



# DISRUPTIVE EVENTS

May 25-27, 1999  
DOE/NRC Technical Exchange on  
Total System Performance Assessments  
for Yucca Mountain

**James R. Firth**  
301-415-6628 - JRF2@nrc.gov  
Division of Waste Management  
High-Level Waste Branch

**Contributors:** Amit Ghosh (CNWRA), Britt Hill (CNWRA), Simon Hsiung (CNWRA),  
Buck Ibrahim (NRC), John Stamatakis (CNWRA)

*Legacy/main - 70*

# **UNDERSTANDING OF VA APPROACH**

## EVENTS CONSIDERED BY DOE (TSPA-VA)

### 1. Seismic Activity

- Failure from Rockfall
- Accelerated Corrosion
- Also Included within "Juvenile Failure"

### 2. Basaltic Igneous Activity

- Failure from Magma and Ash Interactions with Waste Packages
- Airborne Transport
- Enhanced Source Term for Releases to Groundwater
- Changes to Groundwater Flow in Saturated Zone

## EVENTS CONSIDERED BY DOE (TSPA-VA)

### 3. Nuclear Criticality

- Criticality Within Waste Package
  - Commercial Spent Nuclear Fuel and Aluminum Clad Spent Nuclear Fuel
  - Changes to Inventory within Waste Package
- Potential for Out-of-Package Criticality

### 4. Inadvertent Human Intrusion

- Single Waste Package Penetrated
- Borehole Extends to Saturated Zone
- Waste from the Package is Assumed to Reach Saturated Zone  
[550 kg, 2100 kg]
- Event Occurs 10,000 Years After Closure

# **NRC APPROACH**

## **NRC TREATMENT OF DISRUPTIVE EVENTS (TPA 3.2)**

### **1. Seismic Activity**

- Impact Load from Falling Rock Used to Calculate Induced Waste Package Stress
- Impact Load Determined from Rock Size and Distance Rock Falls
  - Size Based on Joint Spacing and Yield Zone Thickness
- Maximum Allowable Strain Used As Failure Criterion (2% Total Strain)
- Fractional Rockfall Area Modeled as a Function of Ground Acceleration
- Failures from Multiple Seismic Events Assumed to Occur at Preestablished Times for Efficient Calculations

## **NRC TREATMENT OF DISRUPTIVE EVENTS (TPA 3.2)**

### **2. Igneous Activity**

- Emphasis on Extrusive Events (to Date)
- Use of Reasonably Conservative Estimate for Probability of Extrusive Events
- ~ 100% HLW from Failed Waste Packages Entrained in Ash
- Modified Convective-Dispersive Model of Suzuki Used for Tephra Transport
- Wind is Assumed to Blow in Direction of Critical Group

## **NRC TREATMENT OF DISRUPTIVE EVENTS (TPA 3.2)**

### **3. Fault Displacement**

- Modeled for New or Inadequately Characterized Faults
- 50% of Fault Displacement Occurs on these New or Inadequately Characterized Faults
- Effective Recurrence Rate for these Faults Estimated to be 200,000 years
- Fault Displacement Exceeding a Pre-established Threshold Results in Waste Package Failure of All Waste Packages within Fault Zone
- Only Waste Packages within Fault Zone May Fail from Fault Displacement

### **Process-Level Presentations with Technical Basis**

- Simon Hsiung (Seismicity: Rockfall)
- Brittain Hill (Igneous Activity: Volcanism)



# **UNDERSTANDING OF DIFFERENCES**

## TREATMENT OF DISRUPTIVE EVENTS

DISRUPTIVE EVENTS	DOE (TSPA-VA)	NRC (TPA 3.2)
Igneous Activity: Intrusive Events	✱	✱
Igneous Activity: Extrusive Events	✱	✱
Igneous Activity: Indirect Effects	✱	
Seismicity: Waste Package Failure (Rockfall)	✱	✱
Seismicity: Accelerated Corrosion (Rockfall)	✱	
Fault Displacement		✱
Criticality	✱	
Human Intrusion	✱	

## EXTRUSIVE IGNEOUS EVENTS

ASSUMPTION	DOE (TSPA-VA)	NRC (TPA 3.2)
Probability	$6 \times 10^{-9}$	$1 \times 10^{-7}$
Number of Conduits in Repository	0 - 4	1
Size of Conduit	2 - 125 m	1 - 50 m
Potential Number of Waste Packages Affected	0 - 136 (Mean: $\sim 1.8$ )	1 - 10
Waste Package Breach	Possible for $T \geq 800^{\circ}\text{C}$ and Thinning of CRM $\geq 50\%$	100% of Intersected WPs
Inventory in Failed WPs Available for Incorporation	50%	100%
Incorporation of Available Waste Into Ash	30%	$\sim 100\%$
Wind Directed Towards Critical Group	14%	100%
Accompanying Intrusive Event	No	Yes

## INTRUSIVE IGNEOUS EVENTS

ASSUMPTION	DOE (TSPA-VA)	NRC (TPA 3.2)
Probability	$1.5 \times 10^{-8}$ (Includes Indirect Effects Scenario)	$1 \times 10^{-7}$ (Probability was Constrained to Equal That for Extrusive Events)
Intrusive Event May Occur without Associated Extrusive Events	Yes	Yes (NRC Sensitivity Studies Have Not Included Intrusive Events without an Associated Extrusive Event)
Failure of Waste Packages Not Directly Contacted by Intruding Magma	Yes, within 1 Dike Width	No
Potential Number of Waste Packages Affected	0 - 170	1 - 65
Waste Package Breach	< 100%; Reductions from: Fragmentation Depth Below Repository	100%
HLW Dissolution in Magma	Yes	No

## ROCKFALL

<b>ASSUMPTIONS</b>	<b>DOE (TSPA-VA)</b>	<b>NRC (TPA 3.2)</b>
Size of Rocks	Based on Fracture Spacing	Based on Fracture Spacing and Yield Zone within Rock
Rockfall Size	Function of Damage Level	Function of Rock Quality
Waste Package Integrity	Time Variant Based on Waste Package Corrosion Estimates	Time Invariant; Maximum Allowable Strain Failure Criterion
Area Affected by Rockfall	Affected Areas are a Function of Rock Quality and Peak Ground Velocity	Related to the Magnitude of Seismic Ground Acceleration and Independent of Rock Quality
Other Factors Used to Reduce Number of Affected Waste Packages	(1) Rocks May Miss Waste Packages (2) Availability of Sufficiently Large Rock	None
Effect on Cladding	Not Clear	N/A
Accelerated Corrosion	Increase in Localized Corrosion Rate	Not Considered
Timing of Failures	Multiple Failure Times Possible	Occur at Midpoint of Time Interval (4 Intervals Used)