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

NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING

SUBJECT: PERFORMANCE ASSESSMENT EFFORTS IN SUPPORT OF NEW ENVIRONMENTAL STANDARDS

PRESENTER: DR. JAMES O. DUGUID

PRESENTER'S TITLE AND ORGANIZATION: SENIOR SCIENTIST
CRWMS M&O/INTERA
VIENNA, VIRGINIA

PRESENTER'S TELEPHONE NUMBER: (703) 204-8851

ARLINGTON, VIRGINIA
JANUARY 12, 1994

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Objectives of Analyses

- To examine uranium ore bodies and parameter sensitivity of simple repository performance assessments as input to DOE positions on environmental standards for Yucca Mountain
- To provide input to the NAS Committee on Technical Bases for Yucca Mountain Standards

Outline

- Effects of uranium ore bodies
- Sensitivity analyses of simple performance assessments of Yucca Mountain
  - Using UCBNE-41, which is the model used by the NAS Waste Isolation System Panel (1983)
  - Comparison with RIP, which is the model used for TSPA-93
  - Comparison with NEFTRAN-S, which is the model used by EPA for 40 CFR 191

Uranium Ore Bodies: Background

- Two ore bodies were derived based on literature review
- Reducing and oxidizing conditions were examined (20 and 500 ppb ^{238}U, respectively)
- Retardation factors for reducing conditions were taken from the WISP report (1983)
- For oxidizing conditions, the retardation factor for uranium was reduced ~ x8

Uranium Ore Bodies: Background
(Continued)

- Dissolved ^{238}U and daughter products were assumed to be in equilibrium at the ore body
- The model UCBNE-41 was used to determine steady-state concentrations 5,000 m down-gradient from the ore body
- The hydrogeologic and geometric parameters were taken from the EPA study by Williams et al., 1980
- A 100,000 metric ton repository was considered (EPA)

Individual Dose from Drinking Water

Radio-nuclide	Concen-tration, Reducing (pCi / l)	Concen-tration, Oxidizing (pCi / l)	Dose Conversion Factor (rem / Ci)	Dose Reducing (rem / yr)	Dose Oxidizing (rem / yr)
^{238}U	6.7×10^{0}	1.7×10^{2}	8.57×10^{5}	4.0×10^{-3}	0.10
^{234}U	6.9×10^{0}	1.7×10^{2}	9.86×10^{5}	4.8×10^{-3}	0.12
^{230}Th	5.7×10^{-2}	1.8×10^{-1}	6.29×10^{5}	2.5×10^{-5}	7.9×10^{-5}
^{226}Ra	5.6×10^{-1}	1.8×10^{0}	1.38×10^{6}	5.4×10^{-4}	1.7×10^{-3}
^{210}Pb	5.7×10^{0}	1.8×10^{1}	7.43×10^{6}	3.0×10^{-2}	9.4×10^{-2}
Total				3.9×10^{-2}	0.32

Integrated Health Effects for Repository Equivalent Ore Body

- The integrated health effects over 10,000 years were calculated assuming that
  - All water flowing through the ore body was used for household use (150 gal/day/person)
  - There are 500 health effects for 10^6 person rem (EPA)
- The number of health effects over 10,000 years is 2,000 and 17,000 for reducing and oxidizing conditions, respectively
- The basis for 40 CFR 191 over 10,000 years is 1,000 health effects

Integrated Releases for Repository Equivalent Ore Body (Oxidizing Conditions)

- Over 10,000 years the integrated release of uranium, ^{230}Th, and ^{226}Ra is 74.0, 0.04, and 0.4 Ci, respectively (per 1,000 MTHM)
- The release limit (40 CFR 191) for uranium, ^{230}Th, and ^{226}Ra is 100, 10, and 100 Ci, respectively (per 1,000 MTHM)

