UNITED STATES
NUCLEAR REGULATORY COMMISSION
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September 13, 1998

MEMORANDUM TO: Margaret V. Federline, Deputy Director
Office of Nuclear Regulatory Research

FROM: John T. Greeves, Director
Division of Waste Management
Office of Nuclear Material Safety and Safeguards

SUBJECT: NMSS RESPONSE TO ACRS REVIEW AND EVALUATION OF THE NUCLEAR REGULATORY COMMISSION SAFETY RESEARCH PROGRAM

In response to Bill Morris' request received on August 25, 1998, I am attaching comment responses to be reflected in the Office of Nuclear Regulatory Research's (RES') response to the subject document for the Executive Director for Operations. Although the subject report (NUREG-1635, Volume 1) focuses primarily on research activities performed by RES, there are observations and recommendations which are directed to technical assistance activities being performed by contractors to the Division of Waste Management in the Office of Nuclear Material Safety and Safeguards (NMSS). The comments provided on pages 51-54 of NUREG-1635 apply directly to these DWM activities.

The rationale which was described in SECY-97-022 and subsequently in the Commission's September 16, 1997, *Staff Requirements Memorandum, DSI 22 Implementation (Role of the* Office of Nuclear Regulatory Research) resulted in the transfer of much of the responsibility for technical work in radioactive waste management being done for RES to NMSS. Although some aspects of these investigations are technically innovative, to a degree, they are directly focused on the U.S. Nuclear Regulatory Commission's (NRC's) licensing decision role in the high-level waste disposal program.

NRC's reorganization of RES and program office functions has resulted in contracted activities, which should be considered technical assistance (TA). The Advisory Committee on Reactor Safeguards elected to consider these TA efforts as part of its review of NRC's overall safety research program. With this understanding, the previously mentioned pages of NUREG-1635 can be more clearly addressed.

Finally, I would note that RES and NMSS have been working and are continuing to work cooperatively to achieve an integrated waste management program that meets the needs of the agency. As an example of this integration, NMSS recently identified to RES the need for RES to pursue activities to assist in the validation of dose modeling computer codes currently being used in NMSS. Such code validation activities are more suitably performed in RES,

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where the staff is not engaged in day- to-day licensing activities, in contrast to the role and function of NMSS. However, such code validation activities are an essential feature of the NMSS licensing program, because they provide a basis for confidence in licensing decisions. We are planning to discuss this topic with you and your staff over the next couple months to develop a suitable program to address the Agency's model validation needs.

Attachment: As stated

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OFC	PAHL*		PAHL		PAHL		DWM			
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DOCUMENT NAME: S:\DWM\PAHL\GNG\RESCOV.WP
ATTACHMENT: S:\DWM\PAHL\GNG\RESNMSS5.TIX

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NMSS RESPONSE TO ACRS REVIEW AND EVALUATION OF THE NUCLEAR REGULATORY COMMISSION SAFETY RESEARCH PROGRAM

BACKGROUND

As part of the Strategic Assessment Initiative process, the Commission decided to redistribute the agency's workload. Specifically, the technical investigations to support the waste management area were reconfigured to shift much of the management of the research activities from the Office of Nuclear Regulatory Research (RES) to the Office of Nuclear Material Safety and Safeguards (NMSS). The U. S. Nuclear Regulatory Commission (NRC) can not afford to run two high-level waste (HLW) Programs, as well as maintain an acceptable level of technical expertise for NRC licensing support needs.

The Advisory Committee on Reactor Safeguards (ACRS) review raised a number of concerns regarding the 1) priority and focus of Key Technical Issues (KTIs); and 2) the adequacy of modeling approaches and data for resolving the technical issues. The following comments address the specific points raised in the ACRS Report: "Review and Evaluation of the Nuclear Regulatory Commission Safety Research Program," NUREG-1635, June, 1998.

