

YUCCA MOUNTAIN PROJECT



Plans for the Development of the Total System Performance Assessment for the Site Recommendation and License Application

Presented to:
NRC/DOE Technical Exchange
License Application Plan

Presented by:
Dr. Holly A. Dockery
Offsite Deputy Manager, Performance Assessment Operations
Management and Operating Contractor



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

September 16, 1998

Yucca Mountain - 70

Outline

- **Approach for Integrating Yucca Mountain Project Elements into TSPA-SR/LA**
- **Major Performance Assessment Milestones and Activities - VA to SR/LA**
- **Schedule of Activities for TSPA in SR/LA Plan**
- **Possible Model Enhancements for TSPA-SR/LA**

Oversight

NRC Technical Exchanges, Appendix 7 Meetings
NWTRB Panel Meetings, Reports to Congress
TSPA Peer Review Interim Reports 1, 2, and 3
State of Nevada Affected Units of Local Government
Public

Prior TSPAs

DOE TSPA-91, 93, 95
NRC IPA -1, -2, -3
EPRI TSPA Phases 1, 2, and 3

Process Model Abstraction Workshops

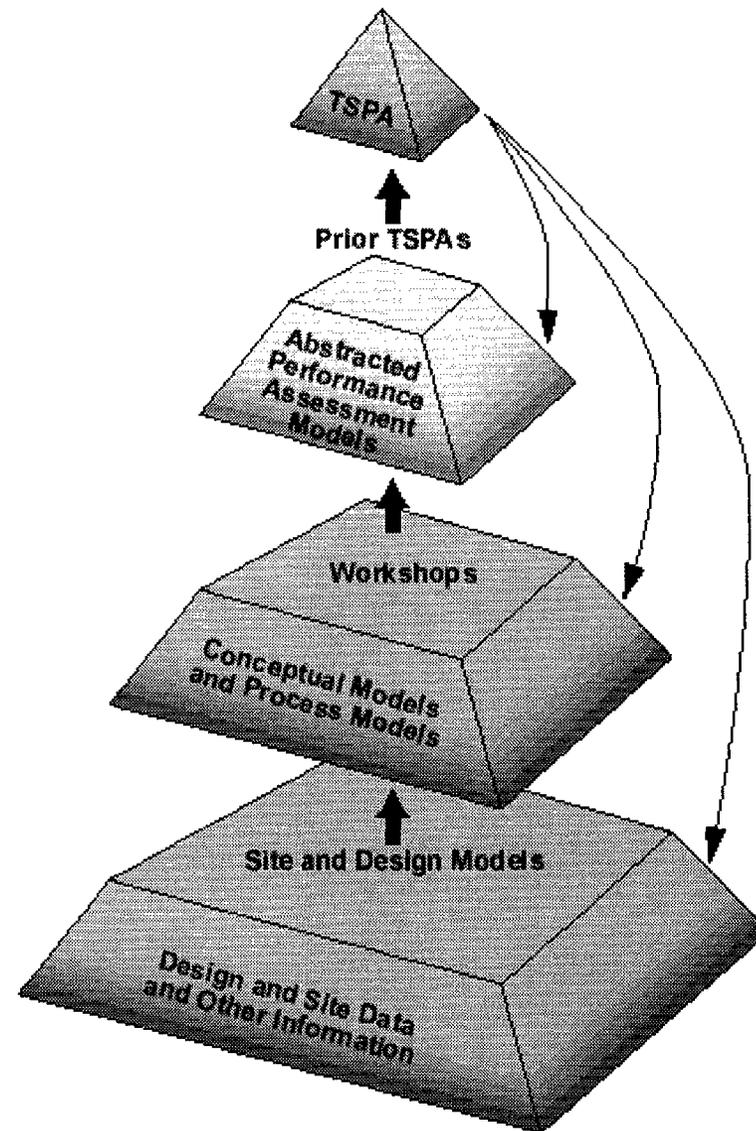
Unsaturated Zone Flow
Thermal Hydrology
Near-Field Geochemical Environment
Waste Package Degradation
Waste Form Degradation and Radionuclide Mobilization
Unsaturated Zone Transport
Saturated Zone Flow and Transport

