ACNW MEETING WITH THE U.S. NUCLEAR REGULATORY COMMISSION

January 11, 2006

OVERVIEW

Michael T. Ryan

Agenda

- Michael Ryan
  - Low-level waste white paper
  - 10 CFR Part 63 revisions
  - Radiation Protection
  - ACNW Action Plan (Tier I and Tier II activities)

Agenda

- **Ruth Weiner**
  - **Research and Technical Assistance Activities**

- **Allen Croff**
  - **Waste Determination**

Agenda

- **James Clarke**
  - **Decommissioning**
- **William Hinze**
  - **Igneous Activity**

Low-Level Radioactive Waste

- White paper summarizes
  - History of LLW regulation
  - Part 61 regulatory framework
  - The LLW classification system and its uses
  - Opportunities for risk-informed improvements

Review of ICRP Documents

- Reviewed the ICRP foundation documents
- Reaffirms its earlier recommendation (Nov. 3, 2004)
- No evidence to support a non-human biota standard

Biological Effects Report-BEIR VII

Cancer risks have not changed significantly from previous BEIR reports

- **Linear no threshold model is the preferred model for radiation**
- **Newer radiation biology information is not sufficient at this time for changes**

OSHA's Request For Information

- Existing radiation protection program is effective and robust
- Trends in worker exposures do not support the need for a new regulatory initiative
- Comments are focused on Commission regulated areas only

ACNW Action Plan (Tier I)

- Proposed Yucca Mountain Repository
- Risk-Informing Nuclear Waste and Materials Regulatory Activities
- Decommissioning
- Waste Determinations
- Low-Level Radioactive Waste

ACNW Action Plan (Tier II)

- **Health Physics**
- **Transportation of Radioactive Materials**
- **Waste Management Research**
- **Fuel Cycle Facilities**

Planned Working Groups

- Decommissioning
- West Valley Demonstration Project
- Modeling and Monitoring
- Cement Materials
- Low-Level Radioactive Waste
- Risk-Significant Yucca Mountain Issues

ACNW LETTERS

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

June 21, 2005

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

SUBJECT: PROPOSED RULE ON NATIONAL SOURCE TRACKING OF SEALED SOURCES

Dear Chairman Diaz:

During its 159th meeting on April 18-19, 2005, the Advisory Committee on Nuclear Waste (ACNW) discussed a proposed rule that would require a national source tracking system for sealed radioactive sources. The ACNW also discussed sealed source tracking and control during its 156th meeting December 13-14, 2004. The Committee had the benefit of discussions with the Department of Energy, the Maryland Department of the Environment/Radiological Health Program, the Conference of Radiation Control Program Directors (CRCPD), and the NRC staff.

The Committee commends the NRC staff for its leadership in creating a U.S. sealed source tracking system. The system will focus on larger sources that pose greater risks. The Committee believes that the tracking system, as currently envisioned, is appropriate. The system requires the owners of large sources to register them when manufactured or received, report changes of ownership when transfer is completed, and annually verify their inventory.

The Committee offers the following recommendations.

- The system is intended to operate online. As a consequence, care must be taken to ensure the tracking system remains secure from unauthorized entry while still being accessible to users.

- Information will be entered into the system by the manufacturers or owners of the sealed sources. The quality of the information entered into the system must be ensured.

- The Committee continues to see significant progress in the planning for control and tracking of sealed sources. While the proposed sealed source tracking system is an appropriate and useful first step, the Committee believes a continuing effort is needed to make the tracking system comprehensive, consistent, and risk informed. Federal and State agencies, the CRCPD, and the Organization of Agreement States should be encouraged to participate.

We look forward to continuing to work with the staff and the other interested parties as they develop a national source tracking system.

Sincerely,

Michael T. Ryan
Chairman

Reference:
E-mail to R. Major from M. Horn, dated 3/30/2005, Subject: Proposed Rule—National Source Tracking of Sealed Sources (RIN 3150-AH48), undated, official use only

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

June 28, 2005

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

SUBJECT: DEPARTMENT OF ENERGY PLANS FOR TRANSPORTING SPENT NUCLEAR FUEL AND HIGH-LEVEL RADIOACTIVE WASTE

Dear Chairman Diaz:

At its 159th meeting on April 18-19, 2005, the Advisory Committee on Nuclear Waste (ACNW) heard a presentation by Gary Lanthrum, Director of the Office of National Transportation (ONT) of the Department of Energy (DOE).

Summary of the ONT Presentation

ONT will build and operate a system for transporting spent nuclear fuel (SNF) and high-level radioactive waste (HLW) to a repository at Yucca Mountain, Nevada. ONT has been organized around four project areas:

- Institutional
- Operational Infrastructure
- Fleet Acquisition
- Rail Through Nevada

The Institutional Project will collaborate with stakeholders to refine the transportation system as it is developed. A key effort will be to develop policy and procedures for awarding grants under Section 180(c) of the Nuclear Waste Policy Act to assist State, Tribal, and local emergency response personnel in preparing for repository shipments and to develop information for the public and interested stakeholders.

The Operational Infrastructure Project will define, develop, implement, and demonstrate the operational infrastructure needed to support waste transportation from the utility and DOE locations where the SNF and HLW are currently stored to the proposed Yucca Mountain repository. The transportation infrastructure is intended to ensure optimal transportation from the origin sites to Yucca Mountain, but optimization depends on other factors: maximal utilization of existing casks and other facilities, as few shipments as possible, acceptable and safe routes, and rapid transportation from each origin site. Optimization is complicated by the uncertainty about when fuel of various types will be shipped.

The Fleet Acquisition Project will define the approach to purchasing transportation casks and rolling stock to support transportation to the repository. The ONT's goal is to procure the minimum suite of casks and undertake as few certifications as possible. Existing casks will be used as much as possible, but DOE has found that the existing casks will fill only about 30% of the need.

A rail line will be built in Nevada to connect the repository to an existing main rail line. ONT is preparing a rail alignment environmental impact statement (EIS) in accordance with the National Environmental Policy Act. DOE is evaluating the environmental inputs of a 318-to-344-mile-long corridor beginning in Caliente, Nevada. As a result of the scoping hearings on this EIS and the ensuing approximately 4000 comments to DOE, several additional routes are being considered for the proposed rail line.

DOE is also asking to be allowed to take credit for fuel burnup; i.e., to recognize that relatively high-burnup fuel has significantly less fissile content, and significantly more radionuclides that can poison the fission reaction than fresh fuel or low-burnup fuel. ONT said that there is little data on this topic in the U. S. The French have developed a considerable database and are working with the DOE. The chance of a criticality is significantly lowered in high-burnup fuel, and if this credit is allowed, the amount of SNF in a shipment can be increased. Without burnup credit, the space in some transportation casks could not be utilized fully. As the amount of SNF per shipment increases, the number of shipments needed decreases.

ACNW Observations

- The entire SNF transport system should be optimized from storage at the site of origin through transport, receipt, repackaging and emplacement in the drift. The transportation plan should be integrated with the strategy and plan for emplacing the waste in the repository.

- The DOE plan to try to obtain burnup credit — credit for reducing the risk of criticality in high burnup fuel — appears to be a wise move toward more realism in analysis of transportation of SNF and toward increased transportation efficiency.

ACNW Recommendation

NRC staff should consider allowing realistic burnup credit for cask certification.

Sincerely,

Michael T. Ryan
Chairman

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

June 28, 2005

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

SUBJECT: DEFINITION OF A TIMESPAN OF REGULATORY COMPLIANCE FOR A GEOLOGICAL REPOSITORY AT YUCCA MOUNTAIN

Dear Chairman Diaz:

In a decision dated July 9, 2004, the U.S. Court of Appeals for the District of Columbia Circuit ruled that the 10,000-year compliance period (hereafter the time period of compliance or TOC) specified by the U.S. Environmental Protection Agency (EPA) for its Yucca Mountain site-specific radiation standards at 40 CFR Part 197 violated Section 801 of the Energy Policy Act of 1992 (EnPA). It is unclear what changes will be made to Part 197 to address this ruling, but such changes will require the Commission to modify the regulations in 10 CFR Part 63. The Committee believes it may be useful for the Commission to consider previous ACNW advice on TOC, as well as other views on TOC.

BACKGROUND

Before 1992 the generic radiation standards and implementing regulations for evaluating geologic repository sites and licensing repository designs were given at 40 CFR Part 191 and 10 CFR Part 60. In 1992 Congress directed EPA and NRC to develop new radiation standards and NRC to develop implementing regulations for licensing of the Yucca Mountain site. In developing radiation standards, Congress directed EPA to contract with the National Academy of Sciences (NAS) to advise EPA on the appropriate technical basis for public health and safety standards for any Yucca Mountain repository.

