

SUMMARY OF
U.S. NUCLEAR REGULATORY COMMISSION/U.S. DEPARTMENT OF ENERGY
TECHNICAL EXCHANGE ON TOTAL SYSTEM PERFORMANCE ASSESSMENT
April 3-4, 2008
Las Vegas, Nevada

INTRODUCTION

On April 3 and 4, 2008, U.S. Nuclear Regulatory Commission (NRC) and U.S. Department of Energy (DOE) met in Las Vegas, Nevada, to discuss DOE's Total System Performance Assessment (TSPA). The meeting was held at the NRC Las Vegas Hearing Facility, and was open to the public.

To support staff and stakeholder interactions, the meeting included video connection to NRC offices in Rockville, Maryland, and the Center for Nuclear Waste Regulatory Analyses (CNWRA) in San Antonio, Texas. Teleconference connections were also available to interested stakeholders. Participants included representatives of the NRC, DOE, State of Nevada, Affected Units of Local Government, Nuclear Energy Institute, other industry representatives, and members of the public.

The meeting agenda, list of attendees, and meeting presentations, with a list of the DOE documents discussed are available on the NRC web site, at <http://www.nrc.gov/waste/hlw-disposal/public-involvement.html>.

PURPOSE OF THE MEETING

The purpose of this meeting was to discuss DOE's planned performance assessment for a potential geologic high-level waste repository at Yucca Mountain, Nevada. Performance assessment is the systematic analysis of features, events, and processes that may affect the performance of a repository, including quantitative estimates of possible doses that may result from releases of radioactive waste.

TOPICS OF DISCUSSION

In its opening remarks, NRC clarified the purpose of the technical exchange was to gain an improved understanding of DOE's planned TSPA, to make the NRC staff review more efficient, and not to provide technical feedback to DOE on the adequacy of the TSPA.

In its opening, DOE provided an overview of the TSPA for its Yucca Mountain license application. Subsequent presentations covered discussions of results, repository barrier capabilities, model support activities, and selected TSPA model abstractions. All of the formal presentations over the two days of the meeting were given by DOE.

In the first presentation, DOE explained how the scenarios and modeling cases were constructed, presented dose calculations for different scenarios, and explained how uncertainties associated with the various scenarios were combined to yield a mean dose curve over time, with an estimate of the total uncertainty. DOE then identified the scenarios and radionuclides that contribute most to the mean dose estimates, and discussed the statistical stability of these estimates. The information presented was primarily based on results available in the report "Total System Performance Assessment Model/Analysis for the License Application" (MDL-WIS-PA-000005 Rev 00

Addendum 01, LSN Accession Number DEN001579005). NRC and CNWRA staff asked questions to clarify how the scenarios were mathematically combined, and which events and processes most affected the barrier capabilities of the potential repository.

The second presentation identified the repository barriers and provided a quantitative description of the repository barrier capabilities. The DOE identified three barriers (the upper natural barrier, the lower natural barrier, and the engineered barrier system) and provided quantitative results illustrating barrier capabilities. NRC and CNWRA staff questions focused on identifying and characterizing the individual processes that contribute to barrier capability, rather than the aggregate capability of the barrier.

The final presentation of the day covered the activities done by DOE to build confidence in the TSPA results. DOE described activities carried out during development of the TSPA, such as data and software verification and model stability testing, and confidence-building activities performed after development of the TSPA. The latter included corroboration of the abstractions in the TSPA with the results from detailed process models and with observations of natural analogs; independent peer reviews; and auxiliary analyses that included detailed examination of individual TSPA realizations and comparisons with other total system performance assessment models of the Yucca Mountain system. NRC and CNWRA questions focused largely on clarification of the explanation of results presented from the single TSPA realizations.

On the second day, the discussion focused on selected TSPA model abstractions. The abstractions considered were drawn from those that DOE believed had changed significantly since the last publicly-available version of TSPA, which was released in 2002 in support of DOE's Final Environmental Impact Statement. The selected abstractions included DOE's models for waste package corrosion, for engineered barrier system radionuclide transport, and for the seismic and igneous extrusive disruptive scenarios.

The first presentation of the day considered the model for radionuclide transport within the engineered barrier system. In TSPA, this model domain is discretized into a waste form domain and a corrosion product domain, both within the waste package, and the invert and upper portion of the unsaturated zone along the base of the drift. The presentation also explained how the behavior of colloids and sorption processes within the waste package are modeled. NRC and CNWRA questions focused largely on how to determine the relative importance of the different processes (e.g., waste form degradation, colloid formation, precipitation, or sorption/desorption) in limiting releases from the waste package. The questions also clarified how the model considered release of radionuclides into fractures or matrix of the unsaturated zone below the repository drifts.