Site and Design Models

Unsaturated Zone Flow Model
Seepage Model
Near-Field Environment Model
Corrosion Model
Unsaturated Zone Transport Model
Saturated Zone Flow and Transport Model

Site and Design Information

Site Description Document
Repository Design
Waste Package Design
Laboratory Data
In situ Data
Analog Data



TSPA-LA.012

TSPA-VA, Principal Factors, and KTIs

ATTRIBUTES OF THE REPOSITORY SAFETY STRATEGY	PRINCIPAL FACTORS	TSPA MODEL COMPONENTS	NRC KEY TECHNICAL ISSUES
Limited Water Contacting Waste Packages	Precipitation and Infiltration of Water into the Mountain	Climate	Unsaturated and Saturated Flow under Isothermal Conditions
	Percolation to Depth	Infiltration	
	Seepage into Drifts	Unsaturated Zone Flow	
	Effects of Heat and Excavation on Flow	Seepage	Repository Design and Thermomechanical Effects
	Dripping onto Waste Package	Thermal Hydrology - Mountain Scale	Thermal Effects on Flow
Humidity and Temperature at Waste Package	- Drift Scale		
Long Waste Package Lifetime	Chemistry on Waste Package	Near Field Geochemical Environment	Evolution of the Near Field Environment
	Integrity of Waste Package Outer Barrier	Waste Package Degradation	Container Life and Source Term
Integrity of Waste Package Inner Barrier			
Low Rate of Release of Radionuclides from Breached Waste Packages	Seepage into Waste Package	Cladding Degradation	
	Integrity of Spent Fuel Cladding	Waste Form Degradation	
	Dissolution of UO ₂ and Glass Waste-form	Radionuclide Mobilization and Engineered Barrier System Transport	
	Solubility of Neptunium-237	Unsaturated Zone Transport	
	Formation of Radionuclide-Bearing Colloids		
Transport within and out of Waste Package	Saturated Zone Transport and Dilution		
Radionuclide Concentration Reduction during Transport from the Waste Packages	Transport through Unsaturated Zone	Biosphere Transport	Unsaturated and Saturated Flow under Isothermal Conditions and Radionuclide Transport
	Transport in Saturated Zone		
	Dilution from Pumping		
	Biosphere Dilution		

NRC KTIs LACKING DIRECTLY CORRESPONDING PRINCIPAL FACTORS

+ THE TSPA AND INTEGRATION KTI APPLIES TO ALL PRINCIPAL FACTORS +	Disruptive Events - Volcanic	Igneous Activity
	Disruptive Events - Seismic	Structural deformation and Seismicity
		Total System Performance Assessment and Integration
		Activities Related to the EPA Standard

Major Site Investigation Milestones to Performance Assessment - VA to SR/LA

<u>Level 2 Milestone</u>	<u>Date</u>
NFE Model for SR/LA	1/00
UZ Flow Model for SR/LA	2/00
SZ Flow Model for SR/LA	2/00
UZ Transport Model for SR/LA	2/00
SZ Transport Model for SR/LA	2/00

Major Design Milestones to Performance Assessment: VA to SR/LA

<u>Level 2 Milestone</u>	<u>Date</u>
Waste Form Characteristics Report	12/98
Waste Form Characteristics Report - Update	11/00
Engineered Materials Report	12/98
Engineered Materials Report - Update	11/00
Select Initial SR/LA Design and Options	5/99
Design Verification for Performance Assessment	3/00

Major Performance Assessment Milestones: VA to SR/LA

<u>Level 2 Milestone</u>	<u>Date</u>
TSPA Peer Review Final Report*	3/99
Complete DEIS	6/99
TSPA-SR/LA Methodology Document*	7/99
TSPA-SR/LA Base Case Results Document <i>indication of acceptability for review</i>	6/00
TSPA-SR/LA Document	11/00

