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

NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING

SUBJECT: PEER REVIEW OF THERMOHYDROLOGIC MODELING AND TESTING PROGRAM: STATUS REPORT

PRESENTER: ARDYTH SIMMONS

PRESENTER'S TITLE AND ORGANIZATION: PHYSICAL SCIENTIST/GEOCHEMISTRY TEAM LEADER, DOE

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SALT LAKE CITY, UTAH
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Outline

- Reason for convening Peer Review
- Objective and Scope
- Selection Criteria
- Composition of Panel
- Main Ideas of White Paper
- Schedule

Reasons for Convening External Peer Review

- Thermohydrologic behavior of Yucca Mountain under repository thermal load is a key factor in housing a thermal load
- Choice of thermal load is major programmatic decision
- Use as management tool to evaluate DOE's approach to understanding thermohydrologic (T-H) processes
- Evaluate adequacy of conceptual T-H models and adequacy of testing program used to build confidence in models
- Design of *in situ* tests to evaluate T-H response of Yucca Mountain is underway, wanted external check prior to inception of test as redesign could prove costly

Objective

- Evaluate Project approach to understanding hydrothemal conditions at Yucca Mountain that would be generated by repository heating. Consider adequacy and sufficiency of laboratory and *in situ* test design, as well as adequacy and sufficiency of conceptual models

- Evaluation criteria include
  - Validity of basic assumptions and conclusions
  - Adequacy of requirements and applications
  - Alternative interpretations
  - Accuracy of calculations
  - Appropriateness and limitations of methods
  - Uncertainty of results of impact, if incorrect

Scope

- Evaluate White Paper on thermohydrologic modeling and testing, including key references
- Evaluate adequacy of laboratory and field experimental program to build confidence in understanding and predicting thermohydrologic processes and development of models
- Evaluate sufficiency of models and modeling approaches to predict moisture redistribution and changes in water chemistry in response to heat

Selected Key Questions

1 Do the number, types, and spatial and temporal scales of proposed tests represent the range of conditions needed to build confidence in thermo-hydrologic behavior of the site?

2 Do the coupled processes described in the White Paper reasonably encompass the range of effects associated with the influence of repository heat on the mountain?

3 Are there additional parameters that have greater sensitivity in models and should be addressed?

4 Is it reasonable to decouple thermo-hydrologic processes from thermo-mechanical and thermo-chemical processes in modeling behavior at the site?

5 If it is not reasonable to decouple these processes, how might the coupling best be accomplished?

Selection Criteria for Panelists

- Candidates are well known in the fields of groundwater hydrology, thermal effects (e.g. boiling and heat transfer), multiphase effects, coupled thermohydrologic processes, process modeling, and/or experimental and field test design and analysis. They are acknowledged experts in one or more of these fields
- Candidates do not have U.S. Nuclear Regulatory Commission contracts
- Candidates are independent from those who performed the original work to be reviewed
- Candidates indicated they are able to commit the time required to conduct the peer review

Peer Review Team

- **Dr. Paul A. Witherspoon, Chairperson**
  - Large-scale, underground hydraulic and thermal testing of fractured rocks
  - Multi-phase fluid flow modeling
- **Dr. R. Allan Freeze**
  - Hydrogeological analysis in geotechnical projects
  - Numerical modeling of saturated, unsaturated, multi-phase, and fluid flow
- **Dr. Francis A. Kulacki**
  - Heat transfer, thermodynamics, and fluid flow in porous and fractured media
  - Heat transfer in radioactive waste canisters
- **Dr. Joseph N. Moore**
  - Geology and hydrogeochemistry of geothermal, epithermal, and contact metamorphic environments
  - Exploration and characterization of fracture-dominated geothermal resources
- **Dr. Franklin W. Schwartz**
  - Flow and mass transport in fractured and porous media
  - Reactive chemical transport
  - Nuclear waste management
- **Dr. Yanis C. Yortsos**
  - Fluid flow, fluid displacement processes, mass and heat transport, and chemical reactions in porous and fractured rocks
  - Numerical modeling with application of percolation and fractal methods
  - Reservoir engineering of petroleum and geothermal systems

Main Ideas in White Paper

- Tells how numerical codes handle different conceptualizations for fracture-matrix interactions
- Describes preliminary results of laboratory thermohydrologic tests and knowledge gained from G-tunnel tests
- Compares results of repository and drift-scale analyses as well as conduction-only analysis
- Describes sensitivity analyses that considered variable fracture/matrix properties and variable boundary conditions
- Discusses uncertainties of current analyses and physical properties, hydrologic parameters, model idealizations
- Outlines Project's approach to reducing uncertainties through testing at different scales, additional data collection, model calibration, and numerical testing. Recognizes residual uncertainty is unfavorable
- Project seeks to identify processes having the greatest sesitivity and tests that will optimize confidence building

Main Ideas in White Paper

(Continued)

- Recognizes need for building confidence in predictive models of couples processes. Confidence built through testing at various scales and through natural analogues
- Provides current understanding of ambient hydrologic conditions, and variation in properties across Yucca Mountain. Discusses potential role of faults as pathways or barriers to moisture flow
- Describes current understanding of thermohydrologic processes, need to account for multi-phase flow
- Recognizes need to couple mechanical and chemical processes with thermohydrologic, (T-H-M-R), but this is proceeding step-wise
- Discusses T-H-M-C conceptual models, including mechanical alteration of fracture permeability and bulk volume charges induced by mineral phase changes

Peer Review Schedule

Completion of Peer Review Plan	June 15, 1995
First Meeting of Peer Review Team	July 13-14, 1995
Second Meeting of Peer Review Team	August 21-25, 1995
Peer Review Report	December 15, 1995
DOE's Response to Peer Review Report	January 17, 1996
Final Comments by Peer Review Team	February 9, 1996
Issuance of Peer Review Record Memorandum	February 16, 1996