

U.S. Department of Energy



Integration of Total System Performance Assessment (TSPA) and Repository Design

Presented to: Nuclear Waste Technical Review Board

Presented by: William J. Boyle Kirk Lachman Office of Repository Development

February 09, 2005 Las Vegas, Nevada

Overview

- Historical Perspective
- Drip Shield Example
- Current Practice





TSPA/Design History

TSPA Iteration	Summary of Key Results
1988 Site Characterization Plan	 Applied basic methodology for Monte Carlo uncertainty analyses based on scenarios.
TSPA-1991	 Demonstration of TSPA approach. Models limited to UZ and SZ, and volcanism identified importance of uncertainty in UZ flow paths.
TSPA-1993	 Improved models for UZ, SZ, early models for coupled processes, EBS, biosphere. Importance of uncertainty in thermal hydrology, UZ flow, corrosion of engineered materials.
TSPA-1995	 Incorporate new science and design, evaluate alternative models. Importance of robust process models for WP degradation, seepage, UZ and SZ transport.
TSPA-VA	 Supported the 1998 Viability Assessment, models based on best current information. Ranked importance of uncertainty in each of the major components for 10,000, 100,000, and 1,000,000 years. Emphasis on seepage, water chemistry, corrosion, and SZ.
1999 License Application Design Selection (LADS)	 TSPA tools used to evaluate relative merits of design alternatives. Demonstrated that multiple designs were viable for long-term performance.
2000 TSPA for Site Recommendation	 Robust modeling system using fully qualified inputs Conservative approach to some components. Regulatory importance of volcanism identified. Conservative treatments of uncertainty complicated realistic understanding.
2001 Supplemental Science and Performance Analyses (SSPA)	 More realistic treatment of uncertainty. Incorporation of new information since TSPA-SR. Confirmed potential suitability. Confirmed importance of volcanism and EBS performance for 10,000 years. Insights into EBS and natural system effects on peak dose.
2001 TSPA for the Final Environmental Impact Statement	 Updated SSPA to include new information, revised regulatory boundary.
2002 Sensitivity Analyses (one-on and one-off)	 Insight into barrier performance. Risk-importance information regarding model components. Importance of volcanic disruption for 10,000-yr regulatory compliance.
TSPA-LA (in progress)	 Models updated to current information.



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License Application Design Selection Report

MOL.19990908.0319

WBS: 1.2.1 QA: QA

Civilian Radioactive Waste Management System Management & Operating Contractor

License Application Design Selection Report

B0000000-01717-4600-00123 REV 01 ICN 01

August 1999

Prepared for:

U.S. Department of Energy Yucca Mountain Site Characterization Office P.O. Box 30307 North Las Vegas, Nevada 89036-0307

Prepared by:

TRW Environmental Safety Systems Inc. 1261 Town Center Drive Las Vegas, Nevada 89134-6352

> Under Contract Number DE-AC08-91RW00134

Evaluation Criteria

- Meets Regulatory Criteria
- Safety/Licensibility
- Construction/Operation/Maintenance
- Flexibility
- Cost/Schedule





Exploratory Studies Facility Alternatives Study

SANDIA REPORT

SAND91-0025/2 • UC-814 Unlimited Release Printed September 1991

Yucca Mountain Site Characterization Project

Exploratory Studies Facility Alternatives Study: Final Report

Volume 2: A Comparative Evaluation of Alternative Exploratory Studies Facility Options

A. W. Dennis, editor

Prepared by Sandia National Laboratóries Albuquerque, New Mexico 87185 and Livermore, California 94550 for the United States Department of Energy under Contract DE-AC04-760P00769 Two sets of seventeen options each were evaluated and ranked

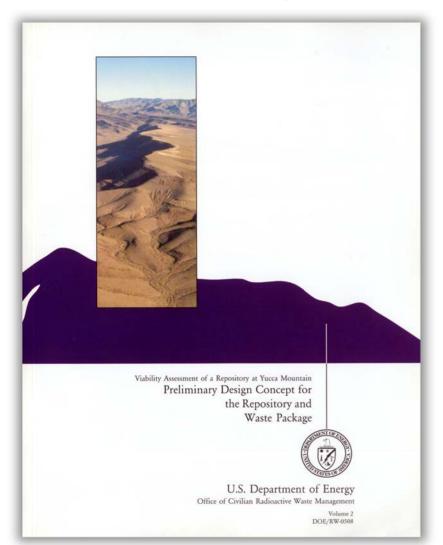
Evaluation Criteria

- Postclosure health impacts
- Preclosure radiological releases
- Preclosure non-radiological safety
- Aesthetic impacts
- Impacts on historical properties
- Cost impacts





Viability Assessment (VA) and Site Characterization Plan Conceptual Design Report (SCP CDR)



