



FRAMEWORK FOR THE YUCCA MOUNTAIN REVIEW PLAN

DOE/NRC TECHNICAL EXCHANGE ON
TOTAL SYSTEM PERFORMANCE ASSESSMENTS FOR YUCCA MOUNTAIN
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Christiana H. Lui
High-Level Waste and Performance Assessment Branch
Division of Waste Management
Office of Nuclear Material Safety and Safeguards
(301)415-6200/CXL@NRC.GOV

Legacy/mission 70

ELEMENTS OF THIS PRESENTATION

- Principles
- Features
- Outline
- Relationship to the Content of License Application (§63.21)
- Integration of Issue Resolution Status Reports into the Yucca Mountain Review Plan
- Relationship to DOE Repository Safety Strategy and Principal Factors
- Advantages of the Approach
- Schedule

PRINCIPLES

1. Staff is responsible to defend the conclusion of its review of Yucca Mountain License Application (YMLA). DOE is responsible to make sure that an adequate safety case is made in the YMLA.
2. Performance-based site-specific rule should be accompanied by a performance-based site-specific review plan
 - Focus NRC staff's evaluation on DOE's safety case including site characterization and experimental work necessary and sufficient to support the safety case
3. To produce a streamlined, transparent and effective performance-based review plan consistent with the Yucca Mountain licensing strategy paper (SECY-97-300) and with the guidance document for streamlining the HLW program
4. Review should be done in an integrated fashion and the integration should take place at the technical staff level
 - The YMRP should be formulated based on staff's current understanding of DOE's approach and staff's IPA effort
 - The framework should be sufficiently flexible to accommodate changes in DOE's approaches

FEATURES

- Areas of Review
- Acceptance Criteria
- Review Procedure
- Evaluation Findings
- References

OUTLINE

ABSTRACT

EXECUTIVE SUMMARY

INTRODUCTION

- A. Principles in formulating this performance-based review plan
- B. Structure and progression of NRC HLW program
- C. Explanation on how the YMLA is to be reviewed and in what context the requirements under §63.21 are to be reviewed

I. REVIEW PLAN FOR **GENERAL INFORMATION** (§63.21(b))

- A. General Description (§63.21(b)(1))
- B. Proposed Schedules for Construction, Receipt and Emplacement of Waste (§63.21(b)(2))
- C. Physical Protection Plan in accordance with §73.51 (§63.21(b)(3))
- D. Material Control and Accounting Program to Meet §63.78 (§63.21(b)(4))
- E. Description of Site Characterization Work (§63.21(b)(5))

II REVIEW PLAN FOR **SAFETY ANALYSIS REPORT** (§63.21(c))

- A. Repository Safety Prior to Permanent Closure
- B. Repository Safety After Permanent Closure
- C. Administrative and Programmatic Requirements

II.A REPOSITORY SAFETY PRIOR TO PERMANENT CLOSURE

AREAS OF REVIEW: Compliance demonstration to meet §63.111 (Pre-closure Performance Objectives), §63.112 (Requirements for an ISA) and Subpart F (Performance Confirmation Program)

REVIEW CHAPTER(S)

II.A.1 Integrated Safety Analysis

Content of YMLA to be reviewed in this chapter: §63.21(c)(1) (Site Description), §63.21(c)(2) (Integrated Safety Analysis), §63.21(c)(3) (Materials, Codes and Standards in Design and Construction), §63.21(c)(4) (Description of EBS), §63.21(c)(14) (Radioactive Effluents Control Program), etc.

II.A.2 Retrievability Plan and Alternate Storage

Content of YMLA to be reviewed in this chapter: §63.21(c)(19) (Retrieval and Alternate Storage Plans)

II.A.3 Performance Confirmation Program

Content of YMLA to be reviewed in this chapter: §63.21(c)(20) (Performance Confirmation Program)

Possibly Other Chapters

EVALUATION FINDINGS

In reviewing the content of application identified above, if the staff found that all acceptance criteria in these review chapters have been satisfied, the licensee has successfully demonstrated meeting the pre-closure performance objectives in §63.111 and the technical requirements in §§63.112.

II.B REPOSITORY SAFETY AFTER PERMANENT CLOSURE

AREAS OF REVIEW: Compliance demonstration to meet §63.113 (Post-closure Performance Objectives), §63.114 (Requirements for PA), §63.115 (Requirements for Critical Group) and Subpart F (Performance Confirmation Program)

REVIEW CHAPTER(S)

II.B.1 Performance Assessment

Content of YMLA to be reviewed in this chapter: §63.21(c)(1) (Site Description), §63.21(c)(3)(Material and Codes and Standards Used in Construction), §63.21(c)(4)(i)(EBS Design), §63.21(c)(7) (Performance Assessment), §63.21(c)(8) (Stylized Human Intrusion Analysis), §63.21(c)(10)(Use of Expert Elicitation), etc.

