SENSITIVITY ANALYSIS OF WASTE PACKAGE

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OUTLINE

- **Previous Analysis**
- **Current Analysis and Basis**
- **Long-term Passivity**
- **Conclusions**

PREVIOUS NRC ANALYSIS
TOTAL-SYSTEM PERFORMANCE ASSESSMENT (TPA) CODE

- **All corrosion parameters were from electrochemical tests in pure sodium chloride solutions.**

- **Deliquescent salt mixture or inhibitors were not considered.**

- **Drip Shield Life Time:**

  Sampled from lognormal distribution of [3700, 27300] years

- **No corrosion failure of waste packages in 10,000 years**

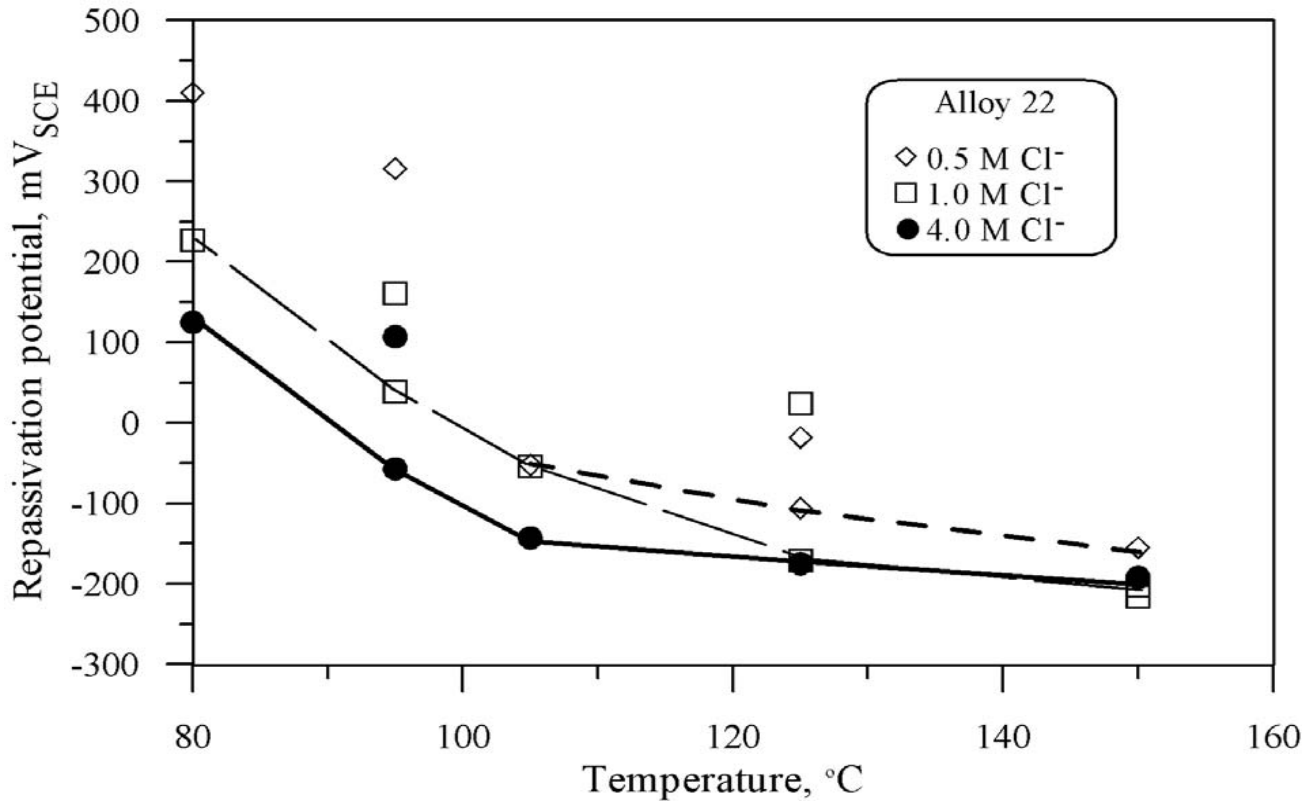
- **TPA Results: ~ 0.03 mrem/yr at 10,000 years**

