Subsurface and Waste Package Design Update

Presented to:
Nuclear Waste Technical Review Board

Presented by:
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Yucca Mountain Site Characterization Project

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Agenda

- **Subsurface design changes**
  - Total length of drift excavated and drift orientation
  - Removal of backfill
  - Placement of ventilation intakes
  - Drip shield emplacement gantry

- **EBS design changes**
  - Waste Packages
  - Drip shield
  - Emplacement Pallet
Subsurface Design Evolution
(Since 6/99 NWTRB Meeting)

- **Major Drift Changes**
  - 8 non-emplacement drifts for ventilation and operational standby placed between emplacement drifts
  - Intake shafts located within footprint of the emplacement area
  - Re-orientation of drifts to improve stability and expansion of upper block on north end to provide contingency

- **Pre-closure ventilation increased from 10 to 15 m³/s**
  - 70% net ventilation efficiency for 50-year pre-closure ventilation period

<table>
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<tr>
<th>Emplacement Area</th>
<th>70,000 tU</th>
<th>1,125 acres</th>
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<tr>
<td></td>
<td>97,000 tU</td>
<td>1,485 acres</td>
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<tr>
<td></td>
<td>115,000 tU</td>
<td>1,750 acres</td>
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Removal of Backfill

- Found candidate backfill material thermal conductivity quite low
  - LADS assumed thermal conductivities about 0.66 W/m K
  - Tests showed thermal conductivities ranging from 0.15 to 0.30 W/m K

- Cladding temperatures predicted to be above 350°C
  - No margin to creep-rupture failure screening criterion
Shafts Within the “Footprint”

- **Closure of Shafts**
  - Plugged at surface
  - Backfilled with mined rock below plug
- **Exhaust shaft connected below emplacement level**
- **Intake shafts have a sump below the emplacement horizon**

The goal of these design features is to preclude the entrance of surface water, and prevent man-made gravity flow paths below the shaft seals.
Shaft Placement

LEGEND:
- Air Flow Direction
- Air Flow Regulator

- Exhaust Fans
- Intake Air Shaft
- Exhaust Air Shaft
- Service Main
- Ventilation Raise (TYP)
- Exhaust Connector (TYP)
- Intake Air Drift
- Emplacement Drift (TYP)
- East Main

Drawing Not To Scale
0603300_SRCC_V1023_Rg-10.CDR
Drip Shield Placement

- The current concept calls for drip shield placement using a gantry very similar to those used to emplace the waste packages
- It will have the same redundancy for critical systems that the waste package gantry design employs
Drip Shield and Gantry
Changes to EBS
(Since 6/99 NWTRB Meeting)

- Changes to waste package design since EDA II
  - Shortening of skirts to accommodate final closure weld heat treatment
  - Addition of a second alloy 22 closure lid for final closure
  - Change to lifting feature
- Changes to drip shield
  - Evolution from corrugated design to smooth surface
- Introduction of emplacement pallet

<table>
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<tr>
<th>21-PWR Waste Package Length</th>
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<tr>
<td><strong>6/99 Design</strong></td>
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<tr>
<td>5.335 m</td>
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</table>
Waste Package Design

21-PWR Waste Package Assembly Configuration
Basis for Waste Package Design Changes

- Shortening of skirts necessitated by need for closure weld final heat treatment
  - Closure welds possibly susceptible to stress corrosion cracking
  - Mitigation of residual stress in closure welds required
- Final closure weld moved to lip of waste package and second alloy 22 closure lid added
- Lifting holes replaced with trunnion collar ring
Mitigation of Stress Corrosion Cracking

- Potential for stress corrosion cracking in final closure weld not credible for stresses < 20% of yield (in this case the hoop stress in the weld)
- Final weld stress reduction by a combination of induction annealing (outer alloy 22 closure lid) and laser peening (inner alloy 22 closure lid)
- Achievable depths are 6.5 mm for induction heating and 2-3 mm for laser peening, which prevent weld region failure for at least 10,000 years
Final Closure Weld Configuration

- **Outer Shell Extended Closure Lid Closure Weld**
- **Outer Shell Flat Closure Lid Closure Weld**
- **Inner Shell Lid Closure Weld**
- **Gaps**

Legend:
- Red—Outer Shell Extended Closure Lid
- Blue—Outer Shell Flat Closure Lid
- Yellow—Inner Shell, including Inner Shell Closure Lid
- Brown—Outer Shell
- Green—Internals
Trunnion Handling Approach

Waste Package Configuration Before Trunnion Collar Emplacement

Unassembled Trunnion Collar
Trunnion Collar Sleeve

Assembled Trunnion Collar

Outer Lid Lifting Feature

Waste Package Configuration After Trunnion Collar Emplacement

Note: Attachment Method is Under Development
Basis for Drip Shield Design Changes

- Ensure drip shields will not separate during seismic events (evaluation proceeding)
- Provide overlap at drip shield junctions and alternate flow paths
- Reduce titanium usage by reducing thickness (to 15 mm from 20 mm)
  - Removal of corrugations
  - Drip shield capable of protecting waste package from a 13 t Rock
Drip Shield Design
Drip Shield Connection

- Water Diversion Rings
- Skirt (Second Drip Shield Segment)
- Axial Seismic Stabilizers
- Second Drip Shield Segment
- Internal Structural Reinforcement Beams
- Alignment and Seismic Stabilization Pin
- First Drip Shield Segment

Drip Shield Segments
- Before Connection
- After Connection
Emplacement Pallet

Alloy 22

SS-316
Waste Packages Loaded in Drift

Steel Set
Drip Shield
Naval SNF
44 BWR
DHLW
21 PWR
Emplacement Pallet - Long
Emplacement Pallet - Short
Steel Invert

Note: Granular Ballast in Invert Section not Shown

Emplacement Drift Segment for Site Recommendation
Cost Differential (TSLCC)

<table>
<thead>
<tr>
<th>Component</th>
<th>June 1999 Design ($B)</th>
<th>Site Recommendation Design ($B)</th>
<th>∆ ($B)</th>
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<tbody>
<tr>
<td>Waste Package</td>
<td>5.8</td>
<td>6.9</td>
<td>1.1</td>
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<tr>
<td>Drip Shield</td>
<td>6.2</td>
<td>4.3</td>
<td>-1.9</td>
</tr>
<tr>
<td>Pallets</td>
<td>1.1</td>
<td>1.0</td>
<td>-0.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13.1</strong></td>
<td><strong>12.2</strong></td>
<td><strong>-0.9</strong></td>
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Summary

• **Sub-surface Changes**
  – Changes to Drift Orientation and Placement of Shafts
    ✷ Reduces cost and complexity of construction
    ✷ Reduces size of design basis rock
  – Removal of Backfill
    ✷ Creates margin to cladding temperature limit
    ✷ Simplifies closure operations
  – Definition of Drip Shield Emplacement Gantry
Summary
(continued)

- Waste Package Changes
  - Introduction of closure lid post-weld heat treatment and peening
    - Extends life of the waste package
  - Use of Trunnion Ring
    - Facilitates close emplacement in drifts and permits post-weld heat treatment
  - Smooth Surface Drip Shield
    - Enhances resistance to shield-to-shield separation
  - Emplacement Pallet
    - Facilitates close emplacement in drifts
Back Up
70,000 MTU
NOTES:
1. 60 MTU/acre.
2. Spacing of emplacement drifts = 81 m.
3. Number of emplacement drifts = 53.

EDA II - Layout

10 m³/s emplacement ventilation