

# **Performance Assessment and Radionuclide Transport**

**Presentation to  
Nuclear Waste Technical Review Board  
July 12, 1994**

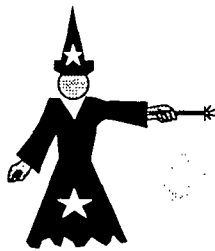
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# Outline

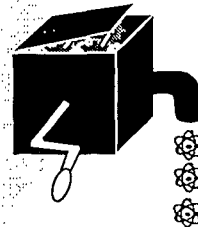
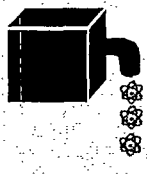
- Near-field performance-assessment models
  - evolution of TSPA source-term models
  - abstraction of near-field processes
  - near-field transport
- Total-system performance-assessment transport models
  - transport models for unsaturated conditions
  - strengths and weaknesses of model abstractions
  - model and parameter sensitivities
- Interactions with site-characterization work
  - guidance for data collection
  - evaluating worth and sufficiency of data

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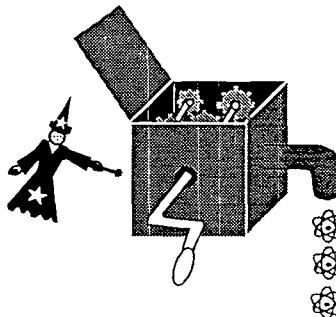
# Evolution of PA Source-Term Models



PACE-90



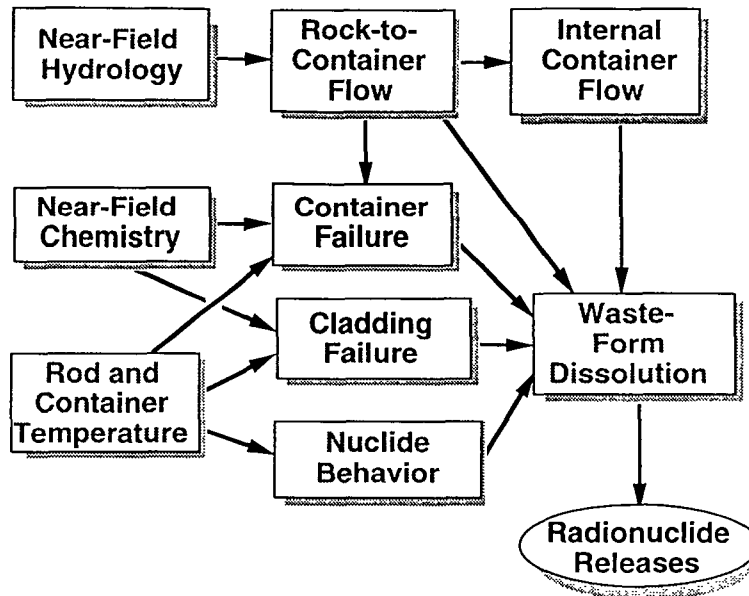
TSPA-91



TSPA-93

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## YMIM Functionality and Modules



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## Source-Term Assumptions Made in TSPA-93

- Waste-package corrosion is strongly temperature- and water-contact dependent
  - in-drift emplacements are backfilled after 75 years
- Cladding is not modeled as a barrier to radionuclide release
- Mobilized radionuclides are transported from the EBS by advection with no time delay
- Solubilities are based on far-field parameters and are not temperature-dependent

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## Transport-Model Assumptions made in TSPA-93

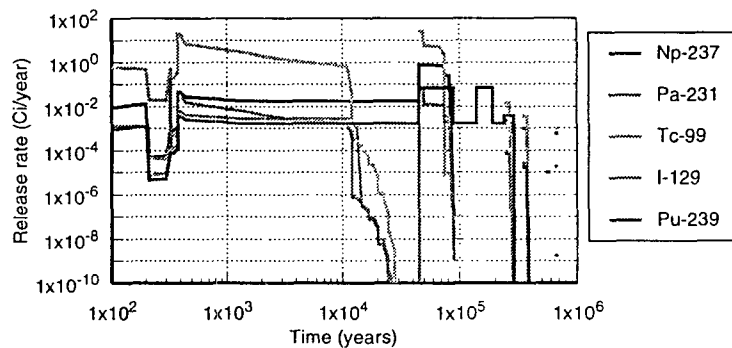
- Two extreme conceptualizations for water transport
  - through fractures (“weeps” model)
  - mostly through matrix (composite-porosity model)
- Sorption strongly controls what radionuclides can be transported to accessible environment
- Colloid transport not considered
- Thermal effects only apply to near field
  - far-field transport is isothermal

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## Consequences of TSPA-93 Assumptions

### (Source Releases)

- Large releases from EBS under some circumstances
  - high releases occur during glacial “wet” periods
  - maximum releases for some radionuclides are up to 100 times the NRC limit



