YUCCA MOUNTAIN PROJECT

Studies

Use of Performance Assessment in the LADS Process

Presented to:
Nuclear Waste Technical Review Board
Panel For the Repository

Presented by:
Robert Howard
CRWMS M&O

January 25, 1999

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

Objective

- **Develop and refine *insight* about the potential for each proposed feature or alternative to improve post-closure repository performance**
  - **The analyses were expected to estimate the change in direction, timing, and magnitude of the dose rate caused by the design option**
  - **The level of detail of the PA analyses for LADS are consistent with the level of detail provided in the design concepts.**
  - **The PA analyses for LADS are not intended to be at the level of detail required for a Safety Case**

Comparison Baseline

- **Deterministic TSPA-VA dose rate history curve was used as the baseline post-closure performance measure**
  - **Calculations used mean values for parameters**
  - **TSPA-VA expected processes were assumed (climite, infiltration, biosphere etc.)**
  - **Results were compared to TSPA-VA 10,000 and 1,000,000 year dose rate histories, time of peak dose, and magnitude of peak dose**
  - **Order of magnitude comparisons are more appropriate than a comparison of absolute values of dose rates**
  - **Changes that are less than an order of magnitude are not considered significant**

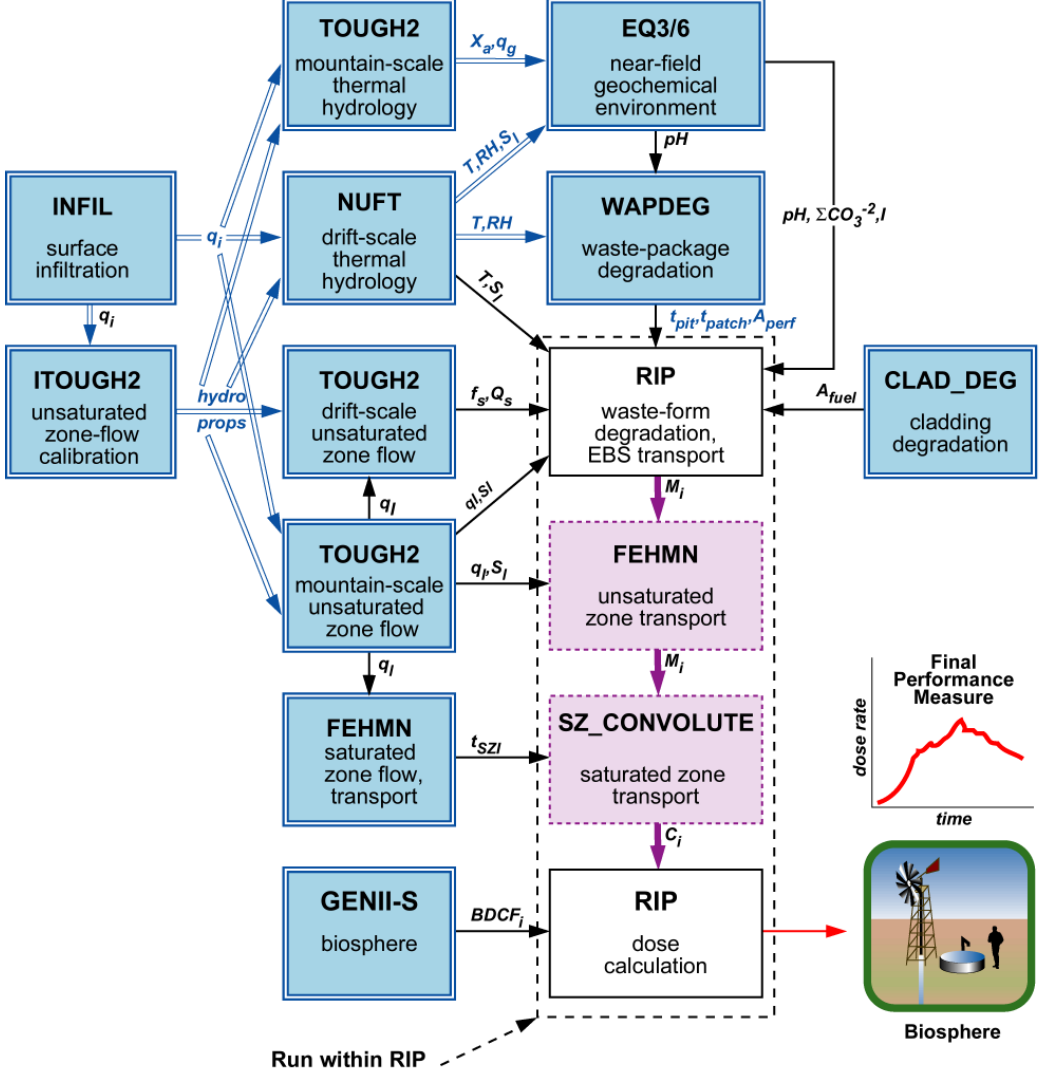
Development of Models for LADS

- **Simple models were used to represent assumptions about performance of various repository design features or alternatives**
  - **Models and parameters representing design options were developed using judgement of PA and Design analysts and documented according to QAP-3-12 and NLP 3-27 quality procedures**
- **Several features were not modeled explicitly, but instead modeled by altering the response of a TSPA-VA component model. (i.e., initiation of seepage was delayed to represent anticipated effect of a Richards Barrier or surface modification)**

Development of Models for LADS

