The National Repository at Yucca Mountain

Presented to:
EM High Level Waste Corporate Board

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July 24, 2008
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Solving a national problem now

- On June 3, 2008, the U.S. Department of Energy submitted an application to the U.S. Nuclear Regulatory Commission for a license to construct a repository at Yucca Mountain
Repository license application

- The LA seeks authorization to construct the nation’s first geologic repository
- It is a culmination of more than 25 years of scientific research and engineering
- The LA describes DOE’s plan to safely isolate spent nuclear fuel and high-level radioactive waste in tunnels deep underground at Yucca Mountain
Repository meets a pressing national need

- Spent nuclear fuel and high-level radioactive waste have been accumulating in the United States since the 1940s.

- Currently, waste destined for Yucca Mountain is stored in temporary facilities at 121 sites in 39 states.
Yucca Mountain, Nevada

- Remote location
- Located on secure, federally controlled land
- 90 miles northwest of Las Vegas in Nye County
License Application Content and Supporting Documents

LA:
- General Information
- Safety Analysis Report

Plans Submitted in Support of License:
- Physical Protection
- Material Control & Accounting
- Emergency, etc.

Principal Supporting Input:
- Analysis & Modeling Reports
- Preclosure Safety Analysis
- Yucca Mountain Site Description

Detailed Supporting Input:
- Data
- Calculations
- Studies
- Reference
- Codes/Software
- Detailed Design Drawings
- Specifications
- Vendor Data

1,000's of Documents

Increasing Level of Detail

Licensing Review

Inspection
LA components

• The LA is accompanied by a final EIS, as well as 200 key supporting documents

• The LA comprises 17 volumes:
  – Total number of pages – 8,646
  – Total number of figures – 2,830
  – Total number of tables – 930
  – Number of inches thick – 78
  – Weight of each complete copy – 110 pounds
Contents of the license application

The license application includes General Information and a Safety Analysis Report (SAR)

The General Information includes:

- A general description of the repository and its operations
- Schedules for construction, receipt, and emplacement of waste
- A description of the physical protection plan for safeguarding the facility
- A description of the material control and accounting program to be implemented to track radioactive materials movement at the repository
- A description of site characterization studies
• The SAR is the principal technical document in the licensing process

• The SAR discusses why the repository is considered safe and how it complies with NRC regulations

• Major topics of the SAR include:
  – Preclosure Safety Analysis
  – Postclosure Safety Analysis
  – Programmatic Requirements
Yucca Mountain Surface at Repository Facility Portals

South Portal

North Portal
Site overview

Nuclear facilities
- Initial handling facility
- Wet handling facility
- Canister receipt and closure facility 1
- Canister receipt and closure facility 2
- Canister receipt and closure facility 3
- Receipt facility

Balance of plant facilities
- Low-level waste facility
- Emergency diesel generator facility
- Heavy equipment maintenance facility
- Central control center facility
- Warehouse and non-nuclear receipt facility
- Utility, security, and administration facilities
Surface design

- The revised surface design provides maximum flexibility in the development of a simple, clean, safe, primarily canister-based repository
  - Based on the use of modular waste handling facilities and processes – expansion as needed
  - Incorporates commercial waste handling experience
  - Can receive by truck and standard rail
  - Can handle multiple forms of wastes
  - Can accommodate multiple sizes of transportation, aging and disposal canisters
    - Canisters would require less handling than individual spent nuclear fuel assemblies at the repository
Surface facilities layout

- This image shows the relative size of the planned surface facilities compared with a large football stadium.
Repository is longer than the Las Vegas Strip
Emplacement Drift

Perforated Stainless Steel Sheet
Pallet
Gantry Crane Rail
21-PWR/44-BWR TAD Waste Package
Codisposal Waste Package Containing Five High-Level Waste Canisters with One DOE Spent Nuclear Fuel Canister
Drip Shield

21-PWR/44-BWR TAD Waste Package

Drawing Not to Scale
00663DC_101a.ai
Estimating how the repository will perform in the future using Total System Performance Assessment (TSPA)
**Key barriers work together**

**Features and Components**
- Surface soils and topography
- Unsaturated zone above the repository
- Emplacement drift
- Drip shield
- Waste package
- Pallet
- Waste form and waste package internals
- Drift invert
- Unsaturated Zone below the repository
- Saturated zone
Upper natural barrier

