U.S. Department of Energy
Office of Civilian Radioactive Waste Management

YUCCA MOUNTAIN PROJECT

Total System Performance Assessment Analyses Evaluating the Final Environmental Protection Agency and Nuclear Regulatory Commission Rules

Presented to:
Nuclear Waste Technical Review Board

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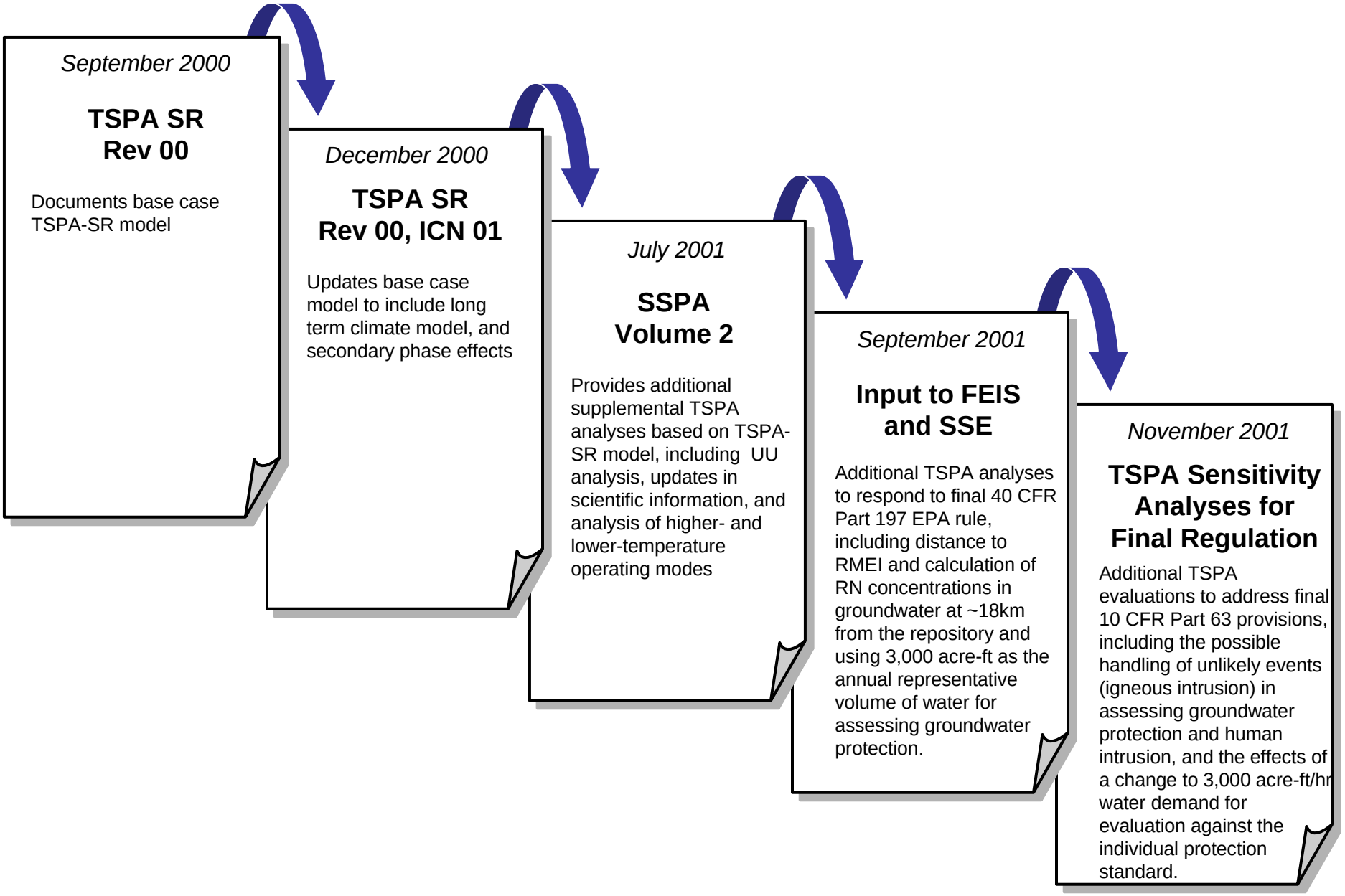
Overview

