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

NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING

SUBJECT: EVALUATION OF ENGINEERED BARRIER SYSTEM RELEASES IN TSPA-1995

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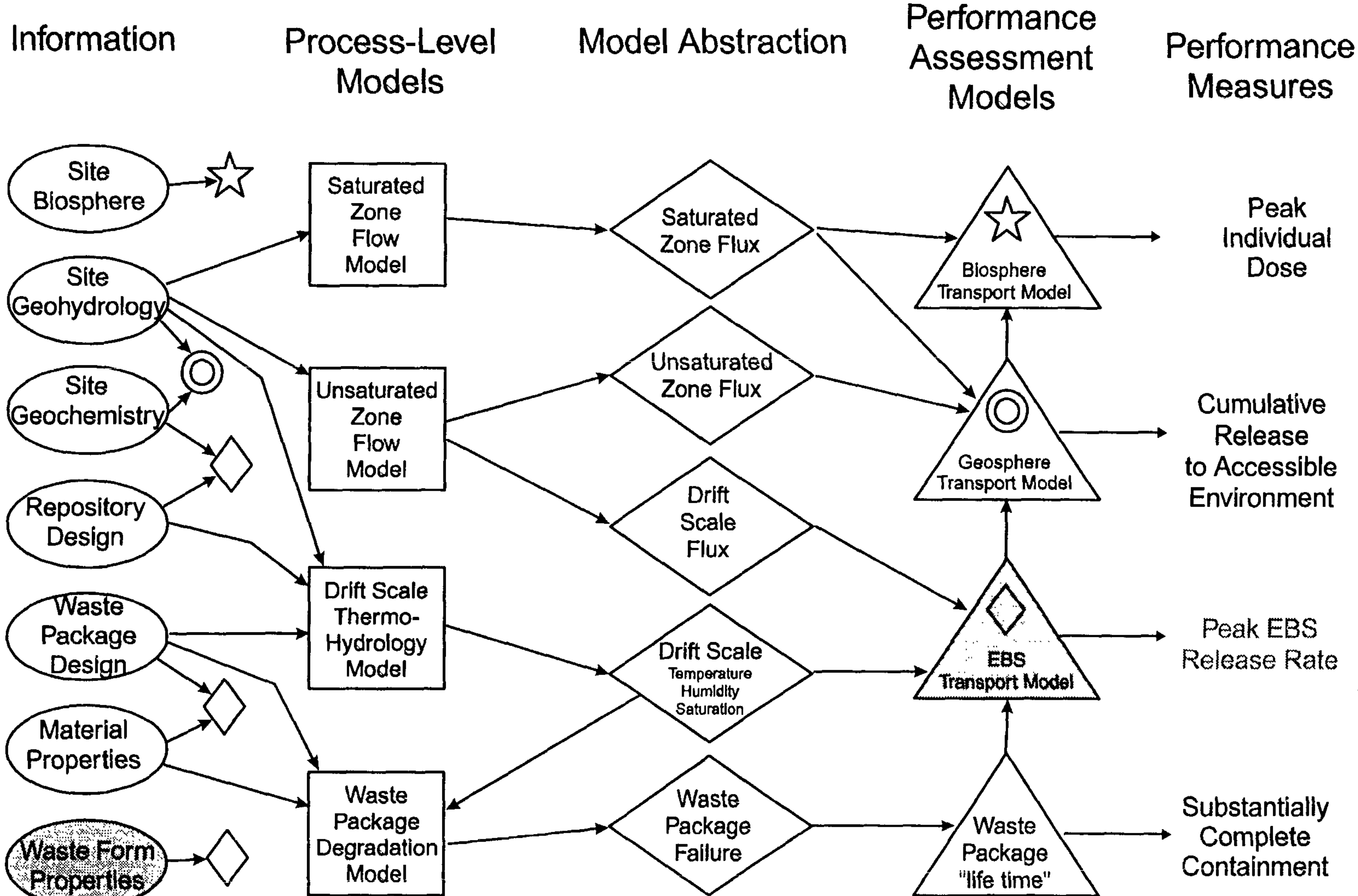
Outline

- Objectives
- Description of Nominal Engineered Barrier System (EBS)
- Waste Form Alteration/Radionuclide Mobilization
- EBS Release Models
- Approach to EBS Release Sensitivity Analyses
- Results of Sensitivity Analyses
- Conclusions

Objectives

- Develop abstractions for radionuclide mobilization processes
  - alteration/dissolution (f ($[CO_3]_T$, pH, T))
  - radionuclide solubility (f (pH, T))
- Evaluate EBS release rate for various alternate conceptual models of EBS transport
- Provide EBS releases to geosphere for predicting total system performance

TSPA-1995 Information Flow Diagram
Engineered Barrier System



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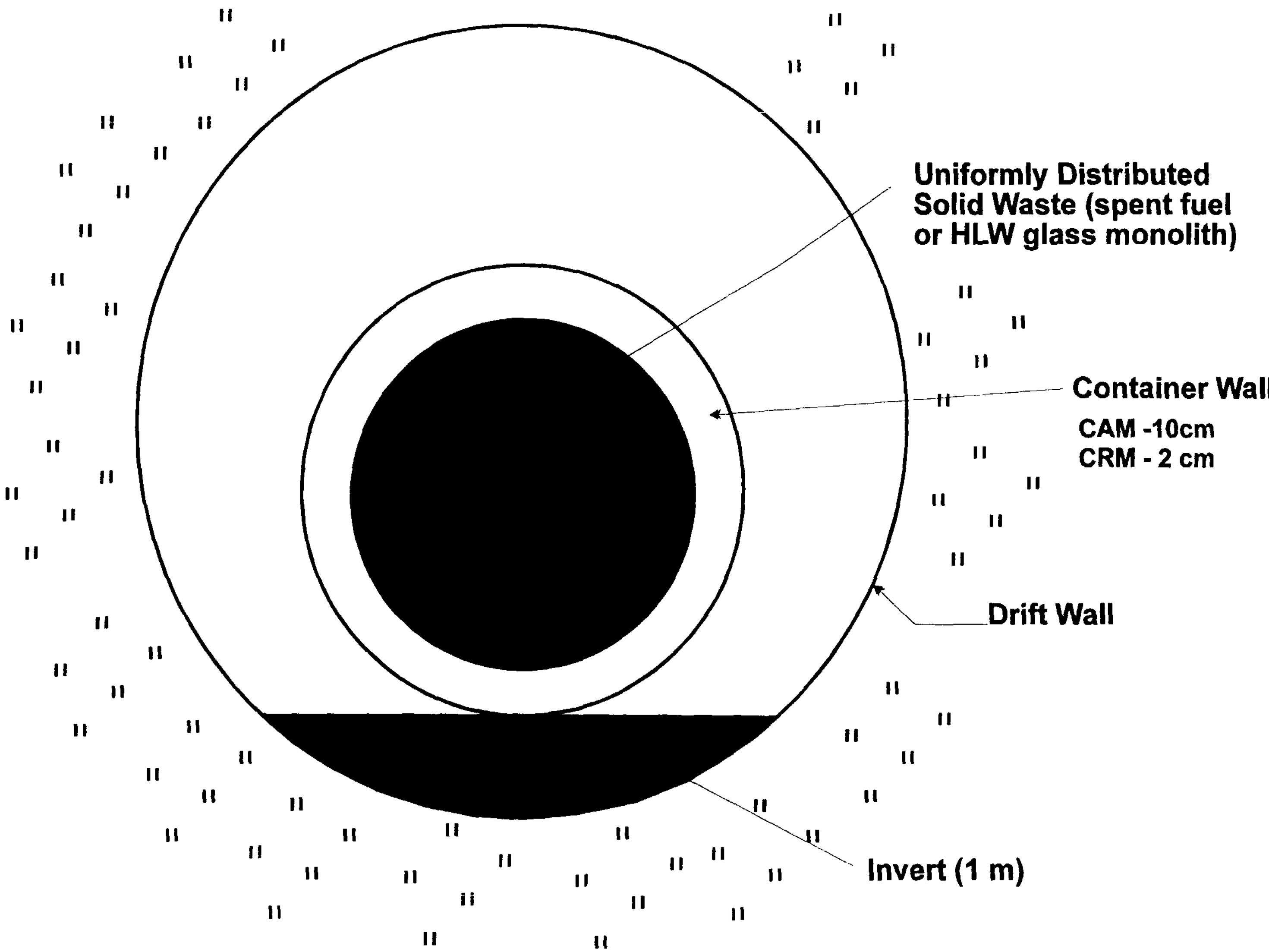
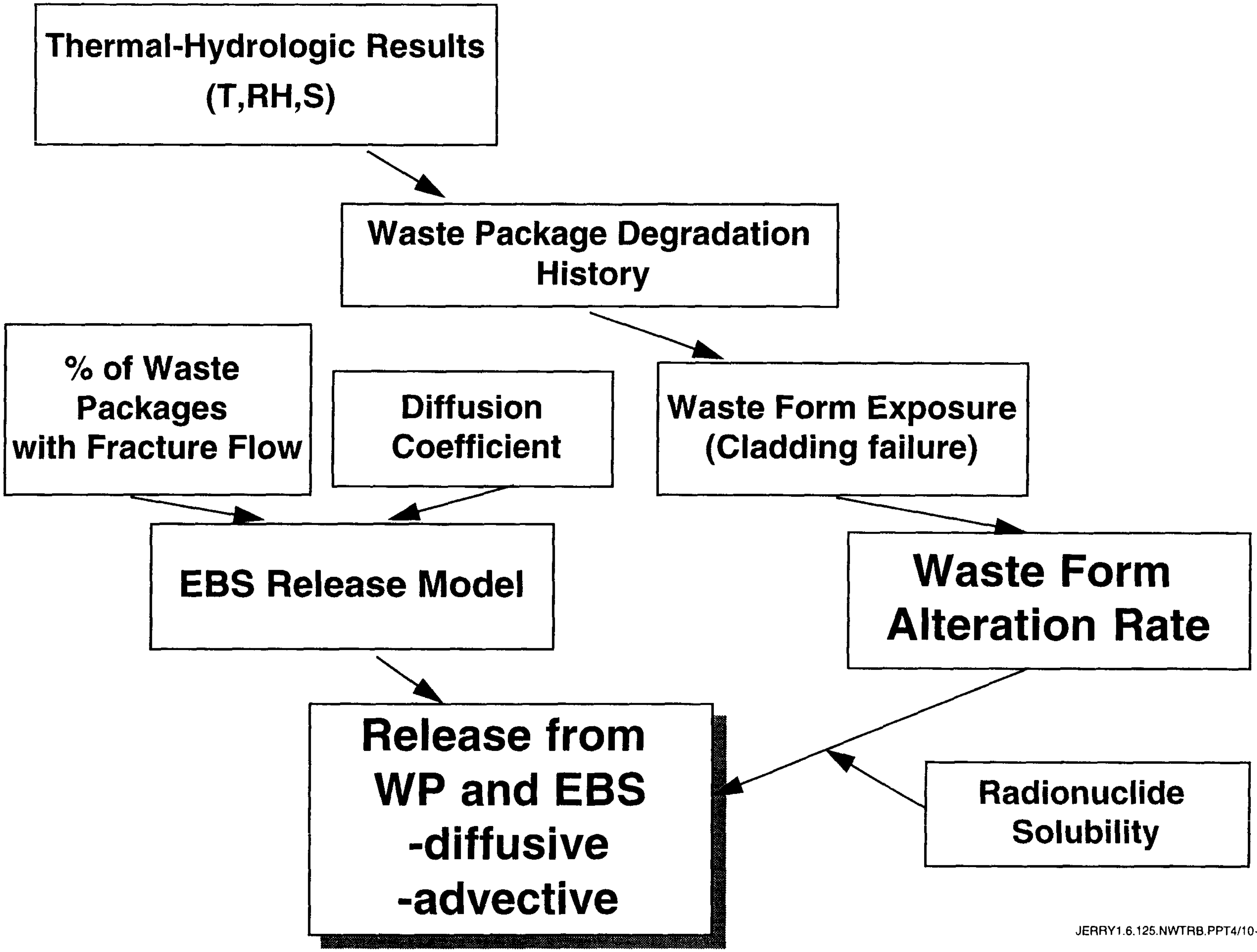
Description of Nominal Engineered Barrier System



