8/02

MELCOR Modeling of Nuclear Power Plant Spent Fuel Pool Accidents

K.C. Wagner
K. W. Ross
R.O. Gauntt

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Ex 2 & Ex 5, portions

Ex 2 entirety

Phebus FPT-1 Release

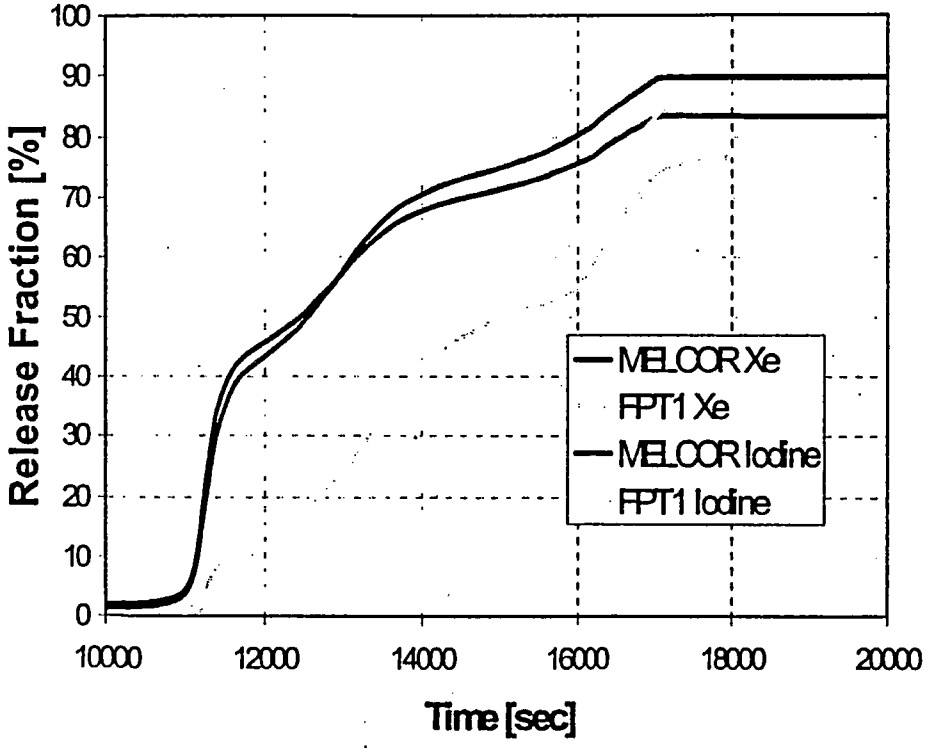

Figure 11. Release of radionuclides

- CORSOR-M gets correct total release, but
- Predicts too-high release rate at low temperature
- We are examining different Booth coefficients recommended by ORNL
  - ORNL Booth
  - Lower early release rate
  - Higher total releases

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Outline

- **SFP Background**
  - Background
  - Geometry
  - Plant Specific Inputs
- **MELCOR Modeling Approach**
  - Separate Effects Model
  - Whole SFP + Building Model
- **Separate Effects Model Results**
  - Complete Loss-of-Water Inventory
  - Partial Loss-of-Water Inventory
- **Modeling Issues/Uncertainties**

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SFP Analysis Background

- Fundamental Scoping Analyses Required
  - Understand Severe Accident Behavior
  - Most Relevant Codes Analyzed Potential for Zirconium Fire
    - Historical Tools Criticized for Modeling Limitations
      - High Burn-up
      - No Mixing
    - NRC, Vendors, and Utilities Recently Applied Computational Fluid Dynamics (CFD) to Analyses
  - Desire to Understand Accident Progression Beyond Onset of Zirconium Fire
    - Apply MELCOR and Other Engineering Codes

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SFP Geometry/Inputs

- **Geometry of Racks Dictated By**
  - **NPP Type (Pitch for BWR or PWR)**
  - **Burn-up (Low or Unirradiated Fuel Have Special Criticality Requirements)**

