(s) to screen/qualify candidate security and safeguards trainees - 2.20.5.1
- Procedure(s) to train and certify security and safeguards personnel - 2.20.5.2
- Procedure(s) to monitor personnel reliability - 2.20.5.3
- Procedure(s) to conduct periodic training exercises - 2.20.5.4
- Procedure(s) to periodically recertify security and safeguards personnel - 2.20.5.5
- Contingency procedure(s) for the event of loss or theft of special nuclear material - 2.20.5.6
- Procedure(s) for security and safeguards unsafe/emergency conditions - 2.20.5.7
- Procedure(s) for security and safeguards facility and equipment maintenance - 2.20.5.8
- Verify transportation vehicle condition and absence of sabotage devices (e.g., explosives) upon receipt of waste disposal package components - 5.3.1

(2) Sabotage Affecting Long-Term Performance

- Conduct investigations and issue long-term authorizations for access to operations areas and specific facilities - 2.7

- Prevent unauthorized access to (and activities in) operations areas - 2.8
- Control temporary individual authorizations for access to operations areas and specific facilities - 2.8.2
- Detect and respond to intrusions and other unauthorized activities - 2.8.3
- Prevent theft, sabotage, or terrorism in waste management facilities - 2.9
- Maintain and secure security and safeguards records and reports - 2.12
- Physical barriers to operations area(s) access - 2.20.1.2
- Detection equipment for unauthorized entry of emplacement opening/location - 2.20.2.2
- Communications network for security and safeguards - 2.20.2.4
- Verify transportation vehicle condition and absence of sabotage devices (e.g., explosives) upon receipt of waste disposal package components - 5.3.1

(3) Application of Relevant Portions of 10 CFR Part 73

- Prevent theft, sabotage, or terrorism in waste management facilities - 2.9
- Account for and maintain inventories of nuclear materials in the waste management system - 2.10
- Maintain and secure security and safeguards records and reports - 2.12
- Ensure the ability of security and safeguards facilities and equipment to perform their intended functions under conditions and events induced by human activities - 2.19
- Contingency procedure(s) for the event of loss or theft of special nuclear material - 2.20.5.6

(4) Security Plans

- Plan nuclear security and safeguards operations - 2.1
- Plan normal security and safeguards operations - 2.1.1
- Plan for security and safeguards contingencies - 2.1.2

4.25.4.2 Relevant Regulatory Citations

- 10 CFR 50.4(b)(4)(i) through 50.4(b)(4)(iv)
- 10 CFR 60.21(b)(3), 60.21(b)(4), 60.21(c)(8), 60.21(c)(10), 60.31(b), 60.41(c), 60.43(b)(5), 60.46(a)(3), 60.71(b), 60.75(c)(3), and 60.135(b)(4)

- 10 CFR 61.23(c) and 61.24(h)(1)
- 10 CFR 70.4
- 10 CFR 72.24(o), 72.44(e), 72.168, 72.180, 72.182, 72.184, 72.186, and Part 72, Subpart H
- 10 CFR 73.1 through 73.24 and 73.40 through 73.80

4.25.4.3 Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations

(1) Security and Safeguards

As part of the license specification and conditions, 10 CFR 60.21(b)(3) and 61.24(h)(1) address security and safeguards. 10 CFR 60.31(b) and 60.41(c) contain similar stipulations.

Maintaining control of and accounting for the inventory of nuclear materials are important to prevent diversion of nuclear materials. Waste package identification and location are covered by 10 CFR 60.135(b)(4) and 60.71(b). Also, maintaining control of and accounting for the inventory of nuclear materials are required in 10 CFR 60.21(c)(10). 10 CFR 72.168 goes somewhat beyond 10 CFR Part 60 by requiring identification of the status of the inspections or tests being performed on individual items of the ISFSI or MRS. The provision in 10 CFR 60.71(b) is similar; however, it requires that records be kept to "provide a complete history of the movement of the waste from the shipper through all phases of storage and disposal."

(2) Sabotage Affecting Long-Term Performance

In 10 CFR 60.21(b)(4), a description of the plan for protection against radiological sabotage is required. Security against radiological sabotage should include environmental controls which prevent sabotage whose effects may not be apparent before permanent closure, but which may affect the GROA ability to meet the performance objectives of containment and isolation. A major difference between 10 CFR Part 60 and 10 CFR Part 72 is that similar requirements are addressing different sections of the license application. The requirement for a description of the physical protection program for sabotage, in 10 CFR Part 60.21(b)(4), is under the "General Information" section of the license application; and for 10 CFR Part 72.24(o) (the similar requirement), it is under the "Safety Analysis Report" section of the license application. This difference does not imply more detail and analysis are required by 10 CFR Part 72 in the license application to address similar requirements because the "General Information" section of the license application can reference more detailed analyses, as necessary.

The plan for protection against radiological sabotage should also include consideration of sabotage of the environment, stored wastes, or waste packages to ensure that long-term performance requirements of containment and isolation will be met. There are preclosure considerations for security which could impair the long-term isolation of emplaced waste. For example, intruders could tamper with waste packages (containers, container components, and backfill if used) or the underground facility and its [illegible]ents. The focus of the text from 10 CFR 61.23(c) appears to be on inadverte[illegible] in contrast to the discussion of sabotage in the relevant texts of 10 CFR Part [illegible] (which includes 72.180, 72.182, 72.184, and 72.186). As a requireme[illegible] of a construction authorization, 10 CFR 60.31(b) requires "a DOE certificatio[illegible]de at the geologic repository operations area such safeguards as it requires at [illegible]DOE surface facilities to promote the common defense and security."

(3) Application of Relevant Portions of 10 CFR Part 73

Concerning the period of operations, the license application must contain, per 10 CFR 60.21(b)(4), "A description of the physical security plan for protection against radiological sabotage. Since the radiation hazards associated with high-level wastes make them inherently unattractive as a target for theft or diversion, no detailed information need be submitted on protection against theft or diversion." In 10 CFR 60.21(b)(3), DOE is required to certify that it will provide "such safeguards as it requires at comparable surface facilities (of DOE) to promote the common defense and security." This also includes DOE facilities used primarily for the receipt and storage of high-level radioactive wastes resulting from licensed activities, per section 202 of the Energy Reorganization Act of 1974 (Ref. 6) (88 Stat. 1244) (from the footnote to the definition of "Person" in 10 CFR 70.4). Relevant requirements in 10 CFR Part 73 (Physical Protection of Plants and Materials) are perhaps appropriate.

In 10 CFR 73.1(b)(6), "This part prescribes requirements for the physical protection of spent fuel stored in either an independent spent fuel storage installation (ISFSI) or a monitored retrievable storage installation (MRS) licensed under 10 CFR Part 72 of this chapter." 10 CFR Part 72 governing an MRS is closely related to 10 CFR Part 60, since spent fuel will be stored at the MRS and disposed of at the GROA. Provisions of 10 CFR Part 73 apply to an MRS [facilities regulated by 10 CFR Part 72 per 72.180, 72.184, 72.186(b)]. Relevant requirements of 10 CFR Part 73 would include general provisions and those texts concerning physical protection against radiological sabotage at fixed sites. Specifically, these would include portions of 10 CFR 73.1 through 73.24 and 73.40 through 73.80. Relevant requirements of 10 CFR Part 73 would be limited to those concerning radiological sabotage (as opposed to theft and diversion), since 10 CFR 60.21(b)(4) states: "Since the radiation hazards associated with high-level wastes make them inherently unattractive as a target for theft or diversion, no detailed information need be submitted on protection against theft or diversion."

The associated safety functions indicate the detail to which security-related functions may be developed to provide protection at the GROA. This also, like 10 CFR Part 72 and 10 CFR Part 73, is in contrast to the more general requirement in 10 CFR 60.21(b)(4) concerning preclosure security and safeguards.

(4) **Security Plans**

"... description of the physical security plan for protection against radiological sabotage" is required in the license application by 10 CFR 60.21(b)(4). In 10 CFR 60.21(b)(3), the DOE must certify that "such safeguards as it requires at comparable surface facilities (of DOE)" will be provided at the GROA.

Controls applied to restrict access to or avoid disturbance of the "controlled area" [10 CFR 60.21(c)(8), 60.43(b)(5), and 60.46(a)(3)] would not be part of a preclosure physical security plan. This is not considered to be within the scope of the ROC Feasibility Studies.

10 CFR 50.4(b)(4)(i) through 50.4(b)(4)(iv) for power reactors address any change in physical security plan, guard training and qualification plan, or safeguards contingency plan made without prior NRC Commission approval. A similar requirement exists for ISFSIs and MRSs in 10 CFR Part 72. 10 CFR 72.44(e) requires that no changes be made by the licensee that would decrease the effectiveness of the physical security plan, without prior Commission approval, unless such changes do not decrease the effectiveness of the plan.

10 CFR 60.75(c)(3) requires that DOE provide "immediate unfettered" access to NRC inspectors, following "proper identification and compliance with applicable access control measures for security, radiological protection, and personal safety," similar to other regulations.

4.26 PERSONNEL

This ROC Topic has the following subtopics:

(1) Personnel Qualification
(2) Personnel Training Program, Facilities, and Equipment
(3) Organization, Administration, and Management
(4) Use of Qualified Personnel

4.26.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) **Personnel Qualification**

10 CFR Part 60 has addressed personnel qualification adequately and sufficiently in 10 CFR 60.21(c)(15)(iii) and Part 60, Subpart H (60.160 through 60.162). These regulations are general and thus require qualifications and training requirements for all personnel conducting activities at the GROA.

Note: Training of offsite personnel for radiological emergencies will be addressed in the section 7.5 ROC Topic.

(2) **Personnel Training Program, Facilities, and Equipment**

10 CFR Part 60 has adequate and sufficient criteria for a training program for the GROA and SSCIS because the requirement in 10 CFR 60.161 is general and includes training and certification of personnel for all operations, not just those important to safety.

(3) **Organization, Administration, and Management**

Criteria in 10 CFR Part 60 addressing organization, administration, and management are adequate and sufficient, because 10 CFR 60.21(c)(15)(i), 60.21(c)(15)(ii), 60.43(b)(6), and 10 CFR 50, Appendix B, require a description of the applicant's operating organization, delegation of responsibility and authority, and identification of key personnel.

(4) **Use of Qualified Personnel**

10 CFR 60.162 adequately and sufficiently assure that the physical condition and the general health of personnel certified for operations important to safety will not endanger the public health and safety. This includes plant personnel.

4.26.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) **Personnel Qualification**

Criteria. Criteria are needed to assure that personnel are qualified to carry out the necessary operations.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.21(c)(15)(iii), 60.160, 60.161, and 60.162.

Rationale for the Operational Criteria. The cited criteria address this concept because they ensure personnel qualifications essential to radiation control and safe handling of HLW. 10 CFR Part 60 is written to generally address requirements for personnel qualification, and includes requirements given in other similar regulations and the elements relevant to personnel qualifications.

(2) **Personnel Training Program, Facilities, and Equipment**

Criteria. Criteria are needed for a personnel training program for activities and operations in the GROA.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.21(c)(15)(iii) and 60.161.

Rationale for the Operational Criteria. The cited criteria address this concept because they require a training program to ensure that the personnel can conduct the activities and operations of a repository safely. 10 CFR Part 60 has criteria for personnel training; it is general and would address training programs for all operating and supervisory personnel in the GROA.

Note: Training of offsite personnel for emergencies is addressed in the section 7.5 ROC Topic.

(3) Organization, Administration, and Management

Concept. Criteria for licensee organization, administration, and management are needed for a repository.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.21(c)(15)(i), 60.21(c)(15)(ii), 60.43(b)(6), and 10 CFR Part 50, Appendix B.

Rationale for the Operational Criteria. These criteria address this concept because they assure that the GROA can be safely managed. 10 CFR Part 60 requires a description of the organizational structure of the applicant as it pertains to construction and operation of the GROA, including a description of any delegation of authority and assignment of responsibilities to various personnel, and use of key personnel.

(4) Use of Qualified Personnel

Concept. Criteria are needed to ensure the safety and protection of plant personnel and equipment as well as the public.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.162.

Rationale for the Operational Criteria. The criteria in 10 CFR 60.162 address this concept because the concept of "public health and safety" as interpreted from the NRC's enabling statutes does mean worker and nonworker safety. This is clearly shown in the criteria developed by the NRC in 10 CFR Part 20. Fitness for duty is not limited to consideration of impacts on "public" (nonworkers) health and safety. The physical condition of one worker impacting the radiological health and safety of another worker is also an NRC concern. In addition, equipment used for handling radioactive material or radiation control must not be endangered. It is clear that operator errors that result in endangering other workers or equipment, as well as "the public," are addressed.

4.26.3 Elements Considered for Regulation

4.26.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) Personnel Qualification

Different levels of qualification are required for personnel depending on the nature of the operations and on the level of responsibilities and authorities delegated to them. Some elements relevant to determining personnel qualifications are as follows:

- Training
- Experience
- Education
- License
- Certifications
- Evaluations (to maintain a set standard)
- Background checks
- Physical abilities
- Pre-employment tests

(2) Personnel Training Program, Facilities, and Equipment

The training program should cover key personnel, for example: security and safeguards, waste preparation, emplacement, maintenance, radiological control, processing, inspection, testing, QA, waste receiving, waste handling, waste packaging, waste transfer, waste emplacement, waste removal, repository monitoring, offsite shipment, closure and decommissioning, backfill material processing and emplacement, and seal emplacement. Therefore, the training program will have different areas to address, for example:

- Radiological training
- Training and drills for radiation emergency
- Retraining programs
- Operating licenses and training
- Safety training which could include first aid, emergency response, review of accidents, technical information, protective clothing, and safety fundamentals
- Training organization
- Local offsite services (e.g., emergency services/civil defense, local law enforcement, and local news media)

Facilities and equipment required for personnel training can be classrooms, drill exercise facility, simulators, mock-ups of actual equipment used in operation, test centers, computer facilities, lessons, tests, and record keeping of license and certification status.

(3) Organization, Administration, and Management

Elements of personnel management are as follows:

- On-the-job supervision, including performance evaluation
- On-the-job testing
- Quality assurance management
- Periodic drill exercises, including performance evaluation
- Keeping updated records of training and recertification of key personnel
- Fitness-for-duty testing
- Organizational responsibilities and authority

Elements related to personnel fitness for duty and providing a drug-free workplace are discussed in NRC Information Notice No. 90-81 (Ref. 28). Examples of these are as follows:

- Publication of a statement of policy regarding a drug-free workplace, outlining actions to be taken for violations of the policy
- Establishment of a drug-free awareness program
- Distribution of a statement of policy to employees engaged in the contract activities
- Establishment of certain conditions of employment based on the drug-free workplace concept
- Timely notification to the contracting agency of employee drug convictions
- Establishment of a good-faith effort to continue to maintain a drug-free workplace through these measures

(4) Use of Qualified Personnel

Elements of qualified personnel use, including both onsite and offsite staff, are as follows:

- Use of staff working with security
- Use of staff for radiation control
- Use of staff working with structures, systems, and components important to safety

Some elements requiring use of qualified personnel are as follows:

- Emergency response
- Coordination of operations

- Accident assessment
- Radiological control and monitoring
- Fire control
- First aid and rescue
- Medical support
- H' adquarters support
- Security and safeguards
- Operation of equipment important to safety and th not important to safety but having secondary effects (e.g., inspection, testing, training, mining, and industrial safety)
- Local offsite services (e.g., emergency services/civil defense, local law enforcement and local news media)

Examples of fitness for duty to protect public, workers, and equipment are personnel in good mental condition (without drug or alcohol addiction).

4.26.3.2 Comments on and Discussion of the Elements Considered for Regulation

(1) Personnel Qualification

10 CFR Part 60 is general in addressing personnel qualifications per 10 CFR 60.21(c)(15)(iii) and Part 60, Subpart H (60.160 through 162), and would address the elements given above, except for the qualification and training of offsite personnel for radiological emergencies. This is addressed in the section 7.5 ROC Topic. 10 CFR Part 60 does not set limitations for "minimum" training and experience for personnel. However, since duties and lines of authorities and responsibilities are discussed in 10 CFR Part 60, it would not be necessary to set "minimum" limitations for qualification.

(2) Personnel Training Program, Facilities, and Equipment

The elements in subsection 4.26.3.1 (2) address specific requirements for facilities and equipment to conduct personnel training. 10 CFR Part 60 does not address training facilities and equipment directly, but 10 CFR 60.161 would require addressing any needed facilities and equipment.

Note: 10 CFR Part 60 may not address training of offsite personnel for emergencies, which is addressed by the section 7.5 ROC Topic.

(3) Organization, Administration, and Management

Organization, administration, and management are covered in 10 CFR 60.21(c)(15)(i), 60.21(c)(15)(ii), and 60.43(b)(6), which require information concerning the organizational structure of DOE as it pertains to construction and operation of the GROA. This information would include a description of any delegation of authority and assignment of responsibilities. With 10 CFR 60.152 referencing 10 CFR Part 50, Appendix B, the applicant is required to establish a quality assurance program that includes indoctrination and training of personnel performing activities affecting quality as necessary to assure that suitable proficiency is achieved and maintained.

(4) Use of Qualified Personnel

Address of fitness for duty in 10 CFR 60.162 is limited to operational errors that could endanger the public health and safety.

4.26.4 Safety Functions and Regulatory Citations

4.26.4.1 Associated Safety Functions

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

(1) Personnel Qualification

- Screen/qualify candidate security and safeguards trainees - 2.2
- Periodically recertify security and safeguards personnel - 2.6
- Ensure fitness for duty of personnel certified for security and safeguards operations that are important to safety - 2.15
- Ensure fitness for duty of personnel certified for waste disposal package component handling and preparation - 5.29
- Ensure fitness for duty of personnel certified for waste preparation operations that are important to safety - 5.34
- Monitor fitness for duty of personnel perfroming safety-related work - 6.8.1.4
- Ensure fitness for duty of personnel certified for repository operations that are important to safety or isolation - 6.37

(2) Personnel Training Program, Facilities, and Equipment

- Train and certify security and safeguards personnel - 2.3
- Conduct periodic training exercises - 2.5
- Procedure(s) to train and certify security and safeguards personnel - 2.20.5.2
- Procedure(s) to monitor personnel reliability - 2.20.5.3
- Procedure(s) to conduct periodic training exercises - 2.20.5.4
- General purpose support buildings (e.g., lab, administrative, computer) for waste preparation operations - 5.35.1.2

- Procedure(s) to ensure fitness for duty of personnel certified for waste disposal package disposal receiving - 5.35.2.5.4
- Procedure(s) to ensure fitness for duty of personnel certified for waste lag storage operations - 5.35.3.5.5
- Procedures to ensure fitness for duty of personnel certified for waste disposal package components lag storage operations - 5.35.4.5.6
- Procedure(s) to ensure fitness for duty of personnel certified for waste packaging operations - 5.35.5.5.5
- Surface general purpose (non-waste handling) facilities and equipment for repository operations - 6.41.1.1
- Procedure(s) to ensure fitness for duty of personnel certified for waste receiving operations - 6.41.2.5.4
- Procedure(s) to ensure fitness for duty of personnel certified for waste lag storage operations - 6.41.3.5.5
- Procedure(s) to ensure fitness for duty of personnel certified for waste transfer operations - 6.41.4.5.5
- Procedure(s) to ensure fitness for duty of personnel certified for waste emplacement operations - 6.41.5.5.5
- Procedure(s) to ensure fitness for duty of personnel certified for waste removal operations - 6.41.7.5.5
- Procedure(s) to ensure fitness for duty of personnel certified for waste off-site shipment operations - 6.41.8.5.6
- Procedure(s) to ensure fitness for duty of personnel certified for closure and decommissioning operations - 6.41.9.5.13

(3) Organization, Administration, and Management

- Monitor personnel reliability - 2.4
- Ensure fitness for duty of personnel certified for security and safeguards operations that are important to safety - 2.15
- Ensure fitness for duty of personnel certified for waste disposal package components handling and preparation - 5.29
- Ensure fitness for duty of personnel certified for waste preparation operations that are important to safety - 5.34
- Ensure fitness for duty of personnel certified for repository operations that are important to safety or isolation - 6.37

(4) Use of Qualified Personnel

- Trained and certified personnel for security and safeguards - 2.20.4
- Trained and certified personnel for security and safeguards unsafe/emergency conditions - 2.20.4.1

- Trained and certified personnel for security and safeguards facility and equipment maintenance - 2.20.4.2
- Trained and certified personnel for waste disposal package components receiving operations - 5.35.2.4
- Trained and certified personnel for waste disposal package components handling in receiving operations - 5.35.2.4.1
- Trained and certified inspection and testing personnel for waste disposal package components receiving operations - 5.35.2.4.2
- Trained and certified personnel for response to waste disposal package component receiving unsafe conditions - 5.35.2.4.3
- Trained and certified personnel for waste disposal package component receiving facility and equipment maintenance - 5.35.2.4.4
- Trained and certified personnel for waste lag storage - 5.35.3.4
- Trained and certified personnel for waste handling in lag storage - 5.35.3.4.1
- Trained and certified personnel for inspection of waste received for lag storage - 5.35.3.4.2
- Trained and certified personnel for waste lag storage unsafe/emergency conditions - 5.35.3.4.3
- Trained and certified personnel for waste lag storage facility and equipment maintenance - 5.35.3.4.4
- Trained and certified personnel for waste disposal package components lag storage - 5.35.4.4
- Trained and certified personnel to off-load/load waste disposal package components in lag storage - 5.35.4.4.1
- Trained and certified personnel to handle waste disposal package components in lag storage - 5.35.4.4.2
- Trained and certified personnel for inspection of waste disposal package components received for lag storage - 5.35.4.4.3
- Trained and certified personnel for response to waste disposal package components lag storage unsafe conditions - 5.35.4.4.4
- Trained and certified personnel for waste disposal package components lag storage facility and equipment maintenance - 5.35.4.4.5
- Trained and certified personnel for waste packaging operations - 5.35.5.4 and 5.35.5.4.1
- Trained and certified inspection and testing personnel for waste packaging operations - 5.35.5.4.2
- Trained and certified personnel for waste packaging unsafe/emergency conditions - 5.35.5.4.3
- Trained and certified personnel for waste packaging facility and equipment maintenance - 5.35.5.4.4

- Trained and certified personnel for repository waste receiving operations - 6.41.2.4
- Trained and certified personnel for handling and decontamination of waste in repository receiving - 6.41.2.4.1
- Trained and certified personnel for inspection and testing of waste in repository receiving - 6.41.2.4.2
- Trained and certified personnel for repository waste receiving radiological unsafe/emergency conditions - 6.41.2.4.3
- Trained and certified personnel for repository waste receiving facility and equipment maintenance - 6.41.2.4.4
- Trained and certified repository personnel for waste lag storage - 6.41.3.4
- Trained and certified personnel for waste handling in repository lag storage - 6.41.3.4.1
- Trained and certified personnel for inspection of waste received for repository lag storage - 6.41.3.4.2
- Trained and certified personnel for waste lag storage radiological unsafe/emergency conditions during repository operations - 6.41.3.4.3
- Trained and certified personnel for repository lag storage facility and equipment maintenance - 6.41.3.4.4
- Trained and certified personnel for waste transfer - 6.41.4.4
- Trained and certified waste transfer conveyance operators - 6.41.4.4.1
- Trained and certified personnel for radiological emergency conditions during waste transfer - 6.41.4.4.2
- Trained and certified personnel for waste transfer facility and equipment maintenance - 6.41.4.4.3
- Trained and certified personnel for waste transfer network maintenance - 6.41.4.4.4
- Trained and certified personnel for waste emplacement operations - 6.41.5.4
- Trained and certified personnel for waste emplacement - 6.41.5.4.1
- Trained and certified personnel for waste emplacement facility, equipment and process inspection and testing - 6.41.5.4.2
- Trained and certified personnel for waste emplacement radiological unsafe/emergency conditions - 6.41.5.4.3
- Trained and certified personnel for waste emplacement facility and equipment maintenance - 6.41.5.4.4
- Trained and certified personnel for monitoring during repository operations - 6.41.6.4
- Trained and certified personnel for waste removal operations - 6.41.7.4 and 6.41.7.4.1

- Trained and certified personnel for waste removal facility, equipment and process inspection and testing - 6.41.7.4.2
- Trained and certified personnel for waste removal radiological unsafe/emergency conditions - 6.41.7.4.3
- Trained and certified personnel for waste removal facility and equipment maintenance - 6.41.7.4.4
- Provide trained and certified personnel for off-site shipment operations - 6.41.8.4
- Trained and certified personnel for preparation of shipping cask for waste off-site shipment operations - 6.41.8.4.1
- Trained and certified personnel for waste handling (e.g., load/off-load) in off-site shipment operations - 6.41.8.4.2
- Trained and certified personnel for inspecting and testing waste disposal package in preparation for off-site shipment - 6.41.8.4.3
- Trained and certified personnel for refurbishment of waste disposal package in preparation for off-site shipment - 6.41.8.4.4
- Trained and certified personnel for off-site shipment unsafe/emergency conditions - 6.41.8.4.5
- Trained and certified personnel for off-site waste shipment facility and equipment maintenance - 6.41.8.4.6
- Trained and certified personnel for closure and decommissioning - 6.41.9.4
- Trained and certified personnel for backfill material processing - 6.41.9.4.1
- Trained and certified personnel for backfill emplacement - 6.41.9.4.2
- Trained and certified personnel for seal material processing - 6.41.9.4.3
- Trained and certified personnel for seals emplacement - 6.4..9.4.4
- Trained and certified personnel for emplaced backfill and seal inspection and testing - 6.41.9.4.5
- Trained and certified decontamination personnel - 6.41.9.4.6
- Trained and certified personnel for equipment salvaging - 6.41.9.4.7
- Trained and certified personnel for contaminated material packaging and shipping - 6.41.9.4.8
- Trained and certified personnel for decontaminated material packaging and shipping - 6.41.9.4.9
- Trained and certified personnel for closure and decommissioning radiological unsafe/emergency conditions - 6.41.9.4.10
- Trained and certified personnel for post-closure monitoring - 6.41.9.4.11

- Trained and certified personnel for closure and decommissioning facilities and equipment maintenance - 6.41.9.4.12

4.26.4.2 Relevant Regulatory Citations

- 10 CFR 50.34(a)(9), 50.34(b)(7), and Part 50, Appendix B and Appendix E-IV.F
- 10 CFR 60.21(c)(15), 60.31(a)(4), 60.43(b)(6), 60.152, 60.160, 60.161, and 60.162
- 10 CFR 61.11(b) and 61.23(a)
- 10 CFR 72.24(h), 72.28, 72.40(a)(4), 72.40(a)(9), 72.44(b)(4), 72.44(b)(5), 72.142(b), 72.144(d), 72.190, 72.192, and 72.194

4.26.4.3 Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations

(1) Personnel Qualification

Technical qualifications, including training and experience of both the applicant and members of the applicant's staff, to engage in the proposed activities are required in 10 CFR 50.34(a)(9), 50.34(b)(7), 61.11(b)(2), and 72.28(a). In addition, 10 CFR 61.11(b)(2) addresses minimum training and experience requirements for personnel filling key positions. The regulations in 10 CFR 60.21(c)(15)(iii) with regard to personnel qualifications and training requirements are more general.

10 CFR 72.28(d) requires a commitment by the applicant to have and maintain an adequate complement of trained and certified personnel prior to the receipt of waste for storage. Similarly, 10 CFR 61.11(b)(4) requires a plan to maintain an adequate complement of trained personnel to carry out waste receipt, handling, and disposal operations in a safe manner. This requirement appears to be implied by 10 CFR 60.21(c)(15)(ii), (iii), and (iv).

Both 10 CFR 61.23(a) and 72.40(a)(4) require the applicant to be qualified by reason of training and experience to carry out the necessary waste disposal operations in order for a license to be issued. 10 CFR 60.21(c)(15)(iv) is not as specific a requirement.

10 CFR 60.21(c)(15) generally addresses personnel qualifications and training in the Safety Analysis Report, while the other regulations are more specific.

The safety functions require screening/qualifying of candidate trainees for security and safeguards, and are generally addressed by 10 CFR 60.21(c)(15)(iii). Recertification of security and safeguards personnel is addressed by 10 CFR 60.161. 10 CFR 60.162 addresses the safety function which ensures fitness for duty of personnel certified for operations that are important to safety.

(2) Personnel Training Program, Facilities, and Equipment

Training and certification of personnel are regulated to the same extent in Subpart H (60.160-162) of 10 CFR Part 60 and 10 CFR Part 72, Subpart I (72.190, 72.192, and 72.194). 10 CFR Part 72 contains additional requirements to assure that personnel training meets the requirements of Subpart I in the conditions of the license. For example, 10 CFR 72.24(h) requires a plan for the conduct of operations, including the planned managerial and administrative controls system, and a program for training of personnel pursuant to 10 CFR Part 72, Subpart I, in the license application. Likewise, issuance of a license requires compliance with 10 CFR Part 72, Subpart I, of the applicant's personnel training program [10 CFR 72.40(a)(9)]. Finally, the license conditions state that prior to the receipt of spent fuel for storage at an ISFSI or the receipt of spent fuel and high-level radioactive waste for storage at an MRS, the licensee shall have in effect an NRC-approved program covering the training and certification of personnel that meets the requirements of 10 CFR Part 72, Subpart I [10 CFR 72.44(b)(4)]. 10 CFR Part 60 only requires such compliance with personnel training requirements (Subpart H) in the construction authorization [10 CFR 60.31(a)(4)]. 10 CFR 60.21(c)(15)(iv) and 60.43(b)(6) also address general requirements for training in the license application and license specifications. 10 CFR 61.11(b)(3) is more general in that it requires only a description of the applicant's personnel training program without devoting a separate subpart to training and certification.

10 CFR Part 50, Appendix E-IV.F. "Training," requires a program of training for emergency response, including items such as periodic drills, initial training, and periodic retraining programs for emergency personnel, including training programs for outside contacts. 10 CFR 60.161 contains a more general requirement that DOE shall establish a program for training, proficiency testing, certification, and requalification of operating and supervisory personnel. Since this requirement is very general, it could include training of personnel for emergency response. The requirement in 10 CFR 60.161 would appear to apply to all operations, as does 10 CFR 60.21(c)(15)(iii).

(3) Organization, Administration, and Management

10 CFR 72.142(b) and 72.144(d) require a quality assurance organization and program with respect to providing for indoctrination and training of personnel performing activities affecting quality, as necessary to assure that suitable proficiency is achieved and maintained. By referencing 10 CFR Part 50, Appendix B, the criteria in 10 CFR 60.152 would require similar information with regard to personnel and their training.

Both 10 CFR 72.28 and 61.11(b) discuss the applicant's operating organization and delegation of responsibility and authority in a manner similar to 10 CFR 60.21(c)(15)(i), 60.21(c)(15)(ii), and 60.43(b)(6). The minimum skills and experience for personnel qualifications relevant to the various levels of responsibility and authority are also discussed in 10 CFR 72.28(c). In 10 CFR 60.21(c)(15)(iii), the personnel qualifications and training requirements are more generally addressed.

10 CFR 60.161 requests proficiency testing without determining what minimum technical qualifications are required, unlike 10 CFR 72.28(c), where a description of the applicant's operating organization, delegation of responsibility and authority, and the minimum skills and experience qualifications relevant to the various levels of tasks are determined. However, since 10 CFR Part 60 requires personnel engaged in operations important to safety to be trained and certified, this criterion would imply in more general terms that personnel would have at least the "minimum skills and experience."

10 CFR 60.162 discusses the physical condition and general health of personnel that may cause operational errors that could endanger the public health and safety. 10 CFR 72.194 considers operational errors that could endanger "other in-plant personnel" as well as the public, but the phrase "public health and safety" is understood to include the workers and the "public" outside the facility boundary.

10 CFR 60.162 and 72.194 both address the personnel physical requirements similarly. They do not directly address a monitoring program, as given in the safety functions, but monitoring is an implied part of any program.

(4) Use of Qualified Personnel

The safety functions listed above require qualified personnel for specific activities or operations and are more detailed than the regulations in 10 CFR Part 60. 10 CFR 60.21(c)(15)(iii) is a more general requirement that would address personnel qualifications and training for all operations and activities.

10 CFR 60.160, 72.44(b)(5), and 72.190 all require operations important to safety to be performed by qualified (trained and certified) personnel and/or under direct visual supervision of a qualified (trained and certified) supervisor.

5 TOPICS FOR WHICH SPECIAL GUIDANCE MAY BE REQUIRED

5.1 PRECLOSURE SITE INVESTIGATIONS

This ROC Topic has the following subtopics:

(1) Regulatory Organization
(2) Human-Induced Hazard Considerations
(3) Natural Hazard Considerations

5.1.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) Regulatory Organization

10 CFR Part 60 has general guidance for assessment of the site for preclosure design. This appears deliberate, since NUREG-0804 (Ref. 13), page 12 states: "At this stage of development, the Commission believes it should place emphasis upon the objectives that must be met and not become unduly concerned about the particular techniques that may be used in doing so." The regulatory criteria in 10 CFR 60.21(c)(1) require a description of the site assessments for design of the GROA investigations, which is general in nature, and would fully address any needed preclosure site investigations. However, experience to date suggests that the applicant may need more specific guidance in addition to the 10 CFR Part 60 criteria.

10 CFR 60.122 sets forth specific siting criteria applicable to the postclosure performance objectives, but does not address site investigation criteria for either preclosure surface or underground facilities. The proposed guidance criteria are not separated for the surface and underground facilities.

(2) Human-Induced Hazard Considerations

(a) Population Density and Proximity

This subtopic will be considered in the section 7.3 ROC Topic.

(b) Aircraft and Test-Missile Hazards

Criteria for investigation and assessment of aircraft and missile hazards are not specifically addressed in 10 CFR Part 60. Guidance criteria may be needed because the location of a HLW repository, in areas of low population, may also be desirable for air and missile test ranges.

(c) Induced Seismicity

Criteria for investigation and assessment of induced seismicity for preclosure design are not specifically mentioned in 10 CFR Part 60, and guidance may be needed. Tunneling in hard rock can cause induced seismicity in the form of rock bursts and yielding of faults to regional strain. Induced seismicity can also result from fluid injection/withdrawal, construction of dams and reservoirs, and nuclear testing. Such induced earthquakes appear not to have exceeded magnitudes of 6.5 and, more likely, are much smaller in magnitude, per McGarr (Ref. 29). Following the rationale of the draft NRC "Staff Technical Position on Investigations to Identify Fault Displacement and Seismic Hazards at a Geologic Repository" (Ref. 30), investigations of induced seismicity are restricted to a radius at which 0.1g or more could be caused at the repository disturbed zone. Other induced seismicity, such as nuclear weapons testing, should also be assessed.

(d) Industrial and Transportation Accident

Criteria for investigation and assessment of industrial and transportation accidents for preclosure siting and design are not specifically mentioned in 10 CFR Part 60, and guidance may be needed. For large industrial facilities, which pose a secondary hazard, affected areas may extend to 40 or more miles. Highways and railways are not precluded from crossing the GROA. There is no specific mention of pipelines, which could carry potentially flammable or explosive materials.

(3) Natural Hazard Considerations

(a) Seismic Magnitude and Frequency

Investigations for seismic magnitude and frequency are specifically mentioned in 10 CFR 60.122 for postclosure objectives. However, no descriptions of required investigations are given; nor are the differences in acceleration expected at the surface and at depth discussed in 10 CFR Part 60. Because it is assumed that surface facilities must be located near HLW repository underground facilities, flexibility in siting criteria may be needed. Existing site investigation criteria for other nuclear facilities may be generally inappropriate because of this factor. Also, with respect to nuclear power plants, a repository has no similar pressure and high-temperature heat source capable of dispersing nuclear waste into the biosphere. However, because a statistically significant sample of seismic data is needed to assess recurrence rates of earthquakes, an investigative radius is proposed as potential guidance criteria. It must be sufficiently large to develop a statistically significant earthquake recurrence to enable development of a credible design specification. Faults that could produce 0.1g at the site must be investigated for their earthquake generation capability.

(b) Soil and Rock Properties

10 CFR Part 60 does not specifically address investigation of soil and rock properties for preclosure concerns. Soil and rock properties related to foundations for HLW repository surface facilities are important. Consequently, potential guidance criteria may be needed.

(c) Volcanism

The large open areas of the Western U.S. that may be potentially suitable for repository siting are sometimes sites of volcanism. There is no mention of related preclosure site investigations in 10 CFR Part 60, perhaps because volcanism is so rare that the need for investigations is not obvious. Guidance criteria for investigation of volcanism may be required for some sites.

(d) Fault Displacement

A potential guidance criterion may be needed for the investigation of fault displacements that could affect the safety functions of the GROA, including: tunnels, shafts, ramps, or waste emplacement boreholes.

(e) Groundwater

10 CFR 60.122(c)(20) applies only to postclosure performance objectives. Guidance criteria for groundwater conditions that require unusual engineering solutions for design of the GROA may be needed.

(f) Surface Water

10 CFR 60.122 applies only to postclosure performance objectives. Flooding of the GROA is also a preclosure performance concern, and guidance criteria may be needed.

5.1.2 Concepts, Criteria, and Rationale

This subsection presents guidance concepts and criteria, and the rationale that were developed to substantiate the conclusions presented above.

(1) Regulatory Organization

The overall concept concerning preclosure site investigations should consider general and more specific, or detailed, aspects of preclosure site investigations. An argument against detailed criteria regarding site investigations can be interpreted from Section 2.3, "Level of Detail," in NUREG-0804, "Staff Analysis of Public Comments on Proposed Rule 10 CFR Part 60" (Ref. 13). It states, "At this stage of development (1983), the Commission believes it should place emphasis upon the objectives that must be met and not become unduly concerned about the particular techniques that may be used in doing so." 10 CFR 60.130 states, "All design bases must be consistent with the results of site characterization activities which is very general." This implies that particular site investigations, which may impact design needs, may need specificity. Consequently, the following guidance concepts and criteria are presented for consideration. The proposed guidance for site investigations states what particular investigations

DOE may conduct, without stating the particular techniques to be used in investigating the site, in keeping with the intent expressed in NUREG-0804 (Ref. 13).

(a) General Preclosure Site Criteria

Concept. General preclosure site investigation criteria for repository operations are needed.

Operational Criteria. The criteria required to address this concept are presented in 10 CFR 60.21(c)(1) and 60.130.

Rationale for the Operational Criteria. The criteria in 10 CFR 60.21(c)(1) and 60.130 fully address this concept because they require in general terms that the site be assessed and the design shall be such as to account for the assessed site characteristics.

(b) Specific Preclosure Site Investigations

Concept. Specific guidance for preclosure siting investigations unique to a GROA may be needed.

Potential Guidance Criteria. Guidance criteria for unique aspects of site investigations necessary for preclosure design are presented in the subsections below.

Rationale for the Potential Guidance Criteria. All the specific siting criteria in 10 CFR 60.122 are only related to postclosure concerns per an NRC statement in the *Federal Register* (Ref. 18). NRC does not appear to have any specific guidance criteria for site investigations necessary for the design of the GROA. Specific guidance criteria for investigations of the site to ensure a safe GROA design may be needed (1) for those aspects of a HLW repository that are unique as compared to "similar facilities" (e.g., retrieval and underground facilities) and (2) for those "similar facilities" with existing site investigation criteria that may not be appropriate for a HLW repository.

(c) Surface and Underground Facilities

Concept. Preclosure site investigation criteria could be split into two parts, that is, those related to surface facilities and to underground facilities. However, because the principal applicable effect is from distant earthquakes, it is recommended that the potential criteria not be separated into surface criteria and underground criteria.

