UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

June 24, 1998

MEMORANDUM TO: L. Joseph Callan
Executive Director for Operations

FROM: Malcolm R. Knapp, Acting Director
Office of Nuclear Material Safety and Safeguards

SUBJECT: BRIEFING FOR OFFICE OF SCIENCE AND TECHNOLOGY ON DRAFT ENVIRONMENTAL PROTECTION AGENCY YUCCA MOUNTAIN STANDARD (40 CFR PART 197)

On June 22, 1998, M. Knapp, Acting Director, Office of Nuclear Material Safety and Safeguards (NMSS), and M. Bell, Acting Chief, Performance Assessment and High-level Waste Integration Branch, NMSS, attended a briefing of the Office of Science and Technology Policy (OSTP) staff by the U.S. Environmental Protection Agency (EPA) staff on EPA's draft Yucca Mountain Standard. The briefing was a follow-up to an earlier briefing given by the U.S. Department of Energy (DOE), which U.S. Nuclear Regulatory Commission (NRC) staff did not attend. It was given by L. Weinstock, Acting Director of EPA's Office of Radiation and Indoor Air. OSTP was represented by Dr. Arthur Bienenstock, Associate Director for Science, and several staff members. L. Barrett, Acting Director of DOE's Office of Civilian Radioactive Waste Management, and J. Pfeiffer, Office of Management and Budget, were also present. A copy of the EPA briefing charts is attached.

Dr. Bienenstock stated early in the meeting that he wanted to understand the basis for EPA's draft standard and DOE's and NRC's concerns about implementing it. OSTP's objective in the meetings is to negotiate an acceptable standard, and views getting agreement between DOE and EPA as the principal consideration. While the briefing covered a number of aspects of the draft standard, it focussed primarily on the implementability of the groundwater protection requirements. It was recognized during the briefing that EPA was applying Safe Drinking Water Act Standards, which are implemented at the tap, to groundwater. When questioned on the basis for this, Weinstock referred to letters from Administrator Browner commenting on Congressional legislation, and committed to provide these to OSTP. NRC staff presented its view that an all-pathways standard adequately protects public health and safety, and that groundwater as a source of drinking water is adequately protected as one of these pathways. EPA stated in the briefing that one reason for protecting groundwater in the aquifer underlying Yucca Mountain was its potential as a future source of drinking water for Las Vegas. NRC staff pointed out that the National Academy of Science (NAS) Technical Basis Report on Yucca Mountain Standards advised against speculation on such future human activities and is basing its analyses on the types of activities and lifestyles which currently exist near Yucca Mountain, e.g., in Amargosa Valley, approximately 20 km down gradient from the site.

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A principal outcome of the briefing was the recognition that, given the way EPA's groundwater protection requirements are currently drafted, their implementation would require a level of characterization of the flow system and a level of detail in the modeling of the flow system, that is unimplementable for such a large hydrogeologic system. Part of this discussion involved EPA's desire to protect the individual withdrawing water from the center of the plume of contaminated groundwater, which allows no mixing with uncontaminated groundwater. Under NRC staff's approach, the protected individual drinks water resulting from a typical pumping scenario adequate to supply a farming critical group. (Consideration of such a pumping scenario leads to larger pumping rates and greater mixing in the aquifer than the EPA approach. NRC staff views this approach as being implementable, more realistic and consistent with the recommendations of the NAS.) EPA stated its view that regulating radionuclide concentrations in the aquifer is consistent with other activities it regulates, that it considered the NAS recommendations as only advisory, and that for EPA simply to adopt the NAS recommendations would be to abandon EPA's statutory responsibility to protect public health and the environment. EPA was asked by OSTP to consider the discussion concerning the implementability of its current approach and to come back with a revision that would recognize the state of the technology in being able to characterize and model flow systems as large as that being protected at Yucca Mountain. While it was clear that OSTP had some questions regarding EPA's current draft, it also appeared that, provided an implementable approach were found, OSTP would recommend a Yucca Mountain Standard that included groundwater protection criteria. There was only very brief discussion of EPA's draft 15 mrem/yr individual protection requirements versus NRC's recommended range of 25 to 30 mrem/yr. Since DOE indicated it believed it could meet 15 mrem/yr to an individual at Lathrop Wells, in Amargosa Valley, EPA's recommended point of compliance, this was not viewed as a significant issue.

