EPRI HIGH-LEVEL WASTE PERFORMANCE ASSESSMENT EFFORT

Presentation to

Nuclear Waste Technical Review Board
Vienna, Virginia

by

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GENERAL OBJECTIVES

1. Explore procedural methodology for:

   - Identifying alternative descriptions of site characteristics

   - Identifying alternative scenarios on future occurrences

   - Assessing probabilities representing randomness and uncertainty of these descriptions and scenarios

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GENERAL OBJECTIVES (cont.)

2. Explore calculational method for:

   - Considering how a repository works: the integrated effects of descriptions and scenarios

   - Estimating site performance (release and dose) using integrated effects

   - Calculating site performance for range of descriptions, scenarios, and their probabilities

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GENERAL OBJECTIVES (cont.)

3. Demonstrate:

   - How interaction among different disciplines can be used to build an integrated model
   - How information in diverse disciplines contributes to an integrated model
   - How an integrated model documents interpretations and credibilities, for review and discussion

4. Investigate:

   - Site suitability
   - Sensitivity to input assumptions
   - Issues of priorities in refining interpretations

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SPECIFIC OBJECTIVES

1. Develop a mutual understanding of the relationships among technical issues, as they affect Yucca Mountain site performance.

2. Based on #1, develop a mathematical model that quantifies site performance (including quantifying the risk of not being able to demonstrate that the site meets safety criteria), incorporating current uncertainties in earth science and engineering models, parameters, and data.

SPECIFIC OBJECTIVES (cont.)

3. Exercise the model with reasonable probability estimates, to investigate how the model can be used to:

   (a) Make a current estimate of the likelihood of demonstrating site suitability (with today's knowledge).

   (b) Put priorities on site investigations (to reduce current uncertainties).

   (c) Evaluate to what extent future data collection and modeling will reduce current uncertainties.

4. Document the model and example application.

PROCEDURE FOR DEVELOPING METHOD

1. Identify experts/teams in each discipline; identify expert/team in risk analysis.

2. Hold workshops to:

   (a) Agree on the problem, project goals, project definitions, and a common format for specifying input.

   (b) Provide first sets of interpretations, identify and fix disconnects and loose ends, target areas for refined analyses.

   (c) Provide refined sets of interpretations, review results, make final interpretations.

3. Document input, methodology, and demonstration results.

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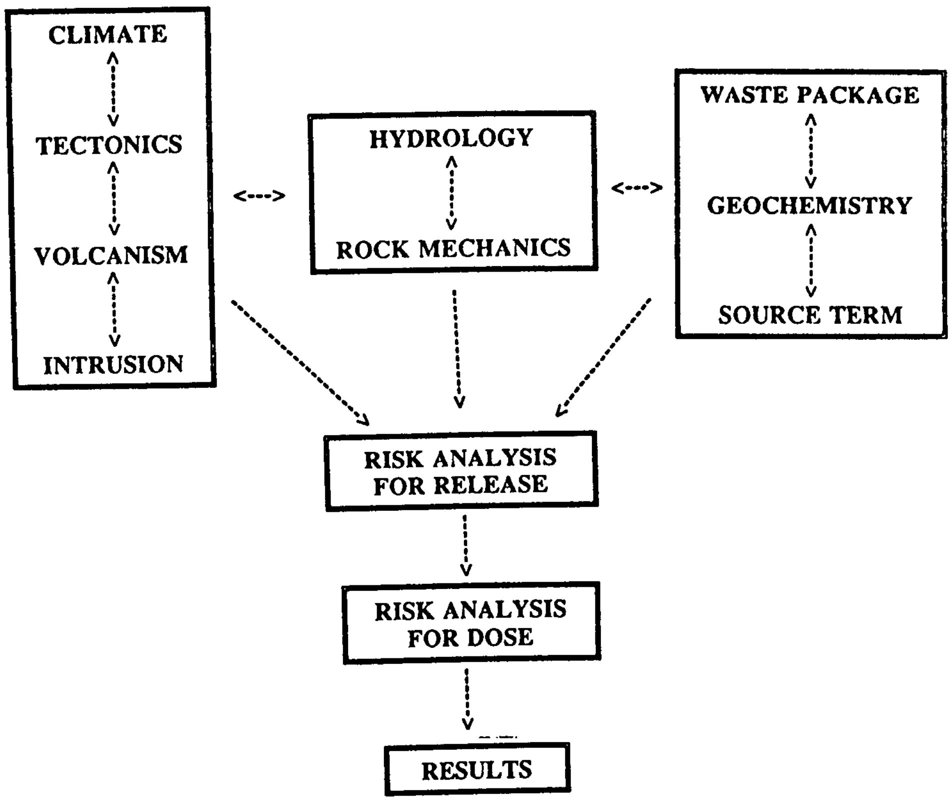
MAJOR DISCIPLINE INTERACTIONS



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<u>MODEL RESTRICTIONS</u>:

1. 1-D flow and transport model; multiple pathways considered.
2. Time-invariant calculations W.R.T.:
   - Elevation of water table
   - Saturated/unsaturated state of repository
3. Daughter products not considered.
4. Dispersion in nuclide transport not considered.

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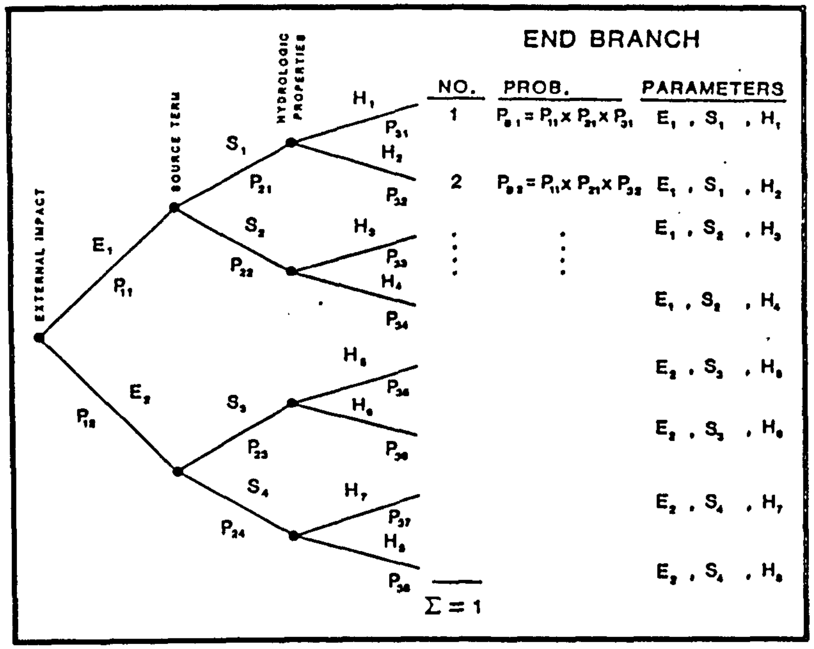


Example logic tree.

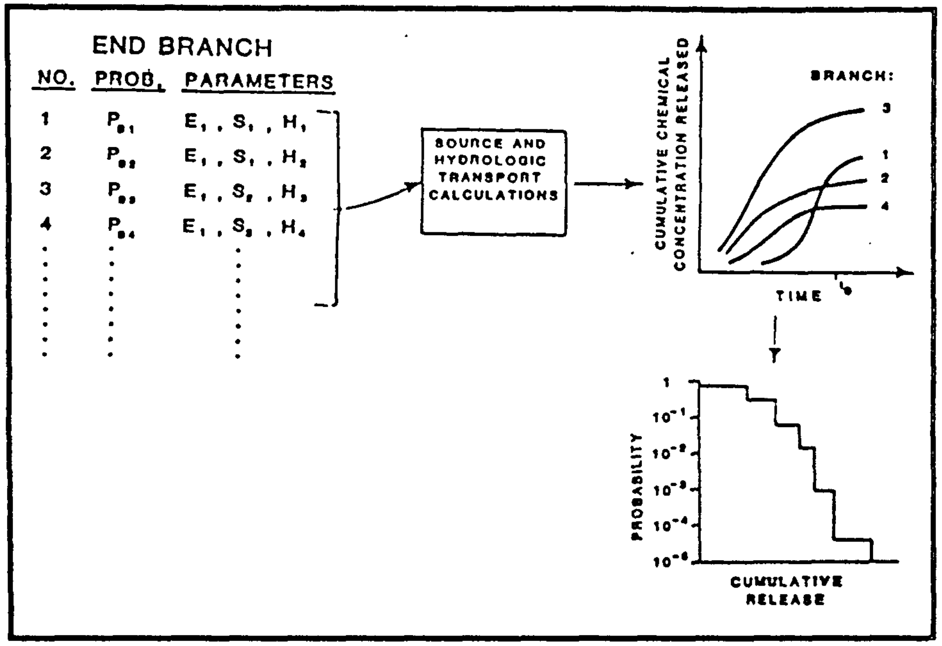
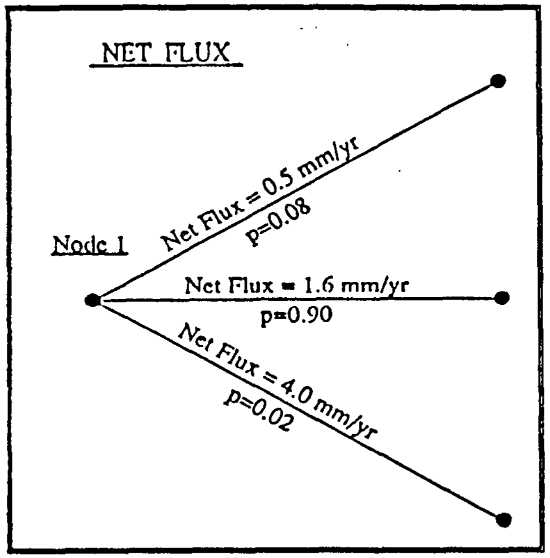


Illustration of use of logic tree parameters to form CCDF of cumulative chemical concentration released.



