Postclosure Thermal Conditions at Yucca Mountain: How Hot Should It Get?

Presented to: Nuclear Waste Technical Review Board

Presented by: William Boyle
Acting Deputy Assistant Manager
Office of Licensing and Regulatory Compliance
U.S. Department of Energy
Yucca Mountain Site Characterization Office

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Outline

- Issues Related to Postclosure Thermal Conditions
- Work Completed to Address Issues Related to Postclosure Thermal Conditions
- Analyses of Postclosure Thermal Conditions
- Testing to Address Postclosure Thermal Conditions
Issues Related to Postclosure Thermal Conditions

- DOE’s interpretation of the Board’s main concerns with respect to postclosure thermal conditions for the Viability Assessment (VA) design (1998)
  
  - The potential for corrosion of the corrosion-resistant waste package material would be significantly reduced if peak waste package surface temperature were reduced
  
  - There would also be significant reduction of coupled thermal-hydrologic and thermal-geochemical processes at lower temperatures
Work Completed to Address Issues Related to Postclosure Thermal Conditions

- Evaluated alternative designs (License Application Design Selection Report - 1999)
- Evolved to the Site Recommendation (SR) design with lower temperature postclosure thermal conditions (2000)
- Evaluated higher (SR) and lower postclosure thermal conditions - Supplemental Science and Performance Analyses (SSPA- 2001)
- Enhanced the experimental program to address corrosion processes and waste package environment
- Completed the Waste Package Materials Performance Peer Review
Evolution of Thermal Conditions (VA - SR)
Analyses of Postclosure Thermal Conditions

- DOE analyzed higher (SR) and lower postclosure thermal conditions (SSPA)
  - Some differences in performance were observed at the subsystem level for some models
  - System level performance was essentially the same for both higher and lower postclosure thermal conditions
Example Subsystem Level Analyses

Chemistry for higher and lower temperatures at the drift scale: carbon dioxide (left panel) and pH (right panel)
Total Dose Uncertainty

- TSPA models apply to both LTOM and HTOM
- The TSPA uncertainty ranges for HTOM and LTOM are similar
- Process level models evaluate subsystem uncertainties, which in some cases, are propagated in TSPA abstractions

**LTOM** - Lower Temperature Operating Mode
**HTOM** - Higher Temperature Operating Mode
Overall Evaluation (02/02)

• For preclosure
  – Dose estimates are below the regulatory limit for both cases
  – Preclosure safety hazards and costs may be higher for a lower postclosure thermal condition (increased excavation, longer timeframes)

• For postclosure
  – Confidence in subsystem effects on total dose is higher for lower postclosure thermal condition because larger thermal effects contribute to uncertainty
  – For postclosure system level performance, both cases result in doses that are well below the regulatory limit

• The results of this study indicate the a Yucca Mountain repository will work for both cases
  – Additional work will be completed before a decision will be made on postclosure thermal conditions
Plans to Address Postclosure Thermal Conditions

- TSPA for License Application (LA) will analyze a design that leads to postclosure thermal conditions similar to the SR Design.
- This approach does not preclude closing in a cooler mode. Lower postclosure thermal conditions can be achieved by:
  - Adjusting the amount of aged fuel, the aging duration, and the ventilation rate and/or duration
  - Derating waste packages
  - Varying waste package spacing
- Subsequent decisions will be informed by results of ongoing tests, analyses, and modeling.
Testing to Address Postclosure Thermal Conditions

- The following tests will provide a stronger technical basis for decisions on thermal operating conditions
  - Drift-Scale Thermal Test
  - Cross-Drift Thermal Test
  - Natural Convection Test
  - Geotechnical Tests
  - Low Thermal Load Testing
  - Waste Package Corrosion and Environmental Tests
  - Postclosure Simulation Test
Availability of Thermal Test Results

**Construction**

- SSPA (1)
- SR (2)
- License Application
- Construction Authorization
- License Update
- Waste Receipt

**Operations**

- Module 1
- Module 2, ...
- Module N

**Staging & Subsurface Modules**

- Decision between LTOM & HTOM impacts construction, emplacement, or staging

**Closure**

- Submittal
- Decision for Post Closure Simulation

**Thermal Tests** (3)

- Drift Scale
- Cross Drift Thermal
- Natural Convection
- Geotechnical Testing
- Low Thermal Load Testing
- Ongoing Waste Package Corrosion and Environment Tests
- Post Closure Simulation

- TH, THC & TM
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- TH & WPE
- TM & TH
- WPE & WPC
- WPE & WPC

- TH, THC, & WPE

**Loading times**

- Loading time with HTOM is about 25 years.
- Loading time with LTOM aging is about 50 years.

**Notes**

- (1) Supplemental Science and Performance Analyses
- (2) Site Recommendation
- (3) Times shown are for completion of tests, not completion of analyses
Recent Test Results

Recent test results suggest that

- Large portions of the repository have benign in-drift environments for corrosion for extended periods of time
- Portions of the repository will pass through aggressive in-drift environments for shorter periods of time
- Work is continuing to improve our understanding of how much of the repository will see aggressive conditions for and for how long
- Mark Peters and Gerald Gordon are discussing some specific test results today