September 26, 1995

MEMORANDUM TO: Michael J. BELL, Branch Chief
ENGB/DWM/NMSS

THRU: Richard M. WELLER, Section Leader
ENGB/DWM/NMSS

FROM: Tae M. AHN TMA
ENGB/DWM/NMSS

SUBJECT: VISIT TO CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES
AUGUST 28-SEPTEMBER 1, 1995

From August 28 to September 1, 1995, I worked at the Center for Nuclear Waste Regulatory Analyses (CNWRA) on the development of Engineered Barrier System Performance Assessment Codes and other waste package issues, as part of the NRC/CNWRA technical exchange. Attached is the trip report for this visit.

Attachment: As stated

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TRIP REPORT

From August 28 to September 1, 1995, I worked at the Center for Nuclear Waste Regulatory Analyses (CNWRA) as part of NRC/CNWRA technical exchange. Attachment A is the agenda for my visit. My interaction with CNWRA staff emphasized the development of Engineered Barrier System Performance Assessment Codes (EBSPAC). Other work conducted includes: (a) review of the development of Compliance Determination Method for Review Plan No.5.2 on Assessment of Compliance with the Design Criteria for the Waste Package and its Components; (b) review of the development of spent fuel white paper; (c) review of Draft Planning and Status Report for Detailed Report for Detailed Analyses of EBS; (d) laboratory tour and prioritization of Engineered Barrier System Experimental Research (EBSER); (e) final review of the colloid report; and (f) review of the Consolidated Document Index System (CDOCS) storage of High-Level Waste (HLW) information. During this visit, I also gave CNWRA staff a special seminar on "dry oxidation of spent fuel."

My work on the EBSPAC developments was prioritized based on: (a) Key Technical Issue Implementation Plan - Waste Package Degradation; (b) Operations Plan of Engineered Barrier System (EBS); and (c) Draft Planning and Status Report for Detailed Report for Detailed Analyses of EBS. For the containment assessment, I discussed with various CNWRA staff my ongoing work in the following three areas:

(1) Intergranular Dry Oxidation of Alloys: Metals are oxidized by oxygen, under dry or aqueous conditions. This (dry) oxidation is a separate process from electrochemically or chemically driven aqueous corrosion. The current Total System Performance Assessments of the Department of Energy calculate that the penetration of the container by oxidation is about 1 μm at 200 C for 1000 years; the oxidation of the container occurs uniformly from the surface into the interior. However, these conclusions were obtained by extrapolating data obtained at high temperatures of about 1000 C to repository temperatures of about 100 to 200 C. This is not a "recommended" practice for long term prediction of oxidation behavior. At repository temperatures, grain boundaries may be oxidized preferentially. Normally, grain boundary oxidation is faster than uniform oxidation, perhaps by many orders of magnitude. The modeling of this process of grain boundary oxidation was discussed.

(2) Materials Stability: Metals are sensitized by the formation of secondary phases such as carbides, or by segregation of certain elements in grain boundaries, e.g. phosphorous. This sensitization is likely to lead to earlier mechanical failure or to localized corrosion of the metal. To model the formation of secondary phases, nucleation and growth of the secondary phases need to be considered. One useful model in nucleation and growth is already available. The available model is the formula for the nucleation time for the secondary phase formation in spent fuel. I derived a formula for the nucleation of U_3O_8 in U_4O_9. This formula can be used equally well to the metal system. The details of the formula were discussed. Regarding the elemental segregation in grain boundaries, future plans for the calculation were discussed.

Attachment

(3) Corrosion Condition: It is generally known that a continuous aqueous film forms on metal surfaces above about 60 percent Relative Humidity (RH). A continuous aqueous film is believed to be a prerequisite condition for various aqueous corrosion processes. However, this 60 percent criterion was obtained from data at room temperature. It is not known whether 60 percent RH is sufficient to form the aqueous film above room temperature. It is suspected that the aqueous film may form at higher RH than 60 percent above room temperature. The proposed model for the film formation is the nucleation and growth of water film. Particularly, capillary-induced fast nucleation is emphasized. Progress made and new plans in modeling this formation process of water film were discussed.

For radionuclide release problems, I have developed more models than in the area of radionuclide containment. These developed models will be incorporated in: (a) the next version of EBSPAC; (b) the next version of EBSPAC status reports; and (c) the source term module of the Iterative Performance Assessment Code. The following specific issues were discussed in details regarding the developed models and the follow-up plan: (a) dissolution of spent fuel matrix for release models of fission products; (b) colloid formation for releases models of actinides; (c) dry oxidation for an important prerequisite process for the dissolution of spent fuel or for the gaseous radionuclide releases; (d) gaseous radionuclide releases; and (e) HLW glass performance.

Regarding C-14 issue, Mark Jarzemba briefed about the status. Recently published National Academy of Sciences report does not conclude that C-14 release is unimportant in the Yucca Mountain project. According to Mr. Jarzemba, the C-14 issue may become important, if the C-14 release from the repository is fast, and the C-14 dispersion in the biosphere is confined in a small volume. Our work on C-14 source term will be a basis for the assessment of the C-14 release from the repository.

Other work conducted was: (a) to review and give inputs for CDM 5.2, spent fuel white paper, EBSPAC OPS plan, laboratory work and EBSER, and colloid report; and (b) to present and discuss modeling results on the dry oxidation of spent fuel, and discuss the importance of HLW glass over spent fuel in the computation of source term. Finally, I was briefed about CDOCS. The detailed instruction for the use of CDOCS will be mailed to us. During all the aforementioned discussions, I promised to send relevant literature to CNWRA staff. The technical reports and articles have been copied and sent to CNWRA to meet this commitment. In conclusion, the visit was very useful and informative both to me and to CNWRA staff. The technical exchanges with CNWRA staff made this a very successful trip. In my next visit, CNWRA staff and I plan to continue work on code development for EBSPAC with a focus on modeling releases from spent fuel.

AGENDA FOR TAE AHN'S VISIT

1. Discuss CDM 5.2 with Hersh and Chuck (Monday – Tae, Hersh, and Chuck)
2. Lab visit and research plans (Monday – Gustavo)
3. Provide input to CDM 5.2 and continued discussion (Tuesday – Tae, Hersh and Chuck)
4. Discuss spent fuel dissolution and release white paper (Tuesday – Tae, Gustavo, Peter)
5. Provide input to white paper (Tuesday – Tae)
6. Discuss EBSPAC report (Wednesday – Tae, Sridhar, Gustavo, Peter)
7. Provide input to EBSPAC report (Wednesday – Tae)
8. Discuss C-14 Issues (Thursday – Mark, Tae, Peter)
9. Seminar – Dry Oxidation of Spent Fuel (Thursday, 10:30 to Noon, Tae)
10. Discuss glass issues (Thursday – Hersh, Tae)
11. Oxidation modeling (Friday – Tae, Sridhar, Gustavo)
12. Discussion of release models (Friday – Tae and Jongsoon)
13. Open items, reports for inclusion in CDOCS system

Attachment A