Summary of Recent Work 4/24/87

Kenneth W. Stephens

Background

My activities for the foreseeable future are predominantly associated with the performance assessment methodology demonstration and the engineered barrier system strategy document. The information summarized below covers those activities and related work.

Methodology Demonstration NUREG

General

Just before we left The Aerospace Corporation at the end of September 1986, the team supporting NRC conducted a preliminary demonstration of the waste package performance assessment methodology. That work was summarized in an Aerospace Technical Report.

Now that we are working as consultants to NRC, we have been asked to put that report into the form of a NUREG or NUREG/CR document so that it can have wider distribution within the waste management community.

The work is progressing nicely, with two objectives:

- Modifications for clarification and amplification
- Addition of updated material based on work since September.

Although much of the text is the same, the material has been consolidated and reorganized to enhance the readability for persons not familiar with the methodology development over the past several years. The attached Draft Table of Contents shows the new arrangement.

First drafts of revised Sections 1 - 4 have been completed, and work is progressing on Sections 5 and 6. The appendixes will probably have only a few, minor changes.

Review Comments

In late 1986, NRC asked Sandia to review our Aerospace demonstration report. Their comments were delivered in late March of this year, and we recently received a copy from NRC.

We are considering the Sandia comments in our current revision of the report. Unfortunately, some of the comments are

inappropriate and are based on the reviewers' misunderstanding of the methodology and the technical principles inherent in it. We are in the process of preparing answers to the Sandia comments and will send them to NRC in the near future.

The methodology is sound. To the extent practicable, we will revise the report to engender confidence in the minds of readers unfamiliar with the methodology.

Engineered Barrier System Strategy Document

In January, I delivered to NRC a draft of a document summarizing the status of the EBS work and its relationship to our overall methodology. The intent is to provide recommendations for the strategy NRC should follow for the EBS analysis. The NRC staff gave the draft a careful review, and their comments are being incorporated in a revision.

The challenge is to incorporate sufficient specifics to satisfy the hunger of all of us for implementation details. The state--of-the art for dealing with the region between the waste package and the periphery of the repository is quite limited.

So far, DOE has concentrated their efforts on showing that they can meet the NRC EBS requirements and the EPA Standard at the waste package boundary. Even though recent work shows that they may have difficulty achieving that objective for all nuclides in certain geologic media, we have seen no significant effort by DOE to develop an analytical basis for claiming credit for the material between the packages and the periphery of the repository.

If it is possible to meet the requirements with the waste packages only, then the EBS analysis consists essentially of the waste package analysis and the process for generating the collective releases of all the packages. However, it is prudent for NRC to consider the possibility that DOE will eventually have to claim credit for more than the packages. Accordingly, my EBS strategy report will include suggestions for NRC contingency efforts toward that end.

Review of DOE AREST Work

The DOE Office of Geologic Repositories is currently funding generic performance assessment work at Pacific Northwest Laboratories. This work, which is independent of the media-specific projects such as BWIP, has objectives quite similar to those of our work with NRC. (Our funding is much smaller.)

The PNL people have developed a computer code called AREST

(Analytical Repository Source Term), for providing a quantitative assessment of the performance of both individual barrier materials and the overall EBS.

We recently received copies of papers by the PNL AREST developers. My review disclosed some interesting parallels between their approach and ours. They use the convolution method we use to generate the source term and cite our work. They, too, use a Poisson process to go from the individual waste package to a collection of packages.

Both they and we assume that individual packages have no effect on other packages (except for the thermal calculations). That is, any synergistic effects are discounted. This assumption has bothered us, because there is a possibility (at least in principle) that the corrosion products could alter the chemistry around other packages, thereby changing the corrosion rate. Unfortunately, the state of knowledge regarding the chemistry within the repository and the state of corrosion knowledge is inadequate to make definitive conclusions at this time. This is a subject that should be explored in the future.

The PNL papers mention that DOE is not currently taking credit for any EBS protection beyond the packages, and thus, the AREST work is based only on the packages. There is no mention of any contingency work for claiming additional credit for other material.