(Continued)

- **Some options required changes to existing TSPA component models and parameters, and development of new process models to reflect temperature dependencies, design configurations, or EBS materials**
  - **Thermal Hydrology (Temperature, RH, layout of heat source, material properties of backfill, pre & post closure ventilation)**
  - **Cladding degradation (temperature dependencies)**
  - **Waste Package degradation (temperature, RH, material properties)**
  - **EBS Transport (material properties - kd's in the waste and invert)**



OUTPUT Parameters

T	Temperature	Q_S	Seep flow rate
RH	Relative humidity	pH	pH
S_l	Liquid saturation	ΣCO_3^{-2}	Carbonate concentration
X_a	Air mass fraction	I	Ionic strength
q_g	Gas flux	t_{pit}	Initial-pit-penetration time
q_l	Liquid flux	t_{patch}	Initial-patch-penetration time
q_i	Infiltration flux	A_{perf}	Perforated container area
M_i	Radionuclide mass flux	A_{fuel}	Exposed fuel area
C_i	Radionuclide concentration	t_{SZi}	Saturated zone transport time
f_S	Fraction of WPs with seeps	$BDCF_i$	Biosphere dose conversion factor
		EBS	Engineered Barrier System

Legend

- External Process Model
- RIP Cells
- Rip Calls External Code
- Response Surface Between Process Models
- Response Surface from Process Model to RIP
- Between RIP Cells and External Code

snl/trw abq56.eps

Analysis Method

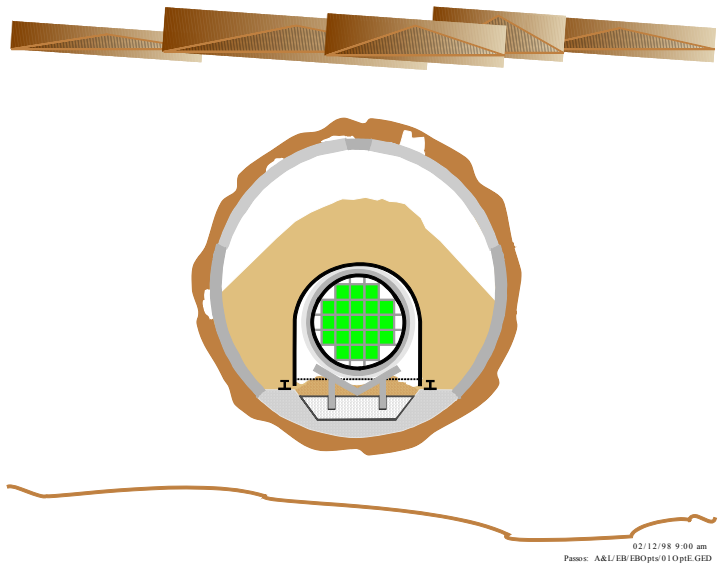
- Interim analyses were run to determine if the option had a significant effect on the dose rate history
- For options addressed as part of previous TSPA-VA sensitivity studies (ceramic coatings, concrete modified water, waste package material thickness variation), alternative EIS cases (25,60, &85 MTU/acre), or waste package size studies, no new analyses were conducted
- A series of one-off analyses was performed to show influence of ”significant” features or alternatives
  - Each feature or alternative was assessed individually, using a central value case
  - To address uncertainty for some features, several different deterministic cases were run

