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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 19, 1999

NOTE TO: Public Document Room (PDR)

FROM: Christiana H. Lui
High Level Waste and Performance Assessment Branch
Division of Waste Management
Office of Nuclear Material Safety and Safeguards

PUBLIC DOCUMENT ROOM
99 JUL 20 P3:13

SUBJECT: BRIEFING MATERIAL FOR NRC/DOE APPENDIX 7 MEETING ON YUCCA MOUNTAIN REVIEW PLAN, JULY 13, 1999

Attached are the briefing material for a recent NRC/DOE Appendix 7 meeting on Yucca Mountain Review Plan which took place on July 13, 1999, at Las Vegas, Nevada. Please place these handouts in the PDR for future references. If there is any question, I can be reached at (301)415-6200. Thank you.

Attachments: FILED ON STACKET
Sent to PDR on July 14, 1999

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DOE/NRC APPENDIX 7 MEETING ON YUCCA MOUNTAIN REVIEW PLAN
July 13, 1999,
Videoconference, Blue Room, Hillshire Building, Las Vegas, NV
U.S. Nuclear Regulatory Commission, White Flint, MD (T2B5)

Purpose: to compare the NRC's proposed Yucca Mountain Review Plan with DOE's Technical Guidance Document for License Application Preparation. (NOTE: this meeting will be an informal discussion to reach understanding; viewgraphs and formal presentations are to be kept to a minimum to facilitate discussion. Times listed are approximate; discussion is encouraged.)

(PDT)		
8:30 AM	Introductions	All
8:40	DOE's License Application Development Process	Gil
8:50	License Application Organization	Richardson
9:00	Overview of Technical Guidance Document Format/content, Differentiated approach, Schedule, IRSR acceptance criteria	Kane
9:30	Overview of YMRP Approach, relationship to IRSR's content, Organization, Schedule, Acceptance criteria	Lui
10:00	Break	
10:15	Discussion	
11:00	Introduction to Process Model Reports and Repository Safety Strategy Concept	Richardson
11:30	LUNCH	
1:00 PM	Process Model Reports	Lugo
1:30	PMRs' relationship to TSPA	Andrews
2:00	License Application Development and Integration	Richardson
2:30	Break	
2:45	Discussion	All
3:45	Closing Remarks	All

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Transmitted with letter dtd. 7/19/99

YUCCA MOUNTAIN REVIEW PLAN INTEGRATION OF KTI SUBISSUES, STRUCTURE, AND SCHEDULE

DOE/NRC APPENDIX 7 MEETING ON YUCCA MOUNTAIN REVIEW PLAN
July 13, 1999

Patrick C. Mackin
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INTEGRATION OF KTI SUBISSUES INTO INTEGRATED SUBISSUES

Integrated Subissue	Relevant KTI Subissues
Spatial and Temporal Distribution of Flow (UZ)	ENFE-1: Effects of coupled THC processes on seepage and flow
	RDTME-3: Thermal-mechanical effects on underground facility design and performance
	SDS-2: Seismicity
	SDS-3: Fracture framework
	TEF-1: Sufficiency of thermal-hydrologic testing to assess reflux
	TEF-2: Sufficiency of thermal-hydrologic modeling to predict thermal effects on flow in near-field
	USFIC-1: Future climate change
	USFIC-3: Present day shallow infiltration
	USFIC-4: Deep percolation (present and future)

INTEGRATION OF KTI SUBISSUES INTO INTEGRATED SUBISSUES (cont'd)

Integrated Subissue	Relevant KTI Subissues
WP Corrosion (temperature, humidity, and chemistry)	CLST-1: Effects of corrosion processes on lifetime of containers
	CLST-2: Effects of phase instability and initial defects on mechanical failure and lifetime of the containers
	ENFE-2: Effects of coupled THC processes on WP chemical environment
	RDTME-3: Thermal-mechanical effects on underground facility design and performance
	TEF-1: Sufficiency of thermal-hydrologic testing to assess reflux
	TEF-2: Sufficiency of thermal-hydrologic modeling to predict thermal effects on flow in near-field

INTEGRATION OF KTI SUBISSUES INTO INTEGRATED SUBISSUES (cont'd)

Integrated Subissue	Relevant KTI Subissues
Mechanical Disruption of Waste Packages	CLST-1: Effects of corrosion processes on lifetime of containers
	CLST-2: Effects of phase instability and initial defects on mechanical failure and lifetime of the containers
	ENFE-2: Effects of coupled THC processes on WP chemical environment
	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-1: Faulting
	SDS-2: Seismicity
	SDS-3: Fracture framework
	SDS-4: Tectonic framework

INTEGRATION OF KTI SUBISSUES INTO INTEGRATED SUBISSUES (cont'd)

Integrated Subissue	Relevant KTI Subissues
Quantity and Chemistry of Water Contacting Waste Packages and Waste Forms	CLST-1: Effects of corrosion processes on lifetime of containers
	CLST-3: Rate at which radionuclides are released from spent nuclear fuel
	CLST-4: Rate at which radionuclides are released from high-level waste glass
	CLST-6: Effects of alternate EBS design features on container lifetime and radionuclide release from EBS
	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

INTEGRATION OF KTI SUBISSUES INTO INTEGRATED SUBISSUES (cont'd)

Integrated Subissue	Relevant KTI Subissues
	RDTME-3: Thermal-mechanical effects on underground facility design and performance
	SDS-3: Fracture framework
	TEF-1: Sufficiency of thermal-hydrologic testing to assess reflux
	TEF-2: Sufficiency of thermal-hydrologic modeling to predict thermal effects on flow in near-field
	USFIC-3: Present day shallow infiltration
	USFIC-4: Deep percolation (present and future)
Radionuclide Release and Solubility Limits	CLST-3: Rate at which radionuclides are released from spent nuclear fuel
	CLST-4: Rate at which radionuclides are released from high-level waste glass
	CLST-6: Effects of alternate EBS design features on container lifetime and radionuclide release from EBS

INTEGRATION OF KTI SUBISSUES INTO INTEGRATED SUBISSUES (cont'd)

Integrated Subissue	Relevant KTI Subissues
	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
	RT-3: Radionuclide transport through fractured rock
	SDS-3: Fracture framework
	TEF-1: Sufficiency of thermal-hydrologic testing to assess reflux
	TEF-2: Sufficiency of thermal-hydrologic modeling to predict thermal effects on flow in near-field
	TEF-3: Adequacy of TSPA with respect to effects on flow
	USFIC-4: Deep percolation (present and future)
Retardation in Fractures in the Unsaturated Zone	RT-3: Radionuclide transport through fractured rock
	SDS-3: Fracture framework

INTEGRATION OF KTI SUBISSUES INTO INTEGRATED SUBISSUES (cont'd)

Integrated Subissue	Relevant KTI Subissues
	USFIC-6: Matrix diffusion
Flow Rates in Water Production Zones	SDS-3: Fracture framework
	SDS-4: Tectonic framework
	USFIC-1: Future climate change
	USFIC-4: Deep percolation (present and future)
	USFIC-5: Saturated zone ambient flow conditions and dilution
Retardation in Water Production Zones and Alluvium	RT-2: Radionuclide transport through alluvium
	RT-3: Radionuclide transport through fractured rock
	SDS-3: Fracture framework
	USFIC-5: Saturated zone ambient flow conditions and dilution
	USFIC-6: Matrix diffusion

INTEGRATION OF KTI SUBISSUES INTO INTEGRATED SUBISSUES (cont'd)

Integrated Subissue	Relevant KTI Subissues
Volcanic Disruption of Waste Packages	CLST-1: Effects of corrosion processes on lifetime of containers
	CLST-2: Effects of phase instability and initial defects on mechanical failure and lifetime of the containers
	IA-1: Probability of igneous activity
	IA-2: Consequences of igneous activity
	IA (Tentative): Effects of thermal stress on dike propagation
	SDS-1: Faulting
	SDS-4: Tectonic framework
Airborne Transport of Radionuclides	IA-2: Consequences of igneous activity
Dilution of Radionuclides in Groundwater Due to Well Pumping	RT-1: Radionuclide transport through porous rock
	RT-2: Radionuclide transport through alluvium
	RT-3: Radionuclide transport through fractured rock

INTEGRATION OF KTI SUBISSUES INTO INTEGRATED SUBISSUES (cont'd)

Integrated Subissue	Relevant KTI Subissues
	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	IA-2: Consequences of igneous activity
	RT-3: Radionuclide transport through fractured rock
	USFIC-1: Future climate change
	USFIC-2: Hydrologic effects of climate change
	USFIC-3: Present day shallow infiltration
	USFIC-5: Saturated zone ambient flow conditions and dilution

YMRP SCHEDULE

- Complete YMRP Revision 0 by March 31, 2000
- Integrate YMRP Development With IRSR Revision
- Make as Much Progress as Possible During FY1999
- Determine Extent of Annotated Outline (Due 11/30/1999) Based on Progress Achieved

EVENT	DATE
Develop First Draft of YMRP Outline and Obtain Management Concurrence	May 1999
Preliminary Discussion of YMRP Framework with DOE at Technical Exchange	May 25–27, 1999
Confirm Crosslink of KTI Subissues with Integrated Sub Issues (ISI)	July 8, 1999
Prepare draft Acceptance Criteria (AC) and Review Methods (RM) for Administrative and Programmatic Sections of YMRP	August 30, 1999
KTI and ISI Teams prepare draft ACs and RMs for Preclosure and Postclosure Performance Sections of YMRP	Through September 30, 1999
Designate and Manage Special Development teams, as Required (e.g., Performance Confirmation)	Through September 30, 1999

EVENT	DATE
Review and Finalize ACs and RMs for Revision 0, Postclosure Portions of YMPR	October 30, 1999
Submit Annotated Outline With final 10 CFR Part 63	November 30, 1999
Public Meetings in Nevada After Finalizing 10 CFR Part 63	January/February 2000
Interactions with DOE on 10 CFR Part 63 and the YMRP	January/February 2000
Complete Preparation of Areas of Review, Evaluation Findings, and References	January 31, 2000
Complete YMRP Revision 0	March 31, 2000
Complete YMRP Revision 1	September 30, 2000
Complete YMRP Revision 2	September 30, 2001

YMRP STRUCTURE AND CONTENT
SCOPE OF GENERAL INFORMATION REQUIREMENTS

- General Description [§63.21(b)]
  - General description of site and environs
  - A description of major components and operations adequate to familiarize interested parties with pertinent features
  - General systems description
  - Identification of agents and contractors
  - Material incorporated by reference
  - Summary of endangered species
- Schedules for Construction, Receipt, and Emplacement of Waste [§63.21(b)(2)]
  - This information is not evaluated elsewhere

YMRP STRUCTURE AND CONTENT
SCOPE OF GENERAL INFORMATION REQUIREMENTS (CONT'D)

- Physical Protection Plan [§§63.21(b)(3) and 73.51]
  - This information is not evaluated elsewhere
- Material Control and Accounting Program [§§63.21(b)(4), 63.78; 72.72, 74, 76, and 78]
  - This material is not evaluated elsewhere
- Description of Site Characterization Work [§63.21(b)(5)]
  - Summary of scope of site characterization work to familiarize interested parties
  - May be included in General Description Section

YMRP STRUCTURE AND CONTENT
EXAMPLE FROM SECTION 3.3
PROGRAMMATIC AND ADMINISTRATIVE REQUIREMENTS

(See Handout Provided)

3.3 ADMINISTRATIVE AND PROGRAMMATIC REQUIREMENTS

3.3.3 Training and Certification of Personnel

3.3.3.1 Organizational Structure of the U.S. Department of Energy as it pertains to Construction and Operation of the Geologic Repository Operations Area

Acceptance Criteria and Review Methods:

AC The application has sufficiently described the DOE organizational structure and administrative control system (for the applicable phase of HLW repository licensing) to enable the staff to determine that the repository will be properly managed and controlled.

To determine if this AC has been met, the reviewer should:

RM Evaluate organizational charts, position descriptions, and descriptions of responsibilities to ensure that the relationship and assignment of responsibilities between the DOE headquarters organization, the onsite DOE organization, and the DOE primary contractor are clearly defined.

RM Examine the scope of proposed administrative procedures to determine whether an adequate program will be established to manage and control the repository.

RM Determine whether the frequency and scope of any quality assurance (QA), management, or other audits or inspections are specified and that the frequencies are sufficient to provide reasonable assurance that the licensed activities at the repository will be conducted safely. The QA program is reviewed under section 3.3.1 of this review plan.

AC The application has adequately described the functions, responsibilities, and authorities of organizations and individuals involved in licensed activities and any delegations of authority and responsibilities such that the reviewer can associate safety- or waste isolation-related activities to specific positions.

To determine if this AC has been met, the reviewer should:

RM Verify that the responsibilities and authorities of each position associated with functions related to health and safety or waste isolation are specifically defined and that all such functions have been addressed.

RM Evaluate the delineations of authority and responsibility and the proposed administrative controls and procedures to ensure that they are sufficient to properly manage functions related to safety or to waste isolation.

