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Mr. Everett A. Wick
High Level Waste Licensing Management Branch
Division of Waste Management
Mail Stop SS 965
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Wick:

We have reviewed the SCR with respect to its usefulness in aiding the NRC in an evaluation of waste packages in basalt. We have found that the SCR does summarize the pertinent literature adequately. However, we feel this report suffers from several major deficiencies and inconsistencies. The common factor pertinent to our concern is that claims and assumptions made with respect to the compliance of the waste package to NRC criteria are not supported by the data given in the text. Although the report states in many sections that the data are inadequate, this assertion is ignored in other sections. In the following we give some examples illustrating this.

While the report asserts that the package is expected to comply with the NRC performance objectives in 10 CFR 60, there are several instances where the information presented implies that the package will not be able to comply with the criteria. The following are examples which we feel cast doubt as to whether NRC criteria can be met:

In Section 11.1.2 a discussion of the waste composition of the final product indicates that the release characteristics will vary over time and with waste type incorporated in the glass. Section 11.1.5 discusses the potential adverse effects of devitrification on the release properties of glass and Section 11.1.13 addresses the increased surface area that may arise as a result of cracking during processing. Finally, in Sections 11.1.9 and 11.1.13 it is stated that there is no reliable leaching data for glasses under the typical basalt conditions anticipated. In order to circumvent these problems and ensure that the package will meet the controlled release criterion, the report proposes the use of a basalt-bentonite backfill. The role of the backfill (11.2.8) will be to control the Eh, precipitate released radionuclides and provide a barrier of low permeability to ensure diffusion controlled transport through the backfill.

The problem is stated specifically in Section 11.2.2.2:

> "11.2.2.2 Backfill Function. Current data are insufficient to show that the waste form can, by itself, meet the proposed NRC (1981) release rate criterion. Thus, the primary function of the backfill is to aid the waste form in controlling hazardous radionuclide release to the host environment to less than 10^{-5} of the inventory per year after 1,000 years. The slow release criterion currently relates to the entire engineered barrier system (waste package plus repository). Since analyses have not been performed, it is not presently possible to assign partial responsibility for meeting this criterion to each of the parts of the system. It is, therefore, presumed for present waste package design that the slow-release criterion applies solely to the waste package until information becomes available (primarily by reliable modeling of radionuclide transport through the total system) to modify the waste package requirement. Using this assumption, the backfill is required to reduce the release rate of the hazardous radionuclides from the waste form."

This is then contradicted by the discussion given in Section 11.2.5:

> "It must be recognized, however, that only a limited thickness of backfill can be contained between the canister and emplacement hole wall because of repository economics. Further, by the very nature of its operation, the backfill additives will be eventually neutralized. Therefore, it is intended only to 'buy time' until repository conditions early in the thermal period become less severe with time."

Throughout the report it is noted that the leach behavior of glass is superior to that of spent fuel. Therefore, any problem associated with the performance of a package containing glass would be expected to be more severe in a package containing spent fuel.

Containment

This report implies that containment will be easier to achieve than controlled release. The arguments presented to support this are centered on assumptions that whatever metal canister is chosen will degrade by uniform corrosion and that the rate will be very low because of the anticipated reducing environment in the repository and the assumption that radiation will not cause a major pertubation in this reducing environment.

After a number of assumptions concerning the reactions that will control the Eh of the water and result in a reducing medium conducive to maintaining the canister integrity, the report further suggests that if the system goes into equilibrium the Eh will be so low that the hydrogen overpressure may inhibit radiolysis of the water. We find several problems with these arguments. For example:

1. It is unlikely that there will be an equilibrium situation in a repository. If these assumptions are correct, it should be demonstrable that the hydrogen overpressure is present in the unperturbed system at the depth of the repository.

2. When the package is emplaced, the environment will be oxidizing and radiolysis will tend to maintain an oxidizing atmosphere. It is not clear that the kinetics tending to drive the system to equilibrium are more rapid than the kinetics of radiolysis which tend to prevent equilibrium reactions.

3. In a temperature gradient there are a large number of potential reactions that may interfere with equilibrium. An experimental verification of the equilibrium condition assumed to occur through the interaction of the water with the basalt is particularly crucial at the canister interface.

4. If the groundwater oxygen fugacity is in equilibrium controlled by the basalt, then for any arbitrary carbon activity the very low oxygen activity requires that the CO/CO_2 ratio is so large a value as to essentially preclude any CO_2. This is not supported by the gas analyses given in Section 6.2.4 where the CO_2 value is larger than the CO value.

The assumption that the Eh will remain reducing is important to three major aspects of package performance: release and transport of radionuclides, corrosion of the canister, and the assumption that radiolysis may not affect package performance. It is, therefore, imperative that this assumption be tested as rapidly and as carefully as possible.

The report asserts that the corrosion data presently available do not insure that these assumptions are valid and that the problem of predictability cannot be adequately addressed at this time. Since the planned approaches are not detailed enough to insure resolution of the issue, we feel that this document without further detail is not sufficient to produce the information the NRC will need to assess whether containment is achieved with reasonable assurance.

Hydrothermal Packages

With the exception of defense high level waste packages, these packages will result in hydrothermal conditions in the repository well into 1000 years after emplacement. The processes (e.g., corrosion and leaching) that tend to degrade the performance of the waste package materials are accelerated under these conditions. Considering that the data available show much poorer performance under hydrothermal conditions, the absence of any serious discussions on lower temperature waste packages indicates that the motivation for package design is determined by cost and not the concept of redundant safety barriers.

Along with specific inconsistencies the report seems to vacillate between the view that the waste package should meet the NRC criteria, a second view in which they give up on the package and claim the basalt will prevent release to the accessible environment, and a third in which the package makes up for deficiencies in basalt. For example, on page 11.3-32 the report states

> "The basalt site, therefore, appears to be capable of adequately controlling the release of the actinides to the accessible environment. Consequently, in terms of meeting the EPA draft and NRC proposed release criteria, the required engineered system performance for these radionuclides is zero. The waste package, although possibly necessary for other radionuclides, would function simply as a secondary barrier to the release of the long-lived actinides to the accessible environment. However, the waste package would still be necessary to meet the NRC's proposed 1,000-year containment criterion, but a much simpler waste package design would now be adequate for the repository." (Our emphasis)

on page 11.3.2

> "Preliminary performance estimates indicate that waste package designs for basalt may not require physical containment of all radionuclides, as presently required by the proposed NRC 1,000-year criterion (Wood, 1980a; 1980b). This feature may greatly reduce waste package complexity for a repository in basalt."

and on page 11.3-38

> "The results of preliminary corrosion studies and estimates of radionuclide behavior in the near-field of the repository indicate, however, that the complexity of the initial early spent fuel waste package developed by the BWIP may be

simplified. This has been accomplished by eliminating the corrosion-resistant titanium overpack and the buffer, and by designing the backfill component to limit or retard only those key radionuclides found to be mobile in the basalt environment."

Considering the uncertainties involved in which "key radionuclides" are mobile in basalt, it seems premature to simplify the "initial early spent fuel waste package."

The report is inconsistent with respect to the objectives for waste package performance. We believe that much more detail on exactly what is going to be done in the future will be required before the NRC can determine if this program will be adequate in providing the information needed to evaluate waste package performance.

Sincerely,

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