Operational Criteria. None.

Rationale for the Operational Criteria. No criteria are recommended because the surface and underground facilities must be designed to operate in an integrated manner. Also, the current NRC regulations do not separate the investigations necessary for surface and underground characteristics for postclosure performance.

(2) **Human-Induced Hazards Considerations**

(a) Population Density and Proximity

This subtopic will be considered in the section 7.3 ROC Topic.

(b) Aircraft and Test-Missile Hazards

Concept. Areas of low population can be desirable for HLW repository operations. Criteria addressing air traffic (airports and military test ranges) may be needed, since a HLW repository may have to coexist with these facilities.

Potential Guidance Criteria. Guidance criteria may be:

> Investigation and assessment shall be made of the frequency and type of air traffic within 50 miles of the site. Arrangements may be made so that regular air traffic routes may be altered away from the surface facilities.

Rationale for the Potential Guidance Criteria. Areas of low population can be desirable sites for both a repository and an air-traffic corridor. Except under inclement weather conditions, aircraft controllers ordinarily do not divert traffic more than 50 miles from prearranged flight plans. The turning radius of large aircraft may be 25 miles. However, it is important not to unduly lengthen diversion time because of fuel constraints. Fifty miles is judgmental, but it is based on typical operating conditions. This topic is not specifically addressed in 10 CFR Part 60 although it has been considered in 10 CFR 960.5-2-4(a).

(c) Induced Seismicity

Concept. Investigation criteria for induced seismicity are needed for design of the GROA.

Potential Guidance Criteria. Guidance criteria for this concept may be:

> Investigation and assessment shall be made of present and potential sources and potential consequences of induced seismicity and attendant fault movement which could cause 0.1g or greater acceleration within the GROA. The sources discussed shall include, for example: (1) fluid injection including hydrofracturing, (2) construction of high dams with deep reservoirs, (3) removal of material during mining (rock bursts, fault movement and small earthquakes), and (4) nuclear device testing (fault movement and small earthquakes).

Rationale for the Potential Guidance Criteria. Tunneling in hard rock, for example, can be inherent in the process of creating a HLW geological repository. This activity can result in rock bursts, small earthquakes, and fault movement. Nuclear testing has produced movements on faults local to the test area. Ground motions due to testing have not resulted in earthquakes that exceeded a magnitude 6.5. The distance at which 0.1g can occur from a magnitude 6.5 earthquake is about 30 miles. This level is one at which well engineered structures without special earthquake design provisions will normally continue to function safely. 10 CFR Part 60 does not discuss this subject although it is mentioned in 10 CFR 960.5-2-11(c)(2).

(d) Industrial and Transportation Accidents Near HLW Facilities

Concept. Criteria to describe the extent or level of investigations needed to define industrial or transportation hazards within or adjacent to the GROA may be needed.

Potential Guidance Criteria. Guidance criteria may be:

> Investigation and assessment shall be made of the location of highways, pipelines, and railways through or adjacent to the GROA and the present and projected incidence of potentially hazardous materials being shipped or that would be likely to be shipped during the period that surface facilities are extant. The existence of, or potential for, industrial facilities within or adjacent to the GROA that have a potential secondary hazard will be evaluated.

Rationale for the Potential Guidance Criteria. A remote location which could generally be considered advantageous to postclosure isolation may also be desirable to protect from industrial facilities posing a secondary hazard during operations, e.g., explosives or chemical manufacture. The existence of the geologic repository will probably bring improved transportation facilities through the area. This may create a beneficial environment for the siting of such facilities which, in turn, could increase transportation of hazardous materials through or adjacent to the GROA. Whether or not this potential inducement exists for a given site, the conditions prevalent at the time of siting of the repository should be assessed. 10 CFR Part 60 does not address this topic although the "Standard Format and Content Guide for ... ISFSI's (Water Basin Type)," Regulatory Guide 3.44 (Ref. 31), Section 3.3.8, and 10 CFR 960.5-2-4(a) and 960.5-2-4(c) do.

(3) Natural Hazard Considerations

(a) Seismic Magnitude and Frequency

Concept. Criteria to describe the extent of or level of investigations required for the determination of a design basis earthquake may be needed.

Potential Guidance Criteria. Site investigation and analysis guidance criteria for this concept may be:

> Investigation and assessment of historic and Quaternary Period movements of major active faults and of historic earthquakes shall be conducted for faults, at any distance that could cause 0.1g or greater acceleration within the geologic repository operations area, and for earthquake frequencies of vibration of concern in the design of the repository or its facilities. Investigation and assessment of earthquakes shall be made over an area sufficiently large that a statistically significant earthquake recurrence is developed. From these investigations, technically supportable analyses will be developed for a design basis earthquake to be applied to the geologic repository operations area. Analyses may be deterministic or probabilistic. In no case will the design basis earthquake be less than a 0.1g anchor for the design spectrum. When designing underground facilities for the preclosure time period, reduced effects at depth may be considered if justified by technical analyses.

Rationale for the Potential Guidance Criteria. Design bases must be specified and must be derived by some means. By restricting investigations to faults that can produce 0.1g or greater and to earthquakes with frequencies of vibration that are of concern in design at the repository disturbed zone, a distinction is made between waste repository preclosure facilities and power production equipment covered under 10 CFR Part 100. Extremely small local faults may be eliminated from the requirements for investigation on the basis of vibration frequency potential. Potential preclosure hazards to the environment from a waste repository is less than from a facility in which active fissioning is taking place (a nuclear power plant). There is no pressure or comparable active heat source capable of rapid dissemination of the radionuclide inventory as in nuclear power plants. Because the surface facility of a HLW repository must be located at or near the HLW repository underground workings, and the sites for a HLW repository are limited, greater flexibility in siting the surface facilities is required. Consequently, the limiting criteria of 10 CFR Part 72 are not used, and the 0.1g within the geologic repository operations area criterion for investigation of major active faults is substituted. This concept is consistent with the philosophy of the draft staff technical position on investigations to identify fault displacement and seismic hazards at a geologic repository (Ref. 30).

(b) Soil and Rock Properties

Concept. Criteria for site investigation and assessment related to properties of soils and rocks which constitute foundations of the surface facilities may be needed.

Potential Guidance Criteria. Guidance criteria related to investigation of soil and rock properties may be:

Foundations that support surface facilities of the GROA shall be investigated and their properties assessed with respect to performance of surface facilities within the GROA. These features should include the following:

a. Areas of actual or potential surface or subsurface subsidence, solution activity, uplift, or collapse.
b. Zones of alteration or irregular weathering profiles, and zones of structural weakness.
c. Unrelieved stresses in bedrock and their potential for creep and rebound effects.
d. Rocks or soils that might be unstable because of their mineralogy, lack of consolidation, water content, or potentially undesirable response to seismic or other events.
e. History of deposition and erosion, including glacial and other preloading influence on soil deposits.
f. Estimates of consolidation and preconsolidation pressures and methods used to estimate these values.

Rationale for Potential Guidance Criteria. These criteria are necessary for preclosure surface facilities design, and are in 10 CFR 72.102(d) for ISFSI and MRS, which can have similarities to HLW repository surface facilities. NUREG-0800 (Ref. 19), SRP 2.5.4, discusses this topic with respect to nuclear power plants. Regulatory Guide 3.44 (Ref. 31), Sections 2.6.1 and 2.6.2, require that these properties be discussed for independent spent fuel storage facilities.

(c) Volcanism

Concept. Criteria addressing investigation and assessment of volcanic hazards during the preclosure time period may be needed.

Potential Guidance Criteria. Guidance criteria addressing investigation of volcanic hazards during the preclosure time period may be:

Volcanoes that have erupted during quaternary time shall be investigated, and the probability of a recurring eruption during a 100-year nominal lifetime for surface facilities assessed. Effects on surface facilities and on potential impoundment of water which could affect surface or underground facilities during the preclosure time span shall be assessed.

Rationale for the Potential Guidance Criteria. Large, and open areas are available in the Western U.S. which satisfy low population density requirements for a repository. Some of these areas could have a significant incidence of volcanism which may affect the repository in both preclosure and postclosure time spans. Water impoundment aspects are mentioned in 10 CFR 60.122(c)(3) but do not apply to preclosure times and facilities. 10 CFR Part 100 states volcanic phenomena would be investigated on a case-by-case basis for nuclear power plants. Because of the potential effects of volcanic hazards, they should be assessed for probability of occurrence.

(d) Fault Displacement

Concept. Investigations regarding potential fault displacements, from any cause, which might impact the safety functions of tunnels, shafts, ramps, or waste emplacement boreholes may be needed.

Potential Guidance Criteria. Guidance criteria related to fault displacement may be:

> Displacement potential of any fault that may impact the safety function of any tunnel, shaft, ramp, or emplacement borehole during the preclosure period shall be investigated and its potential effects shall be evaluated.

Rationale for the Potential Guidance Criteria. Because the repository is underground and covers a large physical area, faults are likely to be encountered in underground workings. Fault displacement during the preclosure period could have a negative impact on operational safety. Criteria like those in 10 CFR Part 72 could be recommended as potential criteria for surface facilities of a repository. However, limiting criteria in 10 CFR Part 72 are not applicable; they state that large, capable faults or certain seismic areas or conditions should be avoided. There are very few potential HLW repository sites compared to potential MRS or ISFSI sites, and surface facilities must accompany the HLW repository site. Therefore, flexibility is required even though costs of investigations and compensating engineering safeguards could be relatively high. The potential guidance defines what is to be investigated, regarding fault displacement, that could impact safety functions of the underground repository during preclosure operations.

(e) Groundwater

Concept. Groundwater investigation criteria may need to be addressed for the preclosure time period.

Potential Guidance Criteria. Guidance criterion for groundwater investigations may be:

> Rock and groundwater conditions that would require complex engineering measures in the design and construction of the GROA shall be investigated and assessed.

Rationale for the Potential Guidance Criteria. A similar statement appears in the current 10 CFR 60.122(c)(20). NRC has noted in a *Federal Register* announcement (Ref. 18) that 10 CFR 60.122 applies only to postclosure performance. However, rock and groundwater conditions are also a potential preclosure concern. 10 CFR 960.5-2-9(d) reiterates the current 10 CFR Part 60 statement. See also NUREG-0800 (Ref. 19), SRP 2.4.12, and Regulatory Guide 3.44 (Ref. 31), Section 2.5. The potential guidance criterion above makes clear that this topic is also a preclosure concern.

(f) Surface Water

Concept. Criteria for site investigation of surface water may be needed for preclosure design and performance objectives.

Potential Guidance Criteria. This concept may be addressed by the following guidance criterion:

> Potential for flooding of the GROA, whether resulting from occupancy and modification of floodplains or from the failure of existing or planned surface water impoundments, shall be investigated and assessed.

Rationale for the Potential Guidance Criteria. This statement is largely in place in 10 CFR Part 60 for the postclosure performance objectives only. The subject is also mentioned in 10 CFR 72.90(f), 960.5-2-8(a), and 960.5-1(a)(3). Potential flooding can have a negative impact during the preclosure time period, and thus needs to be quantified. Also, see the "Standard Format and Content Guide for ISFSI" [Regulatory Guide 3.44] (Ref. 31), Section 2.4 and SRP's 2.4.1 to 2.4.6, of NUREG-0800 (Ref. 19).

5.1.3 Elements Considered for Regulation

5.1.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, and Environmental Considerations, Etc.

(1) Regulatory Organization

Some of the elements considered in this subtopic are:

- Postclosure siting criteria
- Preclosure siting criteria
- Surface and underground facility siting criteria

(2) Human-Induced Hazard Considerations

Some of the elements considered in this subtopic are:

- Population density and proximity
- Aircraft and missile hazards
- Induced seismicity
- Industrial accidents

(3) **Natural-Hazard Considerations**

Some of the elements considered in this subtopic are:

- Seismic magnitude and frequency
- Soil and rock properties
- Volcanism
- Fault displacement
- Groundwater
- Surface water

5.1.3.2 Comments on and Discussion of the Elements Considered for Regulation

(1) **Regulatory Organization**

There are three elements regarding 10 CFR Part 60 that may be enhanced by further guidance. They include (1) specific preclosure siting investigational criteria, (2) separate preclosure surface and underground siting criteria, and (3) kinds and extent of investigations required for acquisition of data to satisfy siting criteria. 10 CFR Part 60 provides few details regarding investigations required other than in 10 CFR 60.21(c)(1). 10 CFR Parts 50, 72, and 100; NUREG-0800 - "Standard Review Plan for ... Nuclear Power Plants, LWR Edition" (Ref. 19) and Regulatory Guide 3.44, (Ref. 31) contain descriptions of investigations required for other types of nuclear facilities and, thus, provide some understanding of the NRC regulatory philosophy. Their content, therefore, is sometimes used as guidance to implement the requirements of 10 CFR Part 60. Hence, citations are made of appropriate required investigations in these Parts of Title 10. The following technical topics are further discussed largely in the context of required site investigations.

(a) General Preclosure Site Investigation Criteria

Postclosure elements of siting criteria are contained in the current regulations of 10 CFR 60.122, Siting Criteria. 10 CFR 60.122 was declared by the NRC to apply only to postclosure concerns, in its *Federal Register* "Notice" (Ref. 18), not to both "Preclosure Siting Criteria" and "Postclosure Siting Criteria." 10 CFR 60.21(c)(1) does have general criteria for preclosure site investigations.

(b) Preclosure Site Investigations

Siting criteria in 10 CFR 60.122 are expressly stated to apply only to the postclosure time period. However, some specific guidance could be made to apply to the preclosure time period. Those regarded as appropriate are discussed as potential guidance criteria.

(c) *Surface and Underground Facilities*

The surface facility is subject to natural hazards at the surface that do not affect the deep repository or have a reduced effect at depth. Hence, separate siting considerations and required investigations could be addressed for the surface facility as compared to underground facilities. Shafts and ramps extend from the surface to the underground workings. Near-surface parts of shafts and ramps would be exposed to surface conditions. Deep parts of shafts and ramps would be affected by conditions underground. No current NRC regulation separates the investigations necessary for the surface and underground facilities of a HLW repository. Preclosure site investigation criteria could be split into two parts, that is, those related to surface facilities and to underground facilities. However, because the principal applicable effect is from distant earthquakes, it is recommended that the criteria not be separated into surface criteria and underground criteria. The surface and underground facilities must be designed to operate in an integrated manner. Also, the current NRC regulations do not separate the investigations necessary for surface and underground characteristics for postclosure performance.

(2) Human-Induced Hazard Considerations

(a) *Population Density and Proximity*

10 CFR Part 60 does not contain exclusion zone criteria based on population or population density. In 10 CFR 60.102(c) a controlled area is discussed as follows. "There is to be an area surrounding the underground facility . . . which is designated the controlled area, within which DOE is to exercise specified controls to prevent adverse human actions following permanent closure. The location of the controlled area is the site." 10 CFR 60.122(b)(6) states "A low population density within the geologic setting and a controlled area that is remote from population centers" is a favorable condition. 10 CFR 60.2 defines a controlled area: ". . . means a surface location, to be marked by suitable monuments, extending horizontally no more than 10 kilometers in any direction from the outer boundary of the underground facility, and the underlying subsurface, which area has been committed to use as a geologic repository . . ." Because 10 CFR 60.122 is considered applicable only to postclosure performance and 10 CFR 60.102(c) defines the controlled area only for postclosure concern, no requirement is given for a controlled area for preclosure safety.

10 CFR 72.90(e) states, ". . . the potential for radiological and other environmental impacts on the region must be evaluated with due consideration of the population, including its distribution and regional environs . . ." 10 CFR 72.98(b) states: "The extent of regional impacts must be determined on the basis of potential measurable effects on the population or the environment from ISFSI or MRS activities." 10 CFR 72.98(c) states: "Those regions identified . . . must be investigated as appropriate with respect to: (1) The present and future character and the distribution of population . . ." 10 CFR 72.100(a) states: "The proposed site must be evaluated with respect to the effects on populations in the region resulting from the release of radioactive materials under normal and accident conditions . . ."

10 CFR 960.5-2-1(c) defines as an adverse condition "(1) High residential, seasonal, or daytime population density within the projected site boundaries. (2) Proximity of the site to highly populated areas, or to areas having at least 1,000 individuals in an area 1 mile by 1 mile . . ." In order to establish these criteria for a particular site, investigations would have to made.

See also Regulatory Guide 3.44, section 2.1.3 (Ref. 31), and NUREG-0800, SRP 2.1.3 (Ref. 19). This will be considered further in the section 7.3 ROC Topic.

(b) Aircraft and Test Missile Hazards

Investigation of aircraft and test missile hazards to surface facilities of a HLW repository is not specifically addressed in 10 CFR Part 60, although 60.21(c)(1)(ii) may encompass them. Remote areas that may satisfy population exclusion zones, e.g., as in 10 CFR Part 72, are often sites for airports or military bombing and test ranges where aircraft traffic may be high. The hazard to surface facilities of a HLW repository should be assessed. For an aircraft accident involving the surface facilities of a HLW repository, investigations necessary to determine the probability of such an accident and of the potential release of radionuclides could be codified.

10 CFR 960.5-2-4(a) lists as a qualifying condition, "The site shall be located such that present projected effects from nearby industrial, transportation, and military installations and operations . . . will not significantly affect repository siting . . ." This implies that investigations concerning transportation (including air transportation) and military installations and operations (including bombing and test ranges) would be required. These topics are also addressed by Regulatory Guide 3.44 (Ref. 31) and NUREG-0800 (Ref. 19).

(c) Induced Seismicity

10 CFR 960.5-2-11(c)(2) implies that an investigation of historical earthquakes and induced seismicity are required as well as a theoretical study extrapolating such occurrences into the future preclosure time span. Seismicity may be induced in several ways. Better known mechanisms are:

- Fluid injection including hydrofracturing
- Construction of high dams with deep reservoirs
- Removal of material during mining (rock bursts, fault movement, and small earthquakes)
- Nuclear and very high-explosive device testing (fault movement and small earthquakes)

Also, see comments and discussion regarding this subject in ROC Topic Preclosure Site Limitations.

(d) Industrial and Transportation Accidents Near HLW Facilities

On-site or nearby off-site industrial or transportation accidents are not addressed in 10 CFR Part 60. However, 10 CFR 960.5-2-4(a) states that a qualifying condition is that "The site shall be located such that present projected effects from nearby industrial, transportation . . . (1) will not significantly affect repository siting, construction, operation, closure, or decommissioning, or can be accommodated by engineering measures and (2) when considered together with emissions from repository operation and closure will not be likely to lead to radionuclide releases to an unrestricted area greater than allowable . . ." Regulatory Guide 3.44 (Ref. 31) Section 3.3.8, Industrial and Chemical Safety, states: "Effects of various industrial accidents (e.g., fire and explosion) and potentially hazardous chemical reactions . . . should be reported." Section 2.2 states: "Identify nearby industrial, transportation and military installations . . ." "Summarize items that may present a hazard . . . explosion of chemicals, flammable gasses . . . large natural gas pipelines . . . fires in adjacent industries . . . effects of accidental releases of toxic gasses from nearby industries and transportation accidents . . . ." NUREG-0800 (Ref. 19), SRP's 2.2.1 and 2.2.2, also address this topic. Industrial or transportation accidents include:

- Pipeline explosions/fires
- Release of toxic chemicals from pipelines, railcars, or tanker trucks

There will be rail and truck access to the surface facility site. Railways and highways are not precluded from passing through the GROA. Pipelines, railways, and highways may be adjacent to the surface facility. The presence of the repository operation may induce zoning for other heavy industry adjacent to the GROA. Therefore, these conditions should be addressed.

(3) Natural Hazard Considerations

(a) Seismic Magnitude and Frequency

10 CFR 50.34(a)(1) states that for a safety assessment of the site, that "Special attention should be directed to the site evaluation factors identified in 10 CFR Part 100 of this chapter." 10 CFR Part 50, Appendix A-I, Criterion 2, states: "Structures, systems and components important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes. . . ." and "The design bases for these structures, systems and components shall reflect (1) Appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity and period of time in which historical data have been accumulated. . . ."

Although 10 CFR 60.122 is exclusively applicable to the postclosure time period, some parts of it could be made applicable to the preclosure time period.

10 CFR 60.122(c)(12) and 60.122(c)(14) state that adverse conditions are: "Earthquakes which have occurred historically that if they were to be repeated could effect the site significantly" and "More frequent occurrence of earthquakes or earthquakes of higher magnitude than is typical of the area in which the geologic setting is located." 10 CFR 60.141(a) states that during repository construction and operation, surveillance, measurement, testing, and geologic mapping shall be conducted to accommodate actual field conditions in design. 10 CFR 60.141(b) states that subsurface conditions shall be evaluated against design assumptions. 10 CFR 60.141(d) further states that if significant differences exist (between the initially assumed field condition and those better defined by monitoring), the need for modifications shall be determined and changes recommended to the Commission.

10 CFR 72.102(a)(1) states that sites will be acceptable in the Eastern U.S. if, ". . . results from on site foundation and geological investigation, literature review, and regional geological reconnaissance show no unstable geological characteristics, soil stability problems, or potential for vibratory ground motion at the site in excess of an appropriate response spectrum anchored at 0.2g." 10 CFR 72.102(a)(2) states: "Alternatively, a site specific DE (design earthquake) may be determined by using the criteria and level of investigations required by Appendix A of 10 CFR Part 100 of this chapter." This section further defines the goal of the investigation by stating in 10 CFR 72.102(f)(1) that, "For sites that have been evaluated under 10 CFR Part 100, the DE (design earthquake) must be equivalent to the safe shutdown earthquake (SSE) for a nuclear power plant." 10 CFR 72.122(b)(2) states: "Structures, systems, and components important to safety must be designed to withstand the effects of natural phenomena such as earthquakes, . . . tsunami, and seiches. . ." implying that investigations to define these hazards are necessary. Further definition is given in 10 CFR 72.122(b)(2) by: "Design bases . . . must reflect: (i) Appropriate consideration of the most severe of the natural phenomena reported for the site and surrounding area, with appropriate margins to take into account the limitations of the data and the period of time in which the data have accumulated, and (ii) Appropriate combinations of the effects of normal and accidental conditions and the effects of natural phenomena." 10 CFR 72.122(b)(3) states that "Capability must be provided for determining the intensity of natural phenomena that may occur. . . ." Earthquakes are a natural phenomenon. It appears that some of these regulatory concepts may be applicable to the preclosure time span of a HLW repository. See also Regulatory Guide 3.44 (Ref. 31) and NUREG-0800, SRP 2.5.2 (Ref. 19).

For earthquake shaking, a rough rule of estimation is that its amplitude would be reduced about twofold to threefold (or more) for all frequencies whose wavelength is less than the depth of underground workings. For example, if compressional wave velocities were 1,000 meters per second in the repository media, and the depth of underground workings were 100 meters, all compressional wave frequencies above 10 hertz would be attenuated by a factor of about 2 to 3 for the body waves P and S. Earthquakes which occur at, or very near the underground workings would generate accelerations like those at the surface only for seismic waves whose wavelengths were near the dimension of the underground workings. For example, if the workings were 10 meters in diameter, and seismic velocities were 3,000 meters per second, only seismic waves of frequency higher than 300 hertz would have as high an amplitude as would be predicted on the surface. These frequencies are usually not of concern in civil or structural design. This leads to two observations regarding using siting limitations, implied or given in nuclear related regulations, for a HLW repository:

- Different seismic design criteria may be appropriate to above ground facilities than are applied to subsurface workings and equipment.
- If siting limitations, based on potential acceleration, are used for the underground workings of a HLW repository, the acceleration criteria should be adjusted to reflect the effect of expected reduced values at depth.

10 CFR Part 100 for nuclear power plants discusses investigations of earthquakes hazards more extensively than other regulations for nuclear facilities, e.g., 10 CFR 100.10(c)(1): "Appendix A . . . describes the nature of investigations required to obtain the geologic and seismic data necessary to determine site suitability. . . . It describes procedures for determining the quantitative vibratory ground motion design basis at a site due to earthquakes. . . ." 10 CFR 100.10(d) states an important concept in regulatory philosophy: "Where unfavorable physical characteristics of the site exist, the proposed site may nevertheless be found to be acceptable if the design of the facility includes appropriate and adequate compensating engineering safeguards." This statement is fundamental to NRC regulatory philosophy and is reflected in NUREG-0804 (Ref. 13).

10 CFR Part 100, Appendix A, includes: "Additional investigations and/or more conservative determinations than those included in these criteria may be required for sites located in areas having complex geology or high seismicity." 10 CFR Part 100, Appendix A-IV, includes: "(a) required investigations for vibratory ground motion. . . ." Paraphrased, the subsections under (a) state: (1) determine lithologic, stratigraphic, hydrologic, and structural geologic (including history) characteristics of the site; (2) identify tectonic structures at or underlying the site and in the surrounding region; (3) evaluate evidence of site response to historical earthquakes; (4) determine engineering properties of materials underlying the site; (5) list all historically reported earthquakes which may have affected the site; (6) correlate epicenters or peak intensity areas with tectonic structures; (7) determine whether faults, within 200 miles of the site and which could generate earthquakes which are significant to the site, are capable; and (8) for faults found to be capable under (7), determine (a) fault length, (b) relationship to tectonic structures, and (c) quaternary displacement related to any one earthquake along the fault.

Investigations implied for the preclosure time period by the conditions expressed in 10 CFR Part 960 follow. This topic is discussed under 10 CFR 960.5-2-11, Tectonics, which is under a section labeled "Ease and Cost of Siting, Construction, Operation, and Closure." The NRC regulation is concerned only with safety and retrievability aspects, but this area of discussion appears also to be safety related, so it is included for discussion. 10 CFR 960.5-2-11(b) implies that investigation of magnitude and intensity of seismicity associated with the site geologic setting is required. 10 CFR 960.5-2-11(c)(1) implies that active faulting in the geologic setting must be investigated. 10 CFR 960.5-2-11(c)(2) implies that an investigation of historical earthquakes and induced seismicity are required as well as a theoretical study extrapolating such occurrences into the future preclosure time span. 10 CFR 960.5-2-11(c)(3) implies that an investigation is required to correlate historic earthquakes with tectonic processes and features within the geologic setting, and to draw inferences regarding the seismogenic capabilities of similar tectonic features for which there are no historically associated earthquakes.

(b) Soil and Rock Properties

No NRC regulation describes investigations required for soil and rock properties applicable to preclosure concerns, although there are inferences that investigations might be required to establish that acceptable conditions exist.

10 CFR 60.122(c)(21) states that "geomechanical properties that do not permit design of underground opening that will remain stable through permanent closure" is a potentially adverse condition. 10 CFR 72.102(d) states that "site-specific investigations and laboratory analyses must show that soil conditions are adequate for the proposed foundation loading." 10 CFR 960.5-2-9(b)(2) states that "a host rock with characteristics that would require minimal or no artificial support for underground openings to ensure safe repository construction, operation, and closure" is a favorable condition. Investigations would be required to show that minimal or no artificial support was required. A clear understanding of the investigations required to satisfy 10 CFR Part 60 could either appear in the regulation or be referenced in the regulation, e.g., to NUREG's. NUREG-0800 (Ref. 19), SRP 2.5.4, discusses this topic with respect to nuclear power plants. Regulatory Guide 3.44 (Ref. 31), Sections 2.6.1 and 2.6.2, require that these properties be discussed for independent spent fuel storage facilities.

(c) Volcanism

10 CFR 60.122(c)(3) lists as a potentially adverse condition, volcanic activity of such a nature that large-scale water impoundments could be created. As noted earlier, this section of the regulation does not address preclosure concerns. 10 CFR Part 100, Appendix A, states that it does not address investigations of volcanic phenomena, but that they would be determined by the NRC on a case-by-case basis. Due to the time spans, volcanism appears to be a much more serious concern for the postclosure period and whether it is a preclosure concern may need to be determined on a case-by-case basis.

(d) Fault Displacement

Some earthquake and fault investigations are interrelated and are placed under the heading that seems most appropriate. 10 CFR 50.34(a)(1) states that for a safety assessment of the site, "Special attention should be directed to the site evaluation factors identified in 10 CFR Part 100 of this chapter."

10 CFR 60.122(c)(4) states that "structural deformation, such as uplift, subsidence, folding, or faulting that may adversely affect the regional groundwater flow system" is an adverse condition. The same applies to 10 CFR 60.122(c)(11): "Structural deformation such as uplift, subsidence, folding, and faulting during the Quaternary Period." These criteria apply to postclosure rather than preclosure performance. Required investigations in these areas are, however, implied. 10 CFR 72.102(b) states, ". . . Sites that lie within the range of strong nearfield ground motion from historical earthquakes on large capable faults should be avoided." This implies that large capable faulting must be investigated. 10 CFR 100.10(c)(1): "Appendix A . . . describes . . . information needed to determine whether and to what extent a nuclear power plant need be designed to withstand the effects of surface faulting." 10 CFR 960.5-2-11(d) implies that an investigation of rates of fault movement or other ground motion is required. 10 CFR 960.5-2-9(b)(5) lists as a potentially unfavorable condition, "Existing faults, shear zones, pressurized brine pockets, dissolution effects, or other stratigraphic or structural features that could compromise the safety of repository personnel because of water inflow or construction problems." This implies that such features would have to be investigated. See also Regulatory Guide 3.44 (Ref. 31) and NUREG-0800 (Ref. 19) - SRP 2.5.3.

(e) Groundwater

10 CFR 60.122(c)(2), 60.122(c)(3), 60.122(c)(5), 60.122(c)(6), 60.122(c)(7), 60.122(c)(9), 60.122(c)(20), 60.122(c)(22), and 60.122(c)(23) discuss groundwater conditions that are considered potentially adverse. Only 10 CFR 60.122(c)(20) appears to have potential preclosure application. It states, "Rock or groundwater conditions that would require complex engineering measures in the design and construction of the underground facility or in the sealing of boreholes and shafts." 10 CFR 960.5-2-9(d) reiterates the 10 CFR 60.122(c)(20) concern. See also NUREG-0800 (Ref. 19) - SRP 2.4.12 for nuclear power plants and Regulatory Guide 3.44 (Ref. 31) - Section 2.5, for an ISFSI.

(f) Surface Water

No specific mention of investigations required for surface water hazards was found in NRC regulations for nuclear facilities although 10 CFR 61.50, for low-level waste disposal, expresses concern over surface water degradation of shallow buried waste. 10 CFR 60.122(c)(1) states that a potentially adverse condition is "Potential for flooding of the underground facility whether resulting from occupancy and modification of floodplains or from the failure of existing or planned man-made surface water impoundments." This concern is relevant to the preclosure time period (although the section addresses postclosure performance) and investigations should be required to ensure that this condition does not occur. 10 CFR 72.90(f) states, "The facility must be sited so as to avoid to the extent possible the long-term and short-term adverse impacts associated with the occupancy and modification of floodplains." 10 CFR 960.5-2-8(a) states that a qualifying condition is that "The site shall be located such that, considering the surface characteristics and conditions of the site and surrounding area, including surface-water systems and terrain, the requirements specified in 10 CFR 960.5-1(a)(3) can be met during repository siting, construction, operation, and closure." Determining whether or not these conditions are met would require appropriate investigation.

See the section on Volcanism regarding the 10 CFR 60.122(c)(3) concern over the impoundment of surface water. Surface water is also addressed in NUREG-0800 (Ref. 19) - SRP 2.4.13 and Regulatory Guide 3.44 (Ref. 31), Section 2.5.

5.1.4 Safety Functions and Regulatory Citations

5.1.4.1 Associated Safety Functions

There were no safety functions identified from the "Repository Functional Analysis" (Ref. 1) that were considered to be associated with this ROC Topic, or any of its subtopics.

5.1.4.2 Relevant Regulatory Citations

- 10 CFR 50.34(a)(1) and Part 50, Appendix A-I, Criterion 2
- 10 CFR 60.2, 60.21(c)(1), 60.102(c), 60.122, 60.130, 60.141(a), 60.141(b), and 60.141(d)
- 10 CFR 61.50
- 10 CFR 72.90(e), 72.90(f), 72.98(b), 72.98(c), 72.100(a), 72.102(a)(1), 72.102(a)(2), 72.102(b), 72.102(d), 72.102(f)(1), 72.122(b)(2), and 72.122(b)(3)
- 10 CFR 100.10(c)(1), 100.10(d), and Appendix A
- 10 CFR 960.5-1(a)(3), 960.5-2-1(c), 960.5-2-4(a), 960.5-2-4(c), 960.5-2-8(a), 960.5-2-9(b)(2), 960.5-2-9(b)(5), 960.5-2-9(d), and 960.5-2-11

5.1.4.3 Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations

Because NRC's *Federal Register* "Notice" (Ref. 18) states that site investigations in 10 CFR 60.122 are for postclosure performance only, there are no specific regulations dealing with preclosure siting criteria. Also, there were no safety functions associated with this ROC Topic. Therefore, there is no basis for a comparison and contrast of associated safety functions and relevant regulatory citations.

6 TOPICS FOR WHICH MINOR RULE CHANGES MAY BE REQUIRED

6.1 LICENSING, LICENSE AMENDMENT, AND LICENSE TERMINATION

This ROC Topic has the following subtopics:

(1) Site Characterization, License Application, Updates, and Amendments
(2) Use of References

6.1.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) Site Characterization, License Application, Updates, and Amendments

10 CFR Part 60 is adequate and sufficient for addressing issues related to licensing, license updates and amendments, and license termination for a high-level radioactive waste repository. One potential exception may be in 10 CFR 60.24(a) where further specific guidance may be necessary. The need for further specific guidance will be determined at a future date.

(2) Use of References

10 CFR Part 60 may be enhanced in regard to the use of references, as suggested by the NRC Staff. A change to 10 CFR 60.23 was suggested by the NRC staff in its "Recommendations" report (Ref. 8) per Uncertainty Reference Number 2. Appendix A, page 3, to clarify the subject of referencing to eliminate repetition and the reference to the "environmental report" versus the "environmental impact statement."

Note: After the public has commented on the draft "Format and Content Guide for the License Application for the High-Level Waste Repository" (DG-3003) (Ref. 32), 10 CFR 60.24(a) may need review according to NRC, [see Uncertainty Reference Number 4, Appendix A, page 5, (Ref. 8)].

6.1.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above to this specific safety related topic for geologic repository operations.

(1) Site Characterization Plan, License Application, Updates, and Amendments

Concept. Criteria are necessary for construction authorization, license application, updating, amendments, amendment for permanent closure, and termination of license.

Operational Criteria. The operational criteria required to address this concept, which are presented in 10 CFR 60.3, 60.4, 60.6, 60.7, 60.9(c)(l), 60.10(a), 60.15(a), 60.21, 60.22, 60.24, 60.31, 60.32, 60.33, 60.41, 60.42, 60.43, 60.44, 60.45, 60.46, 60.51, 60.52, 60.63, 60.73(b), and 60.73(c), appear to address the concept above, with some additional guidance.

Note: The text in 10 CFR 60.24(a) may need to be reviewed after public comments on the draft "Format and Content for the License Application for the HLW Repository" (DG-3003) (Ref. 32) are received by NRC.

Rationale for the Operational Criteria. The above cited criteria dealing with licensing have been addressed by NRC for years. These criteria coupled with the Nuclear Waste Policy Act, as amended (Ref. 17) assure adequate criteria for licensing. Further analysis is needed to address 10 CFR 60.24(a), per Uncertainty Reference Number 4, Appendix A, page 5, of NRC's "Recommendations" report (Ref. 8).

(2) Use of References

Concept. References used for any license-related submissions may be referenced by DOE to eliminate repetition.

Potential Repository Operational Criteria. 10 CFR 60.23 would generally address this concept. It was recommended by NRC in their "Recommendations" report (Ref. 8), Uncertainty Reference Number 2, Appendix A, page 3 that 10 CFR 60.23 be changed as indicated:

> 60.23 Elimination of repetition. In submissions made pursuant to this part, DOE may incorporate by reference information contained in previous applications, statements, or reports filed with the Commission. ~~In its application, environmental report, or Site Characterization Report, the DOE may incorporate by reference information contained in previous applications, statements, or reports filed with the Commission: *Provided*, That such references are clear and specific and that copies of the information so incorporated are available in the public document room located near the site of the proposed geologic repository.~~

Rationale for the Potential Repository Operational Criteria. 10 CFR Part 60 was amended in 1989 to provide for the DOE's submission of its Environmental Impact Statement (EIS) in lieu of the environmental report hitherto called for by the regulations. Inadvertently, one reference to an "environmental report" was not amended (see 10 CFR 60.23). The proposed resolution corrects this situation by allowing incorporation by reference for all

DOE submissions (which would include the EIS). The proposed text of 10 CFR 60.23 and the rationale were extracted from NRC's "Recommendations" report (Ref. 8) regarding Uncertainty Reference Number 2, Appendix A, page 3.

An uncertainty was raised on page B-12 of Appendix B of CNWRA 90-003 (Ref. 7) regarding 10 CFR 60.31. NRC's "Recommendations" report (Ref. 8) regarding Uncertainty Reference Number 6, Appendix A, page 8, suggested a "minor rule change" to 10 CFR 60.21(c)(14). This is addressed in the section 6.11 ROC Topic. An Uncertainty on the "public document room" was raised on Page B-10 of Appendix B of CNWRA 90-003 (Ref. 7). This is discussed further in the section 6.2 ROC Topic.

6.1.3 Elements Considered for Regulation

6.1.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) Site Characterization Plan, License Application, Updates, and Amendments

The site characterization plan has already been submitted by the DOE and commented upon by the NRC. The following elements are important in relation to site characterization activities:

- Prepare study plans to be implemented during site characterization, and submit these plans to the NRC for review and comment
- Determine design for the exploratory shaft facility
- Obtain State permits for allowing site access for characterization
- Initiate site characterization efforts, including preparation of exploratory borehole locations
- Report to the Commission on the nature and extent of site characterization activities
- During site characterization, plan for site visits and inspections by NRC staff
- Prepare the license application to contain the information required to meet the criteria of 10 CFR Part 60
- File and distribute the license application
- Update the license application
- Prepare and file the application for amendment of construction authorization, if necessary
- Determine if license amendment is necessary based on guidelines provided in 10 CFR 60.46

- Prepare and file the application for amendment of license, if necessary, as required by 10 CFR 60.45(a)
- Prepare and file the application for amendment of license prior to permanent closure, as required by 10 CFR 60.51(a)
- Submit a supplemented environmental impact statement with the application for license amendment, as required by 10 CFR 60.51(b)
- Prepare and file the application for amendment to terminate license after permanent closure as directed by 10 CFR 60.52

(2) **Use of References**

The following elements are important to the use of references:

- The references must be made in a consistent manner
- The references must be made available to the staff and the public

6.1.3.2 Comments on and Discussion of the Elements Considered for Regulation

The criteria found in 10 CFR Part 60 address the issues and concerns related to licensing, license amendment, and license termination. The linking of 10 CFR Part 60 with 10 CFR Part 2 and Part 51, described in subsection 6.1.4.3 of this analysis, assures that this ROC Topic is properly addressed. One exception is the text used in 10 CFR 60.23.

6.1.4 Safety Functions and Regulatory Citations

6.1.4.1 Associated Safety Functions

There were no safety functions associated with this ROC Topic identified from the "Repository Functional Analysis" (Ref. 1).