- Total System Performance Assessment-Site Recommendation (TSPA-SR) Documentation
- Contents of TSPA Letter Report on Final Environmental Protection Agency (EPA) Rule (40 CFR Part 197)
  - To evaluate differences between proposed and final rule
- Contents of TSPA Letter Report on Final Nuclear Regulatory Commission (NRC) Rule (10 CFR Part 63)
  - To evaluate minor differences between proposed and final rule
- Summary

TSPA-SR Documentation



Contents of Letter Report on Final EPA Rule (40 CFR Part 197)

- **Conducted TSPA analyses for updated Supplemental Science and Performance Analyses (SSPA) model**
- **Analyses considered various waste inventories**
  - **70,000 MTHM inventory High Temperature Operating Mode (HTOM) and Low Temperature Operating Mode (LTOM)**
  - **Expanded inventory (Module 1 and Module 2) (HTOM)**
- **Analyses for Igneous Activity Scenarios (HTOM/LTOM)**
- **Analyses for Human Intrusion (HI) Scenarios (HTOM)**
  - **30,000 years post closure**
  - **100 years post closure**

Details of Changes in SSPA TSPA Model

- **Groundwater protection assessment modified as specified in 40 CFR Part 197**
  - **Reasonably Maximally Exposed Individual (RMEI) Biosphere Dose Conversion Factors (BDCFs)**
  - **18 km saturated zone (both for groundwater release and ash deposition)**
  - **3000 ac-ft/yr average water demand used in individual protection analyses**
- **Waste inventory calculations removed U.S. Navy spent nuclear fuel from DSNF inventory. Represented Navy fuel as CSNF**
- **Waste-package corrosion calculations assumed general corrosion independent of temperature**

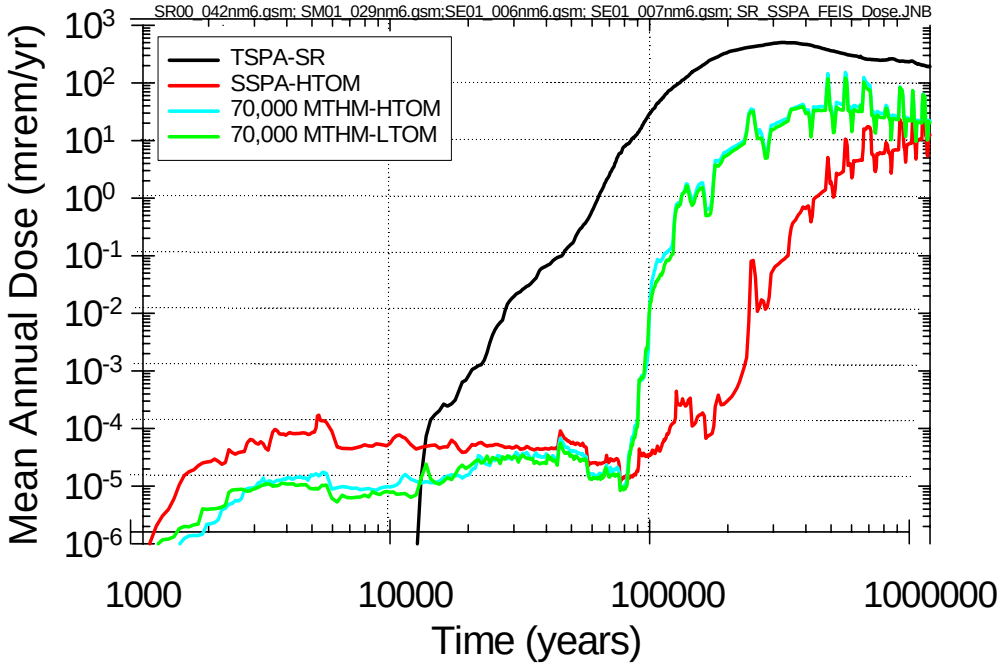
Details of Changes in SSPA TSPA Model

(Continued)

