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NUREG-1423  
Volume 14

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A Compilation of  
Reports of  
**The Advisory  
Committee on  
Nuclear Waste**

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July 2003 - August 2004

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U. S. Nuclear Regulatory  
Commission

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October 2004

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October 2004

## ABSTRACT

This compilation contains 15 of the reports issued by the Advisory Committee on Nuclear Waste (ACNW) during the Fifteenth year of its operation. The reports were submitted to the Chairman and the Executive Director for Operations of the U. S. Nuclear Regulatory Commission (NRC). Reports prepared by the Committee have been made available to the public through the NRC Public Document Room, or from the Publicly Available Records System (PARS) component of NRC's document system (ADAMS) which is accessible from the NRC Web site at <http://www.nrc.gov/reading-rm/adams.html> (the Public Electronic Reading Room); the U. S. Library of Congress, and the Committee's Web site at <http://www.nrc.gov/reading-rm/doc-collections/>.

## **PREFACE**

The enclosed reports are the recommendations and comments of the U. S. Nuclear Regulatory Commission's Advisory Committee on Nuclear Waste during the period between July 1, 2003 and August 30, 2004. Previously issued Volumes 1 through 13 of NUREG-1423 contain the Committee's recommendations and comments from July 1, 1988 through June 30, 2003.

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**EXECUTIVE  
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Advisory Committee on Nuclear Waste  
U. S. Nuclear Regulatory Commission

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UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
ADVISORY COMMITTEE ON NUCLEAR WASTE  
WASHINGTON, D.C. 20555-0001

August 4, 2003

MEMORANDUM TO: William D. Travers  
Executive Director for Operations

FROM: John T. Larkins, Executive Director  
Advisory Committee on Nuclear Waste

SUBJECT: DRAFT FINAL REGULATORY GUIDE DG-1105,  
"PROCEDURES AND CRITERIA FOR ASSESSING SEISMIC  
SOIL LIQUEFACTION AT NUCLEAR POWER PLANT SITES"

During the 144<sup>th</sup> meeting of the Advisory Committee on Nuclear Waste, July 29-31, 2003, the Committee considered the draft final Regulatory Guide DG-1105, "Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites," and decided not to review it. The document was referred to the ACNW by the Advisory Committee on Reactor Safeguards on July 15, 2003 for possible consideration.

Reference:

Memorandum dated July 15, 2003, from John T. Larkins, ACRS, to William D. Travers, EDO, Subject: Draft Final Regulatory Guide DG-1105, "Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites."

cc: A. Vietti-Cook, SECY  
I. Schoenfeld, OECO  
A. Thadani, RES  
M. Mayfield, RES  
Y. Li, RES  
M. Bonaca, ACRS



UNITED STATES  
**NUCLEAR REGULATORY COMMISSION**  
ADVISORY COMMITTEE ON NUCLEAR WASTE  
WASHINGTON, D.C. 20555-0001

August 13, 2003

The Honorable Nils J. Diaz  
Chairman  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555-0001

**SUBJECT: HIGH-LEVEL WASTE: RISK-SIGNIFICANCE RANKING OF  
AGREEMENTS AND THE USE OF RISK INFORMATION TO  
RESOLVE ISSUES**

Dear Chairman Diaz:

During the 143<sup>rd</sup> meeting of the Advisory Committee on Nuclear Waste on June 24–25, 2003, the Committee was briefed by the NRC staff on the status of the subject activities. The Committee has commented in previous reports to the Commission on the value of these efforts and has recommended they be supported (Reference 1). We have also suggested that the NRC staff be cautioned against compromising the principles and practices of risk assessment in developing risk insights and in implementing the risk-informed issue resolution process (Reference 2). In that regard we offer the following comments based on the briefings.

**Evidence-Based Risk-Insights**

The Committee believes that a direct linkage of the risk ranking results with the performance assessments would enhance the risk insights that have been drafted. The current approach discusses risk insights by ranking them into three categories: high, medium, and low risk. The supporting evidence presented was a discussion of the technical aspects of the ranked issues, but did not connect the technical information with the quantitative risk assessment results (i.e., the performance assessment). An example of a high-risk item presented with no supporting risk assessment was "rock fall creating large static loads on waste packages." The Committee is asking that risk assessments which support the risk rankings be provided.

The staff should base their risk insights on "results and findings that come from risk assessments"—such as the analyses employed in the performance assessments (Reference 3). Whenever possible, departure from the analytical processes on which the risk assessment discipline is founded should be avoided. Because a risk assessment is not a decision analysis, factors other than risk should be a part of regulatory decisionmaking. Nevertheless, we see no reason to compromise the traditional quantitative approach to risk assessment. We recommend that the documentation of such linkage be provided to better present the supporting evidence for ranking contributors to repository performance. We understand that the staff plans to include such documentation as part of their risk insights report due for completion in October 2003.

### Completeness of Analysis

The question of when further analysis on issues of risk is not warranted was raised during the briefing. In the opinion of the Committee, termination of analysis of safety issues must be based on the supporting evidence. Thus, any strategy to terminate analysis should consider new evidence that could increase the risk. The availability of a risk-informed performance assessment offers an appropriate metric for terminating analysis of low-risk issues. In particular, one approach would be to terminate analyses of issues that do not significantly contribute to the total risk of the facility. In addition, the safety and regulatory requirements must be met.

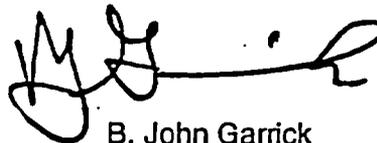
The Committee believes that if the high-level waste risk insights initiative is implemented as recommended, the evidence supporting conclusions regarding safety issues will be documented and transparent.

### Risk Ranking Terminology

In keeping with the Commission's urging of the use of "plain English" in technical documentation of regulatory activities, the Committee has some concerns with the terminology in the technical exchanges between the Department of Energy (DOE) and the NRC staff. The Committee believes that the usage of some terms by DOE is not consistent with NRC and may confuse their meaning. In particular, the use of such terms as risk-informed, risk-based, technical basis, risk information, and technical information is not consistent. Such inconsistencies between DOE and NRC could confuse the public. The Commission's white paper can contribute to greater consistency and clarity in the communications between the two agencies.

In summary, the Committee is extremely pleased with the progress the NRC staff is making in implementing risk-informed regulatory practices. We have especially been impressed with the performance assessment team that has been assembled and the work they are doing. We look forward to receiving future briefings on the implementation of the risk insights initiative and the risk-informed issue resolution process.

Sincerely,



B. John Garrick  
Chairman

### References:

1. ACNW Letter dated June 12, 2003, to Nils J. Diaz, Chairman, U.S. Nuclear Regulatory Commission, from George M. Homberger, Chairman, ACNW, Subject: Total System Performance Assessment Working Group Session.
2. ACNW Letter dated August 7, 2002, to Richard A. Meserve, Chairman, U.S. Nuclear Regulatory Commission, from George Homberger, Chairman, ACNW, Subject: High-Level Waste Performance Assessment Sensitivity Studies.
3. SECY-98-144, White Paper on Risk-Informed and Performance-Based Regulation.



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
ADVISORY COMMITTEE ON NUCLEAR WASTE  
WASHINGTON, D.C. 20555-0001

October 1, 2003

The Honorable Nils J. Diaz  
Chairman  
U. S. Nuclear Regulatory Commission  
Washington, D.C. 20555-0001

SUBJECT: WORKING GROUP SESSION ON PERFORMANCE CONFIRMATION FOR  
YUCCA MOUNTAIN

Dear Chairman Diaz:

During its 144<sup>th</sup> meeting on July 29-30, 2003, the Advisory Committee on Nuclear Waste (ACNW or the Committee) held a working group session (WGS) on performance confirmation (PC) for the proposed high-level waste repository at Yucca Mountain, Nevada. PC refers to the tests, experiments, and analyses that will be performed to evaluate the adequacy of the information used to show compliance with performance objectives in 10 CFR Part 63.

The purposes of the WGS were to (1) increase ACNW's technical knowledge of plans to develop and conduct PC work, (2) understand NRC staff expectations for PC, (3) review examples of PC work being planned, (4) identify aspects of PC that may warrant further study, and (5) complement the previous working group session on performance assessment. The WGS included a panel of six distinguished experts from academia and various government and private institutions. Representatives of the U.S. Department of Energy (DOE), the U.S. Nuclear Regulatory Commission (NRC), and the State of Nevada made presentations, as did various other stakeholders.