Elements of logic tree for climate effects.

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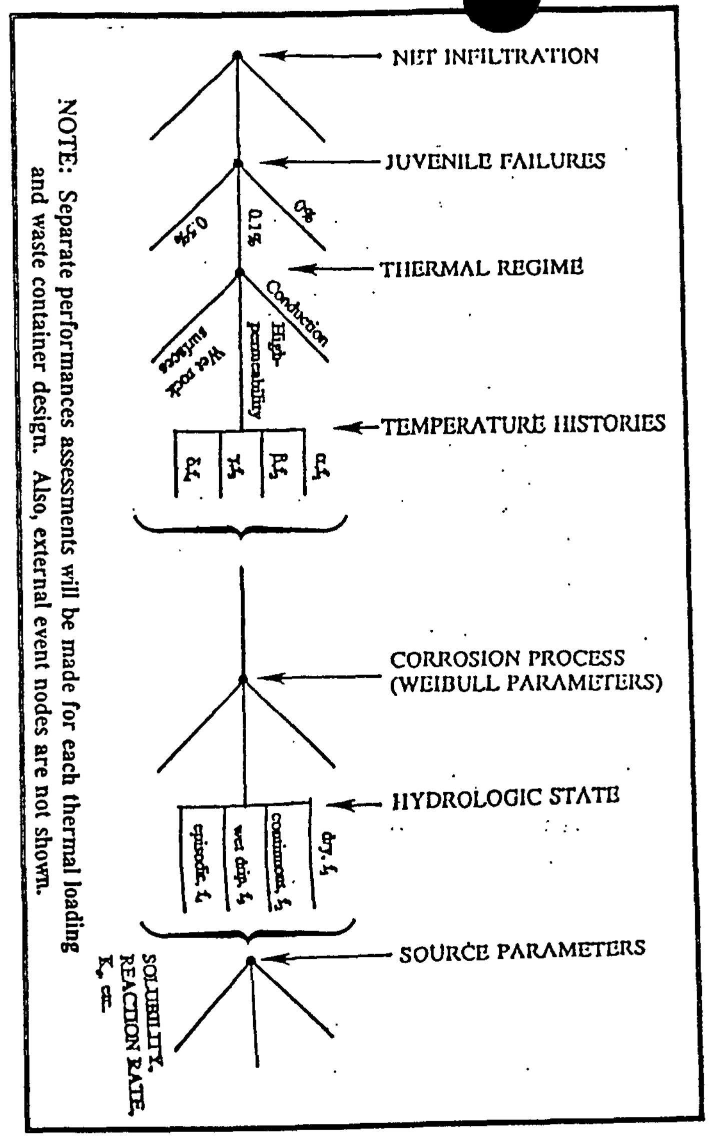

Logic tree showing interaction of source term and near source parameters.

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FEATURES OF THE 1993 IMARC CALCULATIONS

- Analysis extended to 100,000 years
- Release from the moist-continuous condition is interpolated from data generated by Intera's MIDAS source term model
- Episodic fracture flow included
- Three alternative heat loadings (APD = 114 kW/acre, 57 kW/acre, 36 kW/acre)
- Three thermal mechanisms (conduction, high permeability, water mobile in fractures)
- Sixteen flow pathways representing all combinations of:

  Four water contact modes (dry, moist-continuous, wet drip, episodic)

  Four temperature profiles (γ, β, ν, δ)

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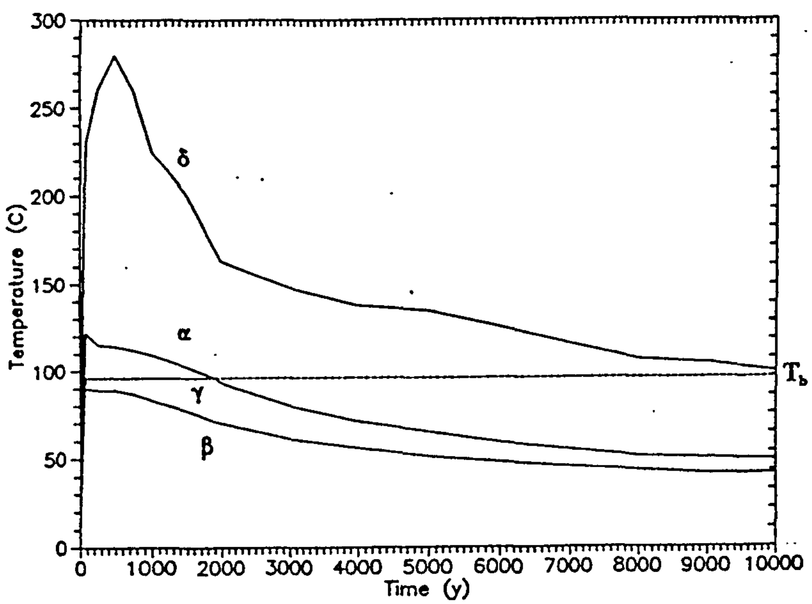
Four Temperature-Time Curves Used to Model Thermal Pulse



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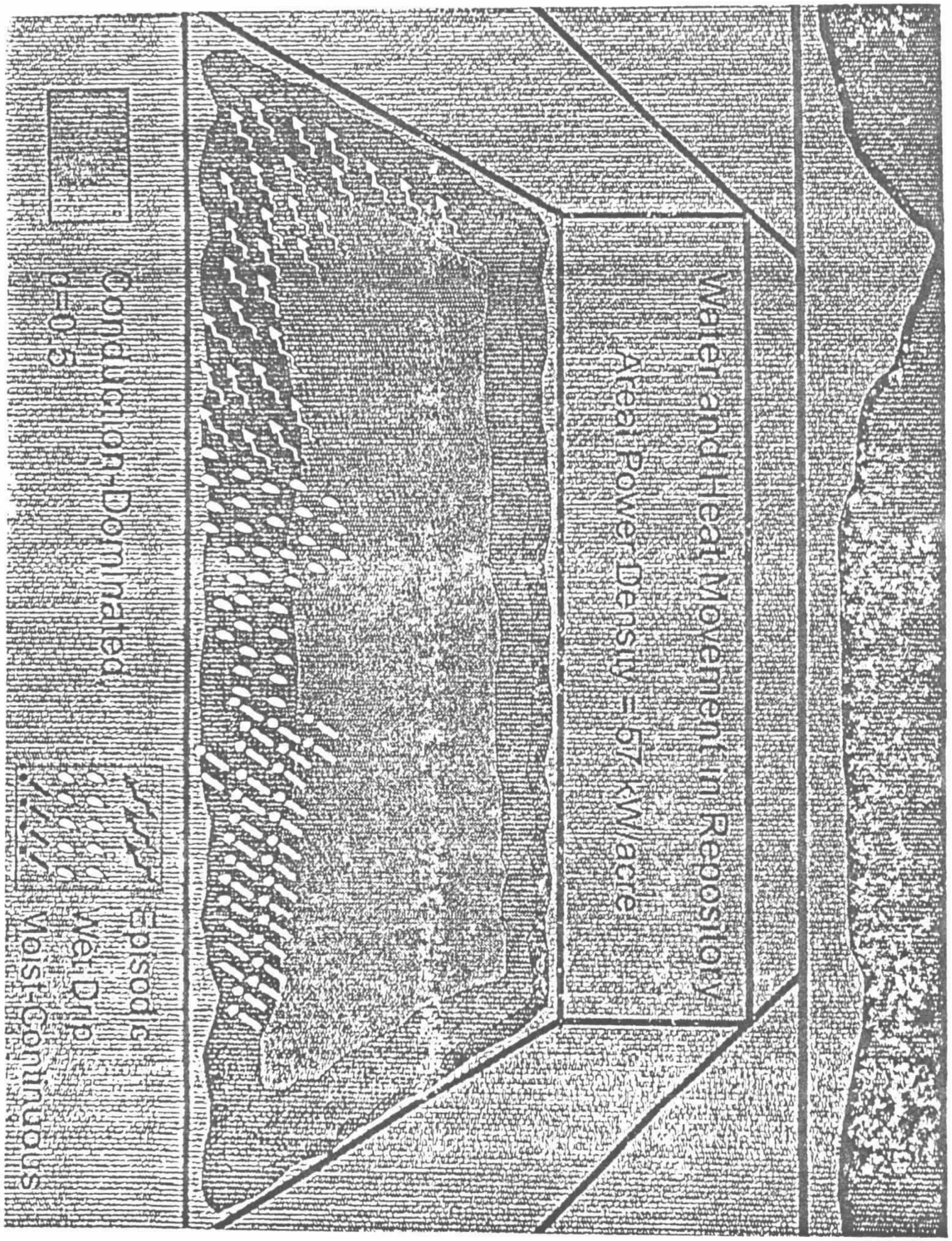