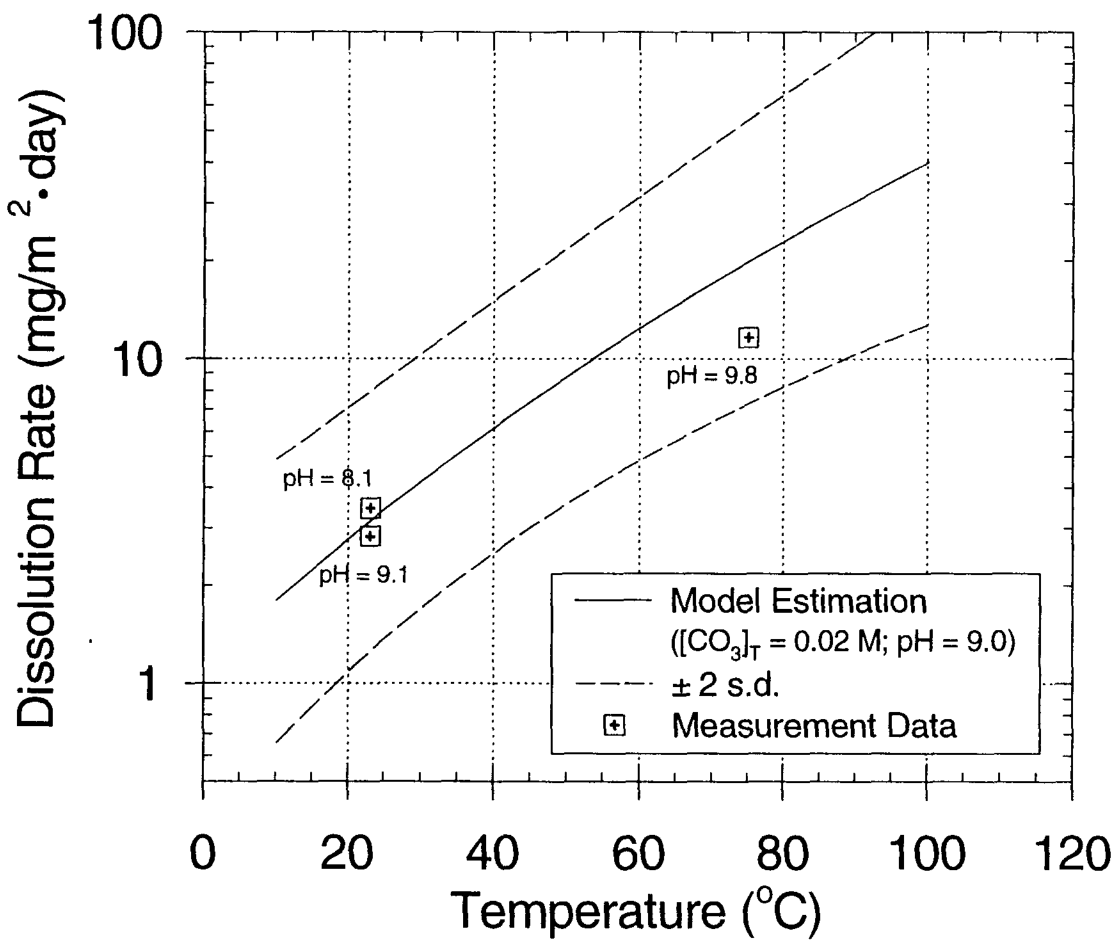
Engineered Barrier System Processes



Waste Form Alteration/ Radionuclide Mobilization

- Spent fuel waste form dissolution rate based on data from Steward and Gray (1994)
  - f (T, [CO3], pH)
- HLW glass waste form dissolution rate based on data from Bourcier (1993)
  - f (T, pH)
- Radionuclide solubilities same as TSPA-1993 (Andrews et al., 1994)
- Diffusion coefficient from Conca Diffusion Curve

Spent Fuel Dissolution Rate



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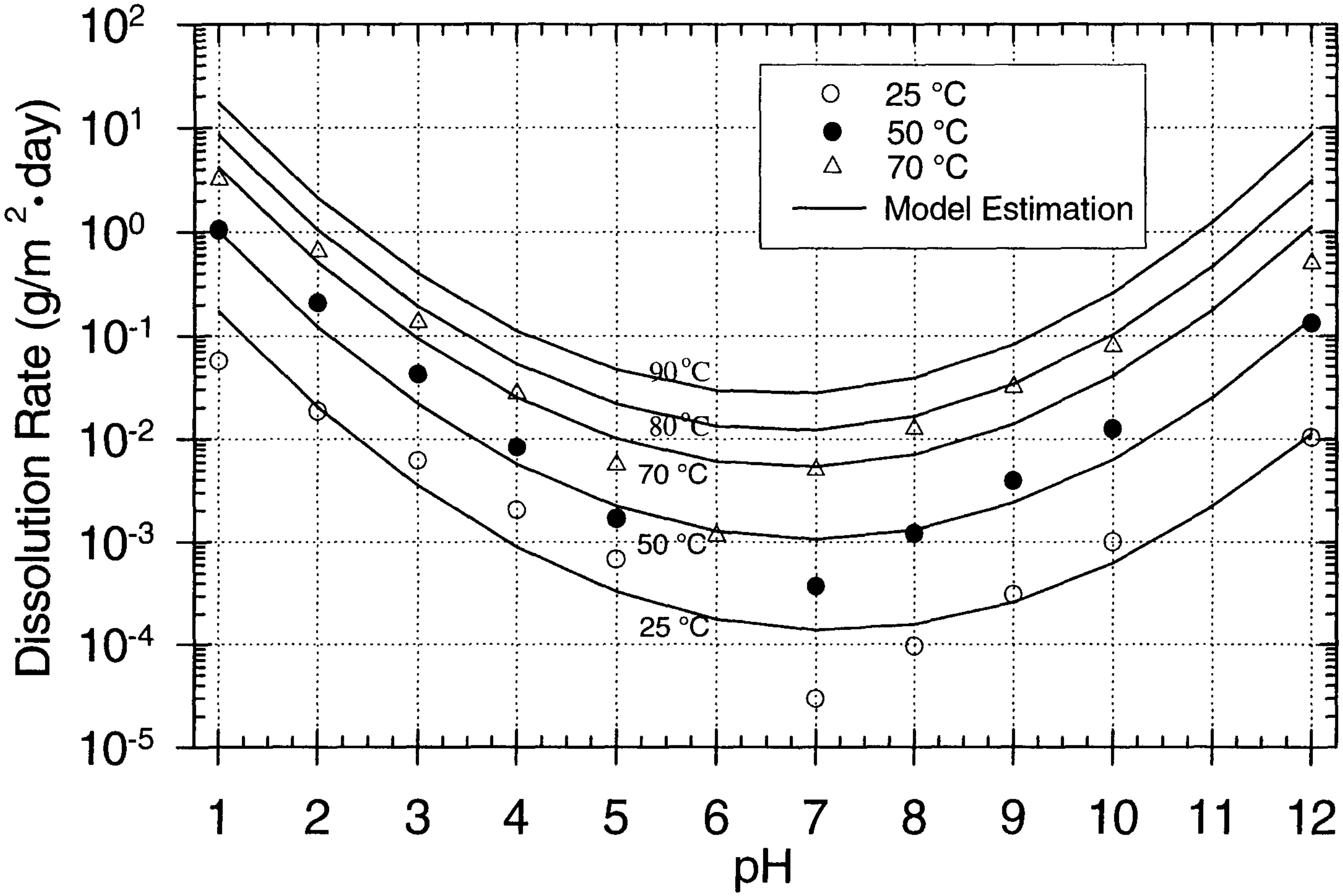
HLW Glass Dissolution Rate