On August 1, 1995, the NAS issued its report, "Technical Bases for Yucca Mountain Standards" (the TYMS report). The NAS concluded there was "no scientific basis for limiting the time period of the individual risk standard to 10,000 years or any other value." According to the Academy, "compliance assessment is feasible for most physical and geologic aspects of repository performance on the time scale of the long-term stability of the fundamental geologic regime — a time scale that is on the order of one million years at Yucca Mountain." The Academy also concluded that humans may not face peak radiation risks until tens to hundreds of thousands of years after the disposal of wastes, "or even farther into the future." The Academy thus recommended "that compliance assessment be conducted for the time when the greatest risk occurs, within the limits imposed by the long-term stability of the geologic environment."

After the Academy issued its findings and recommendations, EPA promulgated its draft Part 197 standards in which it proposed a 10,000-year TOC. In so doing, EPA requested comments on the reasonableness of adopting the NAS-recommended TOC or "some other approach in lieu of the 10,000-year compliance period," that EPA favored. During the public comment period, DOE and NRC went on record supporting the 10,000-year TOC while the State of Nevada proposed adopting a TOC extending to the time of projected peak dose, as NAS recommended. After reviewing the public comments, EPA promulgated its final rule adopting the 10,000-year TOC and in doing so expressed the view that NAS' TOC recommendation was "not practical for regulatory decision-making."

PAST ACNW ADVICE

The most recent ACNW views on TOC were given in two 1996 letters. The first letter gave background on defining a repository TOC, discussed related regulatory principles and selection criteria, and recommended a two-tiered approach to defining a TOC.[1] The second letter provided additional detail on the proposed two-tiered approach to addressing TOC issues.[2]

The first tier of the ACNW recommended approach was to define a quantitative dose limit for the reasonably maximally exposed individual (REMI) at a specific time for times on the order of several thousand years. The second tier was to qualitatively compare the peak dose and uncertainties of the dose standard. The Committee's recommendation did not require a quantitative measure of compliance at the TOC because of the uncertainties in defining future processes and events.

INTERNATIONAL APPROACHES

There is no international consensus on TOC among standard-setting bodies, regulators, and developers. This is not surprising considering the differences in national policies and the variations in design concepts and geologic settings. The attached table shows the variability of international TOC durations. Generally, a multitier approach to timeframes is used with a quantitative evaluation based on an early assessment of 1000 to 10,000 years and a longer, qualitative evaluation of a million years or longer, but there are many exceptions. Some countries, such as Germany, have not specified a TOC, but are considering the use of safety indicators with a qualitative assessment to a million years or more but no less than 10,000 years. Canada has specified a 10,000-year TOC and requires evaluation to an unspecified period beyond 10,000 years to show that there are no dramatic increases in dose in the post-TOC years.

Member countries of the International Atomic Energy Agency and the Nuclear Energy Agency (NEA) are participating in continuing activities to develop a consensus on using the results of performance assessments over long periods of time. Both organizations have recommended a tiered approach for evaluating repository performance. Deliberations on this issue continue. In the Fall of 2005, we expect to review a draft report on NEA's most recent workshop.

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[1] ACNW letter report dated June 7, 1996, "Time Span for Compliance of Proposed Yucca Mountain HLW Repository."

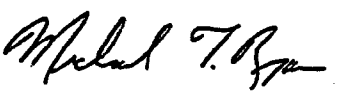
[2] ACNW letter report dated November 14, 1996, "Road Map to ACNW's Recommendation for TOC."

PATH FORWARD

Upon the release of EPA's draft rulemaking for public comment, the Committee plans to review the draft regulation, meet with the NRC staff and stakeholders, and report its observations and recommendations to the Commission. The Committee also anticipates being briefed on the results of a 2005 NEA workshop. The briefing will be useful in the NRC's effort to help develop an international consensus on the use of long-timeframe performance assessment results.

In addition, the ACNW plans to hold a working group meeting in the Fall of 2005 on technical issues associated with long-timeframe performance assessments at Yucca Mountain. The Committee will report to the Commission on the results of this working group meeting.

Sincerely,



Michael T. Ryan
Chairman

Attachment:
As stated

ATTACHMENT

INTERNATIONAL APPROACHES TO DEFINING A REGULATORY TIME OF COMPLIANCE (TOC)

More than 30 countries have research and development programs for managing long-lived radioactive wastes in geologic repositories (Witherspoon and Bodvarsson, 2001[1]). Currently, there is no international consensus among standard-setting bodies, regulators, or developers in these countries on the time scale for evaluating the safety of geologic repositories. An effort is underway in the Nuclear Energy Agency to address this issue (by NEA's Integration Group for the Safety Case or IGSC). This Timescales Project has produced two reports so far.[2,3] A third "state-of-the-art report" is in preparation and will likely be published in 2006.[4]

The table below lists TOCs for 10 countries, including the United States, that have standards or guidance in place for evaluating the safety of long-lived radioactive waste repositories. A review of the literature indicates that several of these countries have TOCs that range from 1000 to 1,000,000 years. In some cases, there is no regulatory TOC cutoff and the calculations can be carried out to as long as 100 million years after facility closure. The technical bases for the specification of a particular TOC vary among developers and regulators. Cutoff times (i.e., the duration of the TOC) have been justified on the basis that (a) the relative hazard (toxicity) of spent nuclear fuel vs. a naturally occurring uranium ore body; (b) the potential for multiple peak doses to future receptors; and/or (c) intergenerational equity concerns. For the purposes of comparison, the table includes the three time frames selected by the International Atomic Energy Agency (IAEA) for an analysis of the use of repository safety indicators.

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[1] P.A. Witherspoon and G.S. Bodvarsson (eds.), "Geological Challenges in Radioactive Waste Disposal – Third Worldwide Review," Berkeley, Ernest Orlando Lawrence Berkeley National Laboratory, LBNL-49767, December 2001.

[2] Nuclear Energy Agency, "The Handling of Timescales in Assessing Post-Closure Safety of Deep Geological Repositories, Proceedings of April 16-18, 2002, Workshop, Paris, France, Paris, Nuclear Energy Agency/Organization for Economic Cooperation and Development, 2002. Also see Nuclear Energy Agency, "Integration Group for the Safety Case (IGSC) Workshop on Handling of Time Scales Assessing Post-Closure Safety – Compilation of Abstracts," Paris, Nuclear Energy Agency/Organization for Economic Cooperation and Development, NEA/RWM/IGSC(2002)6, June 2002.

[3] Nuclear Energy Agency, "The Handling of Timescales in Assessing Post-Closure Safety – Lessons Learnt from the April 2002 Workshop in Paris France," Paris, Nuclear Energy Agency/Organization for Economic Cooperation and Development, NEA No. 4435, 2004.

[4] Belgium proposed the Timescales Project to NEA's IGSC. The purpose of the project is to produce a "state-of-the-art" report to document a consensus for cutting off performance assessment calculations at a specific time, if possible. Belgian officials believe that it would be helpful to be able to cite an international report with a recommendation and a technical basis for the recommendation. Although the NEA document has not been drafted, a 1 million-year cutoff is beginning to emerge as an informal consensus TOC based on discussions among the participants.

A related concern is to use performance assessment results in accounting for the uncertainties of analyses. Performance assessments in timespans of less than 100,000 years are generally considered more reliable. Longer term assessments (TOCs greater than 100,000 years) are generally considered less reliable because the uncertainties increase with time.

Regardless of the length of the specified TOC, there is a consensus among practitioners that a multitier approach should be used to judge repository performance, as noted in the table below. Performance assessments of TOCs of less than 100,000 years are generally more quantitative and TOCs of more than 100,000 years are generally more qualitative.

Country	*TOC*	*Comments*
BELGIUM	**Not established yet**	Safety demonstration analyses for at least **100,000,000 years.** [a]
CANADA [b]	**≈ 10,000 years**	Demonstrate repository safety quantitatively with detailed calculations.
	< 100,000 years	Qualitative demonstration, using "reasoned arguments," that there is no dramatic increase in releases from repository after the first **10,000 years.**
	< 1,000,000 years [c]	An example for the purposes of the environmental impact statement to demonstrate that the radiological toxicity of spent fuel is equivalent to a natural uranium ore body.
FINLAND [d]	**≈ 10,000 years**	Evaluate repository performance over an environmentally predictable period.
	> 10,000 years	Do a stylized, quantitative calculation using a broad range of safety indicators.
	> 1,000,000 years	Do a qualitative calculation.
FRANCE [b, e]	**0–500 years** [f]	Do analysis for assumed period of passive institutional controls.
	< 50,000 years	Minimum period of environmental predictability. Analysis not intended to reflect future climate change and the onset of glaciation.
	> 50,000 years	Do a qualitative analysis as a reference, taking into account the expected evolution of repository system.
GERMANY	**No specified time**	Evaluate repository performance up to about **10,000 years**, taking into account period during which repository barriers would be subject to minor changes.[b]

Country	*TOC*	*Comments*
		Do an analysis on the order of **1,000,000 years** to identify repository sites with overall favorable geologic characteristics. [e] Do other demonstration analyses for beyond **1,000,000 years.** [g]
JAPAN [b]	**Not established yet**	Evaluate repository performance taking into account period of peak dose up to about **100,000,000 years.**[h]
SPAIN [i]	**Not established yet** (To be defined by 2010.)	Demonstration analysis to stop at **1,000,000 years.**
SWEDEN [j]	**< 1000 years**	Do a quantitative calculation.
	< 100,000 years[k]	Do a quantitative analysis, taking into account the next major glacial period. The analysis period must be greater than **10,000 years.**
	> 100,000 years	Do a stylized, qualitative calculation. The analysis is to stop at **1,000,000 years.**
SWITZERLAND [b]	**No specified time**	Duration for demonstration analysis terminated at **10,000,000 years.**[l]
UNITED KINGDOM [b]	**Not established yet**	Timeframe for analysis implied to be less than **1,000,000 years.**
UNITED STATES	**10,000 years** [m]	Timeframe for analysis for evaluation of transuranic (TRU) radioactive wastes.
	1,000,000 years[n, o]	Evaluate Yucca Mountain repository performance, taking into account periods of peak dose up to about **1,000,000 years.**
IAEA[p]	**< 10,000 years**	Quantitative analysis assuming the current biosphere and institutional controls.
	< 1,000,000 years	Mix of qualitative and quantitative "illustrative" calculations intended to reflect future climate change and the present-day reference biosphere
	> 1,000,000 years	Qualitative analysis during the period over which radiological toxicity of repository is equivalent to a natural uranium ore body.