- **Process-level LTOM thermal-hydrologic results were corrected to include radiation connections in the thermo-hydrologic model**
- **Some minor errata corrected in human intrusion scenario, including addition of colloidal transport to UZ borehole**
- **New version of WAPDEG (includes microbiologically influenced corrosion (MIC) and aging multipliers for inside-out corrosion)**

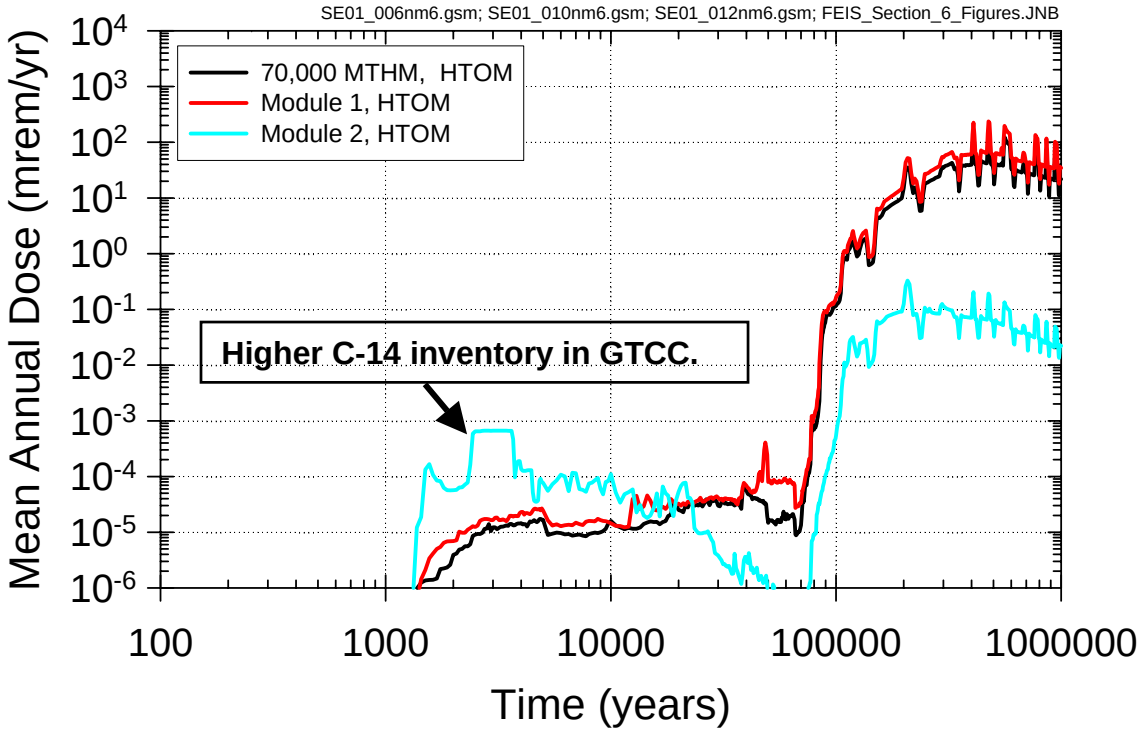
High Temperature Operating Mode Compared to Low Temperature Operating Mode (Nominal case)

- **No significant difference between the 2 operating modes in terms of total system performance**
- **Long waste package lifetime diminishes the effect of early thermal period**