At the close of the meeting DOE informed OSTP that its technical staff involved in modeling groundwater flow and transport at Yucca Mountain would be at its headquarters next week and offered to provide OSTP briefings on its modeling capability. This offer was accepted and June 29, 1998 was discussed as a potential date for such briefings, time and venue to be determined later. Dr. Bienenstock is also making plans to visit the Yucca Mountain site on July 13, 1998. NRC staff will continue to participate in future interactions and to keep the Commission informed of any significant developments.

Attachment: As stated

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PROPOSED STANDARDS FOR DISPOSAL OF RADIOACTIVE WASTE AT YUCCA MOUNTAIN

BRIEFING FOR DR. BIENENSTOCK

OFFICE OF RADIATION AND INDOOR AIR
U. S. ENVIRONMENTAL PROTECTION AGENCY
June, 1998

Purpose

To provide information on proposed standards for disposal of spent nuclear fuel and high-level radioactive waste in a potential repository at Yucca Mountain. The briefing will cover:

- **EPA's Proposed Rule**

  - **Level of individual protection**
  - **Definition of receptor for individual protection**
  - **Regulatory compliance period**
  - **Ground water protection requirements**
  - **Points of compliance**
  - **Population protection**
  - **Human intrusion**

- **Discussion of Engineered Barriers**

Major Issues in Standard Setting: Consistency with Existing High-Level Waste Standards (40 CFR 191)

Although we are setting site specific standards, 40 CFR 191 is an important precedent both legally and politically.

- **40 CFR 191 covers:**

  - **WIPP**
  - **Any potential HLW disposal site other than Yucca Mountain**

- **Examples of potential changes**

  - **Drop containment standard (site in closed basin)**
  - **Change human intrusion (multiple intrusions do not interact)**
  - **Points of compliance (use data from actual site)**

Major Issues in Standard Setting: Consistency with Existing High Level Waste Standards (40 CFR 191)

Places where consistency is needed: individual protection standard, ground water standard

- **All Americans deserve same level of health protection**

  - Cannot provide Nevadans with less protection than New Mexicans

- **All ground water is protected by the Safe Drinking Water Act and Administration Policy**

  - Yucca Mountain is above a large drinking water aquifer

Proposed Yucca Mountain Standards

Level of Individual Protection - 15 mrem/yr (3×10^{-4} lifetime)

NAS recommended a risk level of 10^{-5} to 10^{-6} per year (2 to 20 mrem/yr)

- **EPA Rationale:**
  - **Risk is the highest level considered protective by EPA for environmental carcinogens**
  - **40 CFR 191 standard is 15 mrem/yr, Nevadan's deserve equal protection**
  - **15 mrem/yr is within the NAS recommended range**
  - **Equivalent to NRC's low-level waste disposal standard**

Proposed Yucca Mountain Standards

Definition of Receptor for Individual Protection: Reasonably maximally exposed individual (RMEI) which is calculated by using cautious, but reasonable, exposure parameters.

- **NAS recommended average member of a critical group**
- **EPA Rationale:**
  - **RMEI as a surrogate for critical group approach recommended by the NAS was selected to ease implementation. Critical group approach is very complex and has never been used in U.S.**
  - **RMEI is consistent with other environmental regulations for chemicals. EPA's 40 CFR 191 and most other radiation standards use maximally exposed individual**
  - **RMEI would be implemented by assuming a "rural residential" individual: located at Lathrop Wells (20 km); and ingesting contaminated drinking water and locally grown food**

Proposed Yucca Mountain Standards

Regulatory compliance period for individual and ground water standard 10,000 years, with assessments at longer time frames. Analysis for over 10,000 years should be done for EIS.

