YUCCA MOUNTAIN PROJECT

Studies

Waste Package Degradation

Presented to:
Nuclear Waste Technical Review Board
Performance Assessment Panel
Albuquerque, New Mexico

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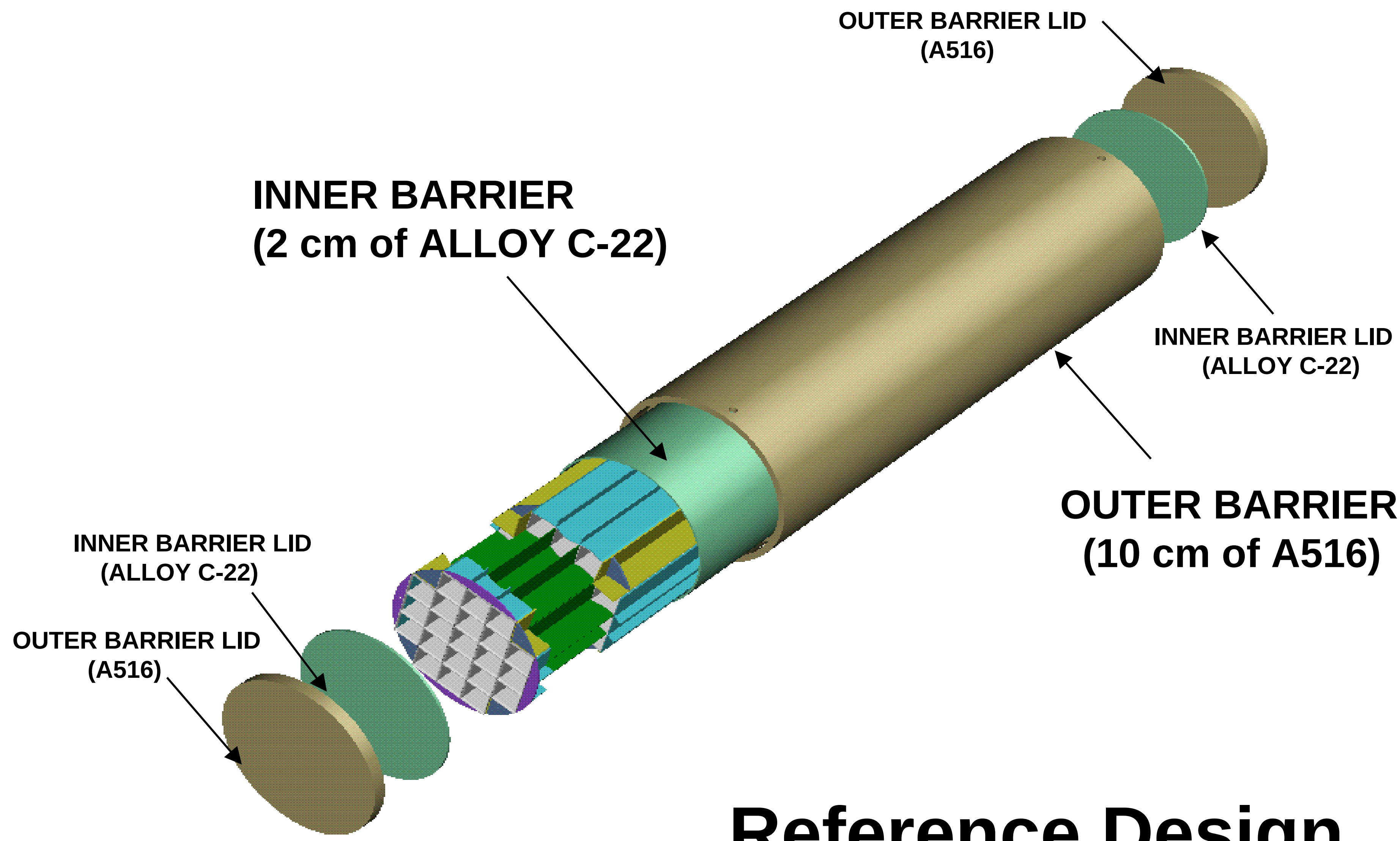
April 23-24, 1998

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

Outline

- Reference Design for Waste Package
- Waste Package Degradation Conceptual Model and Bases
  - Juvenile failure
  - Corrosion allowance material
  - Corrosion resistant material
- Sensitivity Analyses
- Summary



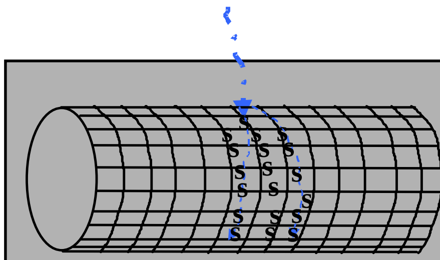
Reference Design for Waste Package

Waste Package Degradation Conceptual Model Key Concepts

Input

- •Design
- •Temperature
- •Relative humidity
- •Dripping
- •Thresholds for corrosion initiation

Model



•Juvenile failure of WP
•CAM degradation
-general corr.
-localized corr.
•CRM degradation
-general corr.
-localized corr.