6.1.4.2 Relevant Regulatory Citations

- 10 CFR Part 2, Subpart J
- 10 CFR 60.3, 60.4, 60.6, 60.7, 60.9(c)(1), 60.10(a), 60.15(a), 60.21, 60.22, 60.23, 60.24, 60.31, 60.32, 60.33, 60.41, 60.42, 60.43, 60.44, 60.45, 60.46, 60.51, 60.52, 60.63, 60.73(b), 60.73(c), and Part 60, Subpart F

6.1.4.3 *Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations*

For all subtopics the following applies. 10 CFR Part 60 covers licensing, license amendment, and license termination as they relate to a high-level radioactive waste repository. 10 CFR Part 2, Subpart J, makes specific reference to 10 CFR Part 60, so that appropriate sections of 10 CFR Part 2 are already linked to 10 CFR Part 60. It is thought that 10 CFR Part 60 need not reference Part 2, since both regulations are linked by reference to the NWPA (Ref. 17). 10 CFR Part 51 is incorporated into 10 CFR Part 60 by specific reference under 60.41(d).

Regarding licensing, a regulatory uncertainty was identified with 10 CFR 60.23, in CNWRA 90-003, Appendix B, page B-5 (Ref. 7). The NRC staff concluded in its "Recommendations" report that Uncertainty Reference Number 2, Appendix A, page 3 (Ref. 8), needed a "minor rule change" for its resolution.

A regulatory uncertainty was raised on page B-8 of Appendix B of CNWRA 90-003 (Ref. 7). In regards to 10 CFR 60.24(a), it appeared uncertain whether 10 CFR Part 60 and other regulations adequately describe the means used to qualify a license application for docketing. Adequate criteria appear to be needed by both DOE and NRC to determine the acceptability of the application for docketing.

The NRC's "Recommendations" report (Ref. 8), regarding Uncertainty Reference Number 4, Appendix A, page 5, states:

> Further analysis is required to determine the need for high-level waste (HLW) repository license application acceptance criteria other than that to be provided in the HLW Repository License Application Format and Content Guide.
>
> In SECY 89-339 (Ref. 33), it was noted that "Developing criteria for acceptance of the License Application will provide a documented basis on which to accept or reject the License Application." "Acceptance criteria might also improve the effectiveness of prelicensing consultation and the Site Characterization Plan (SCP) Progress Report review process by encouraging DOE to resolve NRC staff concerns before the License Application is submitted." In SECY 90-207 (Ref. 34), "First Update of the Regulatory Strategy and Schedules for the High-Level Waste Repository Program," developing license application docketing criteria and content is identified as an activity for reducing regulatory uncertainty.

The Draft Regulatory Guide DG-3003, "Format and Content for the License Application for the High-Level Waste Repository," November 1990 (Ref. 32), includes Section 1.6.2, "Status of DOE Resolution of NRC Objections to License Application Submittal." This section provides guidance to the Department of Energy (DOE) on specific information to be provided for the Nuclear Regulatory Commission (NRC) to reach a decision on docketing the License Application (LA). For example,

"Therefore, as part of the acceptance review of the LA and before a decision on docketing the LA, the NRC staff will evaluate the effect of any unresolved objection to LA submittal, both individually and in combination with others, on the NRC staff's ability to conduct a meaningful review and make a decision regarding construction authorization within the three-year statutory time period."

NRC staff will review public comments on this proposed regulatory guidance, in determining the need for further action on this uncertainty.

This uncertainty will be evaluated, public comments, to determine any revisions to the Draft Regulatory Guide, and to prepare acceptance criteria for the License Application Review Plan.

An uncertainty about 10 CFR 60.31(a) was raised on page B-12 of Appendix B of CNWRA 90-003 (Ref. 7). This uncertainty involved review of the performance confirmation program (10 CFR Part 60, Subpart F) by NRC which is not described in 10 CFR 60.31(a). NRC's "Recommendations" report (Ref. 8) regarding Uncertainty Reference Number 6, Appendix A, page 8, suggested a "minor rule change" for 10 CFR 60.21(c)(14). This is discussed further in the section 6.11 ROC Topic.

The other regulations that address these concepts and may have a potential relationship to licensing, license amendment, or license termination for a repository (e.g., 10 CFR Parts 30, 61, 70, and 72) appear to provide no additional guidance that might be incorporated into 10 CFR Part 60 through modification of or additions to wordings in that regulation.

6.2 RECORDS AND REPORTS

This ROC Topic has the following subtopics:

(1) Quality Assurance Records and Reports
(2) License Activity Records and Reports
(3) Nuclear Materials Records and Reports

(4) Radiation Records and Reports
(5) Licensing Support System Records

6.2.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

For all five subtopics 10 CFR Part 60, in regard to criteria for records and reports, is sufficient and adequate for ensuring safety, except for minor criteria regarding public document rooms (see 10 CFR 60.22). 10 CFR Part 60 establishes criteria for reports and records which are equivalent to, and in most cases are identical to, those established for nuclear power plants and for other radioactive waste handling facilities.

6.2.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria and rationale that were developed to substantiate the conclusions presented above.

Concept. There were several subtopics for this ROC Topic but the same concept applied to all of them. Criteria for records and reports are necessary for NRC review of the design, construction, and operation of a repository to ensure radiological health and safety and for public review and archiving.

Potential Repository Operational Criteria. The potential repository operational criteria required to address this concept are in 10 CFR Part 2; 10 CFR Part 20; 10 CFR Part 50, Appendix B; 10 CFR 60.4, 60.10, 60.18, 60.21(c), 60.22, 60.24, 60.44(b), 60.51(a)(2)(ii), 60.71, 60.72, 60.73, and 60.152. A change was recommended by NRC to 10 CFR 60.22, in the "Recommendation" report (Ref. 8), to clarify the intent of the public document room. 10 CFR 60.22(d) was revised as follows:

> 60.22(d) At the time of filing of an application and any amendments thereto, DOE shall make one copy available in an appropriate location near the proposed geologic repository operations area for inspection by the public. DOE shall make the environmental impact statement and any supplements thereto available in the same manner. If the Commission has established a public document room at such a location, DOE shall comply with this paragraph by depositing the specified documents with the Commission at that public document room.

> ~~60.22(d) At the time of filing of an application and any amendments thereto, one copy shall be made available in an appropriate location near the proposed geologic repository operations area (which shall be a public document room, if one has been established) for inspection by the public and updated as amendments to the application are made. The environmental impacts statement and any supplements thereto shall be made available in the same manner. An updated copy of the~~

~~application, and the environmental impact statement and supplements, shall be produced at any public hearing held by the Commission on the application, for use by any party to the proceeding.~~

Also, NRC recommends a new 10 CFR 60.22(e) to read:

<u>60.22(e) DOE shall produce an updated copy of the application and the environmental impact statement and supplements at any public hearing held by the Commission on the application for use by any party to the proceeding</u>.

Furthermore, it will be necessary to redesignate 10 CFR 60.22(e) as new 60.22(f) and revise the phrase "paragraphs (c) and (d)" to read "paragraphs (c) through (e)," as indicated below:

60.22~~(e)~~ <u>(f)</u> The DOE shall certify that the updated copies of the application, and the environmental impact statement as it may have been supplemented, as referred to in paragraphs (c) through ~~(d)~~ <u>(e)</u> of this section, contain the current contents of such documents submitted in accordance with the requirements of this part.

Rationale for the Potential Repository Operational Criteria. The above cited criteria related to records and reports for a repository fully address the concept because they are broadly written. These criteria require records and reports to be submitted to NRC, or be available for review by the NRC or the public. Maintenance of these records and reports is related to the assurance that the public safety is protected.

NRC's "Recommendations" report (Ref. 8) for Uncertainty Reference Number 5, Appendix A, page 7, presents the text and rationale for the above operational criteria related to 10 CFR 60.22. The amended language would make it clear that if an NRC public document room is established, the DOE's responsibility extends only to depositing the required documents (which would thereafter be the responsibility of NRC, as document custodian). The language would also make it clear that there is a second, independent requirement, for DOE to produce updated documents at public hearings. Separating this from the public document room deposit provision will express the requirements more clearly.

6.2.3 Elements Considered for Regulation

6.2.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

Affected reports, records, and associated functions relevant to quality assurance records and reports, license activity records and reports, nuclear materials records and reports, radiation records and reports, and licensing support-system records are addressed in 10 CFR Part 60. Additional criteria for records controls are identified in ANSI/ASMENQA-1-1986 (Ref. 35), which has been endorsed by NRC, and is being utilized by DOE as a basis for their

QA program for the repository.

6.2.3.2 *Comments on and Discussion of the Elements Considered for Regulation*

10 CFR Part 60 regulations provide criteria to identify all the types and content of reports and for the development and implementation of records-management controls. The nuclear power industry has primarily maintained all required records through implementation of 10 CFR Part 50, Appendix B. These records control criteria have universal application to any nuclear facility and are completely applicable to HLW. The report requirements of 10 CFR Part 60 are unambiguous, and are similar to those encountered within the nuclear power industry.

6.2.4 Safety Functions and Regulatory Citations

6.2.4.1 *Associated Safety Functions*

(1) Quality Assurance Records and Reports

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

- Maintain and secure security and safeguard records and reports - 2.12
- Implement a quality assurance program for security and safeguards - 2.13
- Implement a quality assurance program for waste preparation operations - 5.14
- Implement a quality assurance program for waste disposal operations - 6.13

(2) License Activity Records and Reports

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

- Preserve public records about the location, boundaries and purpose of the controlled area - 7.4.5
- Preserve public records about the location, design, and contents of the geologic repository - 7.4.6

(3) Nuclear Materials Records and Reports

The following safety functions were identified from the "Repository

Functional Analysis" (Ref. 1).

- Account for and maintain inventories of nuclear materials in the waste management system - 2.10
- Verify and record identification of each waste disposal package and its intended emplacement opening/location - 6.6.3
- Verify and record identification of emplaced waste disposal package and emplacement opening location number - 6.6.10
- Update inventory of emplaced waste during repository waste removal operations - 6.9.16

(4) Radiation Records and Reports

No safety functions directly referring to radiation records and reports were identified from the "Repository Functional Analysis" (Ref. 1).

(5) Licensing Support System Records

No safety functions directly referring to the licensing support system were identified from the "Repository Functional Analysis" (Ref. 1).

6.2.4.2 Relevant Regulatory Citations

- 10 CFR 2.1000 through 2.1023
- 10 CFR 21.3(k)
- 10 CFR 50.55(e)(1)(iv) and Part 50, Appendix B-XVII
- 10 CFR 60.4, 60.10, 60.18, 60.21(c), 60.22, 60.24, 60.31(b)(1), 60.32(b), 60.44(b), 60.51(a), 60.71, 60.72, 60.73, and 60.152

6.2.4.3 Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations

Within subtopics 1 through 3, the reporting and records requirements of 10 CFR Parts 50, 60, 61, and 72 are essentially the same, with some variations between specific reporting requirements based on the individual application. Subtopic 4, based on 10 CFR Part 20, has equal application to 10 CFR Parts 50, 60, 61, and 72 concerning radiation safety records and reports. The associated regulatory citations within Subtopics 1 through 4 are very consistent in scope and depth for 10 CFR Parts 50, 60, 61, and 72.

The additional records-management requirements for the Licensing Support System (LSS) in 10 CFR 2.1000 through 2.1023 are unique to the high-level waste repository and, thus, 10 CFR Part 60. The LSS would not replace records-management processes that would be similar to those established for nuclear power plants (10 CFR Part 50, Appendix B-XVII), but provides for a compilation of records to assist in the repository licensing process.

Common practice in the nuclear power industry is to manage all records in the same manner as for Quality Assurance Records (10 CFR Part 50, Appendix B-XVII).

A regulatory uncertainty was raised on page B-22 of Appendix B, CNWRA 90-003 (Ref. 7). Regarding 10 CFR 60.51(a)(2)(ii), in the absence of specific criteria, the phrase "that would likely be consulted by potential human intruders" does not lend itself to explicit definition and requires clarification so that realistic archiving can be accomplished. The NRC's response to this uncertainty, given in the "Recommendations" report, (Ref. 8) for Uncertainty Reference Number 9, Appendix A, page 11, states:

> Archives that are likely to be consulted by potential human intruders are to be identified in the license amendment for permanent closure and should be commensurate with the state of knowledge and data-handling technology.
>
> 10 CFR 60.51(a) calls for the Department of Energy (DOE) to submit an updated license application, before permanent closure, that is to include a detailed description of the measures to be employed to regulate or prevent activities that could impair the long-term isolation of emplaced waste within the geologic repository and to ensure that relevant information will be preserved for the use of future generations. It is in that context that the regulations require placement of records in archives and land record systems that would be likely to be consulted by potential human intruders.
>
> There are good reasons why the regulations are not more specific. In the first place, the appropriate data repositories are not to be defined until the time of permanent closure. This is several decades away, and it is not practicable to identify just what the appropriate archives and record systems will be. Second, the appropriate location for such records is, to some degree, dependent on the specific site of the geologic repository. If, for example, the geologic setting is characterized by the presence of certain economic minerals or by the occurrence of peculiar seismic phenomena, the appropriate archives might include those that relate to the minerals or phenomena that are or may be present. Third, the regulations clearly articulate the policy framework by which the adequacy of the archive and record systems is to be judged -- namely, the regulation or prevention of activities that could impair long-term isolation.

A regulatory uncertainty was raised on page B-10 of Appendix B, CNWRA 90-003 (Ref. 7). 10 CFR 60.22(d), when taken in the context of the balance of 10

CFR 60.22, can be interpreted to require DOE to be responsible for the contents of an NRC public document room. The intent of the regulation needs to be clarified. The NRC's "Recommendation" report (Ref. 8) for Uncertainty Reference Number 5, Appendix A, page 7, recommended "a minor rule change."

A regulatory uncertainty was raised on page B-28 of Appendix B, CNWRA 90-003 (Ref. 7). In regards to 10 CFR 60.72(b)(6), the term "construction problems" requires further definition in order to ensure documentation of all those problems of interest to the Commission, and to clearly identify appropriate recordkeeping requirements for DOE. The NRC's response to this uncertainty, given in the "Recommendations" report (Ref. 8) for Uncertainty Reference Number 10, Appendix A, page 12, states:

> The "construction problems" are those that need to be documented to ensure the long-term information availability to future generations to provide a basis for regulating or preventing activities that may be detrimental to long-term isolation of waste.
>
> The term "construction problems" is adequately defined by its context. That is, the "construction problems" at issue is--as stated in the introductory text of 10 CFR 60.72(b)--in one of eleven categories for which records are ". . . required under paragraph (a)." This means, in turn, that the construction problems that must be documented are those that pertain to "usability for future generations in accordance with 10 CFR 60.51(a)(2)." The latter reference requires the DOE, before permanent closure, to update its license application so as to include a detailed description of measures to be employed to ensure that relevant information will be preserved for future generations. Accordingly, if the construction problems are relevant to future generations--particularly, as stated in 10 CFR 60.51(a)(2), for the purpose of regulating or preventing activities that could impair the long-term isolation of emplaced waste--then they fall within the scope of 10 CFR 60.72(b). Other construction problems may also be of interest, and may need to be documented as part of DOE's quality assurance program or pursuant to a condition of the construction authorization (see 10 CFR 60.31(b)(1)), but they are not addressed by 10 CFR 60.72(b).

A regulatory uncertainty was raised on page B-29 of Appendix B, CNWRA 90-003 (Ref. 7). In regards to 10 CFR 60.72(b)(7), the term "anomalous conditions" requires further definition in order to ensure documentation of all those conditions of interest to the Commission, and to clearly identify appropriate recordkeeping requirements for the DOE. The NRC's response to this uncertainty, given in the "Recommendations" report (Ref. 8) for Uncertainty Reference Number 11, Appendix A, page 13, states:

> The "anomalous conditions" are those that need to be documented to

ensure long-term information availability to future generations.

> The "anomalous conditions" are those that are relevant ". . . to regulate or prevent activities that could impair the long-term isolation of emplaced waste within the geologic repository and to assure that relevant information will be preserved for the use of future generations" (10 CFR 60.51(a)(2)). "Anomalous conditions" is one of eleven categories in 10 CFR 60.72(b) for which construction records must be kept. For a fuller analysis of the provisions of 10 CFR 60.72(b), and their relationship to other provisions of 10 CFR Part 60, see the discussions of Uncertainty 10.

A regulatory uncertainty was raised on page B-31 of Appendix B, CNWRA 90-003 (Ref. 7). In regards to 10 CFR 60.73(b), the term "significant deviation" requires further definition in regard to "design criteria and design bases stated in the application." More specific guidance will ensure that those deviations reported by DOE satisfy the regulatory intent of the Commission. The NRC's "Recommendation" report regarding Uncertainty Reference Number 13, Appendix A, pages 16 and 17, (Ref. 8) states:

> The reporting requirements will be clarified in the License Application Format and Content Guide and License Application Review Plan and may be specified as appropriate by provision of the construction authorization, as described in 10 CFR 60.32(b).

> The term "significant deviation" is not uniqu   CFR Part 60. On the contrary, in similar context, a holder of   ruction permit is required to notify the Commission of every deficiency found, in design and construction, that could adversely affect the safe operation of a nuclear power plant and that represents, inter alia:

> ". . . a significant deviation from performance specifications which will require extensive evaluation, extensive redesign, or extensive repair to establish the adequacy of a structure, system, or component to meet the criteria and bases stated in the safety analysis report or construction permit or to otherwise establish the adequacy of the structure, system, or component to perform its intended safety function." (10 CFR 50.55(e)(1)(iv)).

> The requirement in 10 CFR 60.73--that the Department of Energy (DOE) is to promptly notify the Commission of each deficiency that represents ". . . a significant deviation from the design criteria and design bases stated in the application . . ." --does not stand alone. It must be read in conjunction with 10 CFR 60.32(b), which, among other things, states that "The Commission will incorporate, in the construction authorization,

> provisions requiring DOE to furnish periodic or special reports regarding . . . (2) any data about the site obtained during construction which are not within the predicted limits upon which the facility design was based, (3) any deficiencies in design and construction, which, if uncorrected, could adversely affect safety at any future time. . . ." Thus, there is in place a mechanism to specify the conditions that would call for reports to be filed during construction, pursuant to 10 CFR 60.73. There may be a need to be more specific regarding matters that might need to be reported once a license to receive and possess waste has been issued; but, these might be handled by license conditions and, in any event, there is, no compelling need to address the matter for many years to come.

A regulatory uncertainty was raised on page B-30 of Appendix B, CNWRA 90-003 (Ref. 7). In regards to 10 CFR 60.73, the term "substantial safety hazard" requires further definition in regard to the characteristics of the site and the design and construction of the geologic repository operations area. More specific guidance is needed to ensure that those hazards reported by DOE satisfy the regulatory intent of the Commission. The NRC's response to this uncertainty, given in the "Recommendations" report (Ref. 8) for Uncertainty Reference Number 12, Appendix A, pages 14 and 15, states:

> "Substantial safety hazard" is defined as a loss of safety function to the extent that there is a major reduction in the degree of protection provided to public health and safety.
>
> Section 206 of the Energy Reorganization Act of 1974, U.S.C. 5846, imposed upon certain parties an obligation to notify the Nuclear Regulatory Commission (NRC) of defects that ". . . could create a substantial safety hazard, as defined by regulations which the Commission shall promulgate."
>
> In implementing this provision, the Commission defined the term "substantial safety hazard" (in 10 CFR 21.3(k)) to refer to a ". . . loss of safety function to the extent that there is a major reduction in the degree of protection provided to public health and safety. . . ."
>
> The Commission's statement of considerations, accompanying the promulgation of the rule (42 FR 28801, June 6, 1977), expressly declared that ". . . insufficient experience has been accumulated to permit the writing of a detailed regulation at this time that would provide a precise correlation of all factors pertinent to the question of what is a significant safety hazard." Rather, the Commission identified certain criteria that it indicated to be ". . . appropriate for determination of creation of a substantial safety hazard" -- namely:

- Moderate exposure to, or release of, licensed material;
- Major degradation of essential safety-related equipment; and
- Major deficiencies involving design, construction, inspection, test, or use of licensed facilities or material.

In view of this policy direction from the Commission, the staff regards the existing regulation to provide an adequate basis for determining compliance. However, as the Commission indicated when it issued the rule, ". . . additional guidance in the form of regulatory guides may be developed should experience with the application of 21 indicate the need for such guidance." Such experience would be derived from ongoing activities licensed under other parts of NRC regulations and would be applied to a geologic repository, as appropriate.

6.3 RETRIEVAL, REMOVAL, AND RELOCATION

This ROC Topic has the following subtopics:

(1) Definitions Relevant to Retrieval
(2) Ventilation Relevant to Retrieval
(3) "Facilitate" versus "Not Preclude" Waste Retrieval
(4) Criteria To Be Satisfied During Retrieval
(5) Emergency Retrieval
(6) Demonstration of Retrievability

6.3.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) Definitions Relevant to Retrieval

(a) Retrieval and Removal Definitions

The definition of retrieval in 10 CFR 60.2 includes the word "removing"; consequently, no separate formal definitions for "removal" and "retrieval" are required. The definition of retrieval in 10 CFR 60.2 may not appear wholly consistent with 10 CFR 60.21(c)(12). 10 CFR 60.21(c)(12) may imply that the term "retrieval" is limited to cases in which the geologic repository is proven to be unsuitable for disposal of radioactive waste. Many reasons can be envisioned for which removal following emplacement might be desired, ranging from simple visual inspection to identification of package manufacturing problems.

(b) Definition of "substantially increase the difficulty of retrieving"

The phrase "substantially increase the difficulty of retrieving" is within the context of a particular site and design. Because of the site-specific and design-specific nature of "increased difficulty," engineering judgment should be sufficient to determine what constitutes a substantial increase in difficulty. NRC may present more guidance following the submittal of a license application and design.

(2) **Ventilation Relevant to Retrieval**

The current regulations concerning ventilation apply to retrieval because if retrieval were necessary, it would be a repository operation.

(3) **"Facilitate" Versus "Not Preclude" Waste Retrieval**

The criteria to maintain retrievability are sufficiently and adequately addressed in 10 CFR Part 60. Concerning the point on whether the repository is to be designed to permit waste retrieval, or only that the design must not preclude waste retrieval (i.e., not make retrieval impossible), the NRC intent appears to indicate that the GROA is to be designed for waste retrieval, not simply that retrieval is not precluded or made impossible. The degree of difficulty in retrieval does not appear to be an NRC concern as long as the design allows retrieval in a reasonable time frame. A concern of NRC is that there is a plan for retrieval and that the design allows for retrieval to be accomplished during a defined retrieval period.

(4) **Criteria To Be Satisfied During Retrieval**

10 CFR Part 60 is adequately clear that all regulations relevant to operations apply to retrieval, because retrieval is a potential repository operation.

(5) **Emergency Retrieval**

No criteria appear to be needed for rapid or emergency retrieval because the repository design, site investigation, and performance confirmation are all aimed at ensuring a suitable site and repository design; and any need for retrieval on a rapid schedule is extremely unlikely and would be precluded prior to emplacement.

(6) **Demonstration of Retrievability**

The criteria to design for retrievability are in the present 10 CFR Part 60 regulations. Criteria concerning how and when to demonstrate retrieval will depend upon the site-specific and design-specific features for a particular repository and should be in the nature of guidance.

6.3.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) **Definitions Relevant to Retrieval**

(a) *Retrieval and Removal Definition*

Concept. The definition of retrieval needs to be concerned with any removal of waste emplaced for disposal.

Potential Repository Operational Criteria. The definition in 10 CFR 60.2 for "retrieval" and the related criteria presented in 10 CFR 60.111(b) address this concept. The current criteria in 10 CFR 60.21(c)(12) might be enhanced by a minor change, and might read as follows:

> 60.21(c)(12) A description of plans for retrieval and alternate storage of radioactive wastes <u>that had been previously emplaced.</u> ~~should the geologic repository prove to be unsuitable for disposal of radioactive wastes.~~

Rationale for the Potential Repository Operational Criteria. The definition of "retrieval" in 10 CFR 60.2 and the related criteria in 10 CFR 60.111(b) fully address the concept because they are generally written and the definition of "retrieval" includes the term "removing," as discussed below. No formal definition of "removal" is required nor is a redefinition of "retrieval" required, since the word "removing" is part of the definition of "retrieval."

The proposed potential repository operational criteria, related to 10 CFR 60.21(c)(12), are given because the current criteria may imply that "retrieval" is a term limited to a situation where the geologic repository proves to be unsuitable for disposal of radioactive waste. This is not in the definition of "retrieval," and it may enhance 10 CFR Part 60 to not imply a limited use of the term "retrieval."

A discussion and background for distinguishing between retrieval and removal are described in NRC's draft TP on "Guidance for Determination of Level of Retrieval Demonstration Needed During Site Characterization" (Dec. 88). The following is adapted from the draft TP. The Rule provides for retrieval as a means to implement and make meaningful the NRC's decision to close or not to close the repository. DOE has presumed that the "retrieval" referred to in the Rule is that which the NRC would require because of "evidence that the health and safety of the public would otherwise be adversely affected by the emplaced waste." The DOE position also considers the effects on the environment to be the same as the effects on public health and safety so the provision for "retrieval" called for in Section 122 of the NWPA (Ref. 17) is also addressed in the DOE position. "Retrieval" could also occur for resource recovery reasons at the discretion of the DOE, subject to applicable NRC regulations and the NWPA. All other waste removal is not considered "retrieval" for purposes of the DOE position. Certain aspects of waste removal fall under NRC regulations regardless of the purpose, and it is likely that many of the activities engaged therein would be identical to similar steps taken for the form of "retrieval" identified by the DOE. Movement of waste within the repository for any reason must conform to applicable regulations. Also, the ability of the repository to meet the performance objectives for the undisturbed waste must not be compromised by waste removal activities, regardless of the purpose for the removal of the waste. It is probably impractical and unnecessary to design two entirely different waste removal schemes, one for "retrieval" and one for other purposes of "removal," when most of the regulatory standards would be the same for either case. It appears that some "retrieval" systems and components would be fully operational and would be used occasionally in waste "removal" (testing and inspection related to the performance confirmation program, transferring waste for operational reasons, or other purposes).

The reason for distinguishing waste "removal" and waste "retrieval" may have to do with differences in the expectation of abnormal or hostile conditions. Waste movement ("removal") not falling under the DOE's definition of "retrieval" may be expected to take place under normal conditions, with little or no likelihood that abnormal conditions would be encountered, whereas "retrieval," which by the DOE definition would necessarily be accompanied by some perceived threat to health and safety, would be more likely to encounter off-normal conditions. Nonetheless, measures for environmental or personnel protection against abnormal conditions may not be ruled out in either case. Equipment and procedures used to support retrievability under 10 CFR Part 60 should, therefore, take into consideration abnormal conditions for waste "retrieval" or "removal."

The NRC staff's draft position (Dec. 88) is that an applicant should either submit plans for waste removal operations and explicitly describe such plans in the Safety Analysis Report, or include waste removal activities in the required retrieval plans.

Note: The term "disposal" is used in the definition of "retrieval." Disposal per the NWPA (Ref. 17) means emplacement of waste with no foreseeable intent of recovery. The difference between the definition of "disposal" in 10 CFR 60.2 and in the NWPA (Ref. 17) seems to be beyond the scope of the ROC Feasibilities Studies. Since a definition of "disposal" is explicitly stated in 10 CFR 60.2, it seems logical to apply that definition of "disposal" to all the other related definitions and criteria in 10 CFR Part 60.

(b) Definition of "substantially increase the difficulty of retrieving"

Concept. Actions that modify the difficulty of waste retrieval need to be assessed relative to the design and conditions of the specific site described in the application.

Operational Criteria. The operational criteria required to address this concept are presented in 10 CFR 60.46(a)(1).

Rationale for the Operational Criteria. The criteria in 10 CFR 60.46(a)(1) fully address the concept because it is generally written and would address modifications that could impact the difficulty of waste retrieval. Retrievability methods are site specific and design specific. Consequently, individual technical criteria may change considerably because of specific site conditions. Because of this site-specific nature, retrievability will be defined by the design/plan submitted in the Safety Analysis Report (10 CFR 60.21(c)(12)) when the design/plan is approved by the NRC and incorporated in the license. Any action that would result in a substantial increase in the difficulty of retrieving emplaced waste is relative to the plan in the license and the specific site. Engineering judgment could be used to determine whether the change would "substantially increase the difficulty of retrieving" and, therefore, require a license amendment. This rationale is supported by the NRC's draft TP on retrieval (Dec. 88).

(2) Ventilation Relevant to Retrieval

Concept. If cooling of the emplacement area for retrieval is essential to health and safety, it needs to be required to ensure retrievability.

Operational Criteria. The potential repository operational criteria needed to address this concept are presented in 10 CFR 60.133(g)(3).

Rationale for the Operational Criteria. The criteria in 10 CFR 60.133(g)(3) fully address this concept because 10 CFR 60.133(g)(3) applies to any potential operations and the separation of ventilation is required for excavation *areas* and emplacement *areas*. Even though waste may be retrieved, it can only be retrieved from an *area* that has emplaced waste. Therefore, the criteria in 10 CFR 60.133(g)(3) apply equally to retrieval. Ventilation could be the most reasonable means to cool for retrieval if necessary, but it may not be the only means for cooling.

(3) "Facilitate" Versus "Not Preclude" Waste Retrieval

Concept. Criteria are needed so that the GROA will be designed for retrieval which can be conducted within a reasonable period of time.

Operational Criteria. The operational criteria required to address the concept are presented in 10 CFR 60.111(b).

Rationale for the Operational Criteria. 10 CFR 60.111(b) fully addresses this concept because it requires design of the GROA to preserve the option of waste retrieval. Design is an intentional act. The selected design may allow easy or difficult retrieval. Terms such as "facilitate," "not preclude," "accommodate," "permit," and "preserve the option," all appear to describe varying degrees of difficulty in retrieval. NUREG-0804 (Ref. 13) on page 11 noted that the retrievability requirement "does not imply ready or easy access to emplaced waste . . . the idea is that it should not be made impossible or impractical to retrieve the wastes." The requirement governing ease of retrieval appears to be addressed by the *retrieval period* defined in 10 CFR 60.111(b)(3). NRC staff has expressed the opinion that retrievability should be a part of repository design from the conceptual to the advanced stages [see NRC's "Recommendations" report (Ref. 8), Uncertainty Reference Number 16, Appendix A, pages 20 and 21]. Therefore, the intent and meaning of the regulations appear to be consistent, in that the repository be designed for retrieval, but that design for retrieval does not have to dominate the design efforts.

(4) Criteria To Be Satisfied During Retrieval

Concept. Design criteria for the GROA need to apply to normal operations and retrieval.

Operational Criteria. The operational criteria required to address this concept are presented in 10 CFR 60.131, 60.132, and 60.133; and all these criteria apply to the period of retrieval and, thus, to retrieval itself.

Rationale for the Operational Criteria. The application of selected criteria to the retrieval period are specifically and explicitly stated in the 10 CFR Part 60 regulations. For example, 10 CFR 60.131(b)(7), 60.132(a), 60.133(c) and 60.133(e)(1) directly reference retrieval; but not all the regulations individually and explicitly state that criteria must be satisfied during the retrieval period. 10 CFR 60.111(a) states the radiation safety performance objective must be assured "at all times," which includ s the retrieval period. Those criteria that are silent as to applicability during the retrieval period are assumed to be applicable, since the preclosure performance objective applies to the retrieval period and, thus, retrieval.

(5) Emergency Retrieval

Concept. There should to be no need to design for emergency or accelerated retrieval.

Operational Criteria. None.

Rationale for the Operational Criteria. No new criteria are needed because the repository design, site investigation, and performance confirmation are all aimed at ensuring a suitable site and repository design. The need for emergency retrieval should, therefore, be unnecessary. Also, a requirement to provide for emergency retrieval could be detrimental to waste isolation and be very costly.

Emergency retrival was considered in developing the proposed r s for 10 CFR Part 60. Regarding emergency retrieval, in describing the rationale for the performance objectives in 10 CFR Part 60, it was noted in NUREG-0804 (Ref. 13) on page 537 that, "We can foresee no situation where protection of the public health and safety would require the waste to be removed very rapidly."

(6) **Demonstration of Retrievability**

Concept. Criteria are needed so that retrieval could be demonstrated by an appropriate method at an appropriate time in relation to commencement of waste emplacement operations.

Operational Criteria. Operational criteria to address how and when to demonstrate retrievability can be addressed in routine guidance already planned by the NRC, such as the "Format and Content Regulatory Guide," interactive meetings with DOE, and the draft TP on retrieval (Dec. 88).

Rationale for the Operational Criteria. Operational criteria to address this concept should be provided in guidance documents because how and when to demonstrate retrievability will be site specific and design specific. Operational criteria may not even be necessary because, for some cases (e.g., waste stacked or laid on the floor of stable, open drifts), retrievability is obvious or even trivial, and would be a simple matter to demonstrate. For other cases (e.g., multiple waste packages stored in very long or unstable emplacement holes), there could be other considerations about retrievability; and a physical demonstration may be necessary.

Retrieval is considered to be site specific and design specific. Appropriate demonstration of retrievability is only meaningful in the context of a specific site and design. Issues left open are simulation of the underground environment, repository conditions, waste radioactivity, etc. A physical demonstration, if necessary for a specific site or design, may occur prior to the operations period, but could occur any time before. Other demonstrations may be acceptable for the license application for construction authorization. A physical demonstration might occur prior to commencement of waste emplacement operations to help reduce any of the risks of putting radioactive waste into the ground. It may not be necessary to physically demonstrate retrieval during the site characterization stage because site characterization is required to determine what the design for retrieval should be.

6.3.3 Elements Considered for Regulation

6.3.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) **Definitions Relevant to Retrieval**

Some terms that may require definition are:

- Design to
  - Not preclude
  - Not prevent

- Facilitate
- Allow, etc.
- Waste emplacement in relation to
  - In holes or in drift
  - Host rock
  - Liner
  - Packing
  - Shield
  - Backfill
- Start of retrieval time period
- Emplacement with intent for permanent disposal
- Substantially increase the difficulty of retrieving
- Removal versus retrieval of waste placed in the underground
- Physical simulation or physical demonstration versus a demonstration by analysis

(2) Ventilation Relevant to Retrieval

Some elements relevant to ventilation for retrieval are as follows:

- Access for retrieval
  - Existing underground openings
  - Backfill blocking ventilation
  - New excavations
- Equipment
  - Ventilation equipment (fans, stoppings, seals, instrumentation)
- Environmental considerations
  - Temperature
  - Humidity
- Cooling for retrieval - rock, air, waste packages, workers
- Alternative cooling - liquid air, chilled water, compressed gases, ventilation

(3) "Facilitate" Versus "Not Preclude" Waste Retrieval

Some of the elements involved in understanding the criteria to "facilitate" versus "not preclude" are as follows:

- Actively designing for retrieval
- Intentionally designing for retrieval
- Ensuring retrieval is not made impossible, by designing for retrieval
- Ensuring retrieval is not made impossible, by assuring the proposed design does not prevent retrieval

- Making retrieval as easy as it was to emplace - (facilitate)
- Making retrieval easier than it was to emplace - (really facilitate)
- Designing retrieval equipment
- Designing emplacement equipment that can be used for retrieval
- Designing the waste package so it can be easily grappled by retrieval equipment
- Training for retrieval
- Planning for retrieval
- Not sealing emplacement holes to facilitate retrieval
- Ensuring emplacement hole stability to assure retrieval
- Providing equipment
  - Waste package removal equipment
  - Waste package hauling (transport) equipment
  - Ventilation equipment (fans, stoppings, seals, instrumentation)
  - Alternative cooling
  - Excavation or re-excavation equipment
- Considering environmental conditions
  - Radiation
  - Contamination from leaking packages
  - Temperature
  - Humidity
  - Horizontal versus vertical emplacement holes
  - Lined versus unlined emplacement holes

(4) Criteria To Be Satisfied During Retrieval

The safety criteria to be satisfied during retrieval would appear to need to be the same criteria applicable during emplacement.

(5) Emergency Retrieval

Elements of emergency retrieval would include postulated scenarios that require retrieval in a time significantly shorter than the emplacement time.

(6) Demonstration of Retrievability

Elements to be considered regarding demonstration of retrievability are as follows:

- Physical demonstration
- Analytical studies
- Scale-model demonstration
- Computer simulation
- Site-specific physical demonstration

- Demonstration using HLW
- Timing of any type of demonstration

6.3.3.2 *Comments On and Discussion of the Elements Considered for Regulation*

(1) **Definitions Relevant to Retrieval**

(a) Retrieval and Removal Definitions

DOE appears to have distinguished between the definitions of waste removal and waste retrieval, where retrieval is triggered by accumulation of evidence of a threat to the public health and safety or the environment, and removal being any efforts to remove, extract, or relocate any portion of the emplaced waste for testing, inspection related to performance confirmation, redistribution of inventory for ventilation reasons, or similar operational considerations not related to public health and safety. NRC appears to not contest this distinction; but this separation may be arbitrary and of no practical consequence because the two operations appear to be physically almost identical, and it may be impractical to implement two entirely different waste *removal systems*, one for "retrieval" and one for "non-retrieval" (Dec. 88).

(b) Definition of "substantially increase the difficulty of retrieving"

The word "substantially" apparently introduces some uncertainty wherever it appears in any regulation. For example, the phrase "substantially complete containment" (10 CFR 60.113(a)(1)) may be the source of ongoing discussions. The language of 10 CFR 60.46(a)(1) may appear to introduce two uncertainties. One issue appears to relate to what constitutes a substantial increase in difficulty. Examples of actions that might substantially increase the difficulty of retrieving include the following:

- Backfilling drifts and/or emplacement holes
- Discontinuing ventilation in waste emplacement drifts
- Introducing bulkheads at various locations within the underground facility

For each of these actions, it is reasonable to assume that if all drifts and/or emplacement holes were acted upon in the manner described, then the difficulty in retrieving waste may be substantially increased, particularly if such actions were not described in the original license application. However, the issue may become clouded when only isolated drifts and/or emplacement holes are acted on in the manner described. The difficulty of retrieving waste from the specific drift(s) and/or emplacement hole(s) may be substantially increased; but, in the context of all waste being retrieved, the degree to which retrievability had been made more difficult may depend on the percentage of drifts and/or emplacement holes involved, among other factors such as location, continuity, and age since emplacement. The notion here is that retrieval could be substantially more difficult in a few places, but not necessarily more difficult when the entire repository is considered.

The second issue relates to the intention of the regulations concerning retrieval [see subsection 6.3.3.2(3)]. If the intent of the regulations is that the repository only be designed not to preclude retrieval, then changes to the repository design that make retrieval more difficult, but still possible, remain consistent with this intent. Thus, the requirement to amend the license is unnecessary.

(2) Ventilation Relevant to Retrieval

Under some retrieval schemes, it may be necessary to excavate to gain access to waste packages in the waste emplacement area. If the waste emplacement area is also ventilated, then it would appear necessary to separate the emplaced waste ventilation from the excavation area to access the waste, as required by 10 CFR 60.133(g)(3). If the waste emplacement area is not being ventilated (e.g., if the emplacement drifts are backfilled), then it appears to not be necessary to separate the ventilation systems, since there is, in effect, only one area to be ventilated. If no separate excavations are required for waste retrieval, then separation of the ventilation for separate areas appears to be covered, if new excavation is continuing at the same time while waste is being retrieved from an emplacement area.

