

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

**PRESENTATION TO  
THE NUCLEAR WASTE TECHNICAL REVIEW BOARD**

**SUBJECT: ONGOING AND FUTURE  
PERFORMANCE ASSESSMENT  
ACTIVITIES**

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**ARLINGTON, VIRGINIA  
MAY 20-21, 1991**

# **ONGOING AND FUTURE PERFORMANCE ASSESSMENT ACTIVITIES**

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**Nuclear Waste Technical Review Board  
Arlington, VA  
May 20, 1991**

## **Discussion Topics**

- • **PA evolution and development  
from prior work**
- **Systematic methodology for  
performance assessment analyses**
- **P A support for Project  
mission and goals**

## **PACE-90 Problem Evolution**

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- **Problems defined from prior work**
- **Modeling techniques based on prior work**
- **Results consistent with prior results**
- **Extended PA knowledge and skills**

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## **PACE-90 Lessons**

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- + **No releases without fast paths**
- + **More layers are not more realistic**
- + **Participants' strengths are complimentary**
- + **Need to do more PACE-style projects**
  
- **Analyses didn't stress models**
- **Analyses not tightly structured**
- **Deterministic parameters**
- **Short deadlines for performance**  
(Insufficient time to test and verify)

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## **Improvements for Future PA Analyses**

- **Use systematic methodology**  
(Better-structured problems)
- **Expand analysis scope**
  - Models**  
(More complete investigations)
  - Parameters**  
(Better reflection of uncertainties)
  - Techniques**  
(New codes, algorithms)

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## **Discussion Topics**

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## **Systematizing PA**

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**A method for use with PACE-style calculations . . .**

- 1) Scenario screening**
- 2) Probability estimation**
- 3) Conceptual model development**
- 4) Parameter uncertainty estimation**
- 5) Calculation**
- 6) Interpretation**

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## **Step 1: Scenarios**

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- Identify features, events and processes (FEPs) describing the system**
  
  - Many types of logic diagrams**
    - Event trees**
    - Binary trees**
    - Fault Trees**
    - Matrix methods**
- Systematically describe FEPs**
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## Logic Diagrams

Logic diagrams become complete only after iterations

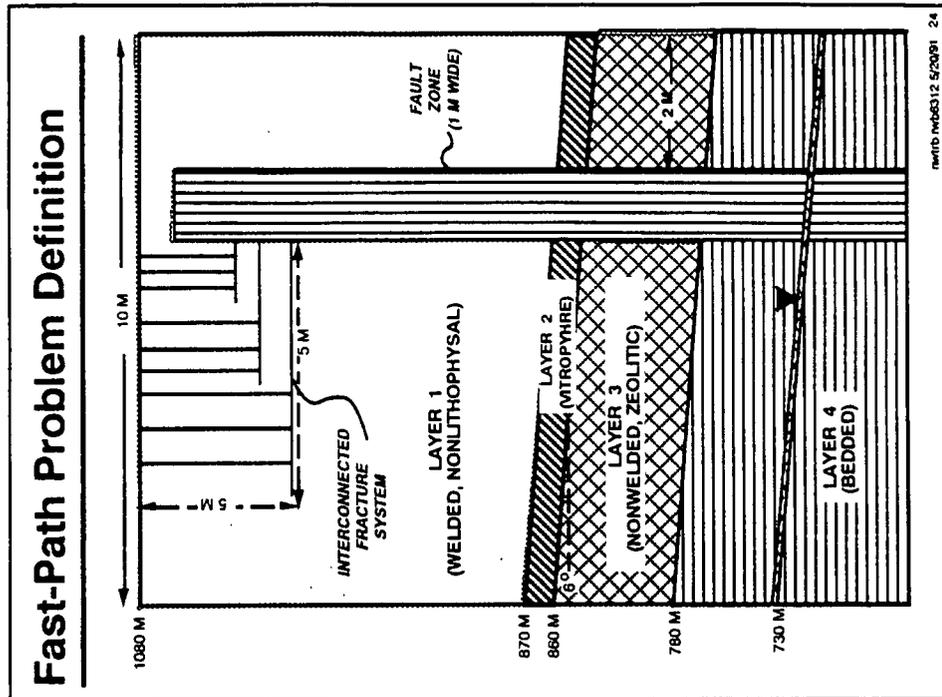


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## Scenario Identification

- Logic diagrams identify classes of FEPs, e.g.,
    - Nominal flow
    - Basaltic igneous intrusion
    - Human intrusion
    - Tectonic events
- } Disturbed Conditions

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## Step 2: Probabilities

- Estimate ranges for probabilities of occurrence
- Resources for estimates
  - Analyses
  - Experts
  - Data from published results

## **Event Classification**

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- **After scenario and probability screening steps are done:**
  - **High consequence events**  
(Igneous intrusion entraining waste)
  - **High probability events**  
(Nominal groundwater flow)
- **Also must identify high public-perception events**

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## **Step 3: Conceptual Models**

