COMMISSION BRIEFING SLIDES/EXHIBITS

MEETING WITH ACNW

OCTOBER 23, 2003

What are the nine key technical issues?

1) **Unsaturated and Saturated Zone Flow Under Isothermal Conditions** – How does water move above and below a potential repository at Yucca Mountain?

2) **Thermal Effects on Flow** – How does temperature affect the timing and mechanisms whereby water reaches the waste containers?

3) **Container Life and Source Term** – How long do we expect the containers and waste forms to last and what will happen to the waste as the containers and waste forms degrade over time?

4) **Evolution of the Near Field Environment** – How do water and heat affect the chemical environment of the containers, waste forms and the immediate area around the repository?

5) **Radionuclide Transport** – How do radionuclides released from degraded waste move away from the repository?

6) **Repository Design and Thermal Mechanical Effects** – How do engineering design, construction, and operation of a repository affect short- and long-term repository safety?

7) **Structural Deformation and Seismicity** – How do the physical characteristics of the rock in the repository and the likelihood of earthquakes affect repository safety?

8) **Igneous Activity** – How likely is it that volcanic eruptions or intrusion will disrupt the repository and what would be the potential consequences to people and the environment?

9) **Total System Performance Assessment and Integration** – How can we best describe how well the entire system of engineered and natural barriers will work together to retain waste, so we can decide whether DOE's proposed repository at Yucca Mountain will comply with safety and environmental standards?

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

October 15, 2003

MEMORANDUM TO: Annette L. Vietti-Cook
Secretary of the Commission

FROM: John T. Larkins, Executive Director
Advisory Committee on Reactor Safeguards

SUBJECT: ADVISORY COMMITTEE ON NUCLEAR WASTE MEETING WITH THE U. S. NUCLEAR REGULATORY COMMISSION, OCTOBER 23, 2003 -- SCHEDULE AND BACKGROUND INFORMATION

The ACNW is scheduled to meet with the NRC Commissioners between 10:00 a.m. and 12:00 noon on October 23, 2003, to discuss the items listed below. Background materials related to these items are enclosed.

	ESTIMATED TIME
INTRODUCTION - NRC Chairman, Nils J. Diaz	5 minutes
ACNW PRESENTATIONS	
1. ACNW Chairman's Report - B. John Garrick • ACNW Priorities and Future Review Plans • Working Groups (Past and Future) • Public Outreach • ACNW Role in Yucca Mountain License Application	10 minutes
2. Key Technical Issue Status and Pathway to Closure - B. John Garrick	20 minutes
3. High-Level Waste Risk-Insights - Ruth F. Weiner	15 minutes
4. Total System Performance Assessment for Yucca Mountain - George M. Hornberger	15 minutes
5. Performance Confirmation for Yucca Mountain - Michael T. Ryan	5 minutes
CLOSING REMARKS - NRC Chairman, Nils J. Diaz	5 minutes

*NOTE: Estimated times are for presentation only and do not include the time set aside for Commission questions and answers.

1

ACNW MEETING WITH THE COMMISSION

B. John Garrick

October 23, 2003

PRIORITIES

First Tier

- Risk-informing the high-level waste licensing process
- Resolution of Key Technical Issues (KTIs)
- Performance Confirmation (PC)
- Transportation of radioactive waste

PRIORITIES (cont.)

Second Tier

- Decommissioning
- Research
- Low-Level Radioactive Waste
- Proposed Private Fuel Storage Facility

WORKING GROUPS

- **Objectives**
  - **Provide in-depth technical focus**
  - **Understand NRC staff expectations**
  - **Review work in progress**

- **Recent Working Group Sessions**
  - **Transportation: 11/02, 4/03**
  - **TSPA/TPA: 3/03**
  - **Performance Confirmation: 7/03**

WORKING GROUPS (cont.)

- **Future Working Group Sessions**
  - **Biosphere: 2/04**
  - **Igneous Activity: Spring 2004**
  - **Geosphere Transport: Fall 2004**

PUBLIC OUTREACH

- **Meet with Stakeholders when in Nevada**
- **Invite Stakeholders (public and technical) to participate in Working Groups**
- **Interact with other organizations (National Academies, NWTRB, International Organizations)**

YUCCA MOUNTAIN PRE-LICENSING

ACNW will:

- **Continue independent oversight**
- **Identify potential technical and safety concerns**
- **Rely on risk-informed, performance-based insights**
- **Need access to information**

YUCCA MOUNTAIN LICENSING

ACNW will

- **Focus on risk-significant issues important to repository performance**
- **Review selected parts of LA and SER**
- **Review issues referred by Commission**

ACNW LETTERS

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

June 23, 2003

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

SUBJECT: FISCAL YEARS 2003 AND 2004 ACTION PLAN FOR THE ADVISORY COMMITTEE ON NUCLEAR WASTE

Dear Chairman Diaz:

The Advisory Committee on Nuclear Waste (ACNW) has updated its Action Plan (hereafter the Plan) to reflect new and continuing priorities for fiscal years (FYs) 2003 and 2004. The Committee will continue to update the Plan at least every 2 years. The Plan identifies our mission, vision, desired outcomes, commitments, goals, objectives, and priority topics. The Plan supports the Nuclear Regulatory Commission's (NRC's) Strategic Plan for FY 2002–FY 2005 (NUREG-1614, Vol. 2). The Plan is also consistent with the ACNW's charter and the Memorandum of Understanding between the ACNW and NRC's Executive Director for Operations, dated March 23, 2001.

The primary purpose of the Plan is to guide the Committee in carrying out its mission. In addition to the priority topics identified in the Plan, the ACNW has identified operational process improvements that it will implement this year to improve its efficiency and effectiveness. The ACNW will track the progress and outcomes of these process improvements in a separate, internal planning document.

The Committee has identified five first-tier priority topics and four second-tier priority topics for FY 2003 and FY 2004:

First-Tier Topics:

1. Risk-Informing the High-Level Waste Licensing Process
2. Resolution of Key Technical Issues
3. Performance Confirmation
4. Transportation of Radioactive Waste
5. Safeguards and Security

Second-Tier Topics:

1. Decommissioning Options
2. Research
3. Proposed Private Fuel Storage Facility
4. Low-Level Radioactive Waste

The Committee plans to address its first-tier priority topics over the next few years, and the second-tier priority topics as time and resources permit, unless otherwise directed by the Commission. One new topic has been added to the Plan – Safeguards and Security. This topic has been added to reflect increased staff activity in this area since the events of September 11, 2001. All of the topics identified in last year's Plan are still included in this revision.

In addition to reviewing issues identified under these nine priority topics, the ACNW will continue to participate in activities of the Joint ACNW and Advisory Committee on Reactor Safeguards Subcommittee. The priority topics are described in more detail in the enclosed Plan.

Sincerely,

George M. Hornberger

George M. Hornberger
Chairman

Attachment:
FY 2003-04 Action Plan for ACNW

FISCAL YEARS 2003 AND 2004 ACTION PLAN
ADVISORY COMMITTEE ON NUCLEAR WASTE

PURPOSE OF PLAN

This Action Plan (Plan) provides strategic direction and guidance for fiscal years (FYs) 2003 and 2004 to the Advisory Committee on Nuclear Waste (ACNW) for addressing the issues that are most important to the Nuclear Regulatory Commission (NRC) in carrying out its mission to protect public health and safety, promote the common defense and security, and protect the environment. The Plan defines the ACNW's mission, vision, desired outcomes, commitments, goals, objectives, and priority topics selected for review. For each goal, the Plan indicates the relationship between the goal and the strategic arenas and management strategies in the NRC's FY 2000–FY 2005 Strategic Plan (NUREG-1614, Vol. 2).

This Plan also provides the Commission, NRC staff, and other interested stakeholders with information about the priority topics on which the ACNW intends to focus its reviews. The Committee selected the first- and second-tier priority topics in a top-down manner designed to support our mission, vision, goals, and objectives. The priority topics consist of self-initiated topics requested by the Commission, as well as those requested by the NRC staff and other stakeholders.

SCOPE OF ACNW ACTIVITIES

The Committee reports to and advises the Commission on technical matters related to nuclear materials and waste management. The bases of ACNW reviews include Title 10, Parts 20, 40, 50, 60, 61, 63, 70, 71, and 72 of the *Code of Federal Regulations* (CFR), as well as other applicable regulations and legislative mandates. The ACNW will undertake studies and activities related to the transportation, storage, and disposal of high-level and low-level radioactive waste (HLW and LLW, respectively), including the interim storage of spent nuclear fuel; materials safety; decommissioning; application of risk-informed and performance-based (RIPB) regulations; and evaluation of licensing documents, rules, regulatory guidance, and other issues, as requested by the Commission. To fulfill its responsibilities, the Committee will interact with representatives of the public, the NRC, the Advisory Committee on Reactor Safeguards (ACRS), other Federal agencies, State and local agencies, Indian Nations, and private, international, and other affected organizations, as appropriate.

RISK-INFORMED, PERFORMANCE-BASED APPROACH

The Committee believes that it best serves the Commission by taking an RIPB approach to ACNW activities. The Committee will accomplish this goal, in part, by supporting the Commission in applying the principles in the NRC's probabilistic risk assessment (PRA) policy statement, dated August 10, 1995 (60 FR 42622), to waste and materials regulations. For example, in its reviews, the ACNW will encourage use of PRA principles and associated analyses (sensitivity studies, uncertainty analyses, and importance measures) to reduce unnecessary conservatism associated with the NRC's regulatory framework. The ACNW will also encourage realism, transparency, and consistency in risk and performance assessments, including the identification of uncertainty in these assessments.

In addition to supporting the PRA policy statement, the Committee will encourage implementation of a flexible overall RIPB regulatory framework for the NRC's materials and waste related regulations. An RIPB approach should reduce rigid interpretation and prescriptive approaches in the application of regulations. An RIPB framework should facilitate the use of more defensible and transparent regulation and will improve confidence in regulatory decisions. In this way, the NRC can develop more efficient regulations that have an obvious link to safety and encourage a more effective allocation of NRC and licensee resources.

ACNW MISSION

The ACNW's mission is to provide the Commission with independent and timely technical advice on nuclear materials and waste management issues to support the NRC in conducting an efficient and effective regulatory program that enables the Nation to use nuclear materials in a safe manner for civilian purposes.

ACNW VISION, DESIRED OUTCOMES, AND COMMITMENTS

The ACNW has identified a vision statement and desired outcomes to guide the Committee's implementation of its mission and commitments that will guide the Committee toward these outcomes.

Vision

The ACNW's advice and recommended solutions are forward-looking, are based upon the best available science and technology, can be implemented, and reflect the need to balance risk, benefit, and cost to society to enable the safe use of nuclear materials.

Desired Outcomes

1. ACNW advice reflects the need for safety and the need to balance risk, cost, and benefit in all of the NRC's decisions.

2. ACNW advice is clear, concise, and easily understood.

3. ACNW provides an effective forum for the public to participate in the regulatory process, increases public confidence in the regulatory process, and ensures that communication paths with the public remain open and effective.

4. ACNW advice is provided in ample time for consideration by the Commission in making regulatory decisions.

5. ACNW advice reflects sound technical judgment and influences the NRC's regulations and guidance.

6. ACNW advice alerts the Commission to emerging and potentially challenging issues.

7. ACNW advice reflects consideration and awareness of relevant waste and materials issues that cut across other Federal agencies, institutions, and industry.

