Department of Energy
Washington, DC 20585

QA: N/A

February 17, 2009

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B. John Garrick, Ph.D.
Chairman
Nuclear Waste Technical Review Board
2300 Clarendon Boulevard, Suite 1300
Arlington, VA 22201-3367

Dear Dr. Garrick:

Thank you for your November 5, 2008, letter providing the Nuclear Waste Technical Review Board (Board) observations and suggestions on information presented by the U.S. Department of Energy at the Board's meeting on September 24, 2008. Our responses to your observations and comments are enclosed.

If you require further clarification regarding any of these issues, please contact me at (202) 586-6850, or Abraham E. Van Luik, at (702) 794-1424.

Sincerely,

Christopher A. Kouts
Acting Director
Office of Civilian Radioactive
Waste Management

Enclosure

ENCLOSURE

Integrated System Operations

Board Observation and Comment:

The Board believes that the Department of Energy (DOE) should perform analyses to determine the effects on the system if conditions differ from those presently assumed. A number of scenarios were suggested that should be addressed to give better understanding of system robustness and flexibility and would allow modifications, if necessary, early in the design process.

DOE Response:

DOE has used a Total System Model (TSM), initially developed in 2005, for numerous systems analyses similar to those recommended by the Nuclear Waste Technical Review Board (NWTRB). The results of those systems analyses have been made available in published TSM reports, fact finding meetings with the NWTRB staff, and DOE briefings at NWTRB meetings.

DOE performed detailed modeling of individual facilities using the TSM. The modeling has the capability to include upset conditions, such as those recommended by the NWTRB. However, DOE is focused at this time on the support of the license application (LA) during the detailed technical review and preparation of a Safety Evaluation Report by the U.S. Nuclear Regulatory Commission (NRC) and the adjudicatory hearing process. Additional studies are not planned at this time as a result of severe funding limitations.

Surface Facility Design

Board Observation and Comment:

The nature of the presentations on surface facility design seemed to reflect a lack of understanding of the design's technical basis. The presentations did not illustrate how the facilities would work and showed only the potential flow of material through buildings. The issue of seismic design basis needs to be reevaluated for consistency with commercial nuclear facilities built for the same purpose. Clarity of the design requirements for surface facilities needs to be addressed to avoid what appears to be excessive design for meeting seismic effects. Three specific items were identified: why building walls need to be four feet thick, percentage of design completeness, and how the fuel pool cooling and cleanup system operates.

DOE Response:

1. Four-Foot Thick Walls

Design of the Important to Safety (ITS) nuclear facility structures must meet two requirements:

- ACI-349 code requirements for the seismic forces resulting from Design Basis Ground Motion-2 (DBGM-2), corresponding to a mean annual probability of exceedance of $5x10^{-4}$ (or 2,000 year return period) and has a peak ground acceleration of 0.45g, based on site-specific seismic data.

  Demand-to-capacity ratio was set at 0.5 to 0.6 as a prudent margin for preliminary design which also facilitated meeting the performance requirements. The shear walls of the surface facilities were determined, in general, to be four feet thick.

- Adequate margins to meet the performance requirements of 10 CFR Part 63 for ground motions beyond the design basis.

  The ITS structures must assure that unacceptable seismic performance of the structure is less probable than one in 10,000 over the preclosure period. This translates to a performance factor of 2×10^{-6} /year for a preclosure period of 50 years. Per NRC Interim Staff Guidance HLWRS-ISG-01, Review Methodology for Seismically Initiated Event Sequences, the performance factors are demonstrated to be met by performing a "convolution" of the hazard probability density function with the building fragility cumulative distribution function. Earthquake levels beyond 10^{-7}/year are included in the convolution to obtain an accurate mean probability of building unacceptable performance.

These two requirements are similar to those imposed on operating commercial nuclear power plants. Both safety related power plant structures and the repository ITS structures are designed to code for specific design basis seismic loads. Additionally, both need to demonstrate adequate margins when evaluated against design basis seismic loads (e.g., the reference earthquake level in a seismic margin analysis).

Design of the nuclear facility structures is within a prudent margin to meet the ACI-349 code and 10 CFR Part 63 performance requirements. Additional information on the seismic design of the ITS structures is provided in Safety Analysis Report (SAR) Section 1.2.2.1.6.3.

2. Design Completeness

The design, as of March 2008, is complete to the point where the safety case has been demonstrated in sufficient detail to support the LA, submitted in June 2008, and to be docketed by the NRC in September 2008. Approximately 1,350 documents (drawings, calculations, and specifications) have been issued for the ITS surface facilities, 125 documents have been issued for the balance of plant surface facilities, an additional 350 documents have been issued for the subsurface facilities and waste packages, and 46 preclosure safety analysis documents comprised of approximately 12,000 pages have been issued. Of the total, 335 documents have been issued since April 2008 and include the finite element structural analyses of the nuclear facilities, completion of the waste package configurations, and performance specifications for mechanical handling equipment. These 335 documents are the result of advancing the design from the LA design towards detailed design while maintaining both configuration control and the safety case in the SAR. Other than those documents that have been classified as official use only, these documents are available on the Licensing Support Network.