DOE's PC program is undergoing significant change at this time. DOE is preparing a revised PC plan that will supersede its earlier plan. A new "portfolio" of PC activities has been selected using a multiattribute utility analysis. The selected portfolio is now being reviewed for approval by DOE's management. When approved, Revision 1 of the plan will be provided to the NRC. It is expected that a Revision 2, to be published in 2004, will include a full description of each PC activity. The staff intends to use the review methods in the Yucca Mountain Review Plan to perform pre-licensing reviews of Revisions 1 and 2 of DOE's PC plan.

***Observation***

A PC plan is required to be a part of a license application; therefore it is clear that this element of DOE's program should receive appropriate pre-licensing guidance. Based on NRC's presentations to the Committee, however, the PC program has not been treated proactively by NRC. The staff is waiting for DOE to propose a structure for a PC plan and to suggest criteria for deciding whether deviations from baseline are significant enough to warrant actions. We

believe that PC is an area that deserves more interaction between DOE and NRC than has occurred to date.

### ***Recommendations***

The Committee recommends that the Commission require the NRC staff to provide additional pre-licensing guidance to DOE concerning PC plans. These communications should focus on:

1. Ways to develop the PC program that are based primarily on risk insights and testing assumptions about key performance factors;
2. How performance assessments can or should be updated using performance confirmation data;
3. How performance confirmation should be used in making decisions; and
4. How to resolve any differences in NRC and DOE approaches to PC.

### ***Attributes of a Successful PC Program***

#### **The PC Program Should Be Informed by Performance Assessments**

The PC program must be risk-based, focusing on parameters and processes that are important to safety. PC needs to be linked to total system performance assessments (TSPA for DOE and TPA for NRC), which means these assessments have to be maintained during PC. Also, PC monitoring should focus on areas where TSPA is based more on assumptions than on evidence. To the extent that TSPA and TPA indicate that performance is insensitive to some systems and processes, monitoring of associated parameters may not be needed. A risk-based PC program would allocate resources to those areas that are most important for performance, thus providing the greatest support for future decisions.

NRC's review of DOE's PC Plan may identify elements that are unnecessary and not risk informed. The staff normally focuses licensing reviews on activities that are needed but have not been proposed by an applicant. The NRC staff seldom comments on unnecessary activities that an applicant may propose. However, in a risk-informed, performance-based arena, it is appropriate to provide guidance to a potential licensee regarding both necessary and unnecessary activities.

To avoid the pitfall of having the PC program become a de facto site characterization or basic research program, there should be a clear mapping between performance assessment and PC.

#### **The PC Program Should be Flexible and Responsive**

Considerable advances in technology can be expected to occur over many decades. A successful PC program should be flexible, with a process to reevaluate, reexamine, and modify PC activities as the state of understanding changes. New tests may be needed, or

may become possible with new technology, and tests that are no longer providing useful information could be discontinued. Some parameters are difficult to measure but nonetheless may be important to safety. The Committee advises an approach to develop and correlate new data, to the extent feasible, to build a body of evidence that will improve the safety-related knowledge base.

#### Objective Criteria Are Needed To Decide on Future Actions

The PC plan should address what happens if some results are unexpected and potentially at odds with assumptions used in development of the safety case. PC is not aimed at detecting performance failures per se. However, the PC program may detect parameters that deviate from an expected range of values. Yucca Mountain is a complex project, so that some deviations from expectations may occur. PC should have a logical pathway to determine whether any of the deviations are significant to safety. The criteria to make this determination should be developed as part of the PC plan.

#### Appropriate Accuracy or Precision Should be Part of the Measurement Design

Parameters to be monitored under PC will require varying degrees of accuracy and precision to support decisionmaking. The appropriate metric should be whether significant deviations important to safety have been detected. Requiring unnecessary accuracy or precision may be misleading regarding the importance of the parameter.

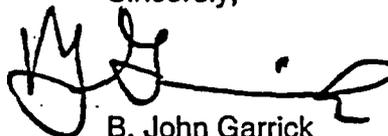
#### Plan Should Include Appropriate Involvement of the Public in PC Activities

The PC plan should address how the public will be involved in the PC process. The public could be involved in identifying those aspects of a PC program that may provide increased confidence. The Committee believes that the PC plan needs to be risk informed. However, some activities may be planned to address issues of unusual public concern, though they may not be high-risk safety issues. The public should be kept informed of any problems revealed by the PC process and of any subsequent mitigation.

#### **Summary**

This WGS provided an excellent forum in which to exchange views on the technical issues associated with PC. It appears to the Committee that, within the high-level waste program, PC planning is relatively immature. The Committee has provided specific recommendations to enhance the pre-licensing guidance so that DOE can improve its PC plan. NRC and DOE have not yet finalized any agreement items related to PC. Continued communication between the NRC and DOE staffs is essential, and must stay focused on matters important to safety.

Sincerely,



B. John Garrick  
Chairman



UNITED STATES  
**NUCLEAR REGULATORY COMMISSION**  
ADVISORY COMMITTEE ON NUCLEAR WASTE  
WASHINGTON, D.C. 20555-0001

March 4, 2004

The Honorable Nils J. Diaz  
Chairman  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555-0001

Dear Chairman Diaz:

**SUBJECT: COMMENTS ON SELECTED NRC-SPONSORED TECHNICAL ASSISTANCE PROGRAMS OF THE CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES**

The Advisory Committee on Nuclear Waste (ACNW) conducts periodic reviews of the activities of the U.S. Nuclear Regulatory Commission (NRC) in the Nuclear Waste Safety Arena as they relate to safety research and high-level waste (HLW) technical assistance. In this report we present comments and recommendations regarding aspects of the NRC-sponsored technical assistance being performed by the Center for Nuclear Waste Regulatory Analyses (CNWRA). On February 17-18, 2004, two ACNW members visited the CNWRA to obtain information to be considered by the Committee during its 148<sup>th</sup> meeting on February 24-27, 2004. Aspects of the CNWRA programs and issues in these programs have also been reviewed with the NRC and CNWRA staffs and other stakeholders at previous ACNW meetings and working groups during the past year. In this letter we focus on:

- Igneous Activity Key Technical Issue (KTI)
- Spent Fuel/Water Interactions in the Waste Package
- Repository Design and Thermal-Mechanical Effects (Post-Closure Drift Stability KTI)
- Pre-Closure Safety Analysis (PCSA Tool)

**RECOMMENDATIONS**

1. An important part of the igneous activities studies is related to inhalation models for exposure to volcanic ash containing radioactive material. The relationship between specific activity in ash particles and airborne concentration should be used to evaluate doses resulting from inhalation of airborne radioactive materials. These evaluations should include the effects of particle size, solubility, and the relative importance of inhalation and ingestion components of internal dose.
2. The CNWRA staff is currently designing experiments to examine the interactions of water and spent fuel in the waste package. The use of experiments with unirradiated UO<sub>2</sub> fuel pellets as a model for spent fuel/water interactions, as currently proposed by CNWRA, needs to be justified.

3. Further, the CNWRA staff should evaluate the use of spent fuel pool data and safety analyses from existing nuclear power plants and seek opportunities to obtain information from these facilities to provide insights into spent fuel/water interactions.
4. CNWRA evaluations of drift stability and degradation may have design implications. The ACNW is aware of differing views between NRC and DOE on drift stability. It is important that these differences be resolved. See the ACNW letter of March 4, 2004, entitled, "Instability of Emplacement Drifts of the Proposed Yucca Mountain High-Level Waste Repository," for more details on drift stability.
5. It is recommended that staff involved in the development of the PCSA tool obtain information and experience by observing operations at nuclear facilities that handle spent fuel. Information regarding safety assessments at these facilities should be reviewed.

## DISCUSSION

The technical assistance work at the CNWRA dealing with issues of importance to an NRC review of the potential Yucca Mountain HLW repository license application continues to be of high quality. For example, the experimental corrosion studies at the Center are building on the evolving knowledge of the near-field environment.

The CNWRA is currently conducting investigations into the consequences of redistribution of volcanic ash containing radioactive material and resuspension of these materials coupled to inhalation exposure scenarios. The Committee supports this effort. Significant progress has been made in developing rational models for addressing this difficult issue. Efforts should be made to use the relationship between the specific activity of airborne particles and airborne concentrations to better develop an inhalation abstraction for intakes. These evaluations should include effects of particle size (from submicron to 100 microns in size), solubility, and the relative importance of the inhalation and ingestion components of internal dose.