(3) "Facilitate" Versus "Not Preclude" Waste Retrieval

Given the time period allowed for waste retrieval by 10 CFR 60.111(b)(3), it could be argued that the repository should be designed for waste retrieval. It would take active design to assure that the time allowed for waste retrieval is about the same as that necessary to construct the repository and emplace the waste. Environmental and any other conditions which did not exist during construction and waste emplacement could be accounted for by providing additional resources for the retrieval effort beyond those used for the construction and emplacement effort. For example, additional shafts and/or ramps could be excavated for the retrieval effort to allow access to many different reaches of the repository. Waste emplacement schemes for which (1) the waste location was not sufficiently known or (2) access to the waste may require very careful monitoring so as not to breach the waste packages might significantly delay and thus "preclude" waste retrieval in the required time frame.

A repository should be intentionally designed with waste retrieval in mind. Design could, for example, make allowances for cooling which might be required for reentry into waste emplacement drifts or take measures to ensure that shafts and ramps (and any other subsurface openings which are not part of the underground facility, but which may be used for waste retrieval) remain stable so that operations can be carried out safely and the retrievability option maintained.

(4) **Criteria To Be Satisfied During Retrieval**

If retrieval is covered by regulations that govern design (including operations), then the basic regulatory requirements appear to assure that radiological health and safety concerns are addressed. The technological conditions and the environment in which removal may be conducted may differ substantially from those during emplacement.

(5) **Emergency Retrieval**

Emergency retrieval is not discussed in the applicable regulations. However, scenarios could be postulated in which the waste might need to be retrieved on an accelerated schedule rather than a reasonable schedule. The need to retrieve on an accelerated schedule could be the result of some emergency, such as a sudden and accelerated degradation of the waste packages or a significant increase in seismic activity. The following reasons can be given for why emergency retrieval need not be considered by the regulations.

- Site conditions which might require emergency retrieval should be detected during site characterization.
- Items that are not site related (e.g., resource recovery) are probably not of NRC concern.
- Even though remotely plausible emergencies can be postulated, their probability is likely very low.
- Emergencies requiring accelerated retrieval would not have a sudden onset which would escape early detection.
- None of the scenarios would require action in a time frame constituting an "emergency."

The preceding discussion has indicated that emergency retrieval need not be considered by the regulations. The following discussion argues that the regulations should not address emergency waste retrieval on the basis that a requirement to permit emergency waste retrieval would not enhance waste isolation. For example, requiring the ability to retrieve on an emergency basis might involve additional shafts/ramps to provide necessary ventilation and cooling for emergency retrieval. However, the additional shafts/ramps would also provide connections between the underground facility and the ground surface and thereby reduce waste isolation. This argument is also addressed on page 537 of NUREG-0804 (Ref. 13).

(6) **Demonstration of Retrievability**

(a) Retrieval Systems and Equipment Demonstrations

Proof-of-principle and prototypical demonstrations may need to be part of the site characterization program, but not necessarily be performed during the site characterization stage of the licensing process. A rational/timely period may be during construction or the operations-readiness review. Examples of such demonstrations might include the following: emplacement hole drilling, emplacement hole components, emplacement mechanism(s), and retrieval backup system. Demonstrations of systems and equipment may be conducted in an underground environment that simulates repository conditions; also these demonstrations may include off-normal conditions. Test areas within or near the repository may be logical choices for such demonstrations.

If components or operations whose failure could preclude retrievability have attributes that are not covered by the construction experience or site characterization data, then a demonstration sufficient to evaluate the reliabilities of such components or operations may be required. In particular, demonstrations of retrieval equipment may be needed for items that incorporate new technology or combinations of technology that have not been proven through field use for similar applications. Examples of equipment fa[illegible] into this category may be the retrieval systems and components used to extract waste packages from emplacement holes.

(b) Timing of Retrieval Demonstrations

All *in situ* testing and demonstrations to establish the "capability to retrieve" may need to be completed prior to submission of a license to receive and possess nuclear material. It appears to be the view of the NRC staff (Dec. 88) that demonstrations and further development may be needed to correct specific design deficiencies, if any are found, in the technical support submitted for the application for Construction Authorization. Such tests and demonstrations may therefore be contemporaneous with repository construction. To the extent (1) that uncertainties in retrieval plans and designs could affect basic aspects of repository construction and (2) that some construction (e.g., completed excavation) may be irrecoverable, whether unfavorable for retrieval or not, questions about the retrieval system at the time of repository construction may need to be answered as early as possible.

6.3.4 Safety Functions and Regulatory Citations

6.3.4.1 Associated Safety Functions

(1) **Definitions Relevant to Retrieval**

There were no safety functions, associated with definitions of terms relevant to retrieval, identified from the "Repository Functional Analysis" (Ref. 1).

(2) **Ventilation Relevant to Retrieval**

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

- Prepare emplacement drifts for reentry to underground facility for waste removal operations (e.g., cool, stabilize (if required)) - 6.9.3
- Ventilation and air conditioning for waste emplacement facilities (surface and subsurface) - 6.41.7.1.4

(3) **"Facilitate" Versus "Not Preclude" Waste Retrieval**

There were no safety functions that address the concept of "facilitate" versus "not preclude" waste retrieval, identified from the "Repository Functional Analysis" (Ref.1).

(4) **Criteria To Be Satisfied During Retrieval**

The following safety functions that address the criteria to be satisfied during retrieval were identified from the "Repository Functional Analysis" (Ref. 1).

- Interface between emplacement opening/location and waste removal equipment - 6.41.7.1.2
- Surface storage facility for waste removed from the underground facility - 6.41.7.1.3
- Facility for maintenance of waste removal facilities and equipment - 6.41.7.1.6

(5) **Emergency Retrieval**

There were no safety functions that address the concept of emergency retrieval identified from the "Repository Functional Analysis" (Ref. 1).

(6) **Demonstration of Retrievability**

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

- Apply unique waste disposal package identification - 5.8.12
- Plan for possible removal of waste from repository and alternative storage - 6.1.3
- Relocate waste within underground facility (as required) - 6.7

- Verify identity of waste to be removed from underground facility - 6.9.7
- Determine condition of waste disposal package prior to removal from underground facility during waste removal operations - 6.9.8
- Survey waste disposal package extern dose rate prior to removal from underground facility during waste removal operations - 6.9.9
- Remove waste from emplacement location during waste removal operations - 6.9.10
- Decontaminate waste disposal package surface area(s) during waste removal operations (if required) - 6.9.11
- Prepare waste for intra-facility transfer during waste removal operations - 6.9.12
- Update inventory of emplaced waste during repository waste removal operations - 6.9.16
- Close waste emplacement opening following waste removal (if required) - 6.9.17
- Close waste access opening following waste removal operations (if required) - 6.9.18
- Monitor waste removal conditions that affect radiological health and safety during waste removal operations (see 6.8, Monitor repository conditions that affect radiological health and safety) - 6.9.19
- Inspect, test and maintain waste removal operations facilities and equipment - 6.9.20
- Prepare waste for off-site shipme ing repository waste handling operations (as required) - 6.
- Protect waste disposal package from damage during repository operations - 6.20
- Limit secondary effects of mine and industrial hazards during repository waste disposal operations, closure and decommissioning that adversely affect safety or isolation - 6.27
- Underground general purpose (non-waste handling) facilities and equipment for repository operations - 6.41.1.2
- Waste removal generic system elements - 6.41.7
- Facilities for waste removal operations - 6.41.7.1
- Access to waste emplacement openings/locations (e.g., shafts, ramps, drifts) - 6.41.7.1.1
- Interface between emplacement opening/location and waste removal equipment - 6.41.7.1.2
- Surface storage facility for waste removed from the underground facility - 6.41.7.1.3
- Equipment for waste removal operations - 6.41.7.2

- Equipment to excavate, muck, and transfer backfill (if required) - 6.41.7.2.1
- Equipment to locate and gain access to waste disposal package (if required) - 6.41.7.2.2
- Equipment to determine condition of waste disposal package - 6.41.7.2.3
- Equipment for removal of waste disposal package from emplaced location - 6.41.7.2.4
- Equipment to load/off-load waste disposal package on transfer conveyance - 6.41.7.2.5
- Equipment for inspection of removed waste disposal package - 6.41.7.2.6
- Waste disposal package transfer conveyance - 6.41.7.2.7
- Software for waste removal operations (e.g. inventory, process control, monitoring) - 6.41.7.3
- Trained and certified personnel for waste removal operations - 6.41.7.4
- Trained and certified personnel for waste removal operations - 6.41.7.4.1
- Trained and certified personnel for waste removal facility, equipment, and process inspection and testing - 6.41.7.4.2
- Trained and certified personnel for waste removal radiological unsafe/emergency conditions - 6.41.7.4.3
- Trained and certified personnel for waste removal facility and equipment maintenance - 6.41.7.4.4
- Procedure(s) for waste removal operations - 6.41.7.5
- Procedure(s) for removal of waste from emplacement opening/location - 6.41.7.5.1

6.3.4.2 Relevant Regulatory Citations

- 10 CFR 60.2, 60.21(c)(12), 60.46(a), 60.46(b), 60.111(a), 60.111(b), 60.112, 60.113, 60.131, 60.132, and 60.133

6.3.4.3 Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations

(1) Definitions Relevant to Retrieval

(a) Retrieval and Removal Definitions

The definition of retrieval might be considered to be a source of some confusion. The definition of retrieval given in 10 CFR 60.2 is "the act of intentionally removing radioactive waste from the underground location at which the waste had been previously emplaced for disposal." However, retrieval may be thought of as "intentional removal of emplaced waste because the repository has been proven unsuitable." This notion could result directly from 10 CFR 60.21(c)(12). Removal is commonly thought of as withdrawing emplaced waste for any purpose including, but not limited to, retrieval.

The definition of "retrieval" in 10 CFR 60.2 does not explicitly state, or even imply, that it covers only a situation in which waste is removed because the repository has been proven unsuitable. However, 10 CFR 60.21(c)(12) states that plans for retrieval and alternate storage are required for the case in which the geologic repository proves to be unsuitable for disposal of radioactive wastes. If only 10 CFR 60.21(c)(12) is considered, there may appear to be an implication that plans for retrieval and alternate storage are not required for cases other than those in which the geologic repository proves to be unsuitable for disposal of radioactive wastes. The Nuclear Waste Policy Act of 1984, as amended (Ref. 17) in Section 122, notes that any repository "shall be designed and constructed to permit retrieval of any spent nuclear fuel placed in such repository, during an appropriate period of operation of the facility, for any reason pertaining to the public health and safety, or the environment, or for the purpose of permitting the recovery of the economically valuable contents of such spent fuel." It must be noted that the statutes and regulations do not appear to preclude the possibility of retrieval for other reasons.

It should be noted that the definition of "retrieval" in 10 CFR 60.2 and the plans for retrieval in 10 CFR 60.21(c)(12) both include the notion that retrieval applies to waste which has been "disposed" of. The NWPA (Ref. 17) defines disposal as "the emplacement in a repository of high-level radioactive waste, spent nuclear fuel, or other highly radioactive material with no foreseeable intent of recovery, whether or not such emplacement permits the recovery of such waste." The point is that the concept of waste retrieval may be tied to intent for disposal. Retrieval therefore is concerned with the removal of disposed waste for any reason.

(b) Definition of "substantially increase the difficulty of retrieving"

According to CNWRA 90-003 (Ref. 7) on page B-20 of Appendix B, there appears to be an inconsistency between the phrase "substantially increase the difficulty of retrieving such emplaced waste" in 10 CFR 60.46(a)(1) and the intent of 10 CFR 60.111(b), as expressed in NUREG-0804 (Ref. 13), Section 2.2, page 11. This apparent inconsistency may place an unnecessary regulatory burden on both NRC and DOE in that it would require license amendments under 10 CFR 60.46(a)(1) for changes which "substantially increase the difficulty of retrieving" while the basic requirement of 10 CFR 60.111(b) specifies that the GROA "be designed to preserve the option of waste retrieval" and specifies the time period involved.

NRC's "Recommendations" report (Ref. 8) in regard to Uncertainty Reference Number 8 on page 10 of Appendix A states:

The existing requirement is appropriate since it ensures that actions affecting retrievability are reviewed by the Nuclear Regulatory Commission (NRC) before irreversible steps are taken by the Department of Energy (DOE).

Actions that ". . . substantially increase the difficulty of retrieving" waste encompass a range of actions that might be undertaken without precluding waste retrieval. However, this does not represent any inconsistency with 10 CFR 60.111(b) or other provisions of Part 60. The objective of 10 CFR 60.46(a) is to ensure that the judgment as to whether such actions should be undertaken is not made unilaterally by DOE. Rather, DOE must describe its intended action to the Commission (under 10 CFR 60.46(b), which will be guided by the considerations that govern the issuance of the initial license. Accordingly, the DOE submission is to be judged by the same performance objectives as set out in 10 CFR 60.111(b), 60.112, and 60.113, and if the action is acceptable under that standard, an amendment will be issued.

If the intent of the regulations are that the repository only be designed not to preclude retrieval, then changes to the repository design that make retrieval more difficult, but still possible, remain consistent with this intent. Thus, the requirement to amend the license would be unnecessary.

Another interpretation possibly could be argued relative to 10 CFR 60.46(a)(1). Retrievability methods are site specific and design specific. Consequently, individual technical criteria may change considerably because of specific site conditions. Because of this site-specific nature, retrievability will be defined by the design/plan submitted in the Safety Analysis Report (10 CFR 60.21(c)(12)) when the design/plan is approved by the NRC and incorporated in the license. Any action that would result in a substantial increase in the difficulty of retrieving emplaced waste is defined relative to the planned design and the specific site conditions. It is reasonable to assume that engineering judgment will be used to determine whether any action is "significant" and therefore would require an amendment. Consequently, it appears that the issue of "actions which substantially increase the difficulty of retrieving" would properly be addressed after the license application is approved.

If this latter interpretation reflects NRC intent, the incorporation in the public record of a statement such as that above would (1) divorce 10 CFR 60.46(a)(1) from any uncertainty in 10 CFR 60.111(b) and (2) address, for all parties, the issue of the point of reference of "increased difficulty."

(2) Ventilation Relevant to Retrieval

Ventilation of excavation (development) areas and waste emplacement areas must be separated, according to 10 CFR 60.133(g)(3). Retrieval could only occur from an emplacement *area*.

(3) "Facilitate" versus "Not Preclude" Waste Retrieval

A regulatory uncertainty was raised on page B-43 of Appendix B of CNWRA 90-003 (Ref. 7). The NRC intent may need to be clarified as to whether the GROA is to be designed to facilitate waste retrieval, or only that the design must not preclude waste retrieval (i.e., not make retrieval impossible). DOE may need guidance regarding what design action, if any, is intended by the regulation, particularly with respect to the waste package and its handling equipment, in order to respond with an acceptable design and to permit NRC to evaluate the DOE compliance demonstration effectively. The NRC's "Recommendations" report (Ref. 8) for Uncertainty Reference Number 16 on page 20 of Appendix A states:

> The design objective is to accommodate necessary measures should retrieval prove to be needed. This perceived uncertainty pertains to a number of design criteria that refer to potential retrieval of waste. The question presented is whether these design criteria should be interpreted actually to facilitate waste retrieval or merely to accommodate necessary measures, should retrieval prove to be needed.
>
> In the staff's view, the requirements must be viewed in the sense stated in 10 CFR 60.131, which defines the scope of all the design criteria. Those design criteria are meant to be minimum safety features ". . . needed to achieve the performance objectives." The pertinent performance objective, of course, is (as stated in 60.111(b)) to ". . . preserve the option of waste retrieval . . ." during the preclosure phase. The design criteria should be construed in a manner that is consistent with the performance objectives, and, as the Commission made clear, are intended to require a design that does not make retrieval impracticable, but there is no requirement that retrieval be otherwise facilitated. Thus, in issuing its technical criteria, the Commission indicated its concern ". . . that retrievability requirements not unnecessarily complicate or dominate repository design." Further, the Commission, in discussing the definition of "retrieval," added to the final rule, that the retrievability requirement ". . . does not imply ready or easy access to emplaced waste--the idea is that it should not be made impossible or impractical to retrieve the wastes if such retrieval turns out to be necessary to protect the public health and safety." (48 FR 28197)

As noted in 10 CFR 60.111(b)(3), ". . . a reasonable schedule for retrieval is one that would permit retrieval in about the same time as that devoted to construction of the geologic repository operations area and the emplacement of wastes."

Several phrases are used in 10 CFR Part 60 to describe retrievability. These include ". . . designed to preserve the option of waste retrieval . . ." and ". . . designed so that . . . waste could be retrieved . . ." (10 CFR 60.111(b)(1)), and ". . . designed to permit retrieval . . ." (10 CFR 60.133(c)). Although these phrases seem to be consistent, a question arises regarding whether the design process and the resulting facility and equipment designs should (1) make provisions for and, to some degree, facilitate retrieval or (2) simply not do anything to prevent retrieval. The intent of the waste retrieval regulatory requirement, as discussed in NUREG-0804 (Ref. 13), Section 2.2, may support both interpretations. In NUREG-0804, NRC adheres to the position that retrievability is an important design consideration, but rephrases the requirement in functional terms. NRC recognizes that any actual retrieval would be an unusual event and may be expensive. The expressed intent is that retrieval should not be made impossible or impractical if such retrieval turns out to be necessary to protect the public health and safety.

The NWPA (Ref. 17) states: ". . . any repository constructed on a site approved under this part shall be designed and constructed to permit the retrieval of any spent nuclear fuel placed in such repository, during an appropriate period of operation of the facility, for any reason pertaining to the public health and safety, or the environment, or for the purpose of permitting the recovery of the economically valuable contents of such spent fuel." It appears reasonable to equate "permit" with "not preclude." However, the language of 10 CFR Part 60 gives a specific time period allowed for retrieval in 10 CFR 60.111(b)(3); and the requirement for underground openings (10 CFR 60.133(e)(1)) does not appear to support the "not precluded" interpretation. 10 CFR 60.111(b)(1) requires that the repository ". . . be designed to preserve the option of waste retrieval . . ."; 10 CFR 60.111(b)(3) requires retrieval to be accomplished "in about the same time as that devoted to construction of the geologic repository operations area"; and 10 CFR 60.133(e)(1) specifies that "Openings . . . shall be designed so that . . . the retrievability option (is) maintained." The structure and wording of all these requirements would, in the engineering context of "design and construct," appear to be interpreted to require specific action. Such action might include explicit consideration of retrieval needs and features in design criteria, equipment designs, and design reviews. In contrast, a requirement that retrieval simply not be made impossible or impractical requires no specific provision in design because, from an engineering perspective, it may be entirely possible and practical, if necessary, to re-excavate the entire facility to gain access to the waste.

As a practical matter, the range of possible interpretations might have an impact on the schedule and cost of the GROA functions, particularly in relation to equipment design. For example, a vehicle designed to transport waste packages to their position in the repository and emplace them might be fitted with a means of waste package retrieval as part of its initial design. Such a design may comply with a "facilitate" requirement. To not make the vehicle capable of retrieval initially, which complies wit. a "not prevent" requirement, may result in a delay for designing and constructing a modification, or even a new vehicle, should retrieval be required later.

Similarly, initial design of the waste package to facilitate retrieval, consistent with the first interpretation, may have little impact on the overall schedule; but it may prevent a lengthy program to develop a means of retrieving packages not made with a "convenient" means of interfacing to a retrieval vehicle.

The minimum degree to which the design must "facilitate" the act of waste retrieval seems to be specified in 10 CFR 60.111(b)(1), 60.111(b)(3), 60.133(c), 60.133(e)(1), and 60.133(i). However, one interpretation provided in NUREG-0804, Section 2.2 (Ref. 13) seems to run counter to requirements such as 10 CFR 60.133(e)(1) and 60.133(i) in that it may be possible and practical to cut rock from around the waste-package. There could, of course, be some associated increase in risk of accidental loss of waste-package containment. Another interpretation of Section 2.2 of NUREG-0804 may be that "retrievability requirements not unnecessarily complicate or dominate repository design," which still means retrievability is part of repository design. Also, NUREG-0804 states, "design shall keep open the option of waste retrieval," which may mean design for retrieval.

The foregoing highlights an additional potential uncertainty relative to the meaning of the second of two phrases in 10 CFR 60.46(a)(1): "Any action . . . which would substantially increase the difficulty of retrieving such emplaced waste." Use of the term "permit" in several of the texts is consistent with language in the NWPA (Ref. 17). "Permit" is a rather neutral term that does not appear to make the commitment that either "facilitate" or "not prevent" would make.

(4) Criteria To Be Satisfied During Retrieval

The need to maintain retrievability appears to be repeatedly stated in the regulations. However, the regulations do not appear to explicitly state what criteria, if any, must be satisfied during retrieval. If it is understood that all regulations that apply during (emplacement) operations also apply during retrieval, then operational criteria, such as 10 CFR 60.111(a), 60.133(a)(2), 60.133(e)(1), and 60.133(g)(3), would apply to retrieval. According to 10 CFR 60.111(a), all aspects of the GROA related to the performance objective for radiation safety apply at all times (during operations until permanent closure), which include the period of retrieval.

(5) Emergency Retrieval

None of the applicable regulations appears to require emergency retrieval. 10 CFR 60.111(b)(1) requires that the GROA be designed so that any or all of the emplaced waste could be retrieved on a "reasonable schedule." A "reasonable schedule" for retrieval is defined by 10 CFR 60.111(b)(3) to be about the same time as that devoted to construction of the GROA and the emplacement of wastes.

(5) **Demonstration of Retrievability**

Review of the safety functions and 10 CFR Part 60 indicates that the aspects of this topic appear to be adequately and sufficiently treated by the existing applicable regulations. None of the applicable regulations or safety functions appears to explicitly discuss how or when to demonstrate retrieval. Retrieval of emplaced waste is a preclosure performance objective [10 CFR 60.111(b)] and, as such, retrievability appears to be a basic design consideration which needs to be considered and demonstrated.

The regulations in 40 CFR Part 191 are promulgated by the EPA and describe the performance requirements for the repository engineered barriers and geologic setting. They refer to an ability to recover wastes after disposal. This provision would rule out certain disposal options, such as deep-well injection, considered undesirable by EPA. The 40 CFR Part 191 regulations specify control of exposure to the public in the preclosure and postclosure periods.

6.4 MINING AND INDUSTRIAL SAFETY AND HAZARDS

This ROC Topic has the following subtopics:

(1) Secondary Effects and Design Considerations
(2) References to Safety Regulations

6.4.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) **Secondary Effects and Design Considerations**

Ensuring that the design of the GROA addresses secondary effects of mining and industrial safety (or lack of safety) that could adversely affect radiation control is implied in 10 CFR 60.132(a) and 60.133(e)(1). This is implied when "safe handling" and "safety" are understood to mean that there should be protection against any worker injuries or events that would give rise to a radiation accident.

(2) **References to Safety Regulations**

The references to specific mining regulations in 10 CFR 60.131(b)(9) are outdated. The regulatory criteria could address safety regulations or standards that should not have a secondary effect on structures, systems, and components important to safety and radiation control, considering the design-specific characteristics of the GROA.

6.4.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) Secondary Effects and Design Considerations

Concept. There may need to be criteria regarding ensuring mining, industrial, and other safety so there are no secondary effects that lead to a radiation accident.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.132(a) and 60.133(e)(1).

Rationale for the Operational Criteria. With regard to safety in general (mining, industrial, or other activities) for repository operations, 10 CFR Part 60.132(a) and 60.133(e)(1) provide implicit criteria for this concept because they address safety in general terms.

(2) References to Safety Regulations

Concept. Reference is needed to relevant safety regulations or standards that may have secondary effects on structures, systems, and components important to safety.

Potential Repository Operational Criteria. The potential repository operational criteria to address this concept are related to 10 CFR 60.131(b)(9), but are more general than 10 CFR 60.131(b)(9). A possible enhancement to 10 CFR 60.131(b)(9) may be:

> 60.131(b)(9) ~~Compliance with mining regulations~~ Safety practices. ~~To the extent that DOE is not subject to the Federal Mine Safety and Health Act of 1977, as to the construction and operation of the geologic repository operations area.~~ The design of the geological repository operations area shall ~~nevertheless~~ include such provisions for worker protection as may be necessary to provide reasonable assurance that all structures, systems, and components important to safety can perform their intended functions. ~~Any deviation from relevant design requirements in 30 CFR Chapter I, Subchapters D, E, and N will give rise to a rebuttable presumption that this requirement has not been met.~~

Rationale for Potential Repository Operational Criteria. The potential repository operational criteria above are suggested because the reference to specific Mine Safety and Health Administration (MSHA) regulations is outdated and not practicable because determination of specific safety standards that are relevant can be design specific. Also, the referenced MSHA citations (30 CFR, Chapter I, Subchapters D, E, and N) were intended only to be examples of the types of safety regulations that may apply to a mined geologic repository. Deletion of these examples allows for the appropriate application of any safety regulations to protect the workers for the given GROA design. Also, secondary effects on radiological safety are not limited to mining safety, but can extend to a variety of other areas such as industrial safety. In this regard, 10 CFR Part 60 should maintain a broad scope in regard to nonradiological safety standards and their potential secondary effect on structures, systems, and components important to safety. The proposed changes to 10 CFR 60.131(b)(9) would state a broader regulatory position related to worker safety. Also, page 69 of NRC's "Recommendations" report (Ref. 8) states:

> Although only minor amendments are needed to address the specific uncertainty, further analysis is needed in order to deal with related issues.
>
> 10 CFR 60.131(b)(9) references mine safety regulations 30 CFR, Chapter I, Subchapters D, E, and N. The cited regulations have been revised, and the references in the Nuclear Regulatory Commission (NRC) regulations are now out of date and incorrect. A straightforward resolution would be a minor rulemaking that simply updates these references. However, there are certain related issues that should be addressed concurrently. The first of these involves possible deletion of all references to the cited Mine Safety and Health Administration (MSHA) regulations. A second matter concerns elimination of the reference to MSHA jurisdiction, since the issue of MSHA jurisdiction no longer remains open (since the geologic repository presently being characterized will not be considered a "mine"). Taking these concerns into account, the rule might be revised to read as follows: "The design of the geologic repository operations area shall include such provisions for worker protection as may be necessary to provide reasonable assurance that all structures, systems, and components important to safety can perform their intended functions."

Note: The specific mining or industrial safety standards that could apply to specific aspects of the GROA design could be specified in guidance developed by NRC.

6.4.3 Elements Considered for Regulation

6.4.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) Secondary Effects and Design Considerations

The following is an example scenario of "secondary effects" that may result from the violation of a safety regulation. This scenario is given to show the design specific nature of "secondary effect." This scenario presents a general statement of a safety regulatory violation, a description of a nonradiological accident that results from the violation, and the impact of the accident on radiological safety, which depends upon design-specific considerations.

- *Violation:* A spent-fuel transport system is not equipped with a canopy to protect the operator from falling objects as specified in 30 CFR 57.14106. The spent fuel is assumed to not be in a "waste package," as during consolidation.

- *Accident:* The operator is disabled by a falling object and cannot maintain control of the transport system.

- *Circumstance A:* The spent fuel is being transported within a container that absorbs the impact load and energy without damage.

- *Circumstance B:* The transport system is equipped with a fail-safe mechanism (dead-man's brake) that monitors the operator and immediately stops the system without damage to the spent fuel.

- *Circumstance C:* The system crashes with sufficient force to rupture the spent fuel and its cladding and causes a release.

- *Circumstance D:* This transport system is incapable of causing a dynamic effect of sufficient energy to cause damage to the spent fuel (slow moving and low-lift system).

(2) References to Safety Regulations

Secondary effects are not limited to mining safety, but can extend to a variety of other generic areas such as industrial safety, chemical safety, electrical safety, fire safety, and traffic safety. Portions of each of these safety areas are addressed by MSHA regulations. 10 CFR Part 60 should reference any safety regulation that if violated could lead to a radiation accident (e.g., MSHA and OSHA (Occupational Safety and Health Administration) regulations).

6.4.3.2 Comments on and Discussion of the Elements Considered for Regulation

(1) Secondary Effects and Design Considerations

As illustrated by the scenario presented in subsection 6.4.3.1(1), the radiological consequences of a nonradiological safety violation involve circumstances unique to a specific design.

The ability to specifically regulate control of secondary effects cannot be established until the design itself has been established. Since design of the repository will naturally evolve from a multitude of choices and decisions, it is not prudent to anticipate the licensee nor unnecessarily limit choices by imposition or exclusion of selected safety-related regulations. For this reason, 10 CFR Part 60 should maintain a broad scope in regard to nonradiological safety standards and their potential secondary effects.

(2) **References to Safety Regulations**

In regard to referenced safety regulations, in 10 CFR 60.131(b)(9) if MSHA regulations apply, then OSHA and other regulations may equally apply. If there is sufficient reason to include MSHA regulations simply because the GROA will in part resemble a mining operation, then it also follows there is sufficient reason to include OSHA regulations because parts of the GROA will resemble industrial operations.

6.4.4 Safety Functions and Regulatory Citations

This ROC Topic includes two subtopics. The first, "Secondary Effects and Design Considerations," deals with nonradiological events whose secondary effects may lead to radiological accidents. Were it not for this relationship, this ROC Topic may be outside the NRC's purview. Consideration of secondary effects should be a factor in the design proposed by DOE to help ensure radiological safety. Consideration of the relationship between mining/industrial safety and radiological safety leads to the second subtopic, "References to Safety Regulations," which addresses the extent to which mining and industrial regulations or standards need to be referenced within 10 CFR Part 60.

6.4.4.1 Associated Safety Functions

(1) **Secondary Effects and Design Considerations**

The following safety fun[illegible] were identified from the "Repository Functional Analysis" (Ref. 1).

- Contain and dispose of any hazardous (nonradioactive) effluents resulting from waste preparation operations - 5.10
- Limit secondary effects of industrial hazards during preparation of waste for disposal that adversely affect safety or isolation - 5.20
- Limit secondary effects of mine and industrial hazards during repository waste disposal operations, closure and decommissioning that adversely affect safety or isolation - 6.27
- Surface facilities and equipment for emergency surface/subsurface escape/rescue during disposal operations - 6.41.1.1.2
- Personal air supply(ies) for underground emergencies - 6.41.1.2.1
- Underground emergency escape/rescue routes and refuges - 6.41.1.2.2
- Equipment for underground emergency escape/rescue - 6.41.1.2.3
- Mine water control (if required) - 6.41.1.2.5
- Underground facility mine water control (if required) - 6.41.1.2.5.1

- Mine water handling in access openings (if required) - 6.41.1.2.5.2
- Ventilation and air conditioning for underground waste operations - 6.41.1.2.6.1
- Underground general purpose support facilities and equipment - 6.41.1.2.8

(2) References to Safety Regulations

No safety functions addressing which safety regulations should be referenced were identified from the "Repository Functional Analysis" (Ref.1).

6.4.4.2 Relevant Regulatory Citations

- 10 CFR 60.75(c)(3), 60.130, 60.131(b)(9), 60.132(a), 60.132(c), and 60.133(e)
- 30 CFR Parts 18 through 36
- 30 CFR 57.14106 and Part 57, Subpart T

Note: Even though 10 CFR 60.131 through 60.134 are referenced by 10 CFR 60.130, not all of these citations are relevant to this ROC Topic.

6.4.4.3 Comments On and Comparison and Contrast of Safety Functions and Regulatory Citations

(1) Secondary Effects and Design Considerations

NRC's regulatory coverage of "secondary effects" is addressed in a Memorandum of Understanding between NRC and OSHA (Ref. 37). While this memorandum applies only to nuclear power plants, in this memorandum NRC states:

> There are four kinds of hazards that may be associated with NRC-licensed nuclear facilities:
>
> a. Radiation risk produced by radioactive materials
> b. Chemical risk produced by radioactive materials
> c. Plant conditions which affect the safety of radioactive materials and thus present an increased radiation risk to workers. For example, these might produce a fire or an explosion, and thereby cause a release of radioactive materials or an unsafe reactor condition
> d. Plant conditions which result in an occupational risk, but do not affect the safcty of licensed radioactive materials. For example, there might be exposure of toxic nonradioactive materials and other industrial hazards in the workplace.

Generally, NRC covers the first three hazards, and OSHA covers the fourth hazard described in paragraph d.

A regulatory uncertainty was raised on page 147 of Appendix B of CNWRA 90-003 (Ref. 7). In 10 CFR 60.131(b)(9), it is uncertain how NRC is going to determine compliance with mining regulations as they relate to nonradiological accidents whose secondary effects are radiological accidents. This uncertainty needs to be addressed to ensure adequate oversight of all potential sources of radiological accidents as well as worker health and safety in the GROA. The NRC's "Recommendations" report (Ref. 8), regarding Uncertainty Reference Number 39 on page 56 of Appendix A, states:

> The NRC has no responsibility or authority to determine compliance with mining regulations.
>
> The cited regulation requires that the design of the geologic repository operations area is to include provisions for worker protection, so that structures, systems, and components important to safety can perform their intended functions. That is as far as the NRC has jurisdiction. It is not the Commission's role to provide oversight of worker safety generally. Thus, while the mining regulations are a guide to the required design, it is not NRC's role to "determine compliance" with those regulations themselves. The staff recognizes that identification of the particular design features that must be included involves technical uncertainties that will need to be addressed.

A regulatory uncertainty was raised on page 155 of Appendix B of CNWRA 90-003 (Ref. 7). In regards to 10 CFR 60.133(e), the NRC intent needs to be clarified as to whether, and to what extent, the term "safety," as used in this paragraph, applies to: radiological safety, nonradiological "mining" safety (i.e., primarily personnel safety in overall construction and nonradiological operations), nonradiological incidents that have the potential to cause radiological accidents, or a combination of the above. NRC needs to address the application of the term "safety" as applied to underground openings, deleterious rock movement, and worker safety in the underground facility, in order to provide guidance to the DOE that will help ensure adequacy of design and operation in the underground facility at the GROA. The NRC's "Recommendations" report (Ref. 8), regarding Uncertainty Reference Number 41 on page 58-59 of Appendix A, states:

> "Safety" means that there should be protection against any injuries that would give rise to significant consequences.
>
> As stated in 10 CFR 60.130, the specific design criteria are ". . . minimum criteria for the design of the geologic repository operations area." Further, "These design criteria are not intended to be

exhaustive, however. Omissions in 10 CFR 60.131 through 60.134 do not relieve DOE from any obligations to provide safety features in a specific facility needed to achieve the performance objective." Since the performance objectives are all radiological standards, the design criteria must be interpreted with that scope in mind. However, because some traumatic accidents may have radiological implications, even though they are not radiological per se, they are of concern. Accordingly, when the regulations call for the design to ensure that operations can be carried out "safely," it means that there should be protection against any injuries that would give rise to significant radiological consequences.

(a) 30 CFR Parts 18 through 36

30 CFR Parts 18 through 36 pertain to the testing, approval, and certification of equipment that poses unique safety hazards. Generically, the equipment addressed therein has one or more of the following attributes:

- Produces and/or emits toxic gases into the mine environment,
- Represents an ignition source,
- Represents a source of fuel for a fire or explosion, or
- Represents a mechanical hazard.

Any equipment that has not been subjected to the testing/documentation requirements of 30 CFR Parts 18 through 36 cannot be used in gassy mines or tunnels in the same manner as equipment that has been successfully tested and approved by MSHA.

(b) 30 CFR Part 57

30 CFR Part 57 presents a compendium of mandatory health and safety standards applied to all metal and nonmetal underground mines and their related surface facilities. As such, 30 CFR Part 57 covers a broad range of safety topics to include equipment (both safety and production oriented), personnel, procedures, monitoring, and environmental criteria. It is from the body of 30 CFR Part 57 that 30 CFR Parts 18 through 36 are referenced. Equipment and procedural requirements are tailored to the operation depending upon the classification of the mine environment. The classification protocol is also specified in 30 CFR Part 57, Subpart T.

(c) *OSHA Regulations*

OSHA regulations cover a wide range of safety-related topics. Furthermore, considerable similarity exists between the two regulations, particularly in those sections devoted to general worker safety. For example, both contain sections outlining the requirements for personal protective equipment, environmental limits, fire protection, etc. Such similarity in the structure and content of certain sections should be expected in the sense that both regulations seek to control and/or eliminate hazards that threaten the health and safety of the worker. In other words, certain hazards will exist in any work area, irrespective of where the work is done in regard to the earth's surface. Where differences in the two regulations are observed, they typically pertain to a hazard that is unique or has special importance. For example, mine-roof falls represent major hazards in the mining industry. Accordingly, the MSHA regulations address this topic whereas OSHA is silent on mine-roof falls

(2) **References to Safety Regulations**

10 CFR 60.131(b)(9) does not reflect the revision of 30 CFR, Chapter I, wherein Subchapters D and E were incorporated in Subchapter B. More importantly, 10 CFR 60.131(b)(9) does not address which regulations of 30 CFR, Chapter I, Subchapter B, should be referenced; nor does 10 CFR 60.131(b)(9)'s limitation to MSHA regulations fully embrace the intent of safety as contained in 10 CFR 60.132(a) and 60.132(c) as discussed in CNWRA 90-003 (Ref. 7) on page B-160 of Appendix B, and in NRC's "Recommendations" report (Ref. 8) on pages 56, 58-59, and 69 of Appendix A.

In regards to what safety regulations to reference in 10 CFR Part 60, an uncertainty regarding 10 CFR 60.131(b)(9) was raised by NRC in their "Recommendations" report (Ref. 8), in Uncertainty Reference Number 47 on page 69 of Appendix A.

10 CFR 60.75(c)(3) does not address use of OSHA or MSHA personnel to conduct inspections on behalf of NRC. Use of MSHA personnel by NRC would appear to be a conflict of interest, since DOE and MSHA have a Memorandum of Understanding (Ref. 38).

With regard to 10 CFR 60.131(b)(9), it may not be necessary to cite specific MSHA regulations. It will not be known until the design is finalized which MSHA regulations may be applicable. It has been recognized that the repository is not a "mine." MSHA regulations may not address all potential worker safety criteria, which, if violated, could result in a secondary effect on radiation control.

6.5 DESIGN OF THE GROA FOR CONTAINMENT OF HLW WITHIN THE WASTE PACKAGE AND LIMITING THE RELEASE RATE FROM THE ENGINEERED BARRIER SYSTEM (EBS)

This ROC Topic has the following subtopics:

(1) Waste Package and EBS Components Handling and Emplacement
(2) Waste Package and EBS Components Inspection, Testing, and Repair
(3) Waste Package and EBS Components Security and Identification
(4) Waste Package and EBS Components Environment
(5) Coordination of Waste Package and EBS Components Design, Construction, Assembly, and Repair with the GROA

6.5.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) Waste Package and EBS Components Handling and Emplacement

In CNWRA 90-003 (Ref. 7), an uncertainty was identified in 10 CFR 60.131(b)(10) concerning the degree of specificity in "shaft conveyances," since regulations in 10 CFR Part 60 are intended to apply generically. The uncertainty is discussed on pages B-153 and B-154 of CNWRA 90-003 (Ref. 7). NRC's "Recommendations" report, (Ref. 8), in Uncertainty Reference Number 40, Appendix A, page 57, concludes that transfer methods are adequately addressed by other sections of 10 CFR Part 60. But 10 CFR Part 60 does not appear to address transfer of waste regarding potential adverse effects on containment. The proposed criteria address the uncertainty identified in CNWRA 90-003 (Ref. 7) and this other issue.

(2) Waste Package and EBS Components Inspection, Testing, and Repair

10 CFR Part 60 is sufficient and adequate regarding waste package inspection, testing, and maintenance (repair or replacement) to ensure postclosure containment. 10 CFR Part 60 is adequate and sufficient because the waste package is a component important to safety, and is addressed by 10 CFR Part 60 in 60.131(b)(6) and Subparts F and G.

(3) Waste Package and EBS Components Security and Identification

See the section 6.7 ROC Topic.