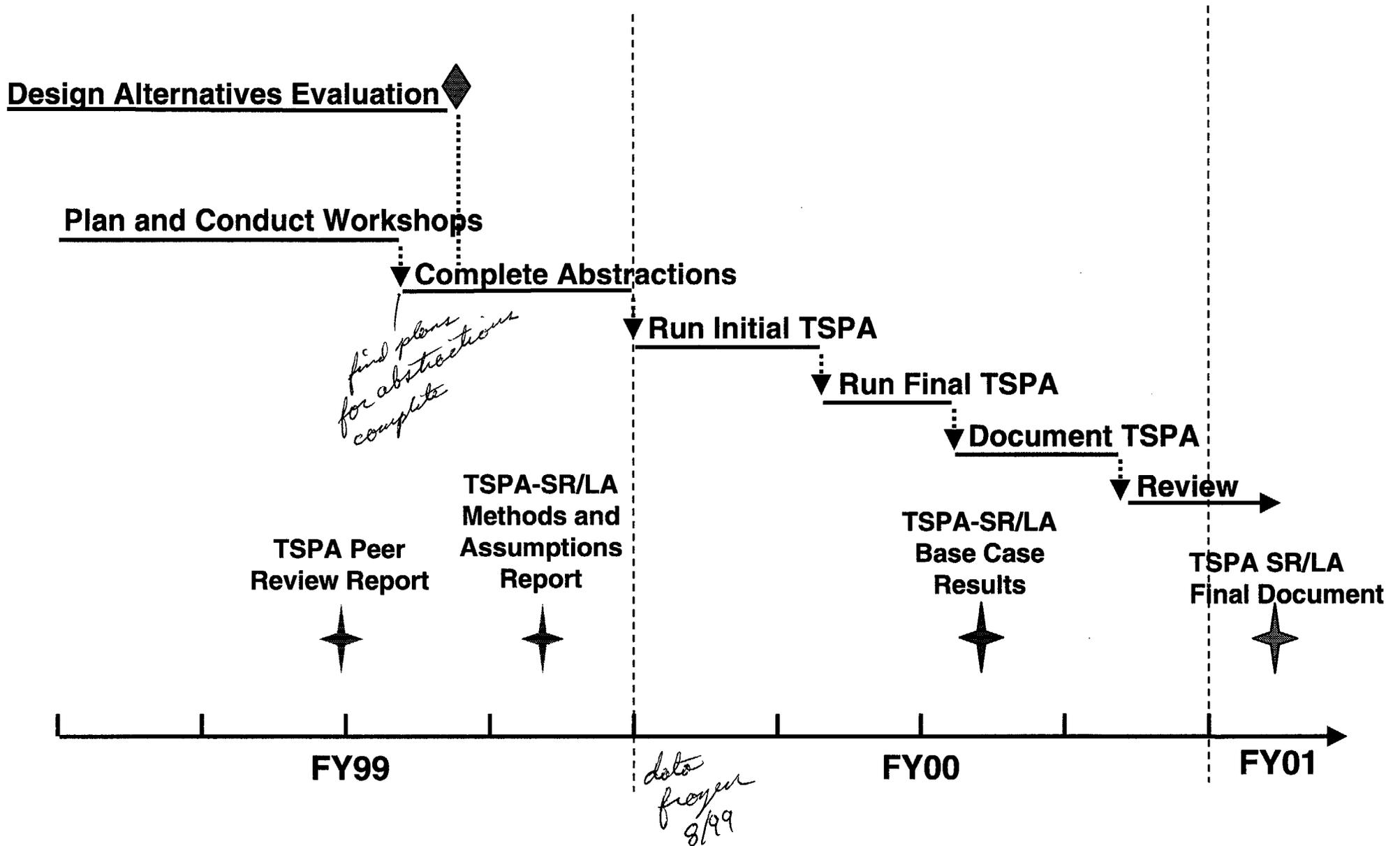
Major Performance Assessment Activities: VA to SR/LA

<u>TSPA Activities</u>	<u>Duration</u>
TSPA-VA Documentation	10/98 - 4/99
LA Design Selection	10/98 - 5/99
Process Control and Management	10/98 - 9/02
Design Analyses	10/98 - 9/02
TSPA Approach and Model Development	10/98 - 2/00
Regulatory Analyses	10/98 - 9/02
EIS Analyses	10/98 - 9/02
TSPA for SR/LA	3/00 - 10/00
Sensitivity Studies for TSPA-SR/LA	11/00 - 5/01
Finalize TSPA-SR/LA	6/01 - 11/01