RM Ensure that procedures for the control of interactions among elements of the organizational structure and with any contractors are adequate.

RM Examine the procedures for management of major contractors to determine whether adequate contractual controls have been established.

3.3.3.2 Key Positions Assigned Responsibility for Safety and Operations of the Geologic Repository Operations Area

Acceptance Criteria and Review Methods:

AC The application has described the key positions and their responsibilities with emphasis on positions that perform functions important to safety or to waste isolation.

To determine if this AC has been met, the reviewer should:

RM Ensure that the distribution of responsibilities for functions important to safety or to waste isolation is unambiguously defined.

RM Determine that any alternates who are authorized to act in the absence of individuals assigned to key positions have been identified, that positions having shutdown or stop-work authority for health or safety reasons are delineated, and that minimum staffing levels for major entities within the onsite organizations have been specified.

RM Ensure that DOE has committed that operation of systems and components that have been identified as important to safety or to waste isolation will be performed only by trained and certified personnel or by personnel under the direct visual supervision of an individual with training and certification in such operation.

RM Consider the importance of specific positions to safety or to waste isolation and the expected level of onsite technical support that will be required in such areas such as nuclear criticality safety or structural design analysis when evaluating staffing requirements.

AC The authorities and responsibilities assigned to the various positions provide an appropriate degree of independence between the organization responsible for construction or operations at the repository and other parts of the onsite organization that verify compliance with functions important to safety or to waste isolation.

To determine if this AC has been met, the reviewer should:

RM Verify that entities responsible for the functions of radiation protection, nuclear criticality safety, and other safety- or waste isolation-related functions are

organizationally independent of the entities responsible for facility construction and operations.

AC If a safety committee will be established, the application has described the membership, duties, responsibilities, operating procedures, and reporting requirements of the committee.

To determine if this AC has been met, the reviewer should:

RM Verify that, if the DOE proposes use of a safety committee (or an entity with equivalent functions), the committee will have appropriate representation and responsibilities. In making this determination, the reviewer shall consider whether the membership of this committee includes representatives from operating and safety support organizations. The reviewer shall ensure that the safety committee has appropriate review and approval authority, and that formal procedures will be used for systematic review of proposed operations and changes. The reviewer shall verify that the committee reports directly to the facility manager or other appropriate senior management position.

3.3.3.3 Personnel Qualifications and Training Requirements

Acceptance Criteria and Review Methods:

AC The application has adequately described the organization that will be responsible for personnel selection, training, and certification.

To determine if this AC has been met, the reviewer should:

RM Verify that the description of the training organization includes a discussion of the organization and management of the training component and identifies the positions responsible for developing training programs, conducting training and retraining of employees (including new employee orientations), and maintaining records on the status of trained personnel.

RM Evaluate the proposed training program for compliance with regulatory requirements relating to personnel selection, training, certification, exercises, and training records. The reviewer shall determine the acceptability based on satisfaction of these regulatory requirements, the content of Regulatory Guide 3.48 guidance (Nuclear Regulatory Commission, 1989), and evidence of facility staff experience in planning and conducting training programs.

AC The requirements for certification of personnel who will operate equipment and controls that are important to safety or to waste isolation are clearly delineated and address the physical condition and general health of personnel to be certified.

To determine if this AC has been met, the reviewer should:

RM Evaluate the minimum qualifications for operating, technical, maintenance, and supervisory personnel. The reviewer will exercise professional judgment in accepting the proposed qualifications, because there are no standard minimum qualifications. Generally the minimum qualifications for these personnel include a bachelor's degree and several years' experience in a related technical area that is commensurate with the level of assigned responsibility. Higher level managers typically have similar experience requirements in addition to a requirement for previous supervisory or management experience.

RM Verify that minimum qualification requirements for operating, technical, and maintenance supervisory personnel are provided. (Qualifications, in résumé form, of persons who will be assigned to managerial and technical positions will be evaluated prior to beginning construction or operations.)

RM Ensure that the organization is committed to evaluate the physical condition and general health of personnel who are certified for operations that are important to safety or to waste isolation. These personnel are to be evaluated according to NRC Form 396 which is used to evaluate licensed operators at commercial nuclear reactors.

AC The process by which security guards (including watchmen, armed response persons, etc.) will be selected and qualified is acceptable

To determine if this AC has been met, the reviewer should:

RM Verify that security guard training is compliant with 10 CFR 73.51(d)(5). The general criteria for security personnel are contained in 10 CFR Part 73, appendix B. This information may be submitted as part of the physical security plan, as addressed in review plan section 2.3. Regulatory Guide 5.20, "Training, Equipping, and Qualifying of Guards and Watchmen" (Nuclear Regulatory Commission, 1974) provides additional guidance for training and certification of security personnel. The acceptability of the DOE physical protection plan will be reviewed under section 2.3 of the Review Plan for General Information.

AC The training program description has adequately identified the scope of operational and safety training. The scope of the radiation safety training program has also been provided and incorporates the appropriate topics.

To determine if this AC has been met, the reviewer should:

RM Verify that operational and safety training includes such topics as repository design and operations, instrumentation and control, methods for conducting

safety- or waste-isolation-related functions, decontamination procedures, and emergency procedures.

RM Verify that radiation safety training includes topics such as the nature and sources of radiation, methods for controlling exposure and contamination, radiation monitoring, shielding, dosimetry, biological effects, and criticality hazards control.

RM Verify that the type and level of training to be provided for each job description (personnel classification), including training to be provided for specific job descriptions has been delineated. Alternatively, the reviewer may confirm that the basis to be used to identify the type and level of training by job description has been provided.

RM Verify that the DOE has described the implementation of the training program before conduct of operations involving radioactive material (i.e. preoperational training) and has committed to substantial completion of staff training and certification before receipt of the radioactive material to be disposed.

RM Examine the testing methods to be used to evaluate the effectiveness of the training program, including the process for evaluation against established objectives and criteria.

RM Assess the frequency of retraining and the content and period of retention of training and testing records. In general, the retraining should be periodic, should be conducted at an interval of at most every two yr, and should include, at a minimum, refresher instruction on administrative, radiation protection, emergency, and security procedures.

RM Determine whether DOE has committed to maintain training records up-to-date and to retain them for a minimum of three yr.

RM Ascertain that appropriate pass/fail criteria for certified operator training have been defined.

RM Consider the guidance on training criteria and training program content available in the following documents, as appropriate:

ANSI/ANS 8.20, "Nuclear Criticality Safety Training" (American National Standards Institute, 1991)

ANSI/ANS 3.1, "Selection, Qualification, and Training of Personnel for Nuclear Power Plants" (American National Standards Institute/American Nuclear Society, 1993)

ASTM E 1168, "Radiological Protection Training for Nuclear Facility Workers" (American Society for Testing and Materials, 1995)

Regulatory Guide 1.8, "Qualification and Training of Personnel for Nuclear Power Plants" (Nuclear Regulatory Commission, 1987)

Regulatory Guide 1.134, "Medical Evaluation of Licensed Personnel for Nuclear Power Plants" (Nuclear Regulatory Commission, 1997)

Regulatory Guide 3.68, "Nuclear Criticality Safety Training" (Nuclear Regulatory Commission, 1994)

Regulatory Guide 8.27, "Radiation Protection Training for Personnel at Light-Water-Cooled Nuclear Power Plants" (Nuclear Regulatory Commission, 1981)

Regulatory Guide 8.29, "Instruction Concerning Risks from Occupational Radiation Exposure" (Nuclear Regulatory Commission, 1996a)

NUREG–0800, "Standard Review Plan," section 13.2.2 (Nuclear Regulatory Commission, 1996b)

References:

American National Standards Institute. "Nuclear Criticality Safety Training." New York, NY: American National Standards Institute. ANSI/ANS 8.20. 1991.

American National Standards Institute/American Nuclear Society. "Selection, Qualification, and Training of Personnel for Nuclear Power Plants." New York, NY: American National Standards Institute. ANSI/ANS 3.1. 1993.

American Society for Testing and Materials. "Radiological Protection Training for Nuclear Facility Workers." West Conshohocken, PA: American Society for Testing and Materials. E 1168. 1995.

Nuclear Regulatory Commission. "Training, Equipping, and Qualifying of Guards and Watchmen." Washington, DC: Nuclear Regulatory Commission, Office of Standards Development. Regulatory Guide 5.20. 1974.

Nuclear Regulatory Commission. "Radiation Protection Training for Personnel at Light-Water-Cooled Nuclear Power Plants." Washington, DC: Nuclear Regulatory Commission, Office of Standards Development. Regulatory Guide 8.27. 1981.

Nuclear Regulatory Commission. "Qualification and Training of Personnel for Nuclear Power Plants." Washington, DC: Nuclear Regulatory Commission, Office of Standards Development. Regulatory Guide 1.8. 1987.

Nuclear Regulatory Commission. "Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation or Monitored Retrievable Storage Installation (Dry Storage)." Washington, DC: (Nuclear Regulatory Commission, Office of Standards Development. Regulatory Guide 3.48, Revision 1. 1989.

Nuclear Regulatory Commission. "Nuclear Criticality Safety Training." Washington, DC: Nuclear Regulatory Commission, Office of Standards Development. Regulatory Guide 3.68. 1994.

Nuclear Regulatory Commission. "Instruction Concerning Risks from Occupational Radiation Exposure." Washington, DC: Nuclear Regulatory Commission, Office of Standards Development. Regulatory Guide 8.29. 1996a.

Nuclear Regulatory Commission. "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, LWR Edition." Washington, DC: Nuclear Regulatory Commission. NUREG–0800. 1996b.

Nuclear Regulatory Commission. "Medical Evaluation of Licensed Personnel for Nuclear Power Plants." Washington, DC: Nuclear Regulatory Commission, Office of Standards Development. Regulatory Guide 1.134. 1997.

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Studies

DOE's License Application Development Process and License Application Organization

Presented to:
DOE-NRC Appendix 7 Meeting

Presented by:
Dan Kane
Yucca Mountain Site Characterization Project

July 13, 1999

U.S. Department of Energy
Office of Civilian Radioactive
Waste Management

Overview of Technical Guidance Document

- NRC staff developing YMRP for DOE's LA
- DOE developing TGD for LA that will specify
  - Format and content
  - Acceptance criteria and guidance
  - Differentiation between the level of detail to be provided to support receipt of CA and that to be provided to support receipt of LR&P

Schedule for Completing TGD

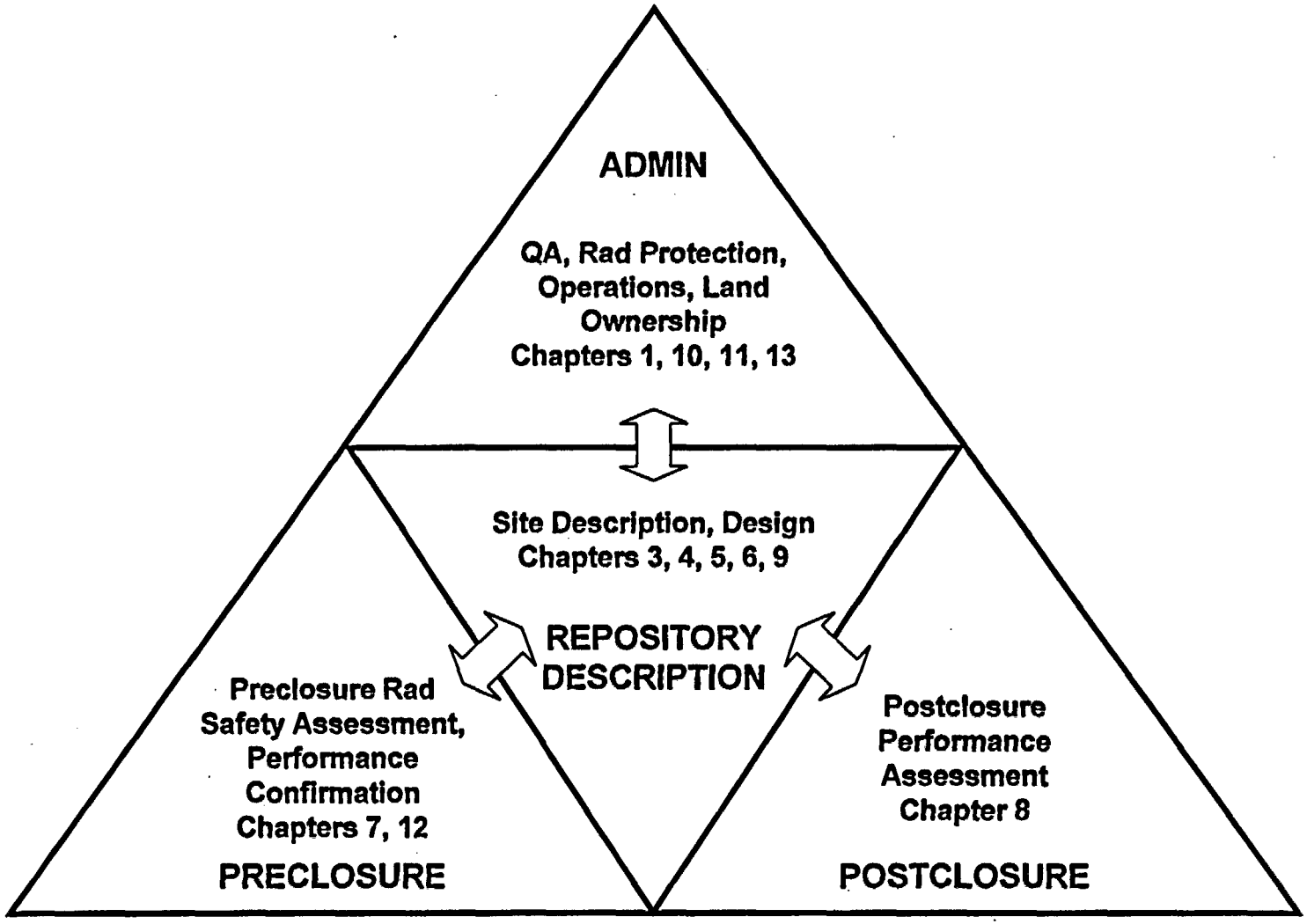
- Complete the content of the document by end of September 1999
- Provide copies to NRC by mid-November 1999
- Modify the format to be consistent with the NRC's Part 63 final rule