The CNWRA staff is currently designing experiments to examine the interactions of water and spent fuel in the waste package. The Committee questions the value of experiments with unirradiated  $UO_2$  fuel pellets as currently proposed by CNWRA. Existing data and analyses from spent fuel pools may be useful to address the question. Fuel has been stored in water at these facilities, in some cases for decades, and pool waters have been sampled and cleaned with ion exchange systems. Information regarding the accumulated activity in pool water and cleanup resins may provide insights about the behavior of spent fuel stored under water over time.

During its October 2003 and November 2003 ACNW meetings, the Committee heard presentations from CNWRA and the Department of Energy (DOE) regarding drift stability and degradation and how these phenomena were analyzed. Additional information was obtained during the February 17-18, 2004, visit that identified three major concerns of the Center staff regarding calculational procedures:

1. The need for an evaluation of the maximum compressive strength of the repository rocks as a function of Young's modulus over a range of values spanning a suitable confidence interval

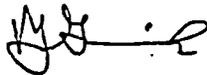
March 4, 2004

2. Boundary conditions used by the DOE in its modeling of drift stability
3. Inadequacies in the correction to the horizontal fracture data derived from geological mapping in the Exploratory Studies Facility (ESF)

The Committee encourages the CNWRA and the NRC staff to meet with DOE in the near future to discuss these issues. It is important that the differences in drift stability and degradation be resolved.

The PCSA Tool is being developed to assess the consequences from accidents in the surface facilities of the potential repository. The framework of the PCSA Tool is adequate for analysis of a range of surface facility designs. The staff has performed well in developing a reasonable framework for analyzing public and worker dose scenarios even in the absence of a detailed DOE design.

Sincerely,



B. John Garrick  
Chairman



UNITED STATES  
**NUCLEAR REGULATORY COMMISSION**  
ADVISORY COMMITTEE ON NUCLEAR WASTE  
WASHINGTON, D.C. 20555-0001

March 4, 2004

The Honorable Nils J. Diaz  
Chairman  
U.S. Nuclear Regulatory Commission  
Washington, DC 20555-0001

Dear Chairman Diaz:

**SUBJECT: INSTABILITY OF EMPLACEMENT DRIFTS OF THE PROPOSED YUCCA MOUNTAIN HIGH-LEVEL WASTE REPOSITORY**

At its 146th and 147th meetings on October 22-23, 2003, and November 19-20, 2003, respectively, the Advisory Committee on Nuclear Waste (ACNW) was briefed on analyses of the stability of the emplacement drifts for the subject repository. At the 146th meeting the NRC staff presented the results of the preliminary analysis of drift instability, followed by a brief comment from a DOE staff scientist. At the 147th meeting the role was reversed: the DOE briefed the Committee on DOE's views of drift instability, while an NRC staff member offered a general comment at the conclusion of the briefing.

**The Issues**

The first issue is the possibility that part of the rock mass surrounding the void space in the emplacement drifts will eventually break into blocks that can drop and damage the drip shield. This is a dynamic impact problem. The second issue is the buildup of static loads of rock rubble that could lead to collapse of the drip shield, possibly resulting in damage to the waste package in the process. During postclosure, when it is no longer possible to maintain the ground support system, there is the concern that the ground support system will lose its capability to prevent the fallout and accumulation of rock in the void space. The key question is, could drip shield-waste package interactions lead to an acceleration of the failure of the waste packages during the 10,000-year compliance period?

**Areas of Disagreement**

An area of disagreement between the NRC staff analyses and DOE analyses relates to the time at which rock fall and rock fall rubble accumulation will become a threat to the integrity of the near-field engineered barriers, primarily the drip shield and the waste package. The NRC staff analyses suggest that seismically induced dynamic impacts of rocks might be a concern in emplacement drifts in the middle nonlithophysal rock unit (12.4 percent of the repository according to the DOE). The NRC staff analyses indicate that dynamic impact such as from large falling rock blocks is not a concern in emplacement drifts in the lower lithophysal rock unit (80.3 percent of the repository according to the DOE). Static loads are another matter. The NRC staff analyses indicate that on average 75 percent of the drip shields will buckle under static rockfall loads within 500 years after closure. The NRC analyses are based on empirical data and observations of coal mining operations.

DOE does not believe that it is inevitable that the tunnels will collapse. The drift spacing (and hence interaction) and ground support system are very different from those in mining operations. DOE believes that empirically related tunneling classification schemes that were made for personnel safety considerations are not applicable to predicting thousands of years of drift performance. DOE is using a rock mechanics model based on site characterization data to predict the collapse of the drifts. Their drift degradation model is based on three primary sources of stress: gravitational stress, thermal loading, and seismic loading. Because the stresses in the tunnel walls are in equilibrium, DOE does not expect gravity to cause rock falls. Their claim is that no significant rock falls have been observed and that there is no driver for rock falls in the future. Although some spalling has been observed as a result of the heater tests, it is considered minor. DOE does not believe that a seismic event could trigger a tunnel collapse; such an event, in their opinion, has never been observed. DOE further pointed out that many natural excavations have stood for millions of years without collapse.

NRC and DOE agree that the primary issue is the static load of rock rubble on the drip shield. Dynamic impact on the drip shield is not considered a major concern by either the NRC or DOE. DOE does not believe that the dynamic impacts of rocks will be a threat to the integrity of the engineered barriers during the 10,000-year regulatory compliance period. The NRC staff has only limited concern about dynamic rock impacts and then only with respect to the middle nonlithophysal rock unit. Two factors diminish the NRC staff's concern. The first is that only a small fraction of the repository (12.4 percent) lies in the middle nonlithophysal rock unit. The second is that the rock blocks would accumulate in the void space; once the drip shield is buried with rock rubble, subsequent rock blocks falling would be on top of the rubble and would not transfer significant mechanical load to the drip shield.

### **Conclusions and Recommendations**

The issue of drift stability needs to be put in context with other features, events, and processes affecting repository performance. ACNW is not aware of any drift stability risk insights from either NRC's or DOE's analyses. Such risk insights should be developed.

Simple scoping models should first be applied to determine if there is a real threat to repository performance from drift collapse. To the extent practical, the modeling should reflect the actual conditions of the repository and the design of the engineered barriers. The Committee questions the appropriateness of the use of coal mining analogs and the relevance of coal mining data to the analysis.

The Committee believes it is important to quantify the impact and uncertainties of drift instability on engineered barrier performance. The Committee further believes that the near-field environment-thermal pulse, moisture flow, humidity, perturbations from operations, etc., should be considered in the analyses.

The Committee has learned of several recent design changes that may enhance emplacement drift stability. The design change most relevant to drift stability has to do with the ground support system. The major change in the ground support system is to install a 3-millimeter-thick stainless steel (type 316) liner in a 240° arc around the drift periphery along the entire drift length. The liner is anchored to the drift with friction rock bolts 3 meters long, spaced at 1.25 meters.

March 4, 2004

To the extent possible, any analyses of the impact of drift stability on repository performance should reflect realistic design considerations as well as the actual properties of the natural system.

Sincerely,

A handwritten signature in black ink, appearing to read "B. John Garrick". The signature is stylized with a large initial "B" and a long horizontal stroke extending to the right.

B. John Garrick  
Chairman



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
ADVISORY COMMITTEE ON NUCLEAR WASTE  
WASHINGTON, D.C. 20555

May 3, 2004

The Honorable Nils J. Diaz  
Chairman  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555-0001

SUBJECT: RISK INSIGHTS BASELINE REPORT

Dear Chairman Diaz:

During its 148th and 149th meetings, the Advisory Committee on Nuclear Waste (ACNW) was briefed by Nuclear Regulatory Commission (NRC) staff on results obtained by implementing the staff's risk insights initiative. This briefing was a follow-on to the April 2002 and July 2003 briefings. The risk insights initiative is a program for risk-informing the regulatory activities of the NRC's high-level radioactive waste (HLW) program. Risk insights were defined by the NRC staff as results and findings from performance assessments. In the Commission White Paper the definition refers to risk assessments, implying that the performance assessments must be risk-based in order to provide risk insight results.

The NRC staff reported on the development of an integrated synopsis report that describes the staff's understanding of the key contributors to performance for a potential geologic repository at Yucca Mountain. The report, "*Risk Insights Baseline Report*," is currently undergoing review. It is expected that the report will be made available to the public on completion of the review. In general, the report reflects the NRC staff's assessment of the risk significance of contributors to overall repository performance. The NRC staff's assessments were based on its own independent performance assessment work, reviews of U.S. Department of Energy (DOE) performance assessments, and other documents.