II.B.2 Performance Confirmation

Content of YMLA to be reviewed in this chapter: §63.21(c)(20) (Performance Confirmation) and §63.21(c)(21) (Identification and Schedule for Resolution)

Possibly Other Chapters

EVALUATION FINDINGS

In reviewing the content of application identified above, if the staff found that all acceptance criteria in these review chapters have been satisfied, the licensee has successfully demonstrated meeting the post-closure performance objectives in §63.113 and the technical requirements in §§63.114 and 63.115 and the post-closure sections in Subpart F.

II.C ADMINISTRATIVE AND PROGRAMMATIC REQUIREMENTS

AREAS OF REVIEW: Compliance demonstration to meet Subpart D (Records, Reports, Tests, and Inspections), Subpart G (Quality Assurance) and Subpart H (Training and Certification of Personnel)

REVIEW CHAPTER(S)

II.C.1 Records, Reports, Tests, and Inspections)

Content of YMLA to be reviewed in this chapter: §63.21(c)(17) (Record Keeping), etc.

II.C.2 Quality Assurance Program

Content of YMLA to be reviewed in this chapter: §63.21(c)(11) (QA Program)

II.C.3 Training and Certification of Personnel

Content of YMLA to be reviewed in this chapter: §63.21(c)(22) (Administrative and Programmatic Requirements), etc.

Other Chapters

EVALUATION FINDINGS

In reviewing the content of application identified above, if the staff found that all acceptance criteria in these review chapters have been satisfied, the licensee has successfully demonstrated meeting the requirements in Subpart D, Subpart G and Subpart H.

LINKING §63.21 TO THE PERFORMANCE-BASED YUCCA MOUNTAIN REVIEW PLAN (PRELIMINARY)

Content of Application (§63.21)	Review Done in YMRP Chapter(s)
(b) General Information	I.A, I.B, I.C, I.D and I.E
(c)(1) Site Description	II.A.1 and II.B.1
(c)(2) Integrated Safety Analysis	II.A.1
(c)(3) Materials, Codes and Standards in Design and Construction	II.A and II.B.1
(c)(4) Description of EBS	II.A and II.B.1
(c)(5) Site Investigation	II.A and II.B
(c)(6) Thermal Effects	II.B
(c)(7) Performance Assessment	II.B.1
(c)(8) Stylized Human Intrusion Analysis	II.B.1
(c)(9) Technical Basis for Models	II.A.1 and II.B.1
(c)(10) Expert Elicitation	II.A and II.B
(c)(11) QA Program	II.C.2
(c)(12) Waste Inventory	II.A and II.B.1
(c)(13) Parameters Influence Design	II.A and II.B
(c)(14) Radioactive Effluents Control Program	II.A.1

Content of Application (§63.21)	Review Done in YMRP Chapter(s)
(c)(15) Land Access After Permanent Closure	II.C
(c)(16) Emergency Planning	II.A.2 or II.C
(c)(17) Record Keeping	II.C.1
(c)(18) Decontamination/Dismantlement of Surface Facilities	II.C
(c)(19) Retrieval and Alternate Storage Plans	II.A.3
(c)(20) Performance Confirmation Program	II.A.4 and II.B.2
(c)(21) Schedule and Program for Design Resolution	II.A.4 and II.B.2
(c)(22) Administrative and Programmatic Requirements	II.C.3