(4) Waste Package and EBS Components Environment

10 CFR Part 60 is sufficient and adequate for criteria for the underground-facility waste-package environmental control and protection for postclosure containment. Also, see the section 6.7 ROC Topic.

(5) **Coordination of Waste Package and EBS Components Design, Construction, Assembly, and Repair with the GROA**

10 CFR Part 60 has adequate and sufficient criteria concerning coordination of the GROA with the waste, waste package, and EBS regarding postclosure performance.

5.5.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) **Waste Package and EBS Components Handling and Emplacement**

Concept. Criteria are needed for structures, systems and components important to safety that are used for waste transfer to ensure that preclosure activities are performed safely and that postclosure performance is not adversely affected.

Potential Repository Operational Criteria. Potential repository operational criteria needed to address this concept are related to 10 CFR 60.131(b)(10) as indicated below:

> 60.131(b)(10). Structures, systems, and components important to safety. ~~Shaft conveyances~~ Structures, systems, and components used in radioactive waste ~~handling~~ transfer. (i) ~~Hoists important to safety~~ Waste transfer systems shall be designed to preclude ~~cage~~ free fall and other means of damage to the waste and waste package. (ii) ~~Hoists important to safety~~ Waste transfer systems shall be designed with a reliable ~~cage~~ waste location system. (iii) Loading and unloading systems for ~~hoists important to safety~~ waste transfer shall be designed with a reliable system of interlocks that will fail safely upon malfunction. (iv) ~~Hoists important to safety~~ Waste transfer systems shall be designed to include two independent indicators to indicate when waste packages are in place and ready for transfer.

Rationale for the Potential Repository Operational Criteria. The potential repository operational criteria presented above address this concept because they are written to include any means to transfer the waste and require that the waste and waste package not be damaged, for either preclosure or postclosure aspects. Preventing damage would assure (1) no radioactive material releases during operation and (2) waste package performance objectives after closure are not adversely affected. Also, location control for waste transfers, by any means, are addressed.

The term "shaft conveyances" was replaced with "structures, systems, and components" to broaden the application beyond shafts conveyances. The descriptive phrase "used in radioactive waste handling" was changed to "used in radioactive waste transfer," since the subject is lifting, loading, and unloading of wastes and waste packages. The proposed sections (i) and (ii) state the design conditions for "waste transfer systems." Also, in the proposed section (i), "other means of damage to waste and the waste package" was added to cage free fall as a criterion for completeness to address the concept above. In section (ii) "cage" was changed to "waste," again to have a more generic rule. The fail-safe "system of interlocks" discussed in the proposed section (iii) should be generically applicable, and was expanded to any transfer system rather than just hoists. In the proposed section (iv), "hoists important to safety" was expanded to "waste transfer systems" for the same reason.

The criteria for waste handling and storage need to address the postclosure protection aspects of transfer of the waste. These criteria were added to the text above. The design of the hardware in intimate contact with the waste and waste package during handling and storage should not damage these items. The emphasis is on ensuring that the ability of the waste and waste package to contribute to containment and isolation will be maintained. This means that the margin of safety associated with the waste and waste package is not degraded by preclosure handling. While the underground facility design criteria, in 10 CFR 60.133, require the underground facility to be designed so that performance objectives will be met, the same criteria for the surface facilities are needed. Likewise, the waste package design criteria in 10 CFR 60.135(b)(3) could be complemented by criteria, requiring that equipment interfacing with the waste package contribute to meeting the performance objectives.

In Uncertainty Reference Number 40, Appendix A, page 5, of NRC's "Recommendations" report (Ref. 8), NRC stated:

> Safety of waste transfer methods other than shafts and hoists are covered in several sections of 10 CFR Part 60, 10 CFR 60.131(b)(2) and 10 CFR 60.131(b)(8). This uncertainty calls for additional or more generic guidance for waste transfer methods other than shafts and hoists (which are often bottlenecks and safety concerns), i.e., ramps and vehicles. The staff agrees that the latter transfer methods are not addressed by the paragraph in question. The issue, thus, is not what the regulation means, but rather, whether there is a need for analogous provisions for waste transfer methods other than shafts and hoists. The staff believes there is no such need, as the regulations already contain a number of relevant design features (e.g., protection against dynamic effects of equipment failure 10 CFR 60.131(b)(2), instrumentation and control systems 10 CFR 60.131(b)(8), etc., as well as the overall requirement (10 CFR 60.130) for design to achieve the performance objectives.

The criteria cited by NRC are all primarily addressing preclosure safety and do not address protection of the waste packages to prevent adversely affecting containment by any mode of transfer. Considering the overall criteria recommended for waste transfer, waste transfer damage control needs to be addressed.

(2) **Waste Package and EBS Components Inspection, Testing, and Repair**

Concept. Criteria are needed for waste package testing and inspection and repair or replacement if necessary during GROA operations to ensure postclosure containment.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.131(b)(6).

Rationale for the Operational Criteria. 10 CFR 60.131(b)(6) fully addresses this concept because the waste package is a component important to safety and is therefore within the scope of 10 CFR 60.131(b)(6). Inspection, testing, and maintenance are required to ensure "continued functioning and readiness," and are not limited to preclosure functions.

(3) **Waste Package and EBS Components Security and Identification**

See the section 6.7 ROC Topic.

(4) **Waste Package and EBS Components Environment**

Concept. Criteria are needed so that the surface facility environment is controlled to ensure the postclosure functions of the waste and waste package are not significantly degraded.

Operational Criteria. See the section 6.7 ROC Topic.

Rationale for the Operational Criteria. See the section 6.7 ROC Topic, for rationale.

(5) **Coordination of Waste Package and EBS Components Design, Construction, Assembly, and Repair with the GROA**

Concept. Criteria are needed so that the GROA will be designed, constructed, and operated in coordination with waste package design to ensure postclosure containment.

Operational Criteria. The operational criteria need to address this concept are in 10 CFR 60.21(c)(2), 60.133(a)(1), 60.133(e), 60.133(f), 60.133(h), and 60.135(b)(3) and 10 CFR Part 50, Appendix B-VII.

Rationale for the Operational Criteria. The above cited criteria fulfill the needs for coordination of the GROA with waste package design by requiring (1) criteria for handling, storage, and transfer impacting the waste, waste package, and EBS and (2) coordination of the design of the surface facilities of the GROA which impacts the waste, waste package, and EBS to ensure postclosure containment.

6.5.3 Elements Considered for Regulation

6.5.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) Waste Package and EBS Components Handling and Emplacement

Elements related to the handling and emplacement of the waste package and EBS components include:

- Handling, lifting, and transporting equipment which directly interacts with the waste package, including cranes, hoists, conveyor belts, and forklifts
- Procedures for storing, handling, assembling, testing, transporting, and emplacing waste packages and their components
- Emplacement borehole equipment intended to protect the waste package from physical, chemical, or thermal degradation during the containment period
- Transporters, specialized emplacement equipment integral to transporters, encapsulating radiation shields (which provide a de facto environment), equipment to interface between the transporter and the emplacement borehole, emplacement borehole sleeve, and borehole backfill emplacement equipment (if used)
- Handling, lifting, and transporting equipment which directly interact with the EBS or its components, including cranes, hoists, conveyor belts, forklifts, trucks, trailers, and tractors
- Excavation equipment used to excavate underground facilities and openings, including tunnel boring machines, drill and blast equipment, rock bolts, and associated equipment used to support excavated openings

(2) Waste Package and EBS Components Inspection, Testing, and Repair

Elements related to waste package and EBS components inspection and testing include:

- Test and calibration equipment used to evaluate and maintain the condition of the waste package
- Mechanical inspection devices (calipers, and surface-condition measurement instruments), ultrasonic inspection transducers and coupling media, x-ray or other noncontact instruments
- Repair equipment (welding, grinding, polishing, application of coatings, and thermal treatment for stress relief)

- Weighing devices
- Equipment in contact with backfill (if used as a part of the waste package)
- Procedures for testing, handling, and maintaining waste packages and EBS components (such as backfill, if used), including personnel qualifications, computer software, and post-repair inspections
- Test and calibration equipment for tests of backfill for moisture content, density, physical properties, chemical properties
- EBS component storage facilities, and any equipment necessary to maintain proper storage conditions (e.g., de-humidifiers, temperature controls, and ventilation equipment)
- EBS component assembly and test facilities, and any equipment necessary to maintain proper facility environmental conditions

(3) **Waste Package and EBS Components Security and Identification**

Elements related to waste package and EBS components security and identification include:

- Waste package or waste package component storage facilities, and equipment necessary to maintain proper storage conditions (e.g., physical security controls for entrance to facility and possible sabotage via sabotage of environment, personnel access control devices, interlocks, and alarms for environmental parameter bounds)
- Emplacement borehole equipment intended to provide physical security against tampering by unauthorized persons (e.g., fail-safe design, emplacement borehole locks, transporter locks, personnel access control devices, and interlocks)
- Procedures for controlling the storage, handling, testing, transporting, and emplacing waste packages and their components with respect to security considerations
- EBS components intended to provide physical security against tampering by unauthorized persons (e.g., physical security controls for entrance to facility and possible sabotage via environment, personnel access control devices, interlocks, and alarms for environmental parameter bounds)
- Procedures for storing, handling, assembling, testing, transporting, and installing EBS components intended to provide protection of the waste package or its security against tampering, with respect to security considerations

(4) Waste Package and EBS Components Environment

Elements related to the waste package and EBS components environment include:

- Backfill, if used storage facilities, and any equipment necessary to maintain proper storage conditions (e.g., dehumidifiers, temperature controls, ventilation equipment, inert gas, and environmental monitors and alarms)
- Emplacement borehole equipment intended to protect the waste package and EBS components from physical, chemical, or thermal degradation during the containment period (e.g., fail-safe design, chemical backfill, thermal material for heat transfer control, and mechanical reinforcement)
- Procedures for storing, handling, assembling, testing, transporting, and installing emplacement borehole equipment intended to provide protection of the waste package (e.g., prevention of a surface scratch or induced residual stress which may be where corrosion would more quickly be initiated or where corrosion may be accelerated; prohibiting use of an adhesive or indelible ink to identify a waste package which might initiate chemical degradation, either alone or in conjunction with other environmental factors)

(5) Coordination of Waste Package and EBS Components Design, Construction, Assembly, and Repair with the GROA

Elements of coordination of waste package and EBS components design construction, assembly, and repair with the GROA include:

- Equipment designed to interact with the waste package and EBS components (e.g. pintle, retrieval equipment, transporter cask, and equipment designed to handle or emplace backfill)
- Environmental control equipment
- Procedures for storing, handling, assembling, testing, transporting, and emplacing waste packages and EBS components
- Design limits and specifications which must be coordinated with the GROA (e.g., physical, chemical and mechanical properties of backfill; stability of the underground facility; coordination of underground facility ventilation with design for thermal loading; equipment to control flow of water and gas within and through the EBS; chemical interactions of the EBS components with the underground environment; surface coatings intended to promote radiation of heat from the emplacement borehole; and prevention of

damaging collisions of the waste transporter with the underground facility)

6.5.3.2 Comments on and Discussion of the Elements Considered for Regulation

(1) Waste Package and EBS Components Handling and Emplacement

A review of the elements relevant to handling and emplacement equipment indicates that 10 CFR 60.131(b)(10) should be more generic to include waste and waste package conveyances other than hoists and should address those factors which could adversely affect containment.

(2) Waste Package and EBS Components Inspection, Testing, and Repair

The elements relevant to waste package and EBS components inspection, testing, and repair (all a part of handling) show that these can have a negative effect of waste package postclosure performance. An example of this is application of a coupling medium (gel) for ultrasonic inspection of a container to measure wall thickness or discontinuities.

(3) Waste Package and EBS Components Security and Identification

The relevant elements show that waste package and EBS components security and identification should include environmental aspects of security, so that sabotage of such an environment with subsequent effects on postclosure performance could not go undiscovered before a package is emplaced. Also, see the section 4.2 ROC Topic.

(4) Waste Package and EBS Components Environment

The relevant elements show that the environment in which the backfill is stored must be controlled as well as the environment of the container and the HLW inside, both surface and underground. Backfill is part of the EBS, by definition, and its integrity could be compromised if stored improperly. If the properties of the backfill do not meet design requirements, the postclosure performance of the waste package could be compromised.

(5) Coordination of Waste Package and EBS Components Design, Construction, Assembly, and Repair with the GROA

Elements relevant to coordination of the GROA with waste package and EBS components design show that several interactions could impact postclosure performance. Thus, the design of the GROA must take into account the maintenance of environmental conditions considering the waste package design and the design of EBS components to ensure postclosure performance.

6.5.4 Safety Functions and Regulatory Citations

The scope of this ROC Topic does not include the design construction, and assembly of the waste package nor design of the EBS. The designs of the waste package and EBS are not considered within the scope of the ROC task; and the construction and assembly of the waste package, as well as some EBS components, may well occur in some place other than the GROA. For further information on considerations for the design, construction, and assembly of the waste package, see NUREG/CR-5638, "Technical Considerations for Evaluating Substantially Complete Containment of High-Level Waste Within the Waste Package," (Ref. 39).

The requirement for gradual controlled release of radionuclides from the engineered barrier following the period of containment is a natural extension of the requirement for containment. The condition of the waste package is important to gradual release as well as containment, and the integrity of the EBS can be important to ensure containment performance as well as gradual release. For example, the EBS may protect the waste package from damage during the containment period, while a glass waste form, which is part of the waste package, may contribute significantly to the gradual release of radionuclides after the containment period has expired. Those considerations important for containment as discussed in this ROC Topic (which previously only discussed containment aspects) therefore also incorporate gradual release, and the comments and discussions in this analysis which are limited to those specific to gradual release are separately identified. Associated functions, relevant regulatory citations, the list of elements relevant to regulation, and criteria listed below are also separately identified if they relate only to gradual release and not containment.

The contribution of the geologic setting to isolation is covered by the section 6.7 ROC Topic, so it is not included in this analysis.

6.5.4.1 Associated Safety Functions

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

(1) **Waste Package and EBS Components Handling and Emplacement**

- Protect waste disposal package components from damage during receiving - 5.3.6
- Inspect, test and maintain waste disposal package component receiving facilities and equipment - 5.3.7
- Ensure integrity of waste disposal package prior to transfer - 6.5.3
- Emplace emplacement opening packing or backfill (if required) - 6.6.7
- Install monitoring equipment for waste emplacement (as required)

- 6.6.8

- Verify integrity of waste disposal package and, if used, emplacement opening backfill during waste emplacement operations - 6.6.9
- Remove underground facilities (plumbing, HVAC, etc.) and equipment (as appropriate) - 6.11.1.2
- Remove hazardous and potentially corrosive materials from the underground facility - 6.11.1.3
- Install, calibrate and test subsurface postclosure monitoring equipment (as applicable) - 6.11.1.4
- Emplace emplacement opening/location packing, backfill and/or cover (or plug as required) - 6.11.1.7
- Protect waste disposal package from damage during repository operations - 6.20
- Maintain chemical and physical properties of emplacement opening backfill during repository operations (if used) - 6.21
- Protect waste disposal package from potentially damaging stress during removal (e.g., thermal shock, excessive force) - 6.24

(2) **Waste Package and EBS Components Inspection, Testing, and Repair**

- Inspect, test and maintain waste disposal package components lag storage facilities and equipment - 5.5.7
- Inspect and/or test waste disposal package - 5.8.7
- Apply unique waste disposal package identification - 5.8.12
- Verify identity of individual waste disposal package for intra-facility transfer - 6.5.2
- Ensure integrity of waste disposal package prior to transfer - 6.5.3
- Ensure integrity of waste disposal package at start of emplacement - 6.6.1
- Verify integrity of waste disposal package and, if used, emplacement opening backfill during waste emplacement operations - 6.6.9
- Continuously monitor conditions that may impact personnel safety (radiological & non-radiological) during repository operations - 6.8.1
- Continuously monitor radiation levels during repository operations - 6.8.1.1
- Continuously monitor conditions that may impact radiological exposures, releases and/or containment during repository operations - 6.8.2
- Install, calibrate and test subsurface postclosure monitoring

equipment (as applicable) - 6.11.1.4, see also 6.11.2.1, 6.11.3.2

- Examine performance capability of seals/backfills and monitoring equipment previously emplaced - 6.11.1.5
- Repair/replace previously emplaced seals and/or backfill and monitoring equipment (as required) - 6.11.1.6
- Verify readiness for final closure - 6.11.1.8

(3) **Waste Package and EBS Components Security and Identification**

- Account for and maintain inventories of nuclear materials in the waste management system - 2.10
- Apply unique waste disposal package identification - 5.8.12
- Prevent tampering with emplaced waste disposal package - 6.6.13

(4) **Waste Package and EBS Components Environment**

- Ensure the stability of security and safeguards facilities under local foundation conditions - 2.17
- Ensure the ability of security and safeguards facilities and equipment to perform their intended functions under naturally induced conditions and events (e.g., weather, seismic activity) - 2.18
- Apply unique waste disposal package identification - 5.8.12
- Ensure the ability of general purpose (non-waste handling) waste preparation facilities to perform their intended functions under naturally induced conditions and events (e.g., weather, seismic activity) - 5.23
- Ensure the ability of waste preparation facilities and equipment important to safety to perform their intended functions under naturally induced conditions and events (e.g., weather, seismic) - 5.32
- Remove physical impediments to waste disposal package removal from underground facility (e.g., debris, cover or plug) - 6.9.6
- Remove hazardous and potentially corrosive materials from the underground facility - 6.11.1.3
- Maintain chemical and physical properties of emplacement opening backfill during repository operations (if used) - 6.21
- Maintain the stability of the underground access facilities and emplacement openings/locations during waste removal operations - 6.23
- Protect waste disposal package from potentially damaging stress during removal (e.g., thermal shock, excessive force) - 6.24
- Maintain chemical and physical properties of waste emplacement packing/backfill/seal(s) during closure - 6.25

- Ensure the ability of repository facilities and equipment important to safety to perform their intended functions under naturally induced conditions and events (e.g., weather, seismic activity) - 6.35
- Ensure the ability of repository facilities and equipment important to safety or isolation to perform their intended functions under conditions and events induced by human activity - 6.36
- Limit alterations of the geologic media that adversely affect performance - 6.39
- Limit alterations of existing discontinuities that adversely affect performance (preferential pathways to or between aquifers) - 6.39.1
- Limit creation of new discontinuities that adversely affect performance (preferential pathways to or between aquifers) - 6.39.2
- Limit proximity of openings to preferential pathways - 6.39.3
- Limit adverse effects on geochemistry - 6.39.4
- Backfill bulk materials and material processing equipment (if required) - 6.41.9.2.1
- Confine waste within fixed boundaries (in emplaced disposal package) - 7.1.1
- Resist waste disposal package degradation - 7.1.1.1
- Resist waste disposal package degradation due to chemical or electrochemical processes in emplacement environment - 7.1.1.1.1
- Resist waste disposal package degradation due to mechanical processes in the emplacement environment - 7.1.1.1.2
- Resist waste disposal package degradation due to mechanical-chemical interactions in the emplacement environment - 7.1.1.1.3
- Withstand stress concentrations in waste disposal package - 7.1.1.1.4
- Resist waste disposal package short-duration mechanical failure - 7.1.1.2
- Resist waste disposal package gross plastic deformation - 7.1.1.2.1
- Resist waste disposal package fracturing due to static and dynamic loads - 7.1.1.2.2
- Withstand waste disposal package buckling loads - 7.1.1.2.3
- Limit waste disposal package residual stresses - 7.1.1.2.4
- Withstand external loads on waste disposal package - 7.1.1.2.5
- Control period of postclosure confinement in waste disposal package - 7.1.2
- Delay onset of waste disposal package degradation - 7.1.2.1

- Control condition of waste disposal package material when emplaced - 7.1.2.1.1
- Control chemical composition of waste disposal package materials - 7.1.2.1.2
- Control physical properties of waste disposal package materials (e.g., crystal structure, inclusions, and mechanical properties) - 7.1.2.1.3
- Limit residual stresses in waste disposal package - 7.1.2.1.4
- Control stress state of waste disposal package - 7.1.2.1.5
- Withstand external loads on waste disposal package - 7.1.2.1.6
- Control postclosure thermal environment of the waste disposal package - 7.1.2.1.7
- Control postclosure chemical environment of the waste disposal package - 7.1.2.1.8
- Retard rate of waste disposal package degradation - 7.1.2.2
- Limit waste disposal package surface erosion - 7.1.2.2.1
- Control chemical composition of waste disposal package materials -7.1.2.2.2
- Control physical properties of waste disposal package materials (e.g., crystal structure, inclusions, mechanical properties) - 7.1.2.2.3
- Limit residual stresses in waste disposal package - 7.1.2.2.4
- Control stress state of waste disposal package - 7.1.2.2.5
- Withstand stress concentrations in waste disposal package - 7.1.2.2.6
- Control thermal environment of waste disposal package - 7.1.2.2.7
- Control chemical environment of waste disposal package - 7.1.2.2.8
- Limit number of waste disposal package degradation mechanisms - 7.1.2.3
- Ensure stability of emplacement opening/location - 7.3.1
- Avoid exposure of waste due to natural processes (e.g., volcanism, faulting) - 7.3.2
- Protect waste from adverse effects of surficial processes (e.g., weather, erosion, mass wasting) - 7.3.3
- Impede movement of fluids to the waste disposal package - 7.3.5

(5) **Coordination of Waste Package and EBS Components Design, Construction, Assembly, and Repair with the GROA**

- Apply unique waste disposal package identification - 5.8.1.[illegible]
- Emplace emplacement opening packing or backfill (if required) - 6.6.7

- Close emplacement opening/location following waste emplacement (i.e., install cover or plug) - 6.6.12
- Close and backfill selected drifts as authorized during waste emplacement operations (see 6.11.1, Close underground facility) - 6.6.15
- Close waste emplacement opening following waste removal (if required) - 6.9.17
- Close waste access opening following waste removal operations (if required) - 6.9.18
- Close and decommission repository - 6.11
- Close underground facility (as authorized) - 6.11.1
- Decontaminate underground facilities and equipment (if required) - 6.11.1.1
- Remove hazardous and potentially corrosive materials from the underground facility - 6.11.1.3
- Examine performance capability of seals/backfills and monitoring equipment previously emplaced - 6.11.1.5
- Repair/replace previously emplaced seals and/or backfill and monitoring equipment (as required) - 6.11.1.6
- Emplace emplacement opening/location packing, backfill and/or cover (or plug as required) - 6.11.1.7
- Verify readiness for final closure - 6.11.1.8
- Seal and/or backfill drifts and rooms (if required) - 6.11.1.9
- Emplace drift seal(s) (if required) - 6.11.1.10
- Seal unused piping or conduits to underground facility (if required) - 6.11.2.2
- Backfill and close shafts, ramps, and other access openings, and emplace seals - 6.11.2.3
- Standby electrical power sources and power distribution facilities and equipment for repository operations important to safety - 6.41.1.3.1.3

6.5.4.2 *Relevant Regulatory Citations*

- 10 CFR Part 50, Appendix B-III
- 10 CFR 60.2, 60.21(b)(4), 60.21(c)(1)(ii)(C), 60.21(c)(1)(ii)(D), 60.21(c)(1)(ii)(E), 60.21(c)(2), 60.21(c)(14), 60.23(c), 60.43(b)(4), 60.46(a)(5), 60.46(a)(7), 60.51, 60.71(b), 60.74, 60.102, 60.113(b)(2), 60.122(a)(1), 60.130, 60.131, 60.132, 60.133, 60.135(a), 60.135(b)(3), 60.135(b)(4), 60.140(a)(2), 60.140(b), 60.140(d)(4), 60.142, 60.143, and Part 60, Subpart F and Subpart G
- 10 CFR 61.23(e) and 61.51(a)(6)

- 10 CFR 72.122(h), 72.128, 72.166, 72.168, 72.180, 72.182, 72.184, 72.186, and Part 72, Subpart H

6.5.4.3 *Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations*

(1) **Waste Package and EBS Components Handling and Emplacement**

All of the functions identified as associated with this ROC Topic are concerned with protection of the waste package and EBS components (including backfill) during handling and emplacement. 10 CFR Part 60 addresses this subject in 10 CFR 60.135(b)(3) (Waste Package Handling) and 10 CFR 60.131(b)(10) (Shaft Conveyances Used in Radioactive Waste Handling). However, in neither of the two texts is it expressed that damage resulting in loss of ability to meet the performance objectives of containment and isolation must be avoided.

10 CFR 60.131(b)(10) discusses "shaft conveyances used in radioactive waste handling," but there is no mention of prevention of damage which might affect the postclosure performance. The purpose of care in handling as required in 60.131(b)(10) is so that structures, systems, and components important to safety will be able to perform their necessary (radiation) safety functions; and the current definition of "important to safety" refers to the period of time "until the completion of permanent closure." Thus, for containment and isolation, which are postclosure performance requirements, 10 CFR 60.131(b)(10) does not specifically apply.

The level of detail included in 10 CFR 60.131(b)(10) concerning conveyances for radioactive waste handling is design-specific, as apparent from the discussion of "shaft conveyances" and "hoists," which may not be part of repository radioactive waste handling. On page B-153 of Appendix B of CNWRA 90-003 (Ref. 7) a regulatory uncertainty has been identified concerning "shaft conveyances."

Although the designs of the waste packages and EBS components are outside the scope of this analysis, they are intimately connected with protection of the package during handling, emplacement, and retrieval. In fact, all these activities must be coordinated with the design so that actual environmental conditions encountered by the waste package and the EBS fall within the environmental considerations [described in 10 CFR 60.135(a) for the waste package]. 10 CFR 60.135(b)(3) states that "Waste packages shall be designed to maintain waste containment during transportation, emplacement, and retrieval." The postclosure performance of the waste package is not specifically considered; "containment during transportation, emplacement, and retrieval" does not ensure containment during the postclosure performance period. A change to 10 CFR Part 60 could make the necessary connection between handling and ensuring the postclosure performance objectives; and such a change would logically be located within 10 CFR 60.131(b), since it covers both surface and subsurface structures, systems, and components important to safety.

10 CFR 72.122(h), 72.128, and 72.166 describe in detail the environmental protection required for spent fuel storage at an ISFSI or at an MRS. The level of detail in 10 CFR Part 72 is more than that in 10 CFR Part 60, which is more generic.

Those related texts from 10 CFR 60.133 concerning design, construction, and operations of the underground facility completely cover the design and excavation of the EBS to assure long-term performance. However, protection of EBS materials (such as backfill and borehole emplacement hardware) during storage and emplacement operations is not regulated by 10 CFR Part 60.

10 CFR 60.21(c)(1)(ii)(C), (D), and (E) require assessments or analyses to determine effectiveness of the EBS, in particular for the EBS ability to control the release of radionuclides. 10 CFR 60.51(a)(4) requires that results of tests and analyses on the EBS concerning its ability to provide long-term isolation of HLW be included in the license amendment for permanent closure.

(2) Waste Package and EBS Components Inspection, Testing, and Repair

To verify the integrity of the waste package, the waste package must be accurately identified, as required by 10 CFR 60.135(b)(4). Such identification should not impair waste package and EBS components postclosure performance. Coordination of waste package and EBS components designs with identification methods is also pertinent to another subtopic [6.5.4.3(5)] of this ROC topic. Repository functions pertinent to this subtopic include verification of the integrity of the waste package by tests and evaluations to ensure integrity of emplaced waste and postclosure performance monitoring of waste packages.

10 CFR 60.74, along with its referenced 60.142 and 60.143, addresses testing functions with respect to this subtopic. 10 CFR 60.43(b)(4) requires that the license conditions include "requirements relating to test, calibration, or inspection" concerning waste packaging restrictions. The performance confirmation program is required to continue "until permanent closure," per 10 CFR 60.140(b). 10 CFR 60.143(d) states that the "waste package monitoring program shall continue as long as practical up to the time of permanent closure."

Certain repository operational activities related to the waste package and EBS components may require research and development after receipt of the license to prove that postclosure performance objectives (including containment) will be met. 10 CFR 60.21(c)(14) requires an identification of the engineered barrier structures, systems, and components which require research and development to confirm the adequacy of design, in the Safety Analysis Report of the license application. A detailed description of the programs designed to resolve performance questions, and the schedule for such programs are also required to be a part of the Safety Analysis Report. The process of feedback of information from research and development to affect waste package design is regulated by 10 CFR 60.140(d)(4), 60.46(a)(5), and 60.46(a)(7).

In general, considerations for inspection, testing, and maintenance of waste package components and EBS components are the same, with some additional considerations appropriate for the EBS and its related functions for controlling the release of radionuclides after the containment period.

(3) Waste Package and EBS Components Security and Identification

There are two related aspects to this subtopic: (1) the ability to protect the waste package and EBS components from tampering and (2) the ability to identify the EBS components and waste package to know what is inside and where it should be emplaced during the preclosure period, without compromising the ability of either to meet postclosure performance requirements.

Protection from tampering is the most obvious; and it is covered in part by 10 CFR 60.51(a)(2)(i) and 60.51(a)(2)(ii), whose subject is postclosure controls to prevent contact by intruders. It is unclear as to whether or not 10 CFR 60.51 extends to individual packages, since it addresses the repository contents *en masse*. The focus of this text from 10 CFR Part 60 [as well as the similar excerpt from 10 CFR 61.23(c)] appears to be on inadvertent intrusion.

Sabotage is addressed specifically for an MRS in 10 CFR Part 72, Subpart H (which includes 72.180, 72.182, 72.184, and 72.186). In 10 CFR 60.21(b)(4), protection against theft or diversion is specifically excluded from information which DOE is required to submit in the license application concerning physical security and radiological sabotage. Security against radiological sabotage should include environmental controls which prevent sabotage whose effects may not be apparent before permanent closure but which may affect the GROA ability to meet the performance objectives of containment and isolation. Refer to the section 4.25 ROC Topic for a discussion of the differences between 10 CFR Parts 60 and 72 with respect to prevention of sabotage.

Waste package identification and location are covered by 10 CFR 60.135(b)(4) and by 60.71(b), postclosure records maintenance. 10 CFR 72.168 goes somewhat beyond 10 CFR Part 60 by requiring identification of the status of the inspections or tests being performed on individual items of the ISFSI or MRS. The provision in 10 CFR 60.71(b) requires that records be kept to "provide a complete history of the movement of the waste from the shipper through all phases of storage and disposal." The effect of the method of attachment of identification on postclosure performance of the waste package is specifically addressed in 10 CFR 60.135(b)(4), "The identification shall not impair the integrity of the waste package . . . ."

(4) Waste Package and EBS Components Environment

Controlling the environment of the waste package up to and including emplacement is within the scope of GROA operations; and it is only partially covered in 10 CFR Part 60 (for surface storage facilities) in 10 CFR 60.132(a), 60.131(b)(10), and 60.135(b)(3).

For environmental control during storage before emplacement, 10 CFR 60.132(a) requires that surface facilities ". . . be designed for safe handling and storage of wastes . . .," which does not discriminate between safety during the time of "handling and storage" and safety after permanent closure (containment). It might be argued that it includes consideration of safety after permanent closure to meet the overall system performance objective and the containment requirement. However, elsewhere in 10 CFR Part 60, the term "safety" is consistently used with reference to preclosure performance and the terms "isolation" and "containment" are consistently used for postclosure performance. 10 CFR 60.132(a) as currently written does not appear to include provision for postclosure performance. On page 67 of NUREG-0804 (Ref. 13) it states: "The requirement for safe handling and storage implies provision for inspection, repair, and decontamination as appropriate." Also, 10 CFR 60.132(a) applies only to surface facilities, and waste package storage may be above or below ground. Since 10 CFR 60.131(b) applies to structures, systems, and components important to safety (both above and below ground), criteria for waste-package environmental control during storage would more appropriately be located in 10 CFR 60.131(b).

10 CFR 60.135(b)(3) only covers design of the waste package for handling, not waste-package protection during handling for the purpose of ensuring postclosure performance. 10 CFR 60.131(b)(10) adds detail in discussing shaft conveyances used in radioactive waste handling. In this case, the regulatory text goes into detail by limiting the discussion to hoists in shafts, which excludes ramps and waste transportation by wheeled transporters. An uncertainty has been identified concerning this unwarranted specificity in other areas, e.g., on page B-153 of Appendix B of CNWRA 90-003 (Ref. 7). The NRC's response in their "Recommendations," regarding Uncertainty Reference Number 40, Appendix A, page 57, (Ref. 8), was that safety of waste transfer methods other than shafts and hoists is covered adequately by other design criteria. The NRC proposed guidance as their recommended resolution of this uncertainty.

Control of the emplacement environment to ensure postclosure performance is covered in several texts from 10 CFR Part 60. Control of the emplacement environment for stability and mechanical protection is required by 10 CFR 60.133(e) for stability of underground openings and by 10 CFR 60.133(f) for rock excavation. Corrosion control in the emplacement environment is required by 10 CFR 60.133 (d) and (h). Criteria for the waste package design in 10 CFR 60.135(a) require that a number of potentially degrading environmental factors, including corrosion and thermal control, be considered and that interactions with the emplacement environment not compromise waste package function. 10 CFR 60.133(i), "thermal loads," requires that the underground facility be designed so that the performance objectives will be met. Also, mention of the thermal pulse with respect to age and nature of the waste (in 10 CFR 60.113(b)(2)), while not a requirement on DOE, indicates to DOE that these are factors relevant to containment. Coordination of the design of the underground facility and the EBS is provided for in 10 CFR 60.133(a)(1) and 60.133(h).

10 CFR 72.128 has more detailed environmental requirements during waste handling than 10 CFR Part 60. 10 CFR 72.128 does not consider the postclosure effects of environment on waste package performance, since the performance of an MRS or ISFSI (the subject of 10 CFR Part 72) does not concern postclosure containment. 10 CFR 72.122(h) requires protection of spent fuel during storage, which would appear to be very similar to protection that should be provided for waste packages or containers before emplacement. The postclosure performance of the waste package or container could be altered if such protection were not provided. In 10 CFR 72.166, the control of various activities (handling, storage, shipping, cleaning, and preservation to prevent damage and deterioration) is required with respect to environmental control; and the requirement for "special protective environments, such as inert gas atmosphere, and specific moisture content and temperature levels must be specified and provided" when necessary. 10 CFR Part 60 does not consider the waste package environment with respect to surface facilities to ensure the postclosure performance of the waste package.

10 CFR 61.23(e) is a general requirement that the LLW disposal site provide postclosure stability to preclude the need for maintenance after closure. The corresponding text in 10 CFR 60.102(d) requires that permanent closure be the end of human activity required at the GROA. 10 CFR 61.51(a)(6), which requires that waste contact with water be minimized, corresponds to control of water required in 10 CFR 60.133(d) and the general environmental considerations in 10 CFR 60.135(a).

Regarding environmental control for storage of EBS components, the performance confirmation program is required to be implemented so that "it monitors and analyzes changes from the baseline condition of parameters that could affect the performance of a geologic repository," in 10 CFR 60.140(d)(3). This could include *in situ* monitoring for changes caused by environmental effects on backfill materials (or other components of the EBS) which occur during storage of EBS components. In addition, 10 CFR 60.142(a) and (c) require design testing of backfill. More generally, 10 CFR 60.140(a)(2) requires that the performance confirmation program provide data to indicate whether or not the EBS is "functioning as intended and anticipated." Within the scope of tests required by 10 CFR 60.74, are those which "the Commission deems appropriate or necessary for the administration of the regulations in this part" [10 CFR 60.74(a)]. In 10 CFR 60.74(b), the tests described in the performance confirmation program are included in those mentioned in 10 CFR 60.74(a). Finally, before receiving a license amendment for permanent closure, 10 CFR 60.51(a)(4) requires that the license application include "the results of tests, experiments, and any other analyses relating to backfill of excavated areas, shaft sealing, waste interaction with the host rock, and any other tests, experiments, or analyses pertinent to the long-term isolation of emplaced wastes within the geologic repository." Thus, although the storage environment for backfill is not explicitly regulated, *in situ* monitoring and testing of the backfill is considered. This testing should indicate if storage conditions for the backfill were appropriate.

10 CFR 60.133(g)(2) requires that ventilation for the underground facility re... functional during normal and accident conditions. Ventilation in the underground facility may contribute to long-term performance by controlling the temperature and other environmental conditions, such as humidity. Other texts from 10 CFR 60.133 require the underground facility to be designed and excavated in such a manner that the long-term performance objectives will be met. Coordination of the design of the underground facility and the EBS [discussed also in the following subsection (5)] is provided for in 10 CFR 60.133(a)(1) and in 10 CFR 60.133(h). Control of the emplacement environment for stability and mechanical protection is required by 10 CFR 60.133(e) and 60.133(f). Corrosion control in the underground facility is required by 10 CFR 60.133(a), (d), (h). Criteria for the waste package design in 10 CFR 60.135(a) require consideration of a number of potentially degrading environmental factors, including corrosion and thermal control, and that interactions with the emplacement environment not compromise waste-package function. 10 CFR 60.133(i), on thermal loads, requires that the underground facility be designed so that the performance objectives will be met. Also, mention of the thermal pulse with respect to age and nature of the waste (in 10 CFR 60.113(b)(2)), while not a requirement on DOE, indicates to DOE that these are significant factors to postclosure performance.

Relevant texts from 10 CFR Parts 50, 61, and 72 are not comparable to 10 CFR Part 60.

(5) Coordination of Waste Package and EBS Components Design, Construction, Assembly, and Repair with the GROA

Coordination of the design of the underground facility and the EBS with the GROA is provided in 10 CFR 60.133(a)(1) and 60.133(h). 10 CFR Part 60 does require coordination of the design of the surface facilities of the GROA with the design of the waste package to ensure postclosure performance in 10 CFR 60.21(c)(2) and 10 CFR Part 50, Appendix B-III. Design criteria for the surface facilities are given in 10 CFR 60.131 and 60.132 which requires design "to allow safe handling and storage of wastes." Although storage is defined in 10 CFR 60.102(b)(3), as including disposal, storage with respect to surface facilities does not include disposal.

Waste package tests, inspections, and subsequent repairs are interaction points for coordination with the GROA. 10 CFR 60.74, 60.131(b)(6), 60.142, and 60.143 address the inspection, tests, and performance confirmation program required.

10 CFR 60.122(a)(1) requires that the EBS work in concert with the geologic setting to "provide reasonable assurance that the performance objectives relating to isolation of the waste will be met."

Both 10 CFR 60.133(a)(1) and 60.133(g)(2) provide specific design requirements for the underground facility which are important to long-term performance of the EBS for isolation. 10 CFR 60.133(a)(1) indicates that various aspects of the underground facility are to contribute to isolation. 10 CFR 60.133(g)(2) requires that ventilation for the underground facility remain functional during normal and accident conditions. Ventilation in the underground facility may contribute to long-term performance by controlling the temperature and other environmental conditions, such as humidity.

Coordination of the design of the underground facility and the EBS is provided for in 10 CFR 60.133(a)(1) and 60.133(h). Control of the emplacement environment for stability and mechanical protection is required by 10 CFR 60.133(e) stability of underground openings and by 10 CFR 60.133(f) rock excavation. Corrosion control in the underground facility is required by 10 CFR 60.133 in (d) control of water and gas and in (h) engineered barriers. 10 CFR 60.133(i) thermal loads requires that the underground facility be designed so that the performance objectives will be met. Also, mention of the thermal pulse with respect to age and nature of the waste (in 10 CFR 60.113(b)(2)), while not a requirement on DOE, indicates to DOE that these are significant factors to postclosure performance.