Uranium Ore Body Summary

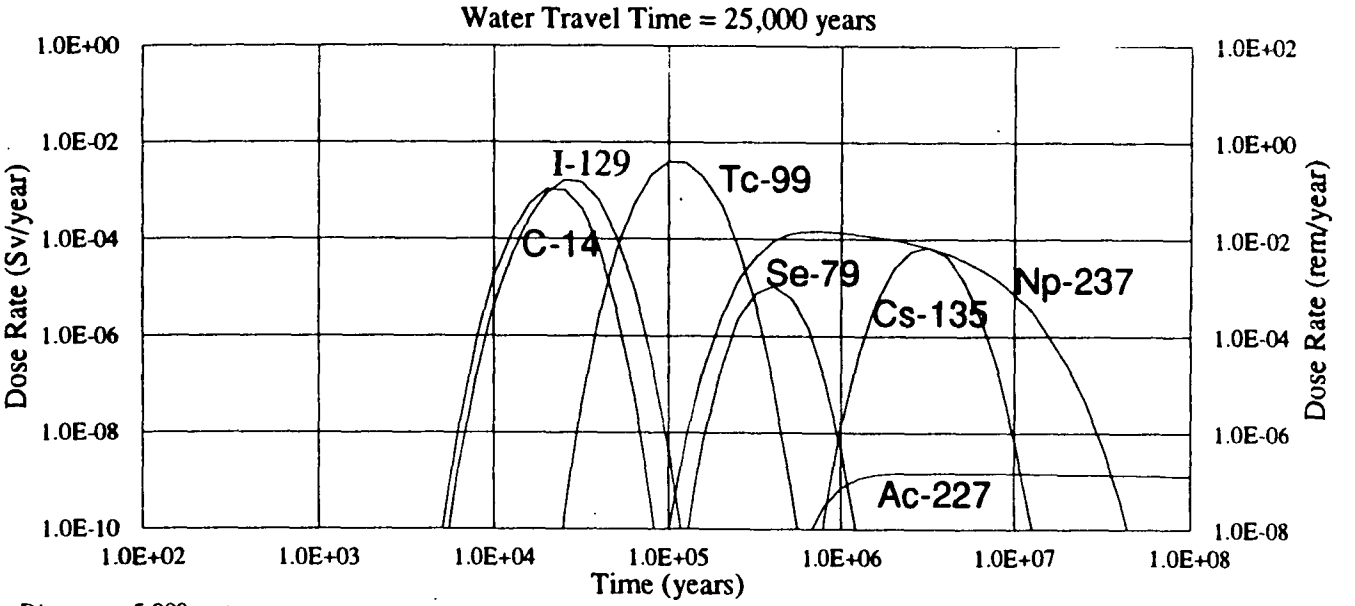
- The dose from drinking water down-gradient of a uranium ore body ranges from 39 to 320 mrem/yr
- The number of health effects over 10,000 years ranges from 2,000 to 17,000
- The integrated release of uranium and daughters over 10,000 years from the ore body (oxidizing) is lower than the EPA standard
- Thus, an average uranium ore body would meet the EPA release standard but not the health effect basis for the Standard

Repository Sensitivity Analyses
Individual Dose Assumptions

- Ground-water travel time = 25,000 yrs
- Infiltration = 1.0 mm/yr = percolation flux
- Porosity = 0.1
- Aquifer thickness = 2400 m
- Dilution factor = 1.15×10^{-4}
- Dispersion coefficient = 50 m^2/yr
- ^{129}I, ^{14}C, ^{99}Tc, ^{79}Se, ^{135}Cs are alteration-controlled
- Other radionuclides are solubility-limited

Individual Dose Rate (UCBNE-41)