Outline of TGD

Similar to that used in Regulator Guides 1.70 and 3.48

Chapter/Section Subject	TGD	RG 3.48	RG 1.70
General Information	1	1	1
Conformance with Technical Criteria	2	3	3
Site Description	3	2	2
Equipment/Activities	4,5,6	4	4
Support Systems	4,6	5	5,6,7,8
Auxiliary Systems	4,6	5	9,10
Radioactive Waste Management	9	6	11
Radiation Protection	10	7	12
Conduct of Operations	11	9	13
QA	14/1	11	17
Radiological Analyses	7,8	8	15
Performance Confirmation	12	NA	NA
Land Ownership & Control	13	NA	NA
License Specifications	11	10	16
Initial Test Program	11	9	14

Organization



Planned YMP LA Chapter Grouping

Preclosure Safety Case

- Integrate equipment, operations, and procedures already approved by NRC and in use at other facilities into the design and operating concept for repository preclosure activities to the maximum extent practicable
- Identify SSCs ITS and demonstrate compliance with NRC performance objectives for preclosure period

Postclosure Safety Case

- Based on integration of site characteristics, EBS design, and TSPA
- Issues and subissues associated with KTIs and IRSRs
  - Interwoven into text discussions and descriptions
  - Not addressed in separate section of LA
  - Cross-walk ex-LA could be provided
- Integration of subsystem models in chapter on PA
  - Chapter on PA provides a complete summary of postclosure performance

Future Interactions

- Develop a mutual understanding of what is required to support NRC issuance of:
  - CA
  - LR&P

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DOE's License Application Development Process: Introduction

Presented to:
DOE-NRC Appendix 7 Meeting

Presented by:
April VanCamp Gil, License Application Team Leader
Yucca Mountain Site Characterization Project

July 13, 1999

U.S. Department of Energy
Office of Civilian Radioactive
Waste Management

Objectives of Appendix 7 Meeting on Yucca Mountain Review Plan and Technical Guidance Document

- Reach mutual understanding on the format for License Application based on:
  - Content guidance to DOE's LA authors in TGD
  - Review criteria for NRC's LA reviews in YMRP
- Ensure Technical Guidance Document will result in an LA that:
  - Provides sufficient information to support the safety case
  - Facilitates NRC review
  - Presents information in a logical and integrated way

Considerations and Topics for Discussion

- Primary: Content (10 CFR Part 63.21(a))
  - LA contains sufficient information to support safety case
    - Repository Safety Strategy
    - Process Model Reports
    - Section approach to LA development
    - Information needs clear definition for Construction Authorization vs. Receive and Possess
- Secondary: Format
  - Goal is consistent LA and YMRP format
    - Industry precedence
    - Assist in review
  - Limit duplicative or redundant information

Considerations and Topics for Discussion (continued)

- Tertiary: Schedules
  - LA scheduled to be submitted to NRC in March 2002
    - Detailed LA planning underway
  - Final 10 CFR Part 63: risk-informed, performance-based regulation
  - Final YMRP, reflecting Part 63 approach
  - Planned revisions to TGD

Considerations and Topics for Discussion (continued)

- DOE supports the performance-based program
  - TGD also considers relevant codes, standards, and licensing precedence
  - YMRP criteria based on repository performance
    - A consistent set of acceptance criteria and review methods
    - Specifying IRSRs' relationship to TSPA

FRAMEWORK FOR THE YUCCA MOUNTAIN REVIEW PLAN

DOE/NRC APPENDIX 7 ON
YUCCA MOUNTAIN REVIEW PLAN AND
TECHNICAL GUIDANCE DOCUMENT FOR YUCCA MOUNTAIN LICENSE APPLICATION
July 13, 1999

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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.

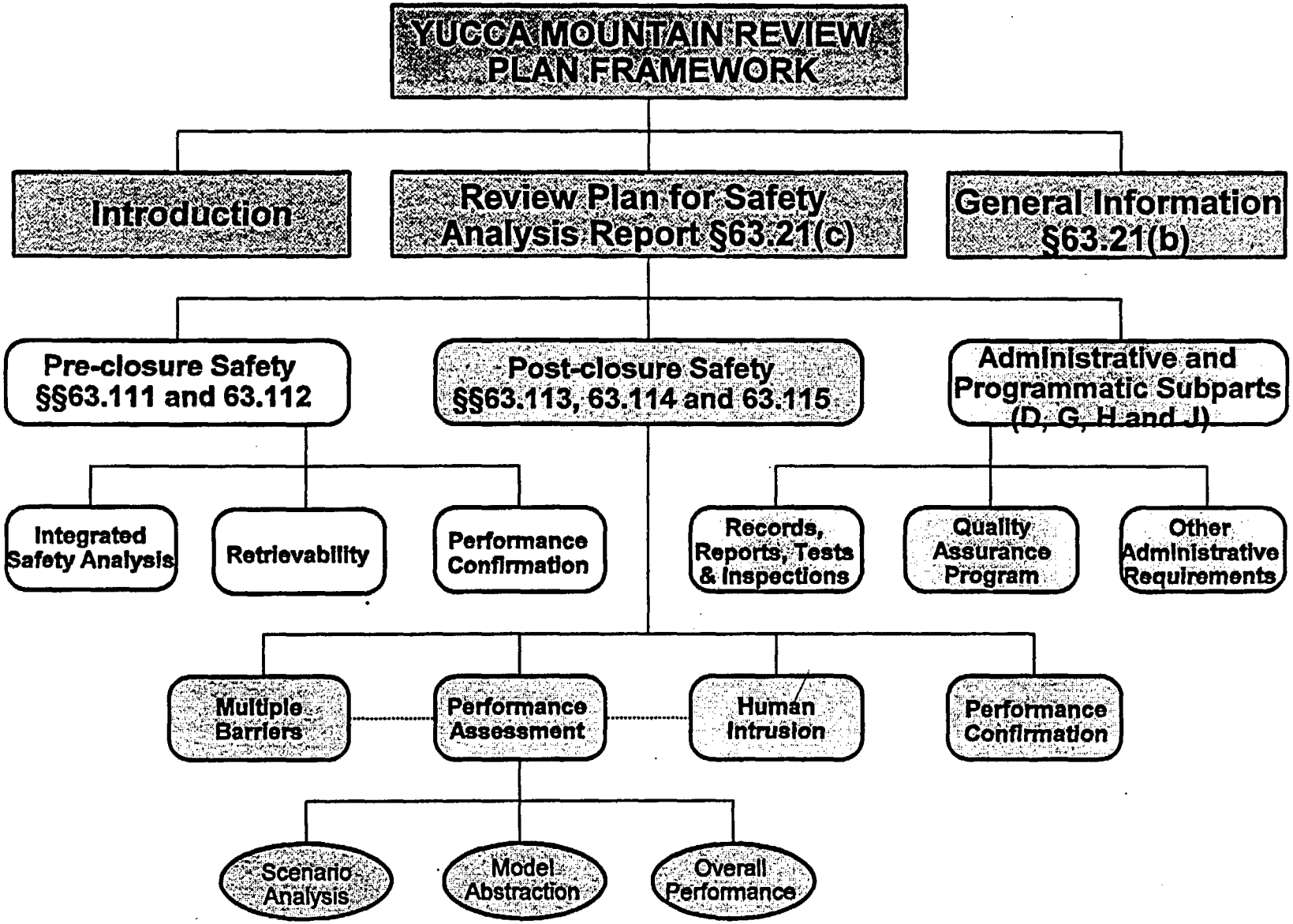
2. Risk-informed performance-based (RIPB) site-specific implementing rule should be accompanied by a RIPB site-specific review plan.
   - Focus NRC staff's evaluation on DOE's safety case including site characterization and experimental work necessary and sufficient to support the safety case

3. A streamlined, transparent, and effective RIPB review plan should be produced 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 and Review Methods
- Evaluation Findings
- References


YUCCA MOUNTAIN REVIEW PLAN FRAMEWORK
Introduction
Review Plan for Safety Analysis Report §63.21(c)
General Information §63.21(b)
Pre-closure Safety §§63.111 and 63.112
Post-closure Safety §§63.113, 63.114 and 63.115
Administrative and Programmatic Subparts (D, G, H and J)
Integrated Safety Analysis
Retrievability
Performance Confirmation
Records, Reports, Tests & Inspections
Quality Assurance Program
Other Administrative Requirements
Multiple Barriers
Performance Assessment
Human Intrusion
Performance Confirmation
Scenario Analysis
Model Abstraction
Overall Performance

OUTLINE

ABSTRACT

EXECUTIVE SUMMARY

1 INTRODUCTION
- 1.1 Principles in formulating RIPB review plan
- 1.2 Structure and progression of NRC HLW program
- 1.3 Explanation on how the YMLA is to be reviewed and in what context the requirements under §63.21 are to be reviewed

2 REVIEW PLAN FOR **GENERAL INFORMATION** (§63.21(b))
- 2.1 General Description (§63.21(b)(1))
- 2.2 Proposed Schedules for Construction, Receipt, and Emplacement of Waste (§63.21(b)(2))
- 2.3 Physical Protection Plan in accordance with §73.51(§63.21(b)(3))
- 2.4 Material Control and Accounting Program to Meet §63.78 (§63.21(b)(4))
- 2.5 Description of Site Characterization Work (§63.21(b)(5))

3 REVIEW PLAN FOR **SAFETY ANALYSIS REPORT** (§63.21(c))
- 3.1 Repository Safety Prior to Permanent Closure
- 3.2 Repository Safety After Permanent Closure
- 3.3 Administrative and Programmatic Requirements

3.1 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 CHAPTERS

3.1.1 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.

3.1.2 Schedule and Program for Design Resolution as It Pertains to Pre-closure Safety
Content of YMLA to be reviewed in this chapter: §63.21(c)(21)(SSCs Requiring R&D to Confirm Adequacy or to Resolve Safety Questions)

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

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

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.

3.2 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 CHAPTERS

3.2.1 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.

3.2.2 Schedule and Program for Design Resolution as It Pertains to Post-closure Performance
Content of YMLA to be reviewed in this chapter: §63.21(c)(21)(SSCs Requiring R&D to Confirm Adequacy or to Resolve Safety Questions)

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

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.