TABLE 2-2
Fractions of Repository in Different Environments
for APD=57 kW/acre

Conduction-dominated
p=0.5

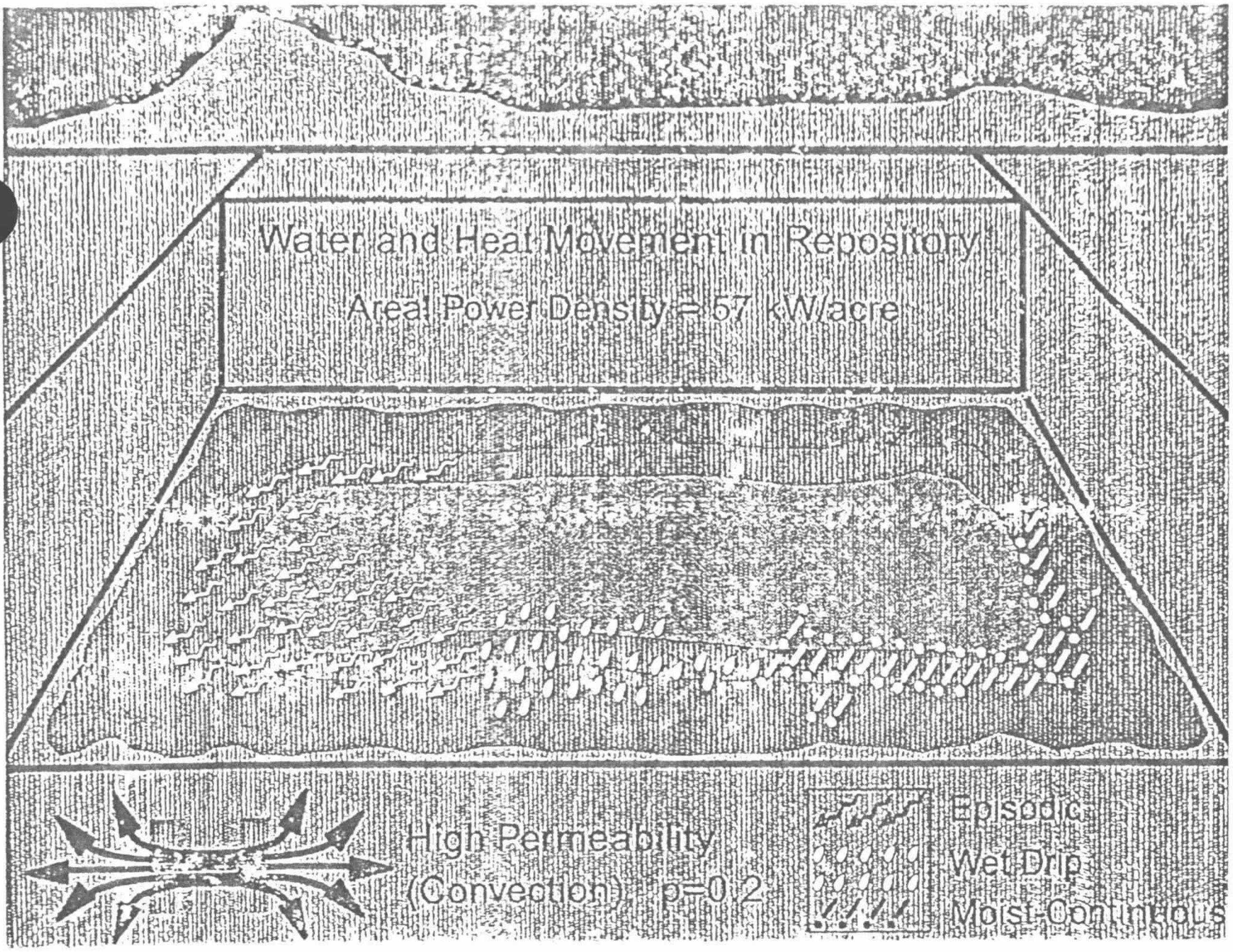
	α	β	γ	δ	Total
Dry	.7	.09	.06	0	.850
Moist.-Contin.	.01	.002	.03	0	.042
Wet-Drip	.02	.004	.02	0	.044
Episodic	.02	.004	.04	0	.064
Total	.75	.10	.15	0	1.0

High Permeability
p=0.2

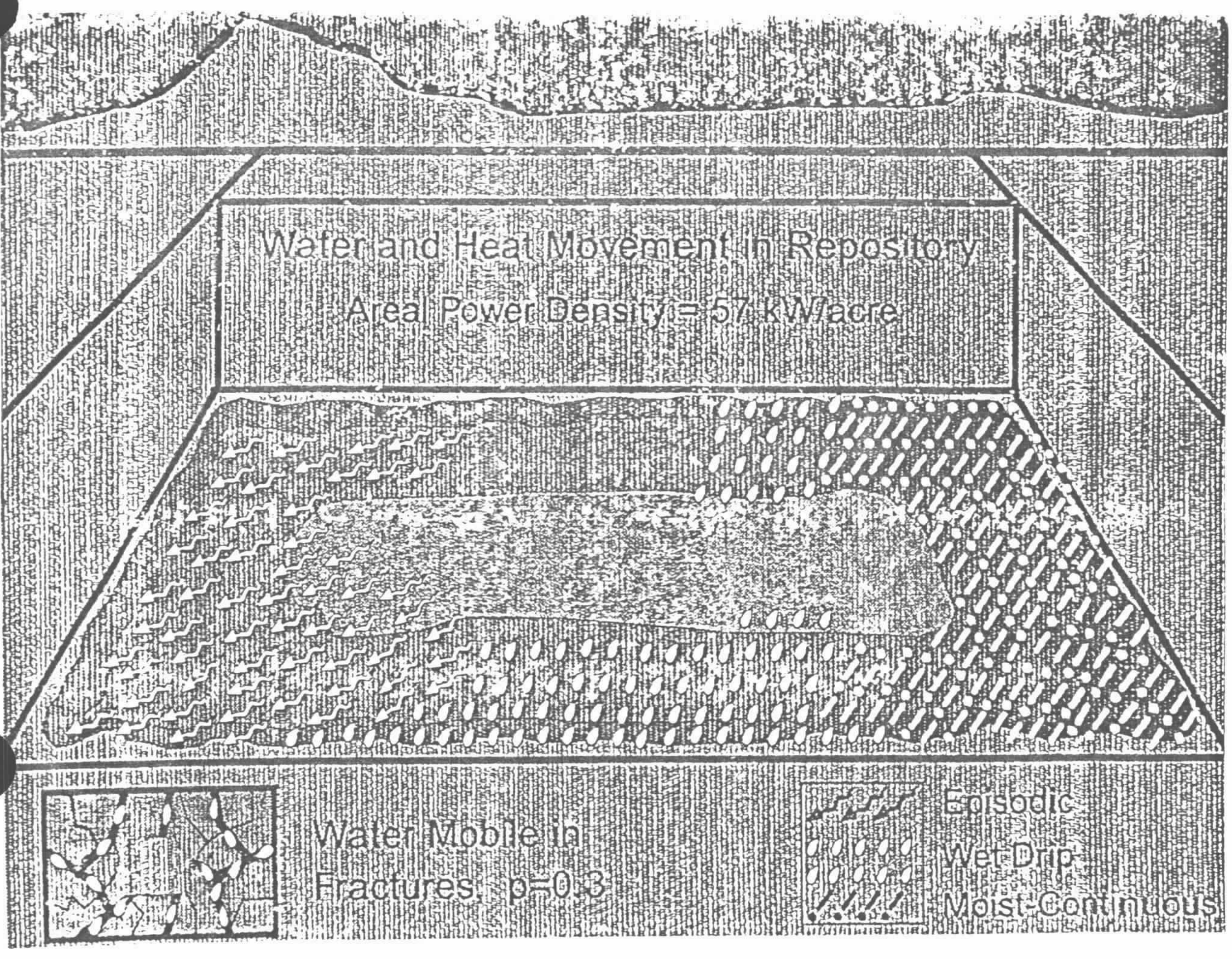
	α	β	γ	δ	Total
Dry	.32	.36	.07	0	.750
Moist- Contin.	.01	.01	.04	0	.060
Wet-Drip	.01	.015	.03	0	.055
Episodic	.06	.015	.06	0	.135
Total	.400	.400	.200	0	1.0