The second presentation described the abstraction of how waste packages and drip shields might fail from corrosion processes. Three corrosion mechanisms (general corrosion, local corrosion, and stress corrosion cracking) were identified, and the abstractions and key intermediate results were presented for each mechanism. NRC and CNWRA questions focused on the sources of the data used in the abstractions, the consequences of the different failure modes, the potential incidence of different failure modes over time, and the treatment of uncertainties in the modeling of corrosion mechanisms.

The third presentation described the abstraction used to estimate the performance of the repository under seismic loading conditions. The TSPA identifies two modeling cases, damage due to vibratory ground motion, and damage due to direct interaction of the engineered system with an active fault. The types of damage resulting from each were discussed. Finally, DOE provided key intermediate results that illustrated the dominant failure mechanisms determined in TSPA. NRC and CNWRA questions focused on clarifying which processes dominated failure of the waste packages under the seismic scenarios.

The final presentation described the implementation and results of the igneous eruptive modeling case. Aspects considered included the methods used to estimate the expected number of waste packages affected by a conduit, and the inventory dispersed along with tephra. Estimated doses from both direct deposition of contaminated tephra in the accessible environment, and remobilization of tephra deposited within the Forty-Mile Wash watershed were also presented. NRC and CNWRA questions focused on the coupling between the tephra deposition models and the biosphere model. In response to staff questions, DOE also clarified the model assumptions used in the igneous intrusive modeling case.

The meeting closed with comments from NRC and DOE. NRC thanked the presenters for the informative presentations, and noted its interest in understanding the contribution of individual features and processes to aggregate barrier performance, and the coupling between the operational period and the postclosure period. DOE expressed its appreciation for NRC's questions, and looked forward to its anticipated license application submittal in June 2008.

PUBLIC COMMENTS

Public comment periods were provided at the end of each day. On the first day, Ms. Judy Treichel, of the Nevada Nuclear Waste Task Force, asked whether engineered components in the drift (for example, rock bolts) might affect the capability of the capillary barrier at the drift wall to divert water. DOE responded that this had been evaluated, but that it could not provide a detailed explanation as the individuals most familiar with the technical evaluations were not present. Dr. Victor Gilinsky, a consultant to the State of Nevada, postulated that the probability of not installing the drip shields was sufficiently high to merit consideration within the performance assessment and asked whether the consequences of not installing the drip shields have been analyzed. He also asked if the drip shields should be emplaced at the same time as emplacement of the waste packages. DOE responded that the TSPA is based on the conditions that are to be laid out in the license application, one of which is that the drip shields would be emplaced. DOE also noted that emplacement of the drip shields concurrent with the waste packages might complicate the ability to maintain retrievability and collect performance confirmation data, and would interfere with drift ventilation during the preclosure period.

On the second day, Ms. Judy Treichel, of the Nevada Nuclear Waste Task Force, asked whether the drip shield plate was fabricated as a one-piece design or a welded construction. DOE clarified that the drip shield would be comprised of a number of individual plate and framework components that would be welded together. Dr. Leon Reiter, of the Nuclear Waste Technical Review Board staff, asked several questions regarding implementation of the disruptive scenarios. For the seismic scenario, he

noted that DOE's presentation had primarily considered rock fall in the lithophysal parts of the planned repository, and asked about the effect of fall of large rock blocks in the non-lithophysal zones. DOE responded that direct damage from large blocks in the non-lithophysal unit was screened out of model consideration, based on low consequences. Dr. Reiter then asked whether overall effects were greater from the more frequent, low-magnitude seismic events, or from less frequent, higher-magnitude seismic events. DOE replied that the main driver of seismic damage in their model is stress corrosion cracking, resulting from damage during low- to intermediate-magnitude events. Dr. Reiter also asked about the peak conditional dose from an igneous extrusive event. DOE indicated that the peak computed conditional dose for an extrusive event could exceed one rem for an event occurring immediately after closure of the repository, but emphasized that the probability of such an event occurring at that time is considered to be very low. They further stated that individual conditional results should be interpreted with care, as they are intended only for use in computing a probability-weighted mean dose. Mr. Marty Malsch, representing the State of Nevada, asked whether the results presented indicate that the dose was still rising at one million years after closure, and if that suggests that the peak dose might occur after one million years. DOE responded that mean dose estimates were not computed past one million years, consistent with the recommendations of the National Academy of Sciences regarding the estimated period of geologic stability. Mr. Malsch then asked whether the planned update of the probabilistic volcanic hazard assessment (PVHA) would be accelerated in order to include its results in the license application. DOE responded that it has no plans to accelerate the schedule for completion of the PVHA update.

ACTION ITEMS / COMMITMENTS

None.

Jack Davis for _____ Date 5/12/08

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Technical Review Directorate
Division of High-Level Waste Repository Safety
Office of Nuclear Material Safety and Safeguards
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William Boyle for _____ Date 5/8/08

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