Performance Assessment Demonstration:
Flow and Transport Modeling

Presentation to:
Panel on Risk & Performance Analysis
U.S. Nuclear Waste Technology Review Board

Timothy McCartin
Modeling Analyst
Waste Management Branch
Division of Engineering
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
(301) 492-3847

May 21, 1991
FLOW AND TRANSPORT MODELING STRATEGY

1) Determine Modeling Approach
   - current site concepts
   - pathways
   - flow and transport phenomena
   - availability

2) Develop/Acquire Model(s)

3) Perform Calculations
   - auxiliary analyses
   - cumulative release

4) Conduct Sensitivity and Uncertainty Analyses
Site Concepts

- layered with large contrasts in permeability

- fracture - matrix interactions are not well understood (i.e., role of fracture coatings)

- low flux would imply primarily vertical flow

- areal extent and dip of the repository could be important
A  Tiva Canyon (welded)
B  Paint Brush (nonwelded)
C  Topopah Springs #1
D  Topopah Springs #2
E  Calico Hills (nonwelded)
F  Prow Pass (nonwelded)
G  Bullfrog (welded)
TSw - Topopah Springs welded unit
CHnv - Calico Hills nonwelded vitric unit
CHnz - Calico Hills nonwelded zeolitized
PPw - Prow Pass welded member
PPnw - Prow Pass nonwelded member
BFw - Bullfrog welded member
### Columns Representing YMP Repository Model

<table>
<thead>
<tr>
<th>Column</th>
<th>Thickness (meters)</th>
<th>Average ksat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>TSw</td>
<td>45</td>
<td>60</td>
</tr>
<tr>
<td>CHv</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>CHnv</td>
<td>20</td>
<td>70</td>
</tr>
<tr>
<td>PPw</td>
<td>34</td>
<td>45</td>
</tr>
<tr>
<td>PPnw</td>
<td>90</td>
<td>20</td>
</tr>
<tr>
<td>BFw</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>

| Fraction of waste in column | 0.40 | 0.33 | 0.17 | 0.10 | -- |
LIQUID PATHWAY SCENARIOS

1) Base Case
   • Infiltration rate (0.1 - 5.0 mm/yr)

2) Pluvial Case
   • Infiltration rate (5.0 - 10.0 mm/yr)
   • Water table raised 100 meters
DRILLING MODEL

- Calculates Probability of Drilling
  - Based upon drilling rate (#/time/area) and area considerations

- Accounts for Waste and Contaminated Rock

- Uses Initial Inventory with Decay and No Production of Daughter Products

- Uses NEFTRAN Leach Model
DETERMINATION OF SCENARIO PROBABILITIES FROM THE PROBABILITIES OF FUNDAMENTAL EVENTS

<table>
<thead>
<tr>
<th>Event</th>
<th>Scenario class # 0</th>
<th>Scenario class # 1</th>
<th>Scenario class # 2</th>
<th>Scenario class # 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>P 0.9</td>
<td>Probability = 2.0 x 10^{-7}</td>
<td>Probability = 2.3 x 10^{-5}</td>
<td>Probability ~ 0.9</td>
<td>Probability ~ 0.1</td>
</tr>
<tr>
<td>D 2.3 x 10^{-7}</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D ~ 1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- 🇺🇸 P is not pluvial
- 🇺🇸 P is pluvial
- 🇺🇸 D is no drilling
- 🇺🇸 D is drilling

Scenario class # 0 is no drilling, not pluvial
Scenario class # 1 is no drilling, with pluvial
Scenario class # 2 is drilling, not pluvial
Scenario class # 3 is drilling and pluvial

Note: Probability combinations assume that fundamental events have independent probabilities of occurrence; this is not a general restriction.
CONSEQUENCE DISTRIBUTION
(Base Case)
CONSEQUENCE DISTRIBUTION
(Pluvial Case)
CONSEQUENCE DISTRIBUTIONS
(Base Case and Drilling)

- - - Base Case
- - - Drilling
- - - Base Case + Drilling

Cumulative Probability

Summed Normalized EPA Release
CONSEQUENCE DISTRIBUTIONS
(Pluvial Case and Drilling)

- - - Pluvial Case
- - - Drilling
--- Pluvial + Drilling

Cumulative Probability

Summed Normalized EPA Release