The Committee was impressed with the baseline report effort as it was presented and believes that it provides another important resource for regulating the safety and environmental impacts of a HLW repository. The presentation provided details on the way that risk considerations are incorporated into the NRC staff's review of key technical issues (KTIs). The report can be a major contributor to risk-informing issue resolution and license review processes. In particular, the Committee agrees with the staff that the three major reports—the Yucca Mountain review plan, the integrated issue resolution status report, and the risk baseline report—provide an important foundation for a comprehensive issue resolution and license review process.

In addition to supporting license review, the Committee understands that the risk baseline report and the risk insights in particular are supporting issue and agreement resolution during the current pre-licensing phase. In keeping with the spirit of the probabilistic risk assessment policy statement of the importance of understanding what is really important to risk and reducing unnecessary regulatory burden, risk insights may be used to screen issues and prioritize the scope and effort of safety reviews and analyses. The risk insights presentation included a

May 3, 2004

thorough explanation of the advantages of knowing the ranking of issues, including the KTI subissues, as low, medium, and high. However, the Committee would like to see this work translated into specific guidance on prioritizing issue resolution. The Committee learned at the 147<sup>th</sup> meeting that not all of the KTI agreements would be resolved at the time the license application is received. The Committee believes only agreements ranked as low risk should remain as unresolved.

Regarding the implementation of the risk insights initiative, the Committee therefore recommends that an effort be made to implement a regulatory risk management process that assures that the resolution of the most important agreements has priority. Such a process implies that there is guidance from the NRC to DOE on screening and prioritizing issues and agreement resolution. The guidance should be clear as to how risk insights are used to rank issues as high, medium, or low significance.

Sincerely,

A handwritten signature in black ink, appearing to read "B. John Garrick", with a horizontal line extending to the right.

B. John Garrick  
Chairman



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

May 3, 2004

The Honorable Nils J. Diaz  
Chairman  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555-0001

**SUBJECT: WORKING GROUP SESSION ON BIOSPHERE DOSE CALCULATIONS**

Dear Chairman Diaz:

During its 148<sup>th</sup> meeting on February 24-26, 2003, the Advisory Committee on Nuclear Waste (ACNW) had a working group session (WGS) on biosphere dose calculations for the potential Yucca Mountain high-level waste repository. The session included an expert panel of six distinguished scientists from academia, research institutions, and private enterprise renowned in the fields of radiological assessment, the fate and transport of radioactive materials in the environment, and related subjects in earth sciences. The Department of Energy (DOE), the Nuclear Regulatory Commission (NRC) staff, and representatives of the State of Nevada made presentations. Stakeholders and members of the public were given opportunities to comment on the discussions that took place during the technical sessions.

The purposes of the WGS were to (1) increase ACNW's technical knowledge of NRC staff plans to develop and conduct biosphere dose assessment work for the potential Yucca Mountain repository, (2) understand NRC staff expectations for biosphere dose assessments, (3) review examples of biosphere dose assessment work being planned by both NRC and DOE, (4) identify aspects of biosphere dose assessments that may warrant further study, and (5) complement previous and planned WGSs.

In addition, there were discussions regarding (1) the technical bases (measurements, analyses, and interpretations) necessary to conduct biosphere dose assessments, (2) the role of risk insights in the development of technical bases, and (3) the impact of outstanding technical issues on the resolution of agreements.

The expert panel offered a number of suggestions and observations regarding assessments and evaluations that will underpin the biosphere dose calculations that are required in a DOE license application.

This letter provides a summary of the WGS expert panel's suggestions and observations. These suggestions and observations should help the NRC staff prepare for the review of the biosphere dose calculations that must be included in a license application.

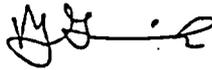
May 3, 2004

**Recommendation**

The Committee recommends that the NRC staff consider the suggestions and observations of the biosphere WGS. The suggestions and observations were directed toward DOE but, to the extent they are adopted, may affect an NRC review of the biosphere dose calculation.

The suggestions and recommendations are provided as an enclosure to this letter.

Sincerely,

A handwritten signature in black ink, appearing to read "B. John Garrick". The signature is stylized and includes a horizontal line extending to the right.

B. John Garrick  
Chairman

Enclosure: As stated

### Observations and Background Information

The major comments of the expert panel<sup>1</sup> focused on several issues related to specific models and parameter values used by the U.S. Department of Energy (DOE) during their pre-licensing work on dose calculations for the proposed Yucca Mountain high-level waste repository. The principal topics are discussed below.

1. *Excessive conservatism in the estimates of the uptake by cows of radionuclides from local alfalfa farms.* The basis for questioning the uptake values used was the degree to which locally produced alfalfa and other hay (produced on about 90 percent of about 2000 acres that are being commercially farmed in the area) could meet the needs of a commercial dairy operation having a reported total of more than 5000 Holstein dairy cows. Experience of one expert panel member indicates that about 2000 acres of alfalfa would provide only a very small percentage of the total feed needs of about 5000 cows.
2. *Failure to consider the Carbon-14 pathway through roots that could contaminate foodstuffs.* Apparently, the analysts did not consider this pathway.
3. *The need to quantify better all of the dose pathways that significantly contribute to the total dose.* An example, which might contribute to the inhalation dose, is the use of evaporative coolers in the Amargosa Valley region.
4. *Overestimation of ingestion dose from fish from the local fish farm.* In this case, the "solution" to the lack of quantified values for various input parameters was to make overly conservative dose estimates. The now inoperative local fish farm used fish feed purchased from outside of the Amargosa Valley. It was noted by several panel members that improved realism would certainly add to the credibility of the dose calculations performed by DOE.
5. *The use of Federal Guidance Reports (FGRs) in performing dose calculations.* DOE is using FGR No. 11 to estimate the doses from internal exposures and FGR No. 12 for external exposures. Dose estimates included time-weighted exposure for five environments by various population groups residing within the Amargosa Valley. The five environments applied to people who were (a) active outdoors, (b) inactive outdoors, (c) active indoors, (d) asleep indoors, and (e) away. DOE has not used FGR No. 13, a compilation of updated dose conversion factors. The panel expressed the opinion that using FGR No. 13 would enhance the credibility of the dose calculations.

### Opportunities for Improving Dose Calculations

The expert panel drew a distinction between dose calculations for the purpose of complying with regulations and calculations not linked to the prescriptive requirements of the regulations. With respect to compliance, the expert panel identified a number of opportunities for improving the

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<sup>1</sup>The chair of the expert panel was Dr. Dade W. Moeller (Dade Moeller and Associates). The other members were Drs. Keith Eckerman (Oak Ridge National Laboratory) David Kocher (SENES Oak Ridge, Inc.) John Till (Risk Assessment Corporation) Jeffrey Daniels (Lawrence Livermore National Laboratory) and Michael Thorne (Mike Thorne and Associates, Ltd., England).

quality of the DOE dose calculations on which the panel was briefed. An overarching issue in this regard is to address the major sources of uncertainty. The enhancements recommended include the following:

1. Dose estimates based on different dose coefficients, including the FGR No. 11 and FGR No. 13 coefficients.
2. Dose estimates for different age groups within the general population, most notably those for infants and teenagers rather than just the required adult. Such analyses might also include a report explaining the nature of the Biosphere Dose Conversion Factors (BDCFs), with emphasis on the various factors conversion into setting the BDCFs, the values currently being assigned to the BDCFs, and their associated uncertainties. It should be recognized, however, that the reasonably maximally exposed individual (RMEI) is an adult.
3. Several members of the expert panel recommended a data update, i.e., a revision of the DOE technical baseline report (DOE, 1997) to include data, on existing conditions related to biosphere parameters. This included the collection and tabulation of information on (a) the relative amounts of water from local ground water sources and the amounts of specific locally produced types of foods being consumed, (b) details on the types of housing in which the people live, and (c) the average residence time of the population and the frequency of population turnover. The expert panel suggested that much more needs to be known about possible site-specific effects, particularly with respect to additional details of the ongoing agricultural activities (the characteristics of each of the crops being grown, including small grains, pistachio nuts, grapes, orchard produce, garlic, and onions). Better documentation of existing conditions in the Yucca Mountain region could serve as an improved reference for modeling parameters. The expert panel recognized that preparation of such a report would undoubtedly require the acquisition of additional site-specific information, including existing concentrations of radionuclides generated by earlier activities at the Nevada Test Site, as well as radionuclides of natural origin.