Major Performance Assessment Activities: VA to SR/LA (Continued)

<u>Abstraction/Testing Activities</u>	<u>Duration</u>
Disruptive Events	10/98 - 7/00
SZ and Biosphere	10/98 - 7/00
Waste Form/EBS	10/98 - 7/00
WP Degradation	10/98 - 7/00
UZ Flow & Transport	10/98 - 7/00
NFG Environment	10/98 - 7/00

Generalized Schedule for TSPA-SR/LA Activities



Plan and Conduct Workshops

- **Planning workshops will include:**
 - **finalization of appropriate scenarios,**
 - **assessment of issues identified in**
 - ♦ **the TSPA-VA conclusions,**
 - ♦ **the applicable NRC IRSRs, and**
 - ♦ **reviews by the PA Peer Review Panel, the NWTRB, and others.**
 - **initial prioritization of issues with respect to repository performance.**
- **Workshops will be held for each TSPA component between 11/98 and 4/99.**
- **Objective of the workshops will be to “finalize” plans for implementing the abstraction and to provide the rationale for the selection of the analyses to be completed.**

Complete Abstractions

- **Analyses to develop abstractions for each TSPA component will be initiated after completion of the associated workshop.**
- **Finalization of data to be included in the respective TSPA-LA components will be tied to the completion date for the appropriate process model (data input will be “frozen” in August, 1999).**
- **Abstractions must be completed for use in TSPA-LA by the end of FY99.**

Run Initial TSPA- SR/LA

- **Purpose of activity will be to combine all of the abstractions, test the TSPA analysis tool, and to verify the qualification status of the codes and inputs for the TSPA-SR/LA.**
- **Testing of the TSPA tool will be completed in 1/00.**
- **No results, in terms of forecasting repository performance, are expected to be available at this point.**

Run Final TSPA-SR/LA

- **The objective of this activity will be to complete probabilistic analyses required for the TSPA-SR/LA, using qualified codes and inputs.**
- **Additional sensitivity analyses will be completed at this time.**
- **Preliminary results, with minimal interpretation, will be presented to YMP in 4/00 for an interim review.**

*last call - course
for mid-course
change*

Document TSPA-SR/LA

- **During the time period from April to July, 2000, PA staff will focus on interpretation and documentation of results of the TSPA-SR/LA.**
- **Any additional analyses, identified as necessary during the review presentations, will be completed.**
- **The draft TSPA-SR/LA will be submitted for internal review in July 2000.**

Review and Revise TSPA-SR/LA

- **The TSPA-SR/LA will enter formal internal M&O document review.**
 - **PA staff will be involved in review, response, and revision of the TSPA-SR/LA documentation.**
 - **Reference review and QA consistency checks will be completed during this time period.**
- **After M&O review, the documentation will be reviewed by DOE and revised, as required.**
- **The current schedule shows the TSPA-SR/LA submission as a Level 2 milestone in November, 2000.**

Possible PA Abstraction Model Enhancements: UZ Flow and Transport

Related to NRC KTIs: Unsaturated and Saturated Flow under Isothermal Conditions and Radionuclide Transport

- Refine treatment of abstraction of climate change (timing, duration, transition between states, changes in infiltration).
vegetation, cloud cover, move away from step functions
- Refine range of uncertainty in infiltration.
- Incorporate effects of localized flow channeling.
- Investigate influence of changes in drift geometry on seepage as well as stability of seep locations and volumes.
- Assess impact of thermal-chemical alteration of hydrologic properties.
- Determine importance of episodic percolation.
- Enhance model for colloid stability and transport.
- Incorporate models of fracture sorption and matrix diffusion.

