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

NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING

SUBJECT: **TOTAL SYSTEM PERFORMANCE ASSESSMENT (TSPA) II: REPOSITORY INTEGRATION PROGRAM (RIP) ABSTRACTIONS ANALYZING NOMINAL CONDITIONS**

PRESENTER: **DR. ROBERT W. ANDREWS**

PRESENTER'S TITLE AND ORGANIZATION: PERFORMANCE ASSESSMENT MANAGER
CRWMS M&O/INTERA
VIENNA, VIRGINIA

PRESENTER'S TELEPHONE NUMBER: (703) 204-8849

DENVER, COLORADO
JULY 13-14, 1993

Major TSPA II Objectives

- Evaluate effects of alternative
  - Thermal regimes
  - Emplacement modes
  - Waste-package designs
- Incorporate new site information
- Evaluate effects of alternative performance measures
- Conduct sensitivity/uncertainty analyses

Goal of Evaluating Thermal Effects in TSPA II

- **Incorporate thermal dependency on relevant processes and parameters**
  - **Waste-package failure**
  - **EBS release**
  - **Radionuclide transport**
- **Evaluate impact of alternate thermal loads on performance**
  - **Cumulative release**
  - **Dose**

General Approach to Evaluating Thermal Effects in TSPA II

- Abstract primary functional relationships between thermal load and temperature, aqueous flux, and gaseous flux from detailed process models
- Define secondary functional relationships between temperature or flux and exposure, release and transport properties using laboratory experiments
- Incorporate functional relationships in Repository Integration Program (RIP)
- Evaluate system performance

Repository Integration Program (RIP)

- Propagates uncertainty in processes/properties to produce probabilistic prediction of performance
- Describes waste-package behavior, radionuclide transport, and disruptive events
- Incorporates rewetting, container failure, waste-form exposure, waste form alteration/dissolution, and mass transfer from waste package
- Allows for one-dimensional advective-dispersive representation of transport or simplified Markovian transition between matrix and fractures for geosphere transport

Primary Functional Relationships

- Temporal and spatial temperature distribution for different thermal loads
- Temporal and spatial water saturation distribution for different thermal loads
- Temporal and spatial aqueous and gaseous flux distribution

Thermal Hydrologic Effects on Waste Exposure

- **Effect of aqueous flux on percent of waste packages in different water contact modes**
  - Nominal ("dry")
  - Moist continuous (diffusive release)
  - "Wet Drip" (advective release)
- **Effect of aqueous flux on transition from dry oxidation to aqueous corrosion**
- **Effect of temperature on dry oxidation and aqueous corrosion rates for primary container**

Thermal Hydrologic Effects on Waste Release

- Effect of temperature on fuel matrix alteration rate
- Effect of aqueous flux on fraction of waste matrix wet (affects alteration rate)
- Effect of temperature on radionuclide solubility
- Effect of aqueous flux on water volume in contact with waste matrix (affects non-solubility-limited release)

Thermal Hydrologic Effects on Waste Release

(Continued)

- Effect of temperature and aqueous flux on liquid saturation along diffusive pathway
- Effect of temperature and aqueous flux on diffusion coefficient

Thermal Hydrologic Effects on Radionuclide Transport

- Effect of temperature on gaseous phase flow-paths and velocity
- Effect of temperature on matrix flow properties
- Effect of temperature on radionuclide retardation

Summary

- An objective of TSPA II is to evaluate effects of alternate thermal loads
- Abstraction of results from detailed thermal and thermal hydrologic process models is in progress (input from LLNL, SNL, LBL, M&O)
- Laboratory measurements of some thermally dependent properties are available (input from LLNL, LANL, PNL, USGS)

Summary

(Continued)

- **Some thermally dependent processes and properties must be estimated in the absence of experimental data and detailed process modeling**
  - **Water saturation in emplacement drifts**
  - **Transition from dry oxidation to aqueous corrosion**
  - **Transition from diffusive to advective release**
  - **Behavior of cladding**
  - **Fraction of waste matrix wet**
  - **Water volume in contact with waste matrix**