CURRENT ANALYSIS

- **Effects of Deliquescent Salts**
- **Effects of Inhibitors**
- **Effects of Perforations**

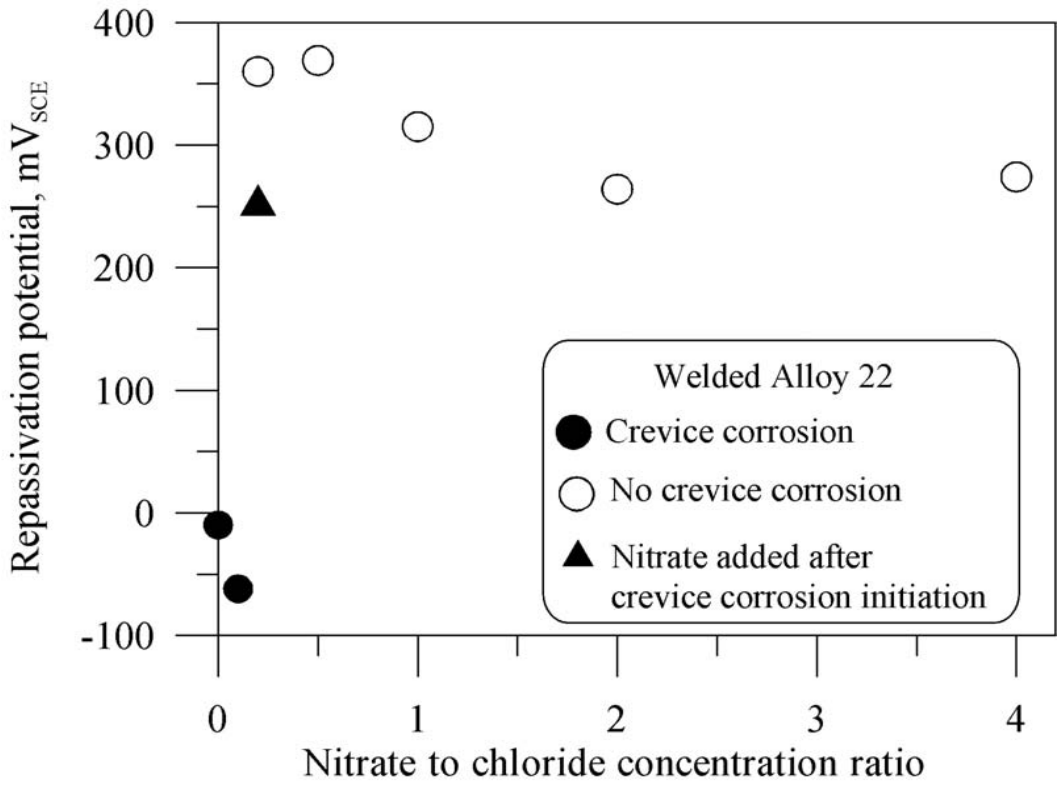
LOCALIZED CORROSION

Repassivation Potentials for Deliquescence at High Temperature



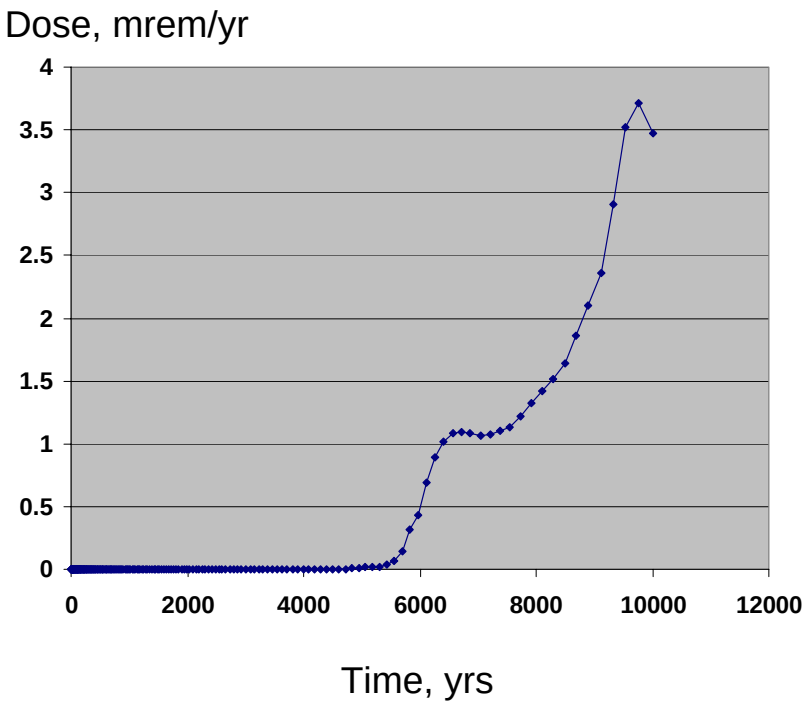
LOCALIZED CORROSION

Inhibitors may reduce susceptibility for localized corrosion.