Water Mobile in Fractures
p=0.3

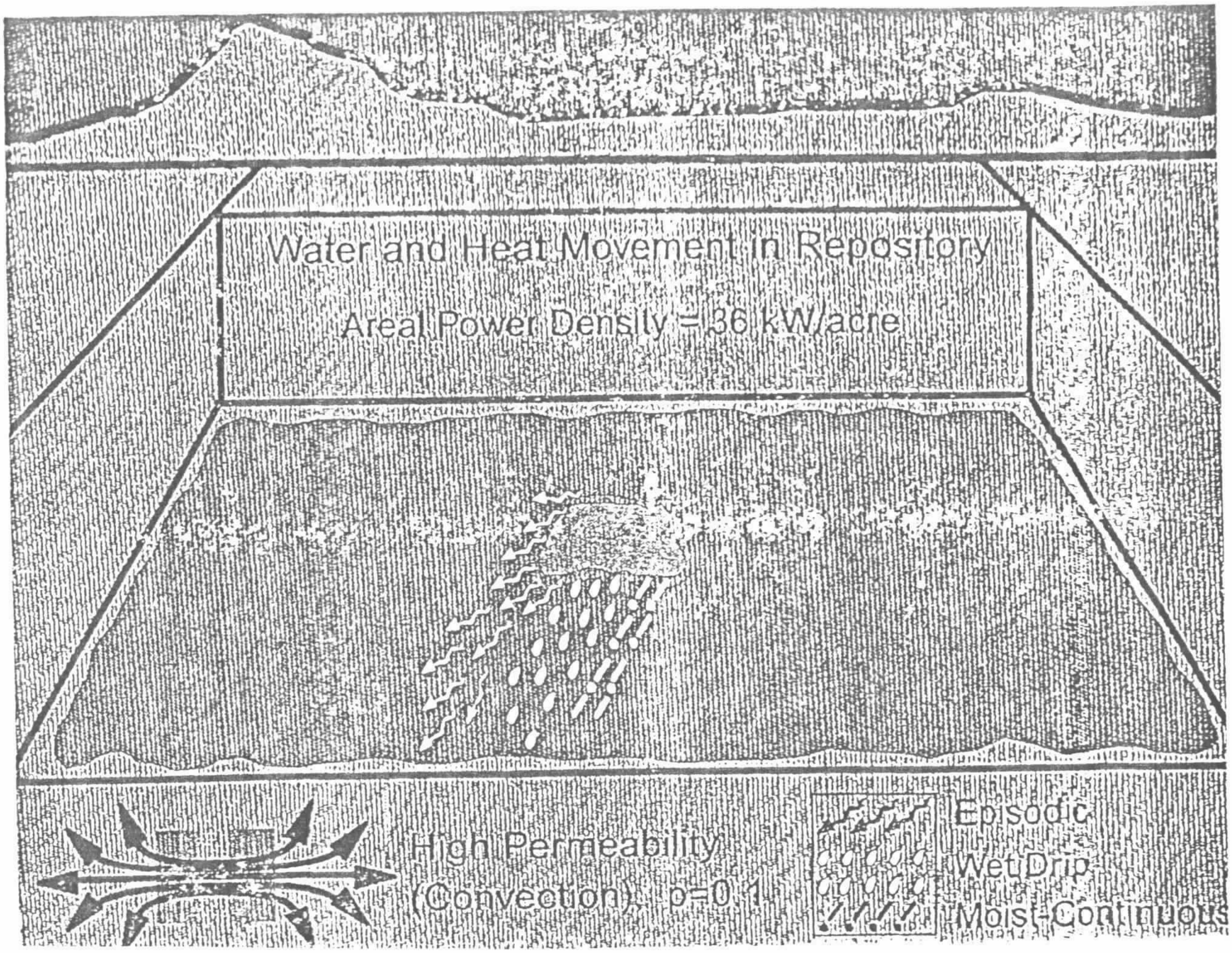
	α	β	γ	δ	Total
Dry	.25	.04	.1	0	.390
Moist-Contin.	0	.025	.15	0	.175
Wet-Drip	.005	.03	.15	0	.185
Episodic	.045	.005	.2	0	.250
Total	.300	.100	.600	0	1.0

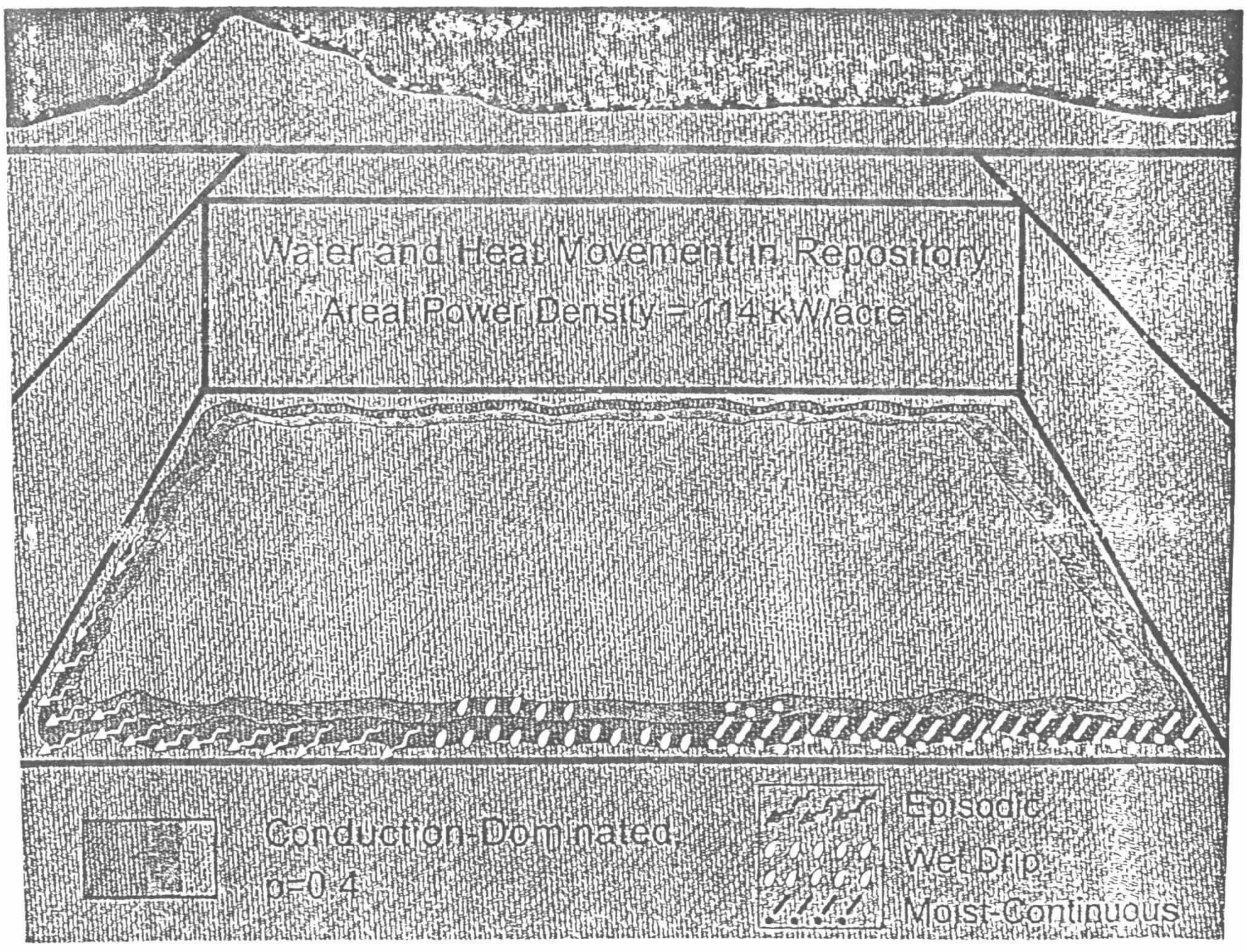


Water and Heat Movement in Repository
Areal Power Density = 57 kW/acre
High Permeability
(Convection) p=0.2
Episodic
Wet Drip
Moist-Continuous



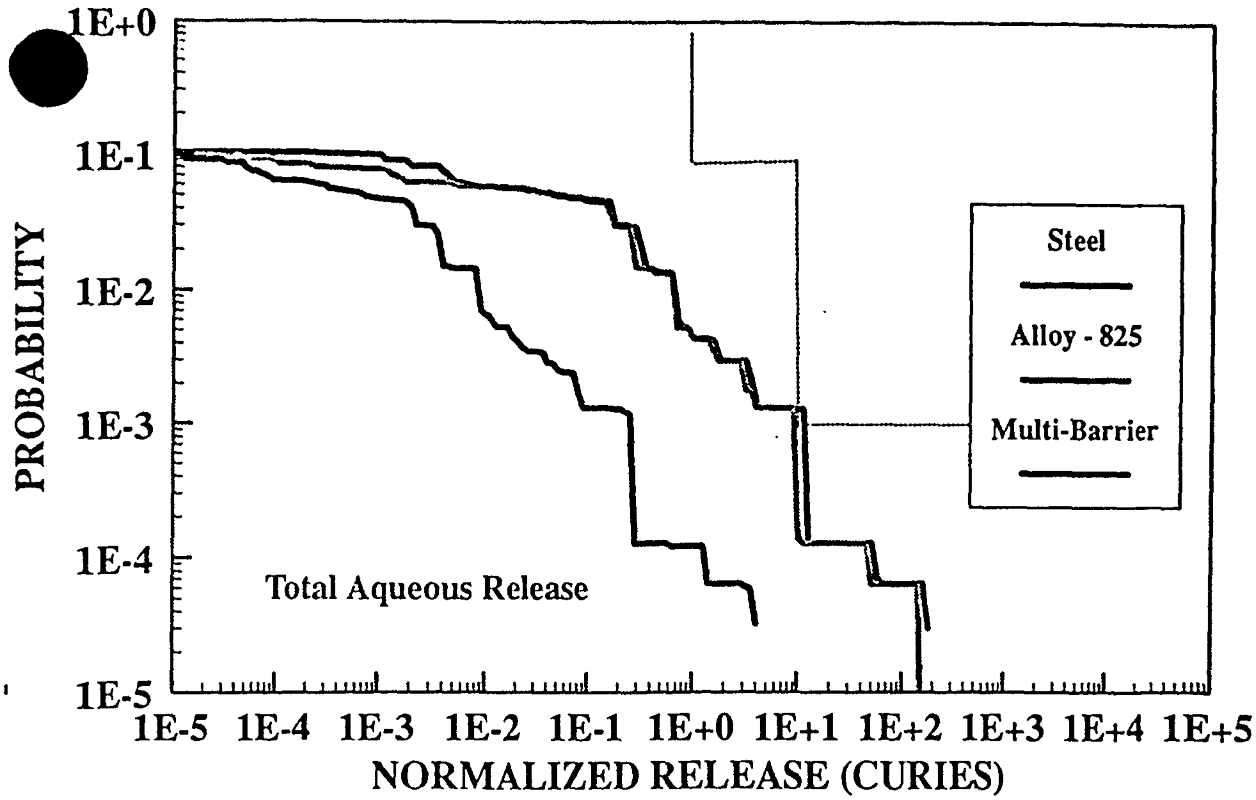
Water and Heat Movement in Repository
Areal Power Density = 57 kW/acre
Water Mobile in
Fractures p=0.3
Episodic
Wet Drip
Moist-Continuous