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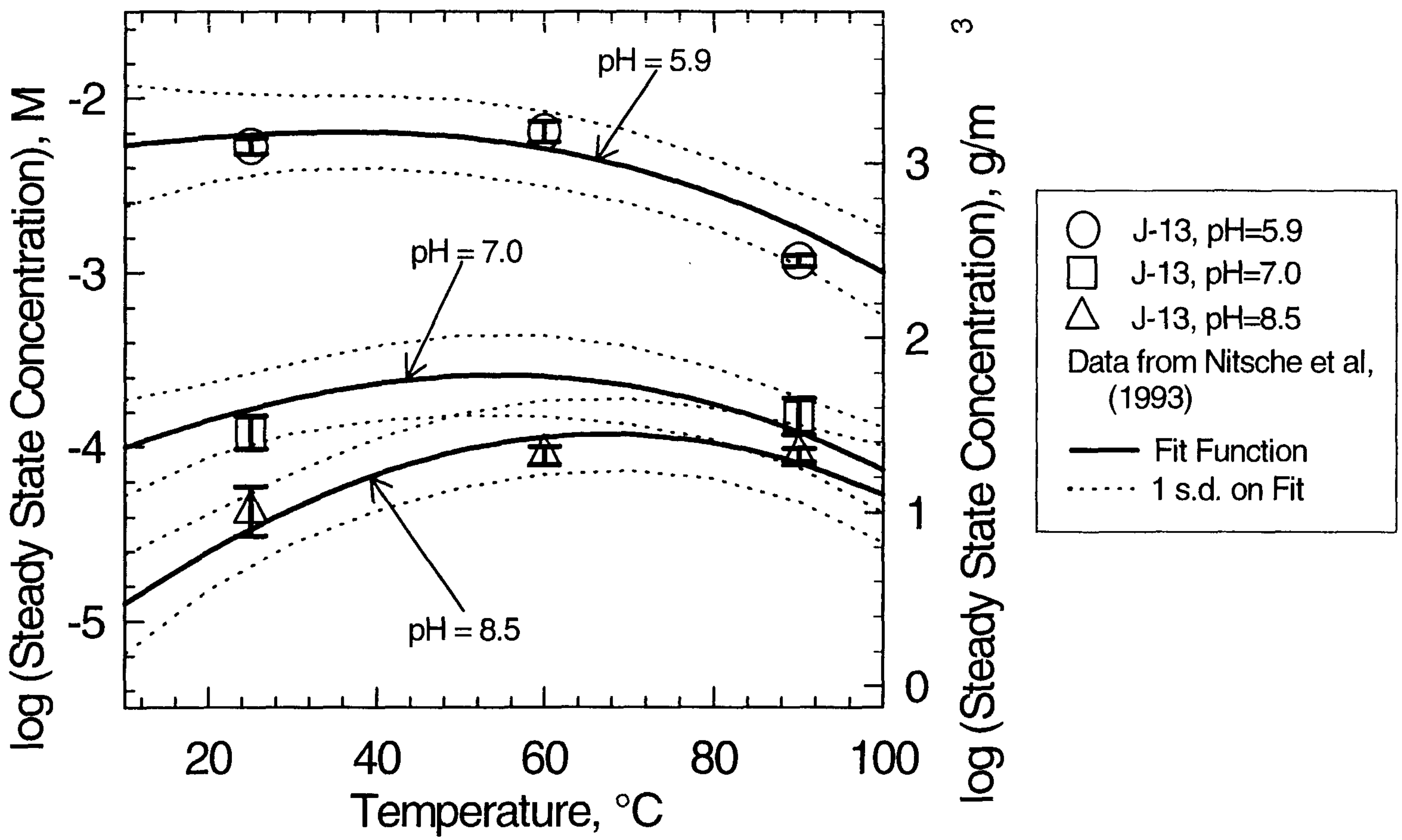
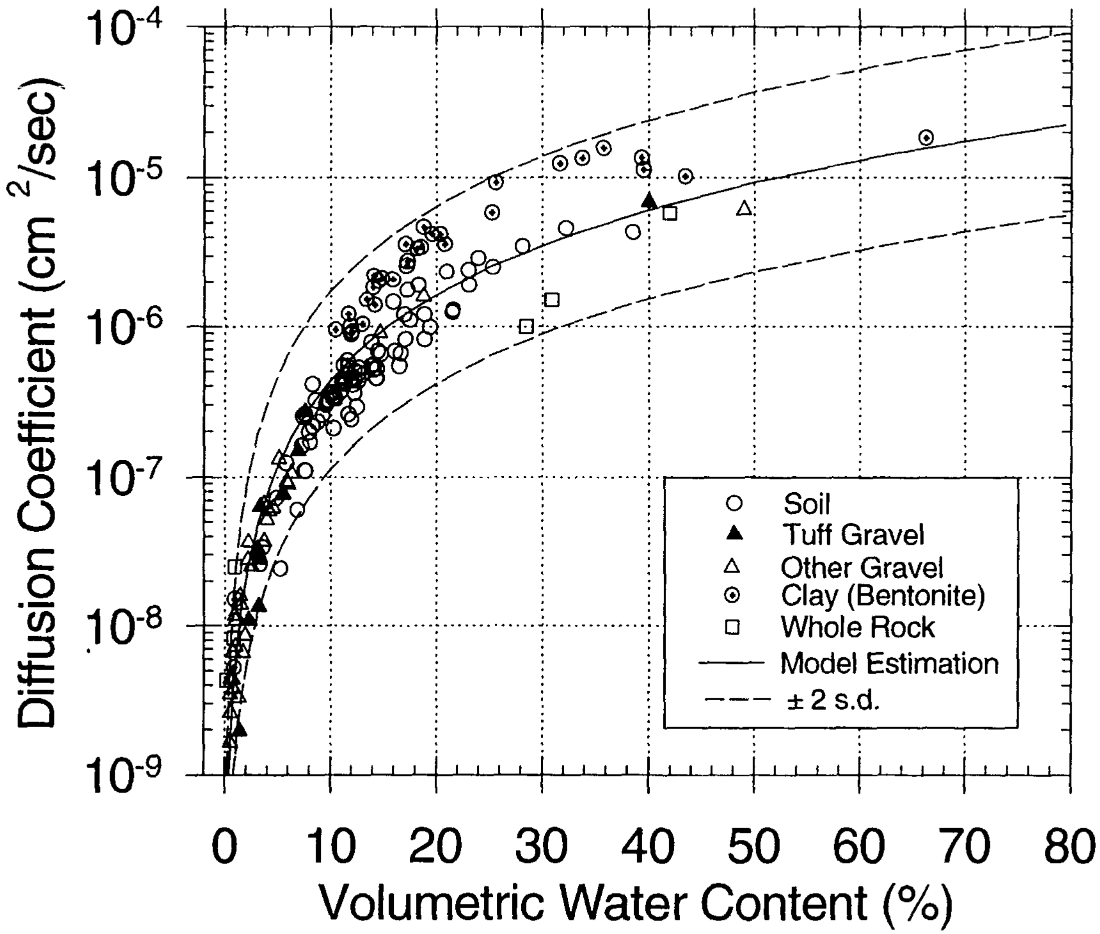
Neptunium Solubility



Diffusion Coefficient (after Conca, 1990)