Topography and Surficial Soils
- Low precipitation
- Runoff
- Evapotranspiration
- Infiltration

Drift Surface
- Capillary Barrier
- Dripping
- Evaporation
- Roughness

Unsaturated Zone Flow
- Flow Focusing
- Percolation
- Dryout Zone

Unsaturated Zone above Repository
- Percolation
- Capillarity
- Flow diversion around emplacement drifts
Lower natural barrier

Unsaturated Zone below the Repository
- Low percolation water flow rates
- Radionuclides trapped in the rock by matrix diffusion
- Sorption of radionuclides onto rock

Saturated Zone
- Low groundwater flow rates
- Matrix diffusion
- Sorption of radionuclides onto rock
- Filtration of colloids

Lower Natural Barrier

Unsaturated Zone Welded Tuff Units
- Dissolved radionuclides move through fracture flow
- Radionuclides sorb onto colloids that move in fracture flow

Unsaturated Zone Nonwelded Tuff Units
- Dissolved radionuclides diffuse into matrix pore space
- Radionuclides sorbed onto colloids generally filtered out of matrix

Saturated Zone Alluvium
- Diffusion and sorption slow transport of radionuclides
- Larger effective porosity in alluvium slows water flow, and radionuclides move by diffusion in slow-moving or stagnant water

Volcanic Tuff

Alluvium

Water Table

Yucca Mountain

Repository

North

South

~18 km

Department of Energy • Office of Civilian Radioactive Waste Management

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Total System Performance Assessment Process

- Screen features, events, and processes to determine those to be evaluated in performance assessment
- Develop models, along with their scientific basis, for each feature, event and process included in TSPA
- Evaluate uncertainty in models and parameters
- Construct integrated TSPA model using all retained features, events and processes in scenario classes
  - Nominal scenario class contain all features, events, and processes expected to occur (including climate change)
  - Disruptive event scenario classes contains unexpected events (e.g., early failure, igneous, and seismic)
- Evaluate total-system performance in terms of individual protection and groundwater protection standards; incorporating uncertainty through Monte Carlo simulation
TSPA model architecture

- TSPA Model consists of four scenario classes
  - Nominal Scenario Class
  - Igneous Scenario Class
  - Seismic Scenario Class
  - Early Failure Scenario Class

- Each model component has an integrated set of inputs and outputs

- Each model abstraction has a conceptual basis
Performance results - individual protection standard

<table>
<thead>
<tr>
<th>Time Period After Closure (yrs)</th>
<th>Projected Maximum Mean Annual Dose (mrem)</th>
<th>Time of Maximum Mean Annual Dose (yr)</th>
<th>Projected Maximum Median Annual Dose (mrem)</th>
<th>Time of Maximum Median Annual Dose (yr)</th>
<th>Limit for Annual Dose (mrem)</th>
</tr>
</thead>
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<td>NA</td>
<td>0.96</td>
<td>~ 720,000</td>
<td>350 (median)</td>
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</tbody>
</table>

NOTE: Numerical Limits from proposed 10 CFR 63.311(a).
Source: SNL 2008a, Table 8.1-1[a].
Adding confidence: natural and man-made analogues

Devils Hole, CA

Cave paintings, France

Peña Blanca, Mexico
Licensing Support Network (LSN) contributors by number of records

3,618,701 records (99 percent)

33,651 records (1 percent)

- DOE
- NRC
- NEI
- State/Local Governments
Repository program steps
What’s next

Yucca Mountain License Application Review Timeline (anticipated)
Upcoming key milestones

- Start Nevada Rail Construction - October 2009
  - Delayed - Inadequate funding to proceed with design
- YM Construction Authorization - September 2011
  - Depends on NRC decision
- Operating License Submittal - March 2013
  - Predicated on funding and construction schedule
- Rail Line Operational - June 2014
  - 2016 is achievable only if adequate funding is provided
- Begin Receipt
  - Currently under evaluation due to FY 07 and 08 actual funding shortfalls and expected near term funding limitations
  - Firm date cannot be set until funding issue resolved
For more information

www.ocrwm.doe.gov