3.3 ADMINISTRATIVE AND PROGRAMMATIC REQUIREMENTS

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

REVIEW CHAPTERS

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

3.3.2 Records, Reports, Tests, and Inspections
Content of YMLA to be reviewed in this chapter: §63.21(c)(17)(Record Maintenance Program)

3.3.3 Training and Certification of Personnel
Content of YMLA to be reviewed in this chapter: §§63.21(c)(22)(i), 63.21(c)(22)(ii), and 63.21(c)(22)(iii)(Organizational Structure, Training and Certification)

3.3.4 Expert Elicitation
Content of YMLA to be reviewed in this chapter: §63.21(c)(10)(Use of Expert Elicitation)

3.3.5 Plans for Startup Activities and Testing
Content of YMLA to be reviewed in this chapter: §63.21(c)(22)(iv)(Plans for Startup Activities and Testing)

3.3.6 Plans for Conduct of Normal Activities Including Maintenance, Surveillance, and Periodic Testing
Content of YMLA to be reviewed in this chapter: §63.21(c)(22)(v)(Plans for Normal Activities)

3.3.7 Emergency Planning
Content of YMLA to be reviewed in this chapter: §63.21(c)(16)(Emergency Planning)

3.3.8 Controls to Restrict Access and Regulate Land Use
Content of YMLA to be reviewed in this chapter: §63.21(c)(15)(Land Access after Permanent Closure)

3.3.9 Uses of GROA for Purposed Other than Disposal of Radioactive
Content of YMLA to be reviewed in this chapter: §63.21(c)(22)(vii)(Use of GROA)

EVALUATION FINDINGS

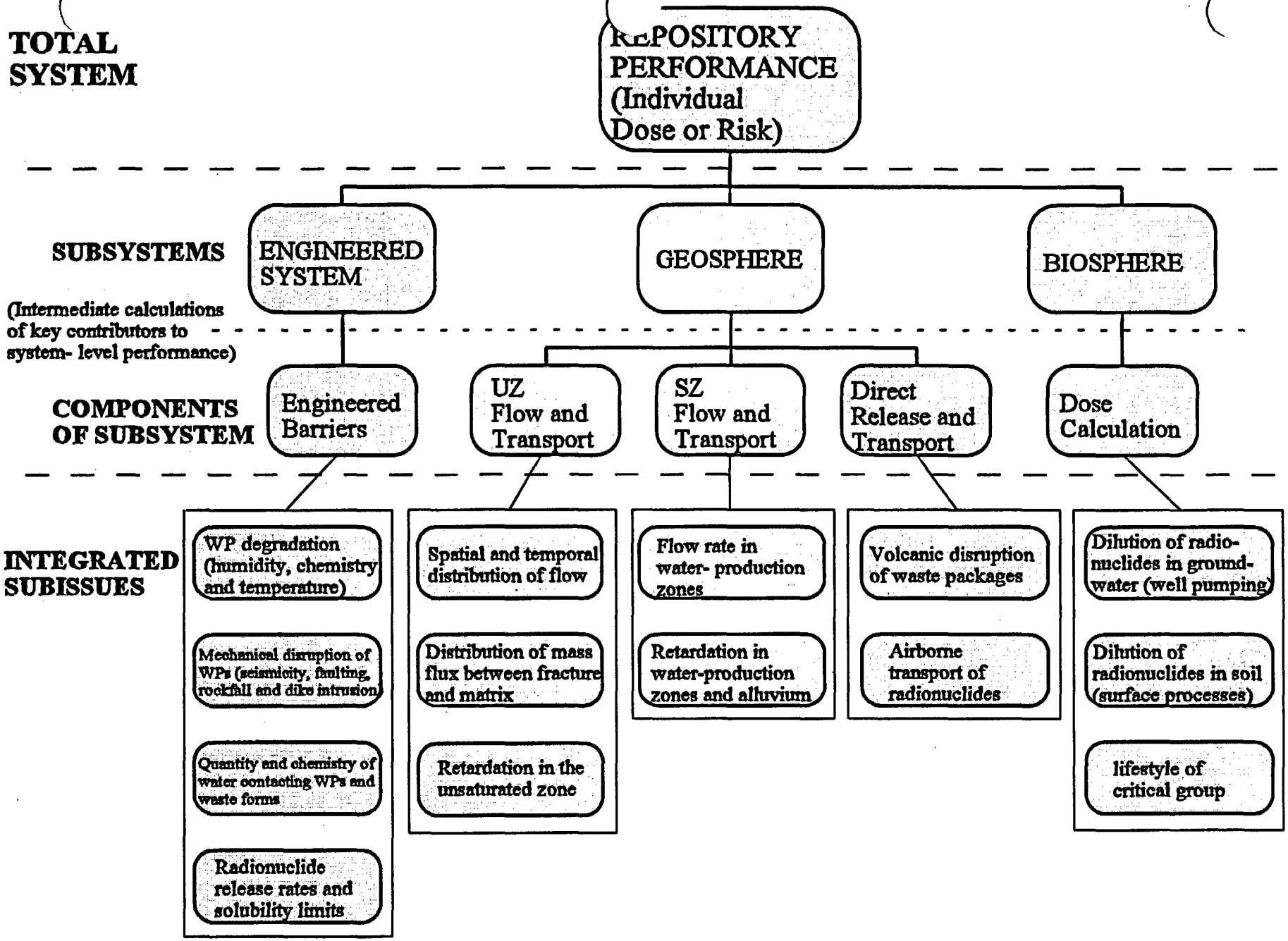
In reviewing the content of application identified above, if the staff found that all acceptance criteria in these review chapters have been satisfied, the licensee has successfully demonstrated meeting the requirements in Subpart D, Subpart G, Subpart H, and Subpart J.

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 and will be removed from the IRSRs starting FY2000
  - The status of issue resolution will continued to be documented in the IRSRs



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)

3.2.1 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 DEGRADATION
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 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)

ADVANTAGES OF THE APPROACH

- Review of both the pre-closure and post-closure safety cases is risk-informed and performance-based
  - Use a top-down approach to evaluate whether the YMLA has met the performance objectives
  - Encompass all related activities
  - Maintain the iterative cycle of performance assessment ↔ data collection
  - 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
  - Minimize duplication of acceptance criteria and review methods
  - Modify or eliminate possibly overly prescriptive acceptance criteria in the IRSRs
  - Justify the requirements under §63.21 and any RAIs
- Produce a streamlined, transparent, and integrated review plan

YUCCA MOUNTAIN PROJECT

Studies

Prioritizing the Factors

Presented to:
DOE-NRC Appendix 7 Meeting

Presented by:
Dennis Richardson
CRWMS M&O

July 13, 1999

U.S. Department of Energy
Office of Civilian Radioactive
Waste Management

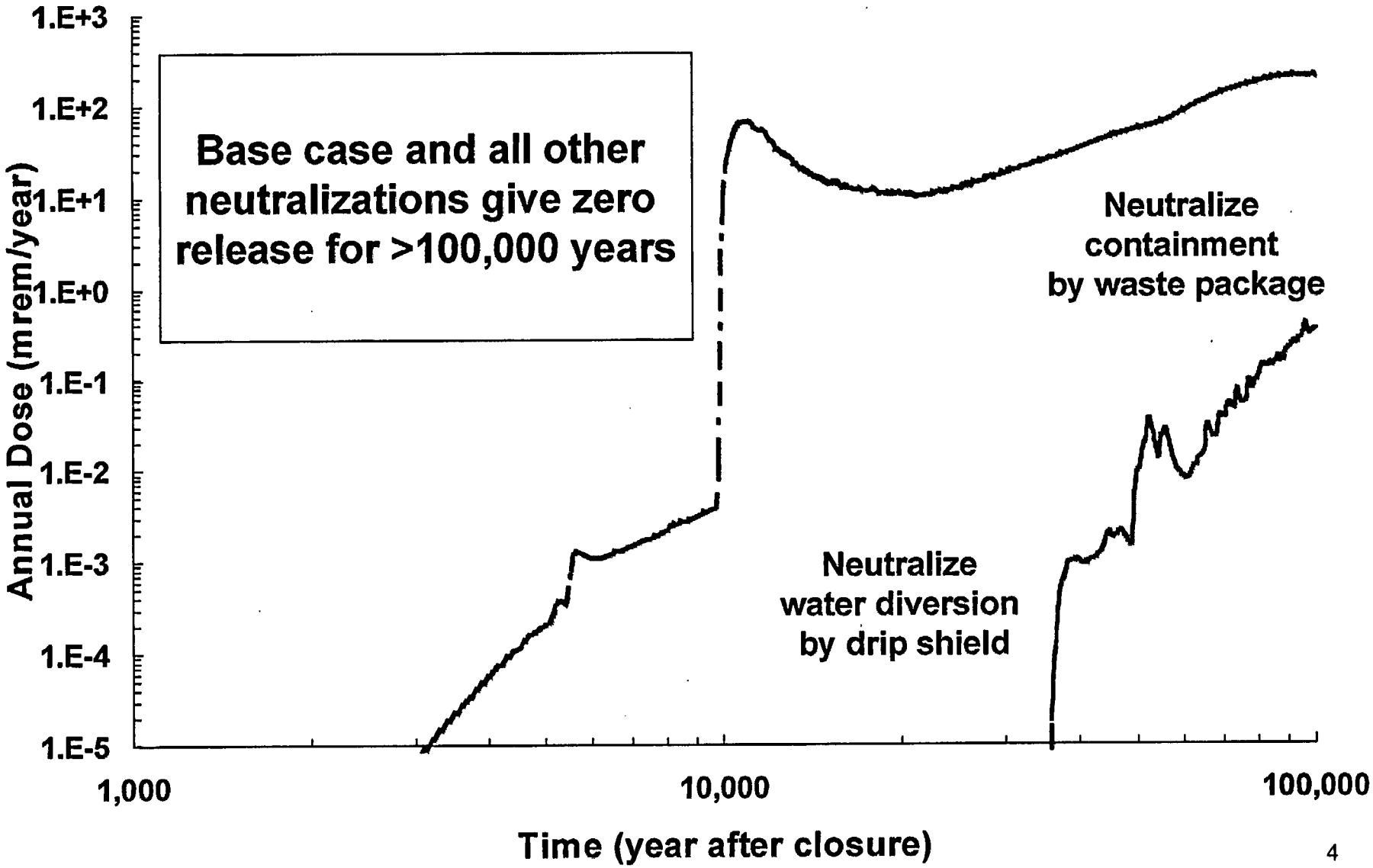
Prioritizing the Factors

- Development of priorities informed by:
  - Evaluating importance of factors using TSPA and Barrier Importance Analyses
  - Accounting for limitations in TSPA models
  - Taking into account defensibility of the models

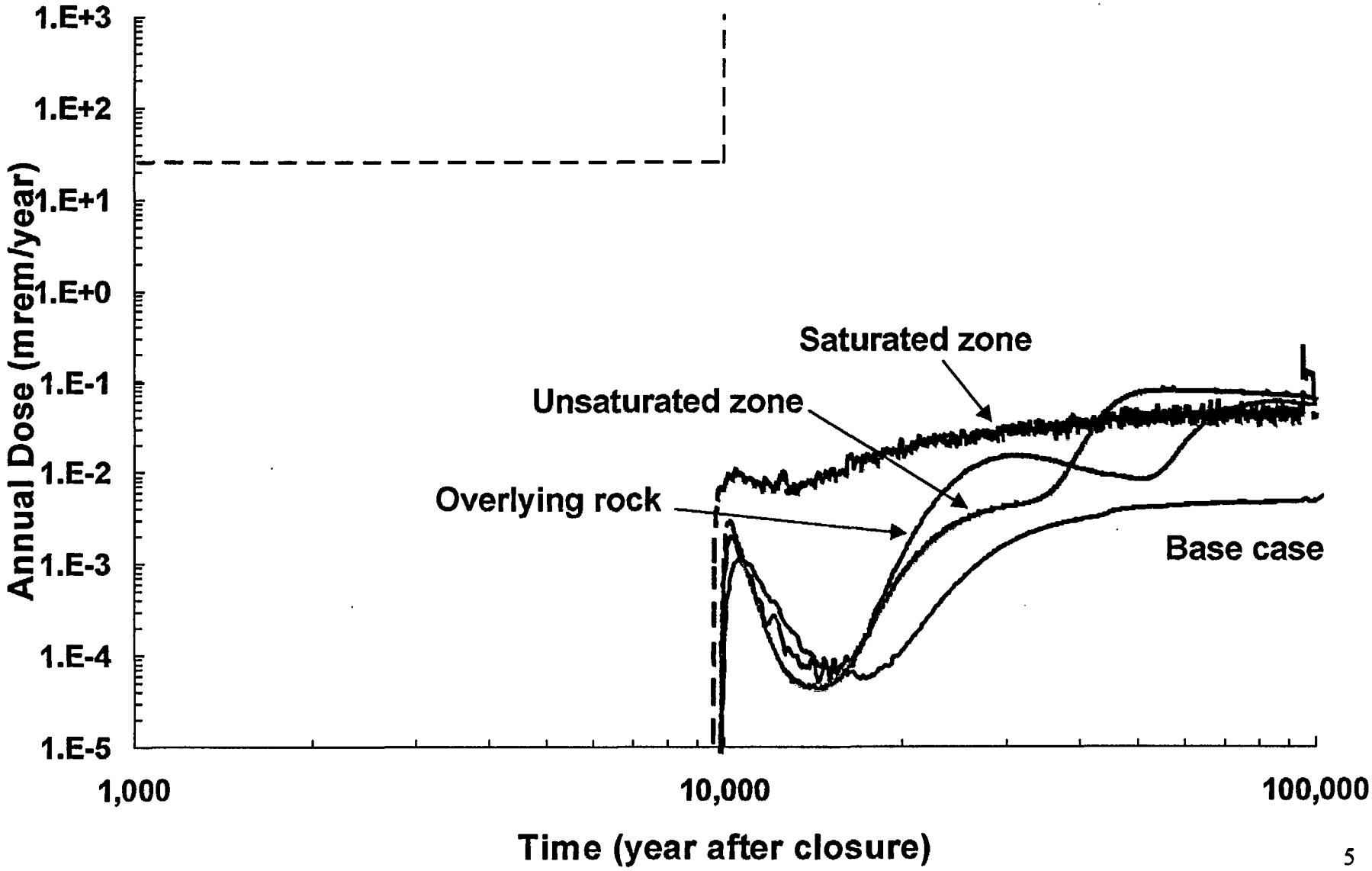
TSPA and Barrier Importance Analyses of Enhanced Design