Example LADS Cases

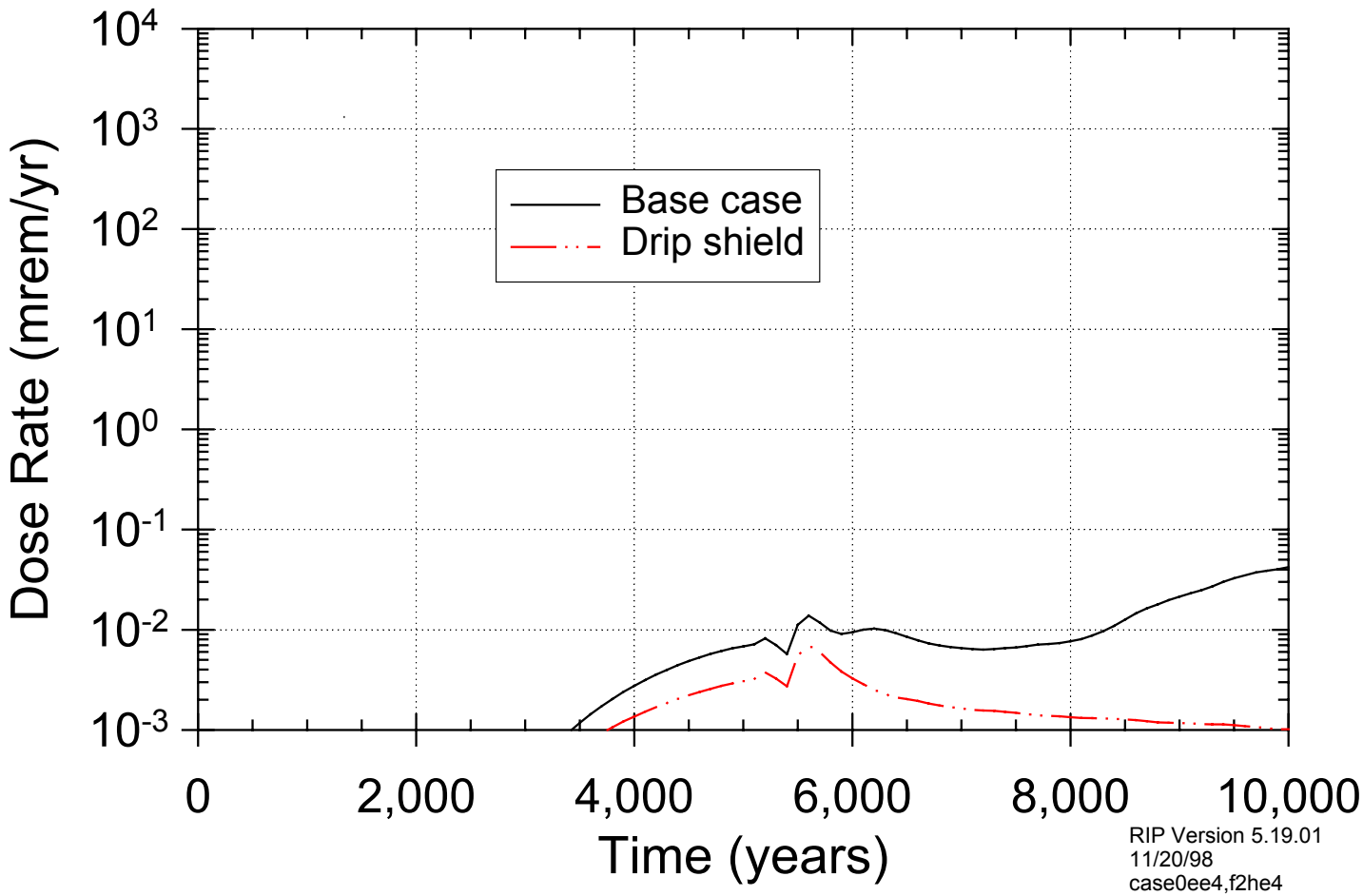
- Drip Shields and Backfill
- Dual Corrosion Resistant Material Waste Packages
- Richards Barrier
- Apatite Getters

Waste Package Drip Shield with Backfill (Feature 2)