Representative Plant	NSSS Vendor	Plant Type	Assembly Size
Zion	Westinghouse 4 loop	PWR	15 x 15
Surry	Westinghouse 3 loop		15 x 15
Fort Calhoun	Combustion Engineering 2 x 4		14 x 14
Calvert Cliffs	Combustion Engineering 2 x 4		14 x 14
TMI	Babcock and Wilcox		15 x 15
CE System 80 (CESSAR)	Combustion Engineering		16 x 16
Westinghouse (Generic SAR)	Westinghouse		17 x 17
Millstone	GE	BWR	7 x 7
	GE		8 x 8
	GE		Canister Width

Ex #2 *

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SFP Geometry/Inputs

- Scoping Study Data Obtained from Utility Submittal for Conversion to High Density Racking
  - Complete Holtec Licensing Analysis
  - Detailed Geometry

[redacted] Ex 5

[redacted] Ex. 2

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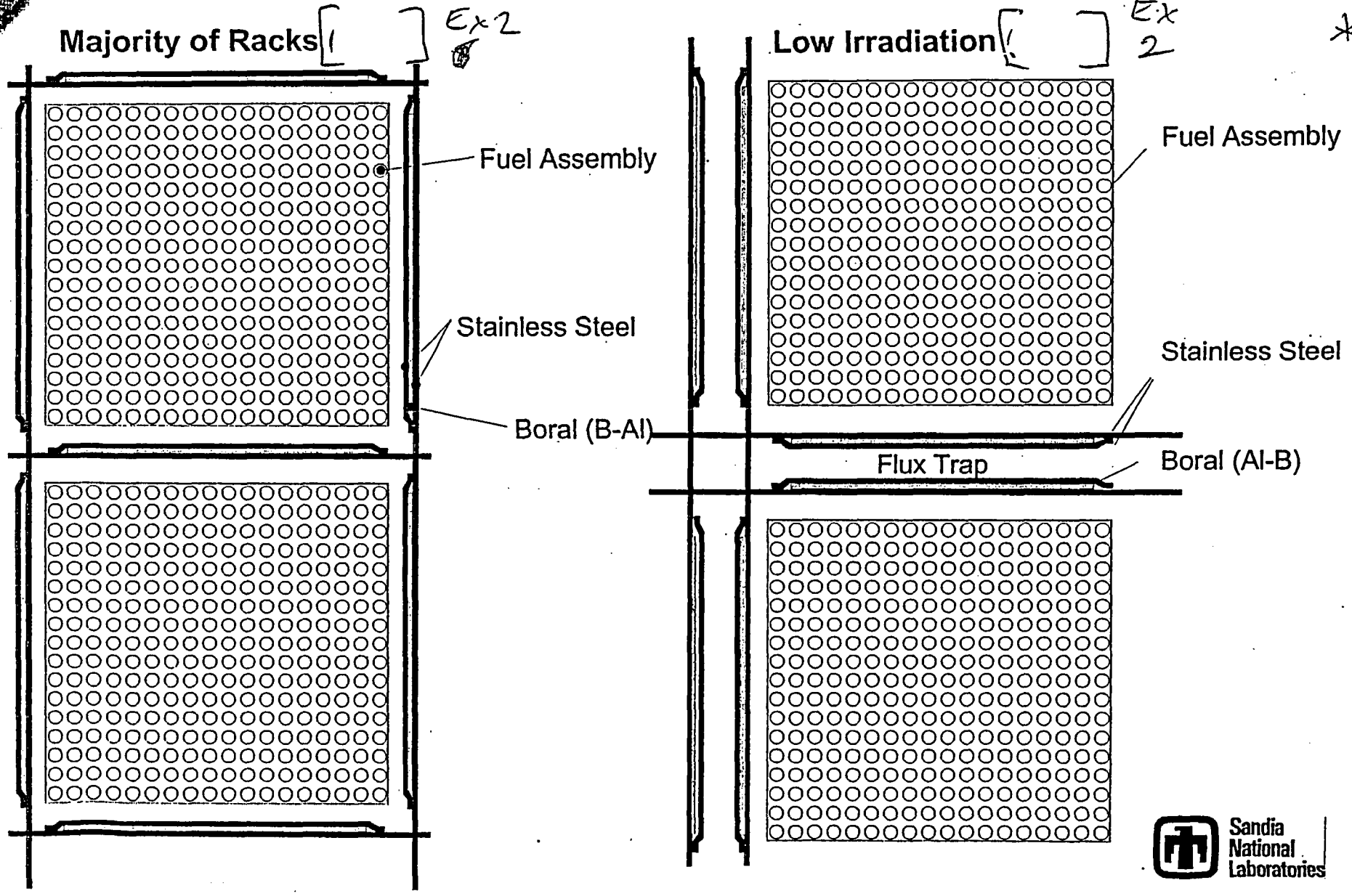
Geometry of Fuel Racks