- Without juvenile failure of waste packages
  - TSPA gives negligible release--expected value is zero--for 100,000 years
  - Separate neutralizations of UZ, SZ, waste form, cladding, drift invert also give negligible release in 100,000 years
  - Only complete neutralization of all waste packages and all drip shields give any release in first 100,000 years
- With imposed juvenile failure, some release occurs, but sensitivities to most barriers of the system are small

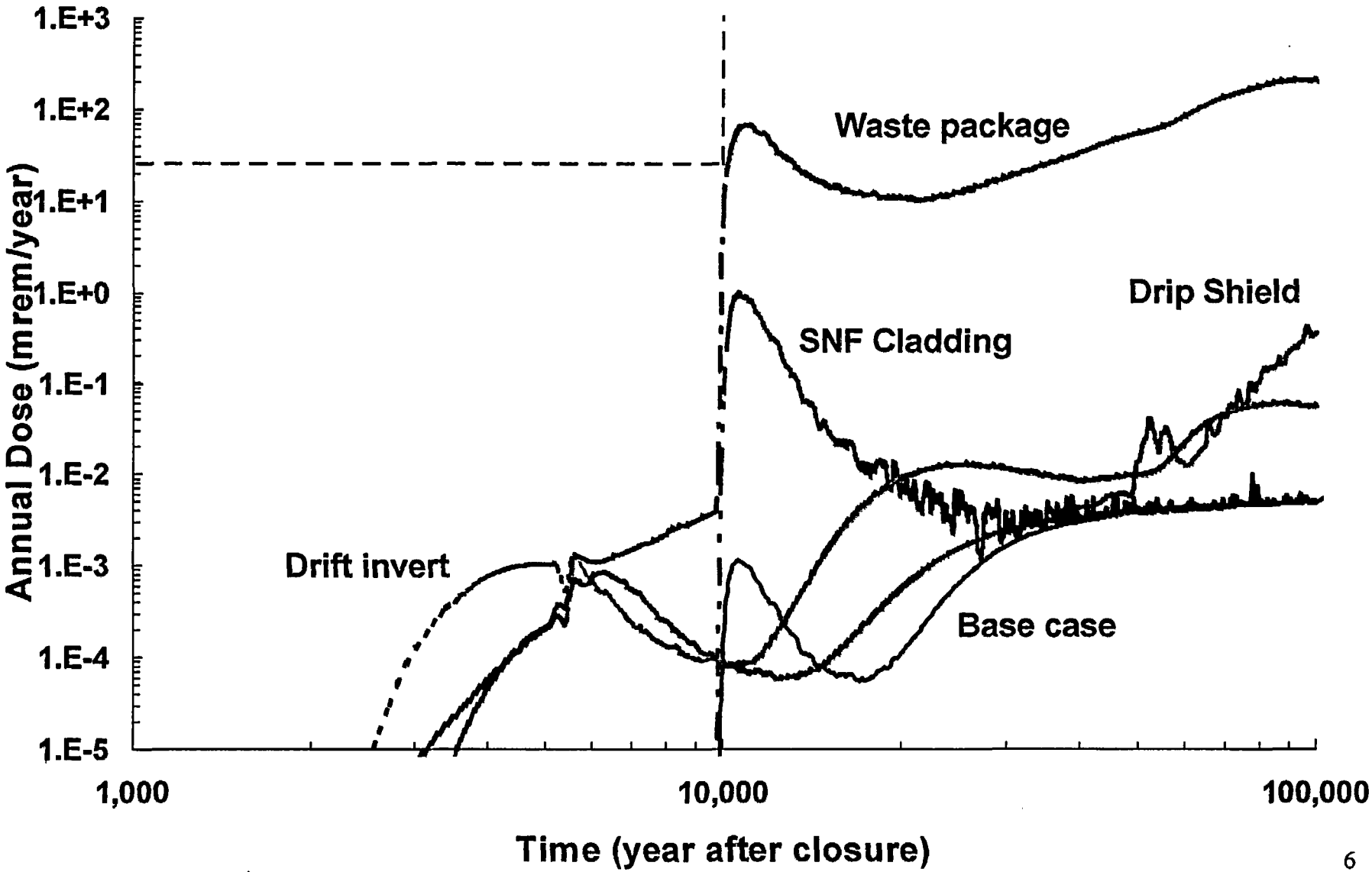
Barrier Importance (Neutralization) Analyses
No Juvenile Failure



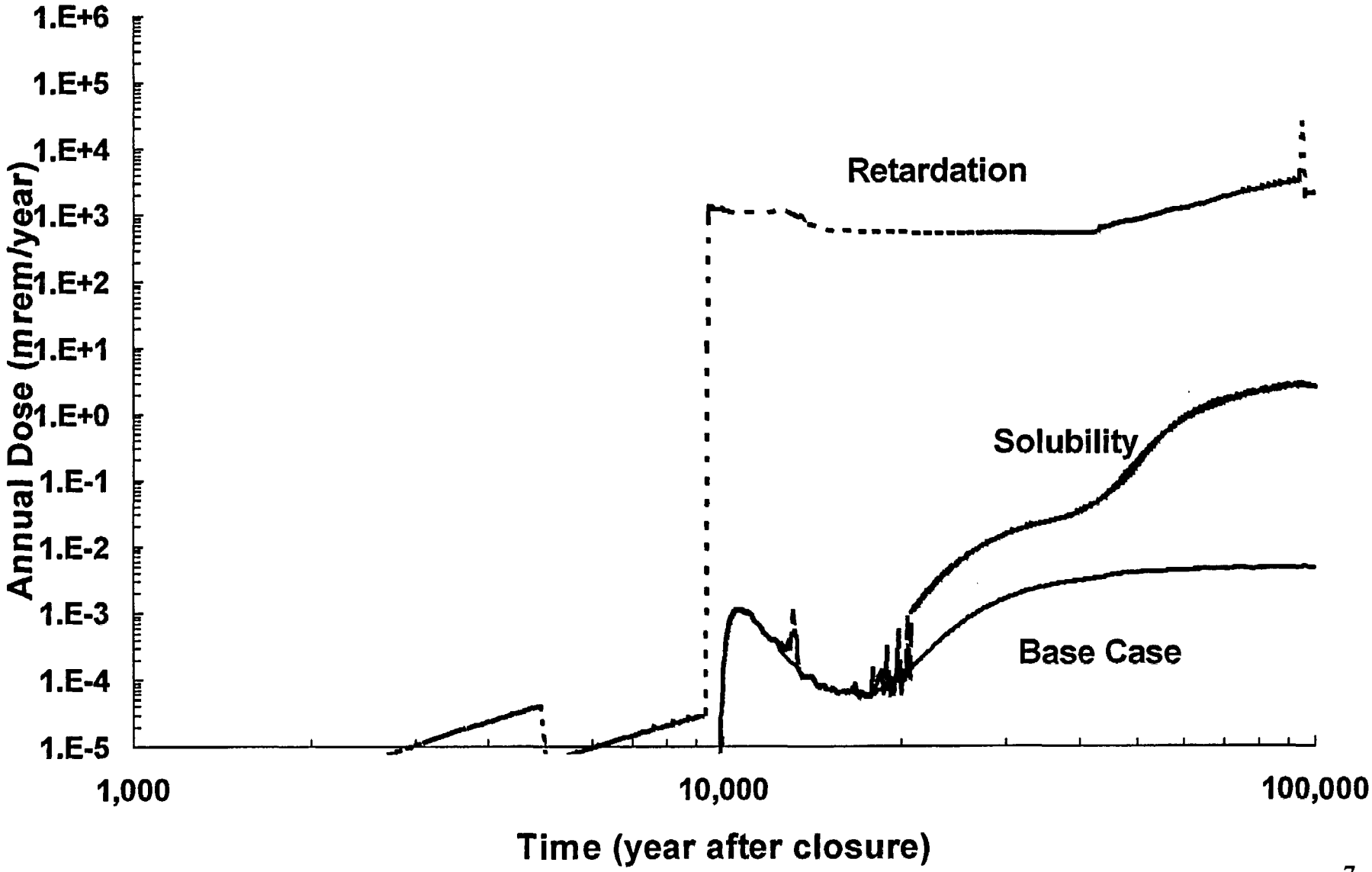
Barrier Importance Analyses
Single Juvenile WP Failure



Barrier Importance Analyses
Single Juvenile WP Failure



Barrier Importance Analyses
Single Juvenile WP Failure



Factors of the Safety Case

Factors for Enhanced System Design
Climate
Infiltration
UZ flow above repository
Seepage into drifts
Coupled processes - effects on UZ flow
Coupled processes - effects on seepage
Mechanical stress, moisture, temperature, and chemistry on drip shield
Performance of drip shield
Mechanical stress, moisture, temperature, and chemistry on waste package
Performance of waste package barriers
Mechanical stress, moisture, temperature, and chemistry within waste package
CSNF waste form (with cladding or canister) performance
DSNF, Navy fuel, Pu disposition waste form performance
HLW glass waste form (including canister) performance
Dissolved radionuclide concentration limits
Colloid-associated radionuclide concentrations
In-package radionuclide transport
EBS radionuclide migration—transport through invert
UZ flow and transport—advective pathways
UZ flow and transport—sorption and matrix diffusion
UZ flow and transport—colloid-facilitated transport
Coupled processes--effects on UZ transport
SZ flow and transport—advective pathways
SZ flow and transport—sorption and matrix diffusion
SZ transport--colloid-facilitated transport
Dilution in SZ
Biosphere transport and uptake

Principal Factors
Seepage into drifts
Performance of drip shield
Performance of WP barriers
Dissolved radionuclide concentration limits
UZ flow and transport—sorption and matrix diffusion
SZ flow and transport--sorption and matrix diffusion
Dilution in SZ

Other Factors
Climate
Infiltration
UZ flow above repository
Coupled processes - effects on UZ flow
Coupled processes - effects on seepage
Mechanical stress, moisture, temperature, and chemistry on drip shield
Mechanical stress, moisture, temperature, and chemistry on waste package
Mechanical stress, moisture, temperature, and chemistry within waste package
CSNF waste form (including cladding and canister) performance
DSNF, Navy fuel, Pu disposition waste form performance
HLW glass waste (including canister) performance
Colloid-associated radionuclide concentrations
In-package radionuclide transport
EBS radionuclide migration—transport through invert
UZ flow and transport—advective pathways
UZ flow and transport—colloid-facilitated transport
Coupled processes--effects on UZ transport
SZ flow and transport—advective pathways
SZ transport--colloid-facilitated transport
Biosphere transport and uptake

Simplifying the Process Model Representations

- Emphasize principal factors to ensure focus of efforts on most important areas
- Reduce emphasis on other factors--use simpler representations in less-important areas to reduce technical effort and work needed to address QA requirements
- However, must still ensure adequacy of technical basis and defensibility of all models (realistic or bounding)

Principal Factors for Enhanced System

- Seepage into the emplacement drifts
- Performance of drip shield
- Performance of waste packages
- Dissolved radionuclide concentration limits in breached waste packages
- Retardation of radionuclide transport in UZ and SZ
- Dilution of concentrations in SZ

Other Factors

Climate	Infiltration
UZ flow above repository	Coupled effects on UZ flow
Coupled effects on seepage	Environments on drip shield
Environments on waste package	Environments in waste package
Waste form performance	Colloid-associated concentrations
In-package transport	Transport through invert
UZ advective pathways	UZ colloid-facilitated transport
Coupled effects on UZ transport	SZ advective pathways
SZ colloid-facilitated transport	Biosphere transport and uptake

- Likewise, safety case includes a representation for each one and identifies the information needs in each case
- Because these are less important to Safety Case, representation is simple or bounding in each case--information needs are limited

YUCCA MOUNTAIN PROJECT

Studies

Development of the Postclosure Safety Case

Presented to:
DOE-NRC Appendix 7 Meeting

Presented by:
Dennis Richardson
CRWMS M&O

July 13, 1999

U.S. Department of Energy
Office of Civilian Radioactive
Waste Management

Objectives of the Effort

- Revisit the strategy tables of Volume 4 of the VA
  - Incorporate design enhancements
  - Incorporate improved understanding from the TSPA and barrier importance assessments
- Identify the principal factors for the enhanced system
- Define the strategies for these factors
  - Safety case representation for each factor
  - Specific information needed to support each representation
- Support prioritization of the work for FY00 planning

Top-Level Safety Case

- Most radionuclides (e.g., plutonium, uranium) are relatively immobile and are isolated by natural barriers alone
- A small fraction is more mobile and could migrate away from the repository
  - Significant concentrations in groundwater are unlikely
  - However, the risk is eliminated if water is prevented from contacting the waste in the first place
  - Site aridity and characteristics limit the flow of water into the repository
  - Engineered barriers used to divert even small amounts of water--characteristics of this site favorable to design of such barriers
- System utilizes multiple natural and engineered barriers to ensure postclosure safety