NAS recommended time to peak dose within the geological stability of the site which the NAS believes is 1 million years

- **EPA Rationale:**
  - **Uncertainties become too great beyond 10,000 years for use in regulatory proceeding**
  - **40 CFR 191 standard uses a 10,000 year compliance period**
  - **10,000 years is the longest period used by EPA in regulation**

Proposed Yucca Mountain Standards

Protect ground water to the MCLs

NAS has no recommendation

- **EPA Rationale:**
  - **Consistent with Administration's Yucca Mountain policy to apply existing environmental laws, including the Safe Drinking Water Act.**
  - **Administration policy is that the responsibility lies with the potential polluter to keep ground water clean; not for users to treat water**
  - **Consistent with 40 CFR 191, all sources of drinking water should be protected**
  - **Yucca Mountain sits on a large, clean aquifer capable of supplying water to 250,000 people. It is likely that water will ultimately be used as drinking water for fast growing Las Vegas metropolitan area.**

Proposed Yucca Mountain Standards

Points of Compliance

Preamble and RegulatoryText

- <u>Individual Protection</u>
  - Lathrop Wells (20 km from Yucca Mountain)
    - Protect current RMEI
- <u>Ground Water Protection</u>
  - Outside a 5 km zone
    - Consistent with 40 CFR 191
  - Lathrop Wells (20 km from Yucca Mountain)
    - Protect current ground water users
  - Amargosa Farms Area (30 km from Yucca Mountain)
    - DOE preference

Preamble Only

- <u>Ground Water Protection</u>
  - Repository Footprint
    - most protective
  - Test site boundry
    - Actual current control area
  - No ground water protection
    - complete set of options

Proposed Yucca Mountain Standards

- **Population Protection**
  - **No regulatory limit**
  - **Considered under the NEPA process**
- **Human Intrusion**
  - **15 mrem/yr limit as test of repository resilience**
  - **Simple, stylized scenario consistent with NAS**
  - **Considered separately from individual and ground water protection standard**

Implementing Ground Water Standards

- **Concentration in representative volume at point of compliance must not exceed**

  - 15 pCi/l gross alpha
  - 5 pCi/l radium
  - 4 mrem/yr beta/gamma

- **Point of Compliance in regulatory language**

  - 5 km
  - 20 km (near intersection of US 95 & Nevada 373)
  - 30 km (Amargosa Farms)

Determining the Representative Volume

- Calculate amount of water necessary for a family of four for a year
- Calculate the capture zone for a well needed to supply the water demand
- Locate that volume of aquifer within the center of the plume at the point of compliance

Engineered Barrier Performance

- Critical to repository performance at Yucca Mountain
  - Ground water *will* pass through the repository over the long-term
  - Releases from the waste package *are anticipated over the long-term*
  - Radionuclide travel times in fractured rock regimes *can be short*
  - Radionuclide retardation mechanisms *may be minimal* in fractured rock regimes
- The engineered barrier is the means to provide containment
  - System elements can be *engineered for site conditions*
  - System elements can be *engineered to maximize performance*

DOE Assessments of Engineered Barrier Performance

- Early doses (<10,000 yrs) are due to early waste package failures
  - Early waste package failure due to failures in closure welds, extreme corrosion rates

- To assess performance, assumptions must be made for:

  - The number of weld failures that result in water entering the package
  - How fast water can contact fuel elements
  - The failure of cladding to permit access to the fuel
  - Dissolution rate of fuel
  - Exit pathway from the waste package and the emplacement drift

