Site Investigations Update

• ESF Testing
  - Thermal Testing Alcove Construction
  - In Situ Thermal Testing
    » Predictive Calculations of Heater Tests
  - Moisture Monitoring

• Surface-Based Testing
  - G-2 Aquifer Test
  - Tracer Testing at C-Hole Complex
  - Ongoing Pneumatic Monitoring
  - SD-7 Instrumentation
Site Investigations Update

(Continued)

• Geology
  - Detailed Geologic Mapping of Repository Area
  - South Ramp Geologic Predictions
  - Probabilistic Volcanic Hazard Assessment
  - Mineralogy/Petrology

• Geochemistry
  - Flow and Transport Modeling
Site Investigations Update (Continued)

- **Hydrology**
  - Apparent Ages of Fracture Minerals
  - Isotope Tracers ($^{36}$Cl) and UZ Flow
  - Update on Conceptual Models
Thermal Testing in the ESF - Phase I
Illustrative Plan View Schematic

ESD: Expected Excavation Start Date
TSD: Expected Testing Start Date

Centerline @ CS 28+27
ESF Main Drift

Heated Drift
TSD: Aug 97
CS 2+20

Plate-Loading Niche
ESD: Aug 96
CS 1+30

Access/Observation Drift - Connecting Drift

ESD: Aug 96
CS 1+30

Thermomechanical Alcove Extension
Completed: April 12, 1996

Thermomechanical Alcove
TSD: Aug 96

CS 0+60.6
April 23, 1996

Began: Jan. 19, '96

ESF North Ramp

ILLUSTPN.CDR.125 NWTRB/4-30-96
In Situ Thermal Testing

- Temperature profiles and moisture distribution predictions for single heater test and drift-scale heater test
In Situ Thermal Testing
(Continued)

- Thermomechanical Heater Test
  - Results from thermomechanical heater test simulations (Nick Francis - SNL)
Temperature Distribution at 1 Year as Viewed From the Thermal-Mechanical Alcove Looking East

Black Lines - 1 Darcy Case
Red Lines - 10 Darcy Case
Liquid Saturation Distribution at 1 year Viewed from the Thermal-Mechanical Alcove Looking East - 10 Darcy Case
• Drift-Scale Heater Test
  - Results from drift-scale heater test simulations
    (Tom Buscheck - LLNL)
Dimensionless liquid saturation distribution transverse to the ESF drift-scale thermal test

The red area corresponds to a region that is drier than ambient (dry-out zone); the blue areas correspond to regions that are wetter than ambient (condensation zones)

\( t = 0.5 \text{ yr} \)

\( t = 1 \text{ yr} \)

\( t = 2 \text{ yr} \)

\( t = 4 \text{ yr} \)
Dimensionless liquid saturation and temperature distribution transverse to the ESF drift-scale thermal test resulting from heterogeneous property distributions

The red area corresponds to a region that is drier than ambient (dry-out zone); the blue areas correspond to regions that are wetter than ambient (condensation zones); temperature contours are shown in (c) and (d).
ESF Moisture Study

• Objectives
  – Determine amount of moisture removed by ventilation & muck as TBM advances
  – Determine rate of moisture removal from rock
  – Provide data for testing thermohydrologic coupled process models
  – Report due September 1, 1996
Preliminary Results from ESF Moisture Study

- From scoping studies, fall 1995:
  - Ventilation air relative humidity increases from the portal to the TBM
  - Water removed in ventilation air averages more than 100 liters per year per square meter of tunnel area (flux 100 mm/yr)

- Humidity measurements and infrared images indicate increase in relative humidity on the weekends and toward the TBM (Joe Wang - LBNL)
Preliminary Results from ESF Moisture Study
(Continued)

• Measurements in Alcove 3 (which was bulkheaded) by USGS (Alan Flint)
  – Flux out of rock depends on rock properties
    » About 1.0 mm/day from columnar unit (Crystal-Poor Member of Tiva Canyon Tuff)
    » About 0.25 mm/day from vitric unit (Vitric Zone of Tiva Canyon Tuff)
G-2 Aquifer Test

• Purpose is to characterize large hydraulic gradient north of site

• Pumping currently in progress (scheduled to end 4-26-96) to be followed by two months of recovery to test if water-bearing zone is a perched water body
C-Hole Complex Testing

• Purpose is to conduct hydraulic, conservative tracer, and reactive tracer tests in the saturated zone at the site

• Have completed two hydraulic tests and a conservative tracer test during the past year

• Next set of hydraulic, conservative, and reactive tracer tests to start 5-1-96
C-Hole Complex Testing
(Continued)

- Breakthrough curve for conservative tracer test (USGS)
Tracer Test at Cwells 02/13/96 NaI (10,000 ppm) Injectate