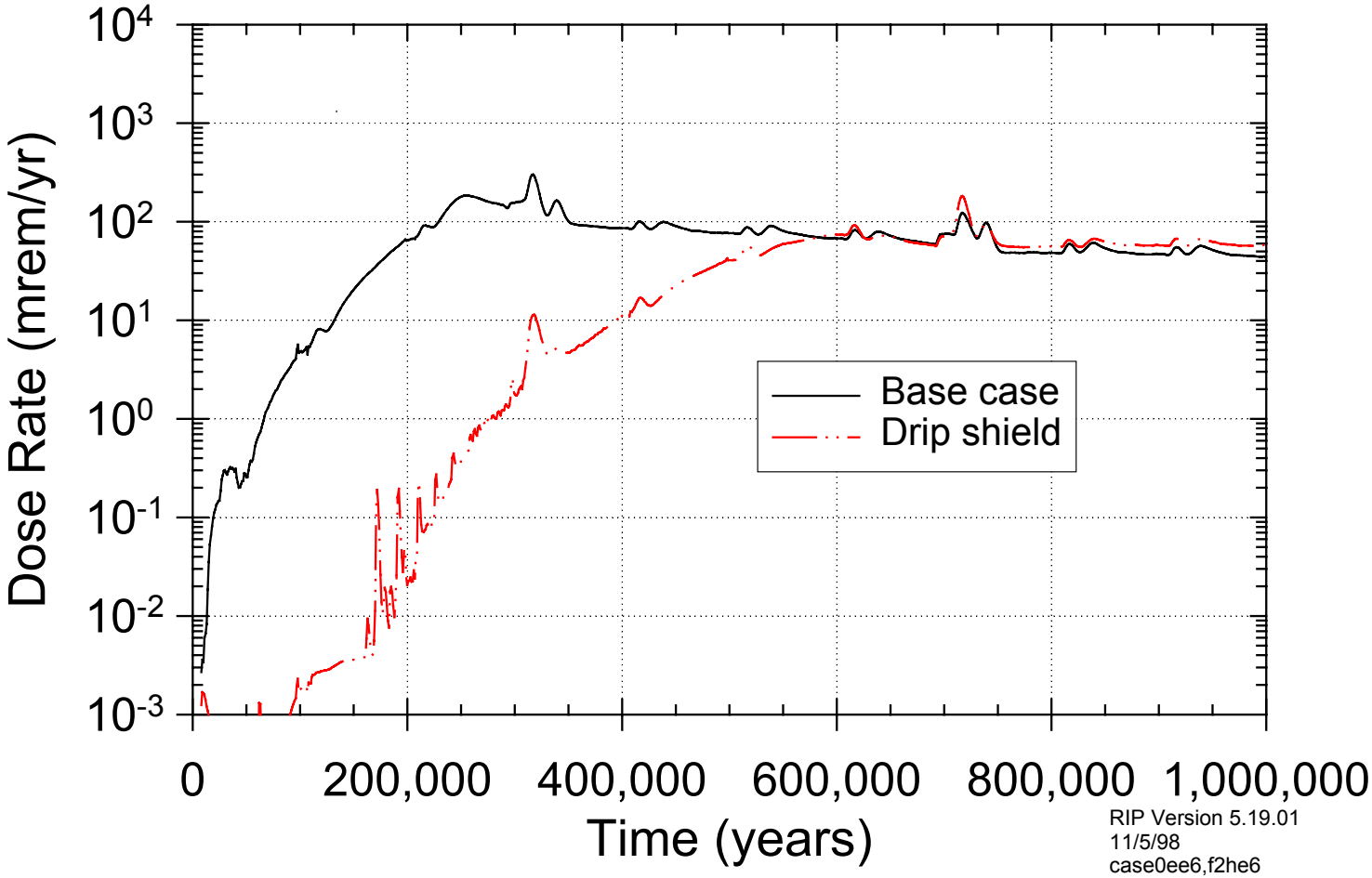
- Key Assumptions
- Drip shield assembly: 2 cm Alloy 22
- Emplaced at closure
- Backfill at closure
- Drip Shield fails by general corrosion