Output

- •1st pit breach
- •1st patch breach
- •# of pits breach f(t)
- •# of patches breach f(t)

Bases

- •Short and long term corr. testing
- •WP expert elicitation
- •In-situ corr. testing
- •Other literature data
- •Field data

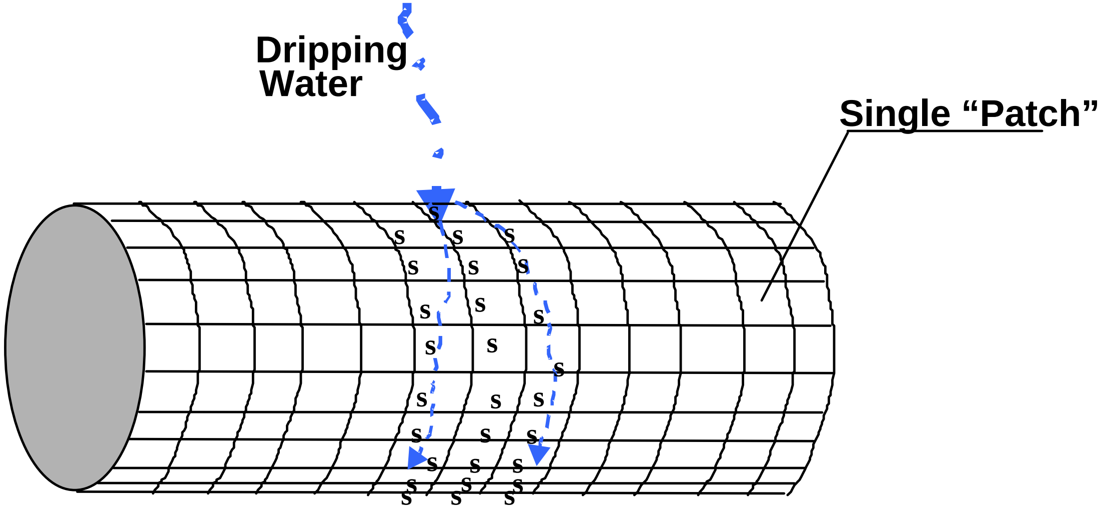
Juvenile Failure of Waste Package

- Early failure due to manufacturing defects,etc
- Analysis of weld failure - 10^{-5} probability of failure for a double-walled container (Massari, 1997)
- Canadian analyses indicate ~10^{-3} probability of early failure
- Base case failure distribution: 10^{-5} to 10^{-3} loguniform
  - deterministic case has 1 failure with 1 patch
- Failures only in dripping zones

Waste Package Degradation Conceptual Model

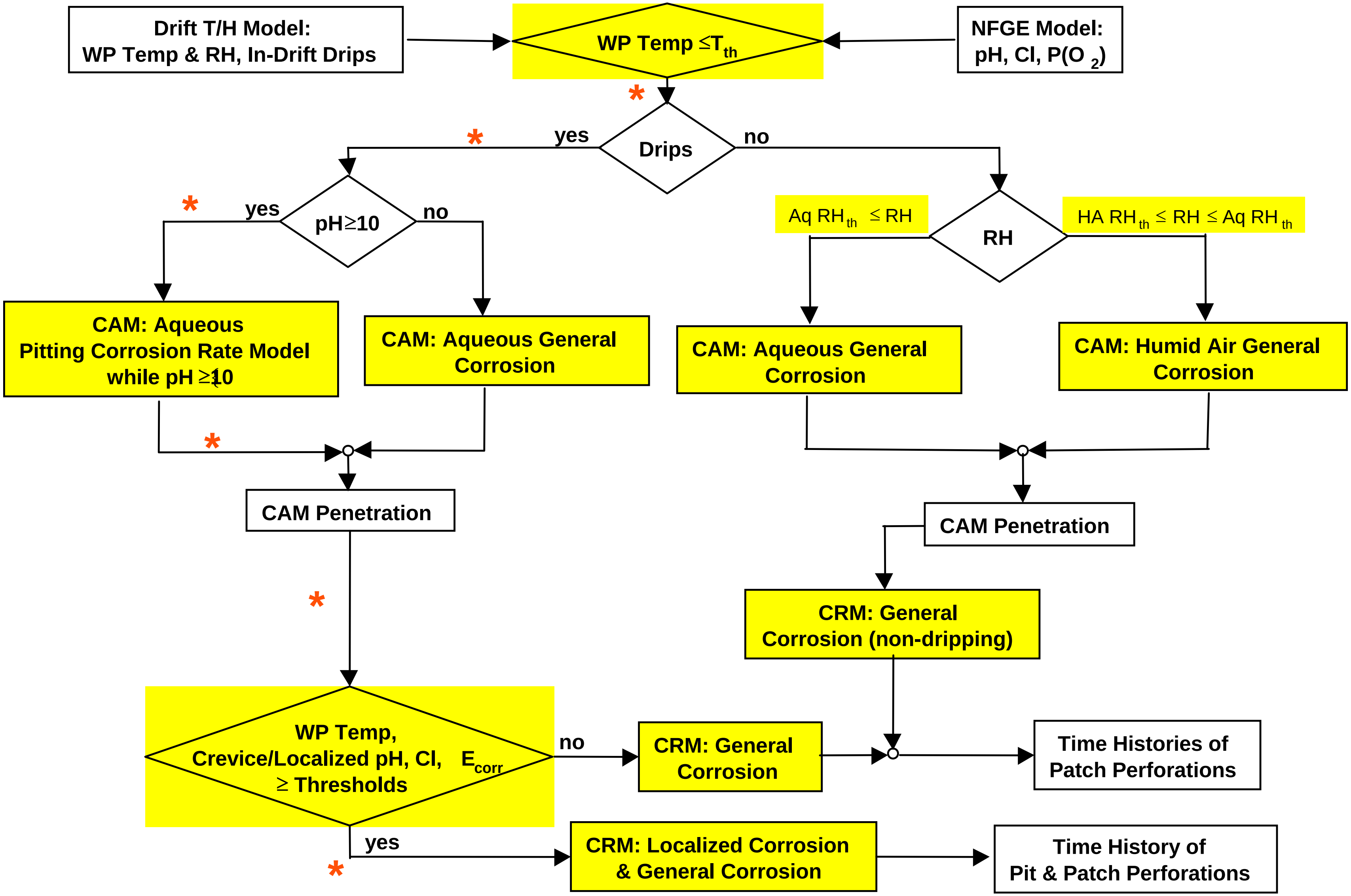
Inputs:

- T, RH, fraction of packages wet from drift-scale T/H abstraction and seepage model
- pH of dripping water from NFGE abstraction
- patches are 310 cm^2



s - Patches with drips;
Potential salt deposits;
CRM localized corrosion

Logic Diagram for the Base-Case TSPA-VA Waste Package Degradation Model



* = fastest degradation pathway

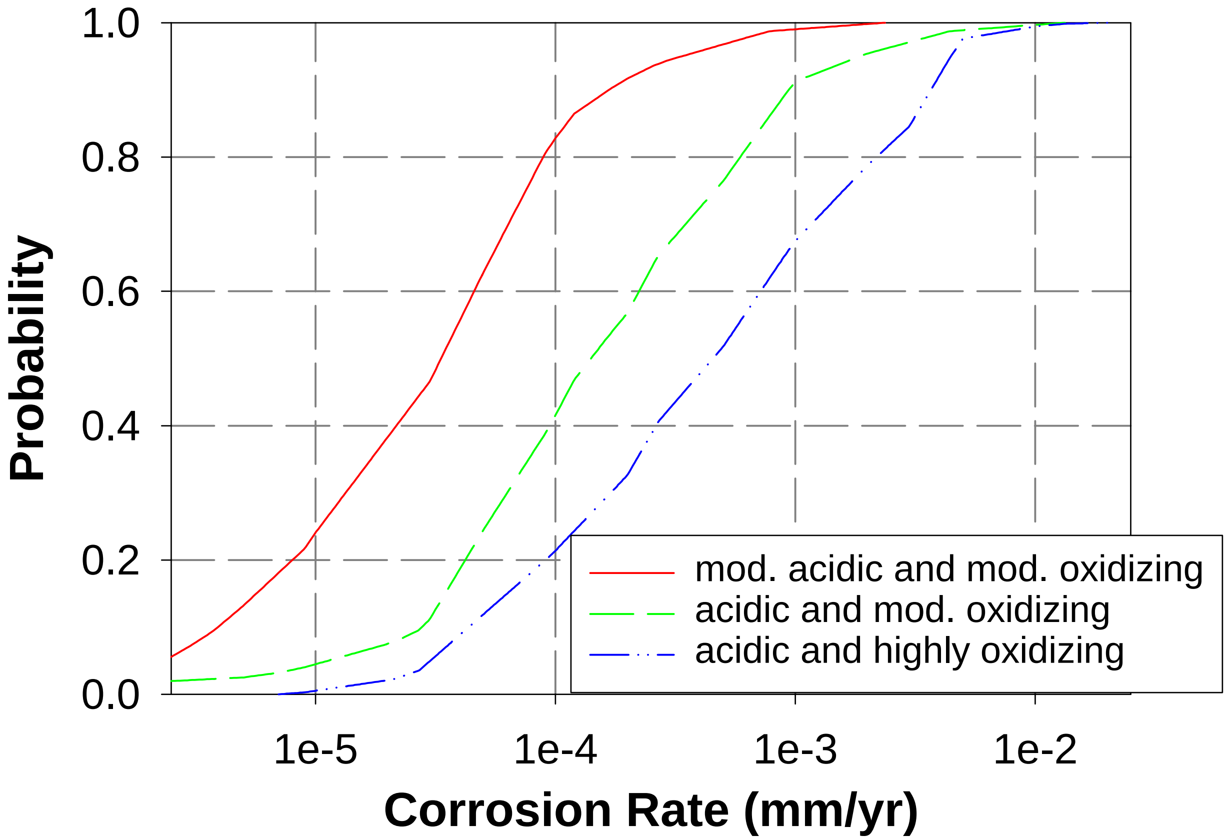
CAM Degradation Summary

- **Details provided to NWTRB in October, 1997**
- **Humid air general corrosion as f(time, Temp, RH)**
  - **Humid air localized corrosion uses pitting factor**
- **Aqueous general corrosion as f(time,temp)**
  - **pH <= 10: localized corrosion uses pitting factor**
  - **pH >10: high aspect ratio pitting corrosion**