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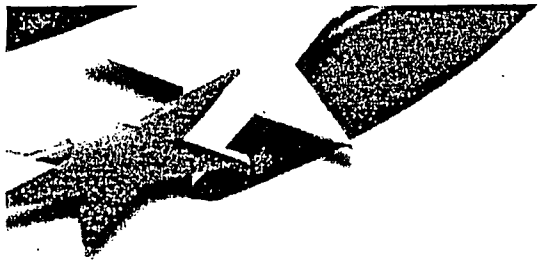
Assembly Decay Heat



Ex 5

Days since shutdown [days]

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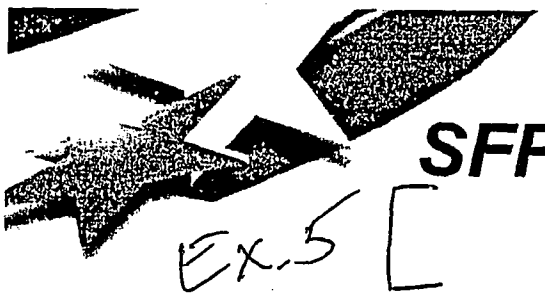

SFP Vulnerability Factors That Are Understood from NPP Research

Ex.5 [redacted]

- Fuel Rod Heatup and Failure Dynamics
  - Convection, Conduction, Radiation
  - Steam Oxidation
  - Fuel Melting and Relocation
  - Assembly Decay Heat
- Building Response
  - Ventilation, Natural Circulation Heat Transfer
  - Fission Product Transport, Deposition

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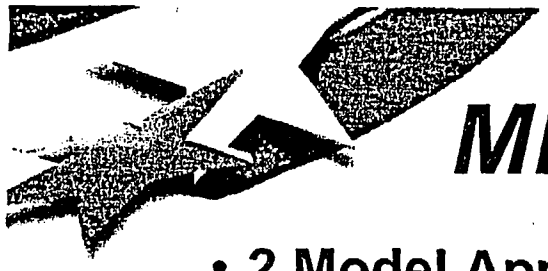

MELCOR Modeling Approach

- **2 Model Approach - Separate Effects and Whole Pool/Building Models**
  - Subdivided into 2 Types of Scenarios
    - **Complete Loss-of-Inventor**
    - **Partial Loss-of Inventory**
- **Separate Effects Model**
  - **Developed First to Guide Full SFP Model Development**
  - **Fast Running**
  - **Many Settings in MELCOR are Not Straightforward**
    - **Use Separate Effects Model to Develop Appropriate Modeling Approach**
    - **Identify Sensitivities and Uncertainties**
    - **Recommend Code Development**
- **Full SFP + Building Model**
  - **Integral Effects**
  - **Whole SFP Source Term**

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