6.6 DESIGN OF THE GROA SO THAT THE ISOLATION CAPABILITIES OF THE SEALS FOR SHAFTS AND BOREHOLES ARE NOT ADVERSELY AFFECTED

This ROC Topic has the following subtopics:

(1) Design and Construction that Impact Postclosure Performance
(2) Operations that Impact Postclosure Performance
(3) Permanent Closure Activities that Impact Postclosure Performance

6.6.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) Design and Construction that Impact Postclosure Performance

The current regulations in 10 CFR Part 60 have requirements (10 CFR 60.112) for construction (excavation, drilling, boring) of shafts (ramps) and boreholes in the GROA as well as for the underground facility [10 CFR 60.133(e)(2), and 60.133(f)]. It is assumed that the present regulatory requirements on sealing for shafts and boreholes (10 CFR 60.134) would imply recognition of the significance of the rock surrounding the seals on performance of the overall seal system.

(2) Operations that Impact Postclosure Performance

See the section 6.7 ROC Topic.

(3) **Permanent Closure Activities that Impact Postclosure Performance**

See the section 6.7 ROC Topic.

6.6.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) **Design and Construction that Impact Postclosure Performance**

Concept. The shafts and boreholes must be designed so that they do not significantly degrade the postclosure performance of their seals. Criteria are also needed to assure that the ability of shafts, boreholes, and their seals to meet the postclosure performance objectives is not significantly degraded.

Operational Criteria. The operational criteria to address this concept are presented in 10 CFR 60.112 and 60.134, with the correction of a minor typographical error ("for" spelled "or") in 10 CFR 60.134(a) as shown below:

> 60.134(a). Seals for shafts and boreholes shall be designed so that following permanent closure they do not become pathways that compromise the geologic repository's ability to meet the performance objectives for the period following permanent closure.

Rationale for the Operational Criteria. Current regulations in 10 CFR 60.134 appear to require that seals be designed so that they do not compromise the geologic repository's ability to meet the performance objectives following permanent closure. This design criterion in a broad sense would take into account the design and construction of shafts and boreholes themselves, since the condition of the rock surrounding a seal would play an important role in its performance. Also, the performance objectives in 10 CFR 60.112 require shafts, boreholes, and their seals be designed so that releases of radioactive material will meet applicable standards for both anticipated and unanticipated events.

It was noted that when 10 CFR Part 60 was published in 1983 (Ref. 40), 10 CFR 60.134(a) was changed from the 1981 proposed rule (Ref. 41) and the typographical error was introduced in the 1983 *Federal Register* notice for the final rule (Ref. 40).

(2) **Operations that Impact Postclosure Performance**

See the section 6.7 ROC Topic.

(3) **Permanent Closure Activities that Impact Postclosure Performance**

See the section 6.7 ROC Topic.

6.6.3 Elements Considered for Regulation

6.6.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) **Design and Construction that Impact Postclosure Performance**

Elements related to structures, systems, components, and equipment that may impact postclosure performance of shafts, boreholes, and their seals are:

- Host rock at and near seal locations
- Reinforcement/support at or near seal locations
- Utilities at and near seal locations (water, gas, electric)
- Seals
- Excavation methods
  - Drilling and blasting
  - Mechanical excavation
- Reinforcement
  - Bolts, concrete, grout
- Inspection equipment
- Maintenance and repair equipment
- Utility lines
  - Water lines
  - Power cables
  - Communications
  - Ventilation pipes
- Seal emplacement equipment (including seal location site-preparation equipment, grouting equipment, and inspection and site testing equipment)

(2) **Operations that Impact Postclosure Performance**

Elements related to operations that may impact postclosure performance of shafts, boreholes, and their seals are:

- Construction
- Excavation
  - Drilling and blasting
  - Scaling
  - Scoring

- Reinforcement/support installation
- Surveying
- Blast vibration monitoring
- Mapping
- Stability monitoring: displacements, stress changes

- Long-term monitoring
  - Instrumental stability/deformation monitoring
  - Seal and backfill monitoring
- Maintenance and repair
  - Removal of loose rock
  - Control of water and gas inflow
  - Repair and replacement of reinforcement/support systems
  - Repair and replacement of defective seals
  - Utility systems
- Ventilation
- Seal emplacement
  - Removal of utility lines
  - Removal of loose rock at seal locations
  - Preparation of surfaces for seal emplacement
  - Emplacement of form work for placing seals
  - Preparation of seal material mixes
  - Emplacement of seals, including control of materials and emplacement procedures
  - Inspection, testing of emplaced seal
  - Grouting of seal host rock and seal/rock interface
- Procedures
  - Design
  - Construction
  - Excavation
  - Inspection, observation, and monitoring including monitoring of excavations at potential seal locations
  - Maintenance and repair
  - Backfill emplacement
  - Seal emplacement

(3) Permanent Closure Activities that Impact Postclosure Performance

Elements related to permanent closure activities of shafts and boreholes are:

- Processing facilities for seals and backfill
- Bulk seal/backfill materials and material-processing equipment
- Seal and backfill emplacement equipment

- Procedures
  - Seal/backfill processing
  - Seal/backfill emplacement procedures
  - Training procedures
  - Repository closure and decommissioning plan
- Personnel
  - Processing crew (seals/backfill)
  - Emplacement crew (seals/backfill)

6.6.3.2 *Comments on and Discussion of the Elements Considered for Regulation*

(1) Design and Construction that Impact Postclosure Performance

Many of the effects that can influence seal performance at the host-rock/seal interface are permanent and irreversible, and can be remedied only partially, if at all. Such effects could include weathering and deterioration of the surrounding rock at seal locations due to excavation practices. Therefore, sealing requirements must be taken into account throughout the sequence from repository site characterization, design, excavation, inspection, and maintenance through permanent closure. The present regulations with regard to sealing of shafts and boreholes (10 CFR 60.134) appear to govern only the emplaced seal materials, and may not fully or explicitly recognize the importance of the host rock adjacent to the seals with regard to seal performance. It is clear from 10 CFR Part 60 that design requirements for excavations that are not part of the underground facility (e.g., shafts, ramps, and boreholes) are not as extensive as those given in some parts of 10 CFR 60.133 for the underground facility, with the exception of openings created during site characterization [10 CFR 60.15(c)]. One could argue that applying similar requirements to the design of shafts (ramps) is equally important in meeting the postclosure performance objectives. Such additional requirements would complement the overall performance objectives required in 10 CFR 60.112 for shafts, boreholes, and their seals.

Excavation of the openings can have a permanent effect on the postclosure sealing capacity of the host rock. Bypass flow around seals frequently is the weakest link in the overall sealing performance of underground seals, since the majority of the rock deformation around an opening will take place soon after excavation and reinforcement for hard rock, such as tuff. Excessive damage due to uncontrolled or insufficiently controlled excavation practices could significantly contribute to the development of such bypass flow channels. On conventional underground construction projects, excavation (blasting) design and practice typically are largely left up to the contractor. Criteria need to be applied to control and minimize damage of the host rock. Current regulations 10 CFR 60.133(e)(2) and 60.133(f) require that the design and construction (excavation) of the underground facility reduce the potential for deleterious rock movement and limit the potential that preferential pathways be created for groundwater flow. These criteria would be construed as indirectly taking into account the need for adequate postclosure sealing performance; however, 10 CFR 60.133(e)(2) and 60.133(f) do not apply to the excavation of shafts or drilling of boreholes. The design criteria in 10 CFR 60.134, which are provided to ensure that seals do not compromise the geologic repository's ability to meet the performance objectives, are taken to include the design and construction of the shafts and boreholes themselves. The design and construction (excavation) of shafts (ramps) and boreholes in which seals are to be emplaced to ensure postclosure performance are regulated in 10 CFR 60.112. 10 CFR 60.112 requires that shafts, boreholes, and their seals be designed to assure that releases of radioactive materials to the accessible environment following permanent closure conform to applicable environmental standards. This requirement could be taken as being adequate in ensuring that shafts and boreholes limit alterations to the geologic media that might adversely affect performance. Similar criteria are given in 10 CFR 61.23(b), 61.23(c), and 61.23(e) for land disposal sites.

(2) Operations that Impact Postclosure Performance

Operations, in a broad sense, may affect postclosure sealing effectiveness of the host rock at the locations of permanent seals. Such permanent effects are most likely to result from gradual loosening, relaxation, and deterioration of the rock and of any support/reinforcement. Ventilation and thermal effects as well as such operations as maintenance of the underground facility are likely factors to affect long-term host-rock behavior. It is assumed in this analysis that "design" accounts for construction and operations so that 10 CFR Part 60 would appear sufficient in regulating these potential and adverse operational impacts. 10 CFR 60.133(i) adequately requires that the predicted thermal and thermomechanical response of the host rock be accounted for in the design of the underground facility so that the performance objectives can be met.

The performance confirmation program in 10 CFR 60.142 requires *in situ* monitoring and field testing to determine the effectiveness of borehole and shaft seals, backfill, etc. before full-scale backfilling and sealing begins. 10 CFR 60.141(c) and 60.141(d) adequately require *in situ* monitoring of the rock mass and comparisons of such measurements and observations with original design assumptions, as a result of development and operations.

(3) Permanent Closure Activities that Impact Postclosure Performance

Permanent closure is addressed mainly in 10 CFR 60.134 in regards to design requirements for seals [10 CFR 60.134(a)] and for the selection of materials and placement methods for seals [10 CFR 60.134(b)]. The regulations in 10 CFR Part 60 do not address many of the detailed aspects of permanent closure such as removal of hazardous or potentially corrosive materials or the opening of potentially conductive electrical paths from the subsurface, which could have possible adverse effects on postclosure seal performance. 10 CFR Part 60 appears to sufficiently and adequately regulate these functions at a higher level by requiring that the "design," which is assumed to account for construction, operations, and permanent closure, not adversely affect postclosure performance of shafts, boreholes, and their seals.

6.6.4 Safety Functions and Regulatory Citations

6.6.4.1 Associated Safety Functions

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

(1) **Design and Construction that Impact Postclosure Performance**

- Maintain emplacement opening/location mechanical stability during repository operations - 6.22
- Ensure the ability of repository facilities and equipment important to safety or isolation to perform their intended functions under naturally induced conditions and events (e.g., weather, seismic activity) - 6.35
- Ensure the ability of repository facilities and equipment important to safety or isolation to perform their intended functions under conditions and events induced by human activities - 6.36
- Limit alterations of the geologic media that adversely affect performance - 6.39
- Limit alterations of existing discontinuities that adversely affect performance (preferential pathways to or between aquifers) - 6.39.1
- Limit creation of new discontinuities that adversely affect performance (preferential pathways to or between aquifers) - 6.39.2
- Limit proximity of openings to preferential pathways - 6.39.3
- Limit adverse effects on geochemistry - 6.39.4

(2) **Operations that Impact Postclosure Performance**

- Install, calibrate and test (sub)surface postclosure monitoring equipment (as applicable) - 6.11.1.4, 6.11.2.1, and 6.11.3.2
- Examine performance capability of seals/backfills and monitoring equipment previously emplaced - 6.11.1.5
- Repair/replace previously emplaced seals and/or backfill and monitoring equipment (as required) - 6.11.1.6
- Maintain chemical and physical properties of emplacement opening backfill during repository operations (if used) - 6.21
- Maintain chemical and physical properties of waste emplacement packing/backfill/seal(s) during closure - 6.25
- Maintain chemical and physical properties of closure backfill/seals during closure - 6.26

(3) **Permanent Closure Activities that Impact Postclosure Performance**

- Plan repository closure and decommissioning - 6.1.6
- Remove hazardous and potentially corrosive materials from the underground facility - 6.11.1.3
- Emplace emplacement opening/location packing, backfill and/or cover (or plug as required) - 6.11.1.7
- Verify readiness for final closure - 6.11.1.8
- Seal unused piping or conduits to underground facility (if required) - 6.11.2.2
- Backfill and close shafts, ramps, and other access openings, and emplace seals - 6.11.2.3
- Procedures for waste emplacement - 6.41.5.5.1
- Repository backfill material processing facility (if required) - 6.41.9.1.1
- Backfill bulk materials and material processing equipment (if required) - 6.41.9.2.1
- Backfill emplacement equipment (if required) - 6.41.9.2.2
- Seal emplacement equipment - 6.41.9.2.4
- Trained and certified personnel for backfill emplacement - 6.41.9.4.2
- Procedure(s) for backfill material processing (if required) - 6.41.9.5.1

6.6.4.2 Relevant Regulatory Citations

- 10 CFR 60.15(c), 60.112, 60.133, 60.134, 60.140, 60.141(c), 60.141(d), and 60.142
- 10 CFR 61.23(b), 61.23(c), 61.23(e), and 61.51
- 10 CFR 72.102(a)

6.6.4.3 Comments On and Comparison and Contrast of Safety Functions and Regulatory Citations

(1) **Design and Construction that Impact Postclosure Performance**

10 CFR Part 60 explicitly requires that neither site-characterization activities nor performance-confirmation monitoring should adversely affect long-term performance of the geologic repository (10 CFR 60.15(c)(1) and 60.140(d)(1)). These criteria relate directly to the safety function that requires limiting alterations of the geologic media that adversely affect performance. No such direct and explicit requirements are included for construction (excavation, drilling, boring) of shafts (ramps) and boreholes for the geologic repository. With regard to design and excavation of the underground facility, 10 CFR

60.133(a)(1), 60.133(e)(2), 60.133(f), 60.133(..), and 60.133(i) can be construed to adequately limit alterations to the geologic media that adversely affect performance. However, based on the definition of "underground facility," these criteria do not specifically regulate shafts (ramps) and boreholes. However, shaft (ramps) and boreholes are part of the GROA and as such are subject to the more general criteria for the GROA.

The design criteria for seals are very explicit [10 CFR 60.134(a)] and placement methods (of seals) are also explicitly regulated [10 CFR 60.134(b)]. These criteria are along the same lines as those in 10 CFR 61.51 for the design of covers for land disposal sites.

The design and construction (excavation) of shafts (ramps) and boreholes in which seals are to be emplaced to ensure postclosure performance are regulated in 10 CFR 60.112. 10 CFR 60.112 requires that shafts, boreholes, and their seals be designed to assure that releases of radioactive materials to the accessible environment following permanent closure conform to applicable environmental standards. This requirement could be taken as being adequate in ensuring that shafts and boreholes limit alterations to the geologic media that might adversely affect performance. Similar criteria are given in 10 CFR 61.23(b), 61.23(c), and 61.23(e) for land disposal sites.

(2) Operations that Impact Postclosure Performance

10 CFR Part 60 contains no explicit operating criteria to regulate possible adverse effects (e.g., testing, monitoring, maintenance, repair, and utility installations) on permanent postclosure repository performance, more specifically on the host rock at eventual seal locations. Similarly, 10 CFR Part 72 contains no operating criteria, only design criteria. However, 10 CFR 72.102(a) has implemented the clause "design criteria establish the design, fabrication, construction, testing, maintenance and performance requirements for structures, systems, and components important to safety," which would mean that operations are accounted for in the design criteria.

The safety functions dealing with monitoring the effectiveness of seals and backfill to ensure that they meet the postclosure performance objectives appear to be adequately regulated by 10 CFR 60.140 and 60.142. This is discussed further in the section 6.7 ROC Topic.

(3) Permanent Closure Activities that Impact Postclosure Performance

10 CFR Part 60 appears to adequately address permanent closure activities (sealing and backfilling) of the geologic repository. This is discussed further in the section 6.7 ROC Topic.

6.7 DESIGN OF THE GROA TO NOT ADVERSELY AFFECT CONTAINMENT AND ISOLATION

This ROC Topic has the following subtopics:

(1) Design and Construction that Impact Containment and Isolation
(2) Operations that Impact Containment and Isolation
(3) Permanent Closure Activities that Impact Containment and Isolation

6.7.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) Design and Construction that Impact Containment and Isolation

10 CFR Part 60 adequately and sufficiently regulates penetrations (i.e., shafts, ramps, and boreholes) into the geologic setting with regard to limiting alterations of the geologic setting that might adversely affect postclosure performance. 10 CFR Part 60 has adequate and sufficient criteria to address the impacts of the underground facility [10 CFR 60.133(a)(1) and 60.133(h)], and site characterization activities [10 CFR 60.15(c)(1)] on postclosure isolation. Design criteria in the overall performance objectives in 10 CFR 60.112 are sufficient and adequate to ensure that construction activites related to shafts and boreholes within the GROA do not compromise the isolation capability of the geologic repository. Operational criteria may be needed to enhance 10 CFR Part 60 to ensure that the design of the surface facilities in the geologic repository operations area do not adversely affect containment and isolation.

(2) Operations that Impact Containment and Isolation

10 CFR Part 60 is sufficient and adequate with regard to ensuring that operational activities do not significantly degrade isolation capabilities within the geologic setting. Operations are assumed to be integral with design and, therefore, the design criteria are applicable to operations. In addition, the performance confirmation criteria are sufficient and adequate in requiring performance confirmation monitoring of the thermal, thermomechanical, hydrologic, and possible geochemical responses of the underground facility as a result of operations to ensure that postclosure performance within the geologic setting can be achieved.

(3) Permanent Closure Activities that Impact Containment and Isolation

10 CFR Part 60 is adequate and sufficient because permanent closure activities are considered to be a part of repository operations, and design criteria that require limiting adverse effects on the isolation within the geologic setting are applicable. In this context, the existing operational criteria are sufficient to cover permanent closure activities.

6.7.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) Design and Construction that Impact Containment and Isolation

Concept. Criteria are needed to ensure that the design of the GROA and shafts, boreholes, and their seals do not adversely affect containment and isolation.

Operational Criteria. Operational criteria required to address several specific aspects of the design of the GROA and shafts, boreholes, and their seals so that they do not adversely affect containment and isolation are presented to 10 CFR 60.112, 60.133(a), 60.133(h) and 60.140(d)(1). Also, a proposed potential repository operational criterion which may enhance 10 CFR 60.132, may be:

> 60.132(f) Postclosure impacts. The surface facilities shall be designed so that they do not adversely affect the ability of the natural and engineered barriers to meet the performance objectives.

The criteria required to address shafts, boreholes, and their seals are presented in 10 CFR 60.112 and 60.134. A minor grammatical correction (adding a comma after boreholes) is recommended for 10 CFR 60.112 as follows:

> The geologic setting shall be selected and the engineered barrier system and the shafts, boreholes, and their seals shall be designed . . .

Rationale for the Operational Criteria. The criteria in 10 CFR 60.112, 60.133(a)(1), 60.133(h) and 60.140(d)(1) fully address several specific aspects of the GROA, with respect to contributing to or not adversely affecting containment and isolation. These specific aspects are:

- The engineered barrier system [60.112]
- Shafts, boreholes, and their seals [60.112]
- Underground facility, and any engineered barriers that are part of the underground facility [60.133(a)(1)]
- Engineered barriers [60.133(h)]
- Performance conformation program [60.140(d)(1)]

Even the site-characterization program in 10 CFR 60.15(c)(1) is to be conducted in such a manner as to "limit adverse effects on the long-term performance of the geologic repository to the extent practicable."

Not included in the current operational criteria in 10 CFR Part 60 is a requirement that the surface facilities of the GROA not adversely affect containment and isolation. Some surface facilities and related activities may impact geohydrology and thus isolation (e.g., changes in surface water impoundments). Some surface activities of the GROA may impact geochemical retardation such as septic systems; unlined or leaking impoundment ponds; or leakage from fuel tanks or chemical tanks near faults, shafts, or boreholes. The surface facilities where wastes and waste packages are stored could adversely affect containment if corrosive conditions are allowed to exist in the storage area. Also, the surface storage conditions for backfill or other EBS components may adversely affect their containment capabilities.

The current regulations may be incomplete with regard to containment and isolation impacts for both the surface and underground facilities because no criteria regulate surface facilities such as access roads, flood-control structures, storage tanks and ponds, and waste storage areas that could impact containment and isolation.

The comma to be added to 10 CFR 60.112 is suggested so that it is clear that the phrase "their seals" applies to both shafts and boreholes (as in 10 CFR 60.134). The criteria in 10 CFR 60.112 fully address the concept because design of shafts and boreholes created during construction of the GROA must be taken into account to meet the performance objectives. Because design criteria for both shaft and borehole seals (10 CFR 60.134) aim to prevent compromise of the geologic repository's ability to meet the performance objectives, it is implicit that design factors be considered in construction of shafts and boreholes.

(2) Operations that Impact Containment and Isolation

Concept. Criteria are needed so that monitoring is conducted to ensure that the thermal, thermomechanical, geochemical, and hydrologic responses of the underground facility, shafts (ramps), and boreholes as a result of development and operations do not adversely affect the postclosure isolation capabilities within the geologic setting.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.140(d)(1), 60.141(c), 60.141(d), and 60.142.

Rationale for the Operational Criteria. The criteria cited above fully address the concept because of the requirement for *in situ* monitoring of the thermal, thermomechanical, and hydrologic responses of the geologic repository as a result of development and operations of the geologic repository is addressed by these criteria. This requirement is for a minimum number of tests to be conducted, and thus could also include geochemical monitoring. 10 CFR 60.142 adequately requires long-term monitoring of backfill and seals to ensure postclosure performance.

(3) **Permanent Closure Activities that Impact Containment and Isolation**

Concept. Criteria are needed so that the permanent closure activities are regulated like the operational activities. For example, the activities undertaken to achieve permanent closure must not degrade the postclosure performance of a repository.

Operational Criteria. The operational criteria needed to address this concept are presented in 10 CFR 60.111(a).

Rationale for the Operational Criteria. The criteria in 10 CFR 60.111(a) fully address this concept because the operational criteria apply during times "through permanent closure" or "until permanent closure has been completed." Since permanent-closure activities are a part of operations, such activities would be regulated sufficiently.

6.7.3 Elements Considered for Regulation

6.7.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) **Design and Construction that Impact Containment and Isolation**

Elements related to structures, systems, and components (facilities and equipment) of the GROA that may impact isolation within the geologic setting are:

- Site characterization excavations
  - Shafts
  - Ramps
  - Drifts
  - Surface trenches, pads, and roadcuts
- Site-characterization boreholes
- Access excavations
  - Shafts
  - Ramps
  - Drifts
- Underground facility excavations
  - Drifts
  - Emplacement rooms
  - Emplacement boreholes
- Construction considerations affecting isolation
  - Excavation/construction methods
  - Blasting (control overbreak/depth of blast damage)
  - Mechanical mining (limit use of water)
- Reinforcement and support of underground openings
  - Borehole casing and cement

- Shaft liners (if any)
  - Rock bolts
  - Steel sets
  - Shotcrete
  - Concrete
  - Shotcrete/concrete steel/fiber reinforcement
  - Emplacement hole liners
- Utility lines and their supports/anchors
  - Electric lines
  - Water lines
- Grout and grouting boreholes
- Roadway beds/crushed rock/concrete and reinforcement
- Surface and underground flood-protection structures (e.g., dams, seals, levees, sumps, drains, ditches, and rail lines)
- Backfill and packing
- Seals
- Waste packages
- Dewatering equipment
- Ventilation equipment
- Transportation equipment
- Monitoring instrumentation
- Borehole sealing equipment
- Backfill preparation and emplacement equipment
- Room, drift, ramp, and shaft sealing equipment

Elements related to the host rock mass/geologic setting that may be impacted by design and construction of the GROA include:

- Rock formations
- Faults, folds
- Joints, fractures
- Bedding planes
- Formation contacts
- Dikes, sills, intrusions
- Caves, lava tubes, lithophysae
- Breccia pipes, dissolution cavities, brine pockets
- Minerals, rock types, fracture coatings and fillings, fault gouge
- Ore deposits, mineral deposits, hydrocarbons, or other naturally occurring materials
- Groundwater, perched water, solutes
- Floodplains, rivers
- Surface water
- Air, ground gases, water vapor
- Soil

- Stress field, thermal field, fluid flow field
- Geochemical properties
- Hydrologic properties
  - Aquifers
  - Aquitards

(2) Operations that Impact Containment and Isolation

Elements related to operations that may impact isolation within the geologic setting are:

- Site characterization borehole drilling, stabilizing (if needed), dewatering (if needed)
- Excavation of site-characterization excavations
  - Shaft sinking, boring raising
  - Ramp driving
  - Drifting
- Repository construction
  - Shaft sinking, boring, raising
  - Driving ramps
  - Driving access drifts
  - Driving emplacement rooms
  - Drilling emplacement holes
  - Drilling and blasting
  - Scaling
  - Dust control/muck pile wetting
  - Reinforcing and/or supporting shafts, ramps, drifts, rooms, emplacement boreholes
  - Ventilating, air conditioning, and controlling dust (e.g., water/foam spraying)
  - Dewatering
  - Construction of surface and underground flood control structures (e.g., levees, dikes, dams, and sumps)
- Monitoring and inspecting underground structures
- Rock, water, gas sampling
- *in situ* data acquisition
- Installation of monitoring equipment
- Maintaining and repairing underground structures
- Inspecting surface flood-control structures
- Maintaining surface flood-control structures
- Environmental conditions impacting isolation
  - Thermal load during operations period
  - Increased stresses/deformations within host rock
  - Hydrological changes (impact on isolation)

- Geochemical changes (impact on isolation)
- Ventilation during operations
- Alterations of *in situ* hydrological conditions (degree of saturation/moisture content)
- Alteration in geochemical conditions
- Alteration in mechanical behavior
- Induced seismic activity/fault movement
- Excavation
- Nuclear testing
- Injection of high-pressure fluids (grout)

(3) Permanent Closure Activities that Impact Containment and Isolation

Elements related to permanent closure of the geologic repository that may impact isolation within the geologic setting are:

- Removing utilities
- Removing equipment
  - Pumps
  - Fans
  - Monitoring instrumentation
- Removing materials and supplies that may be hazardous or corrosive
  - Fuels
  - Oils
  - Grease
  - Pipe
  - Hoses
- Removing structures and components that may have a degrading influence on the geologic setting
  - Roadbeds
  - Utility anchors
  - Ventilation control doors and stoppings
- Preparation of boreholes for permanent abandonment
  - Pulling of casing
  - Dewatering of holes
  - Inspection of holes
  - Sealing of holes
  - Surface preparation for borehole site abandonment
- Preparation of underground facility excavations for permanent closure
  - Scaling of loose rock
  - Emplacement of backfill

- Stress field, thermal field, fluid flow field
- Geochemical properties
- Hydrologic properties
  - Aquifers
  - Aquitards

(2) **Operations that Impact Containment and Isolation**

Elements related to operations that may impact isolation within the geologic setting are:

- Site characterization borehole drilling, stabilizing (if needed), dewatering (if needed)
- Excavation of site-characterization excavations
  - Shaft sinking, boring raising
  - Ramp driving
  - Drifting
- Repository construction
  - Shaft sinking, boring, raising
  - Driving ramps
  - Driving access drifts
  - Driving emplacement rooms
  - Drilling emplacement holes
  - Drilling and blasting
  - Scaling
  - Dust control/muck pile wetting
  - Reinforcing and/or supporting shafts, ramps, drifts, rooms, emplacement boreholes
  - Ventilating, air conditioning, and controlling dust (e.g., water/foam spraying)
  - Dewatering
  - Construction of surface and underground flood control structures (e.g., levees, dikes, dams, and sumps)
- Monitoring and inspecting underground structures
- Rock, water, gas sampling
- *in situ* data acquisition
- Installation of monitoring equipment
- Maintaining and repairing underground structures
- Inspecting surface flood-control structures
- Maintaining surface flood-control structures
- Environmental conditions impacting isolation
  - Thermal load during operations period
  - Increased stresses/deformations within host rock
  - Hydrological changes (impact on isolation)

- Geochemical changes (impact on isolation)
- Ventilation during operations
- Alterations of *in situ* hydrologi conditions (degree of saturation/moisture content)
- Alteration in geochemical conditions
- Alteration in mechanical behavior
- Induced seismic activity/fault movement
- Excavation
- Nuclear testing
- Injection of high-pressure fluids (grout)

(3) **Permanent Closure Activities that Impact Containment and Isolation**

Elements related to permanent closure of the geologic repository that may impact isolation within the geologic setting are:

- Removing utilities
- Removing equipment
  - Pumps
  - Fans
  - Monitoring instrumentation
- Removing materials and supplies that may be hazardous or corrosive
  - Fuels
  - Oils
  - Grease
  - Pipe
  - Hoses
- Removing structures and components that may have a degrading influence on the geologic setting
  - Roadbeds
  - Utility anchors
  - Ventilation control doors and stoppings
- Preparation of boreholes for permanent abandonment
  - Pulling of casing
  - Dewatering of holes
  - Inspection of holes
  - Sealing of holes
  - Surface preparation for borehole site abandonment
- Preparation of underground facility excavations for permanent closure
  - Sc ing of loose rock
  - Emplacement of backfill

- Inspection and testing of emplaced backfill
- Sealing
  - Preparation of excavations for sealing
  - Removal of internal structures
  - Scaling of loose rock
  - Emplacement of formwork for seal construction
  - Seal emplacement
  - Seal inspection
  - Grouting of seal/rock contact and of host rock
- Preparation of surface for permanent abandonment
  - Installation of permanent flood control structures
- Personnel and procedures for processing and emplacement of seals/backfill

6.7.3.2 Comments on and Discussion of the Elements Considered for Regulation

(1) Design and Construction that Impact Containment and Isolation

Surface site-preparation activities are likely to be the first construction activities that could affect the isolation performance of the geologic setting. The most obvious causes of potential changes would be associated with changes in surface topography, alterations of flood plains, diversion or impoundment of surface-water flows, and changes in surface-water infiltration rates and volumes. 10 CFR Part 60 does not currently appear to ensure that the design of *surface facilities* such as access roads, drilling pads, trenches, flood-control structures, waste-storage facilities, and general surface site preparation for the repository surface facilities take into account potential degradation of containment and isolation assisted or provided by the geologic setting. 10 CFR 60.15(c)(1) assures that site-characterization activities limit adverse effects on the long-term performance of the geologic repository.

Drilling of site-characterization boreholes and excavation of site characterization shafts, ramps, and drifts will be the first construction activities that will penetrate the geologic setting. They could have a potentially significant effect on subsurface water-and air-flow patterns, by creating new potential flowpaths of high hydraulic conductivity. Changes in flow rates and directions presumably could in turn induce geochemical changes. The potential detrimental effects of site characterization are regulated in 10 CFR 60.15(c), 17(a)(2)(iii), and (iv). These regulations appear consistent with the current level of detail in 10 CFR Part 60.

Repository access excavations such as shafts, ramps, and drifts are more numerous and probably of larger cross sectional area than the site-characterization excavations, and are more likely to degrade the isolation performance of the geologic setting than the site-characterization openings. Yet, no equivalent, general regulatory criteria govern the number, location, design, and construction of the access excavations as those that regulate site characterization in 10 CFR 60.15(c), and those that regulate accesses considered part of the underground facility (60.133(a)(1), 60.133(e)(2), 60.133(f), 60.133(h), 60.133(i)). The overall system performance objectives in 10 CFR 60.112 could be considered adequate to regulate shafts and boreholes even though no explicit design criteria are given for them in 10 CFR 60.130 through 60.133.

(2) Operations that Impact Containment and Isolation

Thermal loading during both the preclosure and postclosure periods could induce additional fracturing of the host rock and create preferential groundwater pathways. Thermal loading also could alter the geochemistry or hydrology of the host rock over a significant area and adversely affect isolation capabilities within the geologic setting. 10 CFR 60.133(i) appears to adequately require that the underground facility be designed so that the performance objectives will be met taking into account the predicted thermal and thermomechanical response of the host rock, surrounding strata, and groundwater system. The surrounding strata could reasonably be taken to include geochemical characteristics. Performance-confirmation monitoring of backfill and seals to assure that they meet postclosure performance objectives is included in 10 CFR 60.142.

(3) Permanent Closure Activities that Impact Containment and Isolation

Permanent closure is considered part of the operational period, as based on the concepts in 10 CFR 60.102(d). It is also assumed that "design" accounts for construction and operations. Thus, design criteria that specifically require limiting adverse effects on the isolation within the geologic setting would imply design, construction, operation, and permanent closure to limit these adverse effects. In this context, the regulations would be sufficient to cover permanent closure activities. 10 CFR 60.21(c)(15)(vi) also requires plans for permanent closure in the license application.

6.7.4 Safety Functions and Regulatory Citations

6.7.4.1 Associated Safety Functions

(1) Design and Construction that Impact Containment and Isolation

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

- Close shafts, ramps, boreholes, and other access openings - 6.11.2
- Seal unused piping or conduits to underground facility (if required) - 6.11.2.2

- Maintain emplacement opening/location mechanical stability during repository operations - 6.22
- Maintain the stability of the underground access facilities and emplacement openings/locations during waste removal operations - 6.23
- Ensure the ability of repository facilities and equipment important to safety or isolation to perform their intended functions under naturally induced conditions and events (e.g., weather and seismic activity) - 6.35
- Ensure the ability of repository facilities and equipment important to safety or isolation to perform their intended functions under conditions and events induced by human activity - 6.36
- Limit alterations of the geologic media that adversely affect performance - 6.39
- Limit alterations of existing discontinuities that adversely affect performance (preferential pathways to or between aquifers) - 6.39.1
- Limit creation of new discontinuities that adversely affect performance (preferential pathways to or between aquifers) - 6.39.2
- Limit proximity of openings to preferential pathways - 6.39.3
- Limit adverse effects on geochemistry - 6.39.4
- Limit proximity of waste emplacement openings/locations to f[illegible] or fracture zones - 6.40
- Ensure stability of waste emplacement opening/lo[illegible]

(2) Operations That Impact Containment and Isolati[illegible]

The following safety functions were identified from the [illegible]sitory Functional Analysis" (Ref. 1).

- Verify integrity of waste disposal package and, if used, emplacement opening backfill during waste emplacement operations - 6.6.9
- Install, calibrate and test (sub)surface postclosure monitoring equipment (as applicable) - 6.11.1.4, 6.11.2.1, and 6.11.3.2
- Examine performance capability of seals/backfills and monitoring equipment previously emplaced - 6.11.1.5
- Repair/replace previously emplaced seals and/or backfill and monitoring equipment (as required) - 6.11.1.6
- Maintain chemical and physical properties of emplacement opening backfill during repository operations (if used) - 6.21
- Maintain chemical and physical properties of waste emplacement packing/backfill/seal(s) during closure - 6.25

- Maintain chemical and physical properties of closure backfill/seals during closure - 6.26
- Mine water control (if required) - 6.41.1.2.5
- Mine water handling in access openings (if required) - 6.41.1.2.5.2
- Mine water disposal facilities and equipment (if required) - 6.41.1.2.5.3
- Facilities for monitoring during repository operations - 6.41.6.1
- Limit total quantity of emplaced waste - 7.2.1.1.1
- Control age of emplaced waste - 7.2.1.1.2

(3) **Permanent Closure Activities that Impact Containment and Isolation**

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

- Remove underground facilities (plumbing, HVAC, etc.) and equipment (as appropriate) - 6.11.1.2
- Remove hazardous and potentially corrosive materials from the underground facility - 6.11.1.3
- Emplace emplacement opening/location packing, backfill and/or cover (or plug as required) - 6.11.1.7
- Verify readiness for final closure - 6.11.1.8
- Emplace drift seal(s) (if required) - 6.11.1.10
- Seal unused piping and conduits to underground facility (if required) - 6.11.2.2
- Backfill and close shafts, ramps, and other access openings, and emplace seals - 6.11.2.3
- Emplace closure seals for boreholes and other openings - 6.11.2.4
- Return site to natural ecological system following closure and decommissioning - 6.11.3.7

6.7.4.2 Relevant Regulatory Citations

- 10 CFR 60.2, 60.15(c), 60.17(a)(2)(iii), 60.17(a)(2)(iv), 60.21(c)(1)(i)(F), 60.21(c)(1)(ii)(A), 60.21(c)(1)(ii)(C), 60.21(c)(1)(ii)(D), 60.21(c)(1)(ii)(F), 60.21(c)(2), 60.21(c)(5), 60.21(c)(6), 60.21(c)(15)(vi), 60.31(a)(1), 60.43(b)(3), 60.102(d), 60.111(a), 60.112, 60.130, 60.131, 60.132, 60.133, 60.134, 60.140(d)(1), 60.141, and 60.142
- 10 CFR 72.102(a)

6.7.4.3 *Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations*

(1) Design and Construction that Impacts Containment and Isolation

The definition of disturbed zone (10 CFR 60.2) includes the effects of the construction of the underground facility, but not of shafts (ramps) or boreholes. This may be a concern for performance related to groundwater travel time, which is beyond the scope of this ROC task. The requirements (1) that shafts and boreholes shall be sealed (10 CFR 60.134), (2) that their design does not adversely affect isolation (10 CFR 60.112) and (3) that the impact of site-characterization shafts and holes be limited [10 CFR 60.15(c)(1), 60.15(c)(2), and 60.15(c)(3)], place constraints on these penetrations into the geologic setting. The safety functions address a broader set of constraints; that is constraints that apply to all repository structures, systems, and components, rather than to the subsurface only.

Safety functions that limit alteration of or limit creation of discontinuities are addressed specifically by requirements 10 CFR 60.133(e)(2) and 60.133(f) and, in a more general sense, by 10 CFR 60.133(a)(1) and 60.133(h) for the underground facility. 10 CFR Part 60 contains general requirements related to the safety function to limit proximity of openings in 10 CFR 60.133(a)(1) and 60.133(b). Also, 10 CFR 60.15(c)(1), 60.15(c)(3), and 60.15(c)(4) address constraints with respect to site characterization and 10 CFR 60.140(d)(1) addresses performance confirmation constraints.

10 CFR Part 60 contains general regulatory requirements corresponding to the safety function to limit adverse affects on geochemistry because geochemistry affects isolation. The content of the license application requires an analysis of the geochemistry of the site [10 CFR 60.21(c)(1)(ii)(A)] and the anticipated response of the geochemical system to the maximum design thermal loading [10 CFR 60.21(c)(1)(i)(F)].

The safety function to limit waste proximity to faults is generally addressed in 10 CFR Part 60. This constraint would need to be formulated in terms of potential impact on the isolation performance of the geologic setting. Presumably this could include several technical considerations, ranging from the risk of having flowpaths along faults or fracture zones, to possible thermomechanical effects, and/or geochemical effects. All of these issues are postclosure issues and are beyond the scope of this ROC task.

One safety function requires the provision of stable emplacement location(s) for waste. Within the context of this ROC Topic, this function is intended to prevent degradation of that portion of the geologic setting surrounding the underground facility. This is addressed in 10 CFR 60.133(a)(1), 60.133(e)(2), 60.133(f), 60.133(h), and 60.141.

The safety function related to underground postclosure performance is covered in 10 CFR Part 60 in terms of general and particular performance objectives after permanent closure. The analyses demonstrating compliance with this safety function are provided by regulatory requirements 10 CFR 60.21(c)(1)(ii)(C), 60.21(c)(1)(ii)(D), 60.21(c)(1)(ii)(F), and 60.21(c)(2).

(2) Operations that Impact Containment and Isolation

The emplaced waste could degrade the geologic setting as a result of heating. Such degradation could result from thermal expansion and tensile failure within the host rock, and also geochemical and hydrological changes due to thermal loading. This is addressed in the license application, in accordance with the requirements in 10 CFR 60.21(c)(1)(i)(F), and 60.21(c)(2), 60.21(c)(5), and 60.21(c)(6). The construction authorization [10 CFR 60.31(a)(1)] will evaluate "the kinds and quantities of radioactive waste to be . . . disposed of in the GROA." An issued license will include "Restrictions as to the amount of waste permitted per unit volume of storage considering the physical characteristics of both the waste and the host rock" [10 CFR 60.43(b)(3)]. These regulatory citations give the Commission the authority (and obligation) to address thermal aspects of disposal.

