U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING

SUBJECT: STATUS OF WASTE CONTAINMENT AND ISOLATION STRATEGY DEVELOPMENT

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Progress in Strategy Development

- Previewed by Board in October 1995, before the DOE review was completed
- Formal DOE review conducted October-November 1995
- Informal comment resolution meetings were held to resolve concerns
- Final revised text and comment responses being provided to DOE reviewers this week

Benefits of Strategy Development

- Facilitating integration of performance assessment with site and design activities
- Demonstrating the value of what has been learned to date
- Identifying what still needs to be done
- Enabling focus on getting needed information efficiently

Strategy Objective

- The objective of the strategy is to provide projections of waste containment and isolation that are adequate to support a near-term decision on whether to proceed with repository development
- For the purpose of this strategy, waste isolation and containment means:
  - To contain the waste for thousands of years during the high-inventory and high-temperature period
  - To limit the dose rate to any member of the general public at any time
- The strategy is not based on a set of standards, but it is consistent with the NAS recommendations

Approach

- Performance assessment calculations identify factors that could result in 10,000-year containment and background-level peak dose rates
- A subset of these factors can be validated through testing in the near term
- Hypotheses regarding these factors are grouped into five system attributes:
  - Little seepage into the emplacement drifts
  - Containment for thousands of years
  - Low mobilization rates from breached packages
  - Limited release from engineered barriers
  - Strong dilution during transport through natural barriers

Hypotheses: Seepage

- The percolation flux at the repository horizon is low; much less than the bounding value of 0.2 mm/yr supported by current information

- The seepage rate into the emplacement drifts will be a small fraction of the amount estimated by multiplying the percolation flux in the host rock by the cross-sectional area of the drifts due to capillary forces

Hypotheses: Containment

- The amount of liquid water advectively contacting the waste containers will be small
- Humidity in the vicinity of the waste packages will be low for thousands of years
- Corrosion rates for all mechanisms will be negligible under low humidity
- The outer barrier of the waste package will provide cathodic protection for the inner barrier for thousands of years

Hypotheses: Mobilization

- The flow rate of water that can contact waste in breached waste packages will be low
- The solubility of neptunium is orders of magnitude below the current bounding value
- Current values for spent-fuel dissolution rates provide reasonable bounds
- Colloids formed during dissolution of spent fuel do not remain stable under repository conditions

Hypotheses: Transport Through Engineered Barriers

- Seepage into the emplacement drifts will be insufficient to saturate the engineered barriers
- Diffusion coefficients for transport within the waste package are very small
- Backfill materials have very small diffusion coefficients for transport on surface films, and contaminants will precipitate in pore space

Hypotheses: Dilution

- Flow rates of water contacting the waste will be low
- Flow in the saturated zone is much greater than the flow contacting the waste
- Strong mixing occurs in the flow below the water table

Importance of ESF Observations

- Emplacement-drift seepage affects containment, mobilization, EBS transport, and dilution and, therefore, is crucial to the strategy
- The strategy is motivated by ESF observations that support
  - very low flux rates in the Topopah Spring (i.e., fracture-coating and pore-water dates in excess of 100,000 years)
  - lack of dripping fractures
  - indications that flux may be diverted laterally by the Paintbrush Nonwelded unit above the repository horizon

Approach to Cross-Cutting Issues

- Thermal effects: rely both on short-term thermal testing and on waste packages providing adequate containment during the thermal period
- Climate change: develop bounds on pluvial infiltration rates and test sensitivity of hydrologic models to higher infiltration rates; develop model to explain why Topopah Spring fracture coatings and pore water are (apparently) so old
- Tectonics, seismicity, and volcanism: evaluate risk by using available information on potential occurrences to predict consequences
- Human interference: demonstrate that the site is not a likely target for future resource exploration or development

Summary

- The strategy builds on previous work and is supported by ESF observations that suggest very low flux at the repository horizon
- The strategy identifies the key issues and points to what can be done to address them
- The strategy provides a tool for integrating performance assessment, site characterization, and design
- By focusing on what is both important and testable, the strategy provides a way to evaluate repository performance to support near-term decisions about the viability of Yucca Mountain