CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

FOREIGN TRIP REPORT

SUBJECT: High-Level Waste Workshop on Integration of Engineered Barrier Systems in the Safety Case: Design Confirmation and Demonstration
Project Nos. 06002.01.322 and 06002.01.352
AI No. 06002.01.352.619

DATE/PLACE: September 12–15, 2006
Tokyo, Japan

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Enclosure

Subject:

Center for Nuclear Waste Regulatory Analyses (CNWRA) staff participation in a workshop on Integration of Engineered Barrier Systems in the Safety Case: Design Confirmation and Demonstration

Dates of Travel and Countries/Organizations Visited:

September 12–15, 2006, Tokyo, Japan

Author, Title, and Agency Affiliation:

Dr. Sitakanta Mohanty, Assistant Director, Engineering and Systems Assessment, CNWRA

Background/Purpose:

The purpose of the trip was to represent the U.S. and the U.S. Nuclear Regulatory Commission (NRC) as a delegate, present an invited talk, and participate in working group discussions at the Organization of Economic Cooperation and Development /Nuclear Energy Agency workshop on Integration of Engineered Barrier Systems in the Safety Case: Design Confirmation and Demonstration. This workshop was organized by the Organization of Economic Cooperation and Development /Nuclear Energy Agency in cooperation with the European Commission. Nuclear Waste Management Organization of Japan and Japan Atomic Energy Agency cohosted the workshop.

Abstract–Summary of Pertinent Points/Issues:

The workshop focused on the strategy, approaches, and methods for confirming and demonstrating engineered barrier system design in terms of key constraints and requirements that include long-term safety, engineering practicality, and quality assurance. Experts from the U.S., Belgium, Finland, France, Germany, Japan, the Netherlands, Sweden, Switzerland, United Kingdom, and Taiwan participated in the workshop. The workshop began with eight presentations covering a broad range of topics including total-system management approach to engineered barrier system design, methodology for engineered barrier system confirmation and demonstration, current developments in several European national programs on design confirmation and demonstration, examples of engineered barrier system demonstration programs, and lessons learned from performance assessments for engineering design and vice versa. The two presentations from the U.S. were on Yucca Mountain: (i) “Performance Assessments for Design Reviews,” by S. Mohanty and T. Ahn; and (ii) “Practical Lessons Learned on the Role of the Engineered Barrier System in a Total System Performance Assessment,” by A. Van Luik, U.S. Department of Energy (DOE), and D. Sevougian, Sandia National Laboratories.

The workshop also included a technical tour of the Engineering Scale Test and Research Facility and the Quantitative Assessment Radionuclide Migration Experiment Facility at the Japan Atomic Energy Agency’s Tokai R&D Center at Tokai-mura, Ibaraki Prefecture. The technical tour provided an understanding of the types and scales of experiments being carried

out in Japan in support of their repository site selection and repository design activities.

Participation in the workshop and interactions during breaks strengthened existing networks for sharing experiences with respect to gaining international perspectives on high-level waste repository programs, especially on how to achieve the necessary integration for successful design, construction, testing, modeling, and performance assessment of an engineered barrier system. Overall, the visit provided an opportunity to exchange information on regulatory requirements and experience, engineered barrier system design evolution, use of performance assessments in repository design, and the value of early prototype experiments.

Discussion:

In 2001, the Integration Group for the Safety Case of the Nuclear Energy Agency reassessed the need for a project to develop a greater understanding of how to achieve the necessary integration for successful design, construction, testing, modeling, and performance assessment of engineered barrier systems. The Nuclear Energy Agency intended the project to explore various aspects of engineered barrier system design, construction, and operation processes through a sequence of four workshops.

Workshop 1, titled "Design Requirements and Constraints," held in Turku, Finland, in 2003, focused on state-of-the-art systematic and fully documented approaches and tools for aiding repository design and optimization. Workshop 2, titled "Process Issues," held in Las Vegas, Nevada in 2004, focused on the processes that may influence the design and performance of the engineered barrier system and discussed how processes are determined to be important; how they are considered in the design and performance assessment of engineered barrier system; and how they are accounted for in a systematic, defensible, and traceable manner. Workshop 3, titled "The Role of Modeling," held in La Coruna, Spain, in 2005, discussed the role of modeling when integrating the engineered barrier system in a safety case, focusing on the necessary integration of successful design, characterization, and performance assessment. Workshop 4, titled "Design Confirmation and Demonstration," held in Tokyo, Japan, focused on the strategy, approaches, and methods for confirming and demonstrating EBS design in terms of key constraints and requirements that include long-term safety, engineering practicality, and quality assurance.