The Commission may change the performance requirements of particular barriers after permanent closure taking into account factors that may include the age and nature of the waste. Indirectly, 10 CFR 60.133(i) addresses some of the technical considerations that presumably underlie the safety functions. The most fundamental way in which 10 CFR Part 60 integrates the safety functions is within the overall system performance as well as within the requirements for performance of particular barriers after permanent closure. In sum, 10 CFR Part 60 does not place an absolute limit on the waste quantity. The Nuclear Waste Policy Act (Ref. 17) in Section 114(d), however, does limit the inventory to less than 70,000 metric tons. The approach taken in 10 CFR Part 60 requires that the repository site and design accommodate the emplaced waste, and/or that the characteristics of the emplaced waste be compatible with the site and repository design, such that overall and particular performance objective and criteria be satisfied. In this regard, 10 CFR Part 60 appears sufficient and adequate in regulating operations that impact containment and isolation.

Backfill is addressed by several of the associated safety functions. 10 CFR 60.142(a) and 60.142(c) require performance confirmation testing of backfill up to the period of permanent closure to assure that design requirements can be met following permanent closure. These performance confirmation criteria appear to directly regulate the safety functions dealing with examining performance capability and integrity of backfills and seals, and to a lesser extent safety functions which deal with ensuring that the chemical and physical properties of backfills and seals will be maintained. Backfill, within the context of this ROC Topic, needs to be considered from the point of view of its impact on the isolation performance of the geologic setting. From this point of view, the most obvious influence of backfill is to control the deformations of the rock mass, and thus, the alteration of existing discontinuities and the development of new discontinuities. Additionally, backfill may reduce the hydraulic conductivity of the backfilled openings and potential preferential flowpaths for water and air and, hence, may alter flow through the host rock and possibly flowpaths and rates in the geologic setting.

10 CFR Part 60 contains no explicit operating criteria to regulate their possible adverse effects on the geologic setting. Similarly, 10 CFR Part 72 contains no operating criteria, only design criteria. However, 10 CFR 72.102(a) has implemented the clause "design criteria establish the design, fabrication, construction, testing, maintenance and performance requirements for structures, systems, and components important to safety," which would mean that operations are accounted for in the design criteria.

(3) **Permanent Closure Activities that Impact Containment and Isolation**

Repository functions described in the associated safety functions typically are at a much more detailed level than the current level of detail for permanent repository closure in 10 CFR Part 60. 10 CFR 60.134 requires final backfilling of the underground facility and sealing of shafts and boreholes. 10 CFR 60.21(c)(15)(vi) currently only requires plans for permanent closure and plans for the decontamination or dismantlement of surface facilities in the license application. 10 CFR Part 60 does address these safety functions in a broader context.

6.8 PRECLOSURE RADIATION MONITORING

This ROC Topic has the following subtopics:

(1) Monitoring Direct Radiation Levels
(2) Monitoring Airborne Concentrations of Radioactive Material (Restricted Area)
(3) Radioactive Effluent Monitoring
(4) Radiation Alarms
(5) Radiation Surveys

6.8.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) **Monitoring Direct Radiation Levels**

10 CFR Parts 60 and 20 provide adequate and sufficient criteria regarding monitoring personnel radiation exposure and measuring direct radiation levels in all working areas that may handle or store waste or the waste package.

(2) **Monitoring Airborne Concentrations of Radioactive Materials (Restricted Area)**

10 CFR Part 20, which is referenced by 10 CFR Part 60, provides criteria for the measurement of airborne concentrations of radioactive material in restricted and unrestricted areas.

(3) **Radioactive Effluent Monitoring**

10 CFR Part 60 addresses effluent control and monitoring effluents from the underground facility. 10 CFR 20.1501 specifies under which conditions and events, including radiation accidents, monitoring of radionuclides should be performed.

(4) **Radiation Alarms**

10 CFR Part 60 addresses criteria for radiation alarms adequately and sufficiently, in 10 CFR 60.131(a)(6). A minor change to enhance the grammar of 10 CFR 60.131(a)(6) may be needed.

(5) **Radiation Surveys**

10 CFR Part 60 adequately and sufficiently addresses radiation surveys because it references 10 CFR Part 20, which has criteria for radiation surveys.

6.8.2 Potential Repository Operational Criteria

This subsection presents the concepts, operational criteria and rationale that were developed to substantiate the conclusions presented above.

(1) **Monitoring Direct Radiation Levels**

Concept. Criteria are required for measurement of personnel radiation exposures and monitoring of radiation levels in work areas.

Operational Criteria. Operational criteria to address this concept are contained in 10 CFR 20.1501 and 20.1502, and in 10 CFR 60.131(a)(4) and 60.131(a)(6).

Rationale for the Operational Criteria. 10 CFR 20.1501 and 20.1502 address this concept because they cover monitoring in general terms. 10 CFR Part 60 also provides criteria on contamination monitoring and general alarms in 10 CFR 60.131(a)(4) and 60.131(a)(6), and by reference has criteria for monitoring radiation levels in work areas (restricted areas). 10 CFR Part 20 is referenced in 10 CFR 60.111(a).

(2) **Monitoring Airborne Concentrations of Radioactive Material (Restricted Area)**

Concept. Criteria for measuring airborne concentrations of radioactive materials in the restricted area are necessary.

Operational Criteria. Operational criteria to address this concept are contained in 10 CFR 20.1501.

Rationale for the Operational Criteria. 10 CFR 20.1501 fully addresses this concept because it requires monitoring and survey of restricted areas to comply with worker dose limits. 10 CFR Part 20 is referenced in 10 CFR 60.111(a).

(3) Radioactive Effluent Monitoring

Concept. Criteria regarding monitoring of radioactive material in effluents under various conditions and events, including radiation accidents, are required for both the surface and underground facilities.

Operational Criteria. The operational criteria regarding effluent monitoring for all conditions and events, including radiation accidents and any type of effluents, related to 10 CFR 60.131(a) and 60.132(c)(2), are contained in 10 CFR 20.1501.

Rationale for the Operational Criteria. 10 CFR 20.1501 is generally written to require that monitoring continue through the full range of conditions and events that may occur, including radiation accidents. 10 CFR Part 20 is referenced in 10 CFR 60.111(a).

(4) Radiation Alarms

Concept. Criteria regarding radiation alarms should apply to (1) increases in levels of direct radiation in restricted and unrestricted areas, (2) increases in concentrations of radioactive material in air in restricted and unrestricted areas, and (3) increases in radioactivity in effluents.

Potential Repository Operational Criteria. Operational criteria needed to address this concept are presented in 10 CFR 60.131(a)(6). A minor typographical change may enhance the current regulatory criteria as indicated below:

> 60.131(a)(6) Radiological Protection.
> A radiation alarm system to warn of significant increases in radiation levels~~,~~ and concentrations of radioactive material in air~~;~~ and of increased radioactivity released in effluents. The alarm system shall be designed with provisions for calibration and for testing its operability (or delete the word "increased").

Rationale for the Operational Criteria: 10 CFR 60.131(a)(6) addresses the concept because it considers all three aspects necessary for safety. A minor change may enhance 10 CFR 60.131(a)(6) so it states that alarms are for increases in radiation levels and concentrations in air. This may be a grammatical enhancement, since "increases" *and* "increased" are both used in the current regulatory criteria. 10 CFR Part 20 is referenced in 10 CFR 60.111(a).

(5) **Radiation Survey**

Concept. Criteria are required regarding radiation-survey activities necessary to perform radiation-hazard evaluations.

Operational Criteria. The potential repository operational criteria to address this concept are presented in 10 CFR 20.1501.

Rationale for the Operational Criteria. The criteria of 10 CFR Part 20 are referenced in 10 CFR 60.111(a) and 20.1501 require radiation surveys for radiation protection. 10 CFR Part 20 is referenced in 10 CFR 60.111(a).

6.8.3 Elements Considered for Regulation

6.8.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) **Monitoring Direct Radiation Levels**

Monitoring equipment for hazard control is required because instruments such as these are the only way to evaluate the presence of radioactive material. Personnel and environmental monitors measure accumulated doses over a period of time. Elements include:

- Nuclear emulsion monitors (personnel)
- Thermoluminescent monitors (personnel and environmental monitoring)
- Ion chamber dosimeters (personnel)
- Gate monitors
- Monitoring systems
- Alarm systems
- Chirpies

(2) **Monitoring Airborne Concentrations of Radioactive Material (Restricted Area)**

Elements of monitoring airborne concentrations of radioactive material in restricted areas are:

- Air samplers - for radionuclides in air
- Criticality monitoring, for spent fuel stored in water, can be used for the earliest warning of gaseous fission product releases by unplanned criticality
- Environmental monitors

(3) **Radioactive Effluent Monitoring**

Elements of radioactive effluent monitoring are:

- Air samplers - for radionuclides in air
- Water samplers - for radionuclides in water
- Stack monitors
- Fence monitors
- Sewage monitors
- Drain monitors

(4) **Radiation Alarms**

Elements of alarms systems to warn of increased radiation levels or levels of radionuclides in the air are:

- Airborne monitoring and alarm systems for the restricted and unrestricted areas
- Dose-rate monitors and alarms
- Effluent monitors and alarms
- Stack monitors and alarms

(5) **Radiation Survey**

Radiation survey equipment is used to monitor and measure radiation dose rates, contamination levels, or air or water samples. Survey equipment may include:

- Gas ionization meters
- Geiger-mueller tubes
- Scintillation detectors
- Portable air samplers

6.8.3.2 Comments on and Discussion of the Elements Considered for Regulation

(1) **Monitoring Direct Radiation Levels**

A review of the functions and elements, and the pertinent regulatory text reveals that criteria are required regarding measurement of direct radiation levels in the restricted areas at the GROA. These criteria for the protection of worker health and safety are contained in the new 10 CFR Part 20.

(2) Monitoring Airborne Concentrations of Radioactive Material (Restricted Area)

10 CFR Part 60 references explicit criteria regarding the measurement of airborne concentrations of radioactive material in restricted areas in 10 CFR Part 20. These criteria establish a radiation control program to protect workers from inhalation and/or ingestion of radioactive materials in the restricted area. Measurement of airborne concentrations of radioactive material in restricted areas provides a basis for the calculation of internal doses.

(3) Radioactive Effluent Monitoring

10 CFR 60.132 addresses effluent monitoring and control for surface facilities, but contains only criteria for effluent control with respect to airborne concentrations and airborne effluents from the underground facility. There are criteria regarding effluent monitoring in the new 10 CFR Part 20.

It may be unclear under what conditions 10 CFR Part 60 requires effluent monitoring. Although 10 CFR 60.132(c)(2) requires monitoring of "any effluent", this could be interpreted to mean (1) normal and off-normal effluents and effluents resulting under accident conditions, (2) air effluents and water effluents, or (3) both. Although it is unstated, it should be clear that effluent monitoring is required under anticipated conditions and events and radiation accidents. The resultant information is required in order to make decisions about what protective actions must be taken.

(4) Radiation Alarms

Radiation alarms are required to warn personnel of increases in (1) direct radiation levels, (2) airborne concentrations of radioactive materials in the restricted area, and (3) radioactivity in effluents to the unrestricted area. 10 CFR Part 60 contains criteria that address most of these requirements and the new 10 CFR Part 20 addresses any areas not explicit in 10 CFR Part 60.

(5) Radiation Survey

10 CFR Part 60 references criteria regarding radiation survey requirements. It is important that radiation surveys be conducted to best evaluate any radiation hazard. 10 CFR Part 20 outlines survey requirements in 10 CFR 20.1501. 10 CFR Part 60 is linked to the survey requirements of 10 CFR Part 20 by 10 CFR 60.111(a).

6.8.4 Safety Functions and Regulatory Citations

6.8.4.1 Associated Safety Functions

The following safety functions were identified from the "Repository Functional Analyses" (Ref. 1).

(1) **Monitoring Direct Radiation Levels**

- Continuously monitor radiation levels during repository operations - 6.8.1.1
- Continuously monitor personnel radiation exposure levels during repository operations - 6.8.1.3

(2) **Monitoring Airborne Concentration of Radioactive Materials (Restricted Area)**

- Software for waste packaging operations (e.g., inventory, process control, monitoring) - 5.35.5.3
- Install monitoring equipment for waste emplacement (as required) - 6.6.8
- Monitor environmental conditions to provide warning of potentially hazardous conditions or events during repository operations (e.g., air contamination, seismic event) - 6.8.1.2
- Software for repository waste receiving operations (e.g., inventory, process control, monitoring) - 6.41.2.3
- Software for waste lag storage (e.g., inventory, process control, monitoring) during repository operations - 6.41.3.3
- Software for waste transfer operations (e.g., inventory, monitoring) - 6.41.4.3
- Software for waste emplacement operations (e.g., inventory, process control, monitoring) - 6.41.5.3
- Repository monitoring generic system elements (radiological and non-radiological) - 6.41.6
- Facilities for monitoring during repository operations - 6.41.6.1
- Equipment for monitoring and alarm during repository operations - 6.41.6.2
- Software for monitoring during repository operations - 6.41.6.3
- Trained and certified personnel for monitoring during repository operations - 6.41.6.4
- Procedure(s) for monitoring during repository operations - 6.41.6.5

(3) **Radioactive Effluent Monitoring**

- Install monitoring equipment for waste emplacement (as required) - 6.6.8
- Monitor environmental conditions to provide warning of potentially hazardous conditions or events during repository operations (e.g., air contamination, seismic event) - 6.8.1.2
- Software for repository waste receiving operations (e.g., inventory, process control, monitoring) - 6.41.2.3
- Software for waste lag storage (e.g., inventory, process control, monitoring) during repository operations - 6.41.3.3
- Software for waste transfer operations (e.g., inventory, monitoring) - 6.41.4.3
- Software for waste emplacement operations (e.g., inventory, process control, monitoring) - 6.41.5.3
- Facilities for monitoring during repository operations - 6.41.6.1
- Equipment for repository monitoring and alarm during repository operations - 6.41.6.2
- Software for monitoring during repository operations - 6.41.6.3
- Trained and certified personnel for monitoring during repository operations - 6.41.6.4
- Procedure(s) for monitoring during repository operations - 6.41.6.5

(4) **Radiation Alarms**

- Uninterruptable power source(s) (e.g., for repository instrumentation, alarms, communications, and lighting important to safety) - 5.35.1.3.4
- Continuously monitor radiation levels during repository operations - 6.8.1.1
- Monitor environmental conditions to provide warning of potentially hazardous conditions or events during repository operations (e.g., air contamination, seismic event) - 6.8.1.2

(5) **Radiation Surveys**

- Survey transportation package external dose rate upon receipt - 6.2.1.2
- Survey waste disposal package external dose rate prior to removal from underground facility during waste removal operations - 6.9.9

6.8.4.2 *Relevant Regulatory Citations*

- 10 CFR 20.1501 and 20.1502
- 10 CFR Part 50, Appendix A-VI, Criterion 63 and Criterion 64
- 10 CFR 60.21(c)(7), 60.21(c)(15)(v), 60.74(a)(3), 60.111(a), 60.131(a), 60.131(b)(5)(iii)and 60.132
- 10 CFR 61.12, 61.41, and 61.81
- 10 CFR 72.122(h)(4), 72.122(j), 72.124(c), 72.126(b), 72.126(c)(1), 72.126(c)(2), and 72.126(d)

6.8.4.3 *Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations*

(1) Monitoring Direct Radiation Levels

The safety functions identified the need to monitor radiation levels and personnel exposures. A review of the regulations for pertinent regulatory citations revealed the following:

- 10 CFR 20.1501 is generally written for surveys and monitoring
- 10 CFR 20.1501(c) requires the use of the personnel monitoring equipment to measure exposure to radiation
- 10 CFR Part 50, Appendix A-VI, Criterion 63, requires appropriate systems be provided in fuel storage and radioactive waste systems and associated handling areas to detect conditions that may result in loss of residual heat-removal capability and excessive radiation levels
- 10 CFR 60.21(c)(7) requires a description of the program for control and monitoring of radioactive effluents and occupational radiation exposures to maintain such effluents and exposures in accordance with the requirements of Part 20 of this chapter
- 10 CFR 60.21(c)(15)(v) requires the applicant to submit plans for conduct of normal activities, including maintenance, surveillance, and periodic testing of structures, systems, and components of the GROA
- 10 CFR 60.74(a)(3) requires DOE to perform, or permit the Commission to perform, such tests as the Commission deems appropriate or necessary for the administration of the regulations in this part (e.g., Radiation detection and monitoring instruments)
- 10 CFR 60.131(b)(5)(iii) requires that provisions shall be made so that, if there is a loss of the primary electric power source or circuit, reliable and timely emergency power can be provided to instruments, utility service systems, and operating systems, including alarm systems, important to safety

- 10 CFR 72.122(h)(4) requires that confinement systems must have the capability for continuous monitoring in a manner such that the licensee will be able to determine when corrective action needs to be taken to maintain safe storage conditions
- 10 CFR 72.122(j) requires that a control room or control area, if appropriate for the ISFSI or MRS design, must be designed to permit occupancy and actions to be taken to monitor the ISFSI or MRS safely under normal conditions, and to provide safe control of the ISFSI or MRS under off-normal or accident conditions
- 10 CFR 72.124(c) requires that a criticality monitoring system be maintained in each area where special nuclear material is handled, used, or stored which will energize clearly audible alarm signals if accidental criticality occurs
- 10 CFR 72.126(c)(2) requires that areas containing radioactive materials must be provided with systems for measuring the direct radiation levels in and around these areas

10 CFR Part 60 does not have explicit criteria for monitoring radiation levels like 10 CFR Part 72, except for the requirements to have radiation alarms in 10 CFR 60.131(a)(6). 10 CFR 20.1501, "Surveys and Monitoring," and 10 CFR 20.1502, "Individual Monitoring," are referenced by 10 CFR 60.111(a).

Monitoring is generally considered as a continuous process where direct radiation levels and airborne concentrations of radioactive materials in work areas and in effluents are measured over long periods of time. When deviations above normal levels or concentrations occur, more specific measurements are needed; that is, radiation surveys. Radiation survey, as used in 10 CFR Part 20, pertains to the evaluation of radiation hazards incident to the use, release, disposal, or presence of radioactive materials. This evaluation includes (1) physical survey of the location of materials and equipment, (2) measurement of levels of radiation, (3) measurement of concentrations of radioactive materials present, and (4) monitoring.

(2) Monitoring Airborne Concentrations of Radioactive Material (Restricted Area)

The safety functions identified the need to:

- Facilities, equipment, personnel, and procedures for repository monitoring
- Monitoring equipment for waste in storage
- Software for waste preparation for emplacement operations (inventory, process control, monitoring)
- Monitoring equipment

A review of the relevant regulations for pertinent criteria revealed the following:

- 10 CFR 60.21(c)(15)(v) requires the applicant to submit plans for conduct of normal activities, including maintenance, surveillance, and periodic testing of structures, systems, and components of the GROA
- 10 CFR 60.131(a)(4) requires means to monitor the dispersal of radioactive contamination
- 10 CFR 60.74(a)(3) requires DOE to perform, or permit the Commission to perform, such tests as the Commission deems appropriate or necessary for the administration of the regulations in this part (e.g., radiation detection and monitoring instruments)
- 10 CFR 60.131(b)(5)(iii) requires that provisions shall be made so that, if there is a loss of the primary electric power source or circuit, reliable and timely emergency power can be provided to instruments utility service systems; and operating systems, including alarm systems, important to safety
- 10 CFR 72.122(h)(4) requires that confinement systems must have the capability for continuous monitoring in a manner such that the licensee will be able to determine when corrective action needs to be taken to maintain safe storage conditions
- 10 CFR 72.122(j) requires that a control room or control area, if appropriate for the ISFSI or MRS design, must be designed to permit occupancy and actions to be taken to monitor the ISFSI or MRS safely under normal conditions, and to provide safe control of the ISFSI or MRS under off-normal or accident conditions

10 CFR 60.131(a)(4) addresses the Safety Functions in subsection 6.8.4.1(2), but 10 CFR Part 60 is not as specific as the safety functions or 10 CFR Part 72.

(3) Radioactive Effluent Monitoring

The safety functions identified the need to continuously monitor radioactivity in effluents. A review of the relevant regulations revealed the following:

- 10 CFR 20.1501 requires such monitoring
- 10 CFR Part 50, Appendix A-VI, Criterion 64, requires that means be provided for monitoring the reactor containment atmosphere; spaces containing components for recirculation of loss-of-coolant accident fluids; effluent discharge paths; and plant environs for radioactivity that may be released from normal operations, including anticipated operational occurrences, and from postulated accidents

- 10 CFR 60.21(c)(7) requires a description of the program for control and monitoring of radioactive effluents and occupational radiation exposures to maintain such effluents and exposures in accordance with the requirements of Part 20 of this chapter
- 10 CFR 60.21(c)(15)(v) requires the applicant to submit plans for conduct of normal activities, including maintenance, surveillance, and periodic testing of structures, systems, and components of the GROA
- 10 CFR 60.131(a)(4) requires means to monitor and control the dispersal of radioactive contamination
- 10 CFR 60.131(b)(5)(iii) requires that provisions shall be made so that, if there is a loss of the primary electric power source or circuit, reliable and timely emergency power can be provided to instruments, utility service systems, and operating systems, including alarm systems, important to safety
- 10 CFR 60.132(c)(1) requires that surface facilities be designed to control the release of radioactive materials in effluents during normal operations to meet the objectives of 10 CFR 60.111(a)
- 10 CFR 60.132(c)(2) requires that monitoring systems be designed to measure the amount and concentration of radionuclides in any effluent with sufficient precision to determine whether releases conform to the design requirement for effluent control; the monitoring systems shall be designed to include alarms that can be periodically tested
- 10 CFR 61.12 requires technical information to include a description of the radiation safety program for the control and monitoring of radioactive effluents to ensure compliance with the performance objective in 10 CFR 61.41; 10 CFR 61.12 also requires a description of occupational radiation exposure to ensure compliance with the requirements of 10 CFR Part 20 to control contamination of personnel, vehicles, equipment, buildings, and the disposal site; both routine operations and accidents must be addressed; the program description must include procedures, instrumentation, facilities, and equipment
- 10 CFR 72.122(j) requires that a control room or control area, if appropriate for the ISFSI or MRS design, must be designed to permit occupancy and actions to be taken to monitor the ISFSI or MRS safely under normal conditions and to provide safe control of the ISFSI or MRS under off-normal or accident conditions
- 10 CFR 72.126(c)(1) requires that as appropriate for the handling and storage system, effluent systems must be provided; means for measuring the amount of radionuclides in effluents during normal operations and under accident conditions must be provided for these systems; a means of measuring the flow of the diluting

medium, either air or water, must also be provided
- 10 CFR 72.126(d) addresses effluent control

10 CFR Part 60 is general versus being specific in its coverage of the safety functions in subsection 6.8.4.1(3). It may appear unclear whether the criteria in 10 CFR 60.132(c)(2) require monitoring of effluents during radiation accidents (emergencies) because the word "any" could mean (1) any type of effluent (e.g., gaseous particulate), (2) at any time (e.g., during a radiation accident), or (3) both. A conservative approach would assume both.

(4) Radiation Alarms

The safety functions identified the need to provide alarms at the GROA. A review of the regulations for pertinent criteria revealed the following:

- 10 CFR 60.131(a)(6) requires the GROA be designed to include a radiation alarm system to warn of significant increases in radiation levels, concentrations of radioactive material in air, and increased radioactivity released in effluents
- 10 CFR 60.131(b)(5)(iii) requires that provisions be made so that, if there is a loss of the primary electric power source or circuit, reliable and timely emergency power can be provided to instruments; utility service systems; and operating systems, including alarm systems, important to safety
- 10 CFR 61.81 requires the licensee to perform, or permit the Commission to perform any tests as the Commission deems appropriate or necessary for the administration of the regulations in this part, including tests of radiation detection and monitoring instruments
- 10 CFR 72.124(c) requires that a criticality monitoring system be maintained in each area where special nuclear material is handled, used, or stored which will energize clearly audible alarm signals if accidental criticality occurs, except for dry storage areas as might be anticipated at a repository
- 10 CFR 72.126(b) requires that radiological alarm systems be provided in accessible work areas as appropriate to warn operating personnel of radiation and airborne radioactive material concentrations above a given setpoint and of concentrations of radioactive material in effluents above control limits

10 CFR Part 60 provides complete coverage of the safety functions in subsection 6.8.4.1(4). 10 CFR 60.131(a)(6) requires radiation alarms that warn of (1) increases in radiation levels; (2) increases in concentrations of radioactive materials in air,

assumed to be in the restricted and unrestricted areas; and (3) increases in radioactivity in effluents. 10 CFR Part 60 is similar to 10 CFR Part 72.

(5) Radiation Surveys

The RFA (Ref. 1) identified the need to survey transportation package externals and waste disposal package dose rates. A review of the regulations for pertinent criteria revealed the following:

- 10 CFR 20.1501 on radiation surveys and monitoring requires evaluation of radiation hazards incidental to the use, release, disposal, or presence of radioactive materials including physical survey of the location of materials and equipment, measurement of levels of radiation, or measurement of concentrations of radioactive material present

10 CFR Part 60 references 10 CFR Part 20; thus it addresses the evaluation of radiation hazards by radiation surveys and monitoring.

6.9 ACCESS AND EMPLACEMENT STABILITY

This ROC Topic has the following subtopics:

(1) Design and Construction To Ensure Stability
(2) Stability for Safe Operations such as Emplacement, Retrieval, and Closure

6.9.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) Design and Construction To Ensure Stability

The design of openings in the underground facility, which would include the excavation, backfill, and reinforcement, is sufficiently and adequately regulated in 10 CFR 60.133(e), 60.133(f), 60.133(i), and 60.142(c).

(2) Stability for Safe Operations such as Emplacement, Retrieval, and Closure

The criteria in 10 CFR 60.140 and 60.141 (Performance Confirmation Program) are adequate and sufficient to ensure that monitoring is conducted to detect any significant changes in design parameters and assumptions and in subsequent corrective measures as a result of operations within the repository.

6.9.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) Design and Construction to Ensure Stability

Concept. Criteria are needed to ensure that the design of openings, reinforcement, and backfill as well as the excavation methods ensures stability.

Potential Repository Operational Criteria. Operational criteria needed to address this concept are presented in 10 CFR 60.133(e), 60.133(f), 60.133(i), and 60.142(c). A small correction is recommended to 10 CFR 60.133(i) as follows:

> 60.133(i) Thermal loads. The underground facility shall be designed so that the performance objectives will be met taking into account the predicted thermal and thermomechanical response of the host rock, ~~and~~ surrounding strata, <u>and</u> groundwater system.

Rationale for the Operational Criteria. The criteria in 10 CFR 60.133(e), 60.133(f), and 60.133(i) fully address the concept of opening stability and opening reinforcement because the design (which includes opening size, configuration, and support) of underground openings is required by the criteria to consider all possible underground conditions, especially thermally induced loading conditions and construction methods. According to the definition for "underground facility" provided by 10 CFR 60.2, backfill materials are integral parts of the underground facility, if used. Thus, the appropriate use of backfill materials is required to meet design criteria of 10 CFR 60.133(a), 60.133(c), and 60.133(i). 10 CFR Part 60 does contain separate design criteria for backfill, which by definition is part of the underground facility. The performance confirmation program also requires testing the effectiveness of backfill placement and compaction procedures (10 CFR 60.142(c)). The change to 10 CFR 60.133(i) is typographical in nature.

It should be noted that this typographical error was introduced in the publication of the final rule in the *Federal Register* in 1983 (Ref. 40) when the words "surrounding strata" were added to the proposed rule published in the *Federal Register* in 1981 (Ref. 41).

(2) Stability for Safe Operations such as Emplacement, Retrieval, and Closure

Concept. Criteria are needed to ensure that operations within the repository do not impact stability.

Operational Criteria. Operational criteria needed to address this concept are presented in 10 CFR 60.140 and 60.141.

Rationale for the Operational Criteria. The cited criteria for the performance confirmation program are sufficient and adequate for monitoring any changes in design parameters or assumptions as a result of operations of the geologic repository because if significant differences are found to exist between the measurements and original design base and assumptions, 10 CFR 60.140(d)(4) and 60.141(d) would require appropriate corrective action in the design.

6.9.3 Elements Considered for Regulation

6.9.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) Design and Construction Ensure Stability

Some of the elements relevant to design and construction that may impact access and emplacement stability are as follows:

- Structures, systems, and components
  - Shafts, ramps, drifts, emplacement rooms, emplacement holes, monitoring holes
- Excavation methods
  - Tunnel boring (ramp)
  - Controlled drill and blast (shaft or ramp)
  - Raise boring (shaft)
- Excavation design/extraction ratio
  - Rectangular openings (drifts, ramps)
  - Circular openings (shafts, ramps, drifts)
  - Arched openings (ramps, drifts)
- Materials to stabilize access openings
  - Rock bolts/anchors, plates, wire mesh, steel
  - Shotcrete/concrete for shaft lining
  - High-quality backfill to provide structural stability
- Materials to stabilize emplacement openings
  - Noncorrosive materials (steel, concrete) to line the wall of the borehole, protect the canister, and stabilize the collar
  - Cover/seals (for emplacement boreholes, shafts, and emplacement drifts)
- Procedures and plans
  - Ground control plan

- Inspection/maintenance plan
- Personnel
  - Construction crew
  - Operation crew
  - Hoist operator for shaft
  - Mine inspectors
  - Bolt installers/inspectors
  - Liner installers/inspectors
  - Equipment operators
- Inspections
  - Roof bolt loads
  - Accustic monitoring of seismic activity
  - Opening convergence
  - Fracture or fault inspection to detect movement
  - Monitoring emplacement hole/emplacement liner to assure that instability will not affect the waste canisters
- Construction considerations
- Blasting (shafts, ramps, drifts)
  - Explosives (type, quantity)
  - Detonation/initiation sequence
  - Control overbreak
  - Control (limit) blast vibrations (peak particle velocities and accelerations)
  - Control depth of blast damage
  - Opening spacing
- Drilling (emplacement hole)
  - Hole size, direction, location, alignment
  - Optimum hole spacing to minimize stress overlap
  - Optimum drilling method (overcoring, percussive drilling)
  - Use of water for drilling (impact on stability)
- Support methods
  - Control rock-mass deformation/relaxation (i.e., control extent of stress-relieved zone)
  - Control slip along discontinuities
  - Control separation across discontinuities
  - Control excavation deformation (displacements, rate of deformation, total deformation)

(2) Stability for Safe Operations such as Emplacement, Retrieval, and Closure

Some of the elements relevant to stability for safe operations such as emplacement, retrieval, and closure are as follows:

- Procedures and plans
  - Retrieval plan
  - Waste emplacement plan
  - Repository closure plan (timing and sequence)
  - Monitoring plans
- Environmental conditions
- Thermal load during operations period
  - Stresses, deformations
  - Hydrological changes (impact on stability)
  - Geochemical changes (impact on stability)
- Ventilation during operations
  - Alterations of *in situ* hydrological conditions (degree of saturation)
  - Alteration in geochemical conditions
  - Alteration in mechanical behavior
  - Maintenance of access (temperature control)
- Induced seismic activity/fault movement
  - Excavation
  - Injection of high-pressure fluids (grout)
  - Human-induced seismic events (underground nuclear testing)
  - Large water impoundments
- Removal of underground structures and support

6.9.3.2 *Comments on and Discussion of the Elements Considered for Regulation*

(1) Design and Construction To Ensure Stability

Access stability needs to be maintained for several purposes, such as to:

- Allow safe emplacement of the waste,
- Allow inspection/monitoring of the emplaced waste,
- Provide adequate ventilation during and after emplacement,
- Allow timely retrieval of waste,
- Provide emergency egress,
- Allow installation of backfill and sealing, and
- Ensure the emplaced waste is safe.

Ensuring the stability of openings so that operations and retrieval can be carried out safely appears to be adequately covered in 10 CFR 60.133(e)(1), 60.133(e)(2), and 60.133(f) for the underground facility. 10 CFR 60.133(e)(2) specifically requires that the openings be designed to reduce the potential for deleterious rock movement or fracturing of overlying or surrounding rock. It is reasonable to assume that "openings" include accesses and emplacement rooms as well as the waste emplacement holes.

10 CFR 60.133(i) is sufficient in ensuring that the design of the underground facility be designed so that the performance objectives can be met taking into account the predicted thermal and thermomechanical response of the host rock and surrounding strata and the groundwater system. A potential uncertainty was raised by the NRC Staff in Uncertainty Reference Number 44, Appendix A, Page 5, (Ref. 8), regarding whether the interpretation of "performance objectives" in 10 CFR 60.133(i) applied only to preclosure performance objectives in 10 CFR 60.111, or to the postclosure performance objectives in 10 CFR 60.112 and 60.113 as well. The NRC staff's final position was that 10 CFR 60.133 applied to both preclosure and postclosure performance objectives and that only staff guidance was necessary to clarify this point.

10 CFR 60.141(c) and 60.141(e) are sufficient in requiring *in situ* measurements of the changes in rock stresses and displacements as a result of excavation and of thermal and thermomechanical loadings to ensure that performance of natural and engineered barriers, which include the underground openings, are within design limits throughout the operational period. A comparison of these measurements to the original design bases and assumptions to determine if there are any significant changes and need for modifications in the design or construction method is required in 10 CFR 60.141(d).

10 CFR 60.111(b)(2) gives sufficient flexibility to allow backfilling part or all of the GROA prior to the period of design for retrievability. This could be necessary in certain geologic settings (e.g., rock salt) to maintain opening stability after waste emplacement and up through the period for retrievability, depending on the type and quality of the emplaced backfill.

Access openings also need to be designed and maintained to allow retrieval in a timely manner, as required in 10 CFR 60.111(b)(1), 60.46(a)(1), and 60.133(c). Based on these criteria, one could make an argument that it would be acceptable to demonstrate that access can be re-established, rather than to explicitly require, for the purpose of retrieving, that the access be maintained. However, 10 CFR 60.133(e)(2) specifically requires that the opening stability be maintained, at least through the period of operations, which includes possible retrieval. Maintaining stability of the emplacement and access rooms, drifts, shafts, and ramps would facilitate retrieval. Reinforcement and support would normally be sufficient to maintain stability in accordance with 10 CFR 60.133(e)(2). However, in some geologic settings backfilling of the openings upon waste emplacement may be necessary to ensure long-term stability. The design features for such backfill would need to ensure that it provides adequate structural stability. 10 CFR Part 60 does contain design criteria for backfill, which by definition is part of the underground facility. The performance confirmation program adequately requires testing of the effectiveness of backfill placement and compaction procedures. For land disposal of radioactive waste, 10 CFR 61.12(b) requires a description of design features including the structural stability of backfill. 10 CFR Part 60 contains no such requirement.

(2) **Stability for Safe Operations such as Emplacement, Retrieval, and Closure**

Operations within the repository could extend up to a period of 100 years, based on existing regulations in 10 CFR 60.111(b). Because of this long time period, many operational aspects of the repository could have a potentially negative impact on opening stability. For instance, ventilation over the long term could have an impact on the stability of openings because of weathering and changes in saturation of the surrounding rock. Induced seismicity as a result of (1) drill and blast methods or (2) injection of grout or other fluids under high pressure for reinforcement or to seal off zones of water inflow could cause potential for movement along nearby faults or fracture zones, effecting long-term stability. Finally, thermal loading during the operational period could result in significant thermomechanical stresses effecting stability in the rock surrounding the openings. However, thermal loading is explicitly addressed in the design requirement 10 CFR 60.133(i).

10 CFR 60.131(b)(9) references 30 CFR, Chapter I which regulates mining operations, machinery and equipment specifications, and non-radiological health and safety. Many of these regulations can apply to ground control in underground mining operations, which could apply to an underground repository. Also, see the section 6.4 ROC Topic.

6.9.4 Safety Functions and Regulatory Citations

6.9.4.1 Associated Safety Functions

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

(1) **Design and Construction To Ensure Stability**

- Ensure the stability of general purpose (non-waste handling) waste preparation surface facilities under local foundation conditions - 5.22
- Ensure the ability of general purpose (non-waste handling) waste preparation facilities to perform their intended functions under naturally induced conditions and events (e.g., weather, seismic activity) - 5.23
- Ensure the ability of general purpose (non-waste handling) waste preparation facilities to perform their intended functions under conditions and events induced by human activities - 5.24

- Ensure the stability of waste preparation facilities under local foundation conditions - 5.31
- Ensure the ability of waste preparation facilities and equipment important to safety to perform their intended functions under naturally induced conditions and events (e.g., weather, seismic) - 5.32
- Ensure the ability of waste preparation facilities and equipment important to safety to perform their intended functions under conditions and events induced by human activities 5.33
- Maintain the stability of the underground access facilities and emplacement openings/locations during removal operations - 6.23
- Ensure the stability of repository surface facilities important to safety or isolation under local foundation conditions - 6.34
- Ensure the ability of repository facilities and equipment important to safety or isolation to perform their intended functions under naturally induced conditions and events (e.g., weather, seismic activity) - 6.35
- Ensure the ability of repository facilities and equipment important to safety or isolation to perform their intended functions under conditions and events induced by human activity - 6.36
- Limit alterations of the geologic media that adversely affect performance - 6.39
- Limit alterations of existing discontinuities that adversely affect performance (preferential pathways to or between aquifers) - 6.39.1
- Limit creation of new discontinuities that adversely affect performance (preferential pathways to or between aquifers) - 6.39.2
- Limit proximity of openings to preferential pathways - 6.39.3
- Limit adverse effects on geochemistry - 6.39.4
- Limit proximity of waste emplacement openings/locations to fault or fracture zones - 6.40
- Facilities for waste emplacement operations - 6.41.5.1
- Access to waste emplacement opening/location (e.g., shafts, ramps, drifts) - 6.41.5.1.1
- Waste emplacement openings/locations - 6.41.5.1.2
- Waste emplacement opening/location interface with emplacement equipment - 6.41.5.1.3

- Equipment to excavate, muck, and transfer backfill (if required) - 6.41.7.2.1

(2) **Stability for Safe Operations such as Emplacement, Retrieval, and Closure**

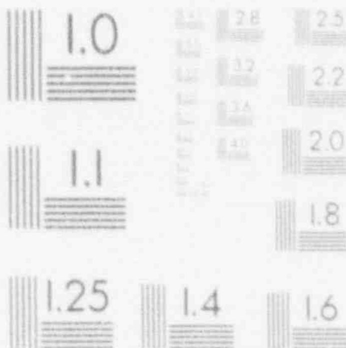
- Facilities for waste packaging - 5.35.5.1
- Prepare emplacement drifts for reentry to underground facility for waste removal operations (e.g., cool, stabilize (if required)) - 6.9.3
- Provide access to waste disposal package opening/location in underground facility during waste removal operations - 6.9.5
- Remove physical impediments to waste disposal package removal from underground facility (e.g., debris, cover or plug) - 6.9.6
- Close waste emplacement opening following waste removal (if required) - 6.9.17
- Close waste access opening following waste removal operations (if required) - 6.9.18
- Ensure the stability of repository surface facilities important to safety or isolation under local foundation conditions - 6.34
- Repository facilities for waste receiving operations - 6.41.2.1
- Facilities for waste removal operations - 6.41.7.1
- Interface between emplacement opening/location and waste removal equipment - 6.41.7.1.2
- Equipment to locate and gain access to waste disposal package (if required) - 6.41.7.2.2

6.9.4.2 Relevant Regulatory Citations

- 10 CFR 60.2, 60.15, 60.21(c)(1)(ii)(E), 60.21(c)(3), 60.46(a)(1), 60.111, 60.112, 60.113, 60.131(b), 60.133, 60.134, 60.140, 60.141, and 60.142(c)
- 10 CFR 61.12(b) and 61.44
- 10 CFR 72.102(c) and 72.102(d)
- 10 CFR 100, Appendix A-V. (d)(1)(v)
- 30 CFR Part 57

2

IMAGE EVALUATION TEST TARGET (MT-3)



150mm

6"

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P.O. BOX 338
WEBSTER, NEW YORK 14580
(716) 265-1600

2

IMAGE EVALUATION TEST TARGET (MT-3)

1.0 1.1 1.25 1.4 1.6 1.8 2.0 2.2 2.5 2.8 3.2 3.6 4.0

150mm

6"

PHOTOGRAPHIC SCIENCES CORPORATION
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6.9.4.3 *Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations*

(1) Design and Construction To Ensure Stability

10 CFR Part 60 appears to adequately assure the protection of structures, systems, and components important to safety due to natural and human induced conditions [10 CFR 60.131(b)] as indicated by the safety functions in subsection 6.9.4.1(1). The regulations do not directly identify structures such as shafts, ramps, and emplacement openings as being important to safety; however, 10 CFR 60.21(c)(ii)(E) does require an analysis of the performance of the major design structures, systems, and components to identify those that are important to safety.