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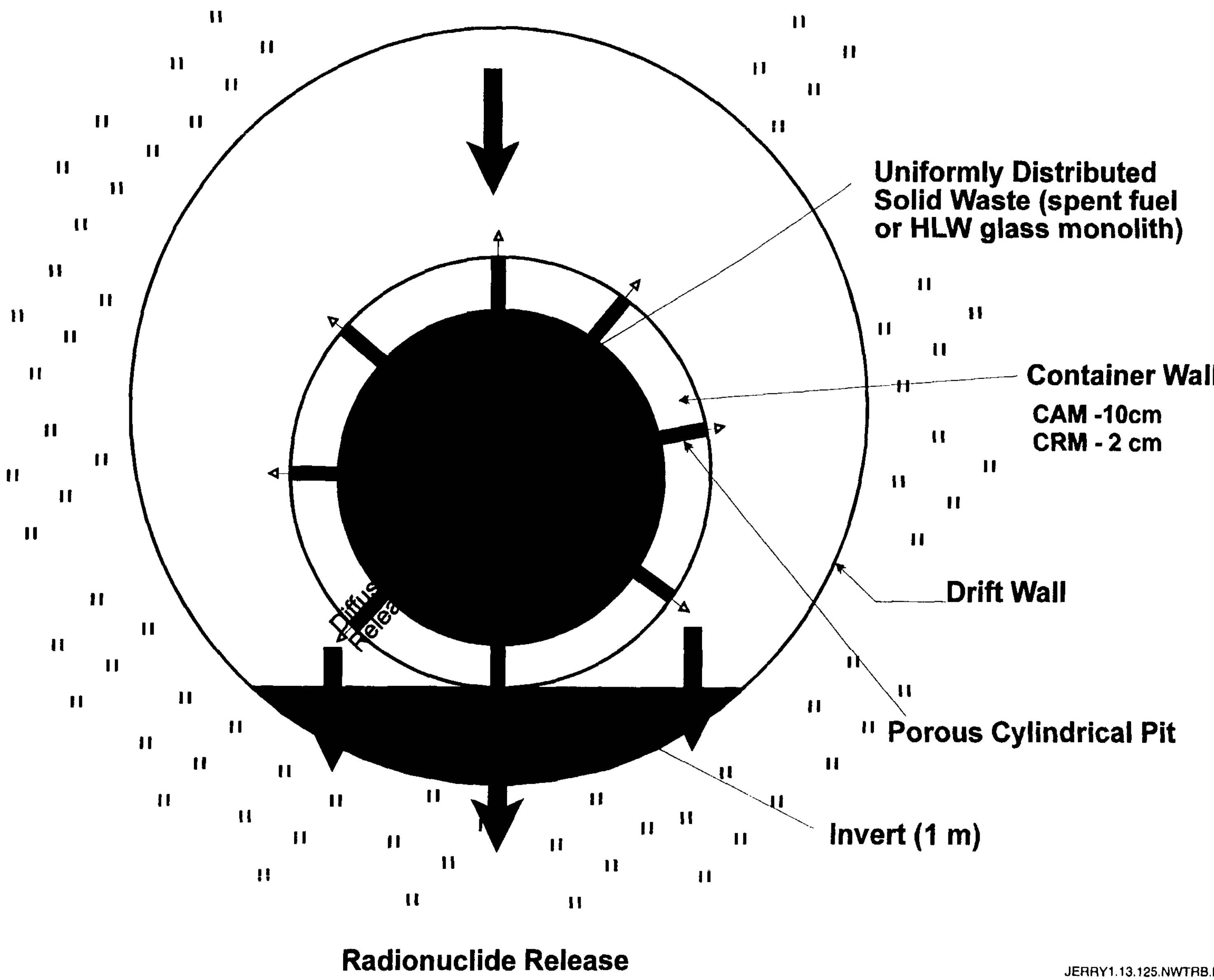
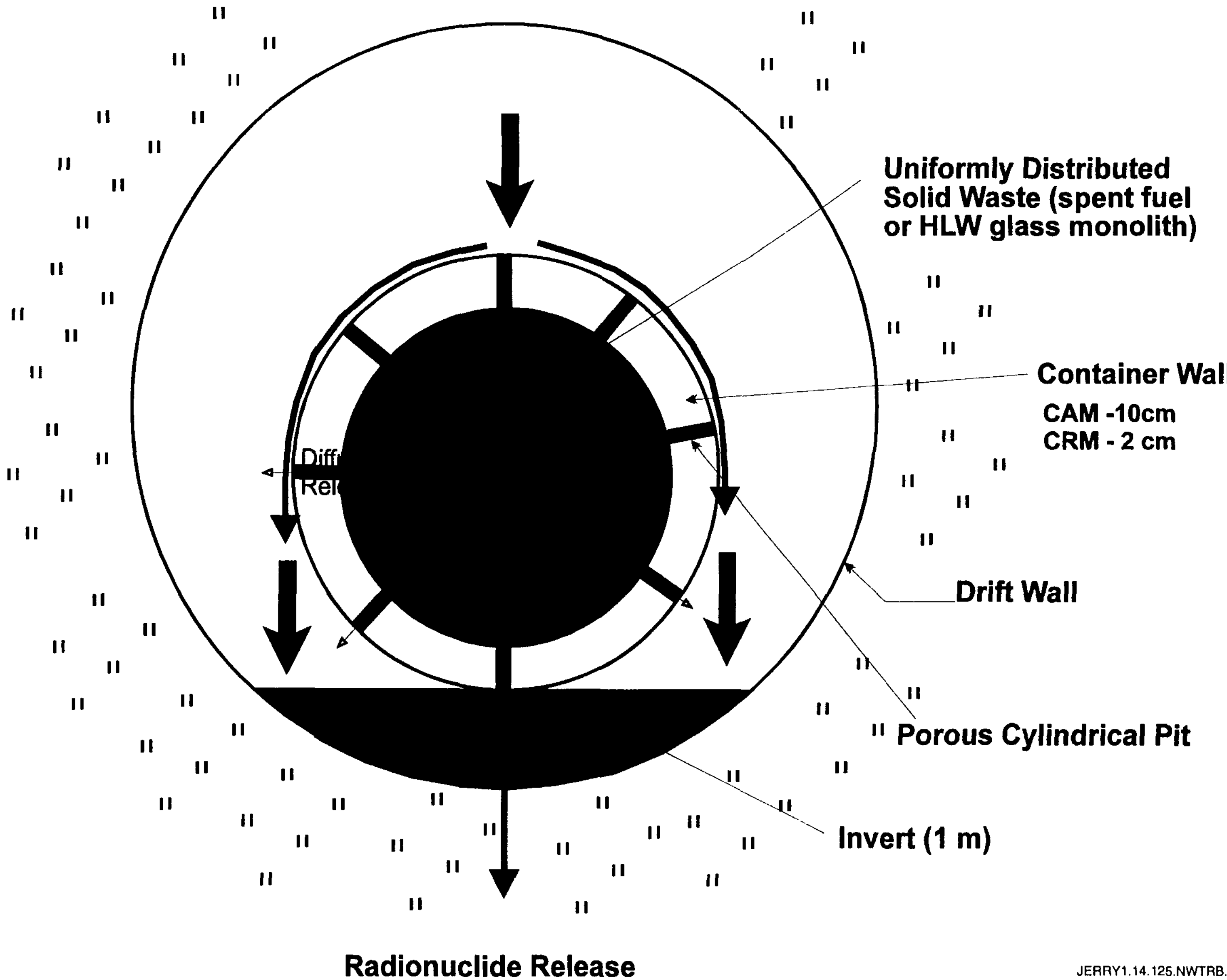
EBS Release Models

- Diffusive <u>and</u> advective release from waste container <u>and</u> EBS
  - Advective release only active if dripping fractures
- Diffusive release through waste container, then advective <u>and</u> diffusive release through EBS
- Diffusive release only
  - Capillary barrier effect does not allow advective release through waste container or EBS

Model for Diffusive and Advective Release from Waste Container and EBS



Model for Diffusive Release from Waste Container and Diffusive/Advective Release from EBS