- Even with conservative assumptions doses are below limits for 10,000 years

DOE Assessments of Engineered Barrier Performance

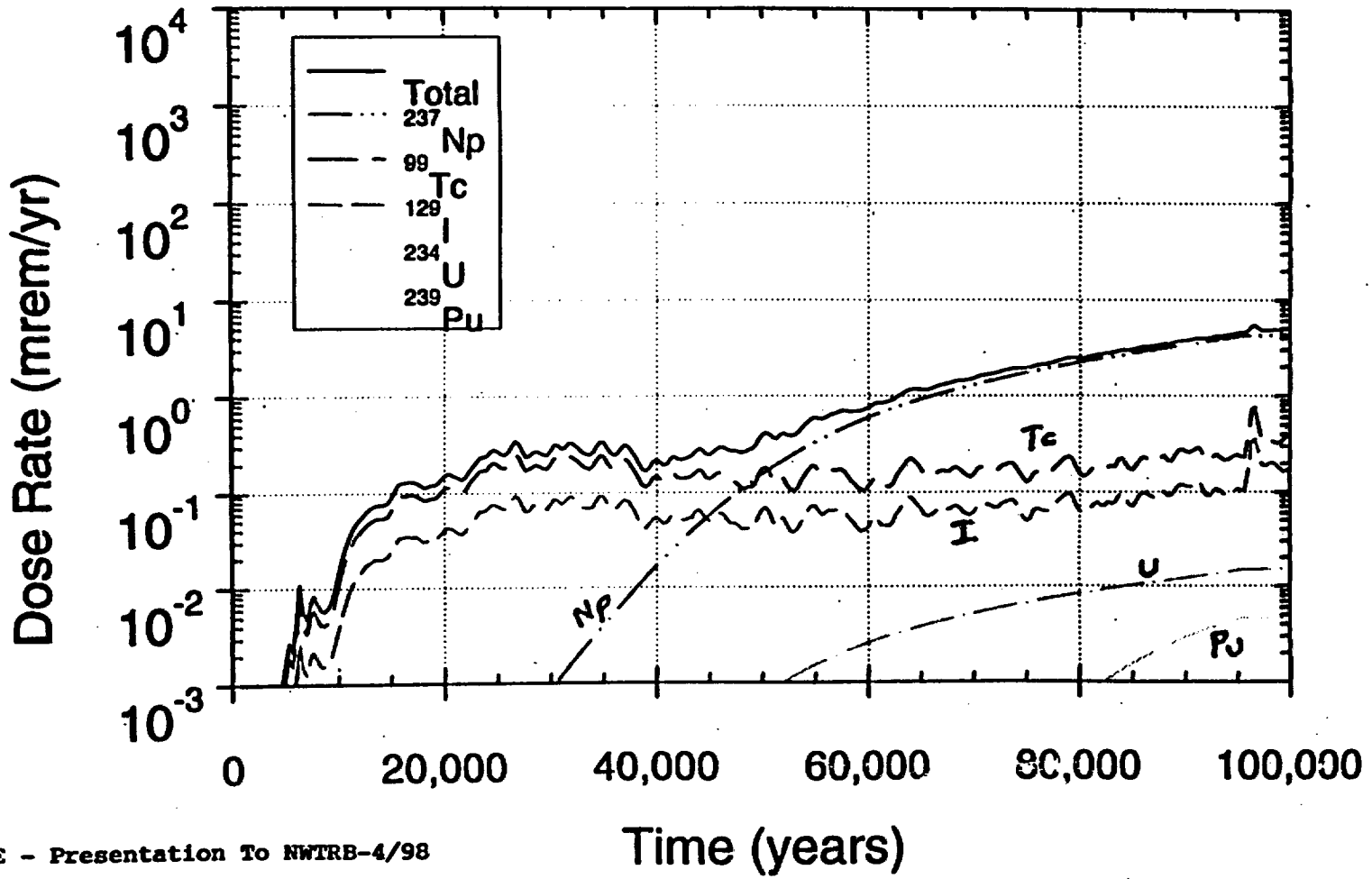
- **Latest DOE results show standard is met by two orders of magnitude**