The sections 6.6 and 6.7 ROC Topics discuss the postclosure impacts regarding the safety function that deals with limiting the alterations of the geologic media that adversely affect performance. This function is addressed in 10 CFR 60.15(c)(1), 60.15(c)(2), 60.15(c)(3), 60.133(e)(2), 60.133(f), and 60.140(d)(1). However, 10 CFR 60.15 deals only with openings created during site characterization, and 10 CFR 60.133 deals only with the underground facility. Additional shafts and ramps constructed for the GROA are adequately regulated in 10 CFR 60.112 regarding the overall performance objectives and in a more general sense in 10 CFR 60.134 regarding the design criteria for seals.

Two safety functions require design of the waste emplacement surface facilities to ensure stability under local soil conditions. 10 CFR Part 60 does not directly address criteria for ensuring the stability of surface structures under local soil conditions (i.e., liquefaction) as is cited in 10 CFR 72.102(c) and 72.102(d) and in 10 CFR Part 100, Appendix A-V.(d)(1)(v). However, 10 CFR 60.131(b)(1) requires that "structures, systems, and components important to safety shall be designed so that natural phenomena and environmental conditions anticipated at the geologic repository will not interfere with necessary safety functions." To most engineers, these criteria would imply that structures, systems, and components important to safety would be designed to take into account natural conditions such as foundation (soil or rock) instability.

Regulatory requirement 10 CFR 60.21(c)(3) requires " a description and analysis of the design . . . for structures, systems, and components which are important to safety . . . under normal conditions . . . under conditions that may result from anticipated operational occurrences . . . and for the prevention of accidents and mitigation of the consequences of accidents . . . ." 10 CFR 60.111(a) has an implicit requirement for stability if instabilities might affect radiation exposures or radiation releases, as does 10 CFR 60.131(b)(1) and 60.131(b)(9). 10 CFR 60.133(e) imposes broader requirements for the stability of excavations.

10 CFR 61.44 requires that "the disposal facility must be sited, designed, used, operated and closed to achieve long-term stability . . . ." This requirement

appears to be more all encompassing in scope than the more narrowly focused and more specifically detailed requirements in 10 CFR Part 60.

(2) Stability for Safe Operations such as Emplacement, Retrieval, and Closure

30 CFR Part 57 is heavily operations oriented, with emphasis on personnel safety (in the nonradiological sense only). It addresses drifting and mine safety, but does not address stability as it might relate to long-term access or to waste package damage.

6.10 PERFORMANCE CONFIRMATION FOR PRECLOSURE PERFORMANCE OBJECTIVES AND DESIGN CRITERIA

This ROC Topic has the following subtopics:

(1) Definition of Performance Confirmation
(2) Preclosure Verification of Design for Safety
(3) Performance Confirmation Integration - See the section 6.11 ROC Topic
(4) Performance Confirmation Plans - See the section 6.11 ROC Topic
(5) Quality Assurance for Performance Confirmation - See the section 6.11 ROC Topic
(6) Monitoring - See the section 6.11 ROC Topic

6.10.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) Definition of Performance Confirmation

The definition of "performance confirmation" may be enhanced in order to not appear to exclude addressing performance confirmation related to the retrieval performance objective in 10 CFR 60.111(b).

(2) Preclosure Verification of Design for Safety

Verification of the GROA necessary to ensure that the design is adequate for radiation safety is sufficiently and adequately addressed in 10 CFR 60.74(a).

(3) Performance Confirmation Integration

See the section 6.11 ROC Topic.

(4) Performance Confirmation Plans

See the section 6.11 ROC Topic.

(5) **Quality Assurance for Performance Confirmation**

See the section 6.11 ROC Topic.

(6) **Monitoring**

See the section 6.11 ROC Topic.

6.10.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) **Definition of Performance Confirmation**

Concept. Performance confirmation for retrieval needs to be included in the definition of performance confirmation.

Potential Repository Operational Criterion. An enhancement to the definition of "performance confirmation" in 10 CFR 60.2 may be as follows:

> 60.2 *Performance confirmation* means the program of tests, experiments, and analyses that is conducted to evaluate the accuracy and adequacy of the information used to determine with reasonable assurance that the performance objectives for retrieval and for the period after permanent closure will be met.

Rationale for the Operational Criteria. The existing definition for performance confirmation in 10 CFR 60.2 is limited to postclosure performance objectives. The definition may be enhanced to include performance confirmation for preclosure retrieval performance.

Note: Tests to verify the operation design of the GROA for radiation safety are presented in 10 CFR 60.74(a).

(2) **Preclosure Verification of Design for Safety**

Concept. Criteria are needed for verification of data and information used for GROA design for safety.

Operational Criteria. Operational criteria to address this concept are presented in 10 CFR 60.74(a).

Rationale for the Operational Criteria. The current requirements in 10 CFR 60.74(a) fully address this concept because these criteria are generally written to cover all safety aspects of operations.

(3) **Performance Confirmation Integration**

See the section 6.11 ROC Topic.

(4) **Performance Confirmation Plans**

See the section 6.11 ROC Topic.

(5) **Quality Assurance for Performance Confirmation**

See the section 6.11 ROC Topic.

(6) **Monitoring**

See the section 6.11 ROC Topic.

6.10.3 Elements Considered for Regulation

6.10.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) **Definition of Performance Confirmation**

The two elements that can be associated with performance confirmation are as follows:

- Performance confirmation for preclosure objectives
- Performance confirmation for postclosure objectives

(2) **Preclosure Verification of Design for Safety**

Some of the elements relevant to confirming environmental information relevant to retrieval and radiation control are as follows:

- Anticipated conditions and events
- Off-normal conditions and events
- Characteristics of releases from waste packages (radiation accidents)

(3) **Performance Confirmation Integration**

See the section 6.11 ROC Topic.

(4) **Performance Confirmation Plans**

See the section 6.11 ROC Topic.

(5) **Quality Assurance for Performance Confirmation**

See the section 6.11 ROC Topic.

(6) **Monitoring**

See the section 6.11 ROC Topic.

6.10.3.2 Comments on and Discussion of the Elements Considered for Regulation

(1) **Definition of Performance Confirmation**

In large measure, the structures, systems, components, equipment, operations, procedures, personnel requirements, and environmental conditions appropriate to this ROC Topic require testing and monitoring for design verification. Certainly, 10 CFR 60.74(a) allows for the possibility of any related testing. Performance confirmation is limited to postclosure performance objectives, which exclude retrieval. The scope of performance confirmation is limited to postclosure performance objectives by the definition of "performance confirmation" in 10 CFR 60.2. Examples of retrieval performance measures to be addressed with respect to performance confirmation may include radiation shielding properties of rock for off-normal conditions and events, rock strength, rock creep, and fault location and seismic activities.

(2) **Preclosure Verification of Design for Safety**

Site information used for designing for retrieval may be necessary in order to assure that waste can be retrieved.

(3) **Performance Confirmation Integration**

See the section 6.11 ROC Topic.

(4) **Performance Confirmation Plans**

See the section 6.11 ROC Topic.

(5) **Quality Assurance for Performance Confirmation**

See the section 6.11 ROC Topic.

(6) **Monitoring**

See the section 6.11 ROC Topic.

6.10.4 Safety Functions and Regulatory Citations

6.10.4.1 Associated Safety Functions

(1) **Definition of Performance Confirmation**

No safety functions associated with the definition of performance confirmation were identified from the "Repository Functional Analysis" (Ref. 1).

(2) **Preclosure Verification of Design for Safety**

No safety functions associated with this subtopic were identified from the "Repository Functional Analysis" (Ref. 1).

(3) **Performance Confirmation Integration**

See the section 6.11 ROC Topic.

(4) **Performance Confirmation Plans**

See the section 6.11 ROC Topic.

(5) **Quality Assurance for Performance Confirmation**

See the section 6.11 ROC Topic.

(6) **Monitoring**

See the section 6.11 ROC Topic.

6.10.4.2 Relevant Regulatory Citations

- 10 CFR 60.2, 60.43, 60.44, 60.74(a), 60.74(b), 60.111(b), 60.131(b)(1), 60.133(a), 60.133(b), 60.133(c), 60.133(d), 60.133(e), 60.133(f), 60.133(g), and 60.133(i)

6.10.4.3 Comments on and Comparison and Contrast of Functions and Regulatory Citations

(1) Definition of Performance Confirmation

The definition for performance confirmation given in 10 CFR 60.2 is: "the program of tests, experiments, and analyses which is conducted to evaluate the accuracy and adequacy of the information used to determine with reasonable assurance that the performance objectives *for the period after permanent closure* will be met." This definition, therefore, excludes performance confirmation for the preclosure performance objectives and designs, which include retrieval. However, 10 CFR 60.74(b) requires that testing and verification of natural and engineered systems and components be conducted to ensure designs are functioning as intended and anticipated. Also, 10 CFR 60.43 requires license conditions that can address verification of design adequacy, and 10 CFR 60.44 allows for changes in the design to assure adequacy.

Waste retrievability is one of the primary performance objectives that may need to be confirmed for the preclosure period. Several design criteria are also related to retrieval such as 10 CFR 60.131(b)(1), 60.133(a), 60.133(b), 60.133(c), 60.133(d), 60.133(e), 60.133(f), 60.133(g), and 133(i).

(2) Preclosure Verification of Design for Safety

The definition of "performance confirmation," does not require confirmation of preclosure repository performance (radiation control and retrieval, if necessary). Testing to verify that the design can meet the preclosure performance objectives is addressed by 10 CFR 60.74(a).

(3) Performance Confirmation Integration

See the section 6.11 ROC Topic.

(4) Performance Confirmation Plans

See the section 6.11 ROC Topic.

(5) Quality Assurance for Performance Confirmation

See the section 6.11 ROC Topic.

(6) Monitoring

See the section 6.11 ROC Topic.

6.11 DESIGN, CONSTRUCTION, AND OPERATION OF THE GROA NECESSARY TO ENSURE THAT PERFORMANCE CONFIRMATION FOR THE POSTCLOSURE PERFORMANCE OBJECTIVES CAN BE CONDUCTED

This ROC Topic has the following subtopics:

(1) Performance Confirmation Integration
(2) Performance Confirmation Plans
(3) Quality Assurance for Performance Confirmation
(4) Monitoring
(5) Adverse Impacts

6.11.1 Conclusions Regarding the Sufficiency and Adequacy of the Regulations

(1) Performance Confirmation Integration

Integration of the performance confirmation program (with respect to postclosure performance objectives) with repository design, construction, and operations is adequately and sufficiently addressed in 10 CFR Part 60. It is clearly the responsibility of the applicant to ensure that design, construction, and operation of the GROA permit the performance confirmation program to be carried out.

(2) Performance Confirmation Plans

It may be an enhancement to 10 CFR Part 60 to require the applicant to provide a description of the performance confirmation program in the license application. At the present time there is no explicit requirement to submit such a description. 10 CFR Part 60 contains the notion that the performance confirmation program should be planned [see 10 CFR 60.111(b) and 60.140(d)(4)], but has no formal requirement for DOE to submit a performance confirmation program description. Since performance confirmation will be an integral and important part of the construction phase, it would seem appropriate for DOE to submit such a description in the license application for construction authorization, for review by the NRC.

(3) Quality Assurance for Performance Confirmation

Quality assurance for performance confirmation has been adequately and sufficiently covered because 10 CFR 60.151 cites performance confirmation and 10 CFR 60.152 references 10 CFR Part 50, Appendix B.

(4) Monitoring

Criteria for inspection, calibration, and maintenance of performance confirmation monitoring equipment are adequate and sufficient because 10 CFR 60.151 cites performance confirmation and 10 CFR 60.152 references 10 CFR Part 50, Appendix B.

(5) Adverse Impacts

10 CFR 60.140(d)(1) adequately and sufficiently addresses criteria related to adverse impact on repository performance when conducting the performance confirmation program. The requirement is understood not to prohibit useful tests that would have trivial impacts upon repository performance, while assuring that significant potentially adverse effects are taken into account in designing the performance confirmation program.

6.11.2 Concepts, Operational Criteria, and Rationale

This subsection presents the concepts, operational criteria, and rationale that were developed to substantiate the conclusions presented above.

(1) Performance Confirmation Integration

Concept. Criteria for integration of the performance confirmation program with repository design, construction, and operations are needed.

Operational Criteria. Operational criteria required to address this concept are presented in 10 CFR 60.32(b) and 60.137.

Rationale for the Operational Criteria. The criteria in 10 CFR 60.32(b) and 60.137 fully address this concept because they provide integration between the performance confirmation program and repository design, construction, and operations.

(2) Performance Confirmation Plans

Concept. Criteria are needed for the license application to describe the performance confirmation program so that NRC can evaluate an update of the performance confirmation program (which is to begin during site characterization) during the license application review.

Potential Repository Operational Criterion. As suggested by NRC regarding Uncertainty Reference Number 6, page 8 of Appendix A, in its "Recommendations" report (Ref. 8), 10 CFR 60.21(c)(14) should be redesignated as 60.21(c)(14)(i) and a new 10 CFR 60.21(c)(14)(ii) should be added to read:

60.21(c)(14)(ii) The Safety Analysis Report shall include a description of the performance confirmation program.

Rationale for the Operational Criteria. Including a description of the performance confirmation program in the license application is important to help provide reasonable assurance of protection of health and safety. This suggested rule change and rationale were adopted from NRC's "Recommendations" report (Ref. 8) on page 8 of Appendix A. The description will be an update of the performance confirmation program because the program will have been established in the Site Characterization Plan (Ref. 42) in Section 8.3.5.16.

(3) Quality Assurance for Performance Confirmation

Concept. A quality assurance program needs to apply to the performance confirmation activities.

Operational Criteria. Operational criteria required to address this concept are presented in 10 CFR 60.17(a)(2)(v), 60.31(a)(3), 60.42(b)(3), and 60.152.

Rationale for the Operational Criteria. The above cited criteria fully address the concept because performance confirmation activities are among the activities requiring quality assurance control. The contents of the Site Characterization Plan (Ref. 42) contain provision for plans to apply quality assurance to data collection, which includes data and information for performance confirmation. During repository construction and operation, the application of the quality assurance program to the performance confirmation program is governed by the construction authorization [10 CFR 60.31(a)(3)] and the license condition [10 CFR 60.42(b)(3)] for QA.

(4) Monitoring

Concept. Criteria are needed for inspection, calibration, and maintenance of monitoring equipment used for performance confirmation.

Operational Criteria. Operational criteria required to address this concept are presented in the QA criteria in 10 CFR Part 50, Appendix B.

Rationale for the Operational Criteria. 10 CFR Part 50, Appendix B, addresses the concept fully because it broadly addresses several aspects of inspection, calibration, and monitoring. Specifically this concept is addressed in Sections X - Inspection; XI - Test Control, XII - Control of Measuring and Test Equipment; XII - Handling, Storage, and Shipping; and XIV - Inspection, Test, and Operating Status.

(5) **Adverse Impacts**

Concept. Criteria are needed so performance confirmation activities do not adversely affect the geologic repository's ability to meet the performance objectives.

Operational Criteria. Operational criteria required to address this concept are presented in 10 CFR 60.140(d)(1).

Rationale for the Operational Criteria. 10 CFR 60.140(c)(1) fully addresses this concept because according to Section 2.2, page 11 of NUREG-0804 (Ref. 13), 10 CFR 60.140(d)(1) was previously modified so as not to prohibit useful tests that would have trivial impacts upon the repository's performance, while assuring that significant potentially adverse effects are taken into account in designing the performance confirmation program.

6.11.3 Elements Considered for Regulation

6.11.3.1 Structures, Systems, Components, Equipment, Operations, Procedures, Personnel Requirements, Environmental Considerations, Etc.

(1) **Performance Confirmation Integration**

Elements for integration of the performance confirmation program with repository design, construction and operation are: (1) procedures for selecting performance confirmation test sites and the extent of testing and (2) procedures for selecting seals and backfill test sites and the extent of testing.

(2) **Performance Confirmation Plans**

Plans for the performance confirmation program should address all aspects of the performance confirmation program.

(3) **Quality Assurance for Performance Confirmation**

Quality assurance, testing, evaluation procedures, etc. for performance confirmation should be similar to quality assurance for site characterization and other data collection activities.

(4) **Monitoring**

Elements of monitoring related to the performance confirmation program are as follows:

- Waste emplacement hole
- Waste emplacement hole liner
- Waste package
- Natural systems of the geologic setting
  - Geologic system
  - Hydrologic system
  - Geochemical system
  - Climatological and meteorological system
- Seals performance
- Backfill performance
- Monitoring instrumentation
  - Sensors
  - Extensometers
  - Stress cells
  - Thermocouples
- Procedures for testing seals, backfill, engineered barrier, etc.
- Inspection, calibration, and maintenance of the monitoring equipment

(5) **Adverse Impacts**

Performance confirmation could have adverse impacts on waste isolation, waste retrieval, or radiation control.

6.11.3.2 Comments on and Discussion of the Elements Considered for Regulation

(1) **Performance Confirmation Integration**

Integration of the performance confirmation program with site characterization and repository construction and operations is required, since the program is to start during site characterization and will continue until permanent closure [10 CFR 60.140(b)]. This is implied in a number of regulatory requirements in 10 CFR Part 60, Subpart F (60.140 through 60.143), specifically in 60.141(a), 60.142(a), and 60.142(c). Further, in the NRC "Generic Technical Position on In Situ Testing During Site Characterization for High-Level Nuclear Waste Repositories," Section 5.6 (Ref. 43), DOE is required in its test plan for site characterization to identify which tests will be completed at the time of construction authorization application, and which tests and long-term activities will continue thereafter.

A description of how the performance confirmation program will be initiated and integrated with Site Characterization was provided in DOE's 1988 "Site Characterization Plan" (Ref. 42), while performance confirmation during the repository construction phase is covered in the conditions of construction authorization 10 CFR 60.32(b).

(2) **Performance Confirmation Plans**

In large measure, the structures, systems, components, equipment, operations, procedures, personnel requirements, and environmental conditions relevant to this ROC Topic depend on the extent of testing and monitoring done as part of the performance confirmation program. 10 CFR 60.74 allows for the possibility of greatly expanding the performance confirmation program and related testing. Some examples related to the required extent of testing are given below:

- *Direct Observations* - Performance confirmation could, for example, include direct observations of the behavior of the waste package and waste package environment under repository conditions at any time prior to construction authorization or during construction.
- *Off-Normal Conditions* - Performance confirmation could include tests of repository response under off-normal conditions and events with respect to postclosure performance objectives.
- *Test Interference* - One of the biggest obstacles to designing, constructing, and operating the GROA to ensure that performance confirmation for the postclosure performance objectives can be conducted relates to test interference. Test interference could result from the following:
  - Failure to allow for uncertainties involved in calculating zones of influence for various tests and consequently placing tests too close together.
  - Failure to adequately address the compatibility of some construction operations and drift ventilation. Operational requirements (e.g., storage of mobile equipment, drill steel, blasting materials, vent pipes, water pipes, support, reinforcement, disabled equipment, etc.) may encroach on some test locations. Ventilation in access drifts may also affect some sensitive tests.
  - Failure to adequately allow for uncertainties in a dedicated test area. Some areas may not be suitable for performance confirmation testing due to proximity to weak zones, faults, breccia, etc.
  - Failure to adequately separate performance confirmation testing from repository construction and/or emplacement areas resulting in interference from construction and/or waste emplacement.
  - Failure to properly sequence tests and allow for testing delays resulting in test postponement or shortening.
  - Failure in allowing for uncertainties involved in zones of

influence for various site characterization tests and, consequently, placing tests too close to "disturbed" areas.

These elements and other important issues should be addressed in the DOE's performance confirmation program. It is the DOE's responsibility to make sure that all important aspects are covered in its performance confirmation program, while it is NRC's responsibility to determine whether the DOE's program is adequate. In order for NRC to have a timely evaluation of such a performance confirmation program, it would seem prudent to have the performance confirmation program included in the license application. Presently, there is no such requirement.

(3) Quality Assurance for Performance Confirmation

The proposed rule 10 CFR Part 60 had a section 60.153 entitled "Quality assurance for performance confirmation." However, this section of the proposed rule was deleted because performance confirmation was referenced in 10 CFR 60.151. The quality assurance program to be implemented is regulated by 10 CFR 60.152, which references Appendix B of 10 CFR Part 50.

(4) Monitoring

Planning and implementation of long-term monitoring programs require that the following points be considered: equipment for use in monitoring, taking into account the natural conditions to which the equipment would be subjected (e.g., *in situ* stress state, rock and water chemistry, and thermal regime); recording and data-gathering equipment; physical and environment aspects that must be monitored to address concerns about long-term health and safety issues; determination of baseline conditions to which collected data can be compared; processing the collected data to determine if health and safety concerns exist; preparation of procedures for the monitoring activities; and training and certification of personnel in proper use of the monitoring-activity procedures.

Considering the required aspects discussed above, it could be considered useful for 10 CFR Part 60 to provide more detail about what should be monitored in order to ensure that public health and safety are not compromised after permanent closure. This suggestion is made because it would appear that the NRC will need to be involved with reviewing data from monitoring programs to determine if any unforeseen problems develop.

In connection with monitoring programs, there are potential design considerations related to the following:

- Monitoring and data-collection equipment
- Protective housings for the monitoring equipment
- Optimum instrumentation locations

In connection with monitoring programs, the potential construction considerations relate to the following:

- Location and construction of instrumentation housings for protective purposes
- Hold-up of construction while instruments are being emplaced, calibrated, repaired, or replaced

In connection with monitoring programs, the potential operations considerations relate to the following:

- Hold-up of activities while monitoring equipment is being emplaced, checked, calibrated, repaired, or replaced
- Inspection and maintenance of recording equipment and monitoring equipment
- Inspection and maintenance of protective housings for monitoring equipment
- Preparation of procedures for the monitoring activities
- Training and certification of personnel in use of the procedures for monitoring activities

(5) Adverse Impacts

Performance confirmation testing has the potential to adversely affect the ability of the natural and engineered elements of the geologic repository to meet the postclosure performance objectives. 10 CFR 60.140(d)(1) indicates that the performance confirmation program should be implemented such that there is no such adverse impact. Cases may arise when performance confirmation testing might adversely impact postclosure performance, but the impact may be insignificant. For example, an exploratory borehole may have an adverse impact, but the impact may be insignificant, and the postclosure performance criteria can still be met.

6.11.4 Safety Functions and Regulatory Citations

6.11.4.1 Associated Safety Functions

(1) Performance Confirmation Integration

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

- Verify integrity of waste disposal package and, if used, emplacement opening backfill during waste emplacement operations - 6.6.9

- Install, calibrate, and test (sub)surface postclosure monitoring equipment (as applicable) - 6.11.1.4, 6.11.2.1, and 6.11.3.2
- Verify readiness for final closure - 6.11.1.8

(2) Performance Confirmation Plans

No safety functions associated with this subtopic were identified from the "Repository Functional Analysis" (Ref. 1).

(3) Quality Assurance for Performance Confirmation

No safety functions associated with this subtopic were identified from the "Repository Functional Analysis" (Ref. 1).

(4) Monitoring

The following safety functions were identified from the "Repository Functional Analysis" (Ref. 1).

- Monitor personnel reliability - 2.4
- Computational capability for security and safeguards (e.g., monitor intrusion and access/egress control) - 2.20.2.3
- Procedure(s) to monitor personnel reliability - 2.20.5.3
- Monitor waste preparation conditions that affect radiological health and safety (see 6.8, Monitor repository conditions that affect radiological health and safety during repository operations) - 5.9
- Monitor radionuclide releases during waste preparation operations - 5.17.1.1
- Software for waste packaging operations (e.g., inventory, process control, monitoring) - 5.35.5.3
- Monitor waste receiving conditions that affect radiological health and safety (see 6.8, Monitor repository conditions that affect radiological health and safety) - 6.2.7
- Install monitoring equipment for waste emplacement (as required) - 6.6.8
- Monitor waste emplacement conditions that affect radiological health and safety during waste emplacement operations (see 6.8, Monitor repository conditions that affect radiological health and safety) - 6.6.16
- Continuously monitor radiation levels during repository operations - 6.8.1.1

- Monitor environmental conditions and provide warning of potentially hazardous conditions or events during repository operations (e.g., air contamination, seismic event) - 6.8.1.2
- Continuously monitor personnel radiation exposure levels during repository operations - 6.8.1.3
- Monitor waste removal conditions that affect radiological health and safety during waste removal operations (see 6.8, Monitor repository conditions that affect radiological health and safety) - 6.9.19
- Monitor conditions during preparation for off-site shipment that affect radiological health and safety (see 6.8, Monitor repository conditions that affect radiological health and safety) - 6.10.10
- Install, calibrate, and test (sub)surface postclosure monitoring equipment (as applicable) - 6.11.1.4, 6.11.2.1, and 6.11.3.2
- Examine performance capability of seals/backfills and monitoring equipment previously emplaced - 6.11.1.5
- Repair/replace previously emplaced seals and/or backfill and monitoring equipment (as required) - 6.11.1.6
- Monitor radionuclide releases during waste disposal operations - 6.17.1.1
- Ensure operability of repository general purpose (non-waste handling) facilities and equipment - 6.29
- Ensure the stability of repository surface facilities important to safety or isolation under local foundation conditions - 6.34
- Ensure the ability of repository facilities and equipment important to safety or isolation to perform their intended functions under naturally induced conditions and events (e.g., weather, seismic activity) - 6.35
- Ensure fitness for duty of personnel certified for repository operations that are important to safety or isolation - 6.37
- Software for repository waste receiving operations (e.g., inventory, process control, monitoring) - 6.41.2.3
- Software for waste lag storage (e.g., inventory, process control, monitoring) during repository operations - 6.41.3.3
- Software for waste transfer operations (e.g., inventory, monitoring) - 6.41.4.3
- Software for waste emplacement operations (e.g., inventory, process control, monitoring) - 6.41.5.3

- Repository monitoring generic system elements (radiological and non-radiological) - 6.41.6
- Facilities for monitoring during repository operations - 6.41.6.1
- Equipment for monitoring and alarm during repository operations - 6.41.6.2
- Software for monitoring during repository operations - 6.41.6.3
- Trained and certified personnel for monitoring during repository operations - 6.41.6.4
- Procedure(s) for monitoring during repository operations - 6.41.6.5
- Software for waste removal operations (e.g., inventory, process control, monitoring) - 6.41.7.3
- Facility for repository postclosure monitoring - 6.41.9.1.9
- Equipment for postclosure monitoring - 6.41.9.2.12
- Closure and decommissioning software (e.g., inventory, process control, monitoring) - 6.41.9.3
- Trained and certified personnel for post-closure monitoring - 6.41.9.4.11
- Procedure(s) for postclosure monitoring - 6.41.9.5.11
- Monitor for drilling or excavation in or adjacent to the controlled area - 7.4.7

(5) **Adverse Impacts**

No safety functions associated with this subtopic were identified from the "Repository Functional Analysis" (Ref. 1).

6.11.4.2 Relevant Regulatory Citations

- 10 CFR Part 50, Appendix B
- 10 CFR 60.2, 60.15(c)(4), 60.15(d)(1), 60.17(a)(2)(v), 60.18(d), 60.21(c)(14), 60.24(b)(1), 60.31, 60.32(b), 60.42(b)(3), 60.74, 60.111(b), 60.131(b)(6), 60.131(b)(8), 60.132(c)(2), 60.137, 60.140, 60.141, 60.142, 60.143, 60.151, 60.152, and 60.153
- 10 CFR 61.12(k), 61.12(l), 61.29, 61.53(c), 61.53(d), and 61.59(b)

6.11.4.3 Comments on and Comparison and Contrast of Safety Functions and Regulatory Citations

(1) Performance Confirmation Integration

The performance confirmation program needs to be fully integrated with the repository facilities and with the stages in the licensing process. Integration of repository facilities with performance confirmation is addressed by 10 CFR 60.137, which states: "The geologic repository operations area shall be designed so as to permit implementation of a performance confirmation program that meets the requirements of Subpart F of this part." Here the word "designed" is understood to imply designed, constructed, and operated.

Performance confirmation is to start during site characterization and continue through permanent closure, per 10 CFR 60.140(b). Specific requirements for conducting or reporting performance confirmation activities within each of these stages are in 10 CFR 60.18(d), 60.24(b)(1), 60.32(b), and 60.137 and in 10 CFR Part 50, Appendix B.

The roles and responsibilities of performance confirmation and site characterization overlap considerably, even during construction. Subsurface exploratory drilling, excavation, and *in situ* testing (which are all site characterization activities) are to be coordinated during construction with the GROA design and construction [10 CFR 60.15(c)(4)]. This implies that assessment of geotechnical and design parameters, such as those described in 10 CFR 60.141, will be made as part of the site characterization program and the performance confirmation program.

The general provisions of 10 CFR 60.140 require that the performance confirmation program provides data which indicate, where practicable, whether conditions and behavior are as anticipated. The provisions for design testing in 10 CFR 60.142 require that testing be initiated "as early as practicable." The phrases "where practicable" and "as early as is practicable" are open to a wide range of interpretations.

10 CFR 60.31 relates various Subparts of 10 CFR Part 60 to review and consideration of construction authorization which, in turn, regulates the authorized activities of DOE. One of these DOE activities is the performance confirmation program (described in Subpart F of 10 CFR 60), which is required to begin during site characterization and continue until closure. NUREG-0804 (Ref. 13), Section 6.0, page 43, states that the reference to Subpart F was deleted here, and moved to 10 CFR 60.74. However, Section 60.74 is directed specifically toward the regulation of DOE actions rather than the review and authorization of these actions by NRC.

A regulatory uncertainty was thus raised on page B-12 of Appendix B of CNWRA 90-003 (Ref. 7). It stated:

The intent of NRC needs to be clarified relative to the review and/or approval of the performance confirmation program (Subpart F of 10 CFR Part 60) to be performed during the construction phase. Performance confirmation should be considered as a part of the construction authorization process to maintain consistency within 10 CFR 60.31(a) (which references consideration of the programs and/or plans of Subparts E, G, H, and I) and to provide consistency with Subpart F (in particular, 10 CFR 60.140). Approval of the planned performance confirmation program should be an aspect of NRC's consideration to authorize construction.

The title of 10 CFR 60.31(a) is "Safety." All the Subparts currently listed under 10 CFR 60.31(a) in sections (1)-(6) are all necessary to *demonstrate* that the repository will adequately ensure both preclosure and postclosure radiological health and safety. Subpart F is different from those Subparts listed under 10 CFR 60.31(a). Performance confirmation is a program of tests, experiments, and analyses to evaluate the accuracy and adequacy of the *information* used to demonstrate compliance. It does not directly impact safety. It just improves the confidence in the data and information about the site. Performance confirmation is thus one step removed from those items required for "safety." Therefore, it is not appropriate to include the performance confirmation program as one item to be considered for "safety" in 10 CFR 60.31(a), which correctly emphasizes "safety" and not performance confirmation. This is supported by the current definition of "performance confirmation" in 10 CFR 60.2, which excludes preclosure performance objectives from the scope of the performance confirmation program.

Performance confirmation, at the stage of repository construction, is considered and required in the conditions of construction authorization in 10 CFR 60.32(b), which requires DOE to submit reports regarding "(1) any data about the site obtained during construction which are not within the predicted limits upon which the facility design was based . . . and (2) results of research and development programs being conducted to resolve safety questions." These two items are performance confirmation related.

(2) Performance Confirmation Plans

It is understood that performance confirmation is to start during site characterization [10 CFR 60.140(b)]. It is, therefore, reasonable to expect that the site characterization plan should include a description of how the performance confirmation program will be initiated and integrated with site characterization. In DOE's 1988 Site Characterization Plan (Ref. 42), plans for performance confirmation were provided and discussed.

The regulations in 10 CFR 60.74 require DOE to perform, or permit the Commission to perform, a performance confirmation program in accordance with Subpart F. Performance confirmation related issues are included in the condition of construction authorization [10 CFR 60.32(b)]. However, according to Uncertainty Reference Number 6, page 8, Appendix A, of NRC's "Recommendations" report (Ref. 8), the content of the license application should make provision for DOE to describe the performance confirmation program which it proposes to undertake.

(3) **Quality Assurance for Performance Confirmation**

10 CFR 60.151 indicates that the quality assurance program applies to performance confirmation. The quality assurance program to be implemented is regulated by 10 CFR 60.152, which references Appendix B of 10 CFR Part 50.

(4) **Monitoring**

In 10 CFR Part 60, the following regulations are concerned with monitoring:

- 10 CFR 60.131(b)(8) - This section discusses instrumentation and control systems to monitor behavior of systems important to safety.
- 10 CFR 60.132(c)(2) - This section discusses effluent monitoring for the surface facility.
- 10 CFR 60.140(c) and 60.140(c)(3) - These sections discuss *in situ* monitoring and monitoring to determine changes in baseline conditions.
- 10 CFR 60.141(b) and 60.141(e) - These sections discuss monitoring of subsurface conditions.
- 10 CFR 60.143 - This section discusses monitoring and testing for waste packages.

For 10 CFR Part 61, the following sections relate to monitoring:

- 10 CFR 61.12(k) and 61.12(l) - Description of radiation and environmental monitoring
- 10 CFR 61.29 - Postclosure observation and maintenance
- 10 CFR 61.53(c) - Environmental monitoring during construction and operation
- 10 CFR 61.53(d) - Environmental monitoring after closure
- 10 CFR 61.59(b) - Environmental monitoring as a part of an institutional control program

These sections of 10 CFR Part 61 treat environmental monitoring as an important aspect of regulation for low-level waste.

10 CFR 60.131(b)(6) requires structures, systems, and

components important to safety to be designed to permit periodic inspection and maintenance, as necessary, to ensure their continued function and readiness. 10 CFR 60.132(c)(2) requires that effluent monitoring systems be designed to include alarms that can be periodically tested.

(5) Adverse Impacts

Performance confirmation testing has the potential to adversely affect the ability of the natural and engineered elements of the geologic repository to meet the postclosure performance objectives. 10 CFR 60.140(d)(1) indicates that the performance confirmation program should be implemented such that there is no such adverse impact. A strict interpretation of the requirement is that any testing having an adverse impact is not allowed. This is slightly different than site characterization where testing is to limit adverse impacts to the extent practical [10 CFR 60.15(d)(1)].

7 TOPICS FOR WHICH MAJOR RULE CHANGES MAY BE REQUIRED

The five ROC Topics that may require major rule changes have been identified and are briefly discussed in this section. All of these ROC topics will be analyzed more fully in activity 3 of the ROC task and will be reported in a separate ROC task report.

7.1 SAFETY PERFORMANCE OBJECTIVES

The performance objectives for safety in 10 CFR 60.111(a) may need clarification as to the applicability of various design basis events and meeting the criteria of 10 CFR Part 20 and the applicable Environmental Protection Agency Standards.

7.2 DESIGN BASES AND CRITERIA

A possible need was identified to clarify any necessary difference in the performance objectives between (1) those structures, systems, and components that are *important to safety* and (2) those structures, systems, and components of the GROA that are necessary for radiation control, but are not *important to safety*. A clarification may be necessary to specify under which conditions and events these two separate types of structures, systems, and components must be designed to meet the performance objectives. Generally, features necessary for radiation control that are *not* important to safety could have less stringent conditions under which to meet the performance objectives than those features that are important to safety.

Design for the conditions and events occurring at the GROA during the 50- to 100-year operational period will cover a range that could vary from daily or routine operations and expected conditions to infrequent but anticipated events that may occur during a 100-year period. Also, there can be less frequent events that are not anticipated to occur during the operational lifetime, but are likely enough to be considered in the design of some features of the GROA.

The design bases for preclosure radiation safety and items important to safety, addressed in 10 CFR 60.131, 60.132, and 60.133, will be further analyzed in regards to this Topic.

7.3 SITING CRITERIA

In order to provide defense-in-depth for a GROA, consideration of release and exposure to radiation resulting from a design basis event may be required. This concept is similar to the criteria in 10 CFR 72.106 and 72.126(d) (last sentence) for a "design basis accident," and in 10 CFR 100.3, 100.10(b), and 100.11 for a "severe accident" or "major accident." Currently the siting criteria of 10 CFR 60.122 do not have explicit regulations that address siting for the GROA for design basis events, "design basis accident," or "severe or major accident."

7.4 DEFINITIONS

A few terms may require definition or clarification in regards to the design criteria for a GROA. The potential need for these definitions or clarifications was determined by an analysis of design criteria terminology used throughout 10 CFR Part 60 and other regulations that may be relevant to the design of a GROA. The primary terms that may require definition or clarification are listed below:

(1) "Important to safety"
(2) "Design bases"
(3) "Design basis events"
(4) "Preclosure controlled area," "Controlled area" or Controlled-use area"

"Important to safety" and "controlled area" are defined in 10 CFR 60.2, and consideration of modification may require definition or clarification of the terms listed above and other terms, as necessary.

7.5 RADIOLOGICAL EMERGENCY PLANNING

For a radiation accident requiring immediate response (radiological emergency), plans for the response to such a situation will be needed. Regulatory criteria for radiological emergency planning will be required to further assure the concept of defense-in-depth. Currently Subpart I - Emergency Planning Criteria of 10 CFR Part 60 is reserved.

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The objective of the "Repository Operational Criteria (ROC) Feasibility Studies" (or ROC task) was to conduct comprehensive and integrated analyses of repository design, construction, and operations criteria in 10 CFR Part 60 regulations, considering the interfaces and impacts of any potential changes to those regulations. The study addresses regulatory criteria related to the preclosure aspects of the geologic repository. The study task developed regulatory concepts or potential repository operational criteria (PROC) based on analysis of a repository's safety functions and other regulations for similar facilities. These regulatory concepts or PROC were used as a basis to assess the sufficiency and adequacy of the current criteria in 10 CFR Part 60. Where the regulatory concepts were the same as current operational criteria, these criteria were referenced. The operations criteria referenced or the PROC developed are given in this report. Detailed analyses used to develop the regulatory concepts and any necessary PROC for those regulations that may require a minor change are also presented. The results of the ROC task showed a need for further analysis and possible major rule change related to the design bases of a geologic repository operations area, siting, and radiological emergency planning.

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