

YUCCA
MOUNTAIN
PROJECT

Studies

License Application Plan - Design Overview

Presented to:
NRCDOE Technical Exchange
License Application Plan

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

Legacy/main - 20

Discussion and Example of Remaining Technical Work-Design

- **Design Requirements**
- **Subsurface Design**
- **Waste Package Design**
- **Surface Design**

Design Requirements

- **Define Systems Structures & Components of the Monitored Geologic Repository (61 Systems)**
- **Systems Engineering**
 - **Provide Definition and Criteria**
 - **Produce System Description Documents**
- **Determine - Applicable Regulatory Requirements**
 - **Applicable Regulations, Codes and Standards**
 - **Test and Evaluation Programs for Post Closure Verification**
 - **Acceptance Criteria, Test, and Inspection**

Design Development

- **Technical Guidance Document (TGD) Provides Overall Framework for License Application**
- **“Binning” Method Applies to All Work**
- **Bin 3 Elements (Important to Safety - No Regulatory Precedent) Utilize Post-Closure Safety Case Priorities**
- **Bin 2 Elements (Important to Safety - With Regulatory Precedent) Utilize Pre-Closure Safety Evaluation (Design Basis Events - DBEs)**
- **NRC KTIs/IRSRs Provide Specific Technical Guidance**
- **Other Technical Issues Resolution**

Design Development (continued)

- **Design Development Includes Activities to Support the Licensing Process**
 - **Improved Performance**
 - **Licensability (Allocation of Performance, Reduced Complexity, Relevant Analogs, Reduction of Uncertainties)**
 - **Defense in Depth**

Design Development (continued)

- **Typical Post-Closure-Related Systems Documentation**
 - **PA Analysis**
 - **Natural Environment Data**
 - **Layouts/Arrangement/Key Structural Elements**
 - **Engineered Materials Data/Key Components Design**

Design Development (continued)

- Major Design Inputs to Performance Assessment:
VA to SR/LA

<u>Milestone Description</u>	<u>Date</u>
Waste Form Characteristics Report	12/98
Waste Form Characteristics Report - Update	11/00
Engineered Materials Report <i>materials in design, not just waste package</i>	12/98
Engineered Materials Report - Update	11/00
Select Initial SR/LA Design and Options	5/99
Design Verification for Performance Assessment	3/00

Design Development

- **Typical Pre-Closure-Related Systems Documentation**
 - **DBE Analysis**
 - **Natural Environment Data**
 - **Arrangements/Key Structural Elements**
 - **Systems Operating/Control Logic**
 - **Equipment Performance**

Design Planned Technical Work - Subsurface

Work Category (Section of VA Vol. 4)	Postclosure Safety Case						Preclosure Safety Case
	1. Expected Postclosure Performance		2. Design Margin/ Defense in Depth	3. Disrup- tive Proc./ Events	4. Natural & Man- Made Analog	5. Perform- ance Confir- mation	
	Principal Factors	Priority To SR/LA					
Subsurface Design							
Subsurface Facility (3.2.1.1)	Effects of heat and excavation on flow (mountain scale)	1	√			√	
	Humidity and temperature at the waste package	0					
Ground Control (3.2.1.2)	Chemistry of water on waste package	2	√				√
	Formation and transport of radionuclide-bearing colloids	2					
Subsurface Ventilation (3.2.1.3)	Effects of heat and excavation on flow (drift scale)	2	√				√
	Dripping on waste packages						
	Humidity and temperature at the waste package	2 0					
Waste Emplacement (3.2.1.4)	Integrity of outer carbon steel waste package barrier	1	√				√
	Integrity of inner corrosion-resistant waste package barrier	3					
Subsurface Safety and Monitoring (3.2.1.5)	N/A		√				√
Waste Retrieval (3.2.1.6)	N/A		√				√
Performance Confirmation (3.2.1.7)	N/A					√	
Sealing and Closure (3.2.1.8)	Formation and transport of radionuclide-bearing colloids	2	√			√	
	Transport through and out of EBS	1					
Subsurface Utilities (3.2.1.9)	N/A		√			√	√
Subsurface Integrated Control Systems (3.2.1.10)	N/A		√				√
Radiological Safety (3.2.1.11)	N/A		√				√
Engineered Barrier System Performance Modeling and Testing (3.2.1.12)	Effects of heat and excavation on flow (drift scale)	2	√				
	Dripping onto waste packages						
	Humidity and temperature at waste package	2					
	Chemistry of water on waste package	0					
	Formation and transport of radionuclide-bearing colloids	2					
	Transport through and out of EBS	2					
		1					