REFERENCES:

[a] Studiecentrum voor Kernenergie – Centre d'étude de l'Energie Nucléaire (SCK·CEN – Belgian Nuclear Research Centre), "Identifying and Testing Indicators for Assessing the Long Term Performance of Geological Disposal Systems: The [European] SPIN Project, *SCK·CEN Scientific Report 2002*, Mol, Belgium, [2002].

b U.S. General Accounting Office, "Nuclear Waste – Foreign Countries' Approaches to High-Level Waste Storage and Disposal," Washington, DC, Resources, Community and Economic Development Division, GAO/RCED-94-172, August 1994.

c Atomic Energy of Canada Limited, "Environmental Impact Statement on the Concept for Disposal of Canada's Nuclear Fuel Waste," Mississauga, Ontario, AECL-10711, COG-93-1, September 1994.

d The Radiation Protection and Nuclear Safety Authorities in Denmark, Finland, Iceland, Norway, and Sweden, "Disposal of High Level Radioactive Waste – Consideration of Some Basic Criteria," Stockholm, Sweden, Swedish Radiation Protection Institute (Statens Strålskyddsinstitut – SSI), 1993.

e Committee on a Site Selection Procedure for Repository Sites (Arbeitskreis Auswahlverfahren Englagerstandorte – AkEnd), "Site Selection Procedure for Repository Sites: Recommendations of the AkEnd," Berlin, German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety, December 2002.

f U.S. Environmental Protection Agency, "Spent Nuclear Fuel and High-Level Waste Programs Disposal Programs in Other Countries (Chapter 3) in Environmental Radiation Protection Standards for Yucca Mountain, Nevada – Draft Background Information Document for Proposed 40 CFR 197, "Office of Radiation and Indoor Air, EPA 402-R-99-008, August 1999.

g Bundesanstalt für Feowissenschaften und Rohstoffe, "Grundsätze der Endlagerung radioaktiver Abfälle – Die Sicherheitsphilosophie des Bundesamtes für Strahlenschutz (Standards for the Permanant Disposal Site for Radioactive Waste – Safety Philosophy of the Federal Office of Radiation Protection), Salzgitter, German Federal Republic, 2004.

h Japan Nuclear Cycle Development Institute [JNC], "H12: Project to Establish the Scientific and Technical Basis for HLW Disposal in Japan – Supporting Report 3: Safety Assessment of the Geological Disposal System," Ibaraki, Japan, Report TN1410 2000-004, 2000. [NOTE: Because of the current regulatory mandate to address international practices and standards, the Japanese are actively participating in the NEA Timescales Project.]

i A. Astudillo, "Geological Disposal of High-Level Radioactive Wastes in Spain," in P.A. Witherspoon and G.S. Bodvarsson (eds.) Geological Challenges in Radioactive Waste Disposal – Third Worldwide Review, Ernest Orlando Lawrence Berkeley National Laboratory, LBNL-49767, December 2001.

j Swedish Radiation Protection Institute, "Health, Environment and Nuclear Waste, SSI's Regulations and Comments," Stockholm, Sweden, SSI Report 99:22, 1999.

k Swedish Nuclear Power Inspectorate (Statens Kärnkraftinspektion), the repository developer whose implementing recommendations, including a time scale for the analysis, will be defended at the time of licensing.

l National Cooperative for Radioactive Waste (National Genossenschaft für die Lagerung radioaktiver Abfälle – Nagra), "Project Opalinus Clay: Safety Report – Demonstration of Disposal Feasibility for Spent Fuel, Vitrified High-Level Waste and Long-Lived Intermediate-Level Waste (*Entsorgungsnachweis*)," Wettingen, Switzerland, Nagra Technical Report NTB 02-05, 2002. (Although the demonstration calculations were carried out to 10 million years, the Nagra report notes that there is little confidence in the calculations beyond 1 million years.)

m U.S. Environmental Protection Agency, "40 CFR Part 191: Environmental Standards for the Management of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes; Final Rule," *Federal Register*, Vol. 50, No. 182, pp. 38066-38089, September 19, 1985.

n National Research Council, "Technical Bases for Yucca Mountain Standards," Washington, DC, Commission on Geosciences, Environment, and Resources, National Academy Press, July 1995.

o U.S. Department of Energy, "Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada, Vol. 1, Impact Analyses, Chapters 1 through 15, "Office of Civilian Radioactive Waste Management, DOE/EIS-0250, February 2002.

p International Atomic Energy Agency, "Safety Indicators in Different Time Frames for the Safety Assessment of Underground Radioactive Waste Repositories. First Report of the INWAC Subgroup on Principles and Criteria for Radioactive Waste Disposal," Vienna, Austria, IAEA-TECDOC-767, October 1994. (The NEA suggestion to evaluate until the dose from the spent fuel is equivalent to a uranium ore body would not likely require calculation beyond a million years.)

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

July 1, 2005

The Honorable Nils J. Diaz
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-001

SUBJECT: COMMENTS ON ICRP FOUNDATION DOCUMENTS – A FOLLOWUP TO THE ACNW'S NOVEMBER 3, 2004 COMMENTS

Dear Chairman Diaz:

The ACNW has reviewed the five "Foundation Documents" offered by the International Commission on Radiological Protection (ICRP) in support of its 2005 Draft Recommendations. By this letter the ACNW reaffirms the recommendations in our November 3, 2004 letter and in the March 16, 2005 briefing to the Commission. Nothing in the Foundation Documents changes our earlier observations and recommendations.

As the ACNW stated, the Commission should consider deferring action on any of the Draft ICRP Recommendations until BEIR VII is published and available for review, and consider implementing changes in tissue weighting factors, radiation weighting factors, and more recent methods and models for assessment of internal dose. There is no urgent need to make these changes; they can be made when regulations are revised for other reasons.

The ACNW has several observations on the Foundation Documents:

1. As written the Foundation Document on the "Representative Individual" lacks clarity. Even though it usefully clarifies compliance with dose limits (constraints); the term "representative individual" is used in different senses in the document. The definitions and their applications need to be clarified. Examples could be used to convey the intent and use of the various dose assessment protocols and strategies discussed in the document.

2. Unless substantial clarifications are made to the definition and use of the "representative individual" concept, it offers little use when compared to the concepts of the "Average Member of a Critical Group" or the "Reasonable Maximally Exposed Individual" (RMEI).

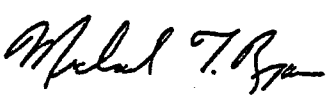
3. Consistent with its November 3, 2004 letter, the ACNW recommends that the Commission defer consideration of the Foundation Documents regarding the "Biology" and "Dosimetry" until the BEIR VII Committee report is issued and available for review and comparison.

4. The ACNW believes that the additional guidance provided in the Foundation Document on "Optimization" would not substantially improve current ALARA programs, or protection of workers, the public, or the environment. The principle of stakeholder involvement discussed in the Optimization document is consistent with the Commission's current programs and activities as discussed in the agency's Strategic Plan and implementing documents.

5. Regarding the draft Foundation Document on "The Concept and Use of Reference Animals and Plants for the Purposes of Environmental Protection," the ACNW continues to hold the view expressed during our March 16, 2005 briefing to the Commission: that there has been no evidence to contradict the philosophy that by protecting humans the environment is protected. This Foundation Document tries to make the case that separate recommendations are needed or justified.

More detailed comments are given on the foundation documents in the Attachment.

Sincerely,



Michael T. Ryan
Chairman

Attachment: Detailed comments on the
ICRP Foundation Documents

ATTACHMENT: DETAILED COMMENTS ON THE ICRP FOUNDATION DOCUMENTS

Foundation Document "Assessing Dose of the Representative Individual for the Purpose of Radiation Protection of the Public"

The document is very repetitive. Basic concepts, ideas, and approaches are repeated many times. Unfortunately, terms like "representative individual" are slightly different in each instance. The Abstract, Executive Summary, and Introduction all cover the same ground with different terminology.