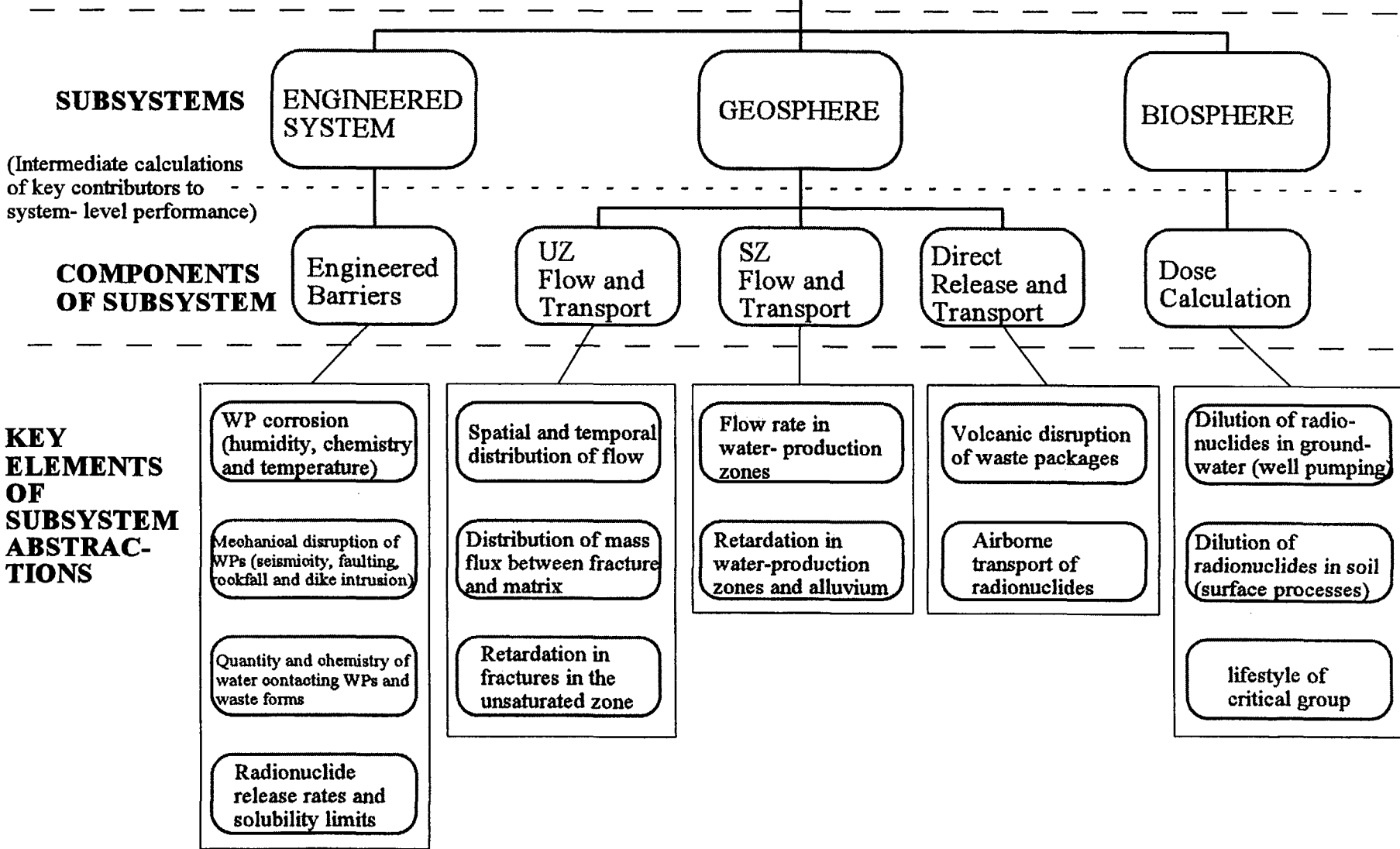
NOTE: Some of the entries currently under §63.21 will be modified (e.g., use of expert elicitation in both pre- and post-closure), consolidated or moved to the technical requirement subpart (e.g., §63.21(c)(5) to §63.114), i.e., leaving §63.21 strictly “content”. The sequence will be re-arranged to reflect a more logical structure in the final rule.

BACKGROUND

- SECY 97-300 describes staff's strategy in developing Part 63 and the Yucca Mountain Review Plan
- Total System Performance Assessment and Integration IRSR sets up the framework for the post-closure portion of the Yucca Mountain Review Plan, other IRSRs identify their relationship to the TSPA using the flowdown diagram
- To avoid duplication and keep a consistent set of acceptance criteria and review methods
 - All acceptance criteria and review methods will be developed under the Yucca Mountain Review Plan starting FY2000
 - The status of issue resolution will continued to be documented in the IRSRs

TOTAL SYSTEM

REPOSITORY PERFORMANCE
(Individual Dose or Risk)



Flowdown diagram for total system performance assessment.