Water and Heat Movement in Repository
Areal Power Density = 36 kW/acre
High Permeability
(Convection) p=0.1
Episodic
Wet Drip
Moist-Continuous


Water and Heat Movement in Repository
Areal Power Density = 114 kW/acre
Conduction-Dominated
p=0.4
Episodic
Wet Drip
Moist-Continuous

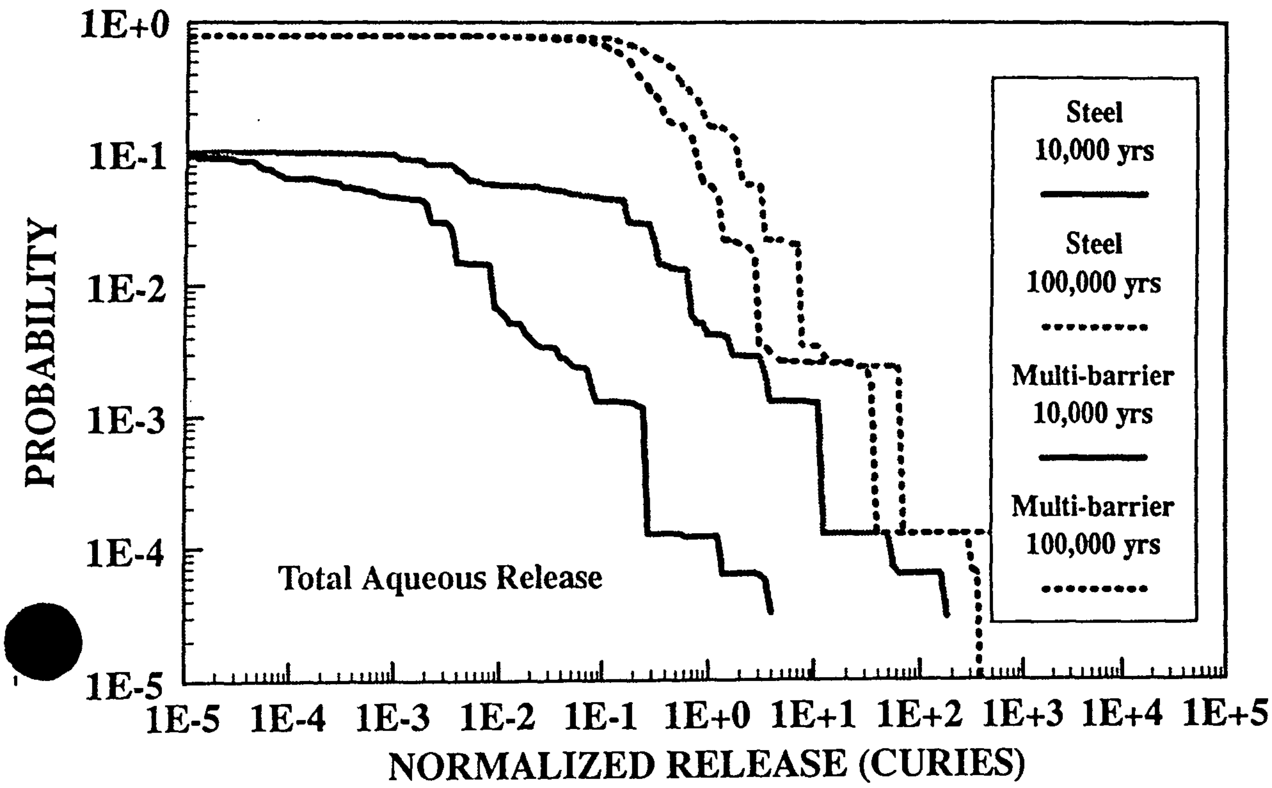
SENSITIVITY TO ENGINEERED BARRIER SYSTEM

APD 57 kW/acre



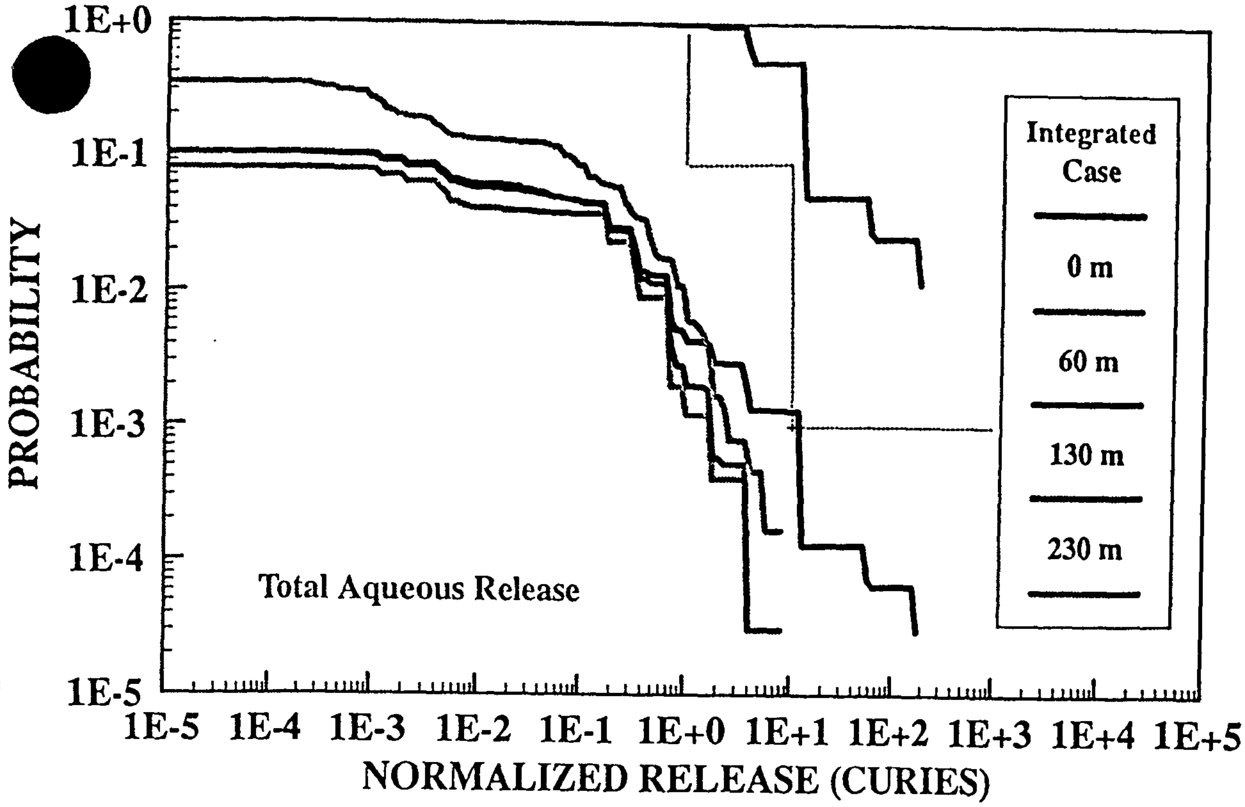
SENSITIVITY TO TIME

ENGINEERED BARRIER SYSTEMS



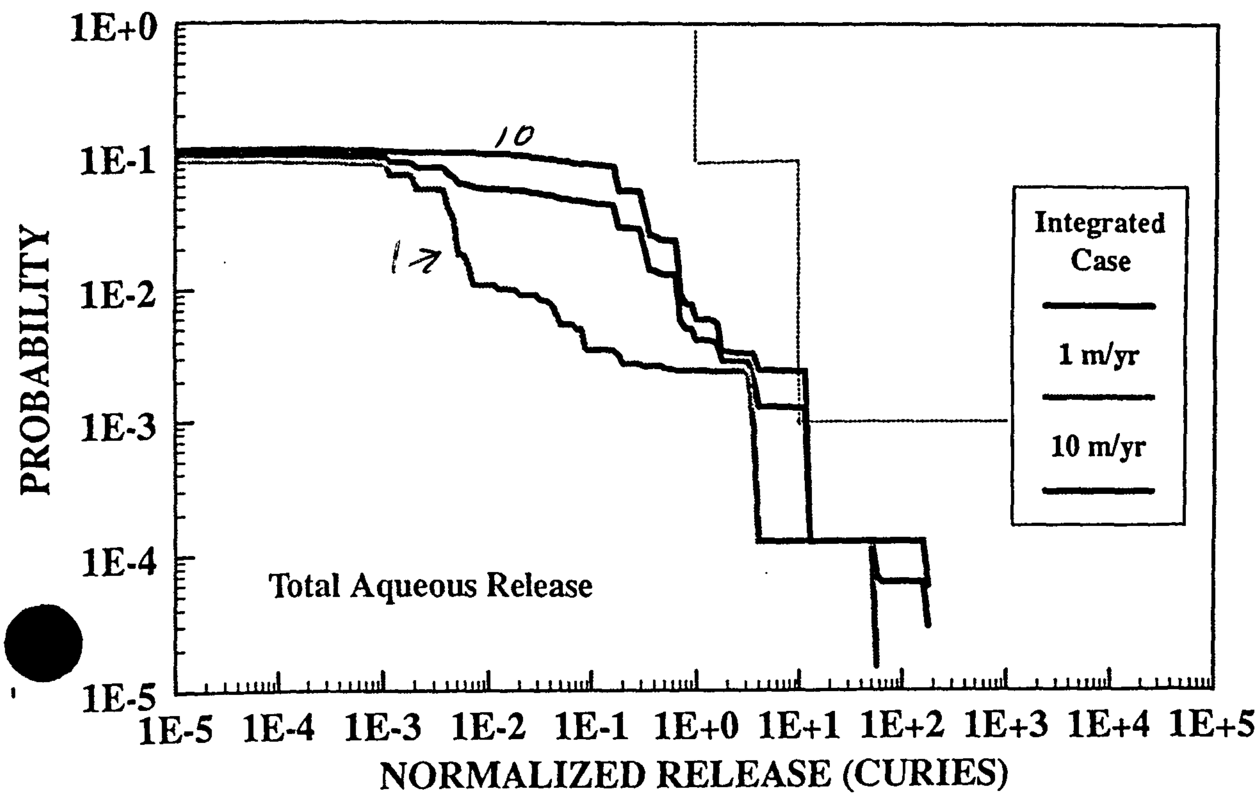
SENSITIVITY TO WATER TABLE CHANGE (TOTAL)

APD 57 kW/acre, Steel Container



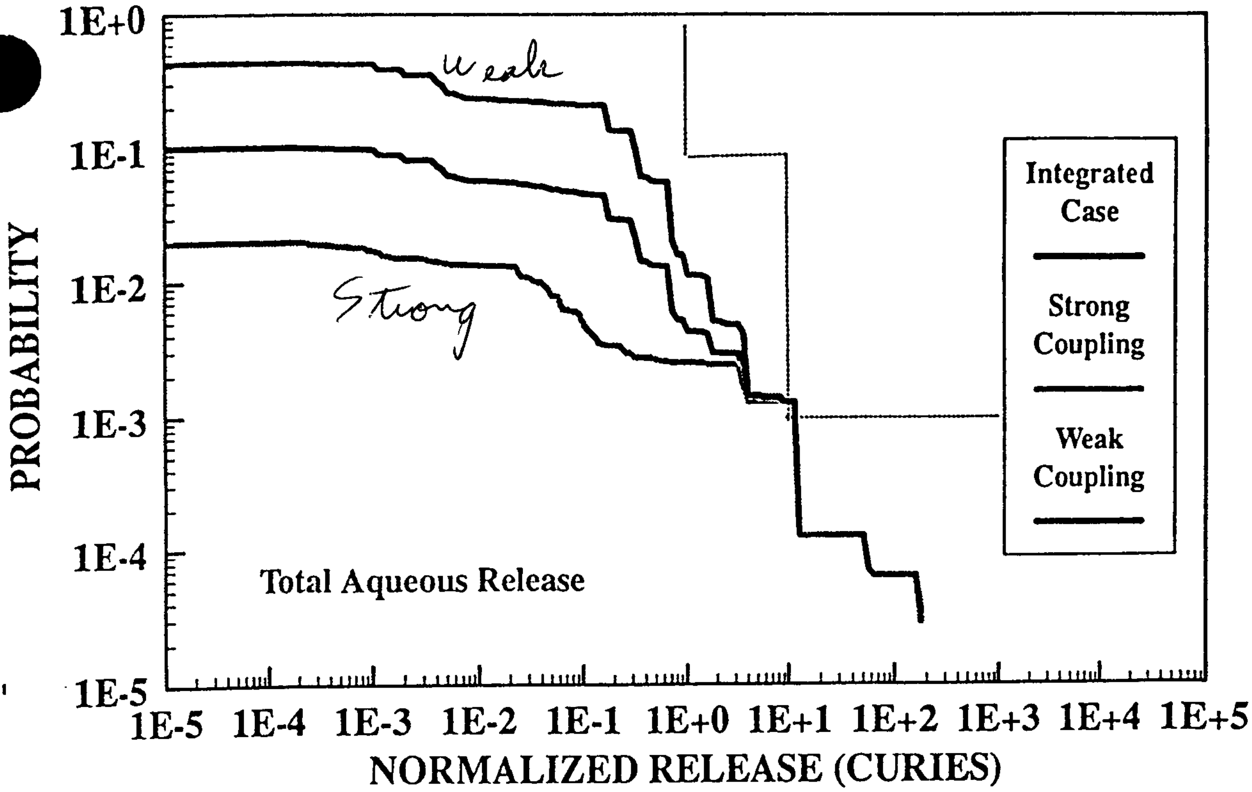
SENSITIVITY TO SATURATED FLOW VELOCITY

APD 57 kW/acre, Steel Container



SENSITIVITY TO FRACTURE / MATRIX COUPLING

APD 57 kW/acre, Steel Container



CALCULATION OF DOSES

p_e = probability of exposure to critical population

f = fraction of critical population that receives a dose

<u>small population (farming scenario)</u>:

$$p_e = p_4 p_{nc}$$

$$f = p_5 p_6 p_7 p_8 p_9 p_{10}$$

<u>large population (city scenario)</u>:

$$p_e = p_4 p_{nc} p_5 p_6 p_7$$

$$f = p_8 p_9 p_{10}$$

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ILLUSTRATIVE PROBABILITIES*

Parameters	Description	Advanced Technology Small Pop.	Advanced Technology Large Pop.	Current Technology Small Pop.	Current Technology Large Pop.
p_4	p[water used]	1.000	0.100	1.000	0.900
p_{nc}	p[no cancer cure]	0.100	0.100	1.000	1.000
p_5	p[hazard not detected]	0.100	0.001	0.900	0.900
p_6	p[well sited over plume]	0.035	0.500	0.035	0.500
p_7	p[prod. from plume]	0.500	0.200	0.500	0.200
p_8	fraction water/food	0.500	0.500	1.000	0.500
p_9	dilution	0.500	0.001	0.500	0.001
p_{10}	fraction life spent	0.500	0.500	0.500	0.500

* see Wilems (1993) for most of these assessments

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p_e modifies the probability of exposure (the vertical axis)

f modifies the dose to the average individual (the horizontal axis)