Feature 2
10,000-yr Total Dose-Rate History
All Pathways, 20 km



Feature 2
1,000,000-yr Total Dose-Rate History
All Pathways, 20 km

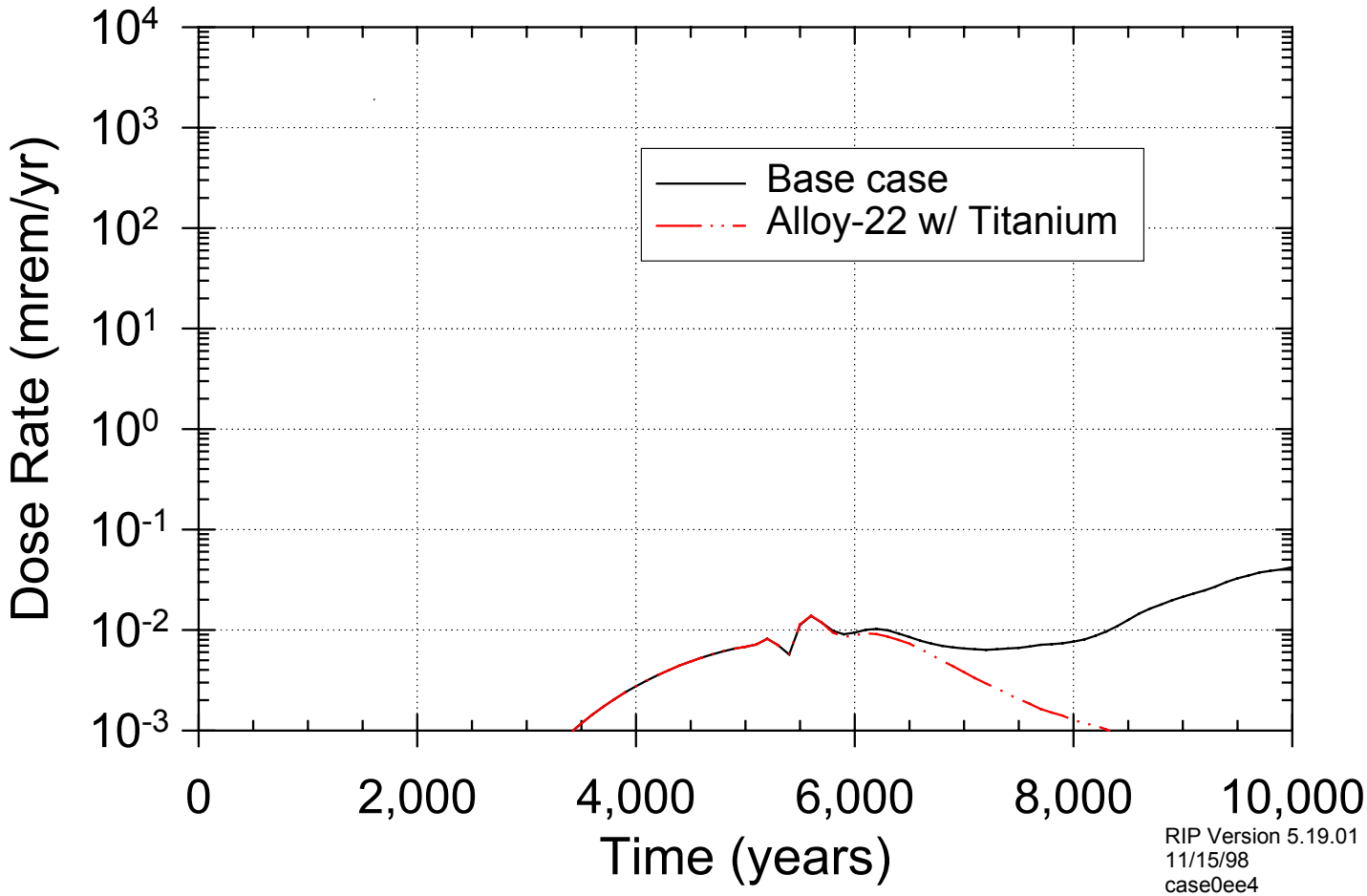


Dual CRM WP (Design Feature 14)

