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

Repository Design Evolution

Presented to:
Nuclear Waste Technical Review Board

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January 30-31, 2001
Amargosa Valley, Nevada

YUCCA MOUNTAIN PROJECT

Agenda

- **Design Flexibility**
- **Recent Accomplishments and Design Refinements**
- **Near Term Next Steps**

Design Evolution and Stepwise Implementation

- **Current Status:**
  - **Further address lower temperature operating modes and reduction of technical uncertainties**
  - **Completing parametric study of modular design, construction and operations**
  - **Evaluating changes to design requirements to incorporate stepwise design and construction as design evolves**
  - **National Academy of Science initiating study of stepwise implementation**
- **Design Evolution:**
  - **Continue trade studies on modular alternatives and below boiling operating modes**
  - **Begin more complete development of surface facilities-design effort to date has been concentrated on post-closure issues**

Evolution of Design Features

Parameter	Viability Assessment	Enhanced Design Alternative II	Current Reference Design	Representative Low Temperature Design Case
Max. Average Waste Package Surface Temperature (^{o}C)	230	230	230	<85
Maximum Drift Wall Temperature (^{o}C)	200	200	200	<85
Pillar Temperature (^{o}C)	>96	Center below 96	50% below 96	< 85
Areal Mass Loading(MTHM/acre)	85	60	60	40
Area for 70,000 MTHM (acres)	741	1,050	1,050	1,600
Total Excavated Emplacement Drift Length (Km)	107	54	60	80
Waste package Spacing (meters)	Variable	0.1	0.1	2
Line/Point Load	Point	Line	Line	Point
Drift Spacing (meters)	28	81	81	81
Preclosure Ventilation Period (yrs)	50	50	50	300
Preclosure Ventilation Flow Rate (M^3/s)	0.1	2 to 10	15	15 for 50 years NVP*driven for 250 years
Waste Package Max Heat Output (KW)	18	11.8	11.8	11.8
PWR Waste Package Avg Heat Output (KW)	9.3	9.8	11.3	11.3
Total Waste Package Avg Heat Output (KW)	7.3	7.4	7.6	7.6
Avg Linear Line Loading (KW /meter)	0.7	1.37	1.45	1.0
Backfill in emplacement drift	Not Precluded	Yes	Not Precluded	Not Precluded
Drip Shields	Not Precluded	Yes	Yes	Yes

*NVP = Natural Ventilation Pressure

Reasons for a Flexible Repository Design

- **To accommodate future:**
  - **Policy decisions**
  - **Alternative technical objectives**
  - **New information**
- **Program objective is to have a resilient design**
- **Support ability to retrieve waste**

Stepwise Implementation

- **CRWMS Program is being implemented in context of programmatic and technical uncertainties**
  - **Funding constraints for construction peaks**
  - **Schedule uncertainties**
  - **Technical uncertainties related to coupled processes (thermal-hydrologic-chemical-mechanical) and corrosion**
- **Stepwise implementation**
  - **Provides for flexibility to adapt to funding, schedule and other programmatic contingencies**
  - **Affords opportunity for learning and improvement**
  - **Provides checks and balances for problem detection and corrective action**
  - **Still requires adequate development of regulatory safety case**

Modular Study

- **Update the CRWMS Modular Design/Construction and Operation Options Report**
- **Address peak construction costs in Total System Life Cycle Cost (TSLCC)**
- **Investigate various approaches to modular implementation**
  - **Modular approach to surface facilities**
  - **Varying size of initial subsurface development**
  - **Varying transportation mode parameters**
  - **Varying operational capacity and timing of operations**
  - **Decoupling of subsurface emplacement from surface waste receipt rates**
  - **Incremental approach to surface storage capacity**
- **Provides input for continuing design evolution**
- **Capabilities available to support NAS stepwise study**