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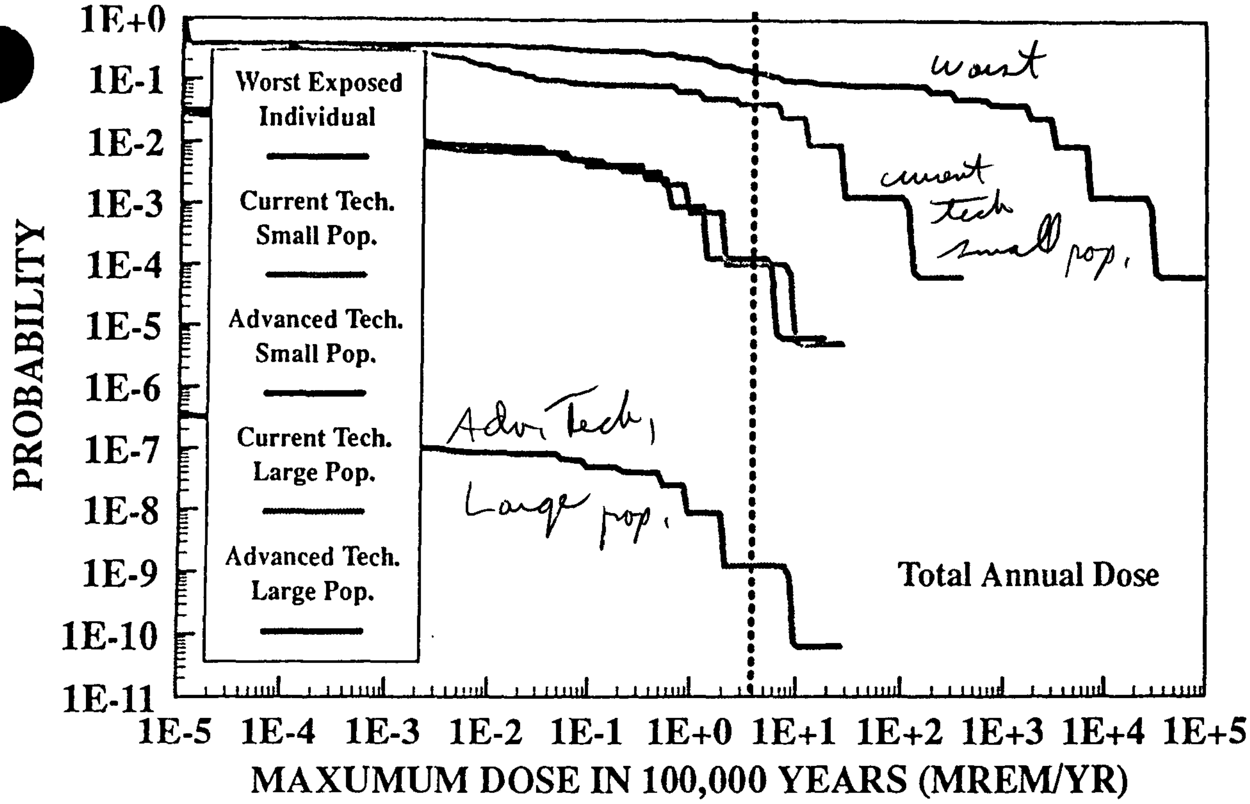
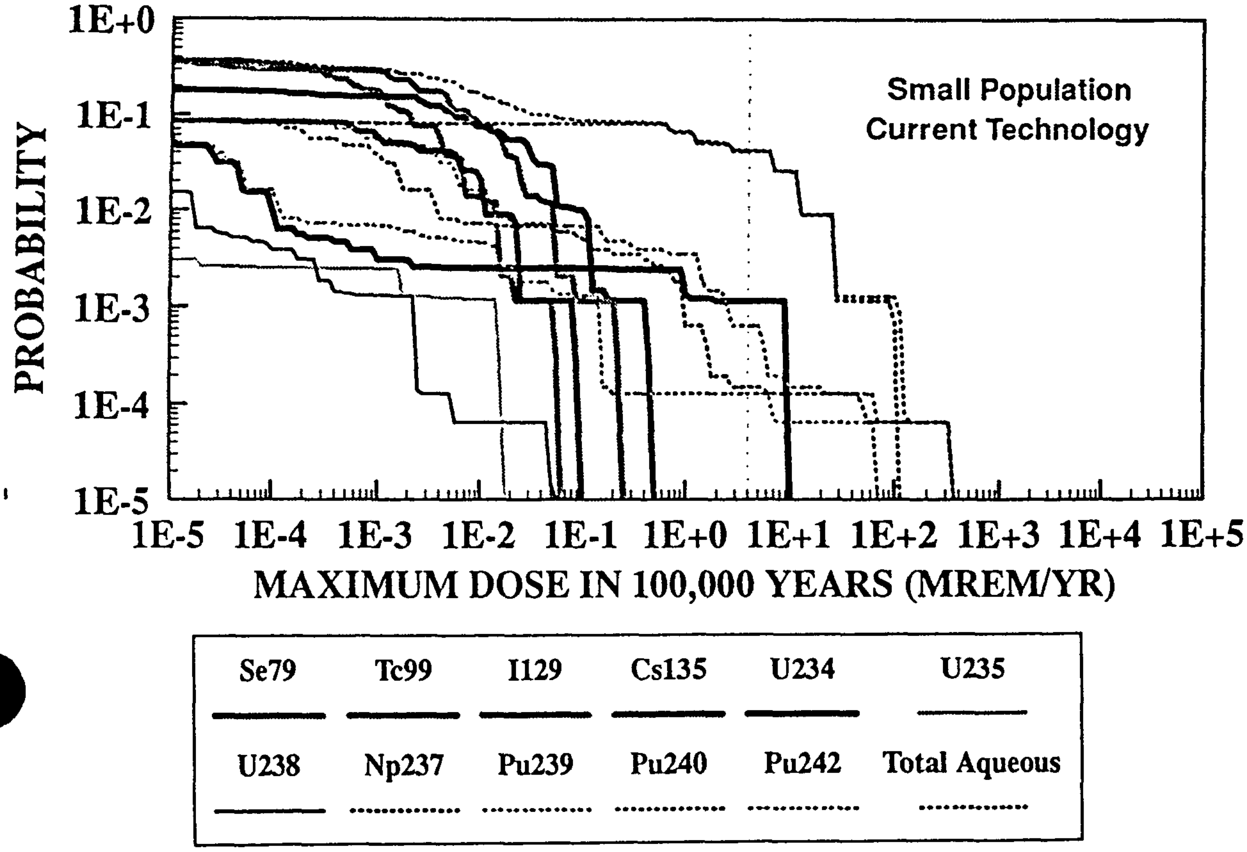
SENSITIVITY TO POPULATION AND TECHNOLOGY