8. ACNW advice is valued by the Commission, the NRC staff, the public, and other stakeholders.

Commitments

To achieve its desired outcomes, goals, and objectives, the Committee makes the following commitments:

1. Make safety its highest priority.

2. Be responsive to the Commission's needs and requests.

3. Maintain technical excellence, independence, and credibility.

4. Adopt the NRC's plain language initiative.

5. Regard the public as its ultimate stakeholder and seek better ways to obtain meaningful public involvement.

6. Implement a risk-informed philosophy by asking: What is the risk? What are the important contributors to risk? What are the uncertainties associated with the risk?

7. Strive to examine issues and offer advice while regulatory solutions are still being formulated.

8. Foster an atmosphere of mutual problem solving with the NRC staff.

9. Remain flexible, anticipate change, and evaluate options and contingencies.

10. Keep informed of external trends and events that may adversely impact the NRC.

11. Keep abreast of international trends and developments that could affect the NRC's regulatory practices or approaches and apply the experience when practicable.

12. Identify relevant waste and materials issues that cut across the NRC and other Federal agencies, institutions, and industry.

13. Abide by the Committee's Action Plan to foster the efficiency and effectiveness of Committee activities and products.

GOALS AND OBJECTIVES

The ACNW has developed general goals and objectives consistent with its mission and vision. The following five goals provide strategic direction for the ACNW over the next 2 years and support selected goals and strategic arenas identified in the NRC's Strategic Plan. Each goal is followed by objectives to help the Committee better select and focus its priority issues.

Goal 1: **Assist the NRC in positioning itself to respond to external change in its regulation of the management of nuclear waste and materials.** (This goal supports the NRC's Nuclear Waste Safety and Nuclear Materials Safety strategic arenas and NRC's strategic goal and primary performance goal to maintain safety, protect the environment, and ensure the common defense and security.)

Objective 1: *Advise the Commission in a timely fashion on technical developments that may require changes in the NRC's regulations, policies, and practices.*

Objective 2: *Inform the Commission of issues that the NRC needs to address and recommend solutions.*

Goal 2: **Support the NRC in employing the best science in resolving key safety issues.** (This goal supports the NRC's Nuclear Waste Safety and Nuclear Materials Safety strategic arenas and the specific performance goal to make NRC activities and decisions more effective, efficient, and realistic.)

Objective 1: *Keep informed of methods and technologies being developed and used worldwide that are applicable for assessing and managing risks associated with the cleanup, disposal, and storage of nuclear waste.*

Objective 2: *Advise the Commission on enhancements to the NRC staff's technical capabilities that are needed to address current and expected Commission needs.*

Objective 3: *Advise the Commission and the NRC staff on ways to use risk-informed and performance-based approaches to develop an efficient and effective regulatory framework.*

Goal 3: **Advise the NRC on how to increase its reliance on risk as a basis for decisionmaking, including methods that (1) implement a risk-informed approach, (2) quantify and reveal uncertainties, and (3) are consistent across programs.** (This goal supports the NRC's Nuclear Waste Safety and Nuclear Materials Safety strategic arenas and the specific performance goal to reduce unnecessary regulatory burden on stakeholders.)

Objective 1: *Encourage the NRC staff in seeking and proposing approaches to gain a better understanding of the inherent risks of activities within NRC's regulatory*

responsibilities, as well as the relationship between regulations, cost, and safety.

Objective 2: *Propose approaches that provide a better understanding of the inherent risks associated with nuclear power and the relationship between safety, regulations, and cost, and advise the Commission on the proposals.*

Objective 3: *Provide technically sound and realistic approaches for resolving new and emerging issues, and identify ways to utilize risk-informed and performance-based approaches related to the safe use of nuclear materials for civilian purposes.*

Goal 4: **Support the NRC in improving public involvement and understanding in its waste and materials programs and in gaining increased public confidence and respect.** (This goal supports the NRC's Nuclear Waste Safety and Nuclear Materials Safety strategic arenas and the specific performance goal to increase public confidence.)

Objective 1: *Provide opportunities through the Federal Advisory Committee Act process for more meaningful public involvement in the regulatory process.*

Objective 2: *Recommend ways for the NRC to achieve more meaningful public involvement in the regulatory process, taking into consideration lessons learned from international experience.*

Objective 3: *Assist the NRC in making the agency's decisionmaking process more transparent and ensuring that agency documentation is readily understandable and addresses the relevant issues.*

Goal 5: **Support the effectiveness and efficiency of NRC operations.** (This goal supports the NRC's corporate management strategies to employ innovative and sound business practices.)

Objective 1: *Select and evaluate feedback from stakeholders on ACNW operations.*

Objective 2: *Evaluate and modify existing ACNW operational procedures as appropriate to accomplish "more with less."*

PRIORITY TOPICS AND PROCESS IMPROVEMENTS

In support of its first four goals, the ACNW has identified its highest priority topics through FY 2004, and other important topics that it plans to address as time and resources permit. The highest priority topics are identified as first-tier priorities, while other important topics are identified as second-tier priorities. The Committee plans to place most of its emphasis on reviewing issues under the first-tier topics, unless otherwise directed by the Commission. The ACNW will address to a lesser extent or stay informed of issues under the second-tier topics,

but is not likely to carry out a concentrated effort on any of these topics. The Committee has taken care to ensure that each priority topic supports one or more of the ACNW's goals.

The Committee has also defined the criteria it uses to select its priority topics. In support of its fifth goal to support the effectiveness and efficiency of NRC operations, the ACNW has identified the improvements in operational processes it will carry out this year and next. The Committee will track its progress toward these process improvements in a separate internal planning document, and will periodically evaluate their impact.

For each priority topic addressed, the Committee plans to prepare a task action plan that will identify the nature and scope of the issue and a strategy for addressing it. These task action plans will include a schedule, purpose, scope, planned products, and performance measures to evaluate the Committee's effectiveness.

Identified below are the criteria for selecting priority topics, followed by a brief background discussion of the selected topics.

Criteria for Selecting Priority Topics

The Committee uses the following criteria to select priority topics:

- the likelihood that a topic, if not properly addressed, will result in significant adverse impact on the environment, significant risk to the health and safety of the public, or unnecessary economic costs

- topics for which the Commission or the Executive Director for Operations requests ACNW review

- topics for which the ACNW can provide a unique input that will add significant value to the resolution of the issue

- the relevance of the topic in the NRC's near-term regulatory agenda and the need for timely ACNW review

- the level of interest shown by NRC's external stakeholders in a topic and the degree to which ACNW engagement of the topic will have a positive impact on stakeholder confidence

Background Information on Priority Topics

On February 15, 2002, President Bush submitted a recommendation to Congress that Yucca Mountain, Nevada, be developed as the Nation's first geologic repository for the disposal of spent nuclear fuel (SNF) and other HLW. On April 8, 2002, the Governor of Nevada filed a notice of disapproval of the proposed Yucca Mountain project. Congress subsequently passed a joint resolution that allowed work to continue on the proposed repository. The U.S. Department of Energy (DOE) now plans to submit a license application to the NRC for approval to construct a geologic repository at Yucca Mountain. Current DOE planning assumptions suggest a potential DOE license application sometime in 2004. Any potential

DOE license application for construction at Yucca Mountain would be reviewed in accordance with the NRC's risk-informed, site-specific regulations for HLW disposal in 10 CFR Part 63.

The NRC has conducted extensive prelicensing interactions with DOE concerning the proposed Yucca Mountain repository. As part of these prelicensing activities, the NRC engaged the DOE in a prelicensing issue resolution process, identifying key technical issues (KTIs) and subissues. By the end of 2001, the NRC and DOE reached a closed-pending status on all KTI subissues, pending receipt and acceptance of information to be provided by DOE on some 293 agreements. Until DOE submits its license application, the NRC staff will continue to collect and evaluate information provided by the Department, and hold technical exchange meetings to close, KTIs at the staff level, prior to licensing. Plans for performance confirmation testing and long-term monitoring will become increasingly more important as the program moves toward a potential licensing decision. Some KTIs may remain open or closed-pending even into the performance confirmation period pending completion of long-term tests and analyses. Consistent with its advisory role, the ACNW expects to provide the Commission with its independent advice concerning the adequacy of the DOE license application.

Transportation of SNF has gained increased national attention since the President's recent Yucca Mountain site recommendation to Congress. A public discussion of the risks associated with the transportation of SNF and HLW and the roles and responsibilities of the various involved entities is needed to improve stakeholders' understanding of and confidence in this activity. Transportation of SNF is also one of the public concerns related to independent spent fuel storage. In 2002, NRC adjudicatory hearings were held concerning a license application from Private Fuel Storage (PFS, a consortium of utilities) to operate an independent spent fuel storage installation on the reservation of the Skull Valley Band of Goshute Indians in Utah. In 2003, the Atomic Safety Licensing Board (ASLB) issued its first decision concerning the PFS License application.

The events of September 11, 2001, have resulted in a reevaluation of the Nation's preparedness for possible terrorists attacks directed at infrastructures, including nuclear licensed facilities and radioactive waste transportation systems. The ACNW will be prepared to advise the Commission on safeguards- and security-related issues in these areas, as needed.

Safe and efficient decommissioning of nuclear reactors and nuclear materials facilities continues to be a critical function of the NRC's mission, and a concern to the public, industry, and other stakeholders. Complex technical and policy issues remain unresolved. Such issues include those associated with the release of property under restricted conditions, such as long-term institutional controls, the proposed rulemaking on entombment options for nuclear power reactors, control of the release of solid materials, and orphan and sealed sources. Because decommissioning waste must be disposed of in LLW disposal facilities, the failure of the Low-Level Waste Policy and Amendments Act of 1985 to bring about the construction of new LLW disposal facilities is also a concern. In addition, the availability of existing LLW sites may become limited in the near future.

First-Tier Priority Topics

Risk-Informing the HLW Licensing Process

Part 63 reflects the NRC's effort to implement an RIPB regulatory framework that relies primarily on the use of iterative performance assessment techniques to simulate the future behavior of the engineered and natural components of a geologic repository at Yucca Mountain. Previously, the ACNW reviewed and commented on the Yucca Mountain Review Plan (YMRP, NUREG-1804), which would be used to review any potential DOE license application. The Committee intends to examine how the NRC staff uses risk insights from sensitivity analyses and other performance assessment investigations to resolve technical issues, consistent with the risk-informed focus of the YMRP. In a follow up to its vertical slice review of DOE's total system performance assessment site recommendation (TSPA-SR), the Committee plans to continue to evaluate DOE's TSPAs and supporting documents. The Committee also plans to continue tracking progress in the NRC's performance assessment capability, including evaluating developments concerning NRC's performance assessment (TPA) computer code. In FY 2003, the ACNW held a working group meeting to evaluate differences between DOE and NRC performance assessment assumptions and results, including the extent to which the respective performance assessment activities have been subject to independent scientific validation. In anticipation of providing the Commission with its independent advice during the staff review of DOE's license application, the Committee intends to convene additional working groups in other priority areas viewed to be risk significant to repository performance in FY 2004.