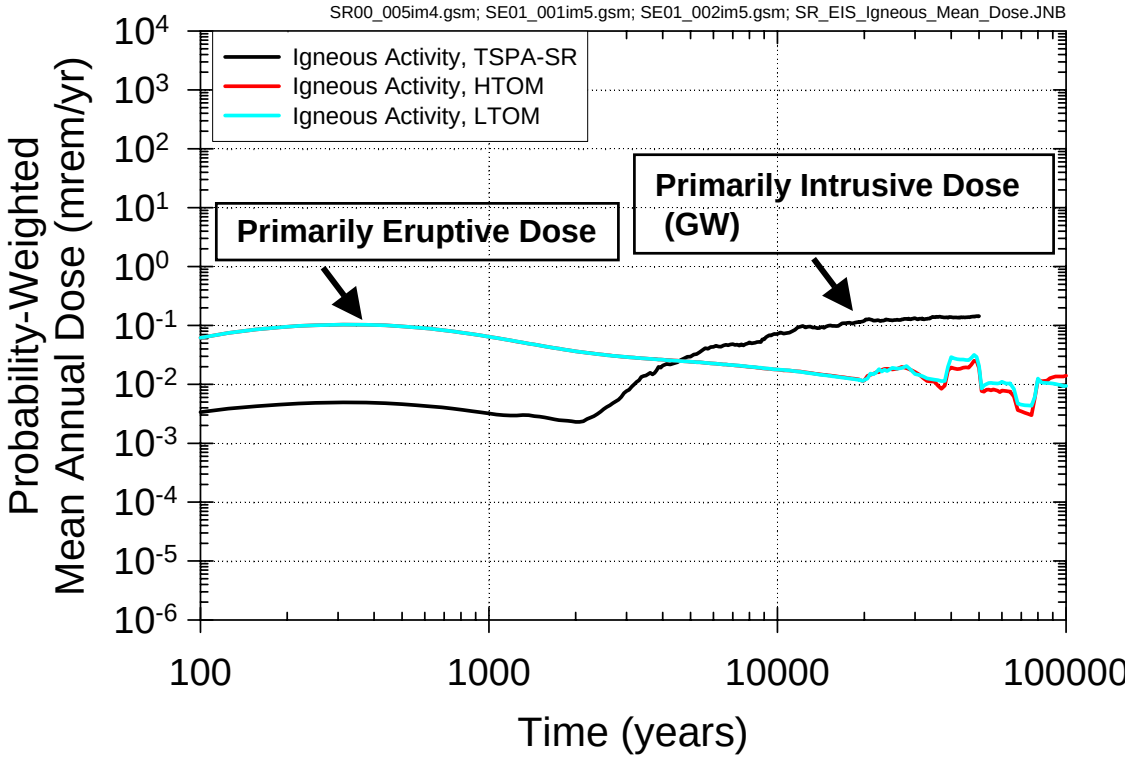
Analyses Considered Various Waste Inventories (HTOM only)

- **70,000 MTHM inventory**
- **Module 1: all waste**
  - **Commercial Spent Nuclear Fuel (CSNF), DOE Spent Nuclear Fuel (DSNF), High-Level Waste (HLW)**
- **Module 2 only:**
  - **Greater Than Class C (GTCC) and Special Performance Assessment Required (SPAR)**