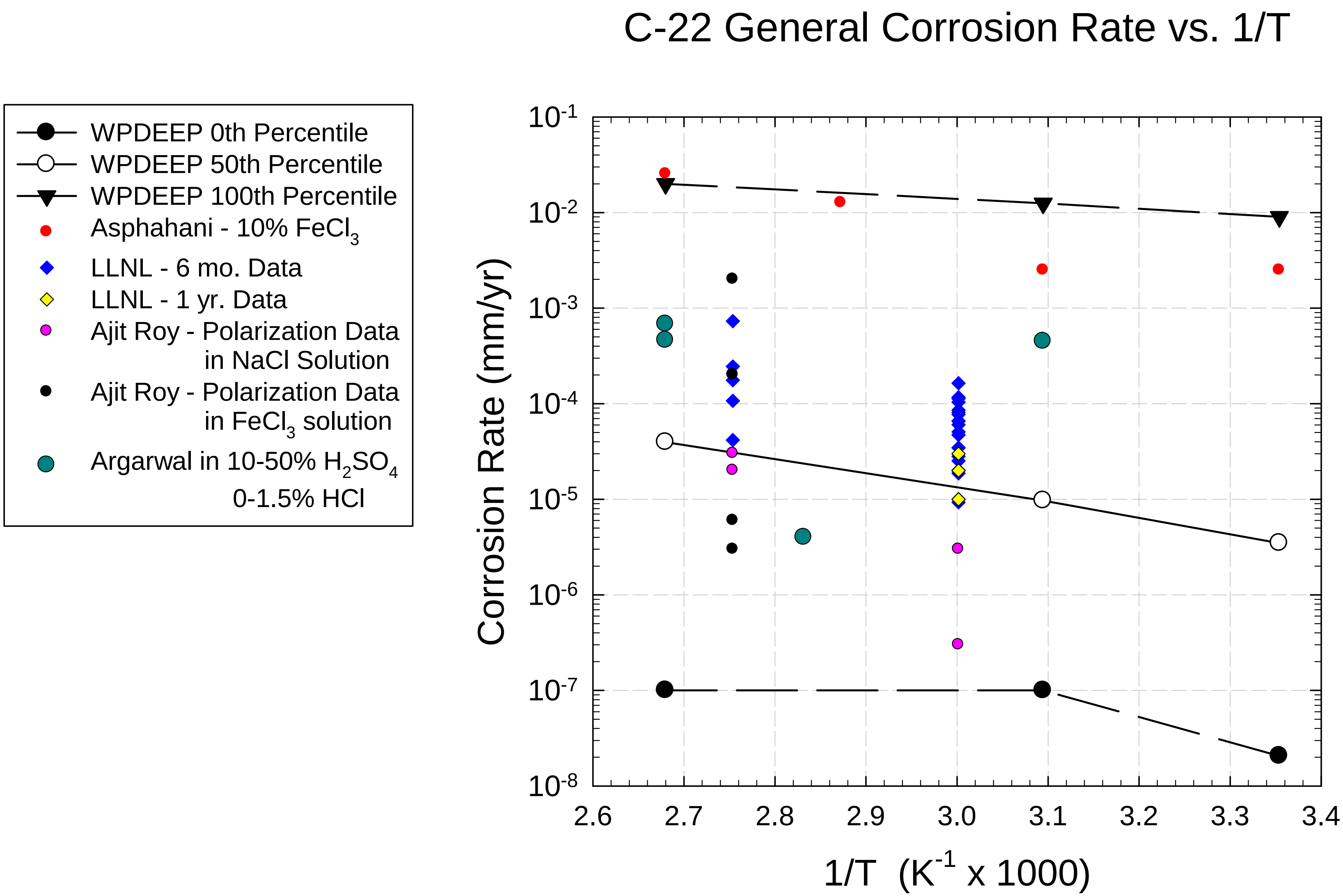
CRM Corrosion Models

- General Corrosion (from WPDEE)
  - non-dripping conditions
  - dripping conditions
- Localized Corrosion
  - based on 6-month data from Long-term Corrosion Test Facility, short term data from LLNL, and literature data