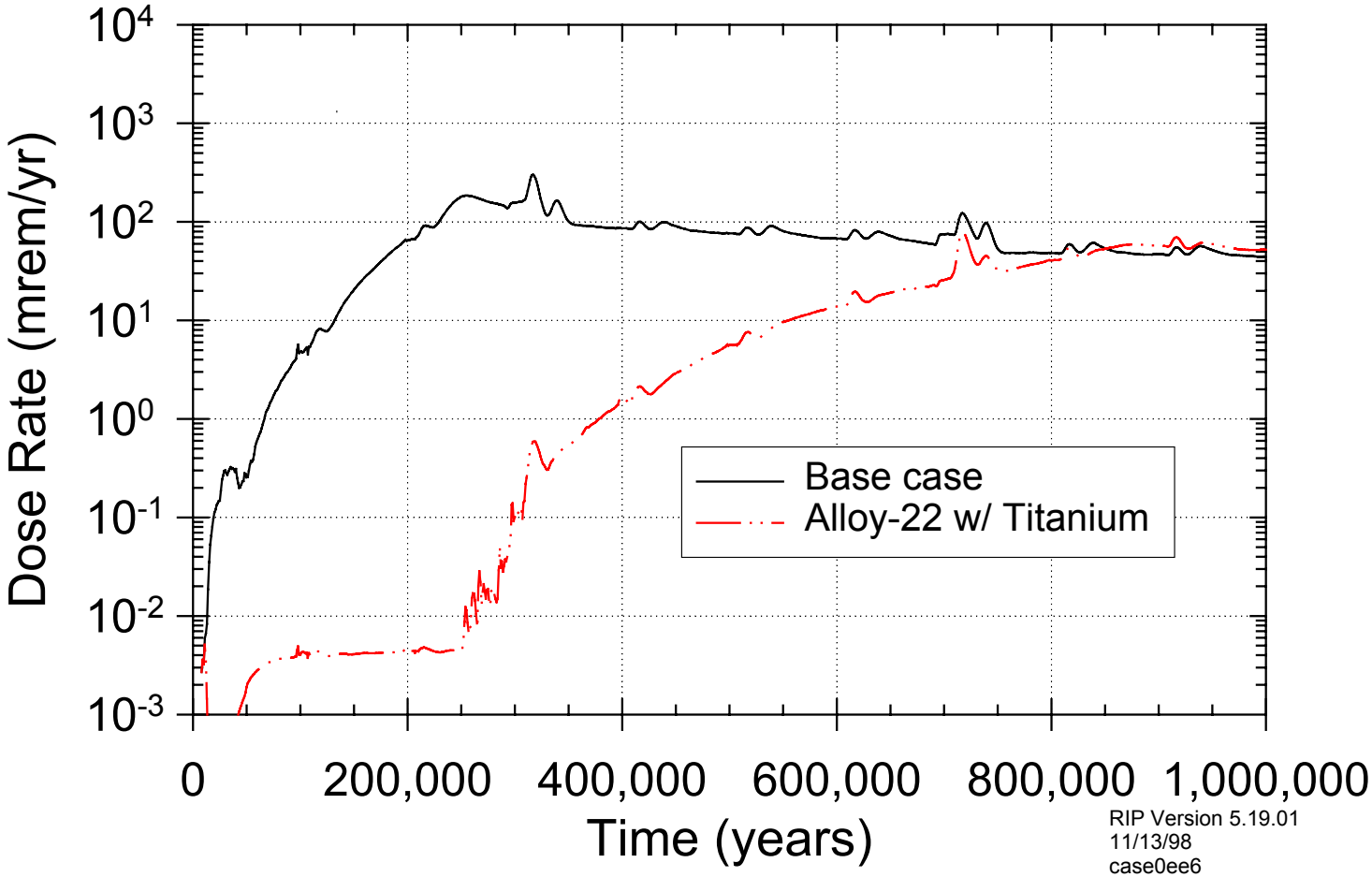
Key Assumptions

- TSPA-VA Base Case RH and T histories
- Waste Packages are dripped on all the time and 100% of the surface area wetted by drips
- Alloy-22 outer barrier subjected to general aqueous corrosion only
- Assumed Ti (Grade 7) inner barrier subjected to general corrosion only after Alloy-22 outer barrier breach