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- **Express processes**
  - **Global** (e.g., one-phase water flow)
  - **Detailed** (e.g., composite model)
- **Identify assumptions**
  - **Site** (e.g., diffusion and advection)
  - **Physical** (e.g., Darcy's Law obtains)
  - **Modeling** (e.g., use of uniform zones)
- **Identify alternatives**

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## **Step 4: Parameters**

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- All natural systems are variable
- Measurements fall in range of values
- Expected value is uncertain, but is within range
- Use systematic methods to quantify uncertainty
  - Distributions of parameter values
  - Sampling from distributions

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## **Step 5: Calculations**

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- Calculations generate "outcomes" from inputs and assumptions
- Modeling assumptions must be stated (e.g., boundary conditions)
- Parameter distributions imply multiple calculations:
  - Gives estimates of central tendencies
  - Indicates which parameters are important

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## **Step 6: Interpretation**

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- **Examine outcomes in terms of inputs**
  - **Effects of parameter and conceptual model uncertainties**
  - **Input uncertainties yield parameter sensitivities**
- **Feed back interpretations to data providers**
- **Increase confidence in analyses**
- **Is essential for model validation and code verification**

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## **Benefits**

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**Iterative PA analyses and data gathering:**

- **Evaluate design alternatives**
- **Provide measures of site suitability**
- **Can prioritize testing, issue resolution site suitability, etc**

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## **Discussion Topics**

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## **Some PA Efforts**

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**Six-step method is being used for . . .**

- **Detailed site suitability calculations**
- **Boundary condition study**
- **ESF Design / T & EP**
- **Site Characterization Plan Issue Resolution**

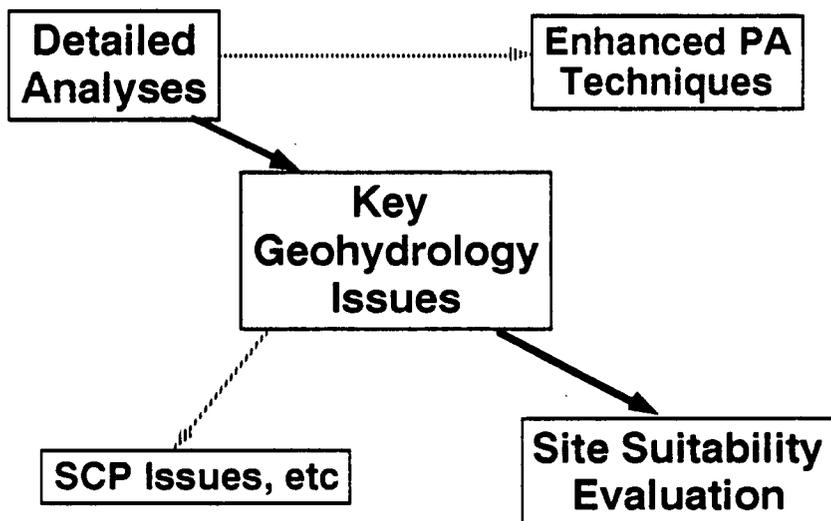
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## Site Suitability Analyses

- Fast paths due to nominal flow
- Human intrusion
- Basaltic igneous activity
- Near-field interactions
- Saturated-zone modeling

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## Fast-Path Problem Interactions



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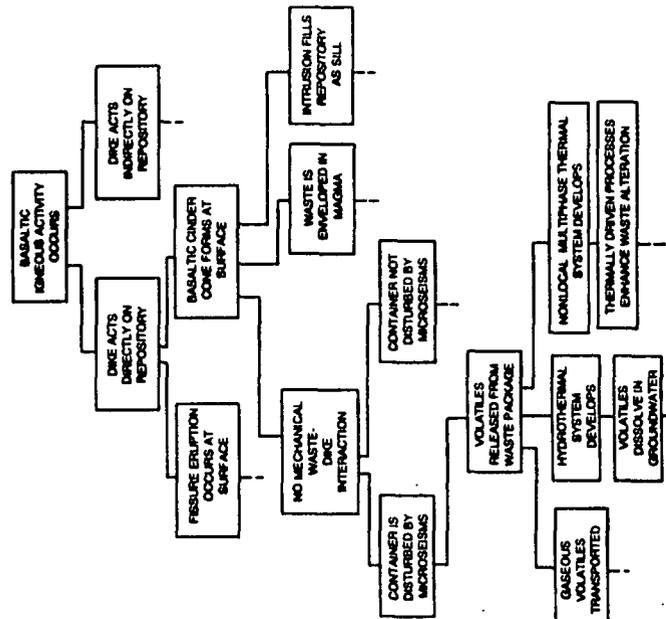
## Fast-Path Analysis

Using the six-step methodology . . .