Developing the Safety Case

- TSPA-VA showed waste isolation with moderate confidence
- We have increased confidence in the safety case by enhancing the system design--updated TSPAs show significantly greater margin and defense-in-depth
- We are prioritizing the factors important to performance to ensure focus on the enhanced system's essential elements
- Focus is on SRR, without losing sight of potential LA requirements

Factors Potentially Important to Performance

Start From Principal Factors of VA System Design

Key Attributes of Repository System	Principal Factors of VA System Design
Limited Water Contacting Waste Package	Precipitation and infiltration into mountain
	Percolation to depth
	Seepage into drifts
	Effects of heat and excavation on mountain-scale flow
	Effects of heat and excavation on near-field flow
Long Waste Package Lifetime	Dripping on waste package
	T, RH at waste package
	Chemistry on waste package
	Integrity of WP outer barrier
	Integrity of WP inner barrier
Low Rate Of Release of Radionuclides From Breached Waste Packages	Seepage into waste package
	Integrity of SNF cladding
	Dissolution of SNF and glass waste forms
	Neptunium solubility
	Formation of radionuclide-bearing colloids
	Transport through and out of EBS
Radionuclide Concentration Reduction During Transport from the Waste Packages	Transport though UZ
	SZ flow and transport
	Dilution from pumping
	Biosphere transport and uptake

Augment List to Address New Design Features

Key Attributes of System	Factors for Enhanced System Design
Water Contacting Waste Package	Climate
	Infiltration
	UZ flow above repository
	Seepage into drifts
	Coupled processes - effects on UZ flow
	Coupled processes - effects on seepage
	Moisture, temperature, and chemistry on drip shield
	Performance of drip shield
Waste Package Lifetime	Moisture, temperature, and chemistry on waste package
	Performance of waste package barriers
Radionuclide Mobilization and Release from the Engineered Barrier System	Moisture, temperature, and chemistry within waste package
	CSNF waste form (with cladding or canister) performance
	DSNF, Navy fuel, Pu disposition waste form performance
	HLW glass waste form (including canister) performance
	Dissolved radionuclide concentration limits
	Colloid-associated radionuclide concentrations
	In-package radionuclide transport
	EBS radionuclide migration—transport through invert
Transport Away from the Engineered Barrier System	UZ flow and transport—advective pathways
	UZ flow and transport—sorption and matrix diffusion
	UZ flow and transport—colloid-facilitated transport
	Coupled processes--effects on UZ transport
	SZ flow and transport—advective pathways
	SZ flow and transport—sorption and matrix diffusion
	SZ transport--colloid-facilitated transport
	Dilution in SZ
	Biosphere transport and uptake

YUCCA MOUNTAIN PROJECT

Studies

Integration of TSPA Analyses, Process Model Reports, and Analysis/Model Reports

Presented to:
DOE-NRC Appendix 7 Meeting

Presented by:
Miguel A. Lugo and Robert Andrews
CRWMS M&O

July 13, 1999

U.S. Department of Energy
Office of Civilian Radioactive
Waste Management

Process Model Reports (PMRs) Purpose

- The purpose is to document the technical basis supporting each TSPA process model
  - Supports the postclosure safety case for SR/LA
- PMRs will focus the development of technical information on what is relevant to developing a defensible TSPA
  - i.e., the information the Project is relying upon to demonstrate postclosure compliance
- The PMR development process will ensure traceability of data, information, and references

PMR Scope
The following PMRs will be developed

1 Integrated Site Model

2 Unsaturated Zone Flow and Transport

3 Near Field Environment

4 Engineered Barrier System Degradation and Flow/Transport

5 Waste Package Degradation

6 Waste Form Degradation

7 Saturated Zone Flow and Transport

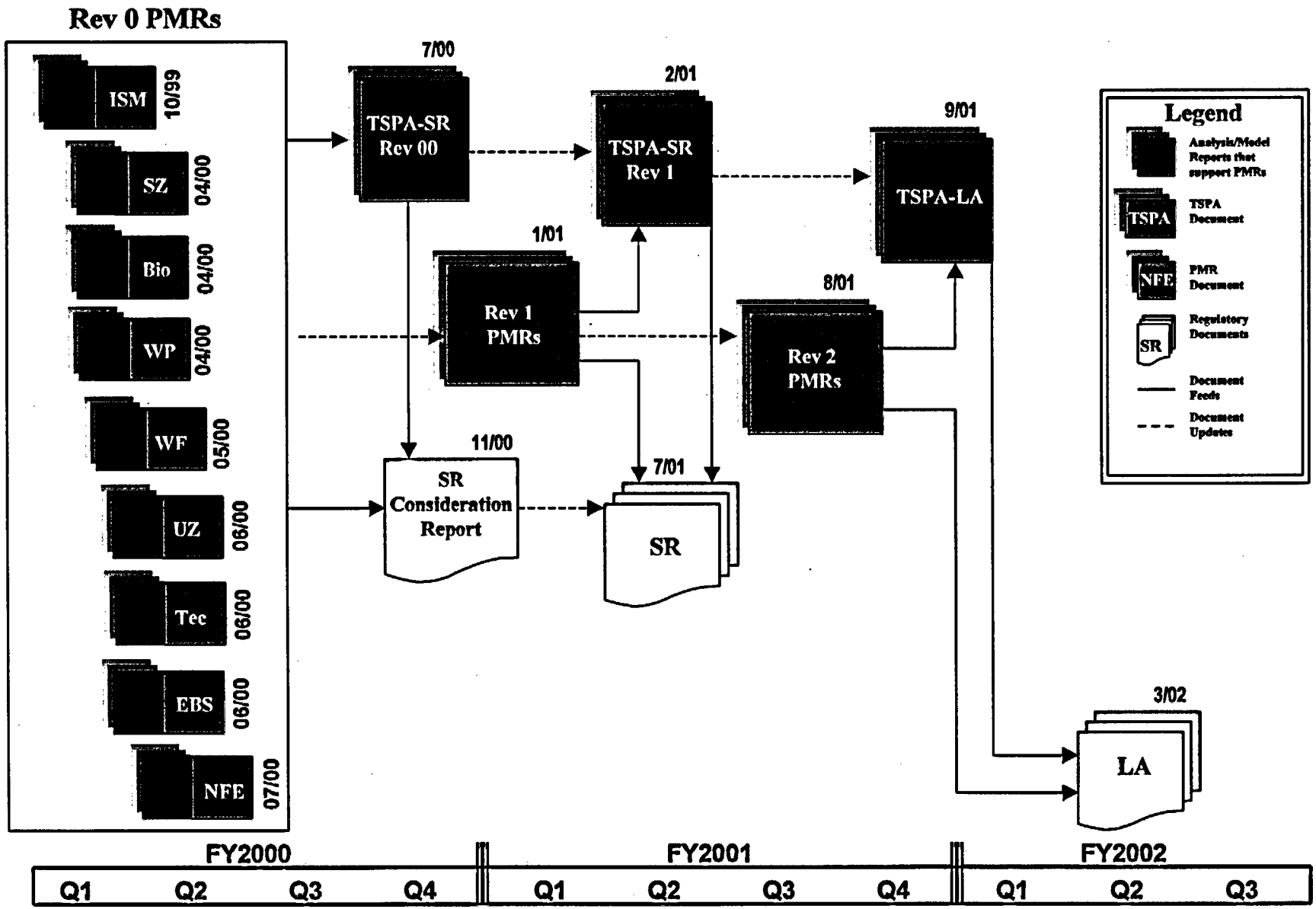
8 Biosphere

9 Tectonic Hazards

PMR Scope
(Continued)

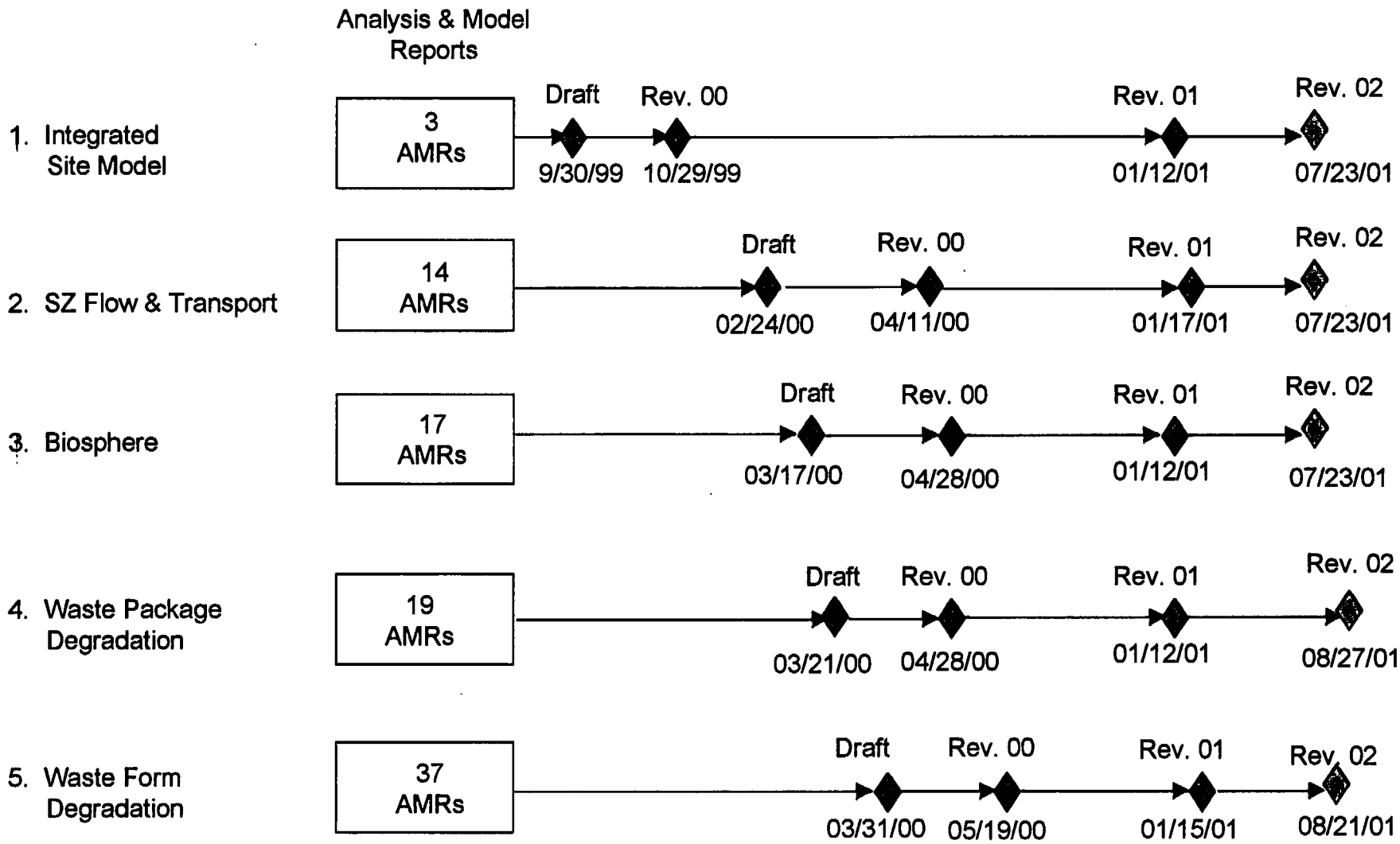
- PMRs will contain:
  - Descriptions of the models, submodels, and abstractions
    - » Relationship to principal factors
  - Relevant data and data uncertainties
  - Assumptions and bases
  - Model results (outputs)
  - Code verification/model validation information
  - Opposing views
  - Information to support regulatory evaluations
    - » NRC Key Technical Issues

Linkage of Major Programmatic SR/LA Milestones



Rev 6 - 7/9/99

Process Model Reports Schedule



Process Model Reports Schedule

(Continued)

	Analysis & Model Reports	Draft	Rev. 00	Rev. 01	Rev. 02
6. UZ Flow & Transport	30 AMRs	04/19/00	06/06/00	01/12/01	07/23/01
7. Tectonic Hazards	13 AMRs	04/27/00	06/23/00	01/12/01	07/23/01
8. EBS Degradation/ Flow & Transport	22 AMRs	05/23/00	06/22/00	02/01/01	08/21/01
9. Near Field Environment	11 AMRs	05/25/00	07/10/00	01/15/01	07/23/01