Subsurface Design

- **Examples of Planned Work**
- **Ground Support**
 - **Temporary (Development-Side) and Permanent (Emplacement-Side) Types**
 - **Alternate Concepts (Concrete, Unlined Drift, Size Variations)**
 - **Requirements Evaluation (Environmental, Seismic, Thermal) (Short Term/Long Term)**
 - **Materials Selections Analyses (Longevity, ^{impact}Input on Near Field and In-Drift Conditions, Maintenance Requirements)**

Subsurface Design (continued)

- **Subsurface Ventilation**
 - **Development and Emplacement Systems**
 - **Design and Performance Under Normal Conditions**
 - **Identification and Analysis of Accident Scenarios and Upset Conditions (Include Development/Emplacement Interactions)**
 - **Consideration/Evaluation of Potential Long Term Ventilation (Effects on Temperature, Humidity, Near Field Environment)**
 - **Preparation of P&IDs, Control Logic Arrangements and Equipment Performance Requirements**

Subsurface Design (continued)

- **Waste Retrieval**
 - **Analysis of “Normal” Retrieval (Emplacement Equipment/Systems Used for Retrieval)**
 - **Evaluation “Off-normal” Retrieval (Special Equipment/Systems)**
 - **Use of Demonstrated Technology**
 - **Develop Analysis and Design Documents for Feasible and Functional Systems**

Design Planned Technical Work - Waste Package

Work Category (Section of VA Vol. 4)	Elements of the Postclosure Safety Case						Preclosure Safety Case
	1. Expected Postclosure Performance		2. Design Margin/ Defense in Depth	3. Disrup- tive Proc./ Events	4. Natural & Man- Made Analog	5. Perform- ance Confir- mation	
	Principal Factors	Priority to SR/LA					
Waste Package							
Waste Package Designs for Uncanistered Spent Nuclear Fuel (3.2.2.1)	Integrity of outer carbon steel waste package barrier	1	√				√
	Integrity of inner corrosion– resistant waste package barrier	3					
Waste Package Designs for Canistered Spent Nuclear Fuel (3.2.2.2)	Integrity of outer carbon steel waste package barrier	1	√				√
	Integrity of inner corrosion– resistant waste package barrier	3					
Waste Package Designs for DOE Spent Nuclear Fuel (3.2.2.3)	Integrity of outer carbon steel waste package barrier	1	√				√
	Integrity of inner corrosion– resistant waste package barrier	3					
Waste Package Designs for High-Level Radioactive Waste (3.2.2.4)	Integrity of outer carbon steel waste package barrier	1	√				√
	Integrity of inner corrosion– resistant waste package barrier	3					
Alternate Waste Package Designs (3.2.2.5)	Integrity of outer carbon steel waste package barrier	1	√				√
	Integrity of inner corrosion– resistant waste package barrier	3					
Disposal Container Fabrication and Closure Welding (3.2.2.6)	Integrity of outer carbon steel waste package barrier	1	√	√			√
	Integrity of inner corrosion– resistant waste package barrier	3					
Criticality Methodology (3.2.2.7)	Transport through and out of EBS	1	√				√
	Flow and transport in the unsaturated zone	3					
Waste Form Testing and Modeling (3.2.2.8)	Integrity of spent fuel cladding	2	√				√
	Dissolution of spent fuel and glass waste forms	1					
Waste Package Materials Testing and Modeling (3.2.2.9)	Integrity of outer carbon steel waste package barrier	1	√				√
	Integrity of inner corrosion– resistant waste package barrier	3					