The value of the document is derived from its focus on several principles:

1. Both nonstochastic (deterministic) and stochastic assessments have a place. The document offers comments on where each is best employed. The document should be more focused on this point. Clear examples should be given for each case and the limitations should be spelled out. A common criticism of nonstochastic analysis is that true risk can be missed. ICRP should offer a case to counter this assertion.

2. For nonstochastic assessments, doses below a limit ("constraint" in ICRP terminology) demonstrate compliance. This is a helpful statement.

3. For probabilistic risk assessment, the document suggests compliance with a dose limit: if the 95th percentile of the dose distribution is within a factor of 3, compliance is demonstrated. This needs clarification. Additionally, the ICRP should advise regulators on how to make the compliance algorithm clear. Examples would help to demonstrate these concepts.

Major drawbacks to the document are:

The "representative individual," as presented in the document, is discussed in contradictory ways. Paragraph 23 states:

> Therefore, for the purpose of protection of the public, it is necessary to characterize an individual, either hypothetical or specific, who receives the highest dose which can be used for determining compliance with the dose constraint. This individual is defined as the representative individual.

How can a representative individual get the "highest dose?"

Paragraph (S9) uses a slightly different definition:

> The representative individual is the hypothetical individual receiving a dose that is representative of the most highly exposed individuals in the population.

This definition implies that the representative individual is a member (perhaps the average, median, or mode) of the most highly exposed group. This qualitative definition is subject to interpretation and is not consistent with paragraph 23.

Paragraphs 67 and 68 imply that the representative individual possessed "mean" characteristics regarding habits that are not "outside the range of day-to-day life." This is not easily reconciled with the individual who receives "the highest dose." ICRP needs to clarify the definition and guidance.

Temporal uncertainty and variability seem not to have been considered. It appears that the approaches to dose calculations address only uncertainty and variability in spatial data. This report seems to indicate that once determined (for a specific point in time), the parameters used to model pathways of exposure and calculated dose are fixed throughout the entire life span of the exposed individual. The dose calculations need to consider temporal uncertainty and variability over time. Both are known to be important.

Foundation Document "Biological and Epidemiological Information on Health Risks Attributable to Ionising Radiation: A Summary of Judgements for the Purposes of Radiological Protection of Humans"

1. This Foundation Document suggests small adjustments to "detriment adjusted nominal probability coefficients for cancer." These small adjustments do not substantially change previous cancer risk values. In addition, additional analyses are expected in the Biological Effects of Ionizing Radiation Committee of the National Academy of Science Report (BEIR VII), expected later this year. The ACNW continues to believe that the Commission should consider deferring action on any of the draft ICRP recommendations until the BEIR VII Report is published and available for review.

2. A related finding is reported: "For cancer and hereditary disease at low doses/dose rates the use of a simple proportionate relationship between increments of dose and increased risk is a scientifically plausible assumption." This conclusion further supports taking no action until the BEIR VII report is published. ICRP recommends no large changes in risk factors.

3. The Foundation Document states: "Knowledge of the roles of induced genomic instability, bystander cell signaling and adaptive response in the genesis of radiation–induced health effects is insufficiently well developed for radiological protection purposes; in many circumstances these cellular processes will be incorporated in epidemiological measures of risk." The ACNW believes that this statement is a fair assessment of the state of knowledge of these issues at this time though new information is reported regularly. The ACNW will keep informed of newer studies and report to the Commission as appropriate.

4. The document states: "Proposed changes in radiation weighting factors for protons and neutrons are noted; these judgements are fully developed in the ICRP Committee 2 Foundation Document, Basis for dosimetric quantities used in radiological protection (FD-C-2)". This additional report provides substantive detail. The Foundation Document on "Biological and Epidemiological Information..." states that: "New radiation detriment values and tissue weighting factors have been proposed; the most significant changes from ICRP 60 relate to breast, gonads and treatment of remainder tissues." ACNW's comments on FD-C-2 are provided separately below.

Foundation Document "Draft for Discussion International Commission on Radiological Protection Committee 2 Basis for Dosimetric Quantities Used In Radiological Protection"

The two principal recommendations in this report are to change the radiation weighting factors for protons and neutrons and change the tissue weighting factors used to calculate the effective dose (formerly referred to as dose equivalent).

For protons, the ICRP recommends that the weighting factor be lowered from 5 (the value recommended in ICRP Publication 60[1]) to 2. Currently, in 10 CFR 20.1004, Table 1004(B).1, Quality Factors and Absorbed Dose Equivalencies, a quality factor of 10 is given for high energy protons. Consistent with our letter of November 3, 2004, the ACNW believes that the Commission should consider updating this quality factor, but that the update can be done by issuing regulatory guidance or at a time when the regulations are revised for other reasons. The ICRP has developed a method to calculate the quality factor for neutrons as a function of neutron energies. Three equations for three different energy ranges are recommended in Equation 4.7:

$$w_R = \begin{cases} 2.5 + 18.2e^{-[\ln(E_n)]^2/6} & , \quad E_n < 1\,\text{MeV} \\ 5.0 + 17.0e^{-[\ln(2E_n)]^2/6} & , \quad 1\,\text{MeV} \le E_n \le 50\,\text{MeV} \\ 2.5 + 3.25e^{-[\ln(0.04E_n)]^2/6} & , \quad E_n < 50\,\text{MeV} \end{cases} . \qquad (4.7)$$

Neutron energy (MeV) (thermal).....	Quality factor (Q) 10 CFR 20.1004 (B) 2	Values Calculated from New ICRP Methods	Ratio of ICRP Recommended Value to Current 10 CFR 20.1104
2.50E-08	2	2.5	1.25
1.00E-07	2	2.5	1.25
1.00E-06	2	2.5	1.25
1.00E-05	2	2.5	1.25
1.00E-04	2	2.5	1.25
1.00E-03	2	2.5	1.25
1.00E-02	2.5	3.0	1.21
1.00E-01	7.5	10.0	1.34
5.00E-01	11	19.3	1.75
1	11	22.0	2.00
2.5	9	19.8	2.20

The table above shows that the current quality factors for neutrons differ from those using the ICRP's recommended formulas by factors ranging from 1.21 to 2.20. These factors are not substantially different and given the uncertainties in determining neutron spectra in practical

[1] ICRP. 1990 Recommendations of the ICRP. ICRP Publication 60. *Ann of the ICRP*, 21(1-3). Pergamon Press, Oxford (1991).

radiation protection situations, these factors may often be comparable to the errors associated with such measurements. Consistent with its letter of November 3, 2004, the ACNW believes that the Commission should consider incorporating this method of calculating neutron quality factors, but that the update can be done through regulatory guidance or at a time when the regulations are revised for other reasons.

This Foundation Document, along with the Foundation Document on Biological and Epidemiological Information, also suggests changes to tissue weighting factors:

> "In the proposals for the new Recommendations the W_T for remainder (0.12) is divided equally between the 15 specified tissues given in Table 2, i.e. approximately 0.008 each. This value is smaller than the least value assigned to any of the named tissues (0.01). In practice this gives the arithmetic average of the doses to these 15 tissues. Since the formulation of remainder is the same in every case the system preserves additivity in effective doses which is a considerable advantage in practical radiation protection."

This change clarifies how to calculate dose to other organs not specifically assigned weighting factors.

In changing these weighting factors, to be consistent it would be necessary to recalculate the existing Annual Limits on Intake and Derived Air Concentrations used in current regulations.

"The Optimisation of Radiological Protection - Broadening the Process," Report by the ICRP Committee 4 Task Group on Optimisation of Protection

The ACNW observed in its letter of November 3, 2004, that

> "current ICRP recommendations ....[are] sufficient regarding "optimization." The Committee questions whether the draft ICRP recommendations are really improvements. ALARA as practiced in the U.S. provides a framework for accomplishing much of what the ICRP says about "optimization." ALARA is well understood and ALARA programs identify both dose reduction opportunities and other safety issues. The draft ICRP recommendations would unnecessarily complicate existing ALARA principles and applications with new terminology or dimensions."

The ACNW believes the additional guidance provided in this Foundation Document would not substantially improve current ALARA programs or protection of workers, the public, and the environment.

Additionally, this Foundation Document provides ICRP's views on the "role of the stakeholder." The ACNW believes that the Commission has developed significant initiatives to involve stakeholders in the regulatory process as described in the Strategic

Plan and implementing documents and programs, particularly with regard to "openness" [reference: NRC's Strategic Plan: FY 2000 - FY 2005, NUREG-1614, Vol. 2, part 1].

Foundation Document: "The Concept and Use of Reference Animals and Plants for the Purposes of Environmental Protection"

The ACNW believes that the ICRP has failed to make a case for overturning the principle that has guided radiation protection practice for more than 50 years. This principle states that protecting humans also protects the environment. The ICRP says in paragraph (6):

> The Commission [ICRP] still believes that this judgement is likely to be correct in general terms, because the steps taken to protect the public, by reference to dose limits for them, have resulted in strict controls and limitations on the quantities of radionuclides deliberately introduced into the environment."