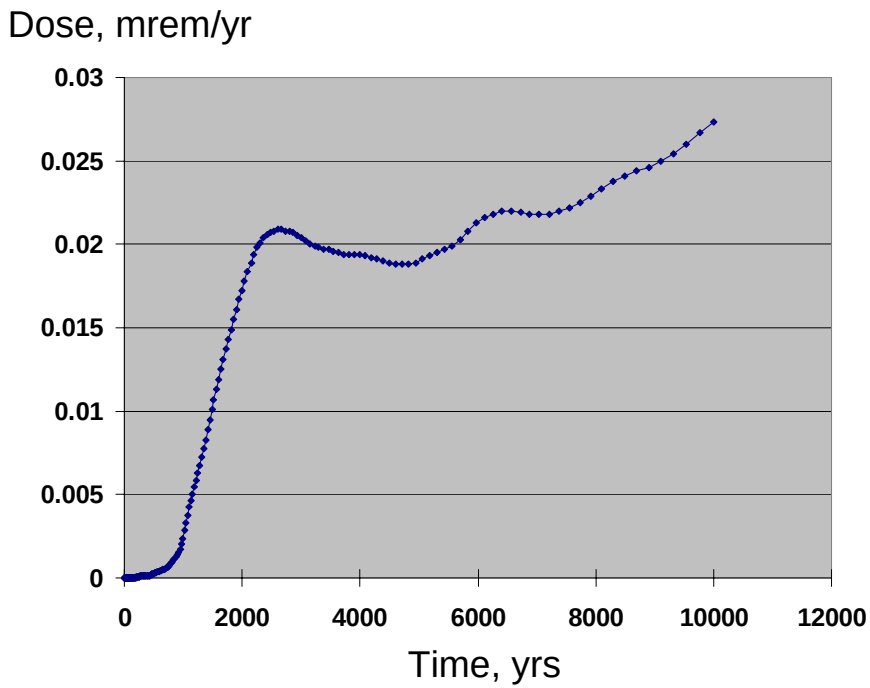
LOCALIZED CORROSION

Analysis using current information on repassivation potential equation



- **About 87 % waste package failure**
- **Sodium chloride solution**

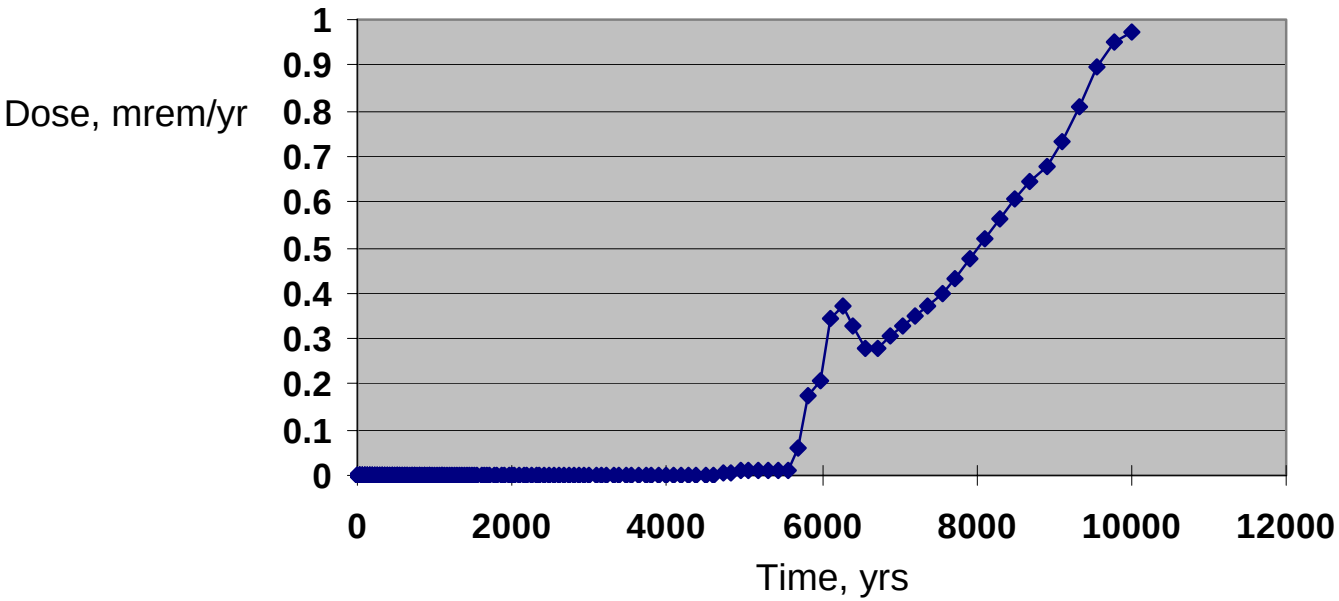
Analysis considering inhibitors in groundwater contacting waste package



- **No corrosion failure of waste package**
- **Sodium chloride solution with abundant nitrate; No drip shields (however, availability of fluorides can limit drip shield corrosion.)**