The uncertainties in the dose assessments should be quantified and possibly separated into two types, those that are prescribed by the regulations and those that are not. Examples of the first type are as follows:

1. Section 63.312 (e) of Title 10 of the Code of Federal Regulations (10 CFR 63.312 (e)) specifies that the RMEI is an adult.
2. The RMEI is assumed to consume 2 liters of water per day from potentially contaminated sources.
3. The estimated concentration of radionuclides in the ground water is based on a withdrawal rate of 3000 acre-feet per year.

Examples of the second type of assessment are:

1. Those associated with the dynamics of the uptake of radionuclides by plants that are irrigated with the ground water.
2. The biokinetics (metabolism) of the radionuclides within the human body, two major factors being the uptake through the gastrointestinal tract and the deposition of the radionuclides in various body organs.
3. The factors involved in the dosimetry of the radionuclides once they have been deposited in various body tissues.

The expert panel suggested that DOE prepare reports in which they identify and quantify the conservatisms and uncertainties associated with various input factors. For example:

1. The expert panel indicated the need to justify the assumed lung solubility of radionuclides, such as plutonium-239.
2. The expert panel noted that values for the soil adsorption coefficients probably encompass the largest uncertainties of any of the input parameters in the overall dose assessments. Estimates on the resuspension of dust deposits on the ground also involve large uncertainties.
3. The expert panel recommended that DOE consider preparing a report that clarifies the circumstances, particularly regarding dose calculations, of each of the three basic requirements of 10 CFR Part 63: (a) individual protection, (b) ground water protection, and (c) human intrusion.

Other issues addressed by the expert panel included the igneous event, coupling of models, radium-226 ( $^{226}\text{Ra}$ ), the RMEI concept, future climate projections, and risk insights.

### **Igneous Activity Disruptive Event**

Information presented to the working group indicated that the igneous activity disruptive event scenario is a postulated event that contributes to dose during the compliance period. This being the case, the expert panel recommended emphasizing the ongoing efforts to reduce the uncertainties in the values of the key model input parameters for analyzing this scenario. Of particular importance are factors such as the density, particle size distribution, and solubility (within the lungs) of the ash that would be produced and subsequently resuspended and inhaled. Also important is the partitioning of radionuclides among particles of a specific size range. The expert panel was encouraged that natural analogs are being vigorously studied and evaluated. While the impacts of the initial release are important, the values of the parameters related to chronic exposure scenarios need careful evaluation. These include the mechanisms of deposition of the airborne ash, its potential for resuspension once deposited, and the rate of aging of the deposited ash, especially the determination of a realistic estimate of its half-time for availability for resuspension.

## **Coupling of Various Models**

Several expert panel members noted that there is interplay, as well as correlation, between the input parameters used in modeling biosphere transport and those used in assessing the impacts of various engineered barriers. For example, if the adsorption coefficient for a specific radionuclide is high, then its uptake by plants should be reduced accordingly. There are also extensive data from detailed analyses of the soil in the Amargosa Valley; these data should be reviewed and evaluated in terms of the potential impacts on the input parameters for the biosphere models. They also cited a need for decoupling different elements of the BDCFs within the total system performance assessment.

## **Radium-226 as a Radionuclide Source**

The importance of  $^{226}\text{Ra}$  and its relevance to the biosphere dose calculations needs to be further assessed. From the standpoint of the individual protection standard,  $^{226}\text{Ra}$  is important only if it is released from the repository.

## **Acceptability of the Reasonably Maximally Exposed Individual Concept**

The NRC regulations (10 CFR 63.312) specify that the dose limits apply to the RMEI, who is an adult with "a diet and living style representative of the people who now reside in the Town of Amargosa Valley, Nevada."

Several members of the expert panel pointed out that the International Commission on Radiological Protection (ICRP) recommends that compliance with the applicable regulations be based on the annual dose and/or dose rate to the average member of what they describe as the "critical group." The expert panel suggested that the NRC consider having DOE perform some auxiliary dose estimates to compare the values based on the RMEI and the ICRP critical group concepts. This is another example of a calculation outside the compliance requirements that could build confidence in the dose calculations.

## **Risk Insights Initiatives**

The NRC and the Center for Nuclear Waste Regulatory Analyses (CNWRA) have been conducting studies since the early 1990s on both the ground water exposure scenario and the postulated igneous activity release. In terms of the former, the analyses indicate that about 50 percent of the dose will occur as a result of direct ingestion and about 40 percent through the consumption of irrigated crops. The NRC and CNWRA concluded that the uncertainties of these estimates are "low relative to other abstractions." As a result, they do not plan any additional technical work in this area.

For a potential igneous event, the analyses show that the inhalation pathway dominates, the key parameters being the mass loading and exposure duration. Mass loading, in particular, is a sensitive and uncertain parameter. The NRC and CNWRA will continue to investigate these parameters. They are also developing new dose assessment models. One observation relative to the key input parameters is that it appears that radionuclides will not be readily leached from the ash. Items needing special attention are the size distribution of the airborne particles and the processes involved in the remobilization of the volcanic ash. The NRC and CNWRA identified two areas that need to receive priority attention: (a) documentation of the basis for the assumed particle size concentrations of the airborne particles and (b) the basis for bounding the redistribution of ash.

**Reference:**

U.S. Department of Energy, "The 1997 'Biosphere' Food Consumption Survey: Summary Findings and Technical Documentation," Las Vegas, Office of Civilian Radioactive Waste Management, 1997. [Prepared by TRW Environmental Systems, Inc.]



UNITED STATES  
**NUCLEAR REGULATORY COMMISSION**  
ADVISORY COMMITTEE ON NUCLEAR WASTE  
WASHINGTON, D.C. 20555

May 3, 2004

The Honorable Nils J. Diaz  
Chairman  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555-0001

**SUBJECT: OBSERVATIONS FROM THE 147TH MEETING OF THE ADVISORY  
COMMITTEE ON NUCLEAR WASTE IN LAS VEGAS, NEVADA**

Dear Chairman Diaz:

During the 147<sup>th</sup> meeting of the Advisory Committee on Nuclear Waste (ACNW) in Las Vegas, Nevada, several important topics were discussed regarding the potential Yucca Mountain high-level waste (HLW) repository. They included public outreach, Amargosa Valley characteristics, the igneous disruptive event issue, the status of the Yucca Mountain repository design, and the analysis of emplacement drift stability. The latter was the subject of a separate letter report to you on March 4, 2004.

The comments in this letter are observations and status reports and not specific recommendations. They are considered important because of their implications for the quality and completeness of the anticipated U.S. Department of Energy (DOE) license application.

#### **Public Outreach**

It has become a tradition to hold an ACNW meeting once a year in the Las Vegas area to take advantage of the available technical personnel working on the Yucca Mountain project. It has also become a tradition to make a special effort to reach out for public participation in our Nevada meetings. While the public forum part of our meetings has been very successful in giving members of the public the opportunity to tell us about their interests and their concerns with the Yucca Mountain project, the Committee continues to be disappointed by the degree of public participation and representation. Clark County officials offered the Committee the use of its public meeting facility for future meetings, suggesting that they said their facility might provide a comfort zone for increasing attendance. To further stimulate public interest in the Las Vegas meetings, the Committee is considering combining working group sessions with future meetings. All of the stakeholders are generally very well represented at the working group sessions.

#### **Amargosa Valley Tour**

One of the key observations by invited experts to the Committee's February 2004 working group session on the biosphere and dose calculations for Yucca Mountain was that more effort should be given to quantifying site-specific features having an impact on dose calculations. To a limited extent, the Committee had a first-hand opportunity as a result of its site visit to Amargosa

Valley to observe and make inquiries with residents on local lifestyle activities, including those that would affect the calculated radiation dose to individuals. A local resident who has been in the valley since 1992 hosted the Committee tour. Features related to ingestion and inhalation pathways were observed. These included a large commercial dairy operation, a few alfalfa farms, irrigation and drinking water wells, and the use of evaporative cooling for human comfort. Most of the feed for the dairy is imported from outside the valley. The local population numbers about 1500 residents in an estimated 500 dwellings, many of which are of the mobile or manufactured type. Our host pointed out that most of the residents work outside of the valley and others maintain part-time retirement homes in the valley. One of the major concerns of the dairy farmers is the perception that the HLW repository will taint their products and handicap their marketing opportunities.

Aside from the dairy, a clay mining operation, and alfalfa farms, there are few commercial enterprises in the valley. The Ash Meadows National Wildlife Refuge with its protected desert pupfish is located in Amargosa Valley. It was reported to the Committee during the tour that a comprehensive documentation of site-specific features clearly linked to performance assessment would add a great deal of credibility to the analysis in the eyes of the local population.