The ACNW believes that the ICRP has not provided any evidence to contradict this long-standing principle.

Further, it seems clear that the ICRP's guidance is driven by other concerns. As the ICRP states:

> However, there are now other demands upon regulators, in particular the need to comply with the requirements of legislation directly aimed at the protection of wildlife and natural habitats; the need to make environmental impact assessments with respect to the environment generally; and the need to harmonise approaches to industrial regulation, bearing in mind that releases of chemicals from other industries are often based upon their potential impact upon both humans and wildlife.

The ACNW believes that this ICRP recommendation goes far beyond radiation protection issues and is more relevant to strategies for national policy on radiation protection. It is telling that in the last quote the ICRP cites "chemicals from other industries" as an example but does not explain why radioactive materials should be included with chemicals. The justification for this linkage is not clear and in any case is not developed or substantiated in the text.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, DC 20555 - 0001

ACNW R-0224

July 27, 2005

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

SUBJECT: RESPONSE TO THE OCCUPATIONAL SAFETY AND HEALTH AGENCY REQUEST FOR INFORMATION ON IONIZING RADIATION

Dear Chairman Diaz:

On May 3, 2005, the Occupational Safety and Health Agency (OSHA) submitted the following request for information in the *Federal Register*:

> OSHA requests data, information and comment on issues related to the increasing use of ionizing radiation in the workplace and potential worker exposure to it. Specifically, OSHA requests data and information about the sources and uses of ionizing radiation in workplaces today, current employee exposure levels, and adverse health effects associated with ionizing radiation exposure. OSHA also requests data and information about practices and programs employers are using to control employee exposure, such as exposure assessment and monitoring methods, control methods, employee training, and medical surveillance. The Agency will use the data and information it receives to determine what action, if any, is necessary to address worker exposure to occupational ionizing radiation.

The Advisory Committee on Nuclear Waste (ACNW or Committee) considered OSHA's request for information (RFI) as published in the *Federal Register* and is providing its independent views on OSHA's RFI.

The Committee notes that many components of a robust system of radiation protection, including radiation protection programs, regulations and regulatory agreements, and other sources of information, already exist:

1. NRC and Agreement States regulations promulgated for activities regulated by the Atomic Energy Act (AEA);

2. State radiation protection programs for non-AEA radioactive materials;

3. Federal guidance on sources of electronic product radiation from the Center for Devices and Radiological Health of the Food and Drug Administration;

4. State programs for electronic product radiation control;

5. U.S. Environmental Protection Agency general applicable radiation protection statutes and related guidance;

6. U.S. Department of Energy radiation protection statutes (10 CFR Part 835, "Occupational Radiation Protection"), regulations, orders, and guidance;

7. Reports of the National Academy of Sciences, including the recent report "Health Risks from Exposure to Low Levels of Ionizing Radiation" Biological Effects of Ionizing Radiation (BEIR) VII - Phase 2, 2005;

8. The Conference of Radiation Control Program Directors (CRCPD) and the Organization of Agreement States (OAS) programs that support Agreement State and non-Agreement State radiation protection programs;

9. The CRCPD and OAS joint letter to OSHA regarding its RFI;

10. NRC data on occupational radiation exposure (NUREG-0713, Volume 25, "Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities," 2003);

11. Nuclear Energy Institute (NEI) data on occupational radiation exposure;

12. Guidance offered by the National Council on Radiation Protection and Measurements (NCRP); and

13. OSHA-NRC Memoranda of Understanding.

This information demonstrates that existing programs provide adequate radiation protection to workers. We have summarized some of the information in the appendix to this letter.

The Committee also believes that the premise of OSHA's request for information that worker exposure might be increasing is not substantiated. For example, the ACNW notes that in Table 3.1 of NUREG-0713 (see the appendix to this letter), the trend in average measurable Total Effective Dose Equivalent (TEDE) per worker has decreased in every one of the six categories of NRC licensees (from 1994 to 2003).

The Committee did not have access to any comprehensive database for radiation dose information for radiation workers in medical areas that use non-AEA radioactive materials or electronic product radiation devices and cannot comment on trends for these workers. The ACNW notes that these workers' groups are monitored under State authority. The 33 Agreement States typically integrate these non-AEA radiation worker monitoring and protection programs into NRC-approved programs. Nonetheless, the ACNW cannot include this radiation worker group in the remaining comments in this letter.

The NEI provided additional analysis to the Committee indicating a clear trend in worker dose reduction in the nuclear power industry for collective dose per reactor and collective dose per megawatt year of operation. The NEI data on average annual number of workers with measurable dose for the period of 1973 - 2003 show a decreasing trend since 1984. The NEI reported that these trends are a result of robust As Low As Reasonably Achievable (ALARA) programs rather than a focus only on strict numerical standards. The ACNW interprets the data to indicate that the current limits, along with the implementation of the ALARA principle, have been effective in providing radiation protection for workers.

While collective dose for Department of Energy (DOE) workers has increased from 2002 - 2003, this increase reflects more work activities rather than an increase for individual workers (DOE/EH-0688, "DOE Occupational Radiation Exposure 2003 Report").

Moreover, the recently released BEIR VII report affirms that cancer risk estimates for exposure to ionizing radiation have not changed significantly from those reported in previous BEIR reports.

In summary, the ACNW believes that existing radiation safety programs and the current regulatory infrastructure promote effective and timely oversight of occupational radiation protection programs required under Federal and State authorities. Furthermore, documented trends in worker exposures do not support the need for a new regulatory initiative. The ACNW recommends that the Commission provide a response to OSHA consistent with this view.

Sincerely,

/RA/

Michael T. Ryan
Chairman

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In summary, the ACNW believes that existing radiation safety programs and the current regulatory infrastructure promote effective and timely oversight of occupational radiation protection programs required under Federal and State authorities. Furthermore, documented trends in worker exposures do not support the need for a new regulatory initiative. The ACNW recommends that the Commission provide a response to OSHA consistent with this view.

Sincerely,

Michael T. Ryan
Chairman

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NAME	SSteele		MScott		JLarkins		AThadani		MTRyan	
DATE	07/27/05		07/27/05		07/27/05		07/27/05		07/27/05	

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APPENDIX
INFORMATION EVALUATED BY ACNW REGARDING OSHA'S REQUEST FOR INFORMATION (RFI)

NRC Data on Occupational Radiation Exposure

NRC summarizes information regarding worker exposure from its databases for several industry segments. The latest available summaries are provided in NUREG-0713, Volume 25, "Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities." Example data from NUREG-0713 (Table 3.1) are provided below. The table shows the average annual exposure for certain categories of NRC licensees: namely industrial radiography, manufacturing and distribution, low-level waste disposal, independent spent fuel storage, fuel cycle licenses, and commercial light water reactors. The table indicates a downward trend in the collective dose (person-rem) from 1994 to 2003 across the industries measured. This observation further supports ACNW's view that the system of radiation protection is robust and effective; thus, OSHA need not intervene to address worker exposure to occupational ionizing radiation.

Agreement State Programs

In its recent review of the NRC Agreement States program, the ACNW found the radiation program to be robust and effective in providing radiation protection programs for workers regulated under both Atomic Energy Act (AEA) and non-AEA-regulatory authority. ACNW has reported previously on the Integrated Material Performance Evaluation Program (IMPEP), created to oversee and review the Agreement States program. IMPEP results are used to determine the adequacy and compatibility of individual Agreement State programs. In the ACNW's 2005 letter to the Commission, "Status of the Agreement State Program and the Integrated Materials Performance Evaluation Program (IMPEP)," the Committee stated the following:

> Two key factors make the IMPEP program proactive rather than reactive, and risk informed and performance based rather than prescriptive. First, the collaboration of independent Agreement State staff members and NRC's regional materials program staff on review teams provides for consistency among the States and lets them share their results and experiences. This interaction has led to improved risk-informed approaches and procedures. Second, IMPEP ratings and responses use a graded approach with progressively more significant levels of action.
>
> Future inspection frequency and the depth of interaction with Agreement States Program staff are determined by review of a program's performance.
>
> This graded approach allows for effective oversight and identification of Agreement State programs needing attention, so that corrective measures can be implemented before significant problems arise.