CRM General Corrosion Rates for Alternative Environments at 100^0 C

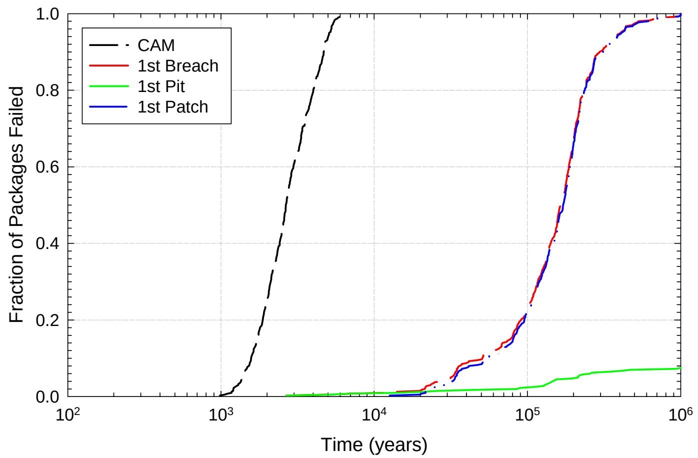


CRM General Corrosion Rate: Expert Elicitation and Data

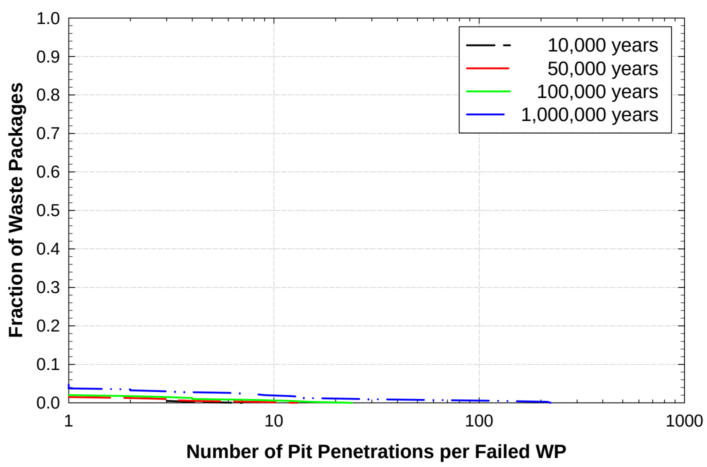


Base-Case WP Performance Analysis Results

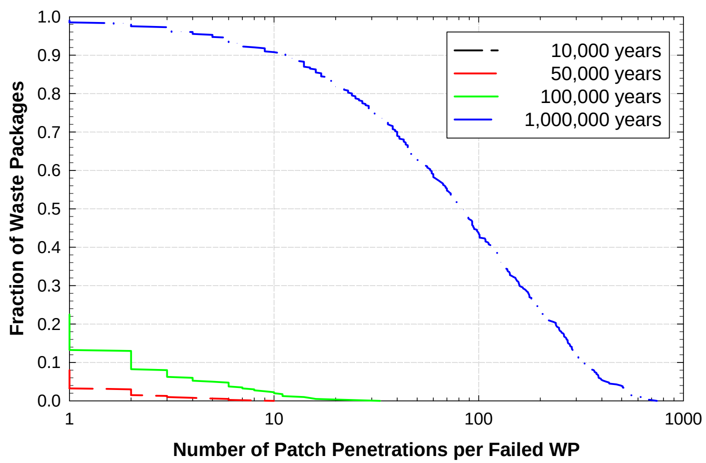
Waste Package Failure