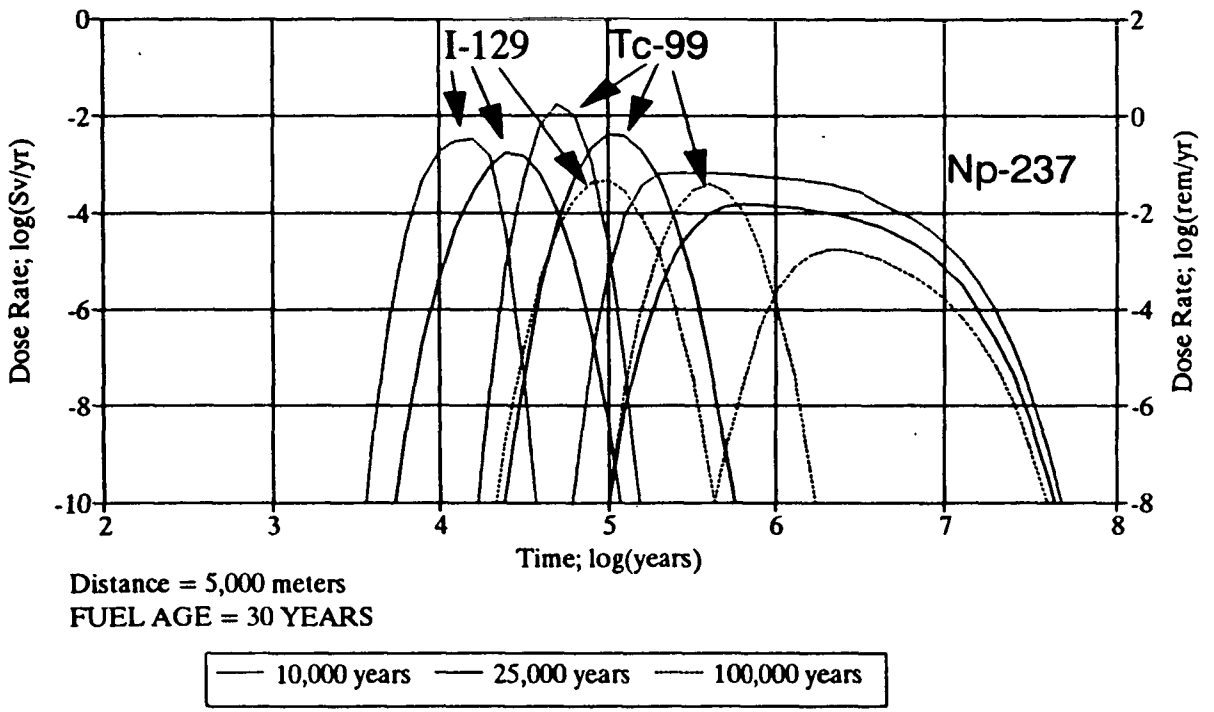
(Baseline Case)