Waste Package Design

- **Examples of Planned Work**
- **Waste Package Design for**
 - **Uncanistered Spent Nuclear Fuel**
 - **Canistered Spent Nuclear Fuel**
 - **DOE Spent Nuclear Fuel**
 - **Spent Naval Fuel**
 - **Defense High Level Radioactive Waste**

Waste Package Design (continued)

- **Disposal Container Fabrication and Closure Welding**
- **Criticality Methodology**
- **Waste Form Testing and Modeling**
- **Waste Package Materials Testing and Modeling**
 - **Short-term and Long-term Corrosion Testing (WP & WF)**
 - **Welded and Un-Welded Test Coupons**
 - **Accelerated/Aggressive Test Environments**
 - **All Candidate Materials (Steel, Nickel, Ti, Ceramics)**

Design Planned Technical Work - Surface

Work Category (Section of VA Vol. 4)	Elements of the Postclosure Safety Case						Preclosure Safety Case
	1. Expected Postclosure Performance		2. Design Margin/ Defense in Depth	3. Disrup- tive Proc./ Events	4. Natural & Man- Made Analog	5. Perform- ance Confir- mation	
	Principal Factors	Priority to SR/LA					
Surface Design							
Surface Facilities (3.2.3.2)	N/A						√
Design Documentation and Engineering Products (3.2.3.3)	N/A						√
Carrier Preparation Building Design (3.2.3.4)	N/A						√
Waste Handling Building Design (3.2.3.5)	Integrity of outer carbon steel waste package barrier Integrity of inner corrosion- resistant waste package barrier Integrity of spent fuel cladding	1 3 2					√
Waste Treatment Building Design (3.2.3.6)	N/A						√
Sitewide Systems and Support Design (3.2.3.7)	N/A						√
Support Activities (3.2.3.8)	N/A						√

Surface Design

- **Example of Planned Work**
- **Waste Handling Building**
 - **Analysis of Waste Handling and Waste Packaging Production (Throughput Requirements, Handling Systems, Welding/Assembly Systems and Equipment, Quality Control, Quality Assurance)**
 - **Building Arrangement, Structural Concepts, Critical Structural Details**
 - **Design Basis Accidents and Events (DBEs)**
 - **Internal Systems P&IDs, Electrical 1-Lines, Control Logic, Critical Equipment Performance**

Design Selection

- **LA Plan - Requirements for Alternative Evaluations**
 - 10 CFR 60 Alternatives
 - Response to NWTRB and Other Reviewer Inputs
- **Implementation of LA Plan Requirements - Work to be Accomplished**
 - Features/Alternatives Lrge
 - Criteria for Alternative Selection
 - Decision Methodology
 - Evaluations (Performance, Cost, Other Criteria)

Design Selection (continued)

- Decision Methodology
- 2 Pass Approach
 - 1st Pass -

- Stripped Alternatives (Develop Analysis for 8 Criteria)
- Individual Features (“ “ “ “ “)
- Evaluate Post Closure Performance

*post closure perf
licensability
D in
schedule
cost
management
sensitivity
maintainance
operability*

- 2nd Pass - Enhanced Design Alternatives
- Combine Features with Alternatives for:**

- Improved Performance
- Licensability and Defense in Depth
- Reduction of Uncertainty
- Evaluate on All Criteria

Design Selection (continued)

- **Major Milestones/Activities**
- **Complete 1st Pass Analysis (12/98)**
 - **Determine “Complete” List of Features/Alternatives**
 - **Determine Decision Criteria/Weighting Factors**
- **Complete 2nd Pass Analysis (2/99)**
 - **Complete Determination of Enhanced Design Alternatives**

Design Selection (continued)

- **Select Initial SR/LA Design (5/99)**
 - Complete Comparison of Alternatives
 - M&O Management Review
 - DOE Review
- **Design Verification for Performance Assessment (3/00)**

*needed through
mgt. reviews*