### **Igneous Disruptive Event**

The ACNW was briefed on a DOE-sponsored review of the igneous consequence modeling program. DOE was motivated to have its igneous work reviewed partly because of technical differences with NRC on the modeling of magma-repository interactions. The final recommendations on the adequacy of the DOE modeling were issued by the Igneous Consequences Peer Review (ICPR) Panel in February 2003. Among the findings of the panel were that (1) DOE's performance assessment conceptual model of igneous activity at Yucca Mountain was adequate and reasonable and (2) major advances in the understanding of localized magma-drift interactions at the site would *not* be available within the next 3 years (the timeframe during which DOE is expected to submit its license application) and therefore the panel did not recommend alteration of current DOE models and computer codes.

The ICPR Panel made 29 specific recommendations for technical analyses that DOE should consider in order to reduce uncertainties in the models and codes. These recommendations included (1) specific improvements in geologic knowledge that were necessary to achieve a better understanding of volcanology in the Yucca Mountain region, (2) specific improvements in the ability to model and predict magma-repository interactions, and (3) specific design elements in the underground repository that, if used, could be expected to mitigate the effects of intrusive volcanism on emplaced waste package canisters.

DOE has prepared responses to each of the 29 ICPR Panel recommendations in a report made available to the NRC on January 23, 2004. In the briefing to the ACNW, DOE noted that the main emphasis of its igneous activity modeling programs prior to the submittal of a license application would be to address the information needs related to the NRC/DOE key technical issue (KTI) agreements. With respect to the ICPR Panel recommendations, DOE noted the following:

- Improvements to its igneous activity consequence models and computer codes, available since the completion of the ICPR Panel's work, were considered generally sufficient by DOE to address some of the panel recommendations. Considering the improvements made thus far, and based on DOE's determination of the risk significance of a potential disruptive igneous event at the site, DOE believes that its improved igneous activity consequence computational module is sufficient for inclusion in a 10 CFR Part 63 license application.
- Using conservative modeling assumptions and bounding parameter distributions can obviate the need for improvements to igneous activity consequence models and computer codes in some areas.
- Ongoing or planned model enhancements, as well as focused confirmatory testing, are expected to satisfy any remaining ICPR Panel-recommended improvements to the consequence models and computer codes.
- DOE intends to update the technical bases for its 1996 probabilistic volcanic hazards analysis (PVHA) used to estimate the probability of a disruptive igneous event at Yucca Mountain. An update to the PVHA would be consistent with the ICPR Panel recommendations and earlier agreements with the NRC staff.

As a result of these developments it is likely that several KTI agreements will still be open at the time of the license application submittal.

The ACNW has long been concerned with NRC's practice of separating the review of an igneous event into a probability and a consequence component. Such decoupling obscures the linkage between the consequence assumptions (or boundary conditions) and the supporting evidence, since assumptions about consequences are often probabilistic. Invoking the triplet definition of risk avoids these anomalies by characterizing the risk as the likelihood of scenarios and their attendant consequences (See SECY-98-144). Consequence assumptions and evidence become properties of the scenarios.

### **Yucca Mountain Repository Design**

The Committee was briefed on the status of the proposed Yucca Mountain repository design. The design of the repository is still very much in a state of flux. The detailed conceptual design for the surface facilities is only now emerging. In addition, the subsurface facilities are currently going through a number of changes.

A transportation cask receipt facility with a buffer storage area is the most recent design change to the surface facilities. A separate building will be used as a canister-handling facility. Two dry transfer facilities with remediation capability are planned and will be constructed in phases. The dry transfer facilities will process the fuel, placing the spent fuel in the waste packages, primarily using dry handling techniques. Each of the dry transfer facilities will have a small pool for remediating and handling damaged fuel. DOE has returned to a rail-based transporter to place the waste packages in the emplacement drifts. Surface aging pads for the spent fuel will have a capacity of up to 20,000 metric tons of heavy metal. Many design changes and decisions are still being made; for example, consideration is being given to how best to address the threat of aircraft impact on surface facilities.

May 3, 2004

There are a number of design changes in the subsurface as well. The emplacement drifts will use perforated stainless steel sheets and rock bolts for ground support. The emplacement gantry will be electrically powered. The emplacement drift invert will be made of carbon steel and used to support the emplacement gantry rail system, waste package supports, and drip shields during the preclosure period. Changes to the drip shield under consideration include increasing the distance between the drip shield and the waste package to prevent contact in the event of rock fall and increasing the stiffness for bending loads and stresses along the bulkheads. Longitudinal stiffener beams will be added between the bulkheads along the axial direction to provide additional strength for axial bending loads.

### Summary

The annual meeting of the ACNW in Nevada has become an important exercise in the Committee's advisory role to the Commission on the safety of the potential Yucca Mountain high-level waste repository. It is an opportunity for the Committee to have access to the extensive technical resources of the Yucca Mountain project while being able to observe first-hand site activities and public involvement. The highlights of this meeting were new information on both surface and subsurface facilities, an outside review of the igneous disruptive event scenario, a demographics presentation and properties of the Amargosa Valley, and the continued challenge of engaging the public in the evaluation process.

Sincerely,



B. John Garrick  
Chairman



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
ADVISORY COMMITTEE ON NUCLEAR WASTE  
WASHINGTON, D.C. 20555

May 5, 2004

The Honorable Nils J. Diaz  
Chairman  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555-0001

**SUBJECT: REVIEW AND EVALUATION OF THE U.S. NUCLEAR REGULATORY  
COMMISSION'S RADIONUCLIDE TRANSPORT WASTE SAFETY RESEARCH  
PROGRAM**

Dear Chairman Diaz:

The Advisory Committee on Nuclear Waste conducts periodic reviews of the activities of the U.S. Nuclear Regulatory Commission (NRC) in nuclear waste safety research and the high-level waste (HLW) technical assistance program. The ACNW provided a comprehensive report on this work and the work being carried out in the Radionuclide Transport Research Program by the Office of Nuclear Regulatory Research (RES) on March 22, 2002. ACNW also reported on research related to the safety of spent fuel storage systems in its June 28, 2002, report.

Research efforts sponsored by RES in the radionuclide transport program address waste management and decommissioning programs. Specific studies address sorption, groundwater monitoring, and evaluation of clay covers. Work is also under way that supports the specific rulemaking activities associated with clearance and entombment. RES is tracking developments related to health effects models (e.g., linear-no-threshold theory) and the work of the International Commission on Radiological Protection and the National Council on Radiation Protection and Measurements. This combination of cross-cutting, specifically focused, and anticipatory research work is an effective approach to conducting a small research program that supports NRC decisionmaking.

One element of the RES-sponsored research is designed to provide generic support for the staff's analysis of factors influencing biosphere transport of radionuclides. While generic in nature, the work could be useful in the NRC staff's evaluation of a potential license application for an HLW repository at Yucca Mountain. Specifically, studies are planned which will provide data and information on radionuclide transport, that may be used in modeling. The radionuclides currently included in this the study matrix are I-129, Tc-99, Np-237, Pu-239, and Ni-63. The Committee was informed that the radionuclides studied were limited and that Am-241 would be evaluated later. The Committee believes, based on the Risk Insights Baseline Report and discussions with the NRC staff, that Am-241 is of high risk significance and recommends that Am-241 be included in the radionuclide matrix for the current studies. The Committee recommends further that the RES program provide some additional rationale for the selection of radionuclides to study.

May 5, 2004

The ACNW believes that the RES program is responsive to the NRC's needs and is producing quality work with limited resources. Progress continues to be made in developing collaborative arrangements with other Government organizations. It is important for RES to continue to focus its work on issues critical to the NRC's regulatory decisionmaking process and to leverage its limited resources.

RES has completed its external peer review of its nuclear-waste-related programs in response to an ACNW recommendation. The staff is in the process of incorporating changes to accommodate some of these recommendations. The staff is also committed to seeking stakeholder input on prioritization of research needs. The Committee believes that these are positive steps toward setting research priorities and will continue to follow RES work in this area.