Distance = 5,000 meters
FUEL AGE = 30 YEARS

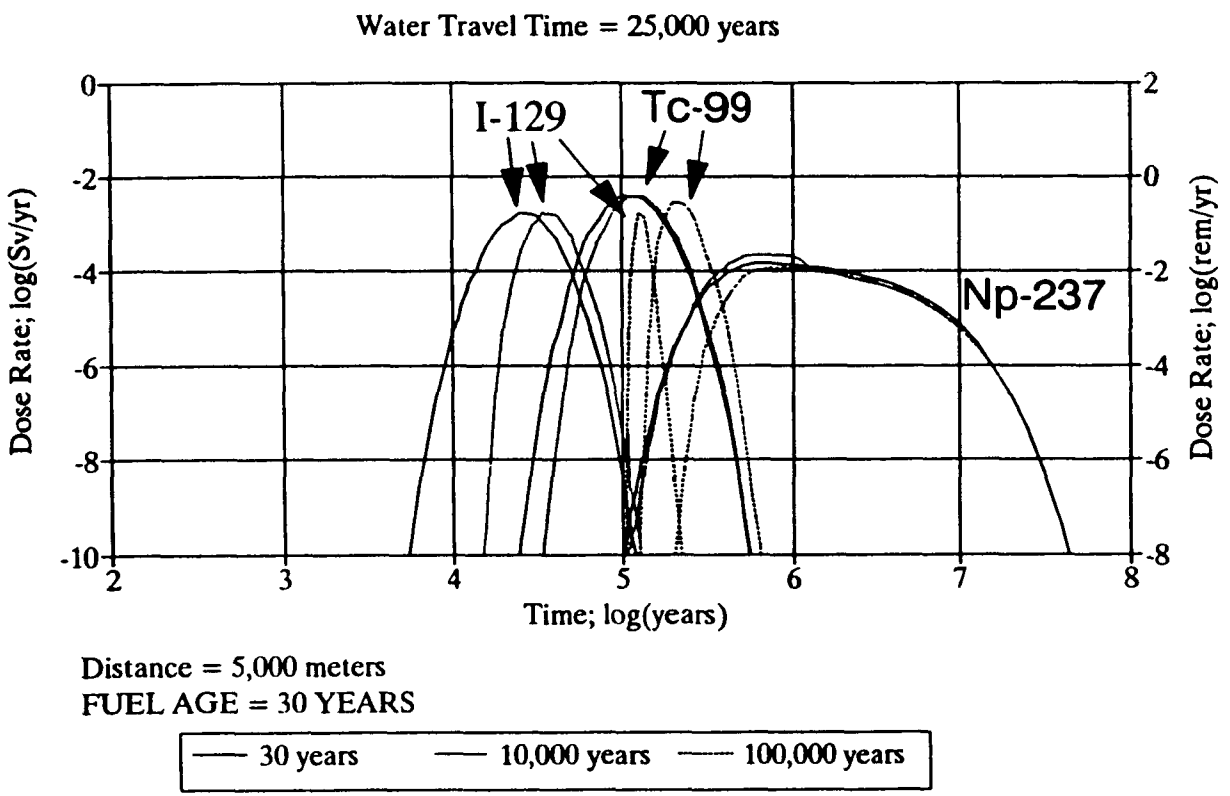
Sensitivity to Percolation Flux

(0.21, 1.0, and 4.0 mm/yr = 100,000, 25,000, and 10,000 yr ground-water travel time, respectively)

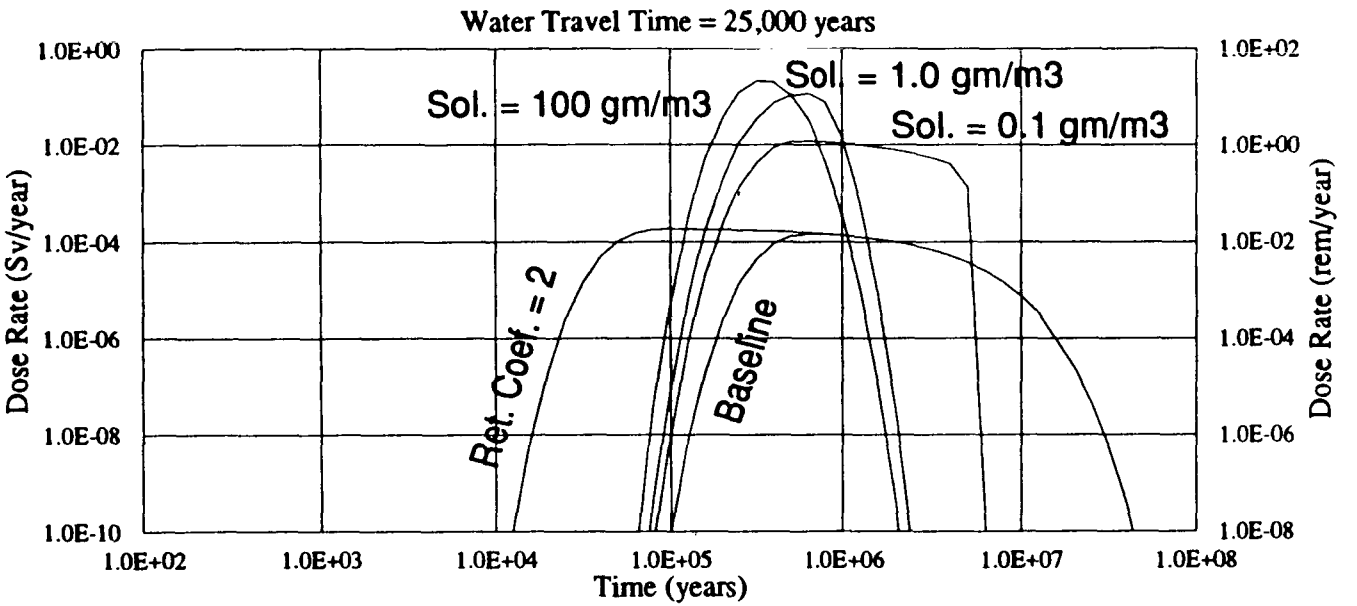


Sensitivity to Waste Package Lifetime

(0, 10,000, and 100,000 yrs)