*issue in A
316
sensitivity studies
done - not sensitive*

Possible PA Abstraction Model Enhancements: Near Field Environment

Related to NRC KTIs: Evolution of Near Field Environment, Thermal Effects on Flow, and Repository Design and Thermal-Mechanical Effects

- **Examine bounds of thermal effects on flow.**
- **Incorporate effects due to T-H-M and T-H-C coupling.**
- **Assess impact of thermal-mechanical effects on hydrologic properties of fractures.**
- **Refine uncertainty bounds in evolution of in-drift water composition and other aspects of near-field chemistry.**

Possible PA Abstraction Model Enhancements: Waste Package Degradation

Related to NRC KTI: Container Life and Source Term

Model enhancement is dependent on LA design selection, however improvements determined from the VA design would:

- Include effects of change in corrosion model as drift collapses.
- Improve representation of localized corrosion based on corrosion test results and mechanistic corrosion model.
- Incorporate effects of additional data on the behavior of Alloy 22 (including stifling process for pitting and crevice corrosion).
- Investigate effects of other processes, including incomplete annealing of welds and long-term structural integrity of the waste package (in part to improve basis for juvenile failure).

rockfall

*will address
corrosion potentials
etc.
will enhance
effectiveness
results*

Possible PA Abstraction Model Enhancements: Waste Form/EBS Transport

Related to NRC KTI: Container Life and Source Term

- **Refine abstractions of cladding degradation.**
- **Refine models of spent fuel degradation based on completed laboratory tests and analog studies (including effects of secondary phases).**
think may be significantly long residence time
- **Enhance abstracted models of radionuclide speciation, solubility, and sorption.**
- **Revise models of the formation and stability of colloids.**

Chapter's
more detail on
tracking
RD's (P70)

Possible PA Abstraction Model Enhancements: Saturated Zone

Related to NRC KTIs: Unsaturated and Saturated Flow under Isothermal Conditions and Radionuclide Transport

will be
radically
different than
VA
channeling

- **Revise PA models based on updated site-scale numerical and conceptual models of saturated zone flow and transport.**
- ⇒ **Address effects of large scale (structural flow channeling) and small-scale (variability of properties within units) features on flow and transport.**
- **Improve models of colloid-facilitated transport.**

NP solubility
will be refined
(P70)

Possible PA Abstraction Model Enhancements: Biosphere

Related to NRC KTI: Total System Performance Assessment and Integration

- Improve definition of the interface between the geosphere and biosphere, including a revised definition of the critical group. (*doses to children under 6 desert soils and RN uptake*)
- Compare impact of using different exposure standards and methodologies with select radionuclides.

Possible PA Model Enhancements: Disruptive Events

Related to NRC KTIs: Igneous Activity and Structural Deformation and Seismicity

- **Complete refinements of volcanic and seismic analyses.**
*minimal, disagree on application w/NRC
agree to disagree*
- **Complete refinements of human intrusion analyses.**
based on regulation
- **Complete refinements of nuclear criticality analyses, including probabilistic analyses.**

*near for-field
and
within WP*

Possible PA Model Enhancements:TSPA Model Development

Related to NRC KTI: Total System Performance Assessment and Integration

- Implement robust features, events and processes screening methodology.
- Examine the basis for alternative conceptual models and parameters to be used in developing abstractions for TSPA.
- Streamline TSPA analysis tool. *how implement*
- Expand treatment of uncertainty.
- Provide more concise representation of conservatisms. *maybe WP degradation model into code*
- Revise method of combining different realizations of post-closure performance. *and/or non-conservatisms*
- Focus analyses on identifying significance of NRC KTIs. *issue this will be handled*

Conclusions

- **In the course of developing the LA Plan, staff from the PA, Site Investigation, and Design organizations have worked closely to ensure an integrated approach and schedule.**
- **The activities planned for the TSPA-SR/LA benefited a great deal from the lessons learned during the implementation of the VA process and from analysis of the TSPA-VA results.**
- **The LA Plan will continue to evolve as work continues:**
 - **Reassessment of priorities and issues will occur as new information becomes available.**
 - **NRC input on the content of the VA, from the finalized IRSRs, and from planned meetings will also be included.**
 - **Other Oversight groups, such as the PA Peer Review Panel and the NWTRB are also expected to provide important insights that will influence the plan.**