Recent Engineering Accomplishments – Subsurface

- Performed preliminary lower temperature 2-D ANSYS thermal calculations
- Performed natural ventilation calcs in support of identification of potential low temperature scenarios
- Updated shielded waste package transporter and emplacement gantry
  - Revised WP handling scheme using pallets
  - Increased shielding on transporter
- Modified emplacement drift turnout
  - Mitigates “shine” effect
  - Eliminate the need for shadow shields
- Modified ground support
  - Modified rock bolt and steel patterns for different rock zones (lithophysal vs. non-lithophysal)

Recent Engineering Accomplishments – Waste Package

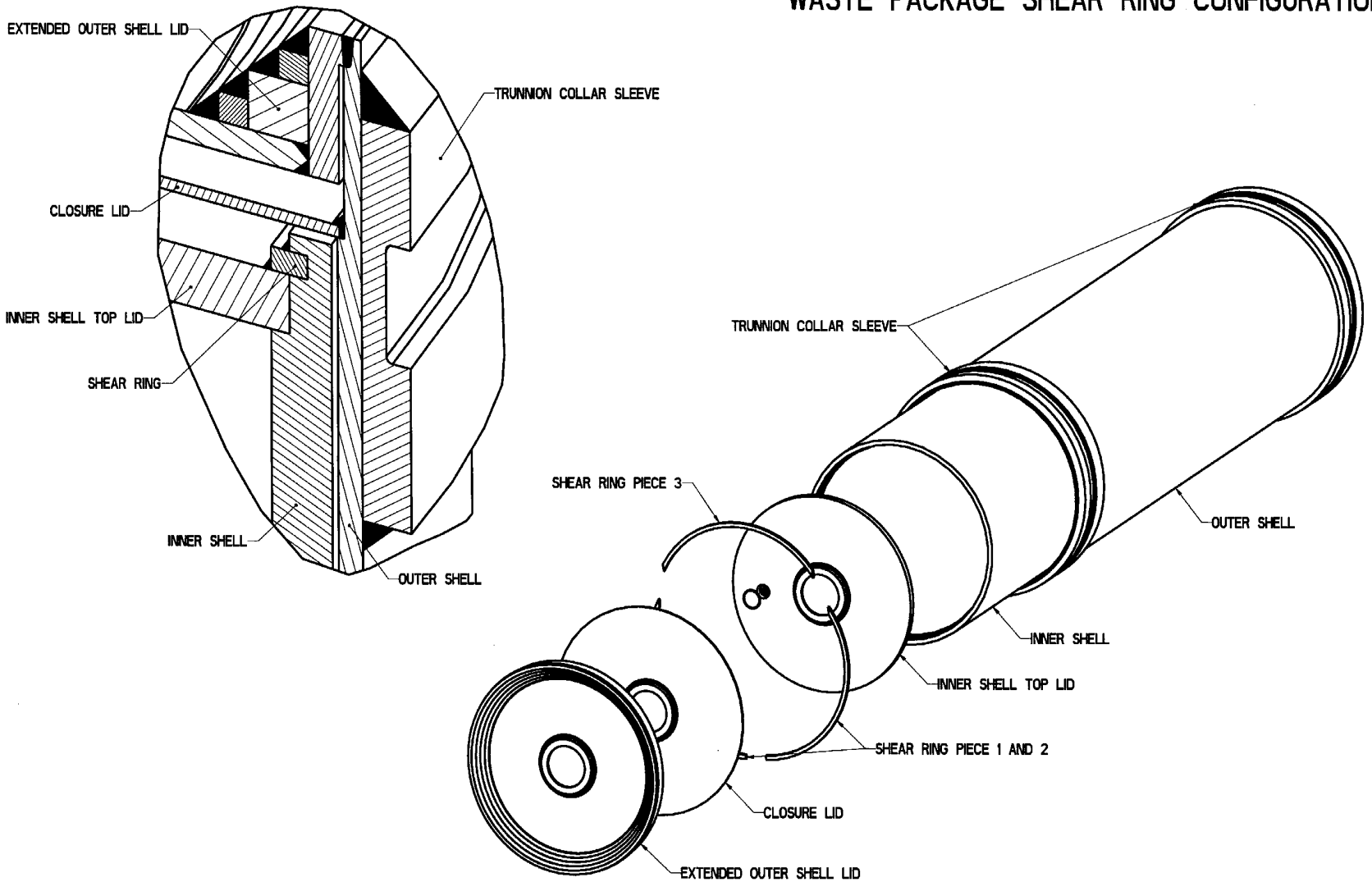
- **Neared completion of engineering files for SR**
  - **Criticality, thermal and structural work focused on four representative designs**
  - **21 PWR and 44 BWR uncanistered absorber plate designs**
  - **Navy long canister design**
  - **DOE short HLW canister and SNF canister codisposal design**
- **Updated Disposal Criticality Analysis Methodology Topical Report**
- **Considering revision to inner stainless steel lid closure methodology**
  - **Current lid thickness is 95 mm**
  - **Current design uses full penetration weld**
  - **Results in long preparation, welding and inspection periods**
  - **Adversely affects throughput in surface facility**