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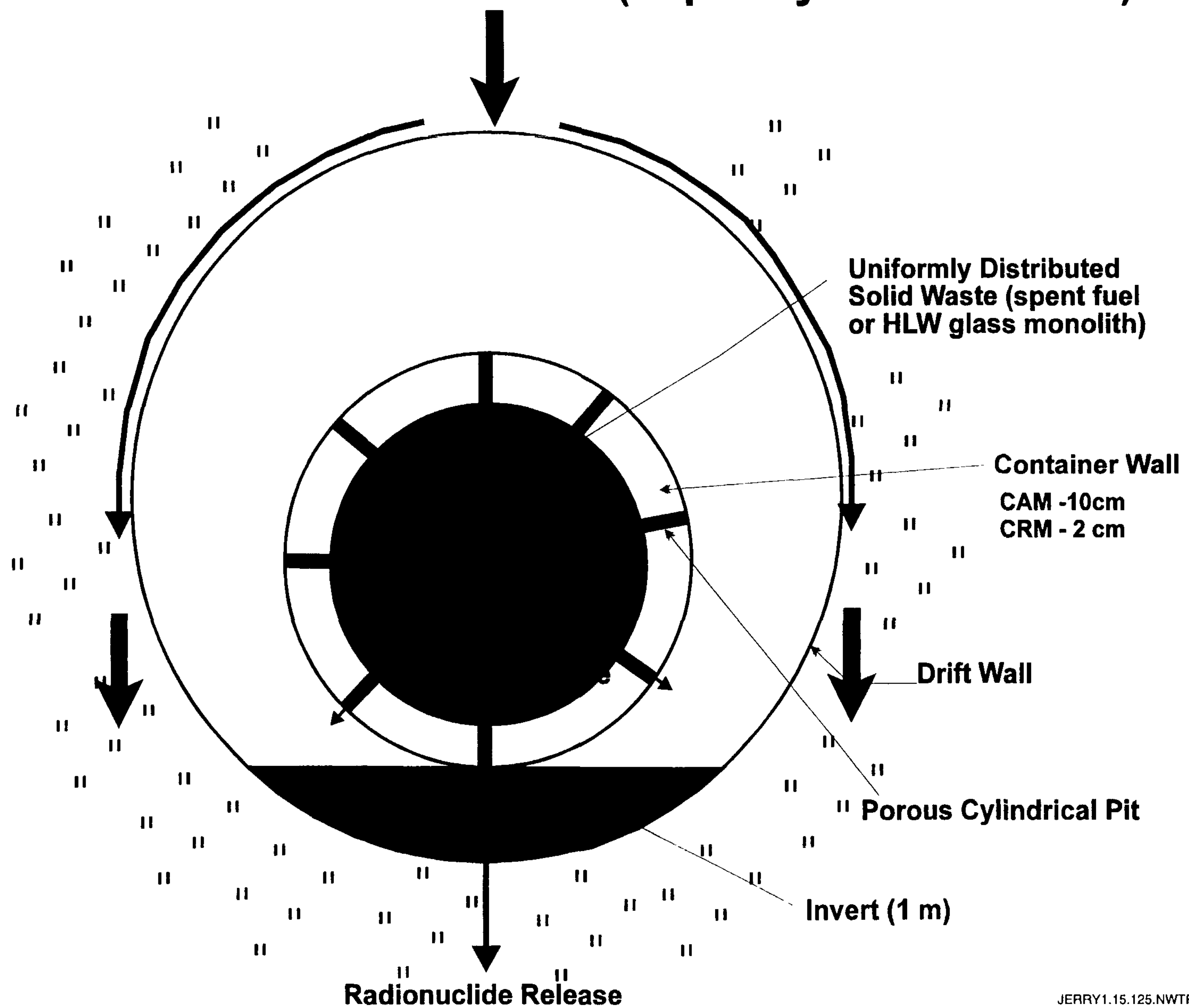
Model for Only Diffusive Release from Waste Container and EBS (capillary barrier effect)



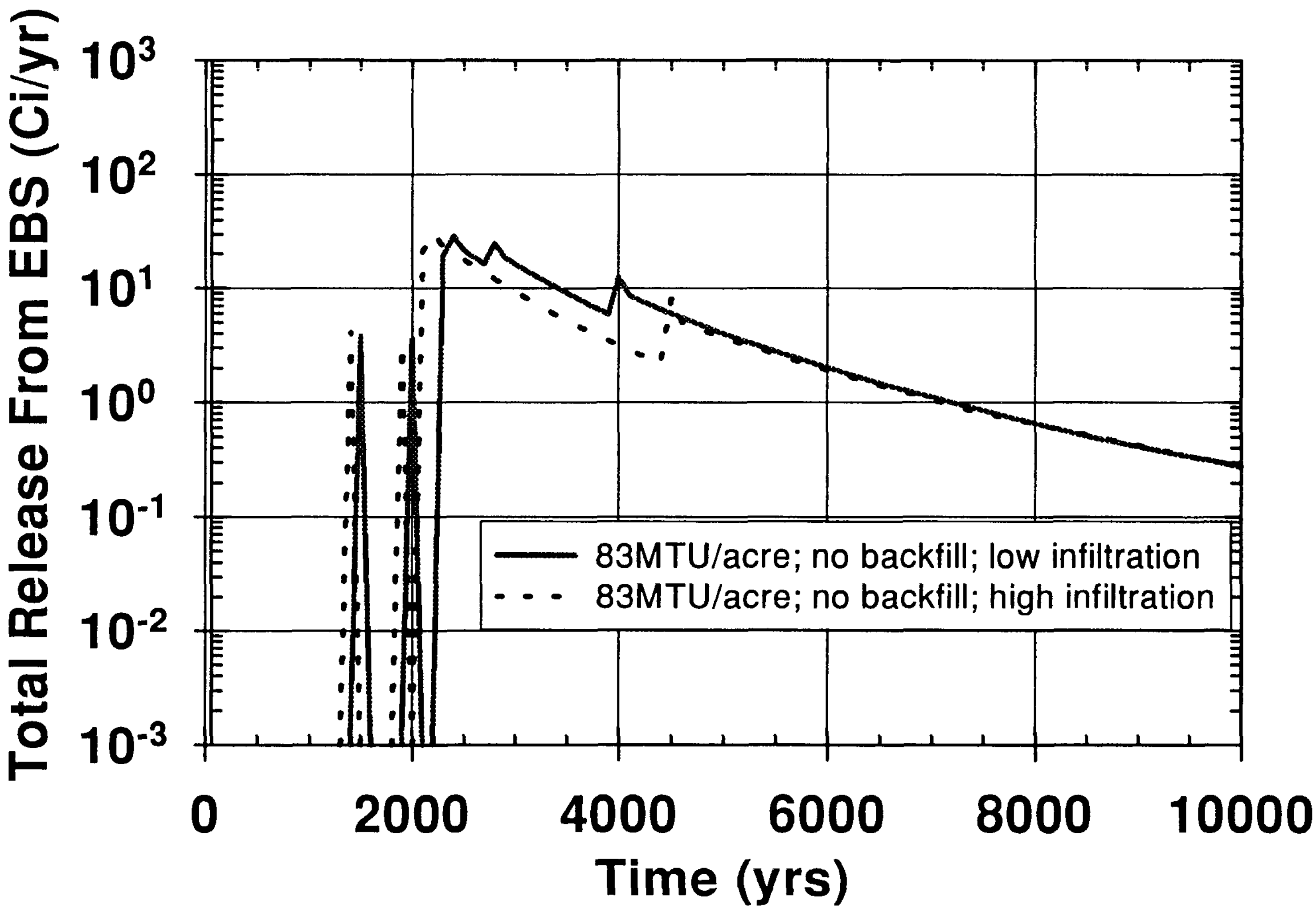
Approach to EBS Release Sensitivity Analyses

- Evaluate EBS release of various spent fuel radionuclides (^{14}C, ^{237}Np, and ^{99}Tc)
- Evaluate sensitivity of peak EBS release rate to alternate conceptual models
  - Infiltration
  - Thermal load
  - Cladding
  - Cathodic protection
  - EBS release models
  - Thermal-hydrologic models

NRC Peak Release Rate Limit

- Peak release rate from EBS following the containment period shall be less than one part in 100,000 per year of the 1,000-year inventory
- Provides basis for looking at Peak Release Rate from EBS