SANDIA REPORT

SAND84—2641 Unlimited Release Printed September 1987

HQS.880517.0945

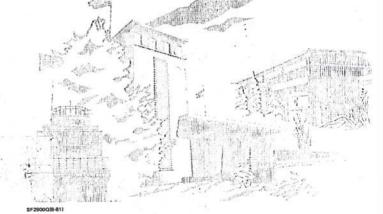
Nevada Nuclear Waste Storage Investigations Project

Site Characterization Plan Conceptual Design Report

Volume 1 Chapters 1-3

Compiled by Hugh R. MacDougall, Leo W. Scully, Joe R. Tillerson

Prepared by Sandia National Laboratories Albuquerque, New Mexico 87185 and Livermore, California 94550 for the United States Department of Energy Under Concerct Dis-COL/SEDE00780





Value Engineering Studies

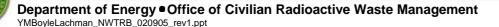
Value Study Report—Emplacem	ent Drift Ground Support
800-3TS-TEG0-00	100-000-000
March 20	03
Prepared By:	
Christine Linden Christine Linden, Associate Value Specialist	<u> </u>
Value Study Team Lead	THE
Approved By:	R. PARIKH
OPER D L	UFE
Steve Parikh Certified Value Specialist - Life	Hard 25, 2003 Date
And the second second second second second	
Mark Brund for Robert Boutin, Deputy Manager	<u>3-25-03</u> Date
Facilities Design	
800-3TS-TEG0-00100-000-000	March 2003

Seven different ground support methods studied by a panel that included non-project experts

Evaluation criteria:

- Design based
 - Ease of operations
 - Ease of maintenance
 - Service life up to 300 years
 - Functioning in varied conditions
 - Ease of construction
 - Science/TSPA based
 - Effect on hydrological/chemical environment in drift
- Management
 - Support 2004 License Application
 - **Environmental Safety and Heath**
 - Environmental health and safety of workers





Value Engineering Studies

(Continued)

Value Study Re	eport—Drip Shiel	d Reevaluation
000-31	S-TED0-00100-0	00-000
	February 2003	
Prepared By:		
Christine Linden Value Study Team Lead		<u>February 28, 2003</u> Date
Approved By:	STATUS VALUE	
Steve Parikh Certified Value Specialist-Life	ANT MEN	<u>February 28, 2003</u> Date
Jack Goud, Manager Analyses and Component Design		<u>February 28, 2003</u> Date
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Ten drip shield concepts studied by a panel

Evaluation criteria

- Performance
- **Regulatory acceptability**
- Compatibility
- **Programmatic risk**
- Schedule compliance
- **Flexibility**
- Adaptability to incremental design evolution





Department of Energy

Office of Civilian Radioactive Waste Management

Repository Design Requirements







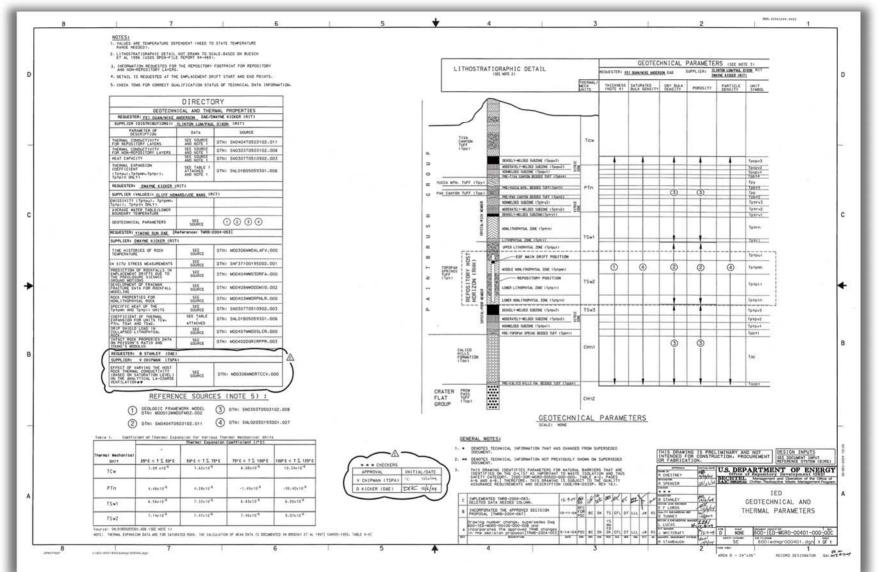
Information Exchange Drawings

- Concept introduced after the Site Recommendation to control data hand-offs between TSPA and design
 - Improved control of data, transparency, and traceability
 - Implemented by Administrative Procedure AP-3.24 Q, Drawings





Information Exchange Drawings





Department of Energy • Office of Civilian Radioactive Waste Management YMBoyleLachman_NWTRB_020905_rev1.ppt

Information Exchange Drawings (continued)