GENERAL COMMENTS

In order to assist the RES response, NMSS provides the following general comments on the ACRS observations and recommendations:

Flexibility of the HLW Program

The discussion in Chapter V, Section A of NUREG-1635 indicates that the available technical expertise may not be adequate in certain areas and that some technical areas are "data starved." ACRS recommends reliance on external peer reviews and on international experts to address areas where budgetary constraints preclude NRC-funded investigations.

NRC's current HLW Program provides sufficient flexibility for staff to effectively evaluate the Department of Energy's (DOE's) evolving Yucca Mountain HLW Repository Program. The following is information relevant to the observations and recommendations listed in Chapter V, Section A of NUREG-1635:

- Although work in some KTIs at the Center for Nuclear Waste Regulatory Analyses (CNWRA) was halted as a result of funding constraints, the FY98 budget restored sufficient funding so that the CNWRA is funded to support all the KTIs.

- Priorities between and among KTIs are reevaluated annually and whenever dictated by significant changes in the program. NRC staff relies on the previous year's reviews of the DOE Program, augmented by NRC's own independent evaluations of systems and processes most important to repository performance in establishing these priorities.

- In the past, when budget perturbations resulted in reduction of effort in some KTIs, the essential KTI activities were continued, to the extent appropriate, under related KTIs. Performance assessment is used to make informed decisions related to the priority of KTIs

to focus NRC efforts on issues that are most important for protecting public health and safety.

Need to Acquire Technical Support from Nationally and Internationally Recognized Experts

The ACRS suggestion has two aspects:

- The budget constraints inhibit the acquisition of data, the conduct of experimental investigations, and the hiring of individuals with the essential expertise, which may raise doubts about the credibility of NRC's technical support for its licensing decision; and

- The recognition of NRC's review approach by well-recognized technical experts in the field of waste management will provide a level of authenticity and confirmation of NRC's assessment.

The current contract with CNWRA provides the vehicle for obtaining input from outside contractors. This avenue has been used on a case-by-case basis as necessary. NRC staff acknowledges the value of external review of its methodology. For example, a peer review of the Total System Performance Assessment (TPA) Code, Version 3.2, has been scheduled for FY99 in order to upgrade the TPA code for DOE's license application expected in 2002. Furthermore, CNWRA has been selected by agencies in the United Kingdom, France and Sweden to review aspects of their own waste management programs and to develop PC-based performance assessment codes.

NRC Staff Reliance on Simplification and Conservatism

ACRS observations on the relative discrepancy between DOE's and NRC's available resources for the HLW Program resulted in concerns that NRC will rely on conservative and/or simplified models to deal with the shortfall in data, model complexity, or expertise. In a letter to the ACNW (Callan to Garrick, dated December 17, 1997, NRC staff noted that because NRC has fewer resources than DOE and because the intended purpose of NRC's activities is the review of DOE's work, some practical simplifications that are consistent with existing data are incorporated into the staff's work. Nevertheless, NRC continues to improve its performance assessment models within the available resources. These improvements are prioritized, based on their potential importance to repository performance.

ACRS indicated that reliance be placed on national and international experts who are recognized authorities in the field of waste management. NRC staff agrees that such individuals supplementing CNWRA and NRC staff can have a positive influence on the quality and credibility of NRC's assessment. NRC relies on such experts in a focused manner that is consistent with available resources and the overall HLW Program.

SPECIFIC CONCERNS IN NUREG-1635

1. Igneous Activity (IA) KTI - should bring work to an orderly conclusion.

Response: The level of effort in this area has been significantly reduced. The IA Issue Resolution Status Report (IRSR) has effectively closed the issue related to probability of volcanic activity. However, in the area of consequences, there are still several items that need to be pursued. An Expert Review of the program has just been completed, and the results of this report are being used to focus NRC staff effort on the remaining open items.

2. Structural Deformity and Seismicity (SDS) KTI - NRC staff needs to improve its understanding of the risk associated with seismic and faulting hazards (e.g., buried faults), and to conduct physical analog experiments, as needed.