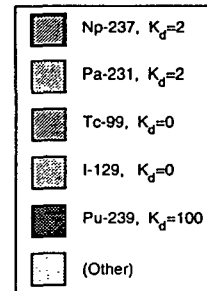
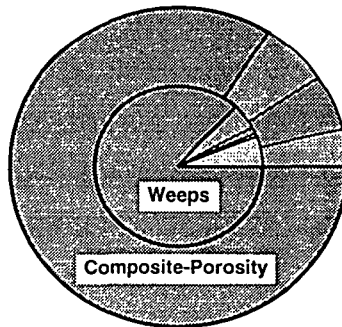
(Vertical emplacement, 57 kW/acre, average parameter values)

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## Consequences of TSPA-93 Assumptions, Continued (Million-Year Doses)

- Doses at accessible environment are due to readily transported radionuclides

- difference between weeps and composite-porosity doses is due to shorter UZ travel time



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## Evaluation of Transport-Model Sensitivities

- Transport processes from waste package to near-field host rock may be a significant barrier to releases
  - models for advective and diffusive transport exist, but their relative importance is not known
- Releases are sensitive to the choice of flow conceptualization
  - 1-D composite-porosity model does not realistically describe fracture flow
    - 2-D dual-porosity flow model being developed for future analyses

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## Transport-Model Sensitivities, Continued

- Colloids must be included in models
  - colloid source term
    - spent-fuel sources
    - glass HLW sources
    - degradation of MPC outer layer
      - Importance of large amounts of  $\text{Fe}_x\text{O}_y$
  - colloid transport
    - interactions with fracture surfaces and fillings

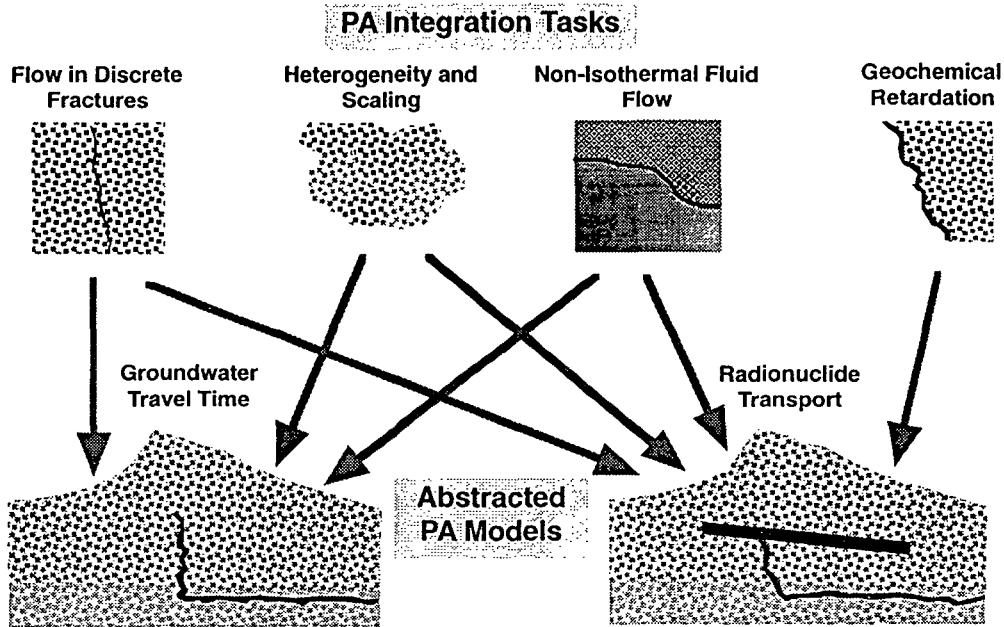
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## Interactions with Site and Process Characterizations

- Source term
  - better understanding of container corrosion processes
  - development of near-field solubility models
  - development of colloid-formation models
- Near-field transport
  - diffusive and advective transport under dynamic conditions
    - high temperatures/limited water
    - aggressive geochemical and radiolytic environments
- UZ flow models
  - coordination of SNL and LBL/USGS site stratigraphic models
  - incorporation of site data/recommendations for further data collection

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# Development of Improved PA Models



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## “When to Say When”

- Heterogeneous groundwater-flow domain is an attempt to provide a realistic basis for evaluation of flow models
  - 3-D geostatistical rock model will allow studies of sensitivity of fast flow paths to hydrogeologic structure
  - data from faults and fractures may be more important than matrix data
- Waste-package design and repository layout may dictate thermal regime
  - range of models used in TSPA-93 may not be appropriate in future
- Colloid transport must be studied further to bound its importance

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# Implementing PA Recommendations

(More than just a list in the PA document)

- Formal presentations to TPOs, WBS managers, NWTRB
- Peer-to-peer interactions among participant PIs
  - ongoing informal exchanges of data and results
  - feedback among participants
- Inclusion of PA recommendations while planning future activities and milestones

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## Summary

- Recent TSPA studies have shown strengths and weaknesses of
  - source-term model
  - flow and transport model
  - geochemical models
- TSPA-93 recommended additional investigations to reduce uncertainties
  - PA integration effort is an attempt to do detailed modeling to reduce uncertainties in TSPA models
- Major areas of process uncertainties are
  - near-field processes (transport, geochemistry, etc.)
  - colloid transport

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