TABLE 3.1
Average Annual Exposure Data for Certain Categories of NRC Licensees
1994-2003

NRC License Category* and Program Code	Calendar Year	Number of Licensees Reporting	Number of Monitored Individuals	Number of Workers With Measurable TEDE	Collective TEDE (person-rem)	Average TEDE (rem)	Average Measurable TEDE per Worker (rem)
Industrial Radiography	1994	139	2,886	2,007	1,415	0.49	0.71
	1995	149	3,761	2,651	1,443	0.38	0.54
	1996	148	3,766	2,639	1,449	0.38	0.55
03310	1997	148	3,570	2,574	1,356	0.38	0.53
03320	1998	142	4,052	3,446	1,863	0.38	0.54
	1999	132	3,837	2,827	1,551	0.40	0.55
	2000	129	3,968	2,542	1,528	0.45	0.60
	2001	124	3,780	3,161	2,111	0.56	0.67
	2002	100	3,420	2,842	1,729	0.51	0.61
	2003	86	2,649	2,319	1,504	0.57	0.65
Manufacturing and Distribution	1994	44	2,941	1,251	580	0.20	0.46
	1995	36	2,666	1,222	595	0.22	0.49
	1996	38	2,631	1,241	556	0.21	0.45
	1997	33	1,154	665	397	0.34	0.60
02500	1998	31	1,986	654	402	0.20	0.61
03211	1999	39	2,181	836	419	0.19	0.50
03212	2000	39	2,461	1,188	415	0.17	0.35
03214	2001	36	1,862	1,211	351	0.19	0.29
	2002	29	1,437	1,052	328	0.23	0.31
	2003	23	1,849	1,459	394	0.21	0.27
Low-Level Waste Disposal**	1994	2	202	83	22	0.11	0.27
	1995	2	212	56	8	0.04	0.15
	1996	2	165	67	8	0.05	0.12
	1997	2	185	50	5	0.03	0.11
03231	1998	1	27	13	1	0.05	0.10
	1999	0					
Independent Spent Fuel Storage	1994	1	158	89	42	0.27	0.47
	1995	1	104	48	51	0.49	1.04
	1996	1	97	53	54	0.56	1.02
	1997	1	55	24	6	0.11	0.24
23100	1998	1	53	21	3	0.05	0.12
23200	1999	2	86	33	5	0.06	0.16
	2000	2	146	83	6	0.04	0.07
	2001	2	154	107	13	0.08	0.12
	2002	2	75	67	5	0.06	0.09
	2003	2	55	45	3	0.05	0.06
Fuel Cycle Licenses - Fabrication Processing and Uranium Enrich.	1994	8	3,596	2,847	1,147	0.32	0.40
	1995	8	4,106	2,959	1,217	0.30	0.41
	1996	8	4,369	3,061	878	0.20	0.29
	1997	10	11,214	3,910	1,006	0.09	0.26
	1998	10	10,684	3,613	950	0.09	0.26
	1999	9	9,693	3,927	1,020	0.11	0.26
	2000	9	9,836	4,649	1,339	0.14	0.29
21200	2001	9	8,145	3,980	1,162	0.14	0.29
21210	2002	8	7,937	3,886	661	0.08	0.17
	2003	8	7,738	3,633	556	0.07	0.15
Commercial Light Water Reactors***	1994	109	139,390	71,613	21,704	0.16	0.30
	1995	109	132,266	70,821	21,688	0.16	0.31
	1996	109	126,402	68,905	16,883	0.15	0.28
	1997	109	126,781	68,372	17,149	0.14	0.25
41111	1998	105	114,367	57,466	13,187	0.12	0.23
	1999	104	114,154	59,216	13,666	0.12	0.23
	2000	104	110,557	57,233	12,652	0.11	0.22
	2001	104	104,928	52,292	11,109	0.11	0.21
	2002	104	107,900	54,460	12,126	0.11	0.22
	2003	104	109,990	55,967	11,956	0.11	0.21
Grand Totals and Averages	1994	303	149,173	77,890	24,910	0.17	0.32
	1995	305	143,115	77,758	25,003	0.17	0.32
	1996	306	137,430	75,366	21,828	0.16	0.29
	1997	303	142,959	75,595	18,919	0.14	0.26
	1998	290	132,069	65,213	16,406	0.12	0.25
	1999	286	129,951	66,839	16,661	0.13	0.25
	2000	283	125,868	65,695	15,940	0.13	0.24
	2001	275	118,869	60,751	14,746	0.12	0.24
	2002	243	120,769	62,807	14,850	0.12	0.24
	2003	223	122,281	63,424	14,419	0.12	0.23

* These categories consist only of NRC licensees. Agreement State licensed organizations are not required to report occupational exposure data to the NRC.

** As of 1999, there are no longer any NRC licensees involved in this activity. All low-level waste disposal facilities are now located in Agreement States and no longer report to the NRC.

*** Includes all LWRs in commercial operation for a full year for each of the years indicated. Reactor data have been corrected to account for the multiple counting of transient reactor workers (see Section 5).

Environmental Protection Agency (EPA) Radiation Protection Programs and Requirements

The EPA has responsibility for protecting the public with considerable authority for developing radiation protection program guidance and setting environmental standards. The EPA has wide-ranging authority to promote, conduct, or contract research for radiation protection information; to promulgate generally applicable environment standards which limit man-made radioactive materials; to provide technical assistance to the States and other Federal agencies with radiation protection programs; to advise them in the execution of such programs; and to provide emergency assistance in responding to radiological emergencies. While EPA's generally applicable radiation protection standards apply to protection of members of the public, they are coordinated with requirements promulgated by NRC and the States.

Department of Energy (DOE) Radiation Protection Programs and Requirements

The DOE's 10 CFR 835, "Occupational Radiation Protection," provides nuclear safety requirements that, if violated, provide a basis for the assessment of civil and criminal penalties. The DOE has a series of guides, standards, programs, and orders which are consistent with 10 CFR 835. The DOE's Office of Health and Safety establishes comprehensive and integrated programs for the protection of workers from hazards in the workplace, including ionizing radiation. The DOE has standard radiation dose limits which establish maximum permissible doses to workers and members of the public. DOE radiation protection standards are based on EPA 1987 guidance, which in turn is based on recommendations from the International Commission on Radiological Protection (1977) and the National Council on Radiation Protection and Measurements (NCRP) (1987). In addition to the requirement that radiation doses not exceed the limits, contractors are required to maintain ALARA exposures.

According to DOE/EH-0688, "DOE Occupational Radiation Exposure 2003 Report,"

> The change in operational status of DOE facilities has had the largest impact on radiation exposure over the past 5 years due to the shift in mission from production to cleanup activities and the shutdown of certain facilities. For 2003, this resulted in an increase in the collective dose as sites handled more radioactive materials for processing, storage, or shipping.

In this document, DOE also stated that a statistical analysis of data over the past 5 years indicates "that while the collective TEDE, neutron, and extremity dose increased between 2002 to 2003, it does not represent a statistically significant change in the dose received by individual workers at DOE."

Other Data Sources

ACNW considered several databases:

- Specific information related to incidents in Agreement and non-Agreement States was included from the NRC's nuclear materials events database (NMED), *http://www.nmed.inl.gov*.

- State radiation control programs most often integrate regulation and control of ionizing radiation and radioactive material not regulated by NRC under the Atomic Energy Act

(as amended). Sources of information include the Conference of Radiation Control Program Directors (CRCPD) <http://*www.crcpd.org*> and the Organization of Agreement States (OAS) <*http://www.agreementstates.org*>.

- Recent examples of emerging guidance include: the work cosponsored by the Center for Devices and Radiological Health (CDRH) and the Transportation Security Administration (TSA) and performed by the NCRP. This work is reported in the "Presidential Report on Radiation Protection and Advice: Screening of Humans for Security Purposes Using Ionizing Radiation Scanning Systems." The report will be completed and delivered to CDRH this summer. The CDRH intends to use the NCRP recommendations as guidance when considering new performance standards. The CDRH also is working with other government agencies and the American National Standards Institute Committee (ANSI) N43 to identify new consensus standards for cargo and vehicle scanners that use ionizing radiation.

- The National Academy of Sciences recently released its BEIR VII report "Health Risks from Exposure to Low Levels of Ionizing Radiation," which provides an update to health risks related to radiation. The report affirms that current cancer risk estimates have not changed significantly from earlier estimates.

- The 2003 DOE Occupational Radiation Exposure Report provides a summary and analysis of the occupational radiation exposure received by individuals associated with DOE activities.

OSHA-NRC Memoranda of Understanding

There are four Memoranda of Understanding (MOU) between OSHA and NRC.

1. **STD 01-04-001 – STD 1-4.1 OSHA Coverage of Ionizing Radiation Sources Not Covered by the Atomic Energy Act 10-30-1978.** This early memorandum recognizes the U.S. Atomic Energy Commission (AEC) authority to regulate source, by-product, and certain special nuclear materials, and that OSHA's authority to regulate radiation sources does not include those regulated by AEC. It further states that OSHA covers all radiation sources not regulated by AEC, such as X-ray equipment, accelerators, accelerator-produced materials, electron microscopes, betatrons, and some naturally occurring radioactive materials.

2. **CPL 02-00-086 – CPL2.86 – Memorandum of Understanding Between OSHA and NRC.** This memorandum characterizes NRC-licensed nuclear facility hazards into four categories:

- Radiation hazards produced by radioactive materials;

- Chemical hazards produced by radioactive materials;

- Plant conditions which affect the safety of radioactive materials and thus present an increased radiation hazard to workers; and

- Plant conditions which result in occupational hazards, but do not affect the safety of the licensed radioactive materials.