Preliminary Data-- not reviewed

Volume water pumped - 7,907,000 gallons
28 % of total tracer recovered
Pneumatic Testing/Monitoring

- DOE currently monitoring eight boreholes
- Nye County monitoring an additional two boreholes
- Response at depth to barometric pressure fluctuations recorded
- Pneumatic response to ESF penetrating PTn recorded
- Pressure response calculations made with UZ gas flow model
SD-7 Instrumentation

- Purpose is to install temporary instrumentation to monitor pneumatic pressure response prior to and during TBM advance past borehole
SD-7 Instrumentation
Geologic Mapping

• Central Block geologic field mapping completed
  – Result will be a much more precise map in terms of locations and interpretations of geologic structures

• South Ramp predictive geology cross-section submitted to ESF design
  – Ground will probably be difficult and several faults and breccia zones will probably be encountered
  – No major structures in the area of the South Portal
Probabilistic Volcanic Hazard Assessment

- Final report delivered to M&O and being reviewed prior to submittal to DOE

- Mean aggregate probability is $1.5 \times 10^{-8}$
  - Value very similar to estimates made by Project scientists
Aggregate Distributions for Frequency of Intersecting the Yucca Mountain Repository Footprint

Annual Frequency of Intersection
Mineralogy/Petrology

- Completed report, *Mineralogy-Petrology Contribution to the Near-Field Environment Report*
  - Significant contribution to the NFER, due at the end of the FY
  - Contains compilation of mineral kinetic and thermodynamic data and discussion of alteration history and past mass transport
Geochemistry

- Refinement of the UZ Flow and Transport model continues
  - Added thermal effects to model
  - First simulations of the effect of heat on Np transport
  - FEHM code reviewed and commented upon by AECL

- Progress on development of first SZ Flow and Transport Model this FY
  - Completed grid construction with GEOMESH
Hydrology

- Apparent Ages of Fracture Minerals
- Isotope Tracers ($^{36}$Cl) and UZ Flow
- Update on Conceptual Models
Apparent Ages of Fracture Minerals

- Purpose is to constrain further the timing of percolation into the repository horizon

- Continuing to collect data from ESF
  - Results to date (Paces et al. - USGS)
(data from Paces et al., 1996)
Isotope Tracers ($^{36}$Cl) and UZ Flow

- Purpose is to constrain further the residence time of UZ water as a function of depth and structural features

- Continuing to collect data from the ESF
  - Results to date (Fabryka-Martin et al. - LANL)
(after Fabryka-Martin et al., 1996)
Conceptual Models

• A fraction of $^{36}\text{Cl}$ in some ESF samples appears to be bomb pulse

• Three possible conceptual models developed to interpret how bomb pulse $^{36}\text{Cl}$ may enter the repository horizon rocks

• the models address specifically how modern water may pass through the PTn

• once through the PTn, the water follows fracture/fault systems
Conceptual Models
(Continued)

- Model A - following the Montazer & Wilson concept
  - Water travels down fault zone, or is laterally diverted at the top of the PTn until a fault zone is encountered
  - Water travels down fault zone through PTn to the TSw
  - Water then travels down nearest available fracture/fault system (optimum path for gravity flow) to the repository horizon
• Model B - variant of Model A
  - Water is laterally diverted at the top of the PTn until a throughgoing fracture/joint system is encountered
  - Water travels down fracture/joint system through PTn to the TSw
  - Water then travels down nearest available fracture/fault system (optimum path for gravity flow) to the repository horizon
Conceptual Models

(Continued)

- Model C
  - Water flow is impeded at the PTn and diverted laterally into "lows" in the PTn to form perched water bodies
  - Water then travels through the PTn by matrix flow to the TSw
  - Water then travels down nearest available fracture/fault system (optimum path for gravity flow) to the repository horizon
$^{36}$Cl Strategy

- Continue systematic and feature-based sampling in ESF to test conceptual models
- Use other isotope tracers to corroborate observations from $^{36}$Cl (e.g., $^3$H?)
- Constrain the amount of bomb pulse $^{36}$Cl required to produce the observed ratios
- Test possible conceptual models with UZ flow models
Conclusions

- Thermal Testing Alcove construction continues to progress
- Predictions being made and finalized prior to initiation of Thermal Testing
- G-2 and C-Hole testing continues
- Geologic mapping being finalized
  - Very useful for location of structural features pertinent to $^{36}$Cl data
- South Ramp geologic predictions made and being used by ESF design
Conclusions
(continued)

- Probabilistic Volcanic Hazard Assessment completed and in form needed by Performance Assessment

- Dating of fracture minerals continues

- $^{36}$Cl studies continue
  - Revised our conceptual models and testing strategy