Predicted EBS ^{14}C Release Rate History: Sensitivity to Infiltration



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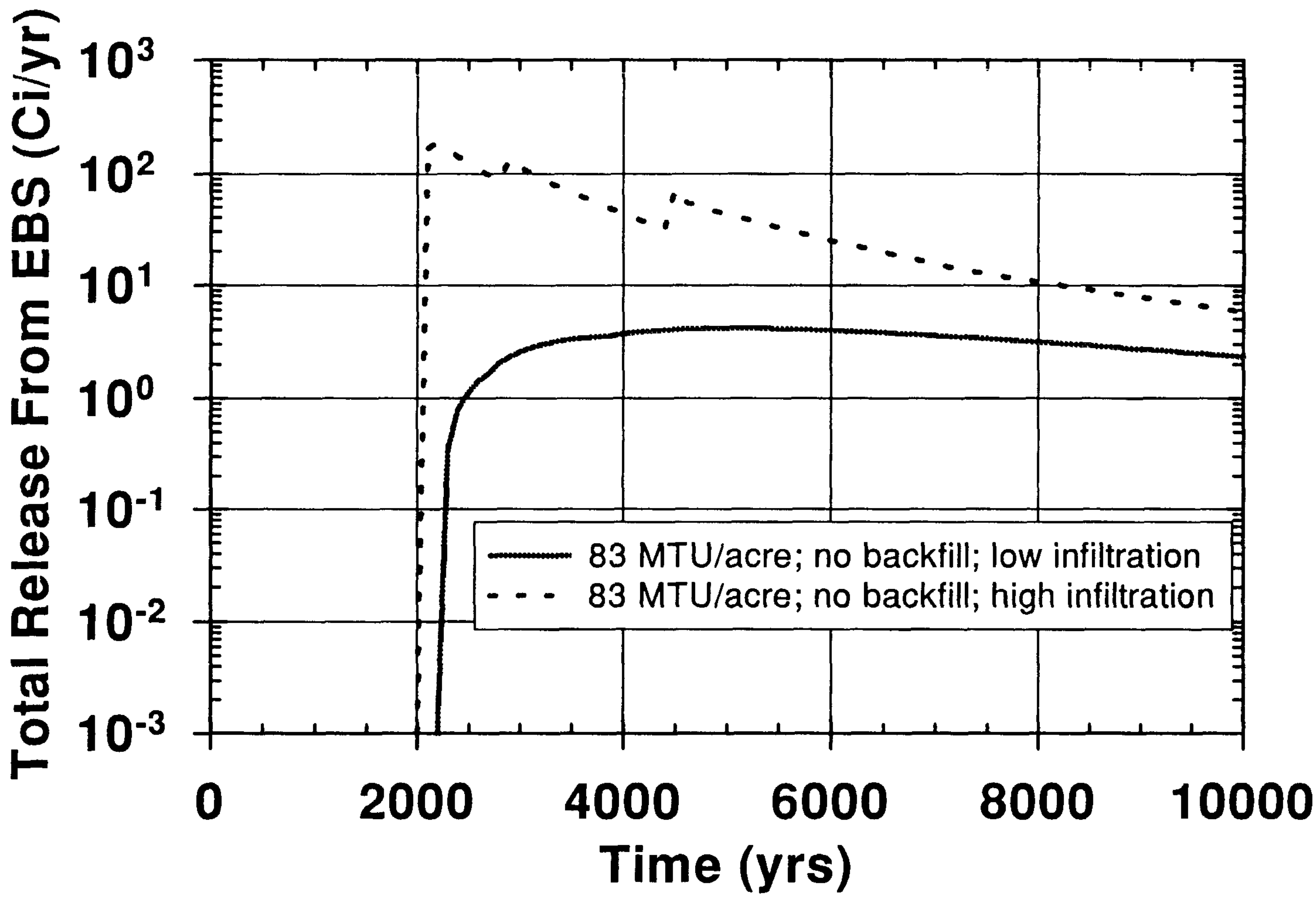
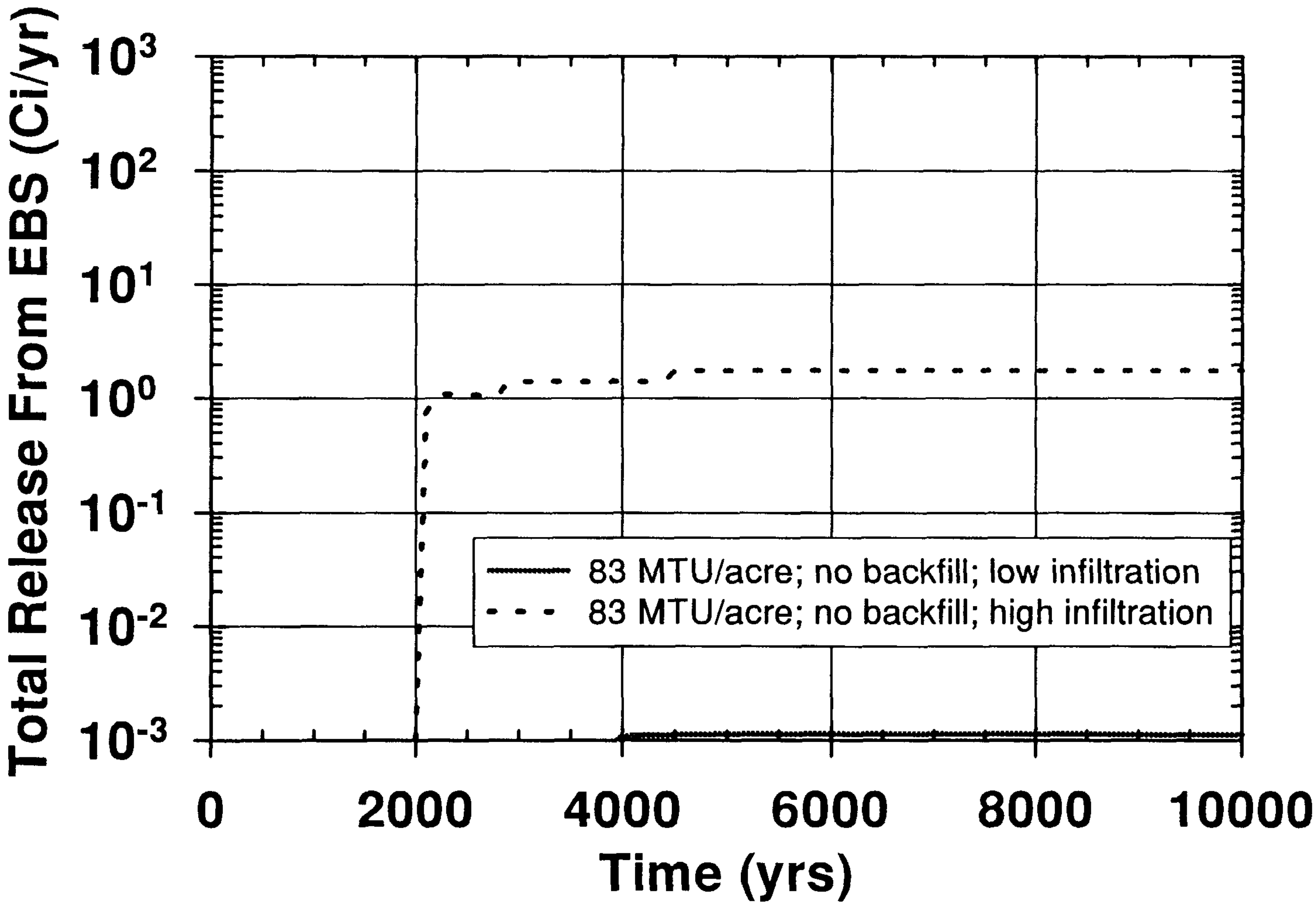
Predicted EBS ^{99}Tc Release Rate History: Sensitivity to Infiltration