   Response: NRC staff agrees with ACRS that investigations are needed to understand how the site and natural barrier system work. Currently, NRC-sponsored activities include field and lab measurements of effects of *in situ* strain and sensitivity studies using computer models, evaluating tectonic models, and developing fracture-network scaling factors to assist flow modelers. The preliminary Probabilistic Seismic Hazard Analysis indicates that the expert teams had considered the existence of buried strike-slip and seismogenic detachments. In some cases these were explicitly included in the models.

3. Evolution of Near Field Environment (ENFE) KTI - The complexity of coupled processes requires a greater degree of attention.

   Response: NRC staff recognizes the significance of coupled processes in several KTIs. This KTI was established specifically to examine coupled thermal-hydrological-chemical (THC) coupled processes. The Thermal Effect on Flow (TEF) KTI focuses on thermal-hydrologic processes and is closely integrated with the ENFE KTI because of recognized interrelations. The Repository Design and Thermal-Mechanical Effects (RDTME) KTI focuses on thermal-mechanical processes. Much effort in the ENFE KTI has been focused on the development of the state-of-the-art coupled THC modeling code (MULTIFLO) which has been used in TEF and Container Life and Source Term (CLST) KTI activities supporting the TPA process. Field studies in the ENFE KTI have examined environments where coupled THC processes have significantly altered hydrologic properties of tuffs. Coupled THC processes also under consideration in the ENFE KTI consider interactions of fluids derived from the tuffs and engineered materials including cementitious materials, container materials, and waste forms. Although the ENFE involves a number of complex, coupled processes, NRC staff is evaluating the processes and approaches for bounding and simplifying the necessary processes. Consequently, NRC staff considers that an appropriate level of attention is being applied to coupled processes and understanding their complexity.

4. TEF KTI - The ACRS raised a concern that the models currently in use are less comprehensive than is required. Furthermore, ACRS feels there is not sufficient data to support the model exercise in this KTI. The ACRS questioned whether there was sufficient expertise, as a result of budget constraints, resident at the CNWRA to provide experimental work coupled with state-of-the-art numerical modeling.

   Response: NRC staff understands ACRS' concern that thermal-hydrologic models may not be sufficiently comprehensive and representative of processes expected at Yucca Mountain. DOE uses NUFT to simulate coupled thermal-hydrologic processes for the

unsaturated zone (UZ). Similar analyses are being conducted at CNWRA using MULTIFLO, a code developed at CNWRA. Both codes are capable of performing simulations for non-isothermal multiphase flow through fractured rock using a dual continual model, a recent critical numerical enhancement.

With regard to the availability of sufficient data to support the thermal-hydrological models, recent and ongoing DOE thermal tests are providing data critical to evaluate the thermal-hydrological models used in Total System Performance Assessment (TSPA) (e.g., the Exploratory Studies Facility drift-scale heater test [DST]). The results of these tests will provide the most comprehensive data to evaluate thermal-hydrologic models. CNWRA thermal experiments will support evaluation of the DOE thermal testing program. A laboratory-scale heater testing program at CNWRA is providing a critical assessment of the refluxing phenomenon, one of the primary objectives of the DST and of importance to waste package (WP) and repository performance and is currently embraced by both DOE and NRC. The CNWRA laboratory-scale thermal testing program has also been modified to include analysis of THC coupling and the response of candidate waste container materials to THC processes. These laboratory-scale experiments are the only independent thermal testing program of the DOE tests conducted in partially saturated fractured rock.

CNWRA has augmented both internal and external (i.e., consultant and sub-contractor) staff to support the TEF KTI. With these recent hires, CNWRA now has a total of seven core-staff hydrologists, of which three are assigned to the TEF KTI. In addition, CNWRA has other consultants and contractors with the necessary expertise. In summary, combined with help from outside consultants, NRC staff believes that the resources of the TEF KTI are adequate.

