KEY TECHNICAL ISSUE
EVOLUTION OF THE NEAR FIELD ENVIRONMENT (ENFE)

ENFE TEAM

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NRC/DOE TECHNICAL EXCHANGE
PRE-LICENSING ISSUE RESOLUTION STATUS
APRIL 25-26, 2000

Status of ENFE Subissues

Subissue 1: **OPEN**	Effects of Coupled Thermal-Hydrologic-Chemical (THC) Processes on Drift Seepage and Flow in the Unsaturated Zone (UZ)
Subissue 2: **OPEN**	Effects of Coupled THC Processes on the Waste Package Chemical Environment
Subissue 3: **OPEN**	Effects of Coupled THC Processes on Chemical Environment for Radionuclide Release
Subissue 4: **OPEN**	Effects of Coupled THC Processes on Radionuclide Transport Through Engineered and Natural Barriers
Subissue 5: **Closed Pending Confirmation**	Effects of Coupled THC Processes on Potential Nuclear Criticality in the Near-Field

Subissue 1: Effects of Coupled THC Processes on Drift Seepage and Flow in the UZ
OPEN

DOE Repository Safety Strategy

Principal Factors:	Seepage into Drifts
Other Factors:	Coupled Processes - Effects on UZ Flow
	Coupled Processes - Effects on Seepage
	Advective Paths in the UZ

NRC Abstractions:

- Quantity and chemistry of water contacting waste packages and waste forms
- Spatial and temporal distribution of flow
- Flow paths in the unsaturated zone

- Need for additional analysis
  - Analyses of Features, Events, and Processes (FEPs) in each abstraction
    - Provide technical bases for excluded FEPs (20% still require additional basis)
    - Link included FEPs to abstractions and their technical bases
  - Analyses of THC effects on drift seepage
    - Complete analyses which demonstrate that neglect of THC processes will not likely underestimate dose or provide models for changes in hydrological properties near drift
    - If latter approach is used, incorporate resulting effects on drift seepage

Subissue 1: Effects of Coupled THC Processes on Drift Seepage and Flow in the UZ (continued)
OPEN

- Need for additional analysis (continued)
  - Analyses of THC effects on unsaturated zone flow fields
    - Complete analyses which demonstrate that neglect of THC processes will not likely underestimate dose or provide models for changes in hydrological properties in zeolitic zones
    - Complete analyses which demonstrate that neglect of THC processes will not likely underestimate dose or provide models for changes in fracture/matrix interaction below repository
    - If models for changes in hydrological properties and fracture/matrix interaction are developed, incorporate resulting effects on unsaturated zone flow

- Need for additional data and analysis
  - Coupled THC model results are inconsistent with laboratory measurements of coupled THC effects on flow
    - Document column THC test results, in particular changes in permeability
    - Incorporate laboratory results [e.g., Lin and Daily (1990)] into modeling analysis
  - Coupled THC model results are inconsistent with field observations
    - Chemistry of Drift Scale Heater Test (DST) fluids (pH < 4.0) different from predictions (pH >7)
    - Provide justification why predicted ranges in pH are not likely to underestimate repository performance or incorporate the range of field observations results into THC modeling analysis
  - To be verified assumptions are used as a technical basis for exclusion of FEPs in Unsaturated Zone Flow and Transport Process Model Report
  - Technical basis needs to be provided for why temperatures predicted for zeolite bearing units will not cause alteration in UZ flow (changes in hydrologic properties)

Subissue 2: Effects of Coupled THC Processes on the OPEN Waste Package Chemical Environment

DOE Repository Safety Strategy

Principal Factors:	Performance of the drip shield
	Performance of the waste package barriers
Other Factors:	Environments on the drip shield
	Environments on the waste package

NRC Abstractions:

- Quantity and chemistry of water contacting waste packages and waste forms
- Degradation of engineered barriers

- Need for Additional Analysis
  - Analyses of Features, Events, and Processes (FEPs) in each abstraction
    - Provide technical bases for excluded FEPs (10% still require additional basis)
    - Link included FEPs to abstractions and their technical bases
    - Explain how Analysis Model Report models are intended to address specific FEPs
  - Likelihood of microbially influenced corrosion
    - Provide data and justification for inclusion or exclusion taking into consideration uncertainties in the definition of in-drift environmental conditions

Subissue 2: Effects of Coupled THC Processes on the OPEN Waste Package Chemical Environment (cont)