Predicted EBS ^{237}Np Release Rate History: Sensitivity to Infiltration



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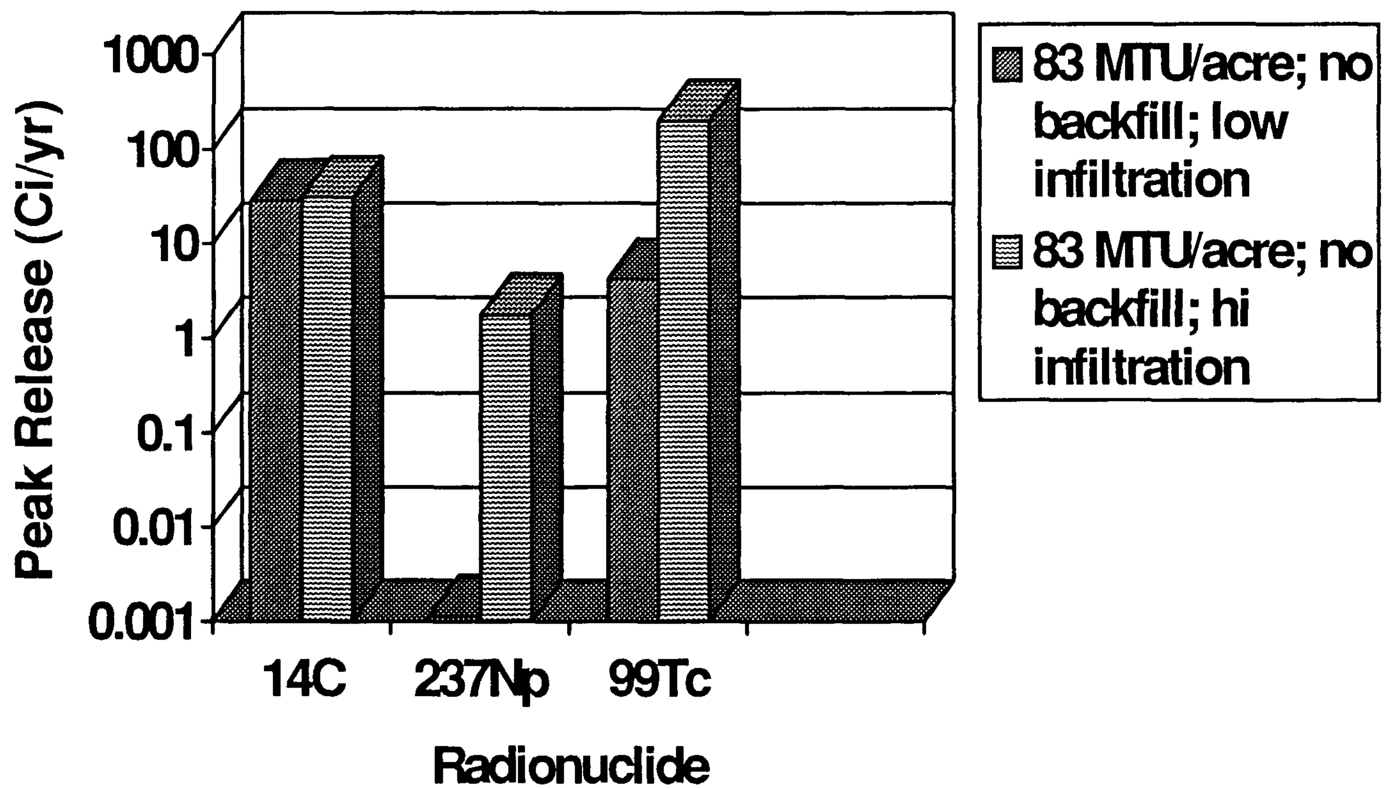
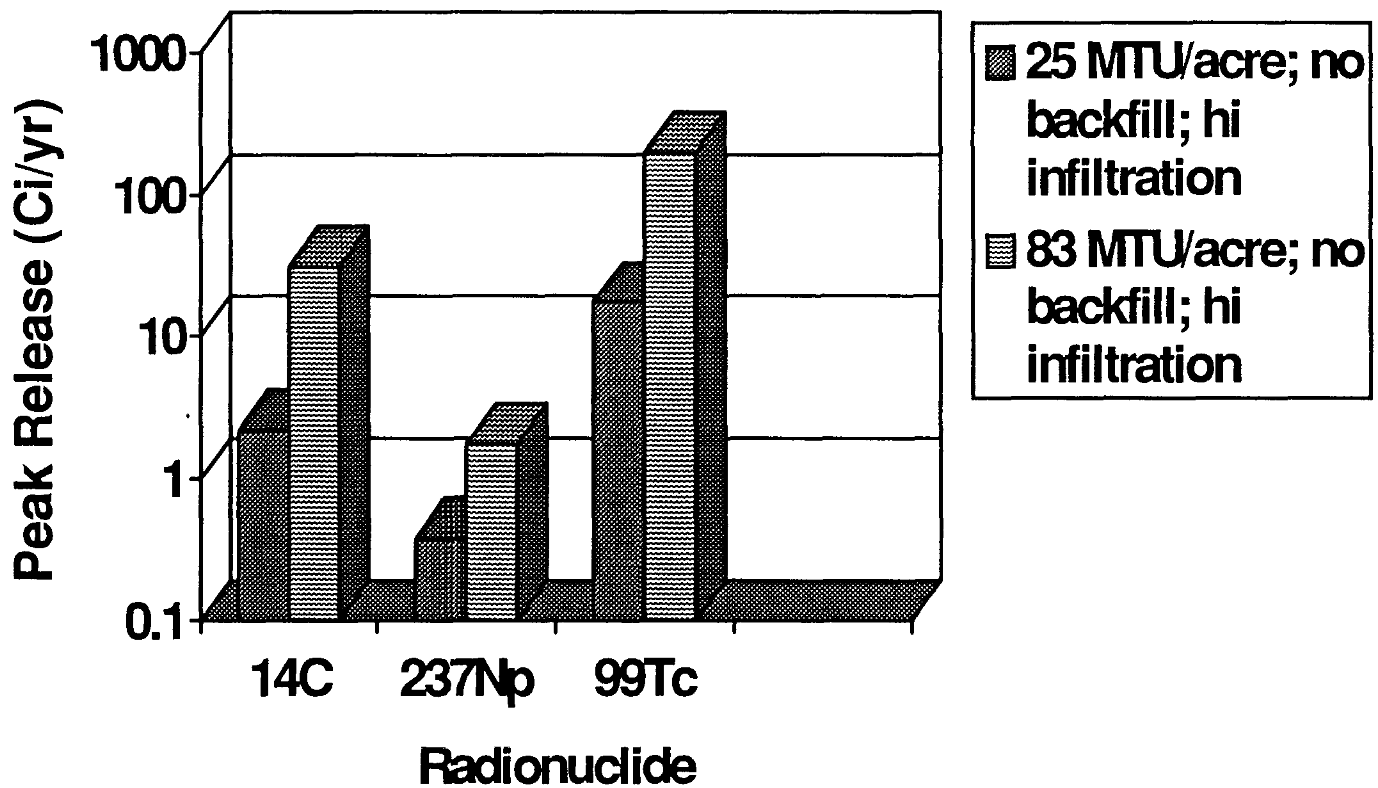
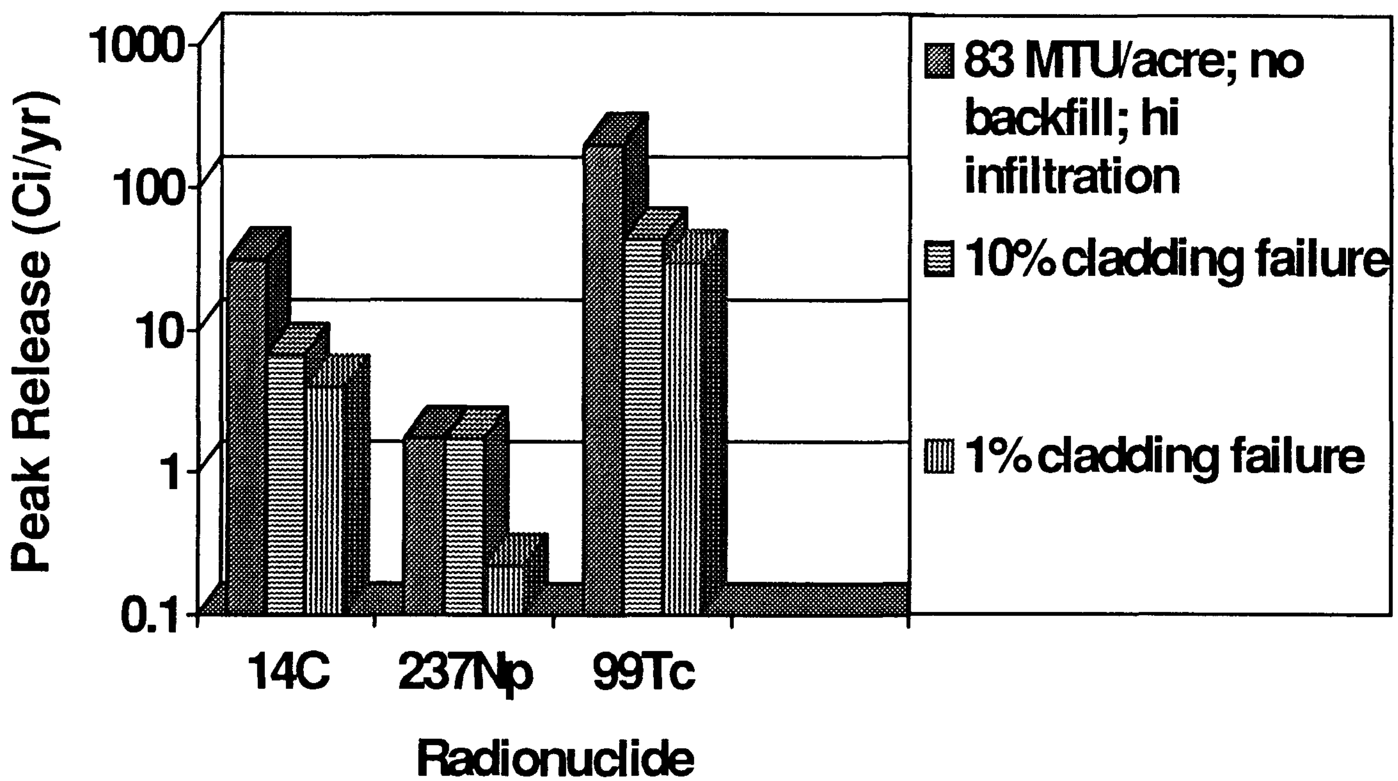
Sensitivity of Predicted EBS Peak Release Rate to Infiltration



