Status Summary of NERI Tasks – Phases 1-3:

Phase 1:

<table>
<thead>
<tr>
<th>Milestone/Task Description</th>
<th>Plan Completion Date</th>
<th>Actual Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition of the Environment</td>
<td>4/30/2000</td>
<td></td>
</tr>
<tr>
<td>Continued Model Development</td>
<td>1/31/2002</td>
<td></td>
</tr>
</tbody>
</table>

Narrative:

Task 1. Definition of the Environment

1. Task status:
   During the past quartile (two month period) most attention has been concentrated on the problem of definition critical temperature at which “wet” corrosion first became operable.

2. Issues/Concerns

   It has been shown that, in principle, “wet” corrosion processes can not be ignored for Yucca Mountain, even for initial times, when the temperature of the surface of containers is well above the boiling temperature of water for the prevailing conditions. This is because the surfaces are covered by highly hydrophilic oxides (e.g. Fe₂O₃, NiO, Cr₂O₃) that will hydrate to the form of corresponding hydroxides, which are proton conductors, at least when in the “wet” condition. Because proton conduction and the presence of “bound” water are all that are required for the external environment to support metallic corrosion in either its general or localized form. Thus, the temperature of dehydration of the hydroxide, e.g. M(OH)₂ → MO + H₂O(g), is a better criterion for the upper temperature limit for “wet” corrosion than is the boiling temperature of “bulk” water. During this first task, we have reviewed the existing thermodynamic data base for the dehydration of metal hydroxides and analytical expressions have been developed that allow the upper temperature limit to be estimated.
DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, make any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.
DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.
Task 2. Continued Model Development:

1. Task status:

During the past quartile (two month period), most of our attention has been concentrated on the problem of growth of individual pits under thin electrolyte films that are considered to exist on the surfaces of high level nuclear waste container during most of their life in the repository.

2. Issues/Concerns:

A computer code has been developed for solving Laplace’s equation within thin films with arbitrary boundary conditions. Our numerical calculations show that:

a. It is absolutely necessary to take into account transport processes within the electrolyte film when quantitatively describing pit propagation.
b. If the width of the film, h, exceeds the radius of the pit, a, the film cannot be regarded as being “thin” (the solution for the pit growth rate does not depend strongly on h).
c. It is generally not possible to average the transport equations across a thin electrolyte film and the problem of the external environment has to be solved in 2 dimensions.

Analytical expressions for the maximum depth of pits, L, as a function of time, t, have been obtained for the important particular cases when

a. The current passing in the electrolyte obeys Ohm’s law. A constant potential drop exists between the active metal surface and a point far away the pit mouth.
b. Concentration gradients exist and the kinetics of metal dissolution in the pit are described by Tafel’s law.

Analytical forms of the pit depth versus time relation, L(t), allow us to investigate the influence of important properties of the liquid film and corrosion system, such as thickness, conductivity, chemical composition of the film, temperature, and the kinetics of the electrochemical reactions that occur on the external surface.

The resulting, fast algorithm for calculating pit growth rate under thin electrolyte films (developed on the basis of approximate analytical expressions obtained in this work) can be directly used for estimating the corrosion damage in the nuclear waste containers. In particular, this algorithm allows us to predict the depth of the largest pit that exists on the container surface, and, accordingly, to predict the time of crack initiation.
Cost Performance:

![Bar chart showing actual and planned costs for August and September. The x-axis represents the months of August and September, the y-axis represents cost in thousands of dollars (K). The chart shows a significant increase in planned cost from August to September, with actual costs remaining relatively low.]

- **Actual Cost ($K)**
- **Planned Cost ($K)**