

## FOREIGN TRIP REPORT

### SUBJECT

Staff Participation in the Workshop on Design and Assessment of Radioactive Waste Packages

### DATES OF TRAVEL AND COUNTRIES/ORGANIZATIONS VISITED

October 5 - 7, 2005; European Commission, Joint Research Center, Institute for Energy, in Petten, The Netherlands

### AUTHOR, TITLE, AND AGENCY AFFILIATION

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### BACKGROUND/PURPOSE

The Institute for Energy organized the workshop to provide an overview of ongoing research, development and best practices for the design and assessment of waste packages (WP). The presentations made by the European Union (EU) countries focused on the geological disposal of high-level waste, the low/intermediate level waste disposal, and transport/storage. The staff was invited to: (i) present a paper on long-term materials behavior at the potential Yucca Mountain (YM) repository; (ii) review papers presented; and (iii) participate in a panel discussion. The participation provided an opportunity to exchange information on current WP issues with EU countries and Japan. Fifteen EU countries participated in the workshop, as well as Japan and the United States (U.S.) (Lawrence Livermore National Laboratory and U.S. Nuclear Regulatory Commission (NRC)).

### ABSTRACT

Extended presentations and discussion were made on the design aspects of the WP such as robust structure, welding, fabrication, nondestructive evaluation, and codes/standards. The design issues were largely from the mechanical performance (e.g., impact or drop) under normal and accident conditions. Corrosion performance, cladding mechanical and thermal properties, and radionuclide release behavior were also discussed among other topics. It was noted that a few countries are working on waste form conditioning such as sludge solidification. On the last day, a panel discussed EU needs for collaboration work. U.S. and Japan were asked to comment on the discussion and to participate in the collaboration. Collaboration topics discussed included: materials specification for disposal; storage and transportation; mockup and prototype tests; waste conditioning and radionuclide release; economics of facility construction/operation; and sharing information and safeguards. The needs will be developed with appropriate internal review/action and commitment from each potential participant for the collaboration. It was also suggested that any further development be coordinated with related activities sponsored by the International Atomic Energy Agency and the Organization for Economic Cooperation and Development/Nuclear Energy Agency.

The NRC participation provided staff with an excellent opportunity to exchange information on the various issues involved in the WP design. Staff gained insights from EU engineers and scientists on the design of a robust WP and future needs for the design. These insights will be valuable during a review of a potential License Application for a geological repository at YM,

Nevada. The participation also allowed an NRC staff member to present staff's current understanding of potential materials behavior to international counterparts. 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

- The specifications for metal fabrication and welding are not standardized for container/canister/cask of nuclear waste. They vary depending on materials (e.g., steel, copper, or nickel alloys), purpose (e.g., disposal, or storage/transportation), national policy (e.g., design base or performance base), and consensus standard organizations (e.g., American Society of Mechanical Engineers, ASME, Japanese Society of Mechanical Engineer, JSME, American National Standards Institute, ANSI, or American Society for Testing and Materials, ASTM).
- Similar to the U.S., the Swedish considers the mechanical failure of the WP. With the Swedish repository, the mechanical force is expected to be exerted onto the WP by the swelling of backfill materials (e.g., bentonite with water). Compared with corrosion performance, the mechanical properties are not extensively studied in the rest of the EU countries. Nonetheless, a presentation by the Institute for Energy in the fracture analysis of ductile materials using J integral showed the dominance of plastic collapse compared with fracture mechanics in copper.
- Drop/impact analyses of canisters/containers were conducted by several countries (e.g., United Kingdom, France and Japan) mostly using finite element methods. The drop/impact scenarios include accidents during transportation, handling and operation and under seismic conditions. However, no information was available on the drop/impact of SF assemblies with or without canister/container/cask. In the analyses, often necessary data are lacking under impact conditions and higher temperatures. Nonetheless, Japanese fracture mechanics analyses of welds under seismic conditions were excellent for various g forces. ANSYS was used for the analyses.
- In Swedish and Finnish programs, the creep of copper is studied. Modeling efforts were addressed with the point defect approach. Although the U.S. program studies titanium creep, the mechanism (e.g., twinning or coarse slip) is somewhat different as the temperature is well below the traditional creep temperature of alloys. Study by the NRC/Center for Nuclear Waste Regulatory Analyses indicates that the point defect model may not be appropriate at lower temperatures.
- In the corrosion allowance materials (e.g., carbon steel or copper), pitting corrosion kinetics considers the decreased pitting factor (or pit depth) as the uniform corrosion proceeds (or time elapses). This is consistent with recent U.S. approach in passive alloys (e.g., Alloy 22).
- Gas arc welding versus electron beam welding were discussed by the U.S. Department of Energy and U.K. The advantage of electron beam welding was emphasized in terms of operation time, economics and weld quality. Nevertheless, electron beam welding would not completely overcome problems associated with inhomogeneous microstructure or chemistry in welds.
- In SF performance, the cladding temperatures varied depending on the performance criteria chosen. More recent investigations of hydride embrittlement or high burnup effects were considered on a limited basis.
- A few Eastern European countries (e.g., Slovakia) made presentations on or mentioned the

conditioning of nuclear waste (e.g., sludge solidification). They requested more experienced countries to provide available technology/information to them. They also would like help in assessing the cost involved in various stages of waste management (e.g., research, construction, and operation).

- In a few radionuclide release assessments (e.g., Russia and Germany), recent U.S. concerns were rarely addressed including colloidal transport or realistic solubility limit.
- In the discussion of potential future collaborations among countries, safeguard issues were raised. Only international public information was suggested to be shared. A list of potential collaboration areas were made as a starting draft. Interested participants need to get back to the EU after assessing their organization's needs and interest.

The purpose of the trip was achieved. The European experience provides a broader data base and insights on the design and assessment of waste packages.

#### PENDING ACTIONS/PLANNED NEXT STEPS FOR NRC

Potential collaboration with EU and Japan in the research & development and best practices of waste package

#### POINTS FOR COMMISSION CONSIDERATION/ITEMS OF INTEREST

None

#### ATTACHMENT

Business Cards

#### "ON THE MARGINS"

None

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