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

NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING

SUBJECT: TOTAL SYSTEM PERFORMANCE ASSESSMENT-1995: CONCLUSIONS AND RECOMMENDATIONS

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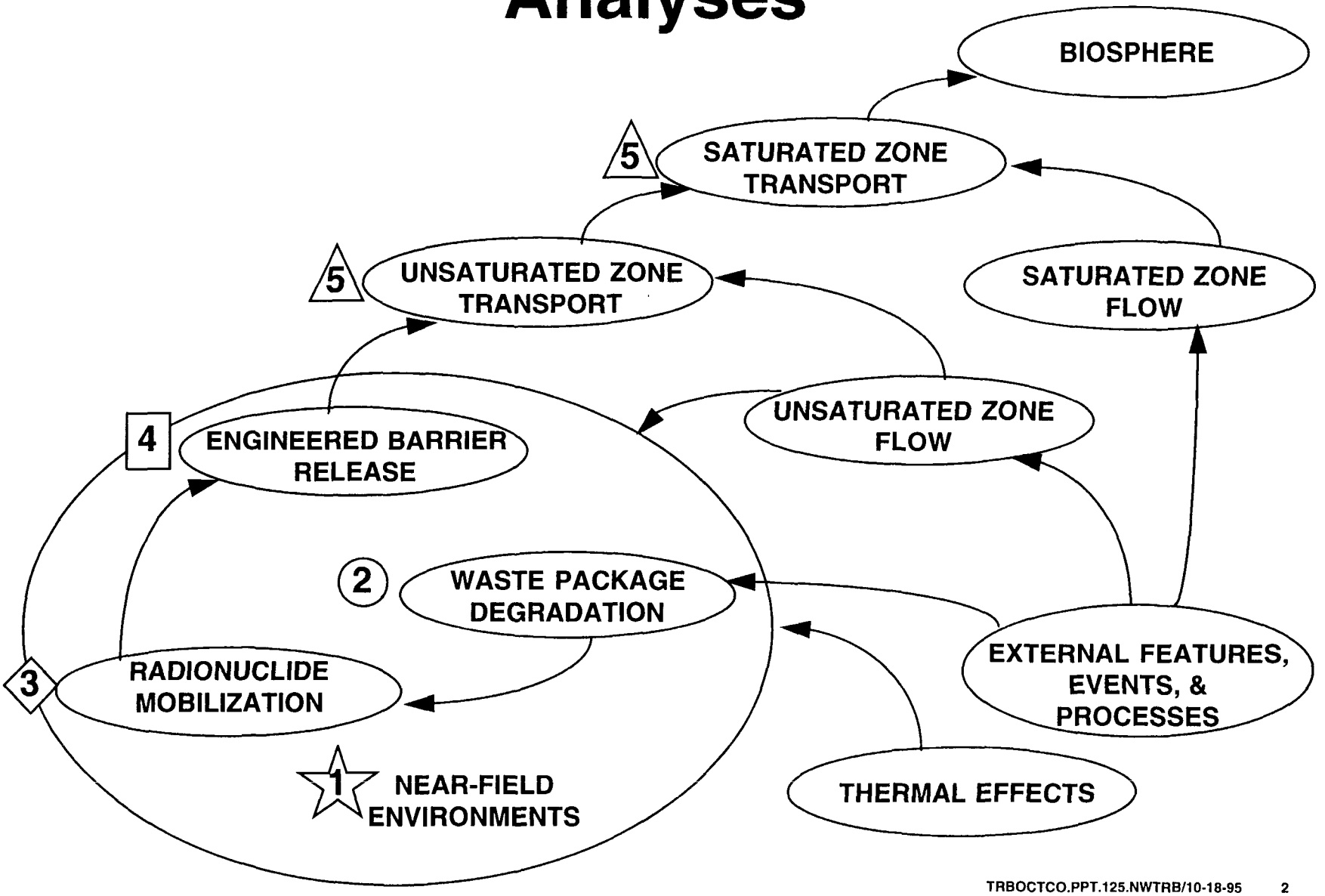
Important Components of TSPA-1995 Analyses



Summary of Major Assumptions in TSPA-1995: Near-Field Environment

- Thermo-hydrologic characteristics of backfill
  - esp. thermal conductivity
- Thermo-hydrologic characteristics of TSw
  - esp. capillary characteristics
- Thermo-chemical and thermo-mechanical effects are neglected
- Distribution of localized percolation flux into the drifts
- Alternative models of flux distribution within the drifts (capillary barrier)

Summary of Major Assumptions in TSPA-1995: Waste Package Degradation

- Corrosion is dominant degradation mode
- Corrosion initiation dependent on relative humidity and temperature
- Localized and pitting corrosion treated stochastically
- Partial waste package degradation used to define diffusive release
- Effects of cathodic protection evaluated
- Pitting corrosion model of corrosion-resistant material same as in TSPA-1993

