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June 27, 2001
Contract No. NRC-02-97-009
Account No. 20.01402.571

U.S. Nuclear Regulatory Commission
ATTN: Mrs. Deborah A. DeMarco
Two White Flint North
11545 Rockville Pike
Mail Stop T8 A23
Washington, DC 20555

Subject:Programmatic review of an abstract

Dear Mrs. DeMarco:

The enclosed abstract is being submitted for programmatic review. The abstract will be submitted for presentation at theInternational Workshop on Prediction of Long-Term Corrosion Behavior of Nuclear Waste Systems in Cadarache, France on November 26–29, 2001. This trip will be included in the list of foreign trips for FY2002. The title of this abstract is:

"Modeling Corrosion of Alloy 22 as a High Level Radioactive Waste Container Material" by D.S. Dunn, O. Pensado, C.S. Brossia, G.A. Cragnolino, N. Sridhar and T.M. Ahn.

This paper is a result of the activities conducted in FY2000 and FY2001 under task 01402.571 to develop experimental data and models for the evaluation of Alloy 22 corrosion.

Sincerely,

Budhi Sagar
Technical Director

Enclosure

BS:VJ:jg

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Modeling Corrosion of Alloy 22 as a High Level Radioactive Waste Container Material

D.S. Dunn, O. Pensado, C.S. Brossia, G.A. Cragnolino, N. Sridhar, and T. M. Ahn,

The performance of the proposed high-level nuclear waste (HLW) repository at Yucca Mountain, NV is strongly dependent on the integrity of the waste packages. Passive dissolution and localized corrosion are the primary degradation processes that could limit the lifetime of the waste packages. These degradation processes will be evaluated in the U.S. Nuclear Regulatory Commission risk informed performance based review of a potential license application from the US Department of Energy (DOE) to construct a repository for the geologic disposal of HLW.

Process level modeling has been used to predict the performance of Alloy 22, a candidate material for the waste package outer barrier. The model considers the passive corrosion rate, the susceptibility of the alloy to localized corrosion, and the localized corrosion propagation rate in chloride-containing environments expected to be present in the emplacement drifts. Corrosion potential is one of the parameters that dictate the mode of corrosion. Kinetic expressions are used for the anodic passive dissolution of the alloy and the cathodic reactions including the reduction of oxygen and water to calculate the corrosion potential. Values of the corrosion potential (E_{corr}) of Alloy 22 are calculated as the potential at which the passive corrosion rate is equal to the rate of the oxygen and water reduction.

The conditions for localized corrosion initiation are defined, once a liquid water film is formed on the surface of the waste package, by comparing the E_{corr} and the repassivation potential for crevice corrosion (E_{rcrev}). Values of E_{rcrev}, determined from laboratory tests, are dependent on environmental parameters such as temperature and water chemistry. If the E_{corr} is greater than the E_{rcrev} localized corrosion is assumed to occur without an initiation time and propagate at a constant rate. Localized corrosion is considered to repassivate if environmental conditions change and the E_{corr} in not maintained above the E_{rcrev}. Passive corrosion of the Alloy 22 outer barrier occurs when liquid water is present on the waste package surface and the E_{corr} is less than the E_{rcrev} The passive corrosion rate, based on the electrochemical measurements of the passive current density was found to be practically independent of both temperature and chloride concentration.

Possible variations in material performance, such as changes in the passive corrosion rate and localized corrosion susceptibility as a result of welding, thermal aging, and alteration of the passive film chemistry, are also captured in the process level modeling. Changes in the localized corrosion susceptibility are modeled through alteration of the parametric equations for the initiation of localized corrosion. Variations in the passive corrosion rate as a result of fabrication and welding processes are measured in laboratory tests and used as inputs to the waste package performance model. Modeling the passive dissolution behavior is necessary to predict the long-term performance of candidate container materials. The point defect model is used to predict the long-term evolution of passive current density by assuming that conduction through a chromium-rich oxide film occurs by interstitial cations or oxygen vacancies. The implications of this model and alternate models for passive dissolution behavior are considered in this paper.

ACKNOWLEDGMENTS

This paper was prepared to document the work performed by the CNWRA for the NRC under contract No. NRC-02-97-009. This paper is an independent product of the CNWRA and does not necessarily reflect the views or the regulatory position of the NRC.