Pit Penetration



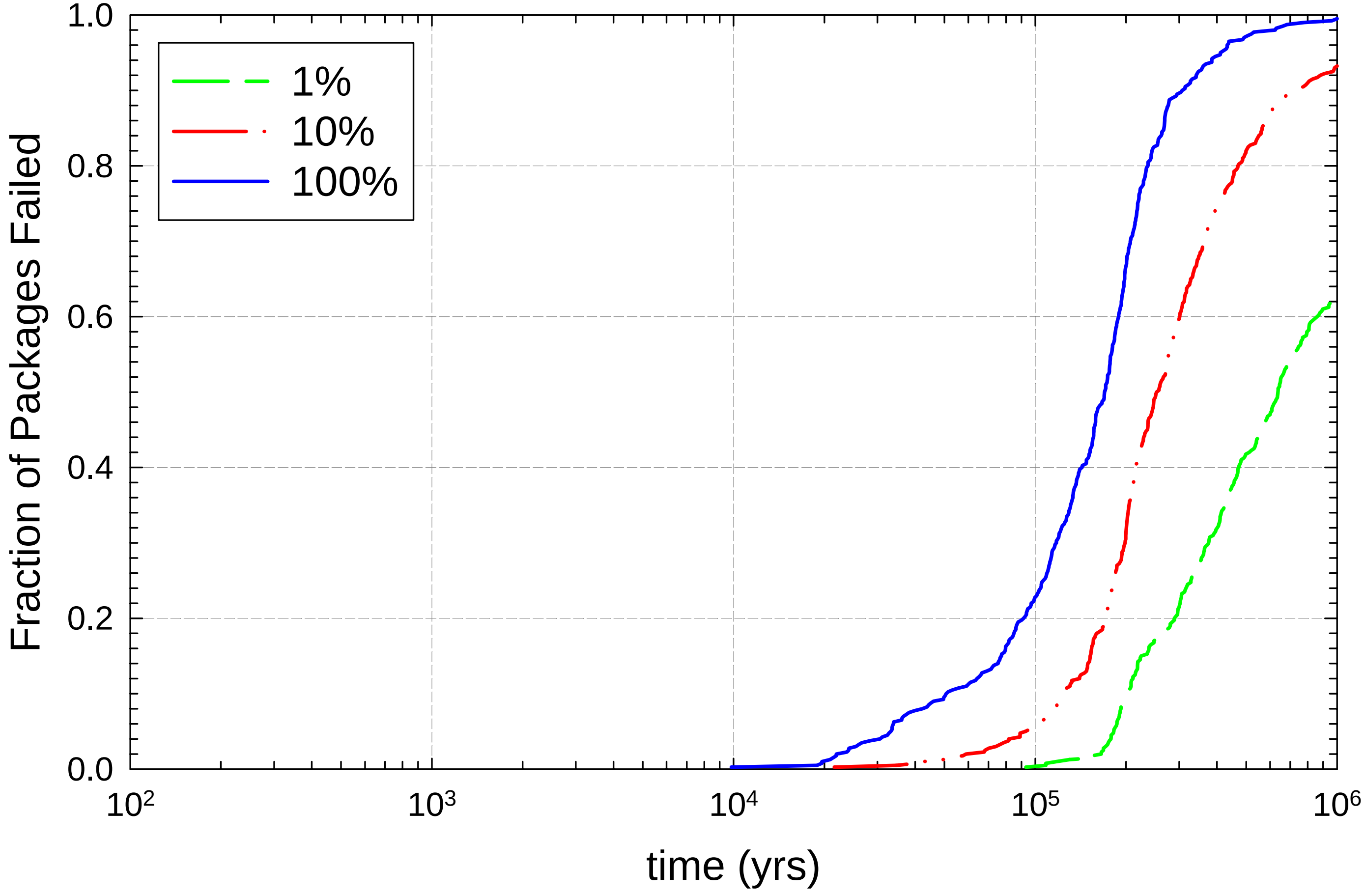
Patch Penetration



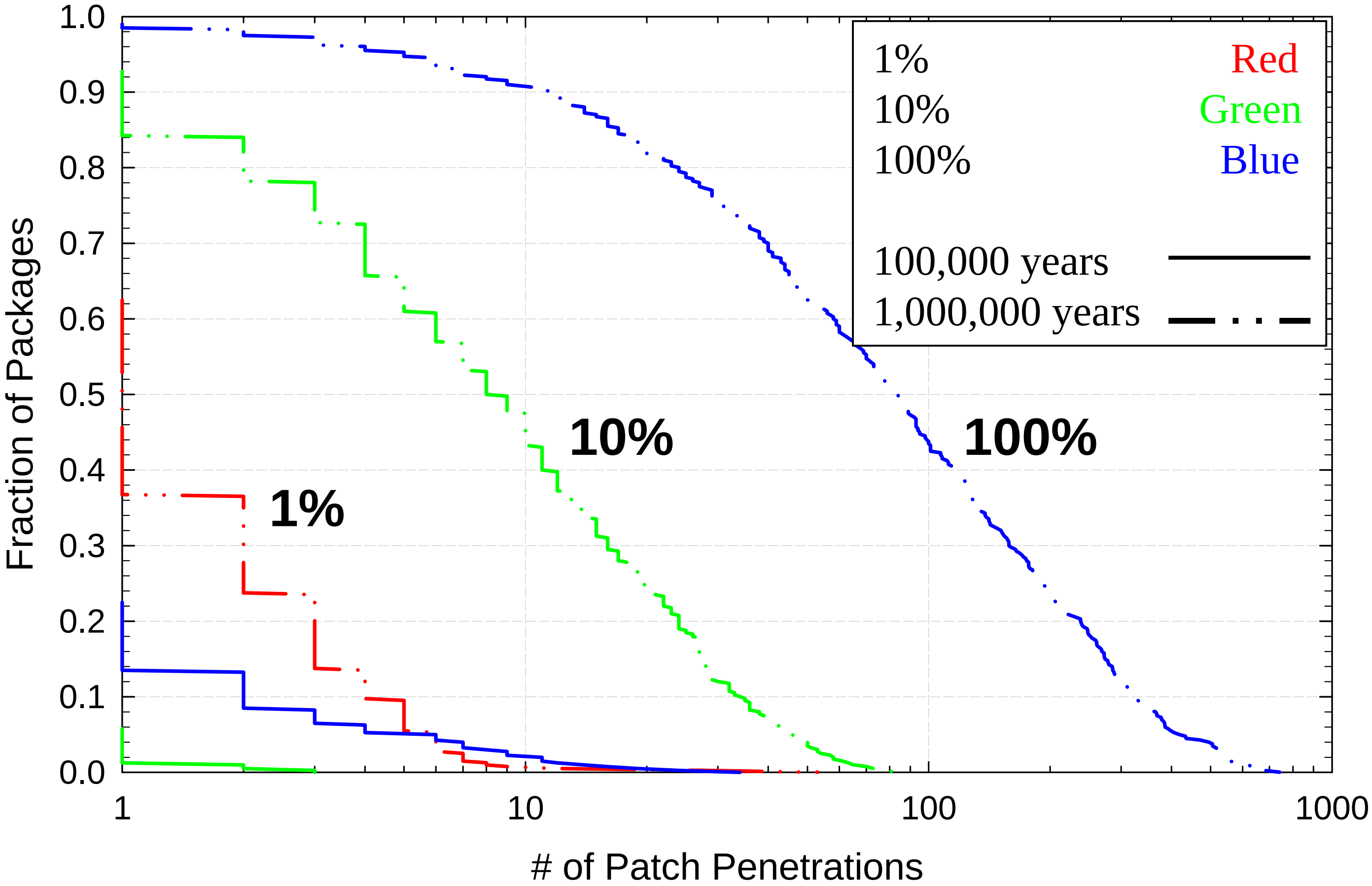
Waste Package Degradation Sensitivity Analyses

- **Wetting conditions**
  - **% of WP wet**
- **Uncertainty/variability**
- **Juvenile failure**
- **Additional cases not completed:**
  - **Design options**