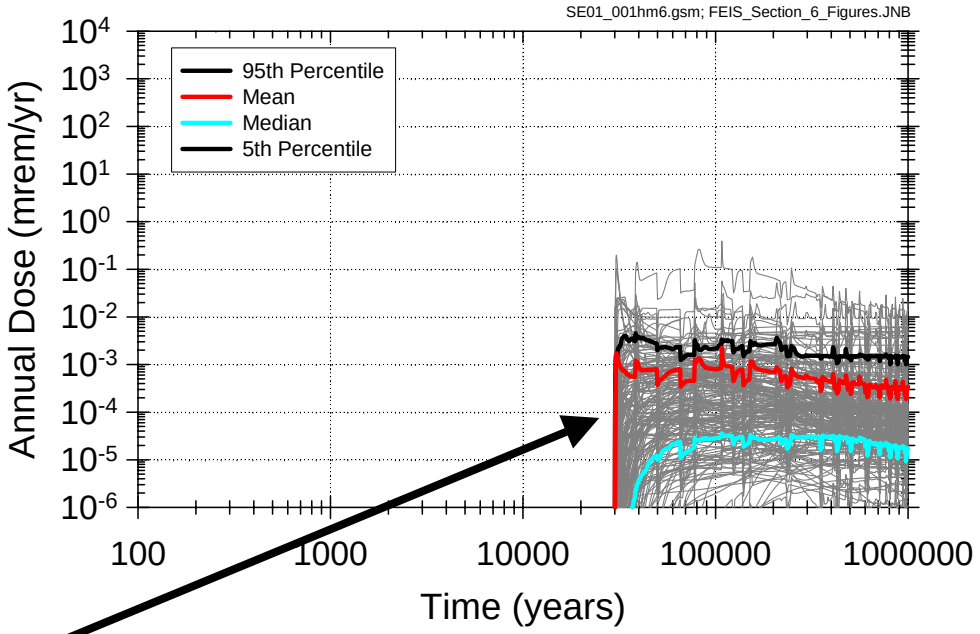
Analyses for Igneous Activity Scenarios (HTOM/LTOM)

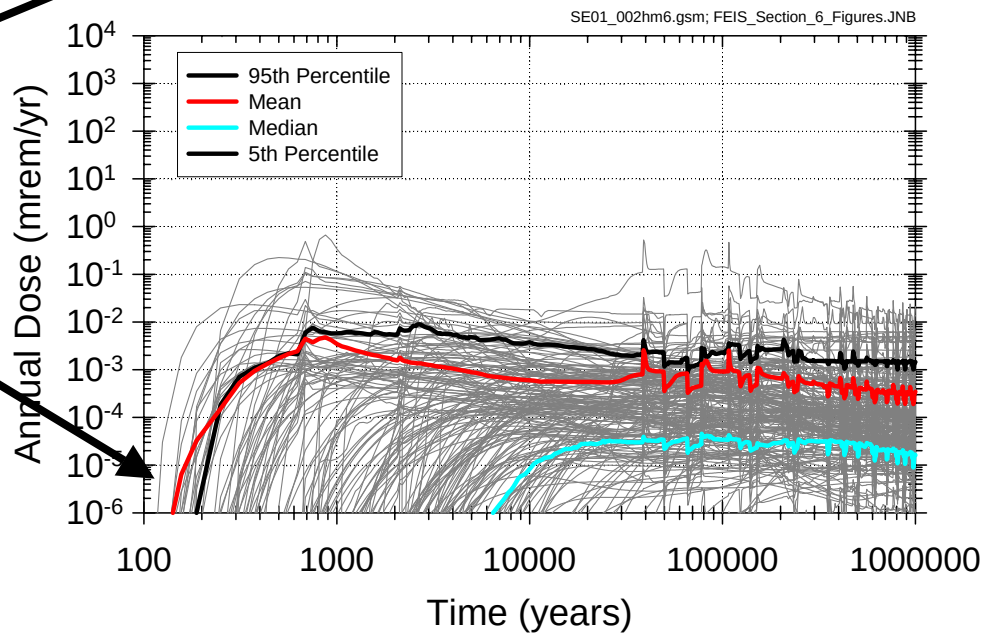
- **Updated for 40 CFR 197**
  - **18 km RMEI location**
  - **BDCFs updated**
  - **Other Features**
- **Early dose greater than TSPA-SR, but dose decreases at later time**



Analyses for Human Intrusion Scenarios

- **Waste package has degraded enough so that driller would not recognize it**
- **Release from 1 waste package through borehole to saturated zone**
- **HI at 30,000 years**
- **Proposed NRC rule of HI at 100 years**