- Problem formulated by reviewing nominal-flow event tree
- Probabilities of occurrence evaluated
- Four conceptual models evaluated
- Ranges of selected parameters used to reflect uncertainties

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## Scenario Screening



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## **Conceptual Models**

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- **Interconnected fracture network**
  - Explicitly modeled fractures
  - Fracture hydraulic properties
- **Heterogeneous matrix zone**
- **Nonequilibrium fracture/matrix interactions**

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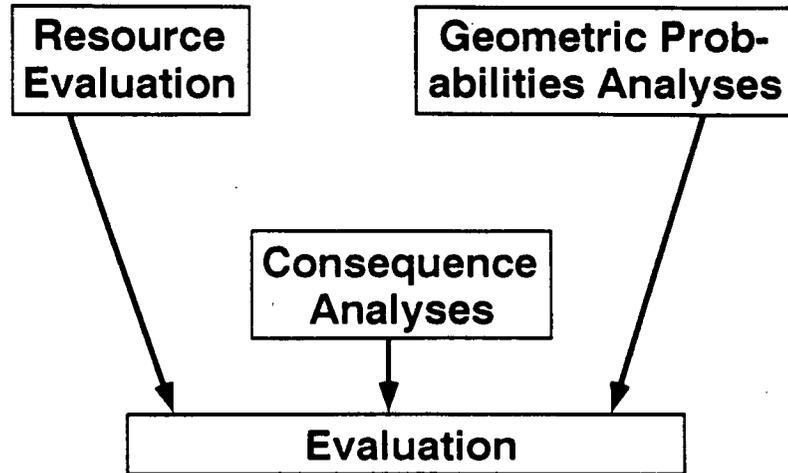
## **Other Aspects**

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- **Source term uses PACE-90 radionuclides, plus Pu and Am**
- **Near-field interactions consistent with fast paths**
  - waste packages exposed to fracture water
- **Saturated-zone calculational "module"**
  - retardation included
- **Results available shortly**

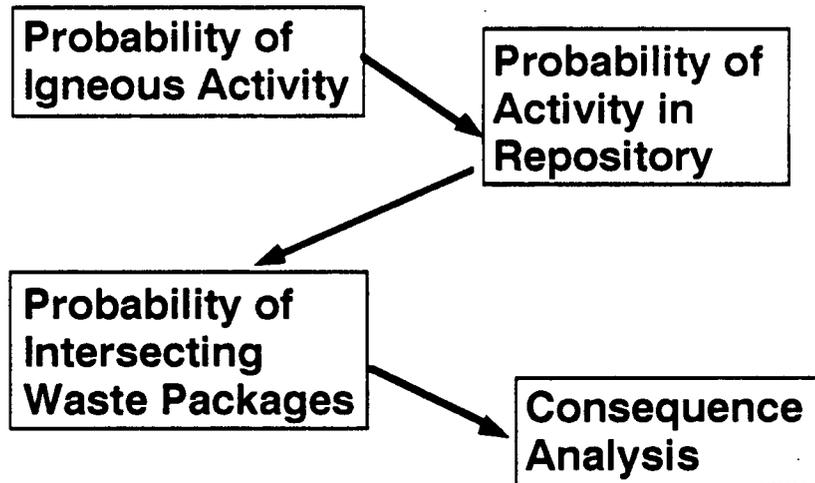
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## Human Intrusion Problem Strategy



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## Igneous Activity Problem Strategy



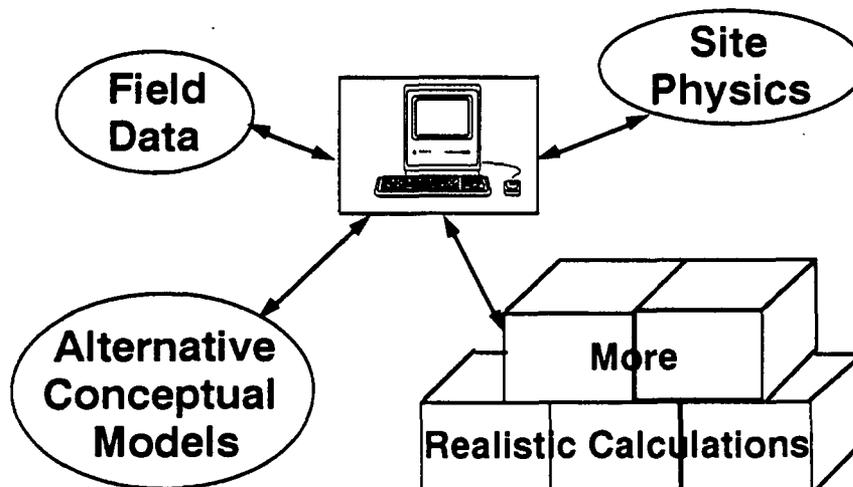
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## Total-System Activities

- Evaluations of site to meet EPA standard must include all available analyses
  - fast paths
  - hydrology
  - human intrusion
- Separate outcomes must be combined for total-system analysis
- Detailed analyses must be simplified for realistic evaluations

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## Boundary Condition Studies



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## **Summary**

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- **PA effort has demonstrated its ability to learn from prior work**
- **PA effort has well-defined:**
  - methodology
  - near-term tasks
- **Methodology will be used for future PA calculations**