Sensitivity to ^{237}Np Solubility and Retardation



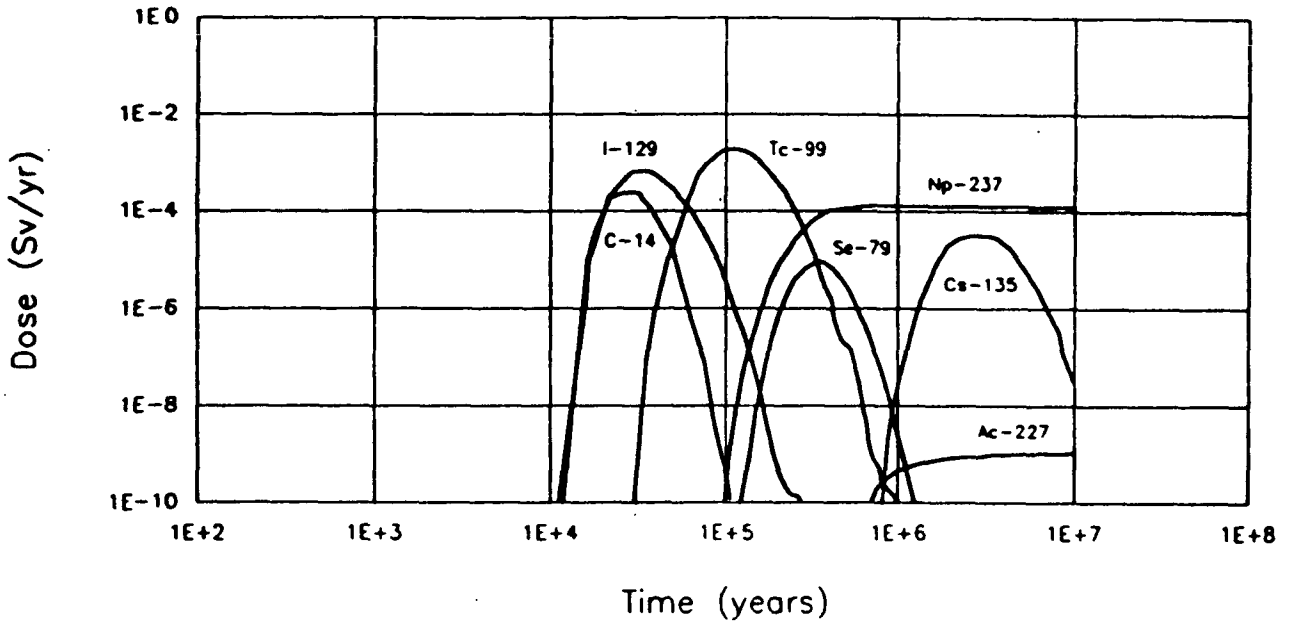
Base Case: Ret. Coef = 16; Sol. = 0.001 gm/m3
Distance = 5,000 meters
FUEL AGE = 30 YEARS

Summary of Sensitivity Analyses

- If new Yucca Mountain standard is for all time, waste package life has little effect on long-term dose
- Long-term doses are sensitive to flux through the package and ^{237}Np solubility (e. g., source term)
- Long-term dose could be reduced by controlled release of the source term