Resolution of Key Technical Issues

The ACNW has closely tracked the KTI resolution process since its inception. In 2001, the ACNW conducted a vertical slice review of several KTIs and subissues to evaluate the NRC's issue resolution process and sufficiency review. The Committee's emphasis was on evaluating whether the issue resolution process was risk-informed, including whether the NRC staff was developing and using risk insights to inform its prelicensing agreements with DOE. As part of its continued evaluation of the KTI resolution process, the ACNW may extend its vertical slice review concept to examine selected subissues considered risk significant, and continue to examine development and use of risk insights. In addition, the ACNW plans to closely follow the progress of the 293 issue resolution agreements, and review and comment on any future updates to the draft Integrated Issue Resolution Status Report (NUREG-1762).

Performance Confirmation

The ACNW plans to hold a working group meeting in FY 2003 to review the staff's plans for evaluating DOE's proposed performance confirmation program for Yucca Mountain. The Committee expects to review the approach used to define those tests, experiments, and analyses that may be proposed in DOE's performance confirmation program, or those suggested by the NRC. The Committee may also evaluate proposed plans for long-term post-closure monitoring for Yucca Mountain as well as the techniques for testing and monitoring that could be useful for other prospective waste sites.

Transportation of Radioactive Waste

The Committee held a working group meeting in FY 2003 to examine past and ongoing risk studies on SNF transportation safety. Participants included NRC staff, and representatives from the Department of Transportation, DOE national laboratories involved in testing spent fuel transportation systems, international organizations, state and local governments, and interested stakeholders. In addition, the Committee commented on the NRC staff's proposed Package Performance Study Test Protocols for waste package transportation (draft NUREG-1768). The Committee will continue to follow developments in the draft NUREG, and possibly review transportation risk studies as documented in updates to the final environmental impact statement for Yucca Mountain.

Safeguards and Security

As needed in FY 2003 and FY 2004, the ACNW will advise the Commission on safeguards and security issues related to the management and transportation of radioactive waste. The areas the ACNW will consider reviewing include risk-informed vulnerability analysis and decisionmaking methodology, consequence analyses, pilot plant studies, recovery, and emergency planning.

Second-Tier Priority Topics

Decommissioning Options

This year, the Committee plans to evaluate developments in controlling the release of solid materials. The Committee also plans to explore developments in alternatives to restricted release criteria and use of institutional controls. The ACNW will continue to follow the development of decommissioning guidance, including the use of RIPB in decommissioning applications. Other issues may include the disposal of greater-than-Class C wastes, including orphan and sealed sources; the decommissioning of the West Valley, New York, Demonstration Project; and the application of the License Termination Plan to a complex decommissioning site.

Research

The ACNW will continue to report once a year to the Commission on NRC's waste-related research and technical assistance programs. Specifically, the Committee will continue to examine the research performed by the NRC's Office of Nuclear Regulatory Research that is associated with nuclear waste safety and the technical assistance work performed by the Center for Nuclear Waste Regulatory Analyses. The ACNW will continue to monitor the integration of research and technical assistance programs. The Committee may consider elements of an appropriate anticipatory research program and lessons learned from past anticipatory research that can be applied to planning future research programs.

Proposed Private Fuel Storage Facility

In June 1997, PFS submitted a license application to the NRC to operate an away-from-reactor independent spent fuel storage installation on the reservation of the Skull Valley Band of

Goshute Indians. After reviewing the license application, the NRC staff issued its safety evaluation report in September 2000, and adjudicatory hearings were completed in 2002. In 2003, the ASLB issued its first decision concerning the PFS license application. The ACNW will continue to stay informed of the technical issues associated with the licensing of this facility and with its proposed operation and will provide such reviews as appropriate.

Low-Level Radioactive Waste

The ACNW will keep informed of any new developments related to LLW issues. Issues of interest include the growing concern that LLW disposal capacity may be decreasing, assured isolation, management of mixed waste (waste with both hazardous and radioactive components), and possibly management of LLW or intermediate-level waste in other countries.

JOINT ACRS/ACNW SUBCOMMITTEE ACTIVITIES

The Commission authorized the establishment of the joint subcommittee in response to a request for ACRS/ACNW assistance on activities associated with risk-informing regulations developed by the NRC's Office of Nuclear Materials Safety and Safeguards (NMSS). The scope of the joint subcommittee's work now includes some activities that are within the purview of both Committees, so as to provide more effective and efficient reviews utilizing the expertise of both committees. The joint subcommittee plans to continue its review of risk-informing NMSS activities, proposed PRA for spent fuel dry cask storage, proposed safety goals for NMSS activities, decommissioning issues that overlap both ACNW and ACRS assignments, and other technical issues that would benefit from a review by the joint subcommittee. One such activity is the review of the Integrated Safety Assessment for the Mixed Oxide Fuel Fabrication Facility.

MEASURES OF SUCCESS

The Committee will assess the extent to which the goals and objectives in this Plan have been met and report the results in the annual ACNW operating plan. The Committee has established performance metrics to measure its overall effectiveness. The performance metrics include the ACNW's effectiveness, efficiency, quality, timeliness, and success in contributing to the RIPB regulatory process. As part of its annual self-assessment, the Committee will solicit stakeholder feedback as one of the sources of information for evaluating the ACNW's effectiveness.

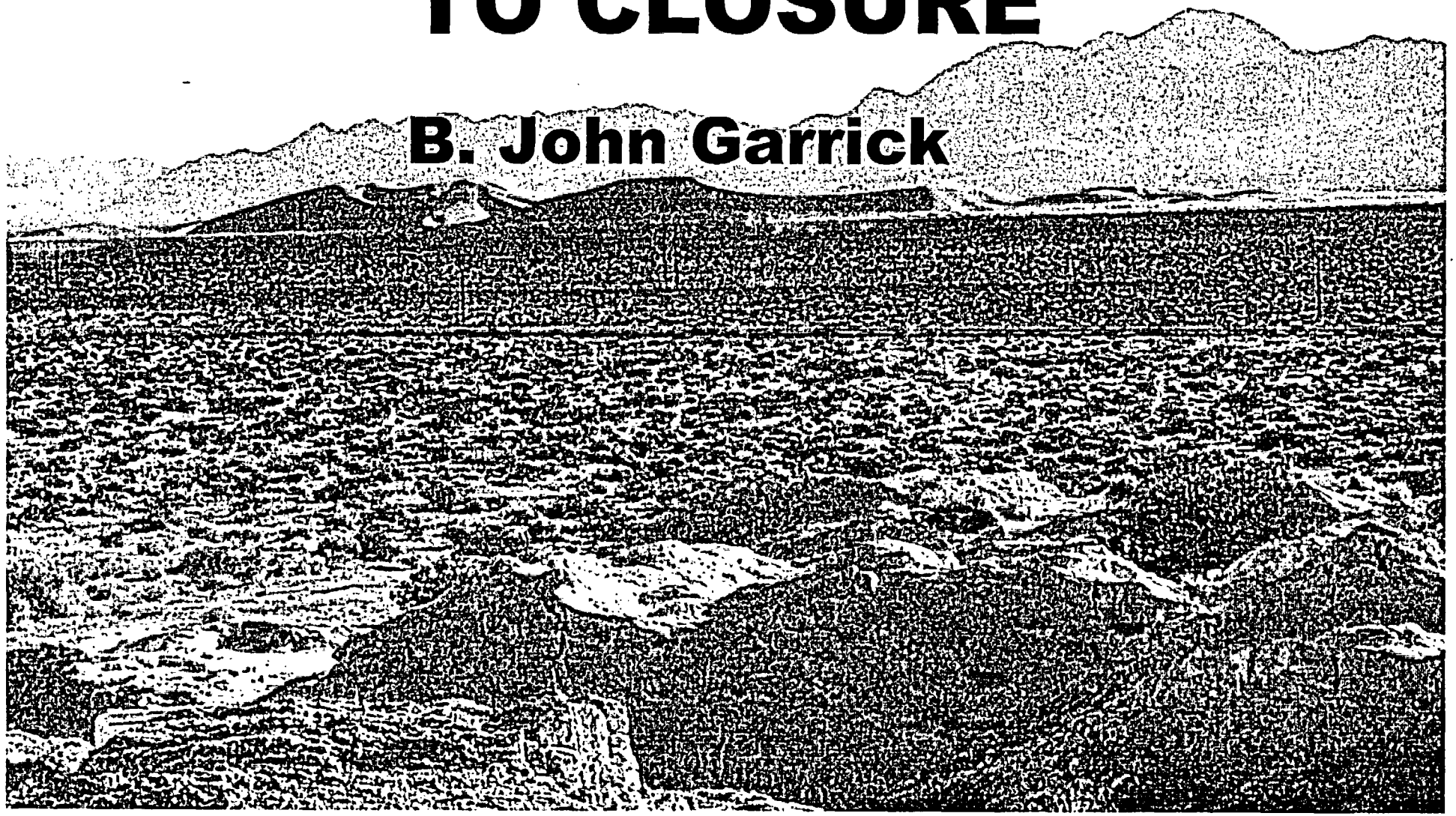
UPDATING THE PLAN

The ACNW will continue to conduct top-down planning on an annual basis to identify goals and priority issues for the coming year. Revisions to the Plan will reflect input from the Commission, changes in legislation, changes to the NRC Strategic Plan, the results of customer surveys and self-assessments, external events, and available resources. As part of its efficiency and effectiveness goal, the ACNW will track, in a separate planning document, outcomes of its operational process improvements, special projects, ideas for working group

meetings, possible follow up action to past ACNW letters, and items that the Committee considers important but cannot pursue this year due to time or resource limitations.

KEY TECHNICAL ISSUE STATUS AND PATHWAY TO CLOSURE

B. John Garrick



ACNW RECOMMENDATIONS

- Develop evidence-based models
- Identify and rank key contributors to risk
- Quantify sources of uncertainty
- Use simplified models

KTI STATUS

- **Staff Identified information gaps for all 9 KTIs**
- **NRC/DOE reached agreements on 293 additional information needs**
- **Providing requested information should result in a complete LA**

KTI STATUS (cont.)

- Some KTI Agreements more important than others
- Risk Insights can help rank and resolve agreements

KTI STATUS (cont.)

- Staff ranked 293 agreements
  - 41 high-risk significance
  - 92 medium-risk significance
  - 160 low-risk significance

*KTI STATUS (cont.)

Status	Risk Significance			TOTALS
	Low	Medium	High	
Completed	55	20	3	78
Under Review	51	21	9	81
Not Received	54	51	29	134
TOTALS	160	92	41	293

*ACNW – derived data based on currently available documents

PATHWAY TO CLOSURE

- **DOE plans to address all KTI Agreements by LA submittal**
- **DOE bundling KTI Agreements as a way of organizing work**

PATHWAY TO CLOSURE (cont.)

- **Staff developing process for risk-informed evaluations of DOE responses**
  - **Technical Basis Report**

- **ACNW will continue to monitor KTI resolution process**

RISK INSIGHTS: BASE CASE EXAMPLE

- **Few radionuclides potentially significant to dose**
  - ^{129}I, ^{99}Tc, ^{237}Np
- **Key factors influence repository performance**
  - Waste package failures
  - Waste form releases
  - Transport in geosphere

RISK INSIGHTS: GEOSPHERE TRANSPORT

Radionuclide Transport KTI Agreements

- **RT 2.06: Provide Data on Retardation Factors for Radionuclides Important to Performance**

- **RT 2.07: Provide Results for Alluvial Field and Laboratory Testing**

RISK INSIGHTS: ^{237}Np BEHAVIOR

- Continually produced by decay of ^{241}Am
- Can be significantly delayed by retardation in alluvium
- Retardation factor varies over 3 orders of magnitude

RISK INSIGHTS: ^{237}Np BEHAVIOR (cont.)