This MOU delineates the general areas of responsibility of each agency, describes generally the efforts of the agencies to achieve worker protection at facilities licensed by NRC, and provides guidelines for coordination of interface activities between OSHA and NRC. To insure against gaps in the protection of workers and avoid duplication of effort, the MOU acknowledges NRC jurisdiction over the first three hazards and OSHA over the fourth hazard.

3. Worker Protection at Facilities Licensed by the NRC 11-16-1998. This MOU describes the efforts of the agencies to achieve worker protection at facilities licensed by NRC and provides guidelines for coordination of interface activities between OSHA and NRC. The accord replaced existing guidelines which had been used to coordinate activities of the two agencies. OSHA will provide NRC information, based on reports of injuries or complaints, about nuclear power plant sites where increased management attention to worker safety is needed. OSHA also will give training in basic chemical and industrial safety to NRC inspection personnel so that they will be able to better identify matters of concern to OSHA in radiological and nuclear inspections. The NRC will provide training in radiation safety to those OSHA and State program personnel who may participate in joint evaluation of safety hazards in some facilities.

4. **Gaseous Diffusion Plant Sites.** The AEA, as amended, created the United States Enrichment Corporation (USEC), to manage and operate the two uranium gaseous diffusion enrichment plants in Paducah, Kentucky, and Piketon, Ohio. The AEA requires USEC to be subject to and comply with the Occupational Safety and Health Act, and with applicable NRC standards for radiological safety and common defense and security. Furthermore, the USEC Privatization Act requires NRC and the OSHA to enter into a memorandum of agreement to coordinate their regulatory programs to assure worker safety, avoid regulatory gaps in the protection of workers, and avoid duplicative regulation.

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

September 29, 2005

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

SUBJECT: REVIEW OF STAFF'S PRECLOSURE REVIEW PREPARATIONS FOR THE PROPOSED YUCCA MOUNTAIN REPOSITORY

Dear Chairman Diaz:

At its 162nd meeting on August 2-4, 2005, the Advisory Committee on Nuclear Waste (ACNW) heard a presentation by the Nuclear Regulatory Commission (NRC) staff on "Status of Yucca Mountain Preclosure Review Preparations." The following are our observations and recommendations regarding the staff's preparations to meet the challenge of this risk-informed, performance-based review.

Background

The NRC staff has undertaken a number of activities to prepare for its review of preclosure design aspects of the license application for the proposed Yucca Mountain repository. An important part of these activities is the organization of review teams for performance assessment, engineering, site characterization, and health physics. The staff is also developing a list of risk-significant topics based on the staff's experience and analysis and on information obtained from visits to relevant fuel-handling facilities. The staff is concentrating on high-risk topics (including the related uncertainties) and on structures, systems, and components that can prevent or mitigate the impacts of postulated event sequences.

The staff identified topics for detailed prelicensing review. The topics include aircraft crash hazard and event sequences, criticality and seismic event sequences, and preclosure safety analysis. The staff has begun to discuss these topics in a series of technical exchanges with the U.S. Department of Energy (DOE).

Observations

The NRC staff informed the Committee that preclosure design aspects of licensing are receiving increased attention and that the staff is applying necessary resources to address them. The staff is developing guidelines for staff interaction with DOE on preclosure topics before the license application submittal. The Committee agrees with this approach. However, the Committee recognizes that the efficiency and effectiveness of the staff's efforts have been challenged by the apparent lack of completeness and detail in available information on the design of preclosure systems, processes, facilities, and equipment that are important to operational safety.

The Committee concurs that the staff's initial list of review topics is appropriate for evaluation. Additional topics for evaluation are identified in periodic staff meetings. The Committee believes iterative preclosure safety assessments and relevant licensing experience (e.g., Private Fuel Storage) are potentially useful in identifying additional topics. The rigor of the staff's approach to preparing and modifying the list of preclosure focus topics would be easier to recognize if the staff had a documented basis for the choice of topics (and, as appropriate, a basis for exclusion of topics).

The Committee believes that lessons learned from other nuclear regulatory licensing experience could also be a useful source of topics for the staff's preclosure review. For example, human reliability and fire protection may dominate the risk at both reactor and nonreactor facilities if not considered early in the design stage. Risk insights indicate that without attention to human reliability aspects of design and adequate training in the early stages of design, human error can be a significant contributor to accidents associated with movement of heavy loads at reactor facilities. A significant number of heavy-load lifts, load manipulations, and movements are expected to occur during the preclosure operational stage of the repository. They should therefore be evaluated in the preclosure review. Likewise, costly fire protection retrofitting at reactor facilities occurred in the past because designers did not have a thorough understanding early in the design stage of the risk from fire. Fire and smoke propagation can lead to adverse system interactions and common-cause failures that may compromise multiple safety barriers.

Another topic deserving attention is equipment and facility aging analysis. The staff informed the Committee that it plans to consider aging effects in estimating the probability of failure of equipment. Given the lengthy period of operation that the DOE contemplates for the preclosure facility, these effects could be significant, although difficult to quantify. The Committee also notes that reliability goals for important preclosure equipment such as have been established for safety-significant reactor equipment could be a significant enhancement to preclosure safety.

Recommendations

1. The NRC staff should develop a documented, risk-informed process for identifying topics that the staff will focus on in reviewing preclosure aspects of the proposed Yucca Mountain repository. Iterative safety assessments could be a useful tool in such a process.

2. The staff should add human reliability analysis and fire protection to the list of high-priority preclosure review topics.

3. The staff should assess DOE's reliability targets for systems and components important to safety and those factors that impact reliability during the preclosure period (e.g., design configuration, operation, equipment and facility aging, surveillance, and maintenance).

4. To increase the efficiency and effectiveness of its preparations for a risk-informed performance-based review, the staff should continue to seek detailed information from DOE on preclosure design.

We look forward to hearing from the staff again on the subject of preclosure safety assessment at a mutually convenient future date.

Sincerely,

Michael T. Ryan
Chairman

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

September 30, 2005

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

SUBJECT: COMMENTS ON USNRC STAFF RECOMMENDATION OF THE USE OF COLLECTIVE DOSE

Dear Chairman Diaz:

On July 20, 2005, staff from the Office of Nuclear Regulatory Research briefed the Committee regarding proposals on effective and realistic uses of the concept of collective dose in radiation dose analysis.

The staff reported they are considering four options (one with three variations) regarding the uses of collective dose. These options as reported are as follows.

Option 1-Truncate individual doses at some nominal value.

- Truncate individual doses at some nominal value from the collective dose calculation.
- Truncate individual doses at some distance from a facility or at some future time.

Option 2-Health Physics Society position on collective dose

- For populations in which *almost* all individuals are estimated to receive a lifetime dose of less than 10 rem above background, collective dose is a highly speculative and an uncertain measure of risk and should not be used for the purpose of estimating population health risks [Radiation Risk in Perspective (position statement of the Health Physics Society),1996, revised in 2004].
- Estimation of health risk associated with radiation doses that are of similar magnitude as those received from natural sources should be strictly qualitative and encompass a range of hypothetical health outcomes, including the possibility of no adverse health effects at such low levels.

Option 3-Individual dose emphasis

- Emphasizes protection of individuals in the critical group of an exposed population and assumes that if the average individual in the critical group is protected, the entire population is protected.
- Consistent with the 10 CFR Part 20 Subpart E, "Radiological Criteria for License Termination Rule," which explicitly states that the average individual of the critical group must be below a 25 mrem per year dose constraint and ALARA.

- No collective dose is calculated in this option.

Option 4-Significance determination of a collective dose calculation

- Use a Commission-approved criterion to judge the significance of a collective dose calculation.

Option 4a: 1 mrem per year and 100 person-rem per year

- International bodies argue that it is not cost-beneficial to do a formal cost-benefit analysis process when individual and collective doses are less than 1 mrem per year and 100 person-rem per year, respectively, and the practice can be exempted from regulatory oversight (IAEA 1996, ICRP 1992, EC 1999).

Option 4b: Background collective radiation dose comparison

- Compare the collective dose from a regulated activity to the collective dose from background radiation to the same population.

- This approach is comparable to the approach in NUREG-1515, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants."

Option 4c: Safety goal evaluation

- Expand the use of the reactor safety goal/quantitative health objective value for latent cancer fatalities of "0.1% of the sum of cancer fatality risks resulting from all other causes" to other applications that use collective dose.

- The staff would compare collective dose calculations to this safety goal value, either in units of person-rem or in latent cancer fatality risk, and make a determination of "not a significant additional risk."

Observations and Recommendations

The Committee believes that collective dose has little value in an *absolute* sense. Irrespective of whether very low doses can be reliably measured or estimated, the product of an individual dose and a population magnitude does not yield a number that has any real meaning. When estimates of risk are desired, the Committee recommends use of individual risk within the context of the critical group or the reasonably maximally exposed individual (RMEI) scenario.

However, the Committee does believe that collective dose is useful for comparing different management options (e.g., steps taken under ALARA to reduce radiation doses to workers).