Recent Engineering Accomplishments – Waste Package

(Continued)

- Three alternatives considered
  - Thinner closure lid, bolted closure, shear-ring closure
- Shear ring closure likely to be recommended
- Has favorable effect on Design Basis Event performance
  - Permits secure closure of inner shell at waste form loading station
  - Greatly reduces potential for loss of waste form due to a tip-over during transfer to welding cell
- Reduction in surface facility cost
- Ability to maintain required throughput

WASTE PACKAGE SHEAR RING CONFIGURATION



Recent Engineering Accomplishments – Systems

- **Updated Project Design Description (PDD) with expanded scope**
  - **Added information on performance assessment approach**
  - **Added site characteristics**
  - **Updated concept of operations approach**
- **Updated System Design Descriptions (SDDs)**
  - **Provide requirements and design solutions for Quality Level 1 and 2 and selected other systems supportive of reference design**
- **Completed Preliminary Preclosure Safety Assessment of reference design**
- **Updated Test & Evaluation Plan and Performance Confirmation Plan**

Recent Engineering Accomplishments – Surface

- **Completed updates to engineering files**
  - **Captures current reference design to be reflected in potential SR**
  - **Used as basis of SDDs and preclosure safety assessments**
- **Completed study on improved surface facility concept**
  - **To address potential design modifications which may be pursued after SR**
  - **Reviewed requirements for surface facility**
  - **Reassessed layout of facility to improve operability**
  - **Proposed modifications to reduce Design Basis Events**

Near Term Activities – Subsurface

- Continue testing and modeling improvements in ventilation performance, thermal conductivity
- Complete reference and lower temperature ventilation analyses
- Review invert design to improve diffusive barrier performance
  - Incorporate diffusive barrier enhancements
  - Optimize structural steel use in invert
- Investigate improvements in waste retrieval
- Analyze ground support for longer term functionality
- Subsurface layout investigation
  - Analyze for various lower temperature options
  - Include thermal management considerations, site geology, shaft siting

Near Term Activities – Waste Package

- **Primary focus remains on testing and modeling improvements in waste package materials and waste form characteristics**
- **Complete update of engineering files**
- **Complete evaluation of revised inner lid closure method**

Near Term Activities – Systems

- **Complete update of Modular Design/Construction and Operations Study**
- **Complete Waste Acceptance System Requirements Document (WASRD)**
  - **Provides criteria for acceptance of waste forms**
  - **Used in conjunction with Technical Information Needs for DOE Spent Nuclear Fuel document and Interface Control Document to describe requirements for DOE SNF and HLW**
- **Provide guidance for low temperature related issues**
  - **Provide revisions to requirements**
  - **Evaluate impacts to preclosure safety resulting from extended ventilation, larger footprint, longer maintenance**
  - **Evaluate impacts to testing and performance confirmation program**

Summary

- **Repository design process will accommodate a stepwise approach**
- **Much of recent engineering effort is directed at reducing uncertainties through identification of various approaches to achieving a lower temperature design**
- **Other engineering activities continue as required to support SR**