- Alluvium retardation expected to have major effect on performance
- Waste package release rate important if retardation is small

RISK INSIGHTS (ADDITIONAL EXAMPLE)

- ^{241}Am and $^{239/240}$Pu
  - Most of repository inventory
  - Relatively immobile in Base Case
  - Remain near repository

- Subject to possible colloid transport
  - Under investigation

RESOURCE PAPER

Licensing Yucca Mountain the Risk-Informed Way

Dr. B. John Garrick, Chairman, Advisory Committee on Nuclear Waste
U.S. Nuclear Regulatory Commission

Presented in the Opening Plenary Session of The 9th International Conference on Environmental Remediation and Radioactive Waste Management, September 22, 2003, Oxford, England

The U.S. Nuclear Regulatory Commission expects to receive a license application for the proposed Yucca Mountain high-level waste repository in late 2004. A key factor in the NRC processing of the license application will be the risk-informed approach of the license review. The foundation of the approach is Part 63 of Title 10 of the U.S. Code of Federal Regulations—a regulation developed explicitly for the Yucca Mountain project. It is the first NRC regulation founded on the principle of a risk-informed philosophy of regulatory practice. The implementation of the regulation is supported with a risk insights initiative. The risk insights initiative is being used to quantify the importance of individual repository protective features. The result is a much sharper focus on the features, events, and processes important to the overall safety performance of the repository. For example, implementing the risk insights initiative has contributed to a much better understanding of the contribution to repository performance of the different components of both the natural setting and the engineered barriers.

As a result of pre-licensing technical exchanges between the NRC and the expected licensee, the U.S. Department of Energy (DOE), considerable experience already exists in applying risk assessment techniques to resolving technical issues on the safety of the proposed repository. Clearly, there have been challenges in changing the safety culture from prescriptive safety regulations to risk-informed and performance based regulatory decision-making. Neither NRC nor DOE is there yet, but much progress has been made.

Why did I choose this topic for this distinguished conference? First, I wanted the subject of my talk to be a high profile project and certainly in the U.S. at least, the proposed Yucca Mountain High Level Waste Repository is that—second only to the international space station in magnitude, visibility, and cost. The second reason I chose to talk about this topic is the emphasis that the U.S. Nuclear Regulatory Commission (NRC) is giving to a risk-informed approach to regulation. It occurred to me that the reasons for this emphasis, especially in relation to nuclear waste, might be of interest to this audience. Third, the NRC's Advisory Committee on Nuclear Waste, on which I serve, has strongly advocated risk-informing the regulatory process. So, a headline-making facility, the

implementation of a new regulatory philosophy, and my passion for quantification and risk assessment are the reasons for my speaking on this topic.

Before I go on I need to offer a few disclaimers. While I come to this meeting in my official capacity of chairman of the U.S. Nuclear Regulatory Commission's Advisory Committee on Nuclear Waste, my remarks have no official basis—they are my own opinions. In passing, I should nevertheless point out that the committee is, in fact, independent. The committee reports directly to the Commission. The committee's reports go to the chairman of the NRC. The committee has five members. They spend about a third of their time on committee business. The committee produces 10 to 12 letter reports for the chairman per year. It is a sister committee to the Advisory Committee on Reactor Safeguards. The two committees have the same full-time executive director and staff.

I'm sure you all played the What is... game when you were young with riddles such as "What is black and white and red all over?" I would like to offer the following riddle. What has a footprint of 8 square kilometers, involves over 110 kilometers of deep underground tunnels, requires the excavation of 4.4 million metric tons of rock, is home to 11,000 to 17,000 waste packages each weighing from 30 to 40 metric tons, involves over 300,000 metric tons of a mixture of Alloy 22, stainless steel, carbon steel, aluminum, Zircaloy, and titanium, not to mention approximately 1,200 metric tons of uranium-235 (^{235}U) and plutonium (Pu) isotopes.

My father was a small-time hard rock mine operator in the western U.S.—I can't imagine what his reaction would have been if he had stumbled onto such an ore body?

The proposed Yucca Mountain high-level waste (HLW) repository is to be licensed by the U.S. Nuclear Regulatory Commission in accordance with the Nuclear Waste Policy Act of 1982, as amended, and the Energy Policy Act of 1992. A license application is expected from the U.S. Department of Energy (DOE), owner/operator of the facility, in late 2004. As stated in the regulation covering Yucca Mountain, "DOE must demonstrate, using performance assessment, that there is a reasonable expectation that, for 10,000 years following disposal, the reasonably maximally exposed individual receives no more than an annual dose of 0.15 mSv (15 mrem) from releases from the undisturbed Yucca Mountain disposal system."

The facility is expected to start receiving waste in 2010 and be the disposal site for up to 70,000 metric tons of heavy metal (MTHM) of spent nuclear fuel and high-level radioactive waste. The breakdown of the 70,000 tons is 63,000 MTHM of commercial spent nuclear fuel and HLW, and 7000 MTHM of DOE spent nuclear fuel and HLW.

The fuel elements of light water reactors, the dominant type of commercial reactor operating in the U.S., are zirconium-alloy tubes containing cylindrical pellets of ceramic uranium oxide (UO_2) enriched to between 3 and 5 percent. There are four sources of

radioactivity in spent nuclear fuel—actinides, fission products, spontaneous fission, and neutron activation, the first two being the dominant contributors to the waste. After a significant runtime at power in a nuclear reactor, neutron-gamma reactions will produce some 51 species of radioactive actinides and the fissioning of uranium produces some 250 new radioactive species. The fission products dominate the short-term decay heat of spent nuclear fuel and, for that matter, control the design of the repository. So, the problem of high-level radioactive waste management is having to deal with approximately 300 radioactive species that weren't there to begin with.

Fortunately, only a few of these several hundred radioactive species are important in spent fuel disposal. Most become unimportant because of minor quantities, short half-lives, and minor biological consequences. Basically three categories of radioactive species dominate geologic repository design considerations. The first consists of strontium-90 (^{90}Sr) and cesium-137 (^{137}Cs). While these are not considered a repository health risk because of their relatively short half-lives, they are the dominant contributors to the heat released by spent fuel during the first several decades of the life of spent fuel. Decay heat load is a major issue in repository design. The radionuclide ^{137}Cs is of concern during preclosure operations because of its radiation shielding requirements for workers.

The second category of important radioactive species for the repository design comprises the fission products technetium-99 (^{99}Tc) and iodine-129 (^{129}I). These fission products are very long-lived (half-lives of 2.12×10^5 and 1.7×10^7 years, respectively). They are generally soluble under geologic conditions and thus able to migrate relatively quickly under ordinary groundwater conditions if they escape the waste package. The third category is from the actinide group of radioactive species. The important actinides are uranium, plutonium, neptunium, americium, and curium.

The Supplemental Science and Performance Analyses prepared by the DOE indicate that neptunium-237 (^{237}Np) alone dominates the long-term risk (greater than 100,000 years) and the peak dose (~35 mrem/yr at ~1 million years). The annual doses between 10,000 and 100,000 years are dominated by ^{99}Tc, with lesser contributions from ^{237}Np and ^{129}I. Annual doses during the first 10,000 years are dominated by groundwater transport of carbon-14 (^{14}C) and ^{99}Tc from waste packages that have experienced early failure. For the case of an igneous disruption event, the major contributors to the dose are the actinides americium (Am) and isotopes of plutonium (Pu). Further analysis has concluded that ^{14}C is not an important contributor to the dose. This leaves us with 5 radioactive species that are driving the risk of the repository, ^{99}Tc, ^{129}I, ^{237}Np, ^{241}Am, and ^{240}Pu—much less imposing than the some 300 species that we started with.

These results are based on probabilistic performance assessments, whose credibility must be confirmed of course. In fact, the NRC staff is challenging the technical analyses before having received a license application from DOE. NRC has its own performance assessment model that it has been using to independently check the DOE results for some time. In addition to reviewing the complex performance assessment models and independently verifying their results, the NRC staff has been performing sensitivity and

uncertainty studies. One such study recommended by the Advisory Committee on Nuclear Waste was to backtrack from the few radionuclides driving the risk and "turn up the microscope" so to speak on why they were the culprits. In particular, by focusing on this limited number of radionuclides what could we learn about the performance of the repository in terms of such issues as the effectiveness of individual barriers, the physical and chemical processes taking place, and whether or not there were opportunities to further reduce the risk. More on this later.

Risk-Informing the Licensing Process

What does NRC mean by risk-informed? In a white paper published by the Commission in 1999, risk informed was described as an "approach to regulatory decision-making [that] represents a philosophy whereby risk insights are considered together with other factors to establish requirements that better focus licensee and regulatory attention on design and operational issues commensurate with their importance to public health and safety." A key term in this definition is "risk insights." Risk insights are defined in the same white paper as results from risk assessments.

Previous regulatory practice was mostly what I call "compliance management" as opposed to "risk management." A risk-informed regulatory decision implicitly must include evidence on the risks involved as determined by risk assessments. Risk-informed is not to be confused with risk-based. The Commission white paper is very explicit that regulatory decisions will not be just risk-based.

Among the advantages of a risk-informed approach to regulatory practice are:

- the flexibility to consider a broad set of potential challenges to safety, as opposed to a prescribed set
- a means to prioritize challenges to safety based on risk significance, operating experience, and engineering judgment
- a more detailed exposure of contributors to risk and hence a clearer indication of the required resources to defend against safety challenges
- a more explicit manifestation of the uncertainties involved—perhaps the most important risk component of all
- a framework that better links safety results with the supporting evidence, thus offering the opportunity to make realistic safety assessments

Of course, these advantages are in principle only. Not all risk assessments measure up to these standards.

An excellent example of how regulations can be made more risk informed is Part 63 of Title 10 of the Code of Federal Regulations (10 CFR Part 63), the NRC regulation written explicitly for the Yucca Mountain project. The earlier 10 CFR Part 60 was a generic rule for the disposal of high-level radioactive wastes and was intended to be applicable to any repository. It included a series of subsystem performance requirements that, as a group,

would probably be difficult to demonstrate for many sites. These subsystem requirements include the following.

- "The repository shall be located such that pre-waste-emplacement groundwater travel time along the fastest path of likely radionuclide travel from the disturbed zone to the accessible environment shall be at least 1,000 years ..."
- "Containment of HLW within waste packages will be substantially complete for a period to be determined by the Commission ... provided that such period shall be not less than 300 years nor more than 1,000 years after permanent closure of the geologic repository."
- "The release rate of any radionuclide from the engineered barrier system following the containment period shall not exceed one part in 100,000 per year of the inventory of that radionuclide calculated to be present at 1,000 years following permanent closure..."

These requirements have to be met under 10 CFR Part 60 in addition to an overall system performance objective for the repository after closure.

NRC's 10 CFR Part 63 specifically regulates Yucca Mountain. It eliminates the subsystem requirements and emphasizes overall system performance objectives, including:

- limiting radiological exposures to the reasonably maximally exposed individual
- limiting releases to the accessible environment to protect ground water
- limiting radiological exposures in the event of human intrusion

Part 63 maintains the requirement that retrievability of waste remain possible, and also requires that DOE describe the capability of both natural and engineered barriers to isolate waste. However, Part 63 does not specify the amount of protection that the natural setting and the engineered barriers must provide.

