

FOREIGN TRIP REPORT

SUBJECT

Staff Visits to Nuclear Research and Development (R&D) Institutes in Tokyo, Japan and Daejeon, Korea

DATES OF TRAVEL AND COUNTRIES/ORGANIZATIONS VISITED

1. Japan Nuclear Energy Safety Organization (JNES) in Tokyo, on March 27, 2006
2. The Central Research Institute of Electric Power Industry (CRIEPI) at JNES in Tokyo, followed by a laboratory tour of CRIEPI in Abiko City, on March 27, 2006
3. The Radioactive Waste Management Funding and Research Center (RWMC) in Tokyo, on March 28, 2006
4. The Nuclear Environment Technology Center of Korea Hydro and Nuclear Power and Korea Atomic Energy Research Institute (KAERI) at KAERI, Daejeon, March 29, 2006
5. Korea Advanced Institute of Science and Technology, Daejeon, March 29, 2006
6. Korea Institute of Nuclear Safety, Daejeon, on March 29, 2006

AUTHOR, TITLE, AND AGENCY AFFILIATION

Tae M. Ahn, Senior Materials Engineer
Technical Review Directorate
Division of High-Level Waste Repository Safety
Office of Nuclear Material Safety
and Safeguards

BACKGROUND/PURPOSE

The purpose of this trip was to visit nuclear R&D institutes in Tokyo, Japan, and Daejeon, Korea, to gather and discuss technical information on spent nuclear fuel (SNF). The focus was on information relevant to how SNF performance can be assessed in the potential Yucca Mountain (YM) High-Level Waste (HLW) Repository.

ABSTRACT

I provided information on the potential YM repository and U.S. Nuclear Regulatory Commission (NRC) staff activities to evaluate materials behavior in a risk-informed, performance-based manner. I obtained information on SNF performance, Japanese and Korean experience in SNF canister and waste package development, and safety assessment code development. Discussion topics included: hydride embrittlement of SNF; issues associated with high burnup SNF; integrity of neutron poisons for criticality control; mechanical behavior and fabrication of canisters and waste packages; localized corrosion of waste package; colloid formation; reliability and the use of codes/standards in the canister and waste package fabrication; and

Enclosure

safety assessment code development. These issues could be relevant to the safety analyses of surface facilities operations at the potential repository, and the performance assessment for HLW isolation during the postclosure period.

The Japanese and Korean experience provides NRC a broader data base and insights on SNF, canister and waste package, for potential repository applications. It is recommended that these types of interactions continue with foreign organizations on various topics related to the performance and design of the potential repository.

DISCUSSION

- During the handling of SNF (e.g., loading, transportation or handling at the repository), it is important to conduct failure analysis to determine any failure of SNF cladding (e.g., scratch/cracking, deformation or embrittlement) for the performance of the repository. Although it is difficult to examine the cladding inside the grid, the examination has been made using fiber optical scopes. Along with this new method, Japan is using more traditional and practical methods such as sipping tests to determine hairline cracks and pinholes.
- Japan considers that delayed-hydride cracking (DHC) of cladding is more likely to occur at very high stress. Such conditions may occur when the reactor is under transitory high stress during the ramping. Subsequent localized stress after use in the reactor has not been studied yet. Also, the flaw size of cladding after use in the reactor has not been assessed fully, especially for high burnup SNF. Korean institutes stated that DHC is included in the activities of the international consortium on cladding studies. Tests are being conducted at Studsvik of Sweden. NRC Office of Nuclear Regulatory Research is an active member of this consortium.
- In regards to the risk assessment associated with the SNF handling, Japan uses the source term of SNF, mainly modeled by U.S. and the European communities. Japan has adopted the assessment made both under normal and accident conditions.
- In regards to the multi-use canister development, drop tests of varying drop height (e.g., 1 to 2 meters) were conducted in Japan. Leak rates were correlated to the extent of sliding (opening) of the cask top. Super Stainless Steels were introduced for use as canister materials. At CRIEPI, hybrid dynamic seismic tests were introduced to conduct the impact tests under more realistic seismic conditions.
- At RWMC, the extensive modeling results of the residual stress associated with welding was presented. Electron beam welding shows less stress and better quality compared with gas tungsten arc welding.
- In regards to the isolation of HLW, an extensive database on the colloid formation was presented by Nuclear Waste Management Organization of Japan (NUMO), including the quantitative determination of the size distribution of colloids. Colloids are considered to form during the HLW glass leaching and the degradation of bentonite backfills. Many colloids, however, are considered to be filtered through the bentonite.

- Neptunium (Np) solubility was modeled by NUMO in carbonate solutions under various pH conditions. It was noticed that carbonate ions form complexes with Np. The carbonated complex model may help NRC determine NP solubilities under YM repository conditions.
- The probabilistic models for the localized corrosion in carbon steels were presented by NUMO. The extreme value theory of pit distribution was utilized to determine the extent of pit propagation under repository conditions. The probabilistic assessment of pitting corrosion may be useful for more quantitative assessments of Alloy 22 corrosion under YM repository conditions.

PENDING ACTIONS/PLANNED NEXT STEPS FOR NRC

None

POINTS FOR COMMISSION CONSIDERATION/ITEMS OF INTEREST

None

ATTACHMENT

Business Cards

“ON THE MARGINS”

None