Sensitivity of WP Failure to Waste Package Surface Fraction Wetted



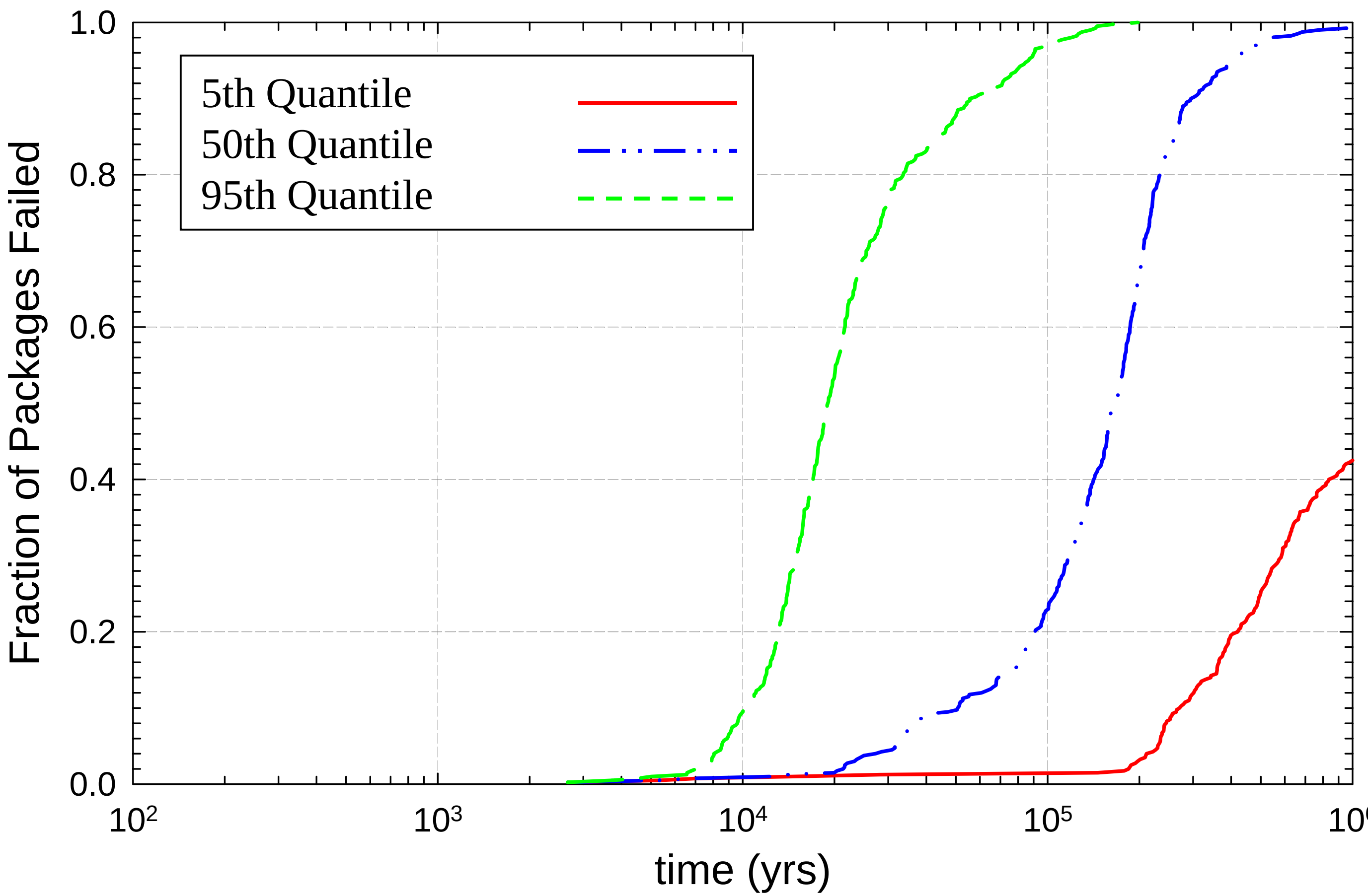
Sensitivity of Number Patch Penetrations to WP Surface Fraction Wetted



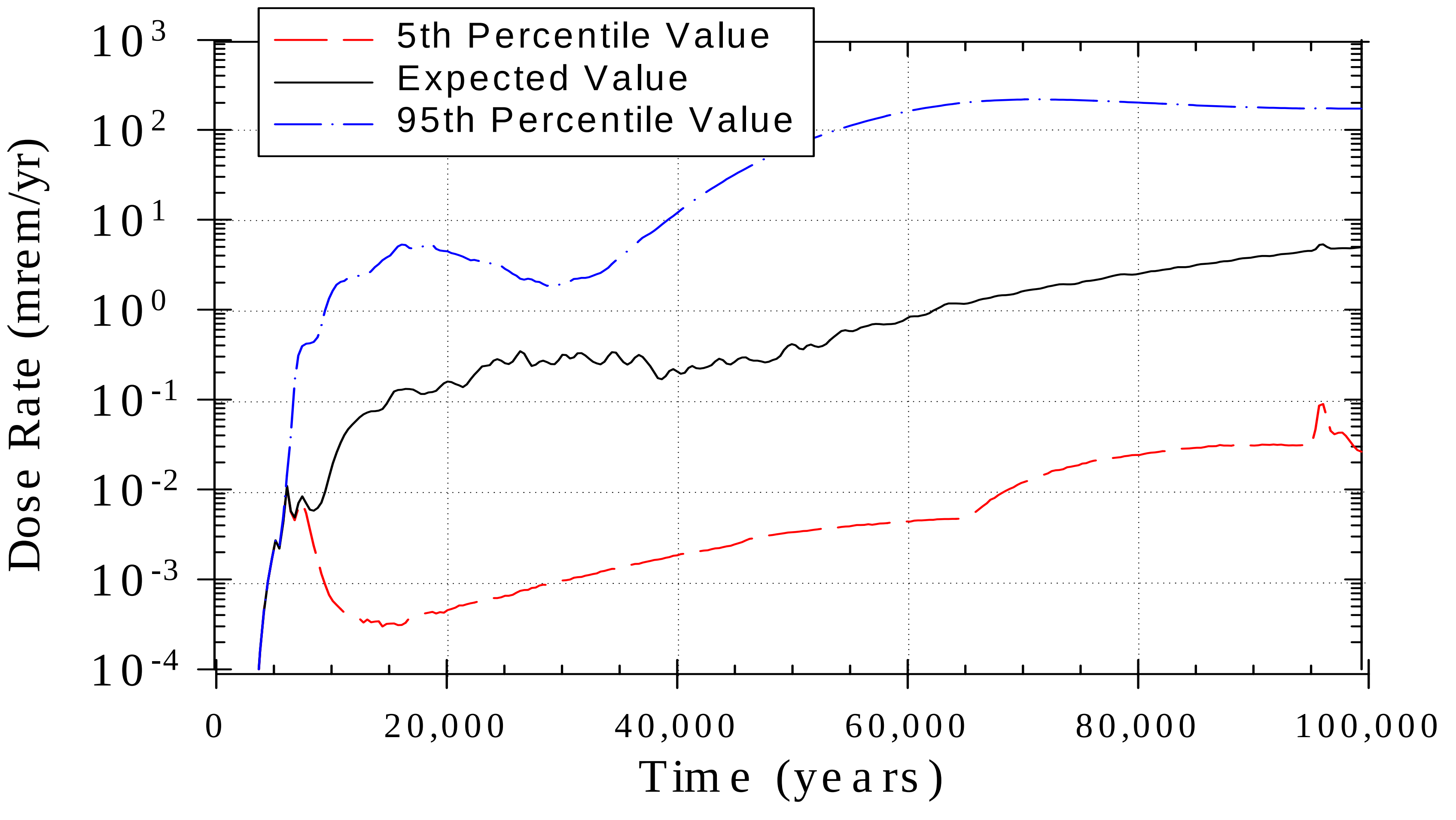
Variability and Uncertainty in Waste Package Degradation Model