Risk Insights Initiative

In implementing a risk-informed regulatory philosophy, the NRC waste management staff has developed a risk-insights initiative to help resolve technical issues associated with the performance assessment of the Yucca Mountain repository. These issues involve details of what have been classified by the NRC as key technical issues in the performance of the repository. These key technical issues have been divided into nine technical areas, for example Container Life and Source Term, Evolution of the Near-Field Environment, Radionuclide Transport, and Unsaturated and Saturated Flow Under Isothermal Conditions. Much of the effort of the risk insights initiative is making the connection between the key technical issues and the probabilistic performance assessment to provide perspective on the issues important to safety. Developing risk insights helps make better decisions on the most appropriate allocation of resources for the safety review. It is through this process that a much better understanding of the source term for the release of radionuclides into the natural setting has been developed.

By "source term" is meant the form and quantity of radionuclides released from the primary barrier, the waste package itself.

Applying risk assessment methods to the source term analyses that have been performed to date indicates that some of the modeling is too conservative (using pessimistic rather than realistic assumptions), while other issues do not appear to be adequately analyzed. An example of overconservatism in an earlier version of DOE's performance assessment is the assumption that the waste package is fully saturated even in the absence of any dripping water. The analysis includes calculating the cladding and waste reaction rates and chemical concentrations for these conditions. The conditions may be bounding in terms of the source term, but the evidence based on risk considerations does not support the need for such an extreme model for mobilizing the waste. In fact, such unrealistic assumptions can lead to erroneous conclusions regarding the likelihood and consequences of events. Examples of possible underconservatisms associated with the source term have to do with the assumptions on fabrication flaws in the waste packages and the decoupling of waste package degradation mechanisms from in-package chemistry conditions.

One of the most constructive outputs from the risk insights initiative has been the use of simplified models to backtrack from the results of the complex performance assessment models to more clearly expose contributors to repository performance. It is much easier to work backwards with only four or five radionuclides, than to work forward with some 300 different radioactive species. The opportunity exists to put the "spotlight" on how these radionuclides worked their way through the barriers to become the major contributors to dose.

The exercises that the NRC staff has carried out have contributed to a much better understanding of how certain phenomena affect performance. Concentrating on the movement of specific radionuclides through the repository and taking into account such properties as half-life, solubility, inventory, retardation, and dose conversion factors allows the staff to put the contributors to performance in a clearer context.

Consider the five radionuclides mentioned earlier, ^{99}Tc, ^{129}I, ^{237}Np, ^{241}Am, and ^{240}Pu. ^{99}Tc and ^{129}I together make up less than 1 percent of the inventory (by curies). If they escape from waste packages, their high solubility and mobility makes them the main contributors to dose in the first 10,000 years. But that dose is small because their inventory is small and the dose conversion factors are relatively low. Given reasonable ranges of in-package solubility and water influx, *most or all* of the waste packages in a repository would have to breach to release 15 mrem/yr at the drift wall (assuming dilution into 3,000 acre-ft/yr at the pumping well).

> **Risk insight:** The natural environment does not retard ^{99}Tc and ^{129}I. Therefore, there's little to gain by collecting huge amounts of data on the behavior of ^{99}Tc and ^{129}I in aquifers.

Risk insight: ^{99}Tc and ^{129}I produce most of the dose in the first 10,000 years. However, to approach 15 mrem/yr, a large number of waste packages would have to fail.

^{241}Am and ^{240}Pu together make up almost 80 percent of the waste inventory (by curies). These radionuclides are alpha and gamma emitters that could accumulate in the body and deliver substantial doses. But ^{241}Am and ^{240}Pu have relatively short half-lives and are highly immobile and unlikely to migrate from a repository through groundwater pathways. Even a short flowpath in saturated alluvium can strongly retard these radionuclides. So we see that Am and Pu, the bulk of the inventory, pose little risk to future generations. However, ^{241}Am has a half-life of 430 yrs and decays to the long-lived, semi-mobile ^{237}Np.

Risk insight: Even though ^{241}Am and ^{240}Pu make up most of the radionuclide inventory, their immobility keeps them in or near a repository for > 10,000 years. By themselves they can contribute little to dose even if many waste packages fail.

The behavior of ^{237}Np introduces much more uncertainty. Its retardation factor in alluvium ranges over 3 orders of magnitude, and it's continually produced in the repository by decay of ^{241}Am (430 yr half-life). So its ability to influence dose strongly depends on its retardation factor (degree of chemical interaction with tuffs or alluvium). If the retardation is high, very little alluvium is needed to retard it. If low, then even a long flowpath in alluvium will have little effect.

Risk insight: The degree to which ^{237}Np is retarded by alluvium will have a major effect on performance.

Risk insight: The release rate of ^{237}Np from waste packages will be very important to performance if the retardation factor is small.

The NRC staff used risk assessment methods for other diagnostic studies. One such study divided the Yucca Mountain repository into subsystems and assumed different performance levels of the subsystems to provide insights on individual subsystem performance in limiting the risk. The idea was to examine the effect on repository performance of a degraded or ineffective barrier. This study indicated that the performance of the engineered barriers and the saturated zone was important. Another such study considered different methods of evaluating alternative conceptual models in a performance assessment. This study provided insights on calibrating modeling uncertainties.

Risk studies performed by the NRC staff have greatly contributed to our understanding of the performance of both engineered and natural systems and have provided added assurance that the right things are being emphasized to assess the safety performance of the repository.

Observations of a Risk Assessment Practitioner

In general, I am very encouraged with the progress being made to risk-inform the regulatory process, particularly during the last couple of years. The progress is evident in (1) the promulgation of 10 CFR Part 63, the first regulation based on risk-informed principles, (2) the pre-licensing activities associated with Yucca Mountain and the consideration of risk in the technical exchanges with DOE, (3) the risk insights initiative, and (4) the hiring and training of staff capable of implementing a risk-informed regulatory process.

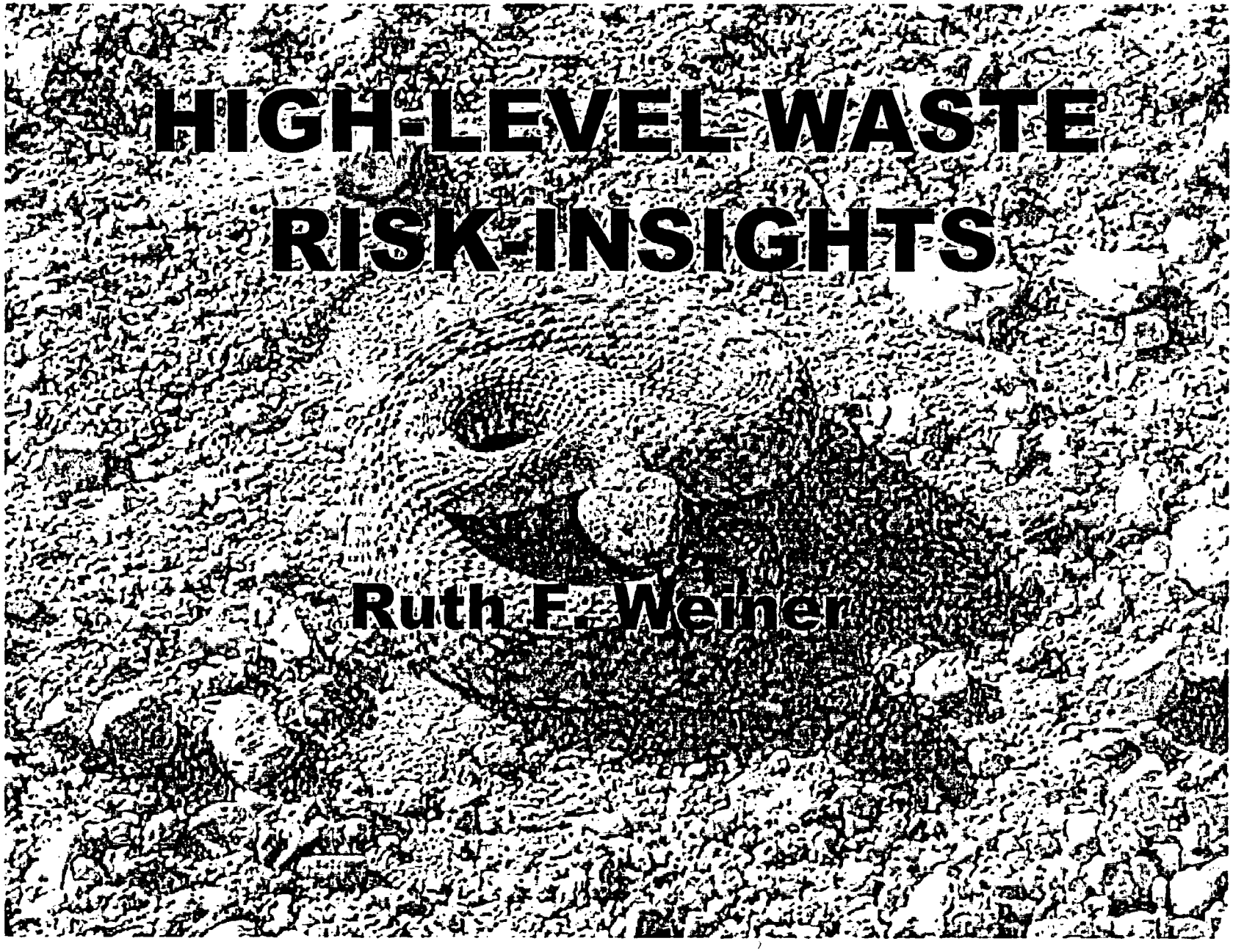
There have been some challenges to get to where we are. Perhaps the biggest challenge has to do with keeping the legacy of probabilistic risk assessment intact; a legacy built on quantification and realism. Quantification to me means telling the truth about risk measures in terms of the supporting evidence. As a colleague of mine likes to say, "let the evidence speak." This requires a level of uncertainty analysis not usually practiced in regulatory agencies. It also requires a means of presenting risk results that clearly communicate those uncertainties. It is the representation of uncertainty in the measures of risk that provides the link with the supporting evidence. Probabilistic risk assessment was invented to answer the question, what is the real risk? —not what is the "upper bound" risk or what is the "conservative" risk? These questions have their place, but quantitative risk assessment (QRA) was invented to dig deeper for more of the truth about the real levels of risk. QRA provides the reference point for knowing how much safety margin must be added to make a regulatory decision. And of course, the regulators must err on the side of safety, but not so much that society is hindered by the decisions that follow. Regulators must *enable* society to have access to technologies and activities that in the grand scheme of things improve our quality of life. Responsible risk assessments provide the reference point for knowing how much safety margin must be added to make a regulatory decision. Without such a baseline the safety margins are blurred.

Getting this view of risk assessment embedded into the NRC safety culture has not been a "slam-dunk" process. And, of course, the agency is not there yet, though much progress is being made. Our committee has heard many NRC presentations of so-called risk insights that violated the basic principles of probabilistic, or as I prefer to call it, quantitative risk assessment. The concept of realism has often been obscured by conservative assumptions. Uncertainty analysis has often been made suspect by probability distributions anchored not to the supporting evidence, but to some unrealistic assumption set. The debate was lively during the course of developing Part 63 to assure a risk-informed emphasis. The temptation was to do business as usual, not to introduce what appeared to some as more complexity. Well, as you heard earlier, by pushing the issue of risk-informing the regulatory process, we were able to eliminate prescriptive requirements for subsystem performance and keep the focus on overall performance.