One of the papers describes how AREST was used in a performance assessment for basalt, salt, and tuff, with spent fuel as the waste form. The results showed that if there is congruent dissolution of the nuclides (i.e., the nuclides dissolve at the same rate as the uranium oxide matrix), the NRC regulations and EPA standards would be met for all nuclides. However, in the non-congruent case, the NRC regulations would be exceeded for some nuclides. (This tends to support analyses done at Lawrence Livermore that showed gap releases may be a problem for the tuff repository.)

The PNL papers cite a considerably body of work, both in the United States and in other countries, supporting as assumption of congruent release. However, the AREST team considers it appropriate (and conservative) for the analysis to include non-congruent release.

We are encouraged that the PNL team is using some of the approaches we are using. These techniques are new, and independent confirmation helps promote confidence in our methodology. We intend to discuss the AREST work at some length with the PNL people and will discuss the findings with NRC.

Corrosion Work

A potentially weak point in waste package performance assessment is the corrosion modeling. Our methodology (as well as the PNL AREST work) is intentionally designed with the flexibility to use different corrosion models. However, for actual analysis, particular models must be applied. Accordingly, the value of the assessment of waste package lifetime is no better than the corrosion models used. Currently, there is no consensus regarding desirable models of uniform and pitting corrosion.

Recently, we received material on the corrosion research being conducted for NRC by the National Bureau of Standards. It is good to see that progress is being made in understanding the basic mechanisms of corrosion and the statistics associated with pitting. Unfortunately, that work is developmental, and it is likely to be some time before there will be phenomenologically-based corrosion models that can be incorporated into performance assessments such as ours.

The PNL people also have been concerned about the availability of good corrosion models. A number of models have been used with AREST, but the researchers make no statements regarding which models appear to be the best. That is a difficult judgment that must await further developments.

We plan to discuss the corrosion models with the PNL people to see whether they have done any studies to quantify the sensitivity of waste package lifetime to the particular models used.

Lead-Iron-Phosphate Glass

The glass waste form adopted for use by the DOE program is a borosilicate glass. Within the past several years, some researchers have advocated use of a lead-iron-phosphate glass with supposedly better leaching resistance. In a prior report to NRC, I suggested that the NRC/NBS work maintain an awareness of this issue, in the event it becomes a licensing contention later.

The NRC staff has been monitoring this issue and sent me a Savannah River document, DP-1729, "Investigation of Lead-Iron-Phosphate Glass for SRP Waste", C.M. Jantzen, October 1986. At face value, it would appear that there is a solid body of knowledge supporting the Savannah River contention that the lead-iron-phosphate glass is undesirable as a waste form. Nevertheless, I am intrigued by the unabashedly slanted tone of the Savannah River report. This is an emotionally-charged issue within DOE and bears continued watching.

Monitoring of BWIP Work

The BWIP project is relatively open with information concerning their work, and we are able to monitor the progress and have a window into part of what DOE is doing. I routinely receive the Document Accessions List and from time to time order documents.

Recently, I received CB-00617, "Exploratory Shaft Facility Water Inflow Design Calculations", February 1987. This is basically a hydrology document, but it is interesting to me because it illustrates the degree to which BWIP is applying probabilistic analysis in their design effort.

In this document, probability distribution functions for geologic and hydrologic variables are used to calculate the expected range of water inflow into the exploratory shaft.

Monitoring of ONWI Work

I am on the distribution for many ONWI documents. One interesting document relates to brine migration: ONWI-384, "A Sensitivity Study of Brine Transport Into a Borehole Containing a Commercial High-Level Waste Canister", J.L. Ratigan, February 1987.

The issue of brine migration has been controversial for some time--especially since the WIPP tests showed much greater brine influx than was predicted by the models. This is an important issue for ONWI, because the amount of brine migrating inward is used to establish an upper limit on the amount of container corrosion.

According to the sensitivity analysis covered in the report, the most significant system parameter uncertainties are the ratio of interconnected porosity to total porosity, initial brine inclusion density, and the threshold gradient below which brine inclusion are immobile. The author advocates that these parameters be quantified with greater certainty so that there can be a more certain prediction of brine flow into the borehole.

Monitoring of NNWSI Work

I try to monitor the work on the NNWSI project, but it is more difficult than for the other projects. The NNWSI philosophy is to keep most of the information internal until late in the development stages. This means that it is much more difficult to get a window into the project's philosophies and analytical approaches. I will keep trying.

DRAFT METHODOLOGY NUREG
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