Feature 14
10,000-yr Total Dose-Rate History
All Pathways, 20 km



Feature 14
1,000,000-yr Total Dose-Rate History
All Pathways, 20 km

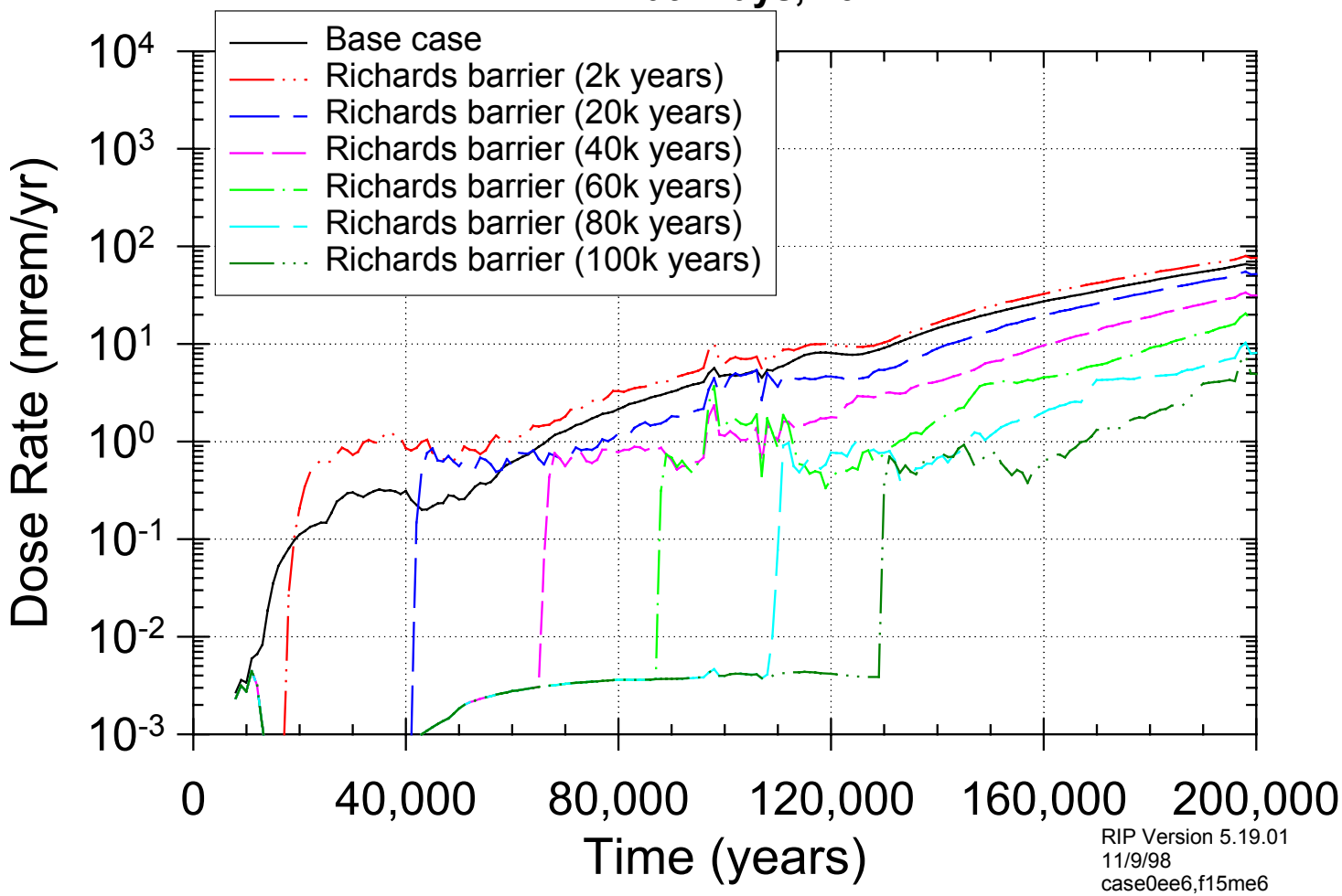


Richards Barrier (Design Feature 15)

Key Assumptions

- The Richards Barrier prevents seepage from contacting waste package until prescribed failure time
- Six failure times were simulated
- Higher temperatures associated with backfill cause an increase in cladding failure
- Presence of backfill prevents cladding failure due to rock fall