- Need for additional data and analysis
  - Determine and assess effects of gamma radiolysis on drip shield and waste package
  - Consider temporal and spatial variations in determination of maximum estimated concentration of anions, temperature, and redox conditions
  - Coupled THC model results for waste package chemical environment are inconsistent with field observations
    - Chemistry of DST fluids (pH < 4.0) different from predictions (pH >7)
    - Provide justification why predicted ranges in fluid chemistry are not likely to underestimate repository performance or incorporate the range of field observations results into THC modeling analysis
  - Provide justification that DOE's major assumptions are not likely to underestimate repository performance
    - Neglect of kinetics in THC modeling
    - THC processes can be decoupled, evaluated separately, then re-linked
  - Evaluation of coupled THC interactions between the DOE's in-drift geochemical abstractions
  - DOE's design changes require additional data, modeling, and FEP analysis

Subissue 3: Effects of Coupled THC Processes on Chemical OPEN Environment for Radionuclide Release

DOE Repository Safety Strategy

Principal Factors:	Solubility limits of dissolved radionuclides
Other Factors:	Environments within waste package
	CSNF waste form performance
	DSNF, Navy fuel, and Pu disposition waste form performance
	DHLW waste form performance
	Colloid associated radionuclide concentrations

NRC Abstractions:

- Quantity and chemistry of water contacting waste packages and waste forms
- Radionuclide release rates and solubility limits

- Need for Additional Analysis
  - Analyses of Features, Events, and Processes (FEPs) in each abstraction
    - Provide technical bases for excluded FEPs (15% still require additional basis)
    - Link included FEPs to abstractions and their technical bases (interaction with corrosion products is relevant to multiple abstractions, yet no technical basis provided for several abstractions)
    - Engineered Barrier System FEPs and Degradation Modes Analysis Analysis Model Report is a good example

Subissue 3: Effects of Coupled THC Processes on Chemical Environment for Radionuclide Release (cont)

OPEN

- Need for additional data and analysis
  - Determine and assess effects of gamma radiolysis on in-package chemistry
  - Apply chemical environment to analysis of waste form degradation
  - Provide basis for maximum estimated concentration of Np, U, and Pu determination given the uncertainty of in-package chemistry (addressed in Waste Form Process Model Report, but not all FEPs considered in determination of solubility)
  - Coupled THC model results for in-package chemical environment are inconsistent with field observations
    - Chemistry of DST fluids (pH < 4.0) different from predictions (pH >7)
    - Provide justification why predicted ranges in fluid chemistry are not likely to underestimate repository performance or incorporate the range of field observations results into THC modeling analysis
  - Provide justification that DOE's major assumptions are not likely to underestimate repository performance
    - Neglect of kinetics in THC modeling
    - THC processes can be decoupled, evaluated separately, then re-linked
  - Evaluation of coupled THC interactions between the DOE's in-drift geochemical abstractions

Subissue 4: Effects of Coupled THC Processes on OPEN Radionuclide Transport

DOE Repository Safety Strategy

Principal Factors:	Retardation of radionuclide migration in the UZ
Other Factors:	In-package radionuclide transport
	Transport through the drift invert
	Coupled processes -effects on UZ transport

NRC Abstractions:

- Radionuclide release rates and solubility limits
- Radionuclide transport in the UZ

- Need for Additional Analysis
  - Analyses of Features, Events, and Processes (FEPs) in each abstraction
    - Provide technical bases for excluded FEPs (15% still require additional basis)
    - Link included FEPs to abstractions and their technical bases
  - Provide transparent link between waste package and unsaturated zone parameters
    - Demonstrate approach is consistent between engineered barrier abstractions and natural systems
  - Demonstrate that neglect of zeolite alteration is not likely to underestimate repository performance

Subissue 4: Effects of Coupled THC Processes on Radionuclide Transport (continued)
OPEN

- Need for additional data and analysis
  - Because DOE is taking credit for retardation during in-package transport and transport through the invert
    - Demonstrate transport parameters are not likely to underestimate repository performance
    - Complete abstraction and analysis of FEPs consistent with design
    - Abstracted models should be supported by lab, field and analog data
  - Coupled THC model results for radionuclide transport through natural barriers are inconsistent with laboratory and field observations
    - Provide justification why predicted ranges in fluid chemistry and mineralogy are not likely to underestimate repository performance or incorporate the range of field (e.g., DST and Busted Butte) and laboratory observations (e.g, THC column tests) into the assessment of THC effects on transport modeling
  - Determine effects of coupled THC processes on colloidal transport
  - Technical basis needs to be provided for why temperatures predicted for zeolite bearing units will not reduce radionuclide retardation
  - Provide justification that DOE's major assumptions are not likely to underestimate repository performance
    - Neglect of kinetics in THC modeling
    - THC processes can be decoupled, evaluated separately, then re-linked

Subissue 5: Effects of Coupled THC Processes on Potential Nuclear Criticality in the Near-Field

Closed Pending Confirmation

- Need for additional analysis
  - Provide technical basis for exclusion of the FEPs associated with criticality in the near-field environment