3. Fuel Pool

The design of the pool water treatment and cooling system (PWTCS) conforms to the requirements identified in ANSI/ANS 57.7-1988, Design Criteria for an Independent Spent Fuel Storage Installation (water pool type), to the extent appropriate given the facility's purpose. The PWTCS is depicted on Piping and Instrument Diagrams 050-M60-PW00-00101-000 through 050-M60-PW00-00106-000.

Pool water is drawn through one of three treatment trains. Each treatment train consists of a pump strainer, pump, and two stages of filtration followed by an ion exchange vessel. Each train is sized to turn the pool's volume over within 72 hours (350 gpm). The PWTCS can draw from multiple locations in the pool including the Dual Purpose Canister (DPC) cutting area, which helps isolate potential crud bursts. After flowing through a treatment train, pool water is fed back into the pool or cooled depending on the temperature of the pool. Boron, in the form of boric acid, is added to the pool water in the return line of the PWTCS. The boron concentration is maintained at approximately 2,500 mg/L.

The unit operations employed in the waste handling facility (WHF) are comparable to pool treatment system operations at commercial nuclear power plants such as Harris, Diablo Canyon, and Hatch, but are not necessarily in an identical processing configuration. The main reasons for the differences are a reduced heat load from spent nuclear fuel (SNF) in the WHF pool, the flexibility to receive multiple types of SNF, and the increase in the frequency of operations occurring in the WHF pool.

Design features, system configurations, and redundancy for system reliability/ maintainability were compared to SAR sections of several commercial power plants for the pool treatment system for both pressurized water reactor and boiling water reactor. In addition, information gathered from plant visits (including Hope Creek, Salem, Limerick, Vogtle, Shearon Harris, Diablo Canyon, and Palo Verde) has been compared to the WHF design, and in some cases, incorporated during the design development.

Additional information on the PWTCS is provided in SAR Section 1.2.5.3.2.

Repository Site Operations

Board Observation and Comment:

The Board is looking forward to DOE's providing a plan for implementing a realistic surface facility throughput model that can be used to evaluate the design and determine the effects of off-normal events, including safety implications.

DOE Response:

DOE has performed detailed modeling of the operations within the individual surface waste handling facilities in order to determine facility throughput and optimize waste handling operations. Using that detailed modeling as input, the TSM approximates the waste handling facilities, using eight-hour time steps, with sufficient fidelity to provide an integrated, systems analysis from the waste generator sites to emplacement of waste packages in the repository subsurface.

Equipment and Facility Testing Program

Board Observation and Comment:

The Board is concerned that the feasibility of several unique components or operations (drip shield fabrication and installation, waste package fabrication, emplacement vehicle operation, etc.) has not been confirmed, yet the items have been included already in the design. The Board seeks assurance that these unique components will function as designed and requests a schedule for implementing the prototyping and testing program.

DOE Response:

Prototyping is being done or will be done for the following:

1. Waste Packages, Waste Package Emplacement Pallets, and Drip Shields to investigate or confirm items, such as fabrication methods (including assuring attainment of desired material properties and capabilities) and assuring there will be qualified vendors. Goals include:

    a. Confirming welding techniques, including desired residual stress distribution for the Outer Corrosion Barrier of the waste package.

b. Confirming effectiveness of nondestructive examination (NDE) methods.

c. Informing, through the lessons learned, the definitive design of the components from prototyping.

d. Providing specimens for operational training—including demonstrating assurance that the waste package may be handled in a manner consistent with ensuring adequate long-term performance.

The prototyping program for the waste packages is described in greater detail in the *Testing Strategy for Waste Package Prototypes,* 000-30R-WIS0-00400-000-001. The procurement strategy for the various prototypes is described in the *Prototype Procurement Strategy for Waste Packages, Pallets, and Drip Shields*, 000-30R-WIS0-00500-000-003.

2. Waste package closure system to demonstrate functionality/reliability. A mockup of the waste package closure cell has been constructed, and test welds have been made using prototype equipment (subsystem testing started about April 2008). Testing of the completed welds will be performed to validate the process, demonstrate/validate NDE techniques, and demonstrate/validate stress mitigation techniques.

3. The DPC cutting machine to demonstrate functionality and ability to remotely perform this process.

Factory acceptance testing will be done for standard and nonstandard mechanical handling equipment, such as overhead cranes, trolleys, the emplacement vehicle, the canister transfer machine, and the drip shield emplacement gantry. While some of this equipment is configured specifically to perform Yucca Mountain Project cask/canister handling functions, it is designed and specified to be comprised of standard, proven components. Nuclear industry codes and standards are directly applicable to the design, fabrication, and testing of this equipment. Testing will ensure that interface requirements are met, such as by the use of mockups of interfacing equipment or use of actual equipment. First equipment tests are currently scheduled for 2012.

See SAR Section 5.5 for information on preoperational and start-up testing. This testing includes dry runs of equipment using mockups of waste containers. The plan is to use the Initial Handling Facility for initial operator training, since it will be available prior to the other nuclear facilities coming on line.