INTEGRATED SUBISSUES

Integrated Subissues are

- The bottom tier of the flowdown diagram for post-closure performance assessment
- Developed based on review of DOE's TSPAs, knowledge of the design options and site characteristics and staff's IPA effort
- Integrated processes, features, and events that could impact system performance
 - providing KTIs an integration framework for describing their contribution in the context of PA calculations
 - facilitating integration at the technical staff level (Many KTIs require interactions with other KTIs in evaluating repository performance)

II.B.1 PERFORMANCE ASSESSMENT REVIEW

System Description and Demonstration of Multiple Barriers

Develop acceptance criteria and review procedures for technical criteria §63.114(h), §63.114(i) and §63.114(j);
Evaluation Findings and References

Scenario Analysis

Develop acceptance criteria and review procedures for technical criteria §63.21(c)(5)?, §63.21(c)(6), §63.114(d), §63.114(e), §63.115(a) and §63.115(b); Evaluation Findings and References

Model Abstraction

Develop acceptance criteria and review procedures for technical criteria §63.114(a), §63.114(b), §63.114(c), §63.114(f) and §63.114(g) in the following proposed integrated subissues (the list may be modified to reflect the existing DOE approach and staff's IPA work):

SPATIAL AND TEMPORAL DISTRIBUTION OF FLOW

WP CORROSION

MECHANICAL DISRUPTION OF WASTE PACKAGES

QUANTITY AND CHEMISTRY OF WATER CONTACTING WASTE PACKAGES AND WASTE FORMS

RADIONUCLIDE RELEASE RATES AND SOLUBILITY LIMITS

DISTRIBUTION OF MASS FLUX BETWEEN FRACTURE AND MATRIX

RETARDATION IN FRACTURES IN THE UNSATURATED ZONE

FLOW RATES IN WATER PRODUCTION ZONES

RETARDATION IN WATER PRODUCTION ZONES AND ALLUVIUM

VOLCANIC DISRUPTION OF WASTE PACKAGES

AIRBORNE TRANSPORT OF RADIONUCLIDES

DILUTION OF RADIONUCLIDES IN GROUNDWATER DUE TO WELL PUMPING

DILUTION OF RADIONUCLIDES IN SOIL DUE TO SURFACE PROCESSES

LIFESTYLE OF CRITICAL GROUP

Demonstration of the Overall Performance Objective

Acceptance criteria, review methods, evaluation findings and references on whether DOE's analysis of repository performance has demonstrated compliance with §63.113(b) and §63.113(d)

RELATIONSHIP BETWEEN INTEGRATED SUBISSUES AND KTI SUBISSUES (PRELIMINARY)

Integrated Subissue	Relevant KTI Subissues
Spatial and Temporal Distribution of Flow (UZ)	SDS-3: Fracturing and structural framework
	TEF-1: Sufficiency of thermal-hydrologic testing to assess reflux
	USFIC-3: Present day shallow infiltration
	USFIC-4: Deep percolation (present and future)
WP Corrosion (temperature, humidity, and chemistry)	CLST-1: Effects of corrosion on lifetime of containers
	ENFE-2: Effects of coupled THC processes on WP chemical environment
	RDTME-3: Thermal-mechanical effects on underground facility design and performance
Mechanical Disruption of Waste Packages	CLST-2: Effects of materials stability and mechanical failure on the lifetime of the container
	RDTME-2: Design of the geologic repository operations area for the effects of seismic events and direct fault disruption
	RDTME-3: Thermal-mechanical effects on underground facility design and performance
	SDS-2: Seismicity
	SDS-4: Tectonics and crustal conditions

Integrated Subissue	Relevant KTI Subissues
Quantity and Chemistry of Water Contacting Waste Packages and Waste Forms	CLST-1: Effects of corrosion on lifetime of containers
	CLST-3: Rate of degradation of spent nuclear fuel
	CLST-4: Rate of degradation of high-level waste glass
	ENFE-1: Effects of coupled THC processes on seepage and flow
	ENFE-2: Effects of coupled THC processes on WP chemical environment
	ENFE-3: Effects of coupled THC processes on chemical environment for radionuclide release
	RDTME-3: Thermal-mechanical effects on underground facility design and performance
	USFIC-3: Present day shallow infiltration
	USFIC-4: Deep percolation (present and future)
Radionuclide Release and Solubility Limits	ENFE-3: Effects of coupled THC processes on chemical environment for radionuclide release
Distribution of Mass Flux Between Fracture and Matrix (UZ)	ENFE-1: Effects of coupled THC processes on seepage and flow
	SDS-3: Fracturing and structural framework
	USFIC-4: Deep percolation (present and future)
Retardation in Fractures in the Unsaturated Zone	RT-3: Nuclide transport through fractured rock