5. Total System Performance Assessment and Integration (TSPAI) KTI - ACRS applauds NRC progress in this area.

   Response: NRC staff relies heavily on this KTI, which integrates the information, models, and data from the other KTIs. From this area, the science from the KTIs is molded to form the TPA tool which will provide the basis for the licensing decision. NRC will continue to use performance assessment and the results of TPA to focus future activities in preparation for licensing.

6. Radionuclide Transport (RT) KTI - ACRS indicated that more confirmatory research needs to be done in this KTI. Mechanisms such as retardation, matrix versus fracture flow, and colloid transport in fractures were cited as examples. A close coordination with RES was encouraged.

   Response: NMSS agrees on the need for close coordination with RES, and RES has maintained an active role in radionuclide transport research through separate contractors. Although this research is generic, results will be factored, as relevant, into this KTI and in TPA. The results from the RES-sponsored and NMSS-sponsored technical efforts are integrated at the CNWRA, as a result of technical exchanges and workshops conducted under RES auspices. Some RT RES work, which is applicable to the HLW program, will be incorporated into the HLW RT methodology.

7. Unsaturated and Saturated Flow under Isothermal Conditions (USFIC) KTI - Uncertainty remains regarding flux entering drifts through the UZ, as well as ground-water flow through the saturated zone (SZ) and its potential use in the future. Among unresolved issues remaining are magnitude and spatial distribution of infiltration in the UZ, role of faults and fractures in flux and spatial distribution of flow in the UZ and SZ, assumptions regarding matrix diffusion and SZ dilution, hydrologic and other properties of fractures and faults, modeling in highly heterogenous media, and interplay of ground-water flow and the elements of the engineered barrier system.

   Response: NRC staff acknowledges the complexity of the modeling challenges in the context of the Yucca Mountain Program. Other KTIs are working in conjunction with the USFIC KTI on common areas; e.g., the USFIC KTI is working jointly with the IA and SDS KTIs on the structural control for flow. The climate IRSR Rev. 2 has resolved -- at the staff level -- subissues related to climatic changes and hydraulic effects from climatic changes. Reasonable bounds for present-day infiltration and deep percolation have been obtained (IRSR, USFIC Rev. 0). In general, matrix diffusion may be significant in the SZ, but not in the UZ. Most dilution in the SZ will likely occur as a result of well pumping, rather than through contaminant dispersion. Part of the knowledge base in this area has been supported by two U. S. Department of Energy expert elicitations on UZ flow and SZ flow and transport, which revealed no significant problems with the conduct of the elicitation and provided bounding estimates for SZ and UZ parameters.

8. Repository Design and Thermal-Mechanical Effects (RDTME) KTI - ACRS indicated that NRC may need to augment its capabilities to allow proper evaluation of engineering considerations. Unresolved concerns include work on coupled thermal-hydrological-mechanical-chemical processes.

   Response: NRC staff agrees that design considerations are becoming more important and NRC's HLW Program reflects this change. DOE's design options that include backfill, use of drip shields, and changes in WP materials impose a need for flexibility within the program. Increased funding in budget allocations for FY99 acknowledged the greater emphasis assigned to RDTME. Sensitivity studies and TPA analyses are expected to provide valuable insights on the importance of design features.

9. CLST KTI - ACRS notes that this KTI is complicated by multiple canister designs and multiple types of fuel. ACRS notes that there is modest corrosion experimentation conducted by the CNWRA. ACRS stressed the importance of research in this area.

   Response: NRC staff agrees that there is complexity in the multiplicity of canister options and in types of fuel. This KTI is part of an integrated effort to determine the effect of water contact on the WP and waste form, which remains one of the most significant sources of uncertainty. NMSS understands the uncertainty inherent in DOE's use of alternate design considerations and their effect on the repository performance. NRC staff is aware of the impact of both the volume and chemistry of water contacting the WP containers and waste forms. Field data results from DOE (e.g., Drift-Scale heater test results) and from natural analog studies will be assessed in the NRC's TPA evaluation of the DOE demonstration.