  - Maximum dose at 10,000 yrs ~ 10^{-2} mrem/yr

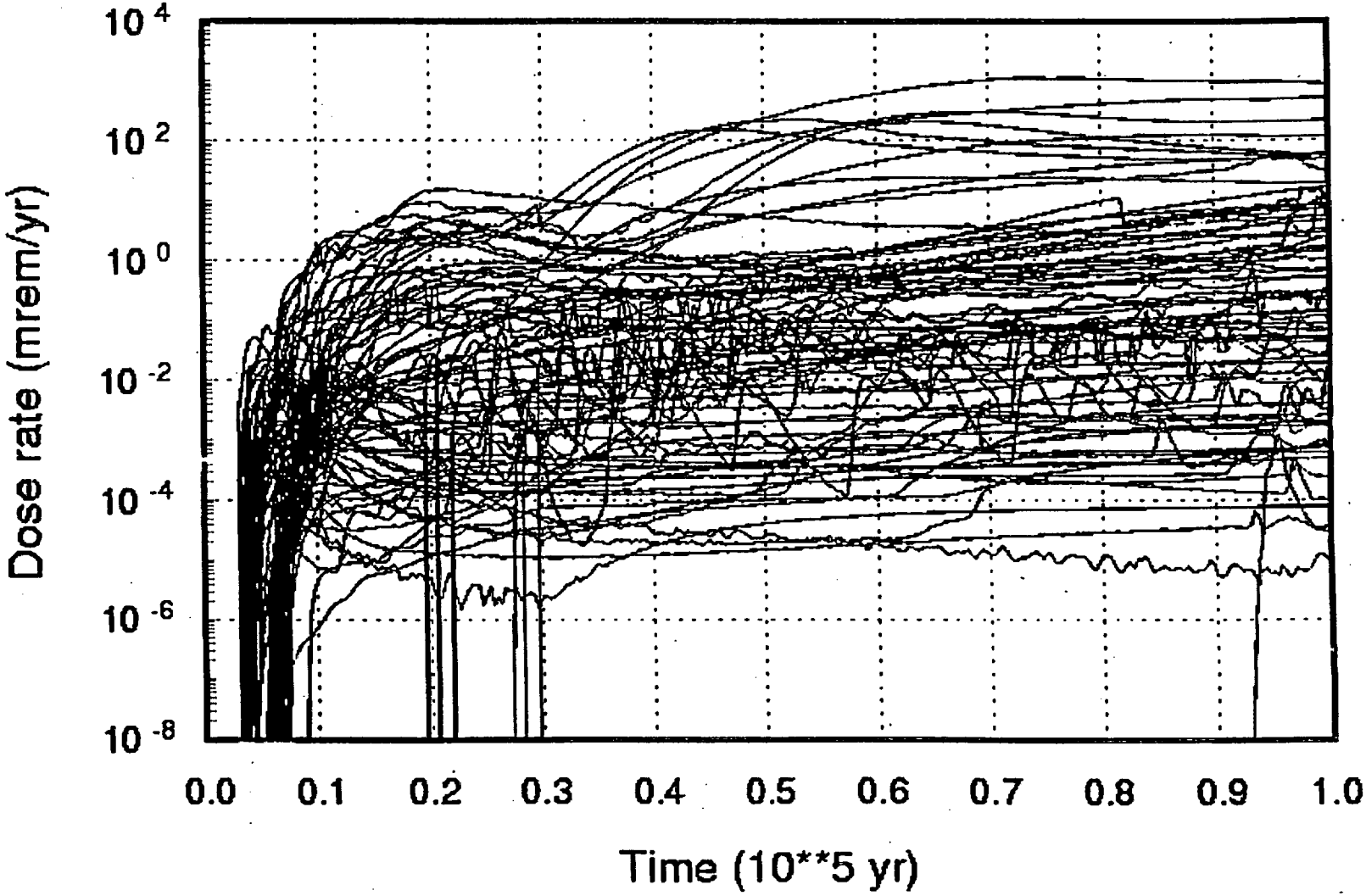
  - Maximum dose at 100,000 yrs ~ 5 mrem/yr