PMR Team

PMR Manager – Mike Lugo

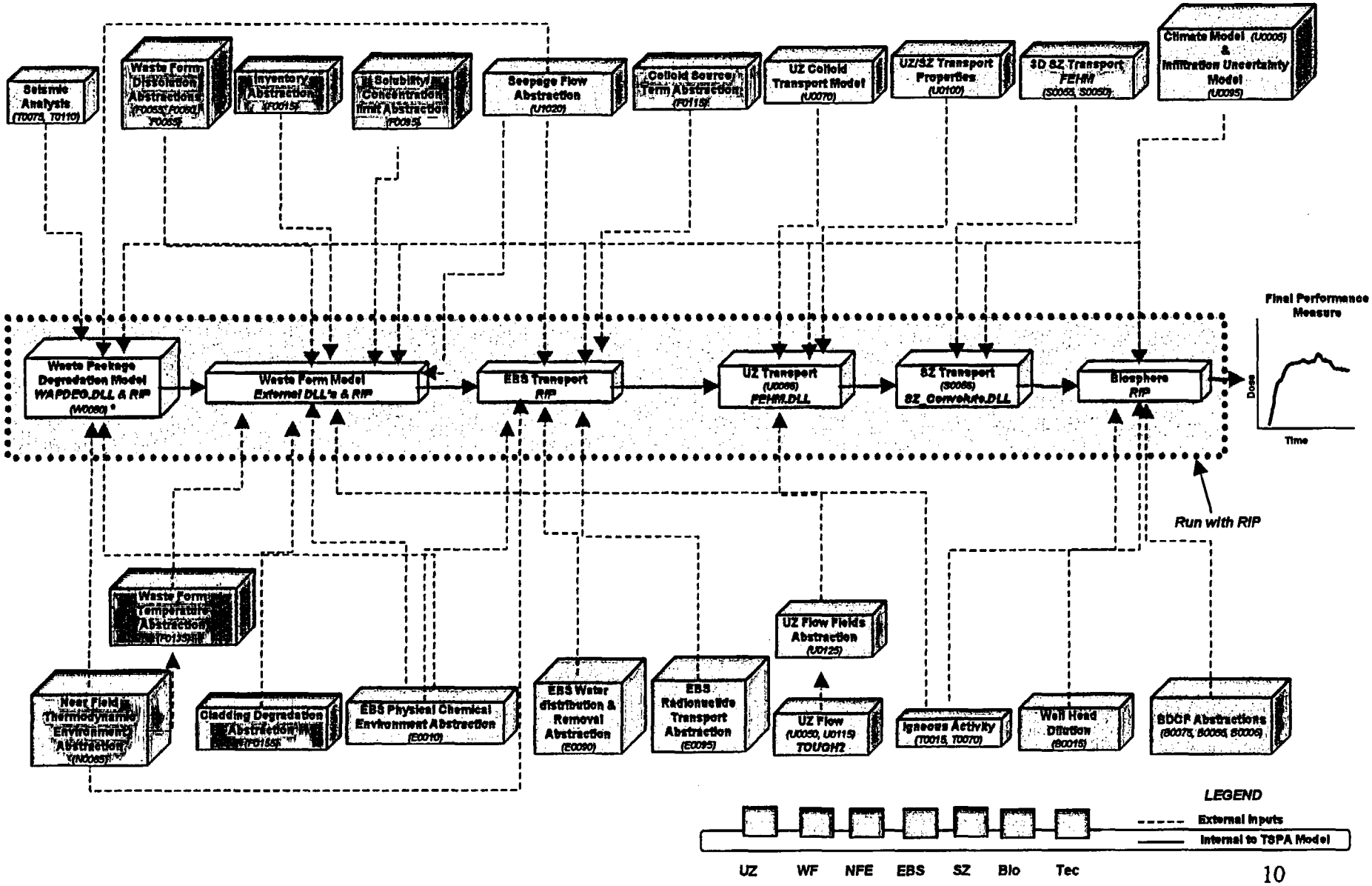
PMR Production Coordinator – Steve Kopelic

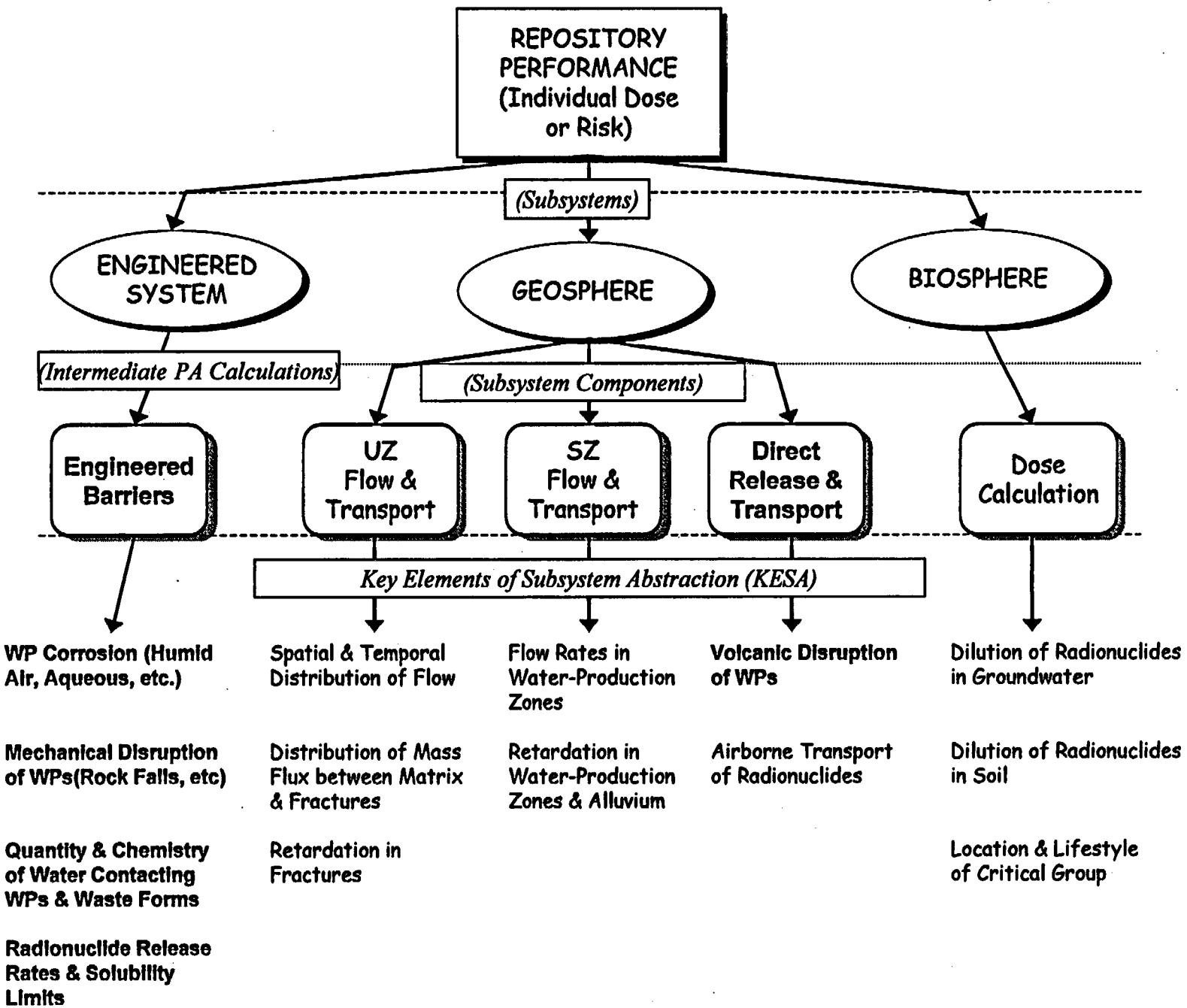
PMR	PMR Lead	PA Representative	Reg. Representative	QA Representative
1. Integrated Site Model	Clinton Lum	Cliff Ho	Terry Crump	Steve Dana
2. Unsaturated Zone Flow/Transport	Bo Bodvarsson	Cliff Ho	Martha Pendleton	Mike Eshleman
3. Saturated Zone Flow/Transport	Al Eddebbarh	Bill Arnold	Augie Matthusen	Mike Eshleman
4. Near Field Environment	Dale Wilder	Nick Francis	Pete Gaillard	Richard Powe
5. Waste Package Degradation	Joe Farmer	Joon Lee	Ali Haghi	Dan Tunney
6. Waste Form Degradation	Christine Stockman	Rob Rechard	Mike Scott	Dan Tunney
7. EBS Degradation/ Flow/Transport	Dwayne Chesnut	Bob MacKinnon	Dale Geiger	Steve Schuermann
8. Biosphere	John Schmitt	Tony Smith	Kayce Prince	Steve Swenning
9. Tectonic Hazards	Richard Quittmeyer	Rally Barnard	Terry Crump	Steve Swenning

Correlation Between DOE's Repository Safety Strategy and NRC's Key Elements of Subsystem Abstraction

- Table on Factors and Attributes of Repository Safety Strategy
- Table on Factors and PMRs and AMRs
- Table on Factors and key TSPA input parameters
- Table on Factors and NRC's KESAs and KTIs

TOTAL SYSTEM PERFORMANCE ASSESSMENT (TSPA) MODEL




REPOSITORY PERFORMANCE (Individual Dose or Risk)
(Subsystems)
ENGINEERED SYSTEM
GEOSPHERE
BIOSPHERE
(Intermediate PA Calculations)
(Subsystem Components)
Engineered Barriers
UZ Flow & Transport
SZ Flow & Transport
Direct Release & Transport
Dose Calculation
Key Elements of Subsystem Abstraction (KESA)
WP Corrosion (Humid Air, Aqueous, etc.)
Mechanical Disruption of WPs(Rock Falls, etc)
Quantity & Chemistry of Water Contacting WPs & Waste Forms
Radionuclide Release Rates & Solubility Limits
Spatial & Temporal Distribution of Flow
Distribution of Mass Flux between Matrix & Fractures
Retardation in Fractures
Flow Rates in Water-Production Zones
Retardation in Water-Production Zones & Alluvium
Volcanic Disruption of WPs
Airborne Transport of Radionuclides
Dilution of Radionuclides in Groundwater
Dilution of Radionuclides in Soil
Location & Lifestyle of Critical Group

Summary

- The PMR process is being implemented to ensure traceability and transparency of models
  - Will document the technical basis for TSPA process models
- PMRs, and supporting analyses and model reports, will address the principal factors of the safety case
  - Focus will be on those factors most significant to performance
- The PMR schedule allows for information to be incorporated as it becomes available

Handouts to support Slide 9 of the presentation on

Integration of TSPA Analyses, Process Model Reports, and Analysis/Model Reports

Table 1-1
Comparison of Principal Factors of the Repository Safety Strategy used in the Viability Assessment with the Factors used in the Site Recommendation

Key Attributes of System	Principal Factors in Viability Assessment[1]	Factors in Repository Safety Strategy Rev. 3[2]
Water Contacting Waste Package	Precipitation and infiltration into the mountain	Climate
		Infiltration
	Percolation to depth	UZ flow above repository
	Seepage into drifts	Seepage into drifts
	Effects of heat and excavation on flow	Coupled processes - effects on UZ flow
		Coupled processes - effects on seepage
	N/A	Environment, (mechanical stress. moisture, temperature, and chemistry) on drip shield
	N/A	Performance of drip shield
Waste Package Lifetime	Dripping onto the waste package	Environment, (mechanical stress. moisture, temperature, and chemistry) on waste package
	Humidity and temperature at the waste package	
	Chemistry on the waste package	
	Integrity of outer waste package barrier	Performance of waste package barriers
	Integrity of inner waste package barrier	
Radionuclide Mobilization and Release from the Engineered Barrier System	Seepage into waste package	Environment, (mechanical stress. moisture, temperature, and chemistry) within waste package
	Integrity of spent nuclear fuel cladding	CSNF waste form (with cladding or canister) performance
	Dissolution of UO_2 and glass waste forms	DSNF, Navy fuel, Pu disposition waste form performance
		HLW glass waste form (including canister) performance
	Solubility of neptunium-237	Dissolved radionuclide concentration limits
	Formation of radionuclide-bearing colloids	Colloid-associated radionuclide concentrations
	Transport within and out of the waste package	In-package radionuclide transport
	EBS radionuclide migration—transport through invert	EBS radionuclide migration—transport through invert
Transport Away from the Engineered Barrier System	Transport through unsaturated zone	UZ flow and transport—advective pathways
		UZ flow and transport—sorption and matrix diffusion
		UZ flow and transport—colloid-facilitated transport
		Coupled processes--effects on UZ transport
	Transport in saturated zone	SZ flow and transport—advective pathways
		SZ flow and transport—sorption and matrix diffusion
		SZ transport--colloid-facilitated transport
	Dilution from pumping	Wellhead dilution
	Biosphere transport and uptake	Biosphere transport and uptake
Effects of Potentially Disruptive Processes and Events		Volcanism
		Seismicity

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[1] Repository Safety Strategy; U.S. Department of Energy; Strategy to Protect Public Health and Safety after Closure of a Yucca Mountain Repository Rev. 01 (DOE 1998)
[2] Repository Safety Strategy; U.S. Department of Energy; Strategy to Protect Public Health and Safety after Closure of a Yucca Mountain Repository Rev. 03 (DOE 1999)

Table 1-2
Correlation of DOE's Repository Safety Strategy Rev. 03 Factors with NRC's Subsystem Components and Key Elements of Subsystem Abstraction

