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Distribution:
CHANG
(Return to WM, 623-SS)

Mr. K. C. Chang
Mail Stop 623-SS
U. S. Nuclear Regulatory Commission
Washington. DC 20555

Dear Kien:

During the past two weeks I have continued to explore and analyze various reports and studies of corrosion on steels and copper. As I pointed out in my last report the use of copper in the Tuff environment looks particularly favorable. I have discussed this with personnel at LLL and they say that copper is being given serious consideration. A particularly important aspect in favor of the use of copper is the fact that as a pure material (not an alloy), the corrosion mechanisms are much better understood than is the case for stainless steels and even carbon steels. One individual expressed the opinion that the inability to thoroughly understand the corrosion mechanisms of stainless steel will make it unsuitable for use in a repository.

An interesting aspect of the use of copper is that for the normal fabrication methods for a container, the end caps would have to be electron beam welded, and this process has not been successful for copper because of its high thermal conductivity. This apparently represents a serious problem for the Swedes. Although the hot isostatic pressing process is an alternative, there are no facilities is existence large enough to carry out the process on fuel rod assemblies and so the process cannot be examined at full scale.

I have reviewed a number of papers published in the Ninth Volume of the series "Scientific Basis for Nuclear Waste Management". Several authors discuss the issue of pitting corrosion in low carbon steel as well as uniform corrosion in this material. There is enlightening information in these reports that I may be able to use. I will provide additional discussion of these reports in my next submission. However it is worth noting that several authors are quite certain that pitting corrosion in low carbon steel is its principal failure mode in the granite environment and most likely in other environments as well.

In this volume Neretniecks discusses the build-up of H_2 around a container and proposes a capillary breaking layer (a layer of fine sand) as a means of inhibiting the penetration of water to the container and thus stopping the corrosion process. He assumes that capillary action in the clay would produce a pressure that exceeds the H_2 pressure and thus corrosion would

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continue until either the hydrostatic pressure or the lithostatic pressure is exceeded. His argument for the capillary pressure is somewhat weak; however, it is true that the swelling pressure of clay can be quite high. Consequently, the H_2 pressure would have to exceed this value before water could be excluded from the vicinity of the container. It seems to me that the argument that the gas bubble would migrate to the top of the container, leaving water in contact with the bottom, would have more force in Neretniecks' arrangement than in one in which no sand layer is present. In the case of clay only, a thin gas layer would form. Water could move along bubble boundaries, but I cannot presently analyze that process. I am reasonable confident that such a thin gas layer would be stable and that it would inhibit the corrosion process, at least for uniform corrosion. An important argument regarding this process is the rapid diffusion of H_2 into iron. At the pressures involved, H_2 dissolves to a very large extent in iron. Thus corrosion would continue until equilibrium is established. Of course embrittlement of some significant magnitude is likely to have occurred by this point.

I have received the various papers on pitting corrosion that you sent me and have read them. I found the statistical analysis of the electrochemical measurements to be quite interesting, but as yet do not know how it might be developed into a useful model. The experiments relate to the development of a single pit rather than a large number of pits. The fact that the observed current pulses do not follow a pattern that is either statistical or causally related to some function results in considerable interpretative difficulty; however it does not invalidate the use of a statistical approach for the occurrence of a pit. I am exploring the possibility of including the observations of the BNL studies in the statistical model but have not arrived at a mathematically sound approach.

I am including three copies of the Voucher for Professional Services for your approval. I am also submitting a Public Voucher for local travel and long-distance telephone charges. If you have any questions, please feel free to call me.

Sincerely,

Robert B Moler

Robert B. Moler