Integrated Subissue	Relevant KTI Subissues
Flow Rates in Water Production Zones	SDS-3: Fracturing and structural framework
	USFIC-5: Saturated zone ambient flow conditions and dilution
Retardation in Water Production Zones and Alluvium	RT-2: Nuclide transport through alluvium
	USFIC-6: Matrix diffusion
Volcanic Disruption of Waste Packages	IA-2: Consequences of igneous activity
	SDS-4: Tectonics and crustal conditions
Airborne Transport of Radionuclides	IA-2: Consequences of igneous activity
Dilution of Radionuclides in Groundwater Due to Well Pumping	USFIC-5: Saturated zone ambient flow conditions and dilution
Dilution of Radionuclides in Soil Due to Surface Processes	IA-2: Consequences of igneous activity
Lifestyle of Critical Group	USFIC-5: Saturated zone ambient flow conditions and dilution

RELATIONSHIP OF THE INTEGRATED SUBISSUES TO DOE REPOSITORY SAFETY STRATEGY AND PRINCIPAL FACTORS

Key Attributes of DOE Repository Safety Strategy	Principal Factors	Integrated Subissues
Limited water contacting waste packages	Precipitation and infiltration of water into the mountain	Spatial and temporal distribution of flow
	Percolation of water to depth	
	Seepage of water into drifts	
	Effects of heat and excavation on water flow	
	Dripping of water onto waste packages	Quantity and chemistry of water contacting waste packages and waste forms
Long waste package lifetime	Humidity and temperature at waste packages	Waste packages corrosion
	Chemistry of water on waste packages	Quantity and chemistry of water contacting waste packages and waste forms
	Integrity of outer waste package barrier	Waste package corrosion
Integrity of inner waste package barrier		
Low rate of release of radionuclides from breached waste packages	Seepage of water into waste packages	Quantity and chemistry of water contacting waste packages and waste forms
	Integrity of spent nuclear fuel cladding	

Key Attributes of DOE Repository Safety Strategy	Principal Factors	Integrated Subissues
	Dissolution of uranium oxide and glass waste forms	Radionuclide release rates and solubility limits
	Solubility of neptunium	
	Formation and transport of radionuclide-bearing colloids	
	Transport through and out of engineered barrier system	
Radionuclide concentration reduction during transport from the waste packages	Transport through unsaturated zone	Distribution of mass flux between fracture and matrix
		Retardation in fractures in the unsaturated zone
	Flow and transport in saturated zone	Flow rates in water-production zones
		Retardation in water-production zones and alluvium
	Dilution from pumping	Dilution of radionuclides in groundwater due to well pumping
	Biosphere transport and uptake	Dilution of radionuclides in soil due to surface processes
Lifestyle of critical group		

ADVANTAGES OF THE APPROACH

- Review of both the pre-closure and post-closure safety cases are performance-based
 - A top-down approach to evaluate whether the YMLA has met the performance objectives
 - Encompassing all related activities
 - The iterative cycle of performance assessment ↔ data collection is clearly and closely maintained
 - Clearly indicate why DOE's supporting data is acceptable or deficient in the context of how that work has been used in DOE's safety cases
 - Minimizing duplication of acceptance criteria and review methods
 - Modification to or elimination of possibly overly prescriptive acceptance criteria in the IRSRs
 - The requirements under §63.21 and any RAIs are clearly justified in this context

- Leading to a streamlined, transparent and integrated review plan

SCHEDULE OF PLANNED ACTIVITIES FOR THE YUCCA MOUNTAIN REVIEW PLAN

Activity	Completion Date	Purpose
1. DOE/NRC Total System Performance Assessment (TSPA) Technical Exchange at CNWRA	May 25 - 27, 1999	Preliminary discussion with DOE on the approach for Yucca Mountain Review Plan
2. TSPA Issue Resolution Status Report	September 30, 1999	This IRSR will become part of the Yucca Mountain Review Plan (YMRP) or be referenced by the YMRP.
3. Final Part 63 with Yucca Mountain Review Plan Annotated Outline	To the Commission by November 30, 1999	To submit to the Commission the final Part 63 and a risk-informed performance-based YMRP annotated outline
4. Public meetings in Nevada after finalizing Part 63	January/February 2000	To present and clarify the final Part 63 and the accompanied YMRP
5. Interactions with DOE	January/February 2000	To present and clarify the final Part 63 and the accompanied YMRP
6. Yucca Mountain Review Plan, Rev. 0	March 31, 2000	Staff's initial attempt to expand the annotated outline into a risk-informed performance-based review plan. It will contain TBD sections that will be developed in the future revisions of this review plan.
7. Future Revisions of Yucca Mountain Review Plan	September 30, 2000 (Rev. 1); September 30, 2001 (Rev. 2)	To update and publish YMRP prior to key DOE milestones: Site Recommendation and License Application. The last revision (Rev. 2) would be published five months before the current expected Yucca Mountain License Application submission date (March 1, 2002)