Finally, I should point out when I say "pushing the issue of risk-informing the process," I'm not just referring to our committee. The Commission itself as well as some dedicated

NRC staff members have been very proactive in supporting the move towards greater quantification of analyses to support regulatory decision-making.

Risk-informing an established regulatory practice is a daunting task, but we are succeeding. Thank you for your attention.


HIGH-LEVEL WASTE
RISK-INSIGHTS
Ruth F. Weiner

RISK INSIGHTS

- Staff risk insights initiative based on qualitative consideration
- Effort was successful
  - Increased awareness of issues
  - Developed "state of knowledge" perspectives on importance
- Most important issues may require more quantitative approaches

ACNW COMMENTS ON STAFF INITIATIVE

August 2003 Report to Commission

- **Evidence-based risk insights**
- **Completeness of analysis**
- **Risk ranking terminology**

EVIDENCE-BASED RISK INSIGHTS

- **Risk insights should be based on quantitative performance assessment**
- **Performance assessment should be evidence-based to the extent possible**

COMPLETENESS OF ANALYSIS

- Risk-informed PA provides a metric for terminating analysis for low risk issues
- Analysis should be based on sufficient evidence
- Analysis should be flexible enough to incorporate new evidence

RISK RANKING TERMINOLOGY

- **NRC/DOE risk terminology is inconsistent and potentially confusing**
  - **NRC White Paper on RIPB Regulation should be used as a common dictionary**

SUMMARY

- **Direct link to the PA results is needed for risk insights**

- **ACNW understands staff is making progress**

ACNW LETTERS

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 143rd 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.

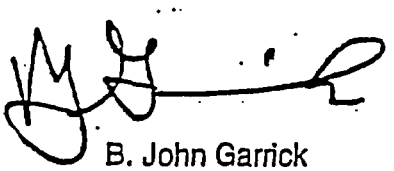
The Committee believes that if the high-level waste risk insights initiative is implemented as recommended, the evidence supporting conclusions regarding safety issues will be documented and transparent.

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. Hornberger, 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 Hornberger, 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
WASHINGTON, D.C. 20555-0001

September 12, 2003

Dr. B. John Garrick, Chairman
Advisory Committee on Nuclear Waste
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUBJECT: RESPONSE TO THE ADVISORY COMMITTEE ON NUCLEAR WASTE LETTER DATED AUGUST 13, 2003, ON THE RISK-SIGNIFICANCE RANKING OF HIGH-LEVEL WASTE AGREEMENTS AND THE USE OF RISK INFORMATION TO RESOLVE ISSUES, HELD JUNE 24-25, 2003

Dear Dr. Garrick:

I am responding to your letter, dated August 13, 2003, that provided the Advisory Committee on Nuclear Waste's (ACNW's) comments on the staff's development of the high-level waste (HLW) risk insights baseline, and the use of the baseline to rank the risk significance of the HLW key technical issue agreements. The staff presented the risk insights baseline and the ranking of the agreements to the ACNW during its meeting on June 24-25, 2003.

We agree with the ACNW that it is important to clearly identify and document the linkage between risk insights and quantitative risk assessment results, derived from ongoing HLW performance assessment activities. The staff is committed to using the results of quantitative risk assessments to support risk-informed regulatory decision-making. As you acknowledged in your letter, the staff indicated during its presentation that quantitative analyses supporting the risk insights will be provided in the final report documenting the development of the risk insights baseline.

One aspect of regulatory decision-making that you discuss in your letter pertains to the sufficiency of information and the termination of analyses. As the staff conducts its pre-licensing reviews and interactions with the U.S. Department of Energy, the staff will continue to use available risk information, and insights drawn from that information, to guide and focus its activities. The staff has compiled and integrated existing risk information into the risk insights baseline to provide a common basis to support risk-informed decision-making in several areas of the HLW program.

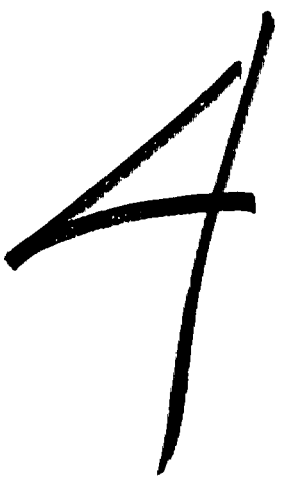
With respect to the use of risk-related terminology, the staff will continue to use SECY-98-144, "White Paper on Risk-informed and Performance-Based Regulation," as the reference for such terms as risk, risk insights, and risk-informed.

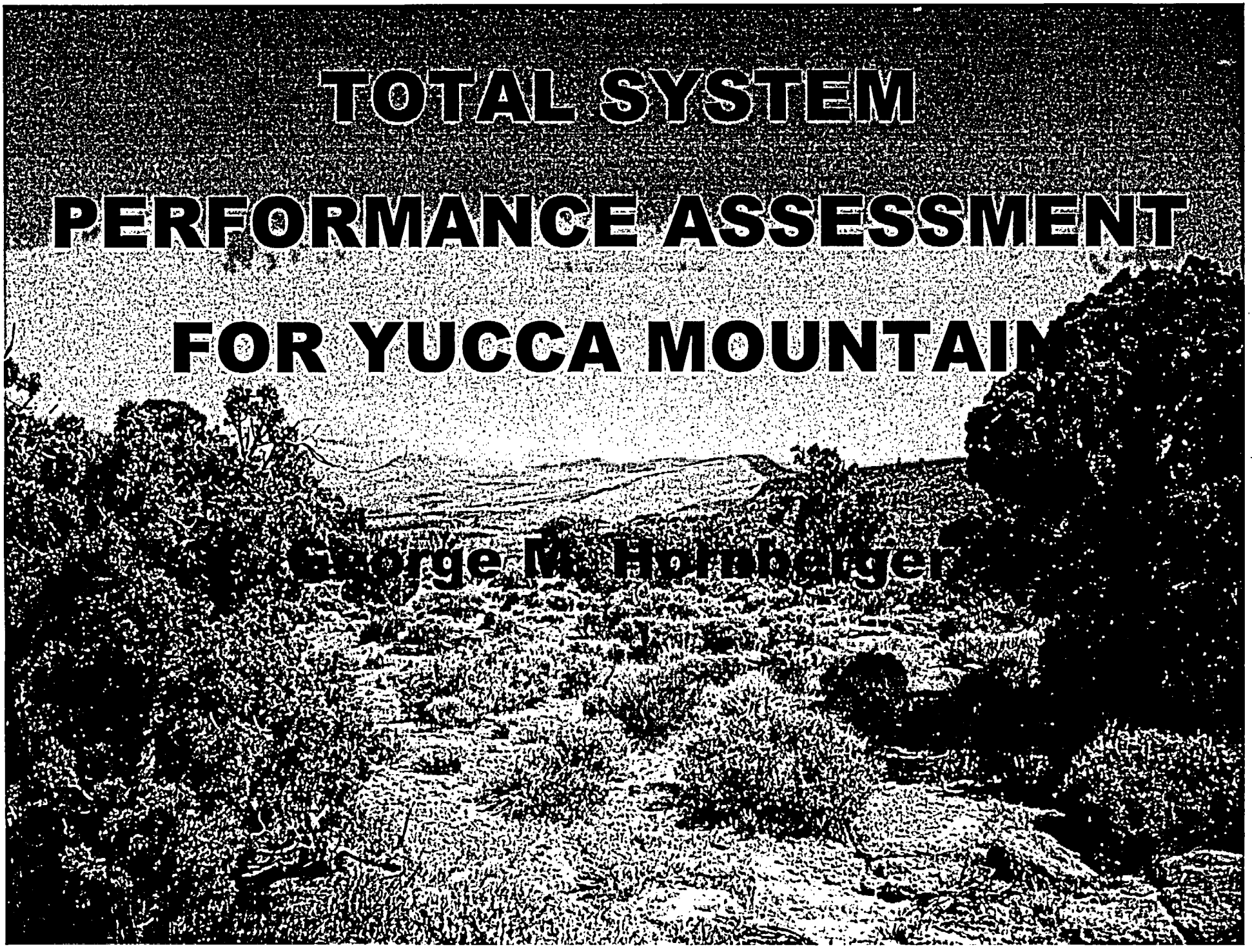
The staff intends to complete its report documenting the HLW risk insights baseline in October 2003. The NRC staff appreciates the ACNW's continued interest in risk-informing the Agency's HLW program, and looks forward to your continued involvement in these activities.

Sincerely,

William D. Travers
Executive Director
for Operations

cc: Chairman Diaz
Commissioner McGaffigan
Commissioner Merrifield
SECY




TOTAL SYSTEM
PERFORMANCE ASSESSMENT
FOR YUCCA MOUNTAIN
George M. Hornberger

TSPA/TPA WORKING GROUP

- Convened March 25-26, 2003
- Included five experts from
  - Geoscience Management Institute
  - Case Western Reserve Univ.
  - Iowa State
  - Univ. of Michigan
  - MIT

PURPOSES OF WORKING GROUP

- Better understand PA issues that could affect licensing
- Assess level of realism in repository modeling
- Assess staff readiness to review LA

FOCUS OF WORKING GROUP: SOURCE TERM

- Refers to processes and rates of radionuclide release from engineered barriers
- Repository performance analysis results are sensitive to release mechanism assumptions

OBSERVATIONS

- **Many assumptions about source term are not evidence-based**
  - **Effects of mineral phases inside waste packages**
  - **Waste package manufacturing flaws**
  - **Waste mobilization mechanisms**

OBSERVATIONS (cont.)

- Sensitivity studies should continue to identify key contributors to repository performance
- NRC and DOE making progress toward more realistic PAs
- Staff demonstrating readiness to review LA

ACNW LETTERS

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

July 17, 2003

Dr. George M. Hornberger, Chairman
Advisory Committee on Nuclear Waste
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUBJECT: RESPONSE TO THE ADVISORY COMMITTEE ON NUCLEAR WASTE LETTER DATED JUNE 12, 2003, ON THE TOTAL SYSTEM PERFORMANCE ASSESSMENT WORKING GROUP SESSION, HELD MARCH 25-26, 2003

Dear Dr. Hornberger:

I am replying to your letter, dated June 12, 2003, that provided the Advisory Committee on Nuclear Waste's (ACNW's) comments on the working group session on performance assessment for the proposed high-level waste repository at Yucca Mountain, Nevada. The U.S. Nuclear Regulatory Commission (NRC) staff concur that the working group session provided an excellent forum in which to exchange views on the technical issues associated with the performance assessment process and to discuss issues surrounding the definition of the source term for the proposed Yucca Mountain repository. The NRC staff appreciated the opportunity to participate in the ACNW's working group session on performance assessment.

The ACNW's letter identified extensive discussion of parameter uncertainties, including uncertainties associated with source term parameters. The NRC staff recognizes the importance of the proper treatment of uncertainties, especially for source term parameters. We believe the NRC's total-system performance assessment (TPA) code is flexible enough to provide the capability to evaluate the importance of the uncertainties associated with specific parameters or groups of parameters. The staff routinely use the TPA code to perform sensitivities studies to gain insights into the importance of specific parameters and to better understand U.S. Department of Energy's (DOE's) treatment of uncertainties. The TPA code also provides the flexibility to allow the staff to update input data for various parameters or mechanisms (i.e., the inclusion of diffusive transport) as new information is identified.