FOR AN AVERAGE PERSON IN THE CRITICAL POPULATION

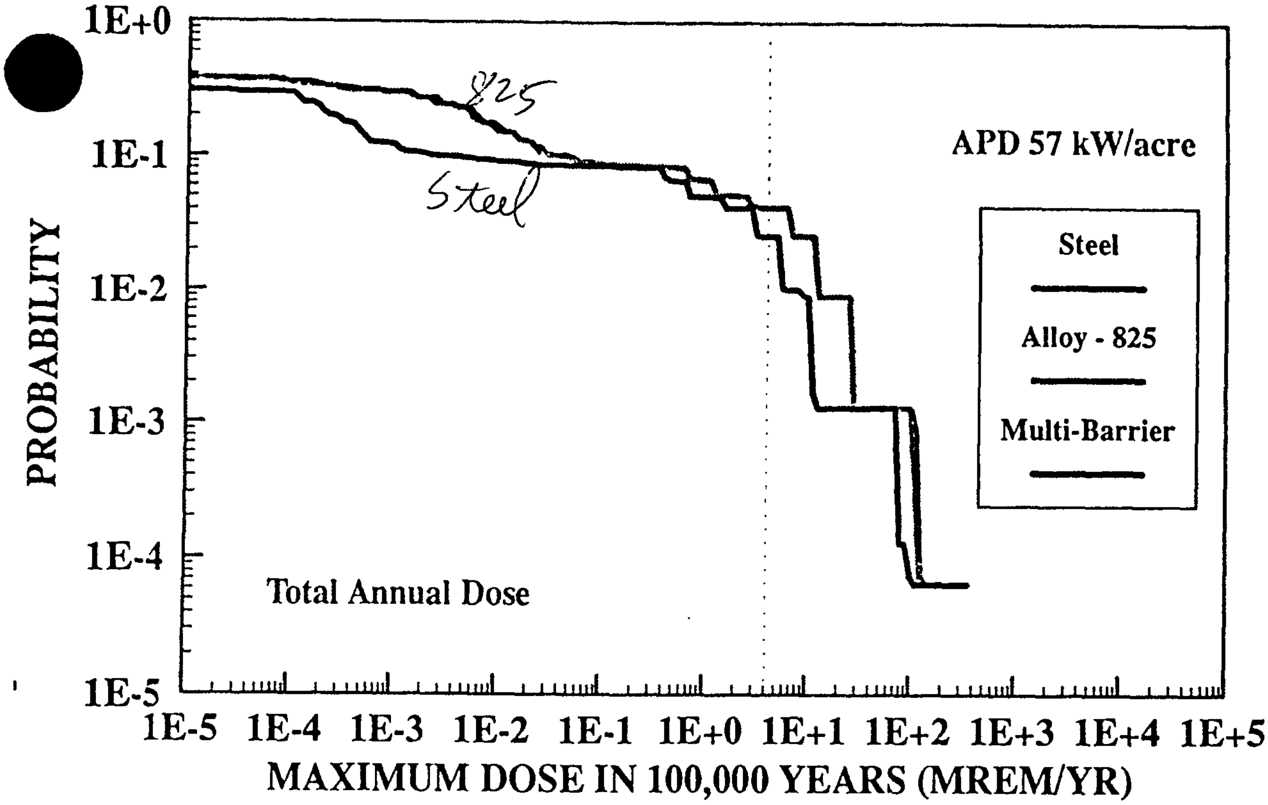


TOTAL AND INDIVIDUAL NUCLIDE ANNUAL DOSE



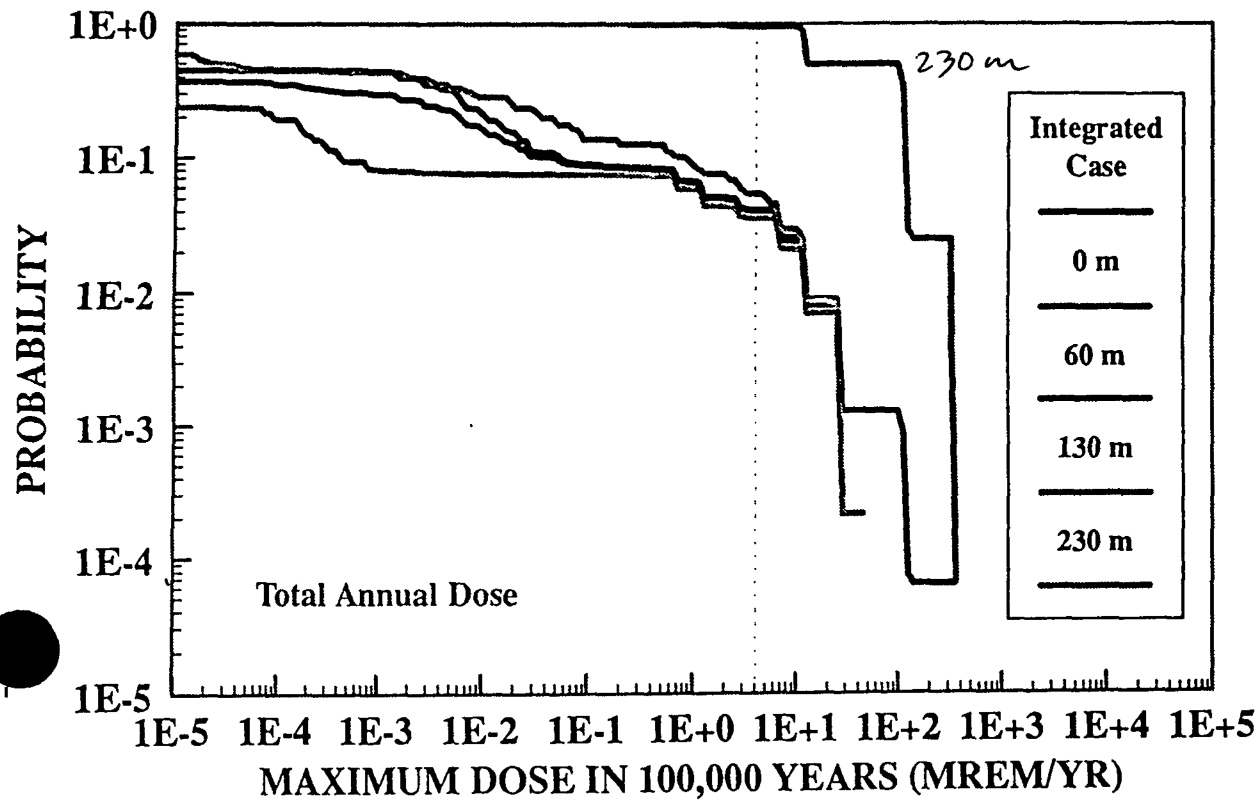
SENSITIVITY TO ENGINEERED BARRIER SYSTEM

CURRENT TECHNOLOGY / SMALL POPULATION



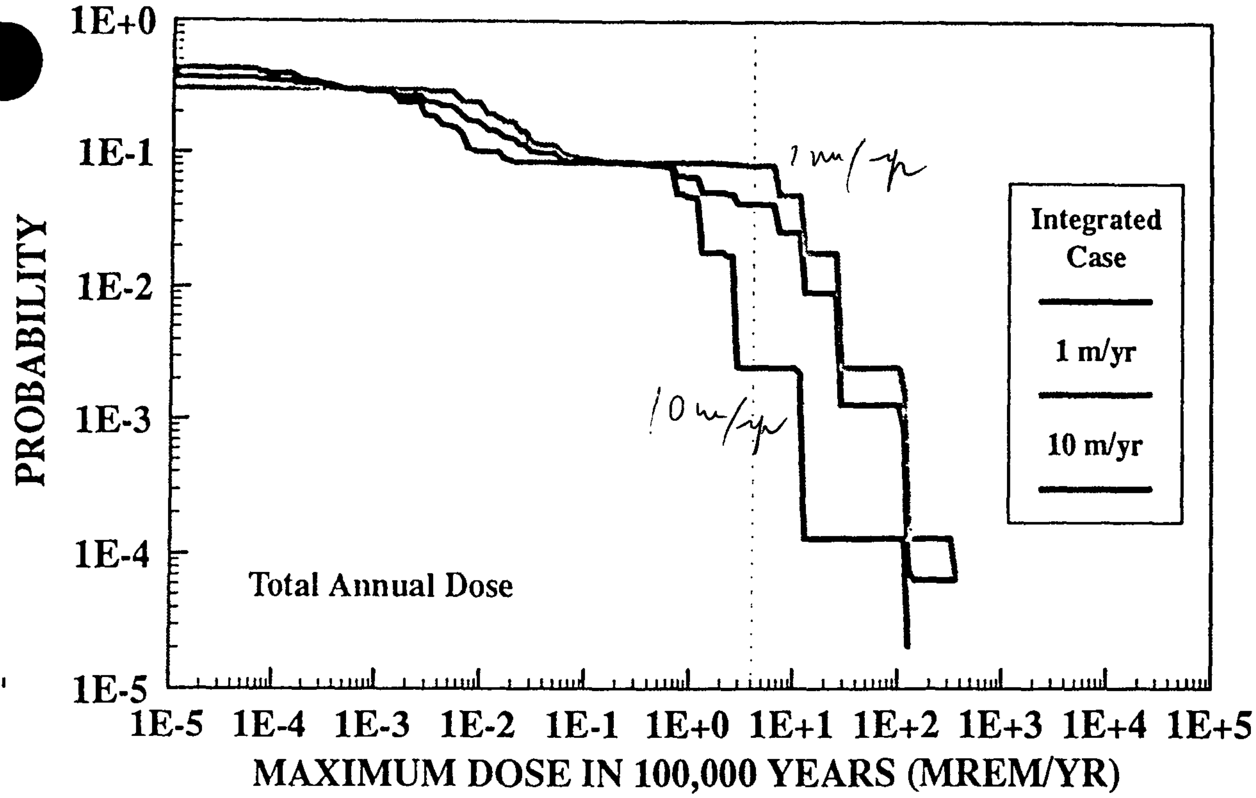
SENSITIVITY TO WATER TABLE CHANGE (TOTAL)

CURRENT TECHNOLOGY / SMALL POPULATION



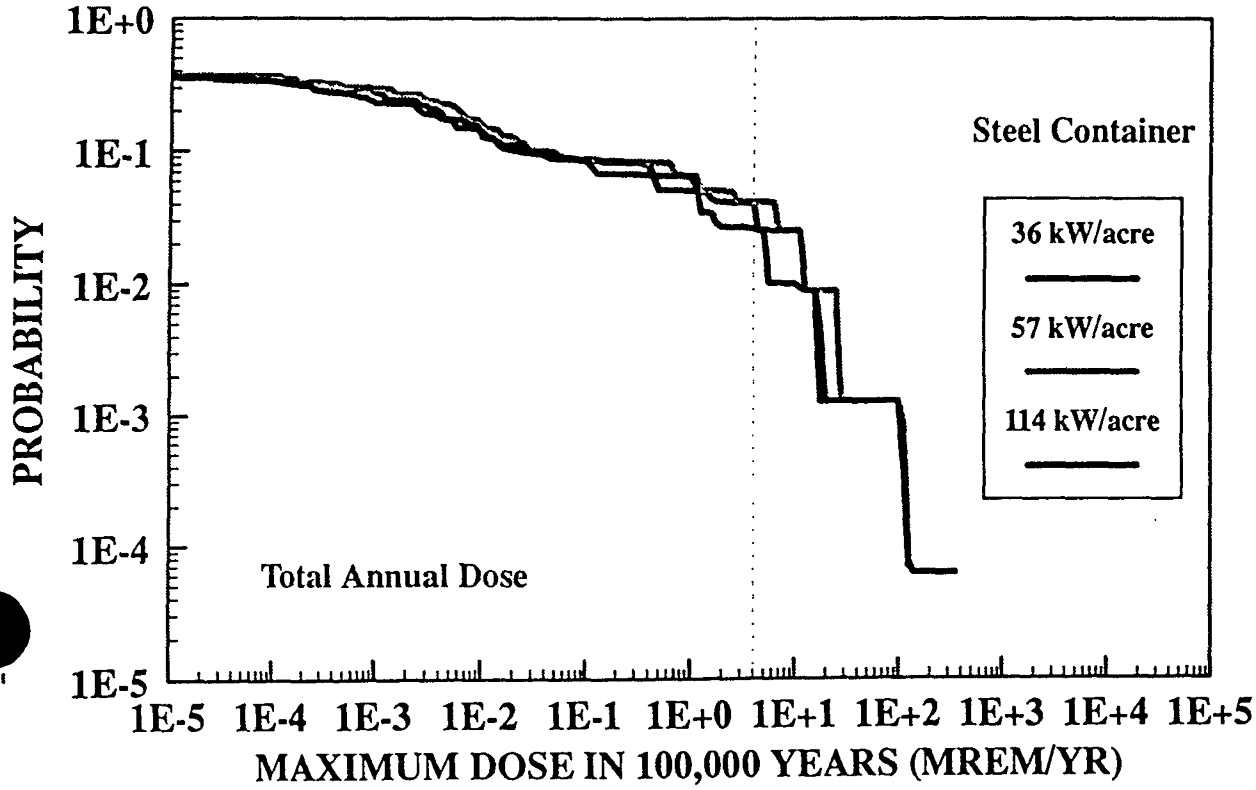
SENSITIVITY TO SATURATED FLOW VELOCITY

CURRENT TECHNOLOGY / SMALL POPULATION



SENSITIVITY TO AREAL POWER DENSITY

CURRENT TECHNOLOGY / SMALL POPULATION



SENSITIVITY TO THERMAL PROCESS

CURRENT TECHNOLOGY / SMALL POPULATION