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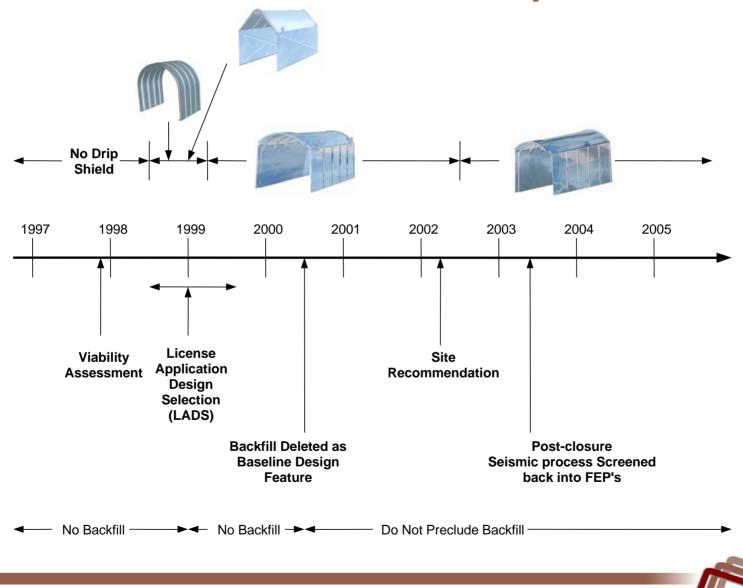


Drip Shield Example





Chronology of Drip Shield Introduction and Development



Drip Shield Historical Background

- Concept of a drip shield emerged from the multilayered, multi-material waste package concepts considered in the LADS
- Based on long-term performance, Alloy 22 and titanium alloys are favored over stainless steel and carbon steel as drip shield material
- Waste package being Alloy 22, titanium alloy chosen for drip shield to avoid common material failure mode guided by defense-in-depth





Drip Shield Historical Background

- The basic geometry of the drip shield has not changed significantly since 1999. The drip shield design incorporated Alloy 22 base plates, titanium grade 7 (Ti-7) sheets and titanium grade 24 (Ti-24) structural members
- The changes from the Site Recommendation design to the LA design involved the addition of longitudinal stiffeners along the length of the inner surface of the "roof" and increasing the height
- The latter change was to ensure that rocks striking the top of the drip shield would not deform the Ti-7 plates such that the waste package would be contacted





Stress Corrosion Cracking of Drip Shields

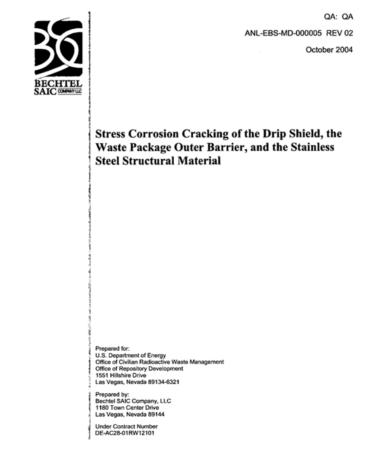
- Ti-Grade 7 may be subject to stress corrosion cracking (SCC)
- A SCC model has been developed to estimate the likelihood of the initiation and propagation
- The model indicates that rock fall may lead to SCC and may be produced by "juvenile failures"
- However, analyses of the interactions of potential seepage on the drip shields with SCC (considering extent of cracking and crack morphology) indicate that the cracks will be tight and/or filled with corrosion products and mineral assemblages to the extent that advective flow through the cracks is extremely unlikely
- Stress corrosion cracking of the titanium drip shield has been excluded from the nominal case TSPA





Stress Corrosion Cracking Analysis and Modeling Report (AMR)

DOC.20041028.0008





Integration of TSPA and Design by Process Control





Technical Management Review Board

- The Technical Management Review Board (TMRB) was established by BSC in April 2003 to formalize the integration process
- This board supports the Repository Development Manager in technical management, integration, and coordination of development of the repository

• Board Composition:

- Design and Engineering Manager
- Post-closure Safety Manager
- License Application Manager
- Chief Science Officer
- Systems Integration Manager
- Repository Development Project Operations Manager
- Repository Operations Manager
- Program Integration Manager
- Total System Performance Assessment Manager
- DOE Observers





Technical Management Review Board

- Functions
 - Provides planning guidance
 - Approves/disapproves new design concepts
 - Integrates technical and design concepts across science, TSPA, and design
 - Reviews and ensures resolution of technical issues associated with design, TSPA, and licensing activities





Technical Management Review Board

- TSPA and Design are under formal configuration control
 - This includes all data, models, calculations, and analyses that are either direct inputs or affect the TSPA configuration; TMRB approval is required for any changes
- This is a key step to ensure that the input data to the TSPA models and the design analyses and calculations are controlled by the same change control process





Summary

- TSPA and design are both managed through a formal change control process
- TSPA and design are integrated
- Integration is an ongoing process in a controlled environment