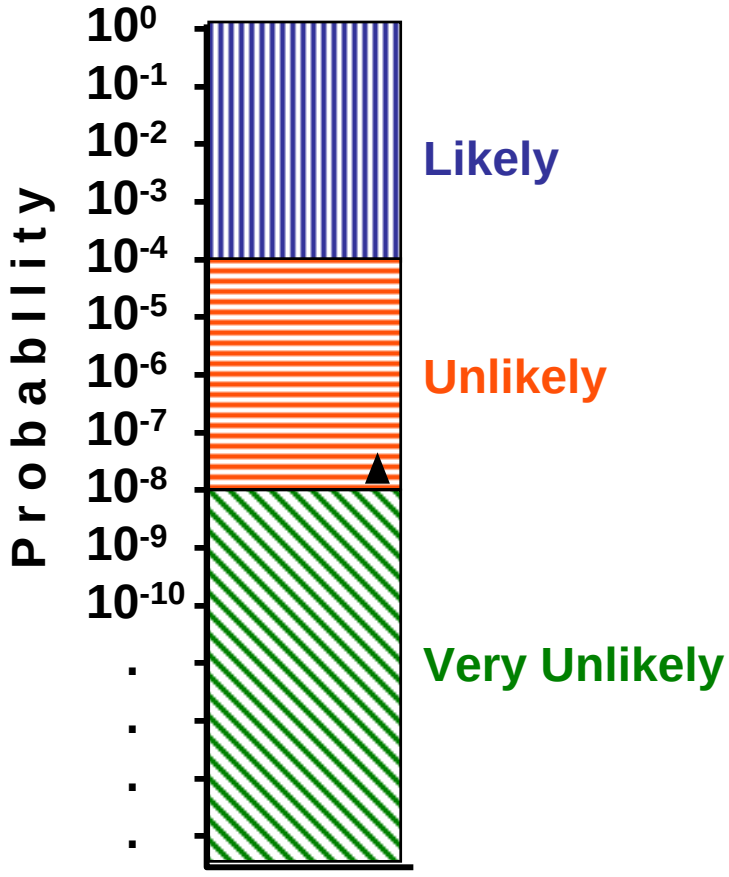


Contents of TSPA Letter Report on Final NRC Rule (10 CFR Part 63)

- **Groundwater (GW) protection standard evaluation utilizing an unlikely igneous-intrusion scenario**
  - **For both HTOM and LTOM**
  - **For total radium concentration, gross alpha concentration, and dose to critical organs**
- **Individual protection standard for HI considering an unlikely igneous intrusion**
  - **HI assumed to occur immediately after the igneous intrusion**
- **Use of 3,000 Acre-ft per year water demand for individual protection standard calculation**
  - **For dose calculation to the RMEI**