LOCALIZED CORROSION

Probabilistic approach of the evaluation of high temperature deliquescence and inhibitors by sampling critical relative humidity (RH): normal distribution [0.35,0.60]



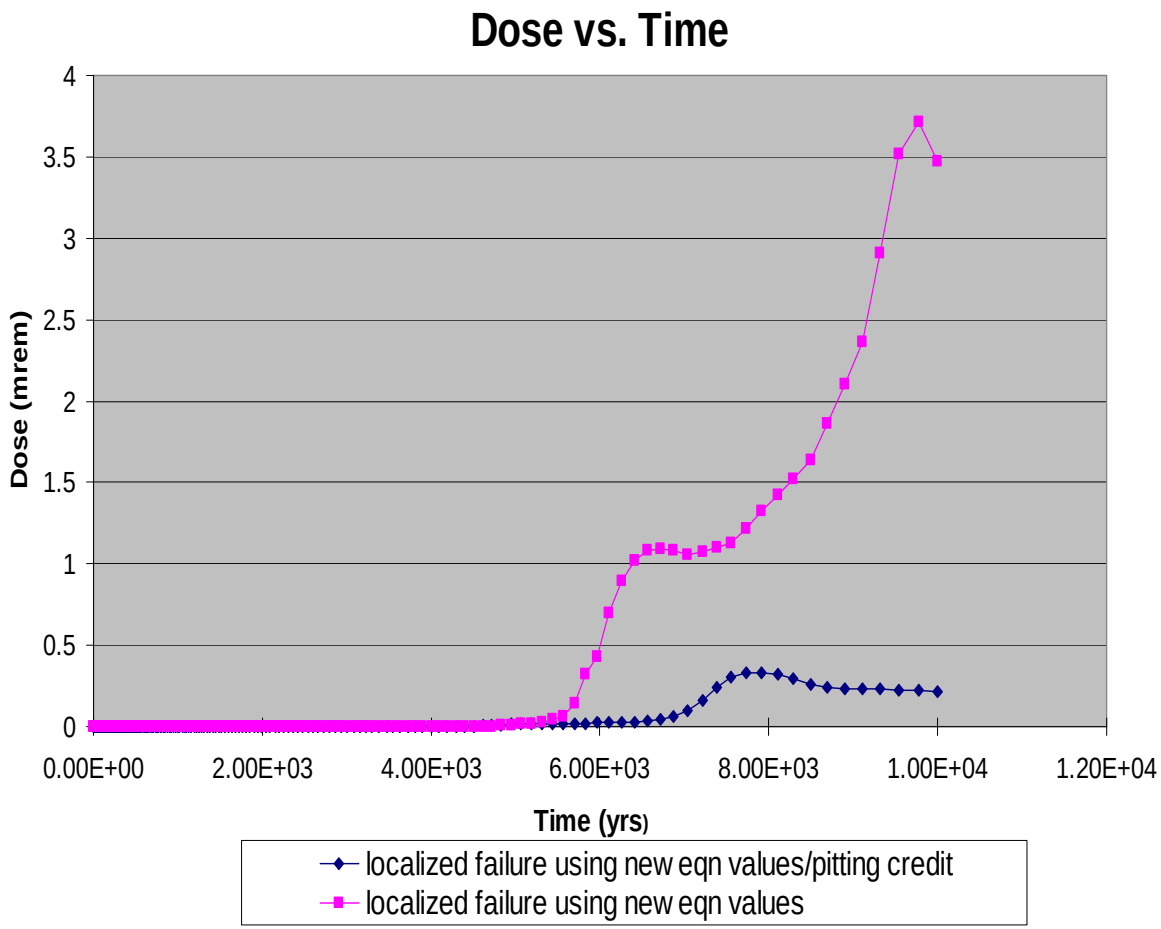
- **About 17 % waste packages were failed from the distribution.**
  - reference: no waste package failure without deliquescence in the previous NRC analysis, ~ 0.03 mrem/yr at 10,000 years)

