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

NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING

SUBJECT: APPROACHES FOR EVALUATING GROUND-WATER TRAVEL TIME

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Presentation Overview

- **Regulatory perspective**
  - NRC and DOE ground-water travel time requirements
  - Early DOE approaches
- **Evolving views**
- **Background for current approach**
- **General plan for evaluating ground-water travel time**

Regulatory Perspective

NRC Regulatory Basis: Ground-Water Travel Time Performance Objective (10 CFR 60.113 (a) (2))

"The geologic repository shall be located so that pre-waste-emplacement groundwater travel time along the ***fastest*** path of ***likely*** radionuclide travel from the disturbed zone to the accessible environment shall be at least 1,000 years ***or such other travel time as may be approved or specified by the Commission***"

DOE Regulatory Basis: Ground-Water Travel Time Disqualifying Condition (10 CFR 960.4-2-1)

"A site shall be *disqualified* if the pre-waste-emplacement ground-water travel time from the disturbed zone to the accessible environment is expected to be less than 1,000 years along *any* pathway of *likely* and *significant* radionuclide travel."

Note: wording was changed from parallel to Part 60 per NRC's concurrence comments (Fed. Reg., V.49, #236, 12/6/84, p 47732)

DOE 1988 SCP GWTT Strategy and NRC 1989 Response

SCP Strategy

1. Develop 3-D hydrogeologic properties model
2. Develop travel time contour maps of site
3. Identify regions of "fastest paths"
4. Perform detailed sensitivity studies on "fastest paths"
5. Produce calculations to be used for compliance evaluations

NRC Response

1. Must generate ground-water travel time cumulative distributions for alternative conceptual models so that extremes can be evaluated
2. Must identify all assumptions about features, events & processes related to hydrologic system for initial strategy
3. NRC SCA comments on GWTT are closed--no specific issue was raised with assumptions presented in SCP

Evolving Views

Current Regulatory Perspective

- Concept of "likely pathways" in both requirements implies a distribution of travel times
- The word "significant" in Part 960 suggests that some pathways and travel times may not be important to performance
- The phrase "...or such other travel time as may be approved or specified by the Commission" in Part 60 implies that system performance may be considered in evaluating compliance with this requirement

Regulatory Perspectives: Disturbed Zone Definition

- Original intent was to start pre-waste emplacement GWTT calculation outside zone of major repository disturbance
- Our understanding of repository effects has matured
- According to both DOE and NRC definitions, only a disturbance that has significant consequences on postclosure performance needs to be considered in defining the disturbed zone

Background for Current Approach

Background for Current Approach

- Ground-water travel time can best be interpreted as particle transport (i.e., not average path length divided by mean velocity but a distribution of radionuclide transport times)

- Transport processes considered in the analysis include
  - Advection
  - Dispersion
  - Matrix Diffusion

Background for Current Approach

(Continued)

- Particle arrival times at the accessible environment depend on
  - Dispersion caused by the different paths followed by different particles (i.e., heterogeneity)
  - Matrix diffusion caused by particles entering the rock matrix where flow is slower
  - Particle starting locations because of the areal extent of the repository
  - Particle ending locations at the accessible environment

- This ground-water travel time distribution defines the likelihood of each particle reaching the accessible environment at a specific time

Background for Current Approach

(Continued)

- The significance of a particular pathway or travel time will be related to either the integral of the mass release along that pathway or the peak mass concentration at the end of the pathway

General Plan

Unsaturated Zone

- Establish reasonable disturbed zone boundary for use in calculating GWTT
- Determine expected distribution of ground-water travel times (i.e., particle transport) from the disturbed zone through the unsaturated zone
- Conduct sensitivity analyses to determine the effects of uncertainty in:
  - Percolation flux
  - Hydraulic properties
  - Alternate conceptual flow models
  - Matrix diffusion
  - Dispersion

General Plan

(Continued)

Saturated Zone

- Determine the expected distribution of ground-water travel times in the saturated zone from points below the repository to the accessible environment
- Conduct sensitivity analyses to determine the effects of uncertainty in:
  - Hydraulic properties
  - Boundary conditions
  - Alternate conceptual flow models
  - Matrix diffusion
  - Dispersion

General Plan

(Continued)

Total travel time

- Sum the travel times through both the unsaturated and saturated zones
- Evaluate significance of shortest travel times to performance to assess compliance with Parts 960 and 60