Sincerely,

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B. John Garrick  
Chairman



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
ADVISORY COMMITTEE ON NUCLEAR WASTE  
WASHINGTON, D.C. 20555-0001

June 9, 2004

The Honorable Nils J. Diaz  
Chairman  
U.S. Nuclear Regulatory Commission  
Washington, DC 20555-0001

**SUBJECT: DECOMMISSIONING THE WEST VALLEY SITE AND THE APPLICATION OF PERFORMANCE ASSESSMENT TO DEMONSTRATE COMPLIANCE WITH THE LICENSE TERMINATION RULE**

Dear Chairman Diaz:

During its 149<sup>th</sup> meeting April 20–22, 2004, the Advisory Committee on Nuclear Waste met with the NRC staff to discuss plans for the decontamination and decommissioning of the West Valley Demonstration Project (WVDP). Representatives of the U.S. Department of Energy (DOE) and the New York State Energy Research and Development Authority (NYSERDA) participated through a videoconference link. The NRC staff has encouraged the Committee to review the work being done to support the decommissioning process for this complex site, which is likely to employ all of the options outlined in the Commission's License Termination Rule (LTR).

Many factors contribute to the complexity of the West Valley site. Land surrounding the WVDP, which is owned by the State of New York, may be available for unrestricted use, and parts of the site may be appropriate for restricted release with institutional controls to limit exposures. By contrast, the WVDP burial sites, which contain long-lived radioactive materials (including actinides) may require a long-term license. Whether the material in the bottom of the high-level waste tanks can be classified as "waste incidental to reprocessing," and disposed in place remains an open question. Groundwater has been contaminated by a process line that leaked during reprocessing operations, thereby resulting in a <sup>90</sup>Sr plume. Monitoring and treatment of the plume is underway. An airborne release during reprocessing resulted in cesium contamination (extending beyond the property owned by the State of New York). The lagoons used for low-level waste treatment are also contaminated. Low-level waste stabilized in concrete filled drums are stored on site awaiting disposal. The stainless steel canisters containing vitrified high-level waste are stored in the process building and await the opening of a geologic repository.

It is anticipated that the DOE will demonstrate compliance with the LTR using a performance assessment (PA). The PA will also serve as the technical basis for the Decommissioning Plan (DP) and the Environmental Impact Statement (EIS). Producing the PA models and writing the EIS and DP will be an iterative process, among DOE, the State of New York, the NRC staff and other stakeholders. Although details of the PA are still developing, the Committee was informed that DOE intends to mix deterministic, bounding and probabilistic analyses in various parts of the assessment. The Committee believes the Commission and staff should encourage DOE to use a risk-informed approach in the PA to the extent practical.

The staff informed the Committee that it is likely to develop an independent PA model for the West Valley site. The staff's model will be probabilistic in nature and the intent is to use realistic assumptions. We strongly encourage and support such a parallel PA effort by the staff. We wish to be kept informed of the staff's progress in producing an independent PA and we stand ready to assist the staff in this effort.

The Committee intends to meet with representatives of the DOE West Valley staff, NYSERDA, and other stakeholders in the future to obtain their perspectives on the decommissioning plans for the West Valley site. The Committee intends to follow decommissioning activities at WVDP and to periodically report on progress to the Commission.

Sincerely,

A handwritten signature in black ink, appearing to read "B. John Garrick". The signature is stylized and includes a horizontal line extending to the right.

B. John Garrick  
Chairman



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
ADVISORY COMMITTEE ON NUCLEAR WASTE  
WASHINGTON, D.C. 20555-0001

July 6, 2004

Mr. Luis Reyes  
Executive Director for Operations  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555-0001

SUBJECT: CNWRA PROPOSED EXPERIMENTAL PROGRAM ON SPENT NUCLEAR  
FUEL DISSOLUTION

Dear Mr. Reyes:

In its March 4, 2003, letter to the Chairman, the ACNW asked that the Center for Nuclear Waste Regulatory Analyses (CNWRA) justify the use of unirradiated uranium dioxide as a surrogate in studies of spent nuclear fuel dissolution. The EDO's response of April 16, 2004, to the ACNW indicated that such use is adequately justified. The ACNW requires additional information to be satisfied that the use of unirradiated uranium dioxide is justified.

We are continuing to work with the NRC staff to understand the issue and rationale. The CNWRA proposal and experimental protocol may provide adequate justification and the ACNW has requested access to the relevant technical portions of the CNWRA proposal.

Sincerely,

A handwritten signature in black ink, appearing to read "B. John Garrick".

B. John Garrick  
Chairman



UNITED STATES  
**NUCLEAR REGULATORY COMMISSION**  
ADVISORY COMMITTEE ON NUCLEAR WASTE  
WASHINGTON, D.C. 20555-0001

July 30, 2004

The Honorable Nils J. Diaz  
Chairman  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555-0001

**SUBJECT: NUCLEAR REGULATORY COMMISSION'S PACKAGE PERFORMANCE  
STUDY – DEMONSTRATION TEST**

Dear Chairman Diaz:

During the 152<sup>nd</sup> meeting of the Advisory Committee on Nuclear Waste (ACNW), July 20-22, 2004, the Committee met with the NRC staff to discuss the package performance study (PPS) plans for spent fuel rail shipment casks. After hearing the staff's presentation, the ACNW recommends that:

The staff should clarify the results expected from the tests and should specify results that the test is not expected to provide.

The staff provided a brief history of the PPS and an overview of the proposed test, but provided insufficient detail on current test plans for the ACNW to make further recommendations at this time.

The cask to be tested will be representative of those casks now certified by the NRC to ship spent nuclear fuel (SNF) and high level waste (HLW) by rail. The test may consist of a locomotive striking the cask at a high but not unrealistic impact speed, after which the cask will be subjected to a fully engulfing fire. These conditions are believed to be "realistically conservative." The staff plans to use this test as a demonstration of cask integrity.

During the past 30 years demonstrations of shipping cask integrity have been conducted in the United States<sup>1</sup> and in other countries, notably the United Kingdom.<sup>2</sup> The tested casks survived with minimal or no damage. Tests also demonstrated that the impacts experienced by casks struck by vehicles moving at high speeds were less severe than the impact caused by a 30-foot drop onto an unyielding surface. Validated mathematical models have also been used to predict cask performance.

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<sup>1</sup> R.M. Jefferson and, H.R. Yoshimura. "Crash Testing of Nuclear Fuel Shipping Containers. SAND77-1462C. Sandia National Laboratories, Albuquerque, MN, December 1977.

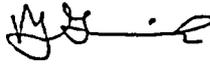
<sup>2</sup> The Institution of Mechanical Engineers (U.K.). "The Resistance to Impact of Spent Magnox Fuel Transport Flasks (Project Smash Hit)." London, England, 1985.

July 30, 2004

The ACNW conducted two working group sessions on transportation. The results including the conclusions, and recommendations of these sessions were reported to the Commission in letters dated January 7 and June 4, 2003. The ACNW concluded that transportation packages for SNF and HLW that meet the regulatory requirements are adequate to protect public health and safety, and that several tests using scale models would be preferable to a single full-scale test for purposes of code validation. The ACNW concluded further that current analysis techniques are adequate to demonstrate that transportation packages meet current regulations.

The ACNW has not seen any compelling science-based justification for the proposed test. In the Committee's opinion the proposed demonstration will add little new information of technical value. If a full-scale demonstration is deemed necessary, it should be justified on grounds other than technical needs.

Sincerely,

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B. John Garrick  
Chairman



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
ADVISORY COMMITTEE ON NUCLEAR WASTE  
WASHINGTON, D.C. 20555-0001

July 30, 2004

The Honorable Nils J. Diaz  
Chairman  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555-0001

SUBJECT: REVIEW THE LTR ANALYSIS - INTENTIONAL MIXING OF CONTAMINATED SOIL

Dear Chairman Diaz:

At its 152<sup>nd</sup> Meeting of July 20 to 22, the Advisory Committee on Nuclear Waste (ACNW) was briefed by staff on the License Termination Rule (LTR) implementation issue related to intentional mixing of contaminated soil. The Committee heard information related to the development of a set of options and the rationale for selecting the option that allows for the continuation of current practices and allows limited (case-by-case) intentional mixing of soil to meet LTR release criteria. The Committee believes that this is an appropriate selection and an improvement toward making the LTR more risk informed.

The detailed guidance that is being developed by staff is the key to success for intentional mixing as part of the LTR. Two licensees have expressed interest in the application of intentional mixing to their licensed activities. These two cases are likely to provide relevant information for the development of detailed guidance. The Committee recommends that staff plan ahead to include information that is likely to develop from these two cases in the guidance under development for wider application of intentional mixing as an option under the LTR.

The Committee recommends that stakeholder meetings be held to gather additional information. These meetings should include licensees planning decommissioning or decontamination projects, entities that provide decommissioning and decontamination services, Agreement State representatives and other stakeholders. Stakeholders should also be invited to provide information, challenges, and experiences that will enhance the development of guidance on intentional mixing.