- Variability in drift environment, waste packages will contribute to range of degradation
- Uncertainty in corrosion rates will contribute to range of degradation
- Evaluated this using split of the total variance for variability and uncertainty to cover possible range
- Model indicates most rapid failure has high variability, high percentile of uncertainty
- Model indicates best performance from low variability, low percentile of uncertainty

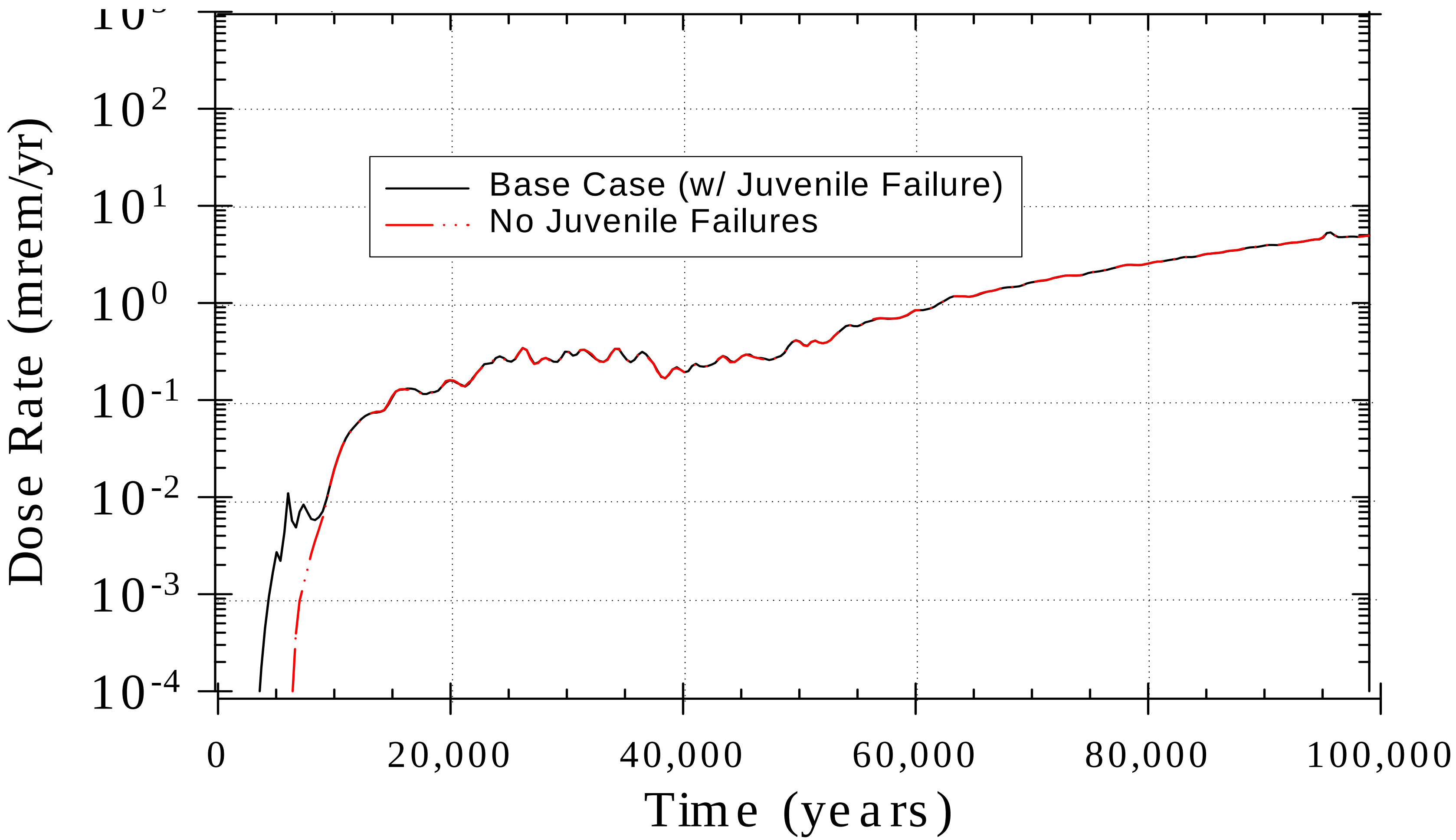
Sensitivity of WP failure to Uncertainty Percentile



Sensitivity of Dose to Waste Package Uncertainty Percentile



Sensitivity of Dose to Juvenile Failures of Waste Package



Summary/Conclusions

- **Model includes juvenile failure of WP, CAM degradation, and CRM degradation**
- **Model supported by significant lab/field data as well as expert elicitation**
- **Primary factor affecting long-term waste package performance is dripping condition**
- **Factors not considered with potential negative performance implications are MIC, stress corrosion cracking, and structural failure of WP at late time**

Summary/Conclusions
(continued)

- **Key additional data requirements**
  - **Additional evaluation of dripping**
  - **Experimental data to substantiate/validate the WPDEE results, especially CRM corrosion rates, in the expected exposure conditions of the potential repository**