Feature 15
200,000-yr Total Dose-Rate History
All Pathways, 20 km



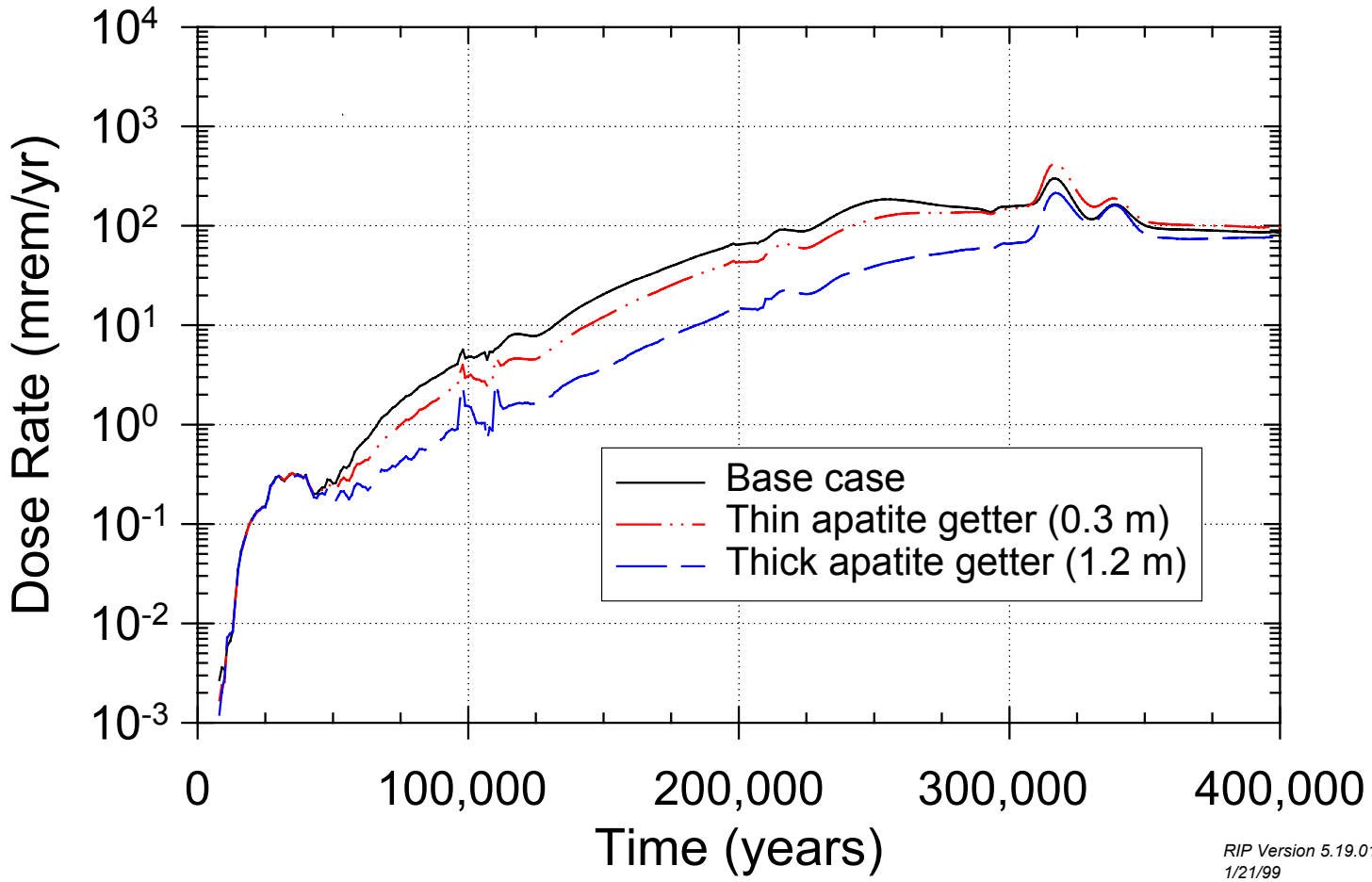
RIP Version 5.19.01
11/9/98
case0ee6,f15me6
f15ne6,f15oe6,f15pe6
f15qe6,f15re6

Apatite Getter (Design Feature 17)

Key Assumptions

- Sorption is linear and not temperature dependent
- The entire mass of getter is available for sorption
- The sorption coefficients for Np-237 and Tc-99 were 2000.0 ml/g and 0.219 ml/g, respectively
- Two design configurations were evaluated
- Thickness of the drift invert was reduced to accommodate getter material

Feature 17
1,000,000-yr Total Dose-Rate History
All Pathways, 20 km



RIP Version 5.19.01
1/21/99
case0ee6,
f17fe6, f17ge6

Insights

- **Proposed Features that address the repository safety strategy can strongly influence performance**
- **Features that address limiting water contacting the waste package and long waste package lifetime can significantly influence post-closure performance during 10,000 and 100,000 year time frames**
- **Uncertainties and assumptions regarding feature service life and design data/configurations can drive performance calculations and must be further evaluated if a feature is to be incorporated**

Next Steps

- **PA will continue to work with the Designers and Scientists to develop or modify process models and PA abstractions required for Phase II enhanced design alternatives**
- **Additional Uncertainty and Sensitivity analyses may be conducted on Enhanced Design Alternatives to assist the designers in refining designs**

Conclusions

- **Performance assessment analyses have been used to provide *insight* regarding which features or alternatives have the potential to provide significant improvements in performance**
- **Results can only be used to help YMP determine the relative benefit that might be provided by a specific option; they are not adequate to support a safety case**
- **If an option is selected by YMP, additional data collection and/or analyses will be necessary to develop a defensible representation for use in future TSPAs**