The Committee believes that the LTR, intentional mixing, and control of disposition of solid materials are interrelated. The Committee recommends that efforts continue to evaluate the relationship among these existing and emerging initiatives so that they are well coordinated and avoid conflicts in guidance to licensees.

Sincerely,

A handwritten signature in black ink, appearing to read "B. John Garrick".

B. John Garrick  
Chairman



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
ADVISORY COMMITTEE ON NUCLEAR WASTE  
WASHINGTON, D.C. 20555-0001

August 3, 2004

The Honorable Nils J. Diaz  
Chairman  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555-0001

**SUBJECT: WORKING GROUP MEETING ON GEOSPHERE TRANSPORT AT YUCCA MOUNTAIN**

Dear Chairman Diaz:

During the 151st meeting of the Advisory Committee on Nuclear Waste on June 22-24, 2004, the Committee held a Working Group Meeting (WGM) on Geosphere Transport. The Committee organized this meeting to review the expected behavior of radionuclides in the tuffs and valley-fill alluvium proximal to and south of Yucca Mountain. The WGM included a panel of four distinguished scientists from academia, research institutions, and the private sector renowned in the fields of the fate and transport of radioactive materials in geological media.<sup>1</sup> The Department of Energy (DOE), the Nuclear Regulatory Commission (NRC) staff, and representatives of Nye County, Nevada, and the Electric Power Research Institute made presentations.

The purpose of the meeting was to examine whether the results of experiments, conceptual models, mathematical implementations, and site data provide confidence that the geosphere is an effective barrier for retarding the movement of radionuclides from a potential repository at Yucca Mountain. In particular, the goals of the meeting were to review what is known about saturated zone pathways from Yucca Mountain to the compliance boundary in Amargosa Valley, and review the state of knowledge of radionuclide sorption in tuffs and alluvium down-gradient from Yucca Mountain.

Presentations made at the WGM confirmed the ACNW's view that NRC staff has done an excellent job of developing an approach to parsing and analyzing performance assessments for Yucca Mountain. This exposes how various flow and transport processes and behavior of specific radionuclides sharpened the staff's risk insights. The staff developed its approach using geosphere transport as the illustrative case. The ACNW believes that the general approach will help staff to focus their reviews and will also be invaluable in communicating results to all stakeholders.

The Committee recommends that the staff continue working to make performance assessment results transparent. We further recommend that the staff expand its approach to include the engineered barrier systems.

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<sup>1</sup>James Davis, US Geological Survey, Richard Parizek, Pennsylvania State University, Don Shettel, Geosciences Management Institute, and Ines Triay, US Department of Energy.

## Observations From the WGM

The risk insights from analyses by NRC staff provide a framework for understanding the context of the discussions at the WGM.

1. The radionuclides  $^{241}\text{Am}$  and  $^{240}\text{Pu}$  constitute approximately 80% of the radioactivity (curies) in the proposed repository 1000 years postclosure, but their immobility keeps them in or near a repository for more than 10,000 years. They would therefore contribute little to estimated receptor dose.
2. The radionuclides  $^{99}\text{Tc}$  and  $^{129}\text{I}$  are mobile and make up a very small fraction of the waste inventory. Current analyses suggest that these radionuclides would move with water once a waste package is breached, reaching the compliance boundary after hundreds to thousands of years. The relatively small inventory and dilution in the aquifer make the estimated doses small.
3. There are significant uncertainties in the behavior of  $^{237}\text{Np}$ . The uncertainty in the retardation factor for  $^{237}\text{Np}$  in alluvium ranges over three orders of magnitude. The degree to which  $^{237}\text{Np}$  is retarded by alluvium can have a major effect on calculated doses.

Flow path length, dilution, and sorption all contribute to the ability of the geosphere to serve as a barrier to radionuclide transport. Presentations and discussions at the WGM highlighted uncertainties in current understanding of those processes.

DOE, NRC, and EPRI all have modeled ground water flow and radionuclide transport to support their performance assessments. Different conceptualizations of the geologic environment, including major faults and fractures, the block sizes that influence matrix diffusion, and recharge fluxes result in similar projected flow paths and travel times. The overall conclusion is that ground water flow is to the east-southeast toward Fortymile Wash and then to the south.

Although the performance assessments for Yucca Mountain all indicate that the geosphere is an effective barrier to the transport of radionuclides, additional information on the geosphere as an effective barrier would enhance confidence in those analyses. A recent letter dated May 3, 2004, from R. Parizek (US NWTRB) to M. Chu (US DOE) regarding comments from the Nuclear Waste Technical Review Board Panel on the Natural System, Las Vegas, Nevada, March 9-10, 2004, makes a similar point.

A DOE representative identified ground water flow rates, matrix diffusion in fractured tuff, and sorption coefficients for the key radionuclides as areas where additional information might reduce uncertainties. NRC risk insights analysis suggests that additional information on flow path length in the alluvium would be helpful.

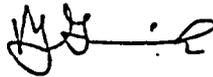
The portion of the groundwater flow path, from Yucca Mountain to the compliance boundary, that traverses the alluvium is a critical element in performance assessment models. Field information to constrain possibilities could be very useful in reducing modeling uncertainties. The work being done by Nye County to study ground water in the alluvium is producing the best available hydrogeological information in Amargosa Valley. Several comments were made at the WGM that large-scale field tests to determine how major faults may act as either conduits or barriers to flow would be beneficial. Work to reduce uncertainties in regional groundwater flux and matrix diffusion was also viewed as potentially useful in strengthening the evidence base.

August 3, 2004

The keynote presentation raised interesting questions relative to sorption of  $^{237}\text{Np}$  at Yucca Mountain. Studies of uranium migration at a mill tailings site indicated that sorption depended much more on water chemistry than on geologic materials properties. Because factors that control sorption of neptunium are similar to those that control sorption of uranium, better characterization of the water chemistry in the alluvium at Yucca Mountain may help build confidence about sorption coefficients used in performance assessments.

Based on our past reviews and the results of the WGM, the ACNW concludes that there is strong evidence that the geosphere will provide significant barriers to the migration of radionuclides from a proposed repository at Yucca Mountain.

Sincerely,

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B. John Garrick  
Chairman



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
ADVISORY COMMITTEE ON NUCLEAR WASTE  
WASHINGTON, D.C. 20555-0001

August 4, 2004

The Honorable Nils J. Diaz  
Chairman  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555-0001

SUBJECT: RESEARCH ON MODEL UNCERTAINTY

Dear Chairman Diaz:

The Advisory Committee on Nuclear Waste (ACNW) has been briefed periodically on work supported by NRC's Office of Nuclear Regulatory Research (RES) on the treatment of uncertainties in hydrogeological models. At its 150th meeting in May 2004, the ACNW was briefed on recent results from this research program.

Performance assessments typically evaluate the uncertainty associated with the parameters of one or more conceptual models. Parameter uncertainties are evaluated by probabilistic methods, sensitivity studies, and bounding analyses. The main question addressed in the May briefing was how the NRC might include conceptual model uncertainty in their analyses, i.e., *how competing conceptual models for a hydrogeological system may be included in an analysis.*

The research team sponsored by RES developed a method referred to as "Maximum Likelihood Bayesian Model Averaging" (MLBMA) to deal with the problem of incorporating model uncertainty into assessments. Part of the briefing package was a very recent paper published in *Water Resources Research*. The methodology is rigorous, elegant, and (necessarily) not simple to apply. The ACNW judges the research to be of very high quality.

A question that arises is how NRC staff in its regulatory role may actually apply such cutting edge research. Following the ACNW briefing, the research team held a training course for the NRC staff to outline the MLBMA and its application. The staff reported to the Committee that this training went well. Although the rigorous details of the MLBMA may prevent its use by NRC staff in all but very selected instances, the staff believes that the insights derived from such work are important in themselves for dealing with the difficult problem of treating model uncertainty.

The ACNW agrees with the staff assessment that the research on the MLBMA is important and has been of great value. It is essential that NRC staff have discussions with researchers who are at the frontiers of the field so they can formulate their approach to vexed problems important to regulatory assessment using the best information available. RES is to be commended for maintaining a part of their research portfolio to recognize excellent research that may not be applied until sometime in the future when it becomes more "routine" and yet has definite indirect benefits in the present.

Sincerely,

A handwritten signature in black ink, appearing to read "B. John Garrick".

B. John Garrick  
Chairman

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