The Committee's letter also discussed the importance of incorporating increased realism in the performance assessment models. The staff recognizes the benefits of incorporating increased realism. As may be dictated by the modeling approaches of DOE, the TPA code provides the NRC staff with considerable flexibility to incorporate varying levels of realism.

The ACNW reiterated its interest in seeing a "pinch point" structure for the performance assessment models. The staff recognize the value of this type of analysis and plan to document its use as part of the staff's risk "insights" initiative.

The Committee's letter also addressed the NRC staff's readiness to perform an independent, competent, and comprehensive review when DOE submits a license application. The Committee expressed confidence that the NRC staff will have the necessary technical tools and personnel in place to perform a competent review of DOE's performance assessment. The

staff will continue to develop the technical capabilities and analytical tools to ensure an independent and comprehensive review of DOE's performance assessment that would be submitted as part of a license application for a high-level waste repository at Yucca Mountain, Nevada.

The NRC staff appreciates the ACNW's continued interest in, and input to, performance assessment and the TPA code. We look forward to your continued involvement in our future activities.

Sincerely,

William D. Travers
Executive Director
for Operations

cc: Chairman Diaz
Commissioner McGaffigan
Commissioner Merrifield
SECY

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

June 12, 2003

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

SUBJECT: TOTAL SYSTEM PERFORMANCE ASSESSMENT WORKING GROUP SESSION, MARCH 25-26, 2003

Dear Chairman Diaz:

At its 140th meeting on March 25–26, 2003, the Advisory Committee on Nuclear Waste (ACNW or the Committee) held a working group session (WGS) on performance assessment for the proposed high-level waste repository at Yucca Mountain, Nevada. The session included a panel of five distinguished scientists and engineers from academia and research institutions renowned in the fields of geosciences, corrosion science, and engineering.[1] 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.

The primary purposes of the working group session were to (1) better understand the principal issues of performance assessment that might affect the licensing process, (2) review the NRC staff readiness to evaluate a total system performance assessment, and (3) assess the level of realism in the modeling of the repository. The principal bases of the discussions were the performance assessment models of the NRC and DOE identified as Total-system Performance Assessment (TPA) and Total System Performance Assessment (TSPA), respectively. While the TSPA was part of the discussions, the focus of the session was on the "near-field," by which is meant the drip shield, the waste package, the radionuclide source term, and the geosphere in the immediate vicinity of the repository drifts. In particular, the discussion emphasized the "source term" and "source term uncertainty."

The rationale for the emphasis on the source term is that it is the principal boundary condition for assessing the performance of the natural setting. One view is that if a strong scientific basis can be established for the argument that not much radioactive material escapes from the waste, any impact of uncertainties about the performance of the geosphere may be of limited concern. Thus, a better understanding of the near-field containment capability may reduce the need for additional characterization of the site.

---

[1]Two of the panel members serve on the Nuclear Waste Technical Review Board (NWTRB). However, they represented themselves at the working group session as individual professionals from their respective universities, rather than as members of the NWTRB.

The focus on uncertainty and realism relates to the issue of risk-informing the performance assessment. The Committee has long held the view that to comply with regulations that are designed to be risk-informed, a license applicant must provide analyses that include an answer to the question, "what is the risk?" Of course the answer is expected to include the applicant's best estimate of what is the *real risk*, not some other assessment such as an extreme over- or under-estimate of the risk. Our point has always been that it is best to estimate the real risk, including its uncertainty, as a baseline against which to determine how much safety margin actually exists and to better aid the decisionmaking process as to what seems to be a "reasonable" safety margin.

The Committee was very pleased with the depth and breadth of the technical discussions and the opportunity to hear the different views and exchanges of the participants. We anticipate that the record and insights provided will enhance our ability to effectively offer advice to the Commission as the Yucca Mountain project moves into the licensing phase. While there was sharp and in-depth discussion of several technical issues, the Committee heard no issues and received no information that would establish a basis for major changes in the positions we have taken in reports to the Commission on past performance assessment work.

The technical discussions centered on the (1) chemical and temperature environment of the drip shield and waste package and their effects on degradation mechanisms, (2) uncertainties and realism of the performance assessment models, and (3) NRC staff readiness to perform a comprehensive review of the performance assessment that will be submitted as a part of the DOE license application. The discussions also included the following highlights:

- The State of Nevada has a concern that severe corrosive environments might be possible in the vicinity of the drip shield and waste package. This concern arises from their opinion that the performance assessments have failed to properly represent the appropriate water chemistries. They believe that water composition is important and that vadose zone water ought to be the basis for the water chemistry, rather than well water as presently assumed. The state representatives presented no evidence concerning the effect of different water chemistries on the overall performance of the repository.

- Two members of the expert panel shared their views about temperature effects on the performance of the repository. They pointed out that exceeding certain temperature thresholds can lead to the activation of specific corrosion processes in the presence of some environments. They have concerns that those conditions exist in the temperature regime of the current design and such temperature data have not been adequately employed in the assessments. For example, DOE's calculations of high- and low-temperature repository designs showed essentially no difference between the two in terms of the dose calculations. Using the TPA, the NRC staff should be able to conduct an independent analysis of different repository temperature profiles to verify the effect on the dose calculations.

- Another participant posed a question, "Do the models simulate all the processes that are major sources of uncertainty?" The large margins of safety in the current dose calculations accommodate considerable uncertainty, but only if the uncertainties are properly represented. Primary sources of uncertainty associated with the near-field are the specific chemical environment of the corrosion models and key parameters

and assumptions in the source term calculation. Examples of important parameters and assumptions are temperature, chemical form and phase, humidity, and solubilities, including in-package chemistry effects on those solubilities. Work is in progress by both DOE and the NRC staff to quantify the important uncertainties, and it appears that they are making considerable progress.

- Other participants challenged the realism of some of the source term modeling. Each successive performance assessment has made progress toward making the models more realistic with respect to both conservative and nonconservative assumptions. Areas of improvement have included the climate process model, treatment of coupled effects (thermal, hydrological, and chemical), use of more realistic solubilities for important radionuclides, treatment of thermal effects, and chemical environment of the drip shield and waste package. A specific example of addressing nonconservatism has been a more realistic representation of the amount of water accessing the near-field. As a result, the infiltration rates in the current models are considerably higher than in the early models. An example of increased conservatism is the radionuclide release model of the DOE TSPA with respect to the assumption of a fully water-saturated environment inside the waste package in the absence of dripping water. Recognizing these inconsistent assumptions and basing the calculations more on the supporting evidence has resulted in the performance assessments moving in the direction of greatly improved realism.

- The WGS provided the opportunity to challenge the NRC staff on their progress toward a capability to perform a comprehensive review of the complex TSPA expected in DOE's license application. The staff did an outstanding job of demonstrating that they are well-positioned for that effort. They recognize that their role is to review the TSPA, rather than simply performing independent analyses, and they manifest that recognition in the way in which they have specialized their performance assessment code. The staff's ongoing investigations of important contributors to the performance of the proposed Yucca Mountain repository are creative and insightful. The Committee strongly recommends that they continue this work.

A more detailed discussion of the WGS follows.

Principal Technical Issues

The principal technical issues discussed during the WGS included the chemical environments for initiating and sustaining corrosion, the temperature at which those environments occur, and the uncertainties and realism associated with the corrosion and radionuclide mobilization and transport models in the near-field. The representatives from the State of Nevada focused primarily on the chemical environment, while two members of the five-member panel emphasized the temperature issue and several participants, including the Committee, contributed to the discussion concerning model uncertainties.

Chemical Environment

Some WGS participants, primarily the representatives from the State of Nevada, were skeptical that sufficient data exist to exclude extreme corrosive environments for the drip shield and waste package. They believe that there is a need for additional data on water chemistries before they can be convinced that extreme environments cannot exist. They

consider water composition to be a major chemical environmental factor and expressed concern at the project's use of well water, rather than vadose (unsaturated) zone water. The Committee has not seen evidence that such changes in water chemistry will lead to changes in the dose calculations of sufficient magnitude to represent a significant compliance issue, but we will follow this issue as the performance assessments evolve.

Temperature Effects

Temperature is an environmental parameter, but it is often discussed as a specific issue because of its high profile in the performance assessment debate. The Nuclear Waste Technical Review Board (NWTRB) has raised this issue for some time and panel members from that Board (participating as individuals, not as representatives of the Board) introduced the topic into the WGS. Their specific concern is that exceeding certain temperature thresholds can lead to the activation of specific corrosion processes in some environments. In particular, they do not believe that the corrosion models are based on realistic temperature data. DOE has analyzed so-called hot and cold temperature profiles in supplemental performance assessment work, but the results did not show any significant difference in the safety performance of the repository. If the phenomena are properly captured, however, differences may arise in both the results and their uncertainties; this will require careful review. The ACNW has not reviewed the details of these differences to form an opinion concerning the effect they may have on the dose calculations. The safety margins of the calculations that DOE has performed are such that it would be surprising if these differences threatened compliance with the dose standard. We are confident that the NRC staff has the capability to determine the sensitivity of the dose calculations to different temperature profiles.

Uncertainties in the Analyses

Uncertainties in the source term parameters were extensively discussed during the WGS. The uncertainties include water composition, because of how it affects the mineral phases inside the waste package, the solubility limits for some of the radionuclides involved, and the details of the corrosion process. The primary parameter and phenomena uncertainties are temperature, chemical form and phase, humidity, and solubilities, including in-package chemistry effects on those solubilities. How much water exists in thin films for diffusive transport or in droplets by advective flow continues to be an issue in the respective DOE/NRC performance assessment models.

DOE's TSPA model treats the release of radionuclides from the engineered barrier system (the source term) by both diffusion and advection from "cracks" associated with stress-corrosion cracking and general corrosion "patches." The NRC's TPA model treats releases from the waste package as being primarily driven by advection, rather than by diffusion. While the models differ, some of the WGS panel members expressed the opinion that the DOE and NRC models have identified most of the relevant processes.

The issues are the rationale for the differences in the details of the corrosion and release mechanisms more than the results obtained. How important are source term uncertainties? The importance of these uncertainties is diminished if (1) they are adequately quantified and (2) in the presence of the uncertainties, there is still a reasonable safety margin in terms of meeting the radiation dose standard. DOE and the NRC staff are currently involved in work to quantify the important uncertainties.

For calculated doses within the first 10,000 years following closure of the repository, uncertainties continue to exist with regard to the assumptions made in the performance assessments about early failures of waste packages as a result of manufacturing flaws. The flaws of greatest interest are improper heat treatment of waste package lid welds. Assumptions about such flaws and the uncertainties therein account for the appearance of a calculated dose in the most recent versions of the TSPA model for the first 10,000 years. The calculated doses are extremely small. The issue discussed at the WGS was the lack of supporting evidence for the calculations of manufacturing flaws and the fact that such flaws could be the most significant cause of early failures of the waste packages.

NRC Staff Readiness

One of the clear benefits of the WGS was that it gave all those in attendance, including the Committee, a chance to see how the NRC staff is progressing in their capability to review a very complex performance assessment. In general, the Committee was very impressed with the staff's progress. We are confident that the necessary technical tools and staff will be in place to perform a competent review when DOE submits its license application (LA). Other factors that contribute to our confidence are (1) the NRC staff's experience base (~25 years) in developing and performing performance assessments (2) specialization of the tools, especially the TPA code, to assess the LA performance assessment, and (3) a capability to map the results of the DOE performance assessment into the NRC's key technical issues.