Sensitivity of Predicted EBS Peak Release Rate to Thermal Load



Sensitivity of Predicted EBS Peak Release Rate to Cladding Failure



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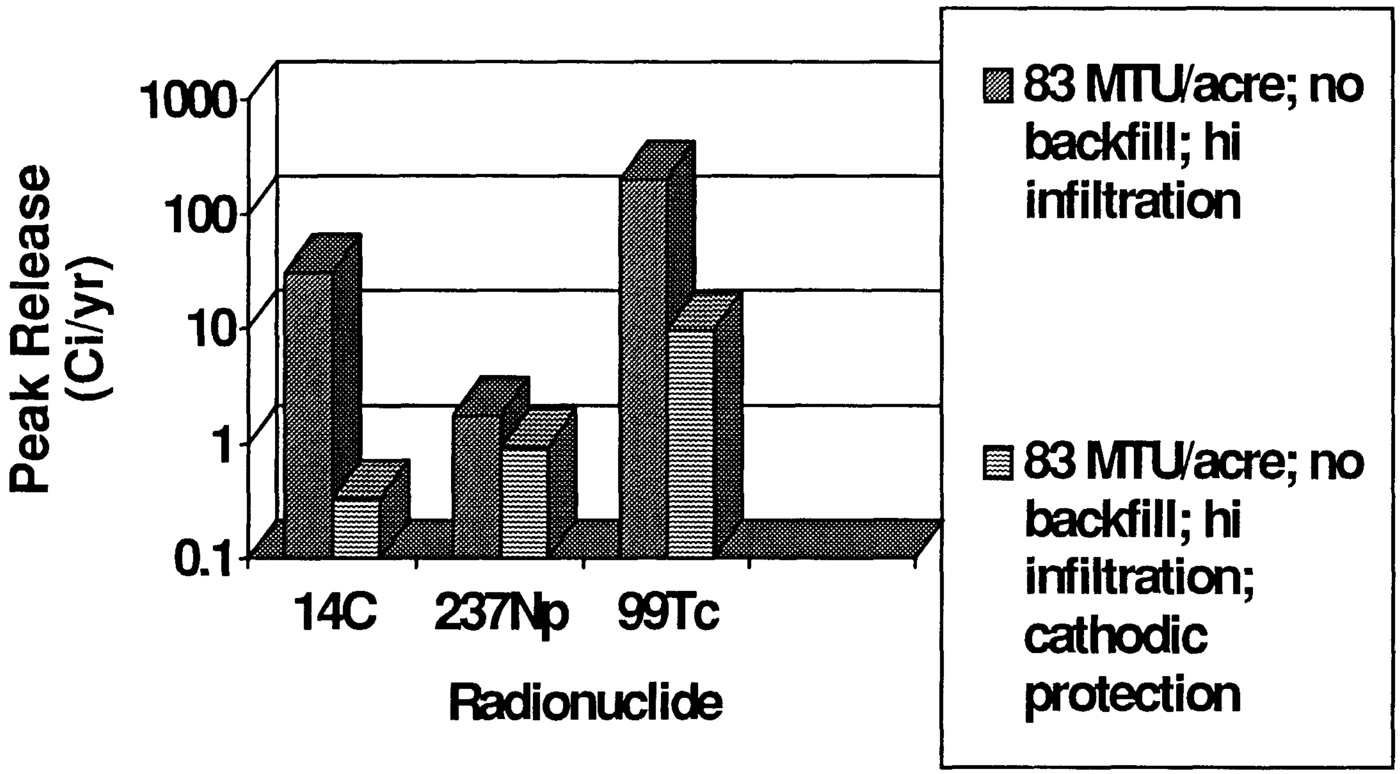
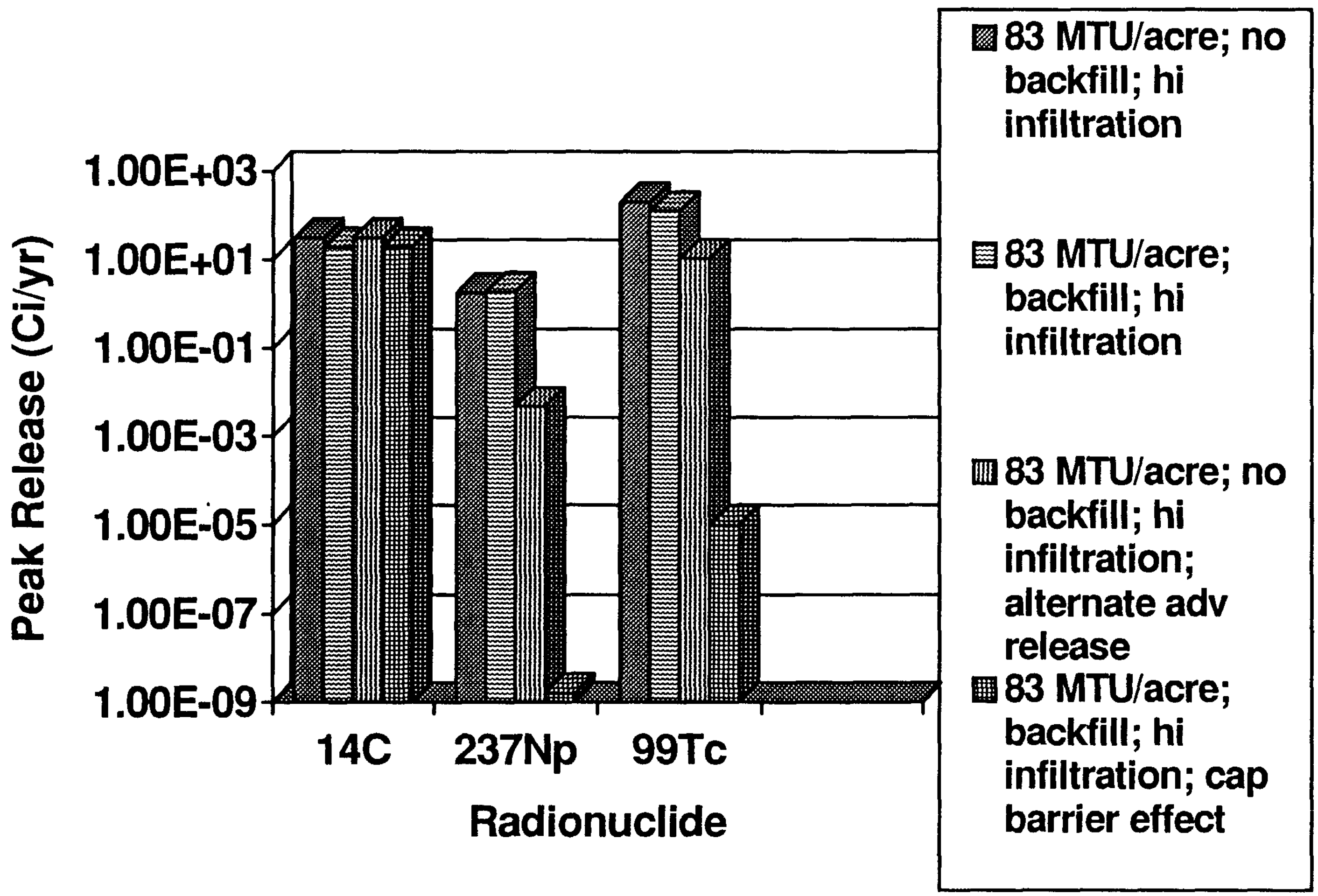
Predicted EBS Peak Release Rate: Cathodic Protection Effect

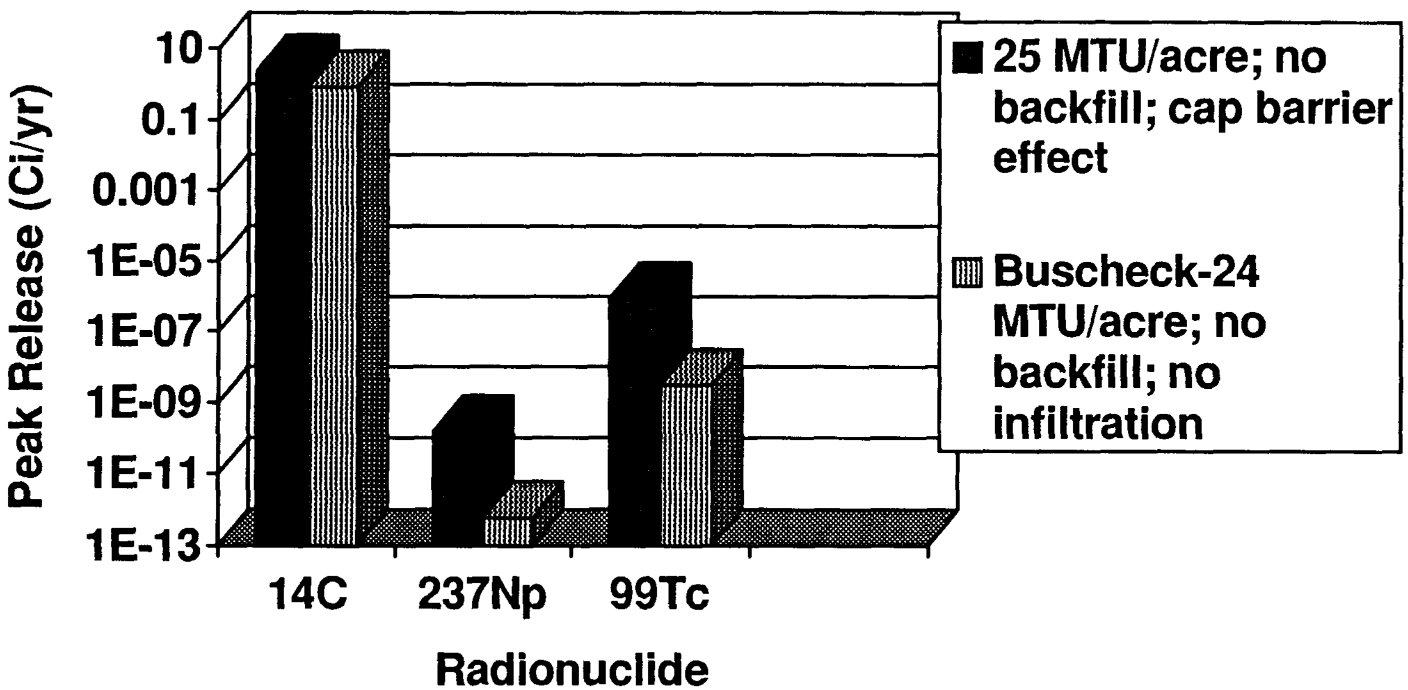


Note: Time of cathodic protection case peak release is greater than 16,000 years.

Predicted EBS Peak Release Rate: EBS Release Model Comparison



Predicted EBS Peak Release Rate: Alternate Thermal-hydrologic Model Comparison



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Conclusions

- Capillary barrier effect produces very large decrease in EBS peak release
- Diffusive release from waste container and diffusive/advective release from EBS produces a large decrease in EBS release due to diffusive release delay
- Alternate thermal-hydrologic model (Buscheck) produces a large decrease in EBS release due to low humidities and liquid saturations
- Advective release component is very important in determining total release