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

NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING

SUBJECT: TOTAL-SYSTEM PERFORMANCE ASSESSMENT EXERCISE (TSPA-91) PROBLEM DEFINITION

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Outline

- Scope
  - PNL/SNL common data set
  - Retardation
  - Boundary conditions
Scope of the Total System Performance Assessment (TSPA)

- Groundwater Flow
  - UZ Composite-Model Transport
  - (SZ) Weeps-Model Transport
  - UZ Transport

- Gas Flow
  - Surface Release

- Human Intrusion
  - Surface Release
  - DirectSZ Release

- Basaltic Volcanism
  - Surface Release

- Tectonism
  - Water Table Rise
  - Gas Flow in Fractures
Conditions Modeled for Yucca Mountain

- Undisturbed Conditions
- Basaltic Volcanism
- Human Intrusion
- Climate Change
Expansions on Previous Exercises

- More phenomena modeled
- Releases calculated to AE along 2 paths
- More sophisticated source term used
  - Better understanding of water contact modes
  - Computationally simpler
  - Larger suite of nuclides incorporated
- Stochastic simulations performed
- Some sensitivity studies performed
- Results used in dose calculations
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Common Factors

- SNL and PNL common data:
  - Stratigraphic cross section
  - Geohydrologic parameters and distributions
  - Suite of radionuclides
  - Boundary conditions
Aqueous Flow Problem Domain

- Horizontal domain
  - UZ modeled from H-5 to 500m east of UE-25a#1
    * Representative of entire repository
    * Area chosen for availability of data
    * Section includes Ghost Dance Fault (14-m offset)
  - SZ extends from beneath repository to accessible environment (5km)
East-West Transect Used for the TSPA

- TSPA Transect
- Ghost Dance Fault
- Outline of Potential Repository
- Points: H-5, G-4, UE-25 a#1

Scale (km): 0, 0.5, 1, 2
Aqueous Flow Problem Domain

- **Vertical Domain**
  - Aqueous flow and tectonism
    * Top of repository to water table
  - Human intrusion
    * Surface to saturated zone
  - Volcanism
    * Repository to surface
Release Pathways

volcanism
gas flow
human intrusion

Repository

aqueous flow
tectonism

human intrusion

Water Table
Tuff Aquifer
Carbonate Aquifer

Surface
Stratigraphy

- Unsaturated zone--5 layers
  - Number of layers decreased from PACE
  - Simplified from USGS downhole logs
    * Data from USW H-5, UE25a#1, and USW G-4
    * Multiple units lumped together, based on gross characteristics

- Saturated zone--2 layers
  - "Tuff" aquifer
  - "Carbonate" aquifer
Geologic Cross Section Used for TSPA

USW H-5

Ghost Dance Fault

USW G-4

UE-25 a#1

Potential Repository

Welded

Vitrophyre

Vitric

Zeolitic

Partially welded

Water Table
Geohydrologic Data Set Development

- Derived from site and analog data
  - Matrix values from Peters et al., PACE, and analog sites (Apache Leap)
  - Fracture properties from Spengler et al., Zimmerman, and Carsel and Parrish
  - Distributions developed for each parameter

- Provided a long-needed tool for this and subsequent analyses
Geologic Data Set Applications

- Flow and transport calculations:
  - SNL
    * Unsaturated aqueous scenarios
    * Saturated aqueous scenarios
  - PNL
    * All scenarios
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Tuff Retardation Coefficients

- Geochemical information interpreted by Meijer (LANL)
  - Rocks subdivided into 3 types: vitric, devitrified, and zeolitic
    * Nuclides with retardation = 0: Tc, I, C
    * Nuclides with retardation = 100: Am, Pu, Sn
    * Nuclides with PDFs: U, Se, Cs, Np
  - Ranges of retardation values established for the range of pH values in J-13 water
    * Oxidizing conditions assumed
Carbonate Retardation Coefficients

- Carbonate-aquifer retardation values based on data from Waste Isolation Pilot Project (WIPP) (Culebra Dolomite)
  - Matrix values only
  - Water chemistry
    * Oxidizing conditions assumed
    * Chlorides assumed to have no effect on $K_d$s
  - PDFs for all nuclides except for Tc, I, and C
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Boundary Conditions

- Lateral boundaries--no flow for 2D

- Run from initial saturation and flux to steady-state for specified percolation

- Range for flux at the repository horizon = 0.0 - 39.0mm/yr
  - Range of values allows for climate change
  - Range ensures some calculations exceed threshold for fracture-dominated flow
  - Shape of distribution weighted to low flux values
Distribution of Percolation Fluxes at Repository