The centerpiece of the staff's analytical tools is the TPA code. The Committee has followed the TPA work since its inception and has urged the staff to risk inform the code as much as practicable, including the ability to quantify uncertainties. We have especially encouraged the staff to develop the ability to rank the importance of contributors to repository performance, including the contribution of individual barriers. While much of the importance-ranking capability is not yet automated, the offline use of the code to make such assessments is impressive. One advantage of the TPA code is that its development and application involve very few individuals and organizational entities. By comparison, DOE does not have such a simple computational management structure, and must rely on many different contributions from several different contractors with their ability to make the proper linkages. The TPA code should be a powerful tool for challenging the completeness of the TSPA in terms of its scope and the degree to which it is fully integrated.

Realism of the Performance Assessment Models

DOE and the NRC staff are making progress toward more realistic performance assessment models. The three scenarios to consider in the TSPA are (1) nominal performance, (2) disruptive events, and (3) a stylized human intrusion scenario that is specified by regulation. Examples of improvements in the realism of the TSPA models include the climate process model, treatment of coupled effects (thermal, hydrological, chemical), use of more realistic solubilities for important radionuclides, accounting for retardation of selected radionuclides, treatment of igneous events, and the uncertainty analysis of selected contributors to risk.

The progress in the TPA code is illustrated by its ability to account for uncertainties including variability of system attributes, the treatment of thermal effects for calculating temperatures at critical locations such as the drift wall and the waste package surface, and improvements in the ability to model groundwater flow and the near-field chemical environment. To assist in reviewing DOE's TSPA, the next version of the TPA code will incorporate a diffusion

model—a release mechanism that figures prominently in DOE's TSPA model. The staff is also considering evaluating cladding protection of the fuel in the next version of the TPA code.

The Committee continues to question the realism of the release model in DOE's TSPA. Much of the skepticism centers on the assumptions about the in-package environment and the supporting data. For example, the TSPA assumes that the waste package is fully saturated, even in the absence of any dripping water, and the analysis includes calculating the cladding and waste reaction rates and chemical concentrations for these conditions. The conditions may be bounding in terms of the source term, but the evidence does not support the need for such an extreme model for mobilizing the waste. We continue to question the extent to which diffusive transport is the basis for radionuclides to exit the waste package. We also need to better understand the effect of different mineral phases on the mobilization of the waste. This issue was discussed at length during the WGS. Again, it is not so much a concern that the dose standard cannot be met, as it is a matter of having a realistic baseline for the level of risk involved.

As previously noted, there are other barriers to complete realism in the models such as the somewhat prescriptive human intrusion model and the biosphere dose model. The result is the possible masking of either conservative or nonconservative contributors to risk. The degree of this masking is difficult to assess at this time, but it is a possibility the Committee will follow.

Of the various activities concerning realism, the Committee strongly supports backtracking from the final results of the performance assessment, where few radionuclides dominate the performance, into the internals of the model. As discussed in previous letters to the Commission, the Committee believes this approach will enable the staff to ferret out the contributing factors and the basis for their respective contributions. The NRC staff is doing just that with their own TPA model and the insights are extremely valuable in exposing what is really important. In fact, they have taken the concept further by seeking answers regarding why other radionuclides do not contribute to the risk. Some of the important insights are the effect of different engineered and natural barriers, the impact of modeling assumptions, and the importance ranking of contributors to performance. As we have in other reports to the Commission, we strongly recommend that this work continue.

Other Points of Discussion

In addition to the key points regarding technical issues, staff readiness, and realism, two other important observations arose from the WGS. One involved the debate over whether Yucca Mountain is a research project or an engineering project. This debate centered on the meaning of "reasonable expectation." Some participants expressed the opinion that given that it is a first-of-a-kind project, it requires a far greater depth of scientific activity than other large-scale projects. Other participants argued that the evidence does not support that view, noting that the analyses performed so far, which many WGS participants consider very conservative, have indicated a trivial safety issue in comparison to other risk issues facing our society. This debate turned out to be an excellent illustration of the value of uncertainty analysis in determining the "adequate" amount of scientific investigation. The Committee has always advocated that the best way to know how much additional scientific work is needed is to quantify the uncertainties of the important contributors to risk. If the contributors, with all of

their uncertainties, make little difference to the bottom-line risk measure, there is evidence that further work is not necessary. This is a primary benefit of risk-informing the analyses.

Finally, in terms of model structure, the participants expressed strong support for staging performance assessment models along the lines of modules that represent "pinch points," that is, structuring the model according to inputs and outputs of specific stages that facilitate the transparency of the total system. Such a structure permits a detailed examination of the initial conditions of the model, and also identifies the boundary conditions for the different stages. Such discretization better portrays the dynamics of the repository. Also, a staged structure allows clear exposition of the assumptions made on critical parameters as material moves through the repository region. Both DOE and the NRC have incorporated relevant modules in their models, but the interfaces between the modules lack definition in terms of specific inputs and outputs in a pinch point sense.

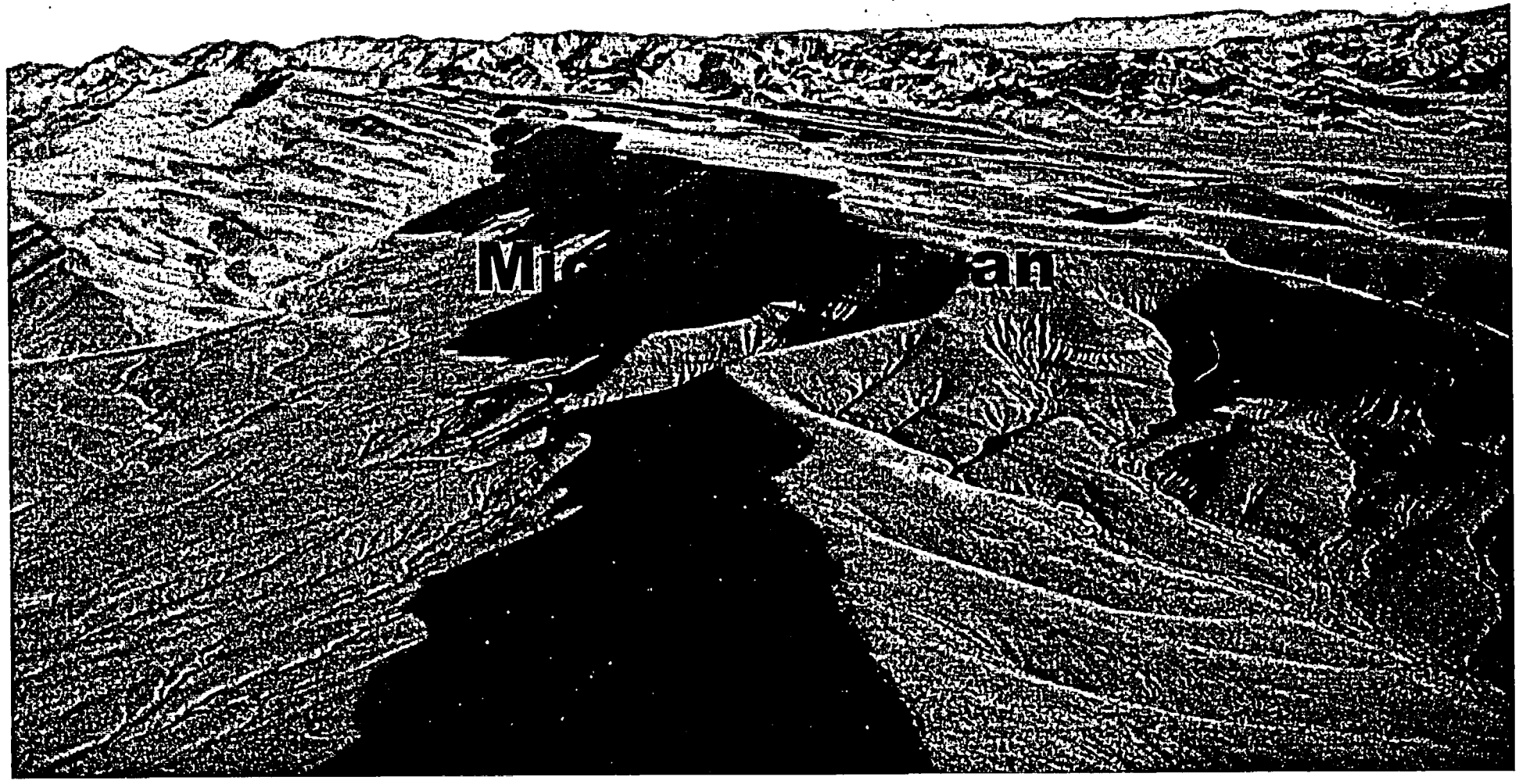
Summary

This outstanding WGS met the goals to (1) better understand the principal issues of performance assessment that might affect the licensing process, (2) review the readiness of the NRC staff to evaluate a total system performance assessment, and (3) assess the level of realism in the modeling of the repository. The WGS provided an excellent forum in which to exchange views on the technical issues associated with the performance assessment process and the particular issues surrounding the definition of the source term for the proposed Yucca Mountain repository.

Sincerely,

George M. Hornberger
Chairman

PERFORMANCE CONFIRMATION FOR YUCCA MOUNTAIN



PC WORKING GROUP

- Convened July 29-30, 2003
- Included six experts from
  - Environ Corporation
  - State of Nevada
  - Penn State
  - EPRI
  - Sandia Labs
  - NRC consultant

PC WORKING GROUP FOCUS

- **Review plans for program of tests, experiments, and analyses designed to evaluate information used to show compliance with Part 63 performance objectives**

WORKING GROUP PURPOSES

- Better understand PC issues that could affect licensing
- Assess appropriateness of scope and content of PC planning
- Understand expectations for DOE's PC program

OBSERVATIONS

- NRC and DOE have not finalized agreements on PC
- NRC expectations for DOE PC program are being developed
- Two revisions to DOE PC Plan expected over next year

OBSERVATIONS (Cont.)

- **A risk-informed program focusing on parameters and processes important to safety will allow DOE to optimize resources**

RECOMMENDATIONS

- **NRC staff should provide further guidance on:**
  - **Using PA results to design a risk-informed PC program**
  - **Using PC results to make decisions**

RECOMMENDATIONS (cont.)

- **NRC staff should provide further guidance on:**
  - **How PAs can or should be updated using PC data**
  - **Resolving any differences in NRC and DOE approaches to PC**

ACRONYMS

ACNW	Advisory Committee Nuclear Waste
Am	Americium
DOE	Department of Energy
EPRI	Electric Power Research Institute
I	Iodine
KTIs	Key Technical Issues
LA	Licensing Application
MIT	Massachusetts Institute of Technology
Np	Neptunium
NRC	Nuclear Regulatory Commission

ACRONYMS (cont'd)

NWTRB	Nuclear Waste Technical Review Board
PC	Performance Confirmation
Pu	Plutonium
RIPB	Risk-Informed Performance-Based
SER	Safety Evaluation Report
TSPA/TPA	Total-System Performance Assessment
Tc	Technetium

ACNW LETTERS

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 144th 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.

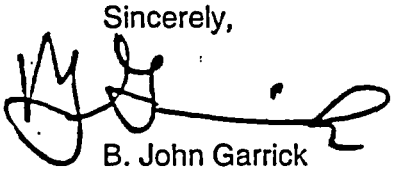
Plan Should Include Appropriate Involvement of the Public in PC Activities

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