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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:

Services Rendered on High Level Waste Repository
Performance Assessment Development: 12-13-86/3-6-87

During the period from 13 December 1986 to 28 February 1987 I have continued to study the problem of developing or adapting appropriate models for corrosion in the three environments, and reviewing relevent literature. There continue to be large uncertainties in this endeavor, particularly for localized corrosion. The BNL/MIT report on pitting corrosion in a chloride or sulfate environment was particularly illuminating.

The report clearly demonstrated the importance of pitting, but was unable to develop a reasonable model for the process although the physical phenomena used in the model are important in controlling the processes. It is apparent that several other processes are involved as was demonstrated by the observation of H_2 formation. It appears possible to adapt the basic model used by including a statistical approach such as that employed in the statistical pitting model that I developed. The most important features of a phenomenological model would be preserved while the statistical features, that are evident because of a lack of detailed knowledge of all relevant processes, can be treated. The result would be a quasi-phenomenological model that might be adequate.

It is interesting to note that hydrogen production was observed in the BNL/MIT studies. Also Neretneiks has investigated the problem of hydrogen production and proposed that a sand layer be incorporated in order to prevent groundwater from contacting the cannister after some hydrogen has been produced. This is essentially the idea that I had suggested in somewhat different form. If hydrogen is produced and cannot escape except by diffusion through the surrounding saturated bentonite, then the layer of hydrogen will limit the rate of corrosion because no groundwater will be able to penetrate the gas bubbles. There is an obvious problem with this concept, adsorption of the hydrogen produced by the steel of the canister. This mechanism will allow more rapid corrosion to occur for some period of time and possibly will result in embrittlement and intergranular corrosion. I will pursue this line of investigation to be sure that the reasoning is correct and that other phenomena do not

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invalidate it. The primary issue is whether or not groundwater can penetrate the layer of surface hydrogen bubbles and allow continued unrestrained hydrogen production and corrosion. This does not seem plausible but some futher thought is needed. Gary Fuller and I will study the impact on corrosion of involking this mechanism even though it cannot be guaranteed to function as stated. The mechanism is that hydrogen must diffuse through the bentonite layer and the rate of corrosion is limited by the rate of mass diffusion of the hydrogen.

There is a growing body of information regarding the uniform corrosion of low carbon steel in a variety of environments. These data tend to verify that the rate of uniform corrosion is low, but have not developed a model based on the kinetics of particular chemical reactions that is plausible. In particular it has not been possible to account for the temperature dependence of the corrosion rate. This may not be a serious problem so long as the temperature effect is small as it appears to be. The models proposed by BWIP are not plausible because they are entirely empirical. Such models will be subject to strong (and justified) criticism by the scientific community that is critical of the repository concept. A more defensible approach will be required.

I have made arrangements with Dr. Boyars to visit the Navy facility at White Oak to discuss with their scientists the results of their program on corrosion. They have a substantial ongoing effort that may provide some useful input. The NBS and BCL work will be studied as well. All of these studies will be important in reaching a balanced position and achieving a meaningful ability to assess the lifetime of the cannister, and in being able to recommend approaches to corrosion studies that may lead to practical and applicable data.

The use of a hazard function for corrosion as discussed by G. Fuller at the recent program review is a useful approach if a function can be developed on heuristic grounds. In general this is a difficult task, and some approach based on physical principals is required in most cases. Nevertheless, in the absence of a mechanistic understanding and adequate data such an approach may be useful even though it will have to be based on engineering judgement.

I have reviewed a number of documents and sources, but have not found any additional data useful for the hazard functions for external events and stand-by failures. Such data exists but will require a more extensive effort than I have been able to provide in order to gather it, and incorporate it in the methodology.

Milestones

I expect that for the next several months I will confine my efforts to gathering information on corrosion and examining the data and models that are available. By the end of May I will

provide a report on these efforts and any conclussions that I have reached.

A brief report on the idea of using hydrogen production and diffusion as a rate limiting process will be provided in April.

Funding

As of 8 March 1987 I had charged 28.5 days against the total of 130 authorized. I anticipate that for the remainder of the contract period I will charge an additional 30 days for an estimated total of 58.5 days.

I have included a voucher covering the work that I have done during since 12 December 1986. This involved principally analysis of some work on pitting corrosion modeling and additional studies of uniform corrosion in the salt environment. This work was summarized in the presentation given by G. Fuller on my behalf. The work also includes the effort required in preparing the presentation material.

If you have any questions please feel free to call me. I can be reached at 703/754-2103.

Sincerely,

Robert B. Moler

Robert B. Moler