UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 10, 1996

Mr. Ronald A. Milner, Director
for Program Management and Integration
Office of Civilian Radioactive Waste Management
U.S. Department of Energy, RW 30
1000 Independence Avenue, S.W.
Washington, D.C. 20585

SUBJECT: TRANSMITTAL OF THE RESULTS OF THE U.S. NUCLEAR REGULATORY COMMISSION AUDIT REVIEW OF THE U.S. DEPARTMENT OF ENERGY'S 1995 TOTAL SYSTEM PERFORMANCE ASSESSMENT

Dear Mr. Milner:

NRC has completed an audit (or screening) review of the DOE TSPA-1995 report. The purpose of this review was to provide early feedback to DOE on the staff's review and analysis of TSPA 95. The results of the review consist of technical concerns developed by the NRC with support from the Center for Nuclear Waste Regulatory Analyses (CNWRA). These concerns formed the basis for discussions at the NRC/DOE Technical Exchange Meeting, May 22-23, 1996. In addition, this review has identified additional topical areas to be investigated during the detailed review which is scheduled to be completed in December 1996. The detailed review will not only include these additional areas, but will also attempt to determine and describe the significance to performance of all NRC staff concerns. Issues will be investigated only to the extent that they continue to demonstrate significance to performance.

In contrast to previous audit reviews of DOE TSPAs, NRC has selected, for this review, very specific topical areas on which to focus the review. These topical areas were selected because of their importance to the developing DOE Waste Containment and Isolation Strategy (WCIS), as well as our own determinations of significance to performance from the iterative performance assessment (IPA) program. An additional consideration in the selection of topical areas was to pick areas where the NRC and CNWRA staffs have performed sufficient technical analyses in the topical areas to independently evaluate DOE's analysis.

For the audit review, five specific topical areas were evaluated by NRC and CNWRA staffs, namely:

- Subsystem Abstractions
- Infiltration and Deep Percolation
- Groundwater Dilution
- Calculation of Temperature and Relative Humidity
- Waste Package Failure Modes

Within these five topical areas, the DOE TSPA methodology presented in TSPA-1995, was reviewed with respect to appropriateness of the technical approach (i.e., conceptual and mathematical models), adequacy of the treatment of uncertainties, use of conservative assumptions, sufficiency of site data, and consistency with previous DOE TSPAs. Supplemental, independent calculations were made by NRC/CNWRA staff to the extent feasible.

The staff's audit review and the corresponding technical exchange have resulted in the development of the following concerns with TSPA 95:

1) TSPA 95 appears to significantly underestimate the effects of fast transport pathways on repository performance.
2) The use of the Markovian model for matrix diffusion may greatly overestimate radionuclide migration time.
3) Unsaturated particle velocities were not calculated in a conservative manner because the effects of partial saturation were not considered, distributions were assumed, and a relatively limited number of realizations were used in the calculations.
4) Saturated flux and mixing depth are not supported by field data.
5) Heat transfer calculations are not transparent and inconsistencies with previous estimates are not adequately explained.
6) The humid air corrosion model and the pitting corrosion model may not be conservative based on current literature.

A description of the five topical area reviews is contained in Enclosure 1 to this letter and a more detailed review report being prepared by CNWRA and NRC documenting the review of these areas will be transmitted to you shortly. These topics and the additional topics identified in Enclosure 2 will be examined more thoroughly in the detailed review of TSPA 95.

If you have any questions regarding this letter, please contact Mr. Rex G. Wescott of my staff. Mr. Wescott can be reached at (301) 415-6727.

Sincerely,

[Original signed by:]
John H. Austin, Chief
Performance Assessment and HLW
Integration Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosures: As stated

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Topical Area Reviews

Subsystem Abstractions - KTI: Total System Performance Assessment and Technical Integration

In this area, CNWRA staff used the NRC/CNWRA IPA Phase 2 code (TPA code) to calculate complementary cumulative distribution functions (CCDFs) for comparison with those developed by the RIP code in TSPA 95. Three CCDFs were plotted for comparison: (1) the results from RIP (83 MTU/acre, high infiltration, backfill, and RH dependent corrosion initiation); (2) the results from TPA (IPA Phase 2 basecase, liquid releases only); and (3) the results from TPA (TSPA 95 corrosion and release data). The analyses showed an almost 2 order of magnitude difference in the low probability parts of the RIP CCDF and the TPA (IPA Phase 2) CCDF. However, at the same low probabilities the TPA (IPA Phase 2) CCDF and the TPA (TSPA 95) CCDF were very close in value. Hence, there appeared to be a significant difference in the CCDFs caused by a difference in basic methodology. It was the NRC/CNWRA conclusion that the major differences in the TPA and RIP code results (i.e., CCDF for total release) arose because of: (i) different representations of the hydrostratigraphy; and (ii) an abstraction used in the RIP code for unsaturated flow appears to underestimate the effects of fast pathways (i.e., pathways with short particle travel times) even under the same infiltration conditions.

In addition to the CCDF calculations, the staff independently calculated drinking water dose from the release of neptunium. This calculation was performed by the NRC staff using intermediate results and information presented for expected values of sampled parameters in TSPA 95. The calculation used TSPA 95 figures and information to: (1) determine the amount of flow contacting the waste; (2) determine the release rate based on solubility limits; (3) determine the concentration of Np-237 in the aquifer; (4) determine the drinking water dose; and (5) compare the NRC result to the TSPA 95 results. The results of our comparison showed a much delayed and reduced drinking water dose in TSPA 95 results than would be expected from our calculations. We concluded that a Markovian Model of matrix diffusion may be providing much more residence-time in the matrix than is justified.

Infiltration - KTI: Unsaturated and Saturated Flow Under Isothermal Conditions

For evaluation of infiltration, CNWRA staff relied upon calculations performed earlier to investigate the effects of focused infiltration. In addition, new calculations were performed using 1-D columns to investigate probable velocity distributions. Using these calculations the CNWRA compared TSPA 95 unsaturated zone particle travel times with CNWRA calculations for infiltration rates of 2.0 and 0.01 mm/yr. Also calculated was the flux going past the repository as a function of the distributed flux across the surface for different locations and conditions. The staff determined that unsaturated particle velocities were not calculated in a conservative manner because the effects of partial saturation were not considered, distributions were assumed, and a relatively limited number of realizations were used in the calculations.

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Waste Package Failure Modes - KTI: Container Life and Source Term

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Additional Topics for Detailed Review

KTI: Radionuclide Transport

Using site geochemical data, the staff plans to evaluate: (1) site evidence for dilution; (2) matrix diffusion; and (3) effects of preferred pathways on transport.

KTI: Repository Design and Thermal Mechanical Effects

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