A. Van Luik, DOE, and D. Sevougian, Sandia National Laboratories, mentioned that a repository program will manage "what if" scenarios for the engineered barrier system by using industrial analogs, although they recognized that such analogs will be limited in scope. Modeling the system assuming it meets design specifications is important but not sufficient to address various "what if" scenarios. They indicated that a combination of industrial analog and modeling studies combined with quality control, even at the material selection stage, should be used to gain confidence on the proposed design. For example, limited but carefully selected and designed sensitivity analyses mimicking potential defects in engineered-system materials, sealing, or emplacement could be used to identify which "what-if" scenarios and timescales are meaningful. Likewise, many manufacturing and emplacement issues could be managed using a formalized design-verification process. At a more fundamental level, component materials, even before manufacturing, can have flaws in composition of alloys used. Quality control could assure that no unauthorized substitution of materials is used.

Dr. Mohanty and Dr. Ahn concluded that any proposed design should meet both long-term performance and operational safety requirements. Performance assessment can guide design reviews by estimating performance (e.g., dose) along with uncertainties in relation to the regulatory threshold and the sensitivity of performance to design parameters. Because large uncertainties may be associated with the long compliance period, the regulations allow the design to evolve as additional information becomes available.

Two one-and-a-half-day-long working group sessions were held during the workshop (i) Working Group Session 1: Decision-Making and the Engineered Barrier System Design Process in the Safety Case and (ii) Working Group Session 2: Confirmation and Demonstration of the Engineered Barrier System in the Context of Confidence Building.

Dr. Mohanty participated in Working Group 1. This working group discussed two key topics: (i) Optimization, Balancing Multiple Design Factors and (ii) Iterative Process, Relationship to Performance Assessments and Safety Assessments.

Under topic (i), the group considered the following two questions:

- What factors are considered in engineered barrier system design, and how are they balanced? How are engineering feasibility, practicality, and cost balanced with respect to operational and long-term safety and other requirements?

- How are possible design alternatives selected, justified, and managed?

Under topic (ii), the group considered the following four questions:

- What are the roles of uncertainty and of sensitivity analysis in decision-making related to the design and in establishing priorities for confirmation of the performance of the design?

- What are the criteria used to determine an adequate margin of safety, and how is this shown in view of the uncertainties?

- What are the reasons and the procedures used to justify design modifications or even a change to a different design concept? Based on what data? What are the lessons learned from organizations that have already conducted such an iterative process?

- How are the consequences of design changes incorporated back into sensitivity analysis?

Representatives from different countries focused on the repository system at different scales while responding to these questions. For example, the U.S. representatives focused on the repository scale; Japanese representatives focused on a scale that is equivalent to the DOE total-system management program (e.g., waste production stream, repository site selection, and transportation); and Swedish representatives focused on design of the engineered backfill or buffer. The outcome of the Working Group 1 discussions are presented in summary form in Attachment B.

The outcome of the Working Group 2 discussions are summarized in Attachment C.
A decision was made to produce a synthesis report for the Engineered Barrier System Project, covering the results of all four workshops. The report will describe the progress regarding engineered barrier system over the course of the project, key messages from all workshops (with specific examples from national programs), issues and challenges identified. The goal is to publish the report by summer 2007.

Attendees agreed on the benefits of the workshops, and there was consensus that maintaining a platform for further collective work under the Nuclear Energy Agency regarding engineered barrier system is valuable. Topics identified for possible future work include: seals and plugs; retrievability considerations in engineered barrier system design; effects of cementitious materials, gas migration; and integrated waste containers.

It is recommended that these types of interactions with foreign organizations continue on various topics related to the performance and design of the potential repository.

Pending Actions/Planned Next Steps for NRC:

None.

Points for Commission Consideration/Items of Interest:

None.

Attachments:

Attachment A:	Business cards of attendees personally contacted
Attachment B:	Working Group 1: Decision-Making and the EBS Design Process in the Safety Case
Attachment C:	Working Group 2: Confirmation and Demonstration of the EBS in the Context of Confidence Building

"On the Margins":

None.

Signatures:

_____/RA/_____ _10/10/2006_____
Sitakanta Mohanty, Assistant Director Date
Engineering and Systems Assessment

Concurrence:

_____/RA/_____ 10/10/2006
Budhi Sagar, President Date
Geosciences and Engineering