Summary of Major Assumptions in TSPA-1995: Radionuclide Mobilization

- Cladding assumed to degrade congruently with waste package (sensitivity evaluated)
- Waste form surface assumed to be covered with thin water film
- Aqueous dissolution rates derived from laboratory observations
- Alternative forms of release of gaseous radionuclides considered
- No radio- or natural colloids considered
- Alternative advective and diffusive release models evaluated

Summary of Major Assumptions in TSPA-1995: Geosphere

- Unsaturated zone percolation flux distribution
- Conceptual representation of fracture-matrix flux distribution in unsaturated zone
- Conceptual representation of fracture-matrix transport in unsaturated zone
- Aqueous flux distribution in saturated zone
- Transverse dispersion in saturated zone not considered

Summary of Major Assumptions in TSPA-1995: Biosphere

- Only evaluated dose to maximally exposed individual at 5 km boundary
  - maximally exposed individual is significantly different than average of "critical" group
- Individual receives ingestion dose by drinking 2 l/day derived from tuff aquifer
- Individual's well assumed to be slotted 50 m into the saturated zone
- Dose conversion factors based on EPA 1988

Major Differences Between TSPA-1995 and TSPA-1993

- **Near-Field Environment**
  - explicit drift-scale thermo-hydrologic analyses rather than panel scale
    - » compare results of different parameters in drift materials and host rock
  - EBS diffusion a function of liquid saturation and localized advective flux
  - potential effect of capillary barrier evaluated
- **Waste Package Degradation**
  - relative humidity and temperature used to initiate corrosion rather than temperature only
  - corrosion model for corrosion allowance material in humid air environment based on empirical fits to observations
  - potential benefit of cathodic protection included

Major Differences Between TSPA-1995 and TSPA-1993

- EBS Release
  - effect of cladding evaluated in sensitivity analyses
  - waste form dissolution and surface area exposed based on empirical fits to laboratory data
  - solubility estimates revised slightly
  - advective release dependent on percolation flux distribution
  - diffusive release dependent on percent of package degraded over time and liquid saturation of invert material
  - evaluated potential effect of capillary barrier and alternate models of release from waste package to backfill/invert materials

Major Differences Between TSPA-1995 and TSPA-1993

- Geosphere
  - two different percolation flux distributions used to reflect conceptual uncertainty rather than single distribution
  - fracture and matrix flux distributions based on process models attempting to incorporate non-equilibrium or dual permeability effects
    - » sensitivity to mean fracture length and matrix diffusion evaluated
  - retardation coefficients revised slightly
  - same saturated zone flux and assumed mixing depth
- Dose conversion factor
  - based on consistent definition of biosphere (2 l/day drinking water only) rather than choosing the maximum among alternative definitions

Major Possible Non-Conservative Assumptions in TSPA-1995 and Their Potential Impacts on 1,000,000-year Predicted Performance

- Percolation flux
  - could be higher based on fracture-initiated infiltration analyses (Flint, 1995)
- Dose conversion factor
  - could be higher if consider maximum of alternative biospheres
- Colloidal transport
  - could enhance peak dose

Major Possible Conservative Assumptions in TSPA-1995 and Their Potential Impacts on 1,000,000-year Predicted Performance

- High percolation flux distribution
  - if low, then different radionuclides control peak dose and peak is lower
- Gaseous release from EBS
  - if aqueous and only diffusive release, then reduction in peak dose
- Advective release fraction from EBS
  - if only diffusive, then significant reduction in peak dose
- Cathodic protection and cladding
  - could limit the available inventory for release and dose
- Dispersive/mixing effects in saturated zone to location of "critical" group
  - could significantly lower peak dose to "average" individual

Limitations of Predictive Modeling used in TSPA-1995

- Results of TSPA-1995 reflect incomplete conceptual understanding of site and engineered system processes
- Site and engineered system process models are preliminary, therefore abstracted models used in TSPA-1995 are uncertain
  - impact of range of alternative models evaluated
- Synthesis of data is required to develop and substantiate process models
- Testing of abstracted models used in TSPA needed for comparison with process models
- Residual uncertainty is expected to remain

Investigations Required to Enhance Representativeness in Long-Term Performance Predictions

- Confirm low unsaturated zone percolation flux at repository horizon
- Establish backfill thermo-hydrologic characteristics
- Confirm low humidity near-field environment
- Confirm cathodic protection of corrosion-resistant material
- Establish stability of colloids
- Confirm Neptunium solubility
- Define mixing/dispersive effects in saturated zone
- Define representative biosphere