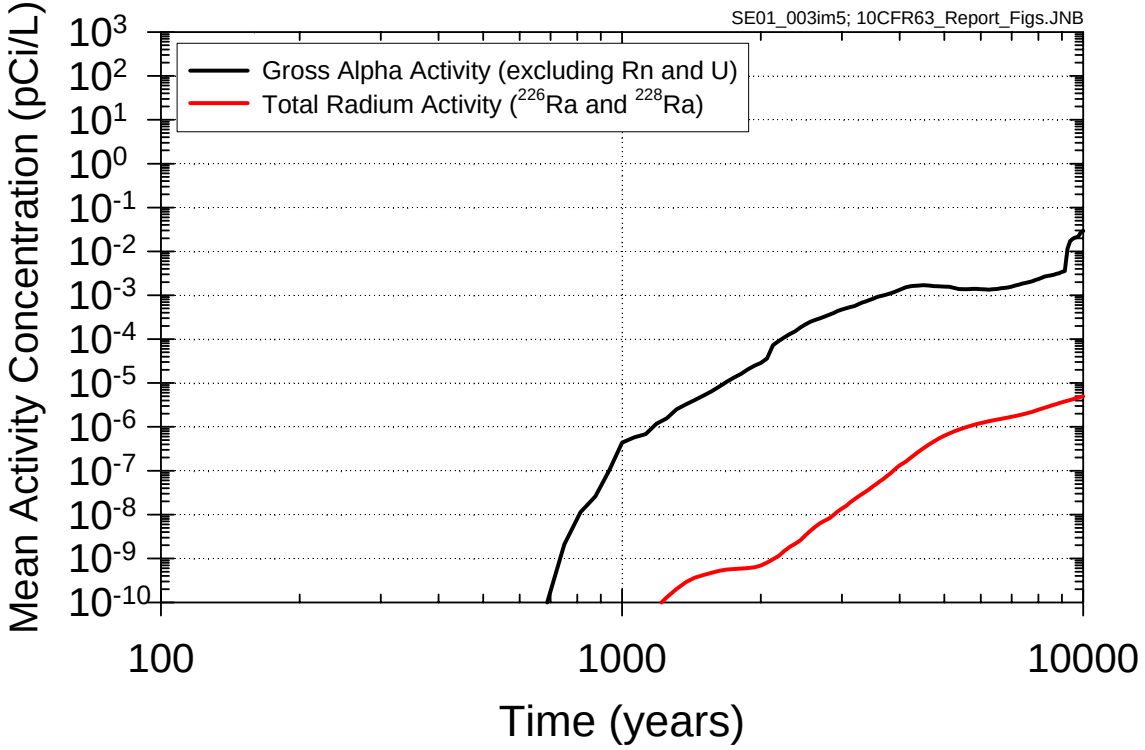
Unlikely Events

- **"Unlikely Features, Events & Processes (FEPs)" not defined in 10 CFR Part 63**
- **Definition of unlikely was expected to be between10^{-8} and 10^{-4} per year at time of these analyses**
- **Mean annual probability of igneous intrusion at potential repository is 1.6×10^{-8} per year (▲)**
- **HI considered to be very unlikely**



GW Protection Standard Evaluation With an Unlikely Igneous-Intrusion Scenario

- **Igneous intrusion disrupts waste packages leading to release to unsaturated zone and then to groundwater**
- **Calculated total radium concentrations are orders of magnitude lower than background (1.04 pCi/l)**
- **Calculated gross alpha concentrations are ~10 percent of background (0.4 pCi/l) for first 10,000 years**



Scenario Logic for Human Intrusion after Igneous Event

- **Base case expects HI wouldn't occur until 30,000 years after closure**
  - **Waste package could be degraded by corrosion processes sufficiently so that driller wouldn't recognize it (a hole is opened in the waste package)**
- **Assumes an igneous event occurs that compromises some waste packages**
- **Assumes driller would not recognize the waste package after igneous disruption**
- **Consequence determined by multiplying the conditional dose, the probability of the initiating igneous intrusion event time, and the probability of the driller not detecting the waste package (assumed to be 1 in this case)**

Individual Protection Standard for Human Intrusion with an Unlikely Igneous Intrusion

- **Assume igneous intrusion probability sometime prior to 30,000 years is 4.8×10^{-4} (30,000 years x 1.6×10^{-8} per year)**
- **Assume HI at 100 years post-closure (max mean dose 4.8×10^{-3} mrem/yr)**
- **Approximate maximum mean dose for this case is 2.3×10^{-6} mrem/year**
- **Potential maximum mean dose due to HI preceded by igneous intrusion is concluded to be much lower than the maximum mean dose due to the igneous intrusion alone**

Use of 3,000 Acre-ft per year Water Demand on Individual Protection

- **Prior to final NRC rule, water demand was approximately 2,000 acre-ft per year (range of 887 to 3367 acre ft per year)**
- **Final rule required use of 3,000 acre-ft per year**
- **Result was to scale the dose to the RMEI by approximately 2/3**
- **Peak mean annual dose for HTOM was reduced from 1.7×10^{-5} mrem/year to 1.1×10^{-5} mrem/year**

Summary

- **Additional analyses conducted to evaluate effect of finalized Environmental Protection Agency (EPA) and Nuclear Regulatory Commission (NRC) rules**
- **Analyses documented in letter reports (included in statewide Supplemental Hearings in December, 2001)**
- **Analyses supplemented other TSPA analyses conducted for SR**