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MOU MEMO

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SUBJECT: TRANSMITTAL OF THE DHLWM/DE MOU PHASE 1 REPORT:  
"PRELIMINARY PERFORMANCE ASSESSMENT OF A HLW REPOSITORY  
AT YUCCA MOUNTAIN, NEVADA"

Under the Memorandum of Understanding between the Division of High-Level Waste Management, NMSS and Division of Engineering, RES on NRC staff work on HLW performance assessment, staff members from both divisions prepared the subject report. The report summarizes the preliminary performance assessment work done under Phase 1 of the MOU. The Phase 1 effort was done essentially with no contractor assistance and used simplified models, and in some cases rudimentary models, of the behavior of the repository's components to estimate a repository performance measure, cumulative release of radionuclides over 10,000 years, that could be compared directly to the overall HLW performance standard cited in 10 CFR 60.112, which incorporates the EPA HLW standard, 40 CFR 191. The analyses did not estimate any of the other performance measures that 10 CFR 60 or 40 CFR 191 requires of the HLW licensee, the U.S. Department of Energy.

The purpose of the Phase 1 effort was to demonstrate the staff's independent capability to perform a performance assessment of a HLW repository and to provide a starting point for later iterations. The results presented in the report have had limited peer review and management review; therefore, the numerical results should not be taken as representative of the performance of a repository at Yucca Mountain, Nevada. The analyses discussed in the report are replete with uncertainties regarding conceptual models, site data, models of physical and chemical processes, and models and data for predicting scenarios that might result in the release of radionuclides from the repository. Only a few scenario classes were incorporated into the modeling.

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Therefore, the report's total Complementary Cumulative Distribution Function (CCDF) comparing predicted repository performance with the EPA HLW standard should not be regarded as representative of total system performance.

Even though the Phase 1 effort was limited in scope as described above, the NMSS and RES staff efforts spent on reviewing the Yucca Mountain Site Characterization Plan added an additional limitation of time spent on Phase 1. A September 1, 1989, memorandum from Ronald L. Ballard to Robert E. Browning recognized this additional limitation and proposed a reduced work schedule so that the Phase 1 work could be finished before the end of 1989.

Despite the two limitations cited above, the DHLWM and DE staffs were able to demonstrate a capability for doing HLW performance assessments. In so doing, the staffs gained insight into the Yucca Mountain repository and increased their insight into the performance assessment methodology that Sandia National Laboratories has been preparing for NRC. They developed a CCDF to describe performance of a Yucca Mountain HLW repository for a limited set of scenario classes; modeled the "base-case" scenario for the Yucca Mountain repository using the NEFTRAN computer code to simulate transport in the unsaturated zone; developed and used a total system code; developed a model for human-intrusion by drilling and a corresponding computer code; and performed a preliminary statistical analysis of results (sensitivity and uncertainty) using LHS and regression analysis methods.

In support of this performance assessment, the DHLWM and DE staffs executed several auxiliary analyses that examined the potential for non-vertical flow at Yucca Mountain, sampling requirements for CCDF generation, consequences of Carbon-14 gaseous releases, and statistical analysis of available hydrologic data for input to flow and transport models.

The analyses performed suggested that the areal extent of the Yucca Mountain repository appears to be an important aspect affecting repository performance and should be included in models of performance. Important aspects or repository performance related to areal extent appear to be the areal variability of waste package failure, depth of rock to the water table under the repository (where radionuclide transport may become faster), and fracturing of rock. The analyses suggested that the gaseous release of C-14 could be an important issue in repository performance, but more analysis and data are needed before a definitive statement on this mode of transport can be made. The potential for non-vertical flow at Yucca Mountain appears, from the analyses, to be great and non-vertical flow could have a substantial effect on performance. There could be perching of water along interbeds and diversion of water to shorter paths to the water table (taken to be one of the borders of the accessible environment in these analyses). For the "liquid pathway" scenario class, the most significant contributors to the estimated consequences represented by the CCDF appear to be isotopes of plutonium. Because plutonium behavior is poorly understood large uncertainties exist regarding colloids, retrograde solubility, and sensitivity of chemistry to oxidation state. Also for the "liquid pathway" scenario class, the important modeling parameters

appear to be infiltration flux, fraction of total waste package surface in contact with liquid water, uranium matrix solubility, and the hydraulic conductivity for saturated flow in the Calico Hills Vitric formation.

Now that Phase 1 of the MOU effort is complete, planning for Phase 2, involving making refined estimates of repository performance using the tuff methodology being prepared now by Sandia under FIN A1266 and additions and modifications to the methodology by the Center for Nuclear Waste Regulatory Analyses and NRC staff, should begin. We already have made some technical recommendations in the previous paragraph. We also would like to make some organizational recommendations.

DOE's extended schedule for site characterization at Yucca Mountain gives NRC an opportunity to assess the site characterization activities with performance assessment in an iterative fashion as site characterization progresses. As more data become available, NRC can do more refined performance assessments and can use the results of performance assessments to evaluate the DOE site characterization program. To take advantage of this opportunity and to enhance the ability of the NRC staff to rapidly evaluate a license application, NMSS and RES should continue and expand the cooperative, iterative performance assessment activities begun under the MOU between NMSS and RES.

NRC should involve the CNWRA as an active participant in Phase 2 of the MOU. CNWRA can help the NRC in HLW performance assessment research by obtaining and modifying the performance assessment methodology prepared by Sandia. RES is drafting a Statement of Work now for this acquisition and modification. CNWRA can also provide the NRC with technical assistance in performance assessment (e.g. acting as a member of the teams modeling performance and maintaining software).

In order to maintain an effective interaction in HLW performance assessment among the staffs of NMSS, RES, and CNWRA, the three organizations should cooperate to conduct monthly or biweekly seminars, to which the entire NMSS and RES waste management staff and CNWRA staff who are working in Washington or visiting NRC from San Antonio would be invited. Each seminar would be on a single topic or subject area, reporting on recent progress under the MOU.

The NRC waste management staff's experience with Phase 1 of the MOU indicates that HLW performance assessment work is very labor-intensive because of its exacting detail and technical nature. The staff worked under severe constraints of time and resources to finish the Phase 1 work. They should be commended for performing extremely well under difficult circumstances. By providing additional staff resources and time for the staff to conduct HLW performance assessment work and by providing additional training to involved staff to assure state-of-the-art quantitative and analytical skills, some of the difficulties encountered in Phase 1 could be alleviated. Many of the staff members involved in the MOU Phase 1 work did not have adequate computer hardware and software for doing all of the MOU work that they needed to do; provision of additional computer hardware and software could improve the

efficiency and productivity of the NRC waste management staff to do this kind of exacting technical work.

We request that all the involved Branch Chiefs, Section Leaders, authors of the report, and contributors to the report provide comments on this First Draft no later than COB January 23, 1990. Please send comments or marked-up version of the report to N. Eisenberg (MS 4-H-3), X20324). We intend to issue this report in final form by the end of January. Reviewers should focus their review on pointing out incorrect statements, wording which is unclear, and misunderstandings of information provided to the authors. There is no time to redo analyses; our goal is to correctly characterize the work that was done. The coordinators and authors are well aware of the significant limitations of this work, so that comments in that regard should be focused on correctly and completely stating these limitations and recommending improvements to pursue in Phase 2.

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MOU Phase 1 Report

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