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Department of Nuclear Energy

June 18, 1984

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

Dear Mr. Wick:

Final Report on FIN A-3167 (Task 4) Program on
Local Conditions Around a HLW Container Emplaced in Basalt

Enclosed please find the subject Final Report. Comments received from NRC on the Phase I Draft Report (Letter Wick to Soo, March 21, 1984) have been incorporated, as appropriate. Some straightforward NRC comments are addressed below, rather than in the report itself.

NRC Comment 8

We did not check for radioactivity in the autoclave cover gas. None should be expected, however, since gamma irradiation usually causes ionization damage rather than transmutational effects.

NRC Comment 12

It is possible that thermal gradients within the autoclave could cause complex convection effects during testing. However, we believe that these would be small and negligible since the packing mixture was relatively viscous and water convection would be slow. In addition, it should be noted that the 75 percent basalt component in the packing forms isolated "cells" of bentonite/water which would further inhibit convection currents.

NRC Comment 17

With respect to the NRC calculation of pH using the BWIP equation:

$$pH = \frac{2640}{T(K)} + 1.64$$

one should remember that this was obtained from experiments carried out for a basalt/H_2O mixture. Such an equation cannot be applied to the BNL work since the latter included bentonite in the tests. Also, the BNL tests were non-isothermal and the applicable dissociation reactions governing pH are not known.

NRC Comment 18

The initial DO content in the BNL slurry was not 8.3 ppm, as stated by NRC, but 2.8-6.5 ppm. It would probably be lower after autoclave sealing and pressurization. The 8.3 ppm value was for a basalt/H_2O mix exposed to air. We feel, therefore, that the higher BNL DO content of water is appropriate since it will address a worse-case scenario, rather than assume that ideal low-oxygen conditions exist. The BNL work, in effect, checks the assumption by BWIP that basalt/H_2O reactions are capable of establishing reducing conditions. If the experiment was carried out with deoxygenated water one would have no way of determining the effect of basalt and carbon steel in decreasing the DO.

NRC Comment 19

We have reworded the statement that ".....significantly less DO in the irradiated system than in the unirradiated system." The intent was to state that there was less DO in the irradiated (tested) system compared to the unirradiated (i.e. starting) system for Phase I. In actual fact the DO levels in all three reacted systems were identical within experimental error.

We were not able to carry out rigid mass balance calculations to ascertain where the DO levels in reacted basalt or in the colloids formed. However, in the section of the report on steel corrosion rates we show that the oxide scale formed during test will account for virtually all radiolytic oxygen generated.

NRC Comment 20

With respect to deviations from Henry's Law at high pressure we feel that such deviations are not likely for oxygen. This is because the 1400 psi test pressure is not due to oxygen, but to the cover gas and steam. Therefore, the low partial pressure of the oxygen should not cause any significant deviation from Ideal Gas Law behavior.

NRC Comment 21

NRC used the following equation from BWIP (DOE/RL 82-3, Vol. II, 1982) to calculate the oxygen fugacity (fO_2) at 400°K to obtain a value of 4.5×10^{-50} Pa, and compares it to the calculated BNL value of 46.3 Pa. This is inappropriate since the BNL value was obtained for 24°C (297°K). The dissolved oxygen was not measured at 400°K and, therefore, an oxygen fugacity cannot be calculated for this temperature.

NRC Comment 23

As stated in our telephone conversation [Gause/Soo (BNL) to Wick/Peterson (NRC)] we did not intend to measure diffraction peak intensities. The difficulty lies in analyzing a range of individual reacted basalt and bentonite control specimens to determine which peaks belong to which material. This would have to be followed by relative intensity determinations. Since the main scope of our work was to measure water chemistries around a container, we feel that detailed quantitative geochemical determinations would be outside the scope of our work.

With respect to predicted and measured test values specified in our Program Plan, the only significant differences are for Fe, Cl^-, SO_4^{-2} and CO_2 concentrations. The predicted values for these parameters were based on BWIP work on basalt/H_2O systems in the absence of irradiation at higher pressures and temperatures than those used by BNL. However, we have attempted in the section of the report on water chemistry determinations to specify the reasons for the differences between BNL and open-literature values.

Sincerely,

Peter Soo

Peter Soo, Associate Division Head
Nuclear Waste Management Division

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