Key Attributes of System	Factors[1]	NRC[2] Subsystem Components	NRC Key Elements of Subsystem Abstraction[2]
Water Contacting Waste Package	Climate	UZ Flow and Transport	Spatial and Temporal Distribution of Flow
	Infiltration		
	UZ flow above repository		
	Seepage into drifts		
	Coupled processes - effects on UZ flow		
	Coupled processes - effects on seepage		
	Environment, (mechanical stress, moisture, temperature, and chemistry) on drip shield	Engineered Barriers	Quantity and Chemistry of Water Contacting Waste Packages and Waste Forms
	Performance of drip shield		
Waste Package Lifetime	Environment, (mechanical stress, moisture, temperature, and chemistry) on waste package		
	Performance of waste package barriers		Waste Package Corrosion
			Mechanical Disruption of Waste Packages
Radionuclide Mobilization and Release from the Engineered Barrier System	Environment, (mechanical stress, moisture, temperature, and chemistry) within waste package		Radionuclide Release Rates and Solubility Limits
	CSNF waste form (with cladding or canister) performance		
	DSNF, Navy fuel, Pu disposition waste form performance		
	HLW glass waste form (including canister) performance		
	Dissolved radionuclide concentration limits		
	Colloid-associated radionuclide concentrations		
	In-package radionuclide transport		
	EBS radionuclide migration—transport through invert		
Transport Away from the Engineered Barrier System	UZ flow and transport—advective pathways	UZ Flow and Transport	Distribution of Mass Flux Between Fracture and matrix
	UZ flow and transport—sorption and matrix diffusion		Retardation in Fractures in the Unsaturated Zone
	UZ flow and transport—colloid-facilitated transport		
	Coupled processes--effects on UZ transport		
	SZ flow and transport—advective pathways	SZ Flow and Transport	Flow Rate in water productions zones
	SZ flow and transport—sorption and matrix diffusion		Retardation in water production zones and alluvium
	SZ transport--colloid-facilitated transport		
	Wellhead dilution	Dose Calculations	Dilution of radionuclides in groundwater
	Biosphere transport and uptake		Dilution of radionuclides in soil
			Lifestyle of Critical Group
Effects of Potentially Disruptive Processes and Events	Volcanism	Direct Release and Transport	Volcanic Disruption of Waste Packages
			Airborne Transport of Radionuclides
	Seismicity/Structural Deformation		Mechanical Disruption of Waste Packages

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[1]Repository Safety Strategy; U.S. Department of Energy; Strategy to Protect Public Health and Safety after Closure of a Yucca Mountain Repository Rev. 03 (DOE 1999)
[2] Total System Performance Assessment and Integration Key Technical Issue – Issue Resolution and Status Report, Rev. 01 NRC (1998)

Table 1-3
Correlation of DOE's Repository Safety Strategy Rev. 03 with NRC's Key Technical Issues and DOE's Process Model Reports

Key Attributes of System	Factors[1]	NRC Key Technical Issue[2]	Process Model Report[1]
Water Contacting Waste Package	Climate	Unsaturated and Saturated Flow Under Isothermal Conditions	Unsaturated Zone Flow and Transport
	Infiltration		
	UZ flow above repository		
	Seepage into drifts	Repository Design and Thermomechanical Effects	
	Coupled processes - effects on UZ flow	Thermal Effects on Flow	Near Field Environment
	Coupled processes - effects on seepage		
	Environment, (mechanical stress, moisture, temperature, and chemistry) on drip shield	Evolution of the Near Field Environment	Engineered Barrier System
	Performance of drip shield		Waste Package
Waste Package Lifetime	Environment, (mechanical stress, moisture, temperature, and chemistry) on waste package		Engineered Barrier System
	Performance of waste package barriers	Container Life and Source Term	Waste Package
Radionuclide Mobilization and Release from the Engineered Barrier System	Environment, (mechanical stress, moisture, temperature, and chemistry) within waste package		Waste Form
	CSNF waste form (with cladding or canister) performance		
	DSNF, Navy fuel, Pu disposition waste form performance		
	HLW glass waste form (including canister) performance		
	Dissolved radionuclide concentration limits		
	Colloid-associated radionuclide concentrations		
	In-package radionuclide transport		
	EBS radionuclide migration—transport through invert		Engineered Barrier System
Transport Away from the Engineered Barrier System	UZ flow and transport—advective pathways	Radionuclide Transport	Unsaturated Zone Flow & Transport
	UZ flow and transport—sorption and matrix diffusion		
	UZ flow and transport—colloid-facilitated transport		
	Coupled processes--effects on UZ transport		
	SZ flow and transport—advective pathways		Saturated Zone Flow and Transport
	SZ flow and transport—sorption and matrix diffusion		
	SZ transport--colloid-facilitated transport		
	Wellhead dilution		
	Biosphere transport and uptake		Biosphere
Effects of Potentially Disruptive Processes and Events	Volcanism	Igneous Activity	Tectonics
	Seismicity/Structural Deformation	Structural Deformation and Seismicity	

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[1]Repository Safety Strategy; U.S. Department of Energy; Strategy to Protect Public Health and Safety after Closure of a Yucca Mountain Repository Rev. 03 (DOE 1999)
[2] Total System Performance Assessment and Integration Key Technical Issue – Issue Resolution and Status Report, Rev. 01 NRC (1998)

Table 1-4
Correlation of DOE's Repository Safety Strategy Rev. 03 with Possible Subsystem Performance Measures

Key Attributes of System	Factors	Possible Subsystem Performance Measures
Water Contacting Waste Package	Climate	• Seepage fraction • Seepage flux
	Infiltration	
	UZ flow above repository	
	Seepage into drifts	
	Coupled processes - effects on UZ flow	
	Coupled processes - effects on seepage	
	Environment, (mechanical stress, moisture, temperature, and chemistry) on drip shield	
	Performance of drip shield	• Fraction of dripshields degraded • Area of degraded drip shield
Waste Package Lifetime	Environment, (mechanical stress, moisture, temperature, and chemistry) on waste package	• Fraction of WPs wetted • Flux contacting WPs
	Performance of waste package barriers	• Fraction of WPs degraded • Area of degraded WPs
Radionuclide Mobilization and Release from the Engineered Barrier System	Environment, (mechanical stress, moisture, temperature, and chemistry) within waste package	• Flux contacting WF
	CSNF waste form (with cladding or canister) performance	• Fraction of WF contacted by water • Release rate from CSNF WF
	DSNF, Navy fuel, Pu disposition waste form performance	• Fraction of WF contacted by water • Release rate from DSNF and other WFs
	HLW glass waste form (including canister) performance	• Fraction of WF contacted by water • Release rate from HLW glass
	Dissolved radionuclide concentration limits	• Release rate from EBS • Cumulative release from EBS
	Colloid-associated radionuclide concentrations	
	In-package radionuclide transport	
	EBS radionuclide migration—transport through invert	
Transport Away from the Engineered Barrier System	UZ flow and transport—advective pathways	• Release rate from UZ • Cumulative release from UZ
	UZ flow and transport—sorption and matrix diffusion	
	UZ flow and transport—colloid-facilitated transport	
	Coupled processes—effects on UZ transport	
	SZ flow and transport—advective pathways	• Release rate from SZ at 20km • Cumulative release from SZ at 20 km • Concentration in aquifer at 20km
	SZ flow and transport—sorption and matrix diffusion	
	SZ transport--colloid-facilitated transport	
	Wellhead dilution	• Concentration at wellhead
	Biosphere transport and uptake	• Dose to average member of critical group
Effects of Potentially Disruptive Processes and Events	Volcanism	• Probability of volcanic disruption • Direct release rate to atmosphere from volcanic disruption • Dose to average member of critical group from volcanic disruption
	Seismicity/Structural Deformation	• Probability of seismicity/structural deformation • Fraction of WPs degraded

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Table 1-5 Correlation of DOE's Repository Safety Strategy Rev. 03 Factors with Analysis/Model Reports that Provide Input to TSPA-SR

Key Attributes of System	Factors	Analysis/ Model Report Number	Analysis/Model Report Title
Water Contacting Waste Package	Climate	U0005	Climate Model Abstraction
	Infiltration	U0095	Infiltration Uncertainty Abstraction
	UZ flow above repository	U0125	UZ Flow Fields Abstraction
	Seepage into drifts	U0120	Drift Seepage and Coupled Process Abstraction
	Coupled processes - effects on UZ flow	U0115	UZ Coupled Process Flow Field Abstraction
	Coupled processes - effects on seepage	U0120	Drift Seepage and Coupled Process Abstraction
	Environment, (mechanical stress, moisture, temperature, and chemistry) on drip shield	N0065	NF Thermodynamic Environment Abstraction
		E0010	EBS Physical Chemical Environment Abstraction
		E0090	EBS Water Distribution and Removal Model
	Performance of drip shield	W0075	Juvenile Failures
		W0125	Abstraction of Model for Mechanical Damage and Failure of Drip Shield and Waste Package by Rockfall
		W0005	Abstraction of Models for General Corrosion of Drip Shield and Waste Package Outer Barrier
		W0040	Abstraction of Models for Pitting and Crevice Corrosion of Drip Shield and Waste Package Outer Barrier
		W0045	Abstraction of Models for Stress Corrosion Cracking (SCC) of Drip Shield and Waste Package Outer Barrier and Hydrogen Induced Cracking (HIC) of Drip Shield
		W0030	Failures Due to Mechanical Degradation
aste Package Lifetime	Environment, (mechanical stress, moisture, temperature, and chemistry) on waste package	E0010	EBS Physical Chemical Environment Abstraction
		N0065	NF Thermodynamic Environment Abstraction
		E0090	EBS Water Distribution and Removal Model
	Performance of waste package barriers	W0075	Juvenile Failures
		W0020	Aging and Phase Stability (APS) of Waste Package Outer Barrier (WPOB)
		W0125	Abstraction of Model for Mechanical Damage and Failure of Drip Shield and Waste Package by Rockfall
		W0005	Abstraction of Models for General Corrosion of Drip Shield and Waste Package Outer Barrier
		W0040	Abstraction of Models for Pitting and Crevice Corrosion of Drip Shield and Waste Package Outer Barrier
		W0045	Abstraction of Models for Stress Corrosion Cracking (SCC) of Drip Shield and Waste Package Outer Barrier and Hydrogen Induced Cracking (HIC) of Drip Shield
		W0120	Abstraction of Models for Stainless Steel Structural Material Degradation
Radionuclide Mobilization and Release from the Engineered Barrier System	Environment, (mechanical stress, moisture, temperature, and chemistry) within waste package	F0135	In-WP Temperature History
		F0130	In-WP Chemistry History
		F0165	In-WP Hydrology History
	CSNF waste form (with cladding or canister) performance	F0015	CSNF Inventory Abstraction
		F0155	Cladding Degradation Abstraction
		F0055	CSNF Degradation Model
	DSNF, Navy fuel, Pu disposition waste form performance	F0015	DSNF Inventory Abstraction
		F0065	Other Waste Form Degradation Abstraction
	HLW glass waste form (including canister) performance	F0015	HLW Inventory Abstraction
		F0060	HLW Glass Degradation
	Dissolved radionuclide concentration limits	F0095	Dissolved Concentration Limits Abstraction
	Colloid-associated radionuclide concentrations	F0115	Colloid Source Term Abstraction
	In-package radionuclide transport	F0165	In –WP Hydrology History
	EBS radionuclide migration—transport through invert	N0065	NF Thermodynamic Environment Abstraction
		E0095	EBS Radionuclide Transport Abstraction
nsport Away from the Engineered Barrier System	UZ flow and transport—advective pathways	U0125	UZ Flow Fields Abstraction
	UZ flow and transport—sorption and matrix diffusion	U0065	UZ Transport Particle Tracking Abstraction
		U0100	UZ/SZ Transport Properties
	UZ flow and transport—colloid-facilitated transport	U0070	UZ Colloid Transport Model
	Coupled processes--effects on UZ transport	U0100	UZ/SZ Transport Properties
	SZ flow and transport—advective pathways	S0055	SZ Flow and Transport Model Abstraction
		S0050	SZ Flow and Transport Stochastic Parameters
	SZ flow and transport—sorption and matrix diffusion	S0050	SZ Flow and Transport Stochastic Parameters
		U0100	UZ/SZ Transport Properties
	SZ transport--colloid-facilitated transport	S0035	Colloid-Facilitated Transport
	Wellhead dilution	B0015	Water Usage
		B0010	Critical Group
	Biosphere transport and uptake	B0075	Biosphere Dose Conversion Factors

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·v Attributes f System	Factors	Analysis/ Model Report Number	Analysis/Model Report Title
Effects of Potentially Disruptive Processes and Disruptive Events	Volcanic	T0015	Framework for Igneous Activity
		T0070	Consequence Analysis of Direct Release
	Seismic	T0075	Framework for Seismicity/Structural
		T0110	Consequence Analysis Result

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