- **Detailed distributions are under study.**

LOCALIZED CORROSION

Effects of Perforation Size and Frequency

- **Modified inputs to estimate the effects of the exposed surface area from size and frequency of perforations**
- **Pits could be stifled under open-circuit corrosion conditions.**
- **Crevice area is likely to be restricted.**



UNIFORM CORROSION

Potential Effects of High Temperature and High Acidity

- **Na-K-Cl-NO_3 High Temperature Deliquescence:**

  - Corrosion rates decrease with time (e.g., weight loss measurements).

- **Ca/$MgCl_2$ High Temperature Deliquescence:**

  - pH may go down leading to enhanced uniform corrosion.

  - The fraction of Ca/$MgCl_2$ is low. Also, Ca/$MgCl_2$ is likely to decompose and the resulting acids will evaporate.

LONG-TERM PASSIVITY

- **Time and extent of waste package corrosion is important.**

- **Given no localized corrosion condition with passivity from laboratory testing, assess the stability of passive film over a geological time period.**

- **Use inference from modeling and analogue study, emphasizing potential long-term latent effects.**

LONG-TERM PASSIVITY

- **Modeling**

  - Void Formation: mechanical and chemical stability of passive film

  - Anodic Sulfur Segregation at Metal-Oxide Interface: mechanical stability and enhanced transient current on unstable passive film

  - Anion Selective Sorption in Crevice: latent initiation of localized corrosion

  - Development of Large Cathodic Surface Area of Corrosion Products: enhanced transient current on unstable passive film

- **Analogue Study**

  - Investigations of responsible mechanisms for the long-term survivability of analogue (e.g., josephinite, Ni_3Fe)

- **Modeling and analogue studies give better technical bases as to the long-term stability of passive film.**

SUMMARY

- **Evaluation of corrosion of Alloy 22 needs to consider both deleterious and beneficial conditions.**

  - **The high temperature deliquescence environment could occur under specific chemical conditions such as Ca/$MgCl_2$ or mixture of Na-K-Cl-NO_3 salts.**

  - **Waste packages could be passivated by the effects of inhibitors.**

  - **The release could be restricted by the limited amount of deleterious Ca/$MgCl_2$ and limited exposed surface area from deleterious localized corrosion.**

- **Performance assessment provides tools to evaluate the impacts of the high temperature deliquescence on the dose and the associated uncertainties. Detailed evaluation of the uncertainties continues.**

- **Understanding of the stability of passive film over a geological period assisted by analogues and modeling**

Disclaimer: The NRC staff views expressed herein are preliminary and do not constitute a final judgment or determination of the matters addressed or of the acceptability for a geologic repository Yucca Mountain