100,000-yr Dose to "Average" Individual at 20 km

Base Case
100,000-yr Expected-Value Dose-Rate History
All Pathways, 20 km



80 Dose Time Histories For the Base Case
20 Realizations Have Zero Dose



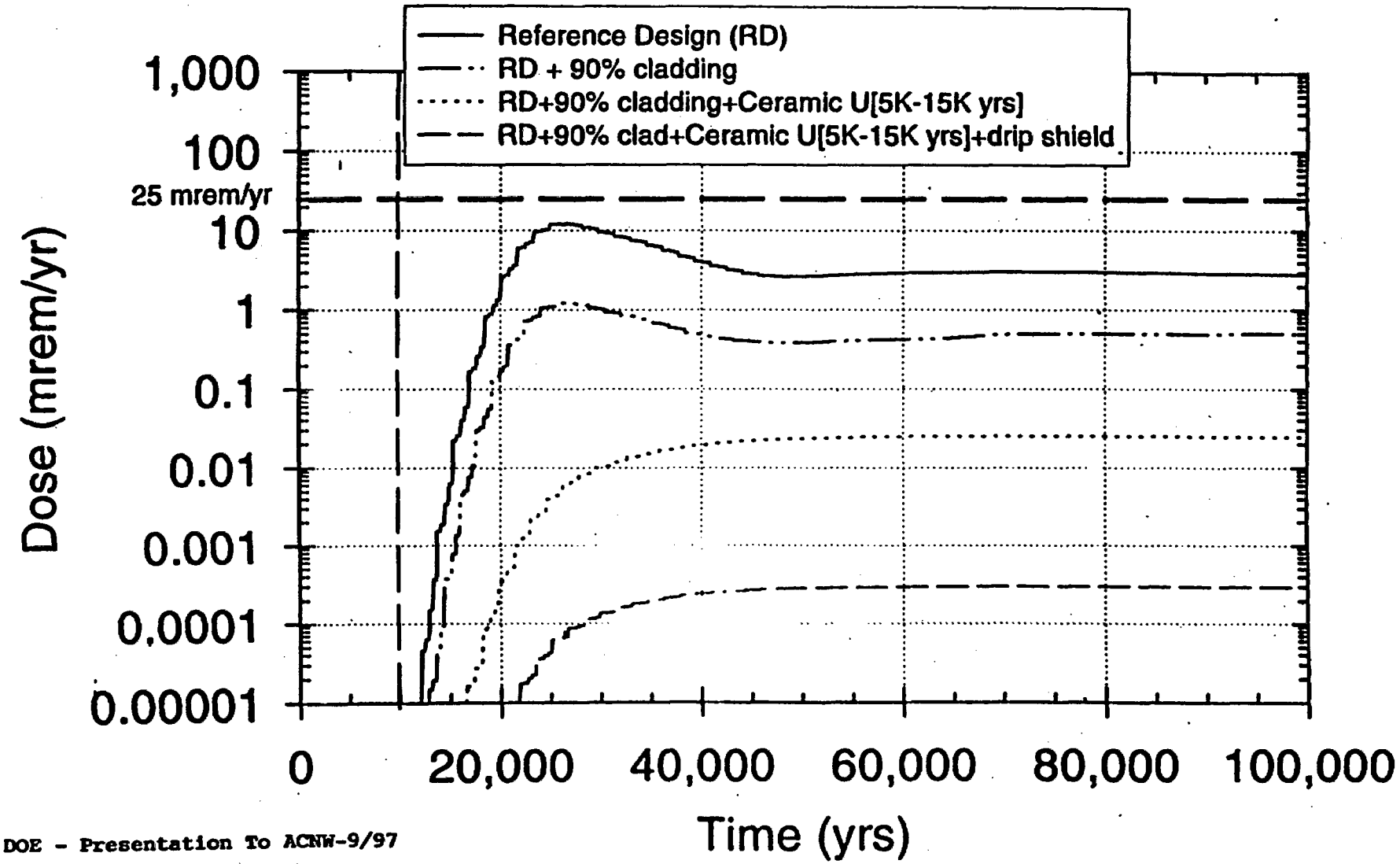
Additional Engineered Barriers 10,000 yr Performance