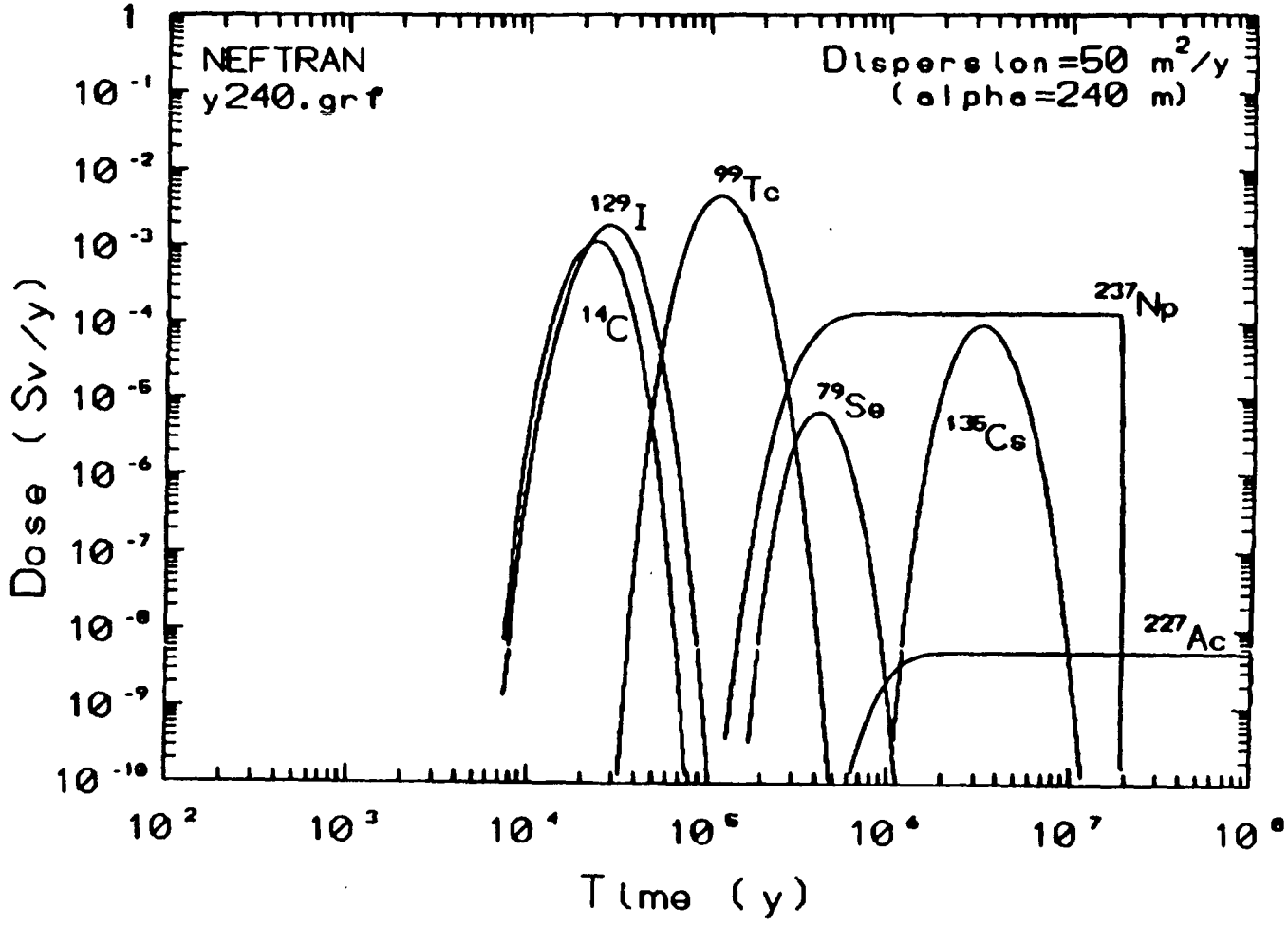
Individual Dose Rate (RIP)

(Baseline Case)



Individual Dose Rate (NEFTRAN-S)

(Baseline Case)



Geohydrologic and Size Characteristics of the Derived Uranium Ore Body

Hydraulic conductivity	**1.0×10^{-4} cm / sec**
Gradient	**0.01**
Porosity	**0.15**
Pore velocity	**2.1 m / yr**
Thickness	**30 m**
Width	**3700 m**
Length	**50 m (in the direction of flow)**
U_3O_8 concentration	**0.09 %**
Host rock density	**2.0 gm / cm^3**
Reserve	**10,000 metric tons U_3O_8**
Repository conversion factor	**62**