- Drip shields placed over waste packages
  - Several designs possible (free standing, attached to waste package, supported by backfill)
  - Prevent water access to waste packages - minimize early package failures

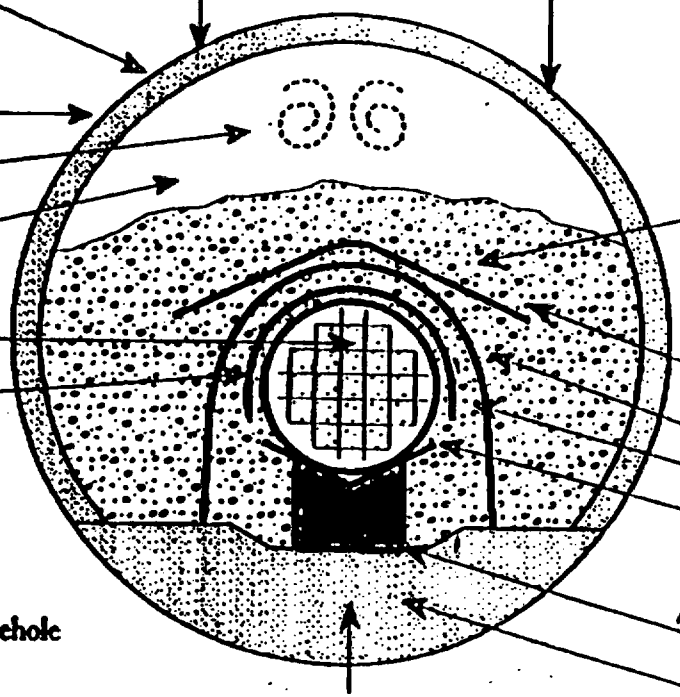
- Increasing Waste Package Containment Lifetime increases penetration time
  - Corrosion resistant material on the outside of the package
  - Two corrosion resistant container metals - increases penetration time

- Design Engineered Barrier System to Minimize Corrosion and Mobilization
  - Backfill and additives condition water and retard radionuclide migration
  - Increase cladding credit justification
  - Add fillers to the waste package to limit fuel dissolution

100,000-yr All Pathways Total Dose History
At 20km boundary



Design Options for Waste Isolation



Surface Control
Land Withdrawal
◆ ★ Infiltration Control

▲ ◆ ★ Altered Near–Field Rock

Drift Liner
★ Normal Concrete
★ Low pH Concrete
◆ ★ Pre–Cast Concrete
◆ ★ Cast–In–Place Concrete
★ Steel Sets

◆ ★ Emplacement Drift Wall

★ Grout Injection

★ Crown Joint
◆ ★ No Crown Joint

★ Ventilation

Air Gap
◆ ★ (Capillary Barrier)

◆ Cladding Credit

Waste Package
● Corrosion Allowance Material
● Corrosion Resistant Material
● Galvanic Protection
◆ ● Filler
Ceramic Coating (Inside or Outside)
★ Large, Small, Small–in–Large
In–drift, Vertical Borehole, Horiz. Borehole

Thermal Design
◆ ★ Areal Mass Load (High, Low)
◆ ★ WP Spacing)Point, Line)
SNF assembley Blending
★ To meet 18 kW limit
To meet criticality limit
★ Control Thermal Variablility
WP Sequencing
★ 4–Drifts Open
Lag Storage
★ Subsurface
★ Surface

Upper Backfill
★ Rock Fall Protection
◆ ★ Limit Flow & Humidity
◆ ★ Dual Layer
◆ ★ Single Layer
◆ ★ Condition Water

Drip Shield
◆ ★ Supported by Backfill
◆ ★ Free Standing
◆ ★ Supported by WP

Lower Backfill
◆ ★ Condition Water
▲ Sorb Releases

★ Pedestal

Invert
▲ Additives (Non–Restricted)
▲ Additives (Restricted)

▲ Layout of Emplacement Drift
Sloped
Level

▲ Zeolites

★ Limit WP Environment
● Robust WP
◆ Limit Mobilization
▲ Radionuclide concentration Reduction