The Committee believes that there is no basis for truncating dose at some nominal value when calculating collective dose.

Given the inherent limitations of collective dose and the serious potential for misuse (e.g., using collective dose as a measure of risk), the Committee does not recommend adoption of any of the options considered above.

Sincerely,

Michael T. Ryan
Chairman

REVIEW OF SELECTED NRC RESEARCH AND TECHNICAL ASSISTANCE

Ruth F. Weiner

Recent Activities

- Visited Center for Nuclear Waste Regulatory Analyses (April 2005)
- Briefing by RES on waste-safety research program (July 2005)
- Briefing by RES on reactive transport programs (November and December 2005)

- **Reported on RES-sponsored work on groundwater discharge (April 2005)**
- **Reported on CNWRA programs (August 2005)**
- **Reported on CNWRA igneous activity work (December 2005)**
- **Reported on RES-sponsored programs (December 2005)**

2005 CNWRA Visit Topics

- Igneous activity
- Container life and source term
- Codes and models for complex decommissioning sites
- Radionuclide retardation

CNWRA Programs

- Strong programs in the areas of container life and source term characterization
- Results to date include:
  - Characterization of the passive film in Alloy 22
  - Quantification of the behavior of localized corrosion and corrosion inhibitors
  - Evaluation of the impact of spatial water chemistry on sorption

RES-Sponsored Work

- High-quality work with limited funding
- Effectiveness of the programs enhanced by cooperative arrangements with national and international research organizations
- Joint working groups are planned

RES-Sponsored Work
Future Activities

- **Review of Package Performance Study protocols**
- **Joint working groups, as appropriate**

ACNW LETTERS

#11

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, DC 20555 - 0001

ACNWR-0225

August 3, 2005

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

SUBJECT: REPORT ON SELECTED NRC-SPONSORED TECHNICAL ASSISTANCE PROGRAMS AT THE CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

Dear Chairman Diaz:

During the past 16 months the Advisory Committee on Nuclear Waste (ACNW) has written five letters to the Commission describing results of the ACNW's continuing oversight of the Nuclear Regulatory Commission's (NRC's) regulatory technical assistance and research programs. The topics discussed were selected programs of the Center for Nuclear Waste Regulatory Analyses (CNWRA) (March 4, 2004), radionuclide transport (May 5, 2004), uranium dioxide solubility (July 6, 2004), model uncertainty (August 4, 2004), and groundwater recharge (April 27, 2005). The ACNW also briefed the Commission on the research program on March 16, 2005.

As part of the Committee oversight, three members of the ACNW led a focused discussion of selected technical assistance topics on April 13-15, 2005 at the CNWRA in San Antonio, Texas. Two ACNW consultants supported these members. The Technical Director of the CNWRA had previously provided the ACNW team an overview of the accomplishments of the CNWRA and future projects during the 157th ACNW meeting in February 2005. The team focused its April 2005 discussions on activities addressing topics likely to be important in evaluating a license application for a potential repository at the Yucca Mountain site and of particular interest to the ACNW.

This letter, the first of two addressing topics discussed during the April 2005 visit, deals with the CNWRA work on corrosion, radionuclide mobility, and performance assessment modeling. A second letter will address analysis of a potential igneous event at Yucca Mountain and its possible consequences.

Summary of the team's Yucca Mountain-related observations:

(1) The presentations on container life, the radionuclide source term, the near-field environment, radionuclide retardation, and the published versions of the Department of Energy's Total System Performance Assessment were comprehensive and illustrated the strength of the CNWRA in these areas.

(2) The CNWRA has made significant progress in ongoing work directed at understanding the controls and the processes involved in container corrosion. Laboratory corrosion studies include stress corrosion cracking resistance of Alloy 22, high-level waste glass dissolution processes, mechanical properties of the waste package, and the relationship between in-package chemistry and package corrosion. The laboratory studies show that corrosion by chloride-containing solutions can be inhibited by appropriate ratios of certain anion concentrations. Studies of Yucca Mountain dust within the waste emplacement drifts indicate that nitrate and sulfate are present in sufficient

concentration to potentially inhibit corrosion. The results of corrosion rate studies are expressed as distributions that incorporate uncertainty in corrosion rates. The CNWRA's humidity deliquescence studies show that, although chloride deliquescence could form corrosive brine, other components of this dust can inhibit such corrosion. The CNWRA is abstracting these results for incorporation in the ongoing model development activities.

(3) Regarding spent fuel dissolution studies in support of the total-system performance assessment, the CNWRA staff is using parameter values from the technical literature and results from laboratory experiments to model the dissolution of radionuclides from spent fuel. These studies have shown that fuel burnup does not significantly influence dissolution of the uranium dioxide matrix.

(4) The CNWRA has been responsive to the suggestions made during the ACNW's Geosphere Transport Working Group meeting (ACNW letter to Chairman Diaz dated August 3, 2004). Potential spatial water chemistry impacts on sorption have been evaluated. Additional experiments are underway to determine neptunium sorption in the alluvium. Retardation in the alluvium can provide a barrier to radionuclide migration, and understanding the spatial variability of retardation reduces uncertainty.

(5) The CNWRA is currently evaluating improvements in the modeling of phenomena such as tephra remobilization, consequences of drift degradation, drip shield and waste container weld corrosion, and colloid transport. Furthermore, numerous parameter values and their distributions reflect recent progress in the understanding of relevant features, events, and processes (FEPs). This work is ongoing and is expected to lead to improvements in evaluation of the risk associated with the FEPs involved in the performance of the proposed repository.

(6) The CNWRA has ongoing programs that address the frequency, consequences, and potential health effects that are associated with igneous activity, and will publish a number of letters in the next several months. The ACNW will continue to interact with the NRC staff on this subject and will provide a letter to the Commission in the near future.

The CNWRA reported to the ACNW team on its evaluation of models and codes for use in pathway dose assessment for complex decommissioning applications and expects to complete a final letter in October 2005. The ACNW plans to review this work when it is completed.

The ACNW will continue its dialog and meetings with the NRC and CNWRA staffs and will keep the Commission apprised of our view of the progress of this work.

Sincerely,

/RA/

Michael T. Ryan
Chairman

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Sincerely,

Michael T. Ryan
Chairman

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

April 27, 2005

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

SUBJECT: BRIEFING ON RES-USDA RESEARCH: ESTIMATING GROUND WATER RECHARGE AND EVALUATING MODEL ABSTRACTION TECHNIQUES

Dear Chairman Diaz:

During its 158th meeting on March 15-17, 2005, the Advisory Committee on Nuclear Waste heard presentations from the Office of Nuclear Regulatory Research and the Agriculture Research Service of the U.S. Department of Agriculture (USDA) about their research on estimating groundwater recharge and evaluating model abstraction techniques. The main thrust of the research is to develop insights leading to (a) better understanding of near surface water movement, saturated zone recharge, and solute transport at sites with complex processes and features, and (b) guidelines on selecting models that are as simple as possible but are realistic enough to provide a basis for risk-informed decisionmaking. The Committee believes that this research should continue.

The Committee learned about work that is being done to evaluate model abstractions of subsurface water flux and pathways at a highly instrumented, densely sampled watershed-scale site operated by the USDA in Beltsville, MD. This work builds on earlier experiments conducted in well-controlled environments. Ground-penetrating radar coupled with soil moisture measurements has been used successfully at the Beltsville site to identify the location of preferred subsurface pathways that are important to the assessment of uncertainty in infiltration and groundwater recharge estimation.

This research shows:

- Infiltration and groundwater recharge can be better understood using the methodology developed in this research. Models used to predict the fate and transport of contaminants in subsurface environments are sensitive to these parameters.

- These field tests can be used to evaluate alternative conceptual models and improve the selection of the best model abstraction.

- The Beltsville facility provides the opportunity for large-scale field testing in a highly instrumented environment. The research setting permits realistic estimates for sites similar in hydrology and subsurface geology to Beltsville through the incorporation of dynamic hydrologic processes.

The Committee offers the following conclusions and recommendations:

- Continued collaboration between the NRC and the USDA is a cost-effective way to participate in high quality research that is relevant to NRC needs. The Committee noted that the cost to NRC to date has been approximately 2% of the total cost.

- The Committee believes that this collaborative research program is important because it is aimed at reducing model complexity and assessing uncertainty while maintaining realism and the ability to support risk-informed decisionmaking.

- Both the field studies and the model abstraction research appear to have important applications in the areas of site characterization, flow and contaminant transport modeling, performance assessment, contaminant isolation technology evaluation, the design of monitoring programs, and uncertainty assessment.

- The Committee encourages the research staff to develop strategies to enable the transfer of results from studies at Beltsville to other hydrologic environments.

- The Committee believes the Beltsville research program should be coordinated with similar programs. For example, field-scale hydrologic research is being conducted at DOE facilities in Washington (Hanford) and New Mexico (Sandia) and at the University of Arizona's Maricopa site. Experience from these other sites should allow extension of the methodology developed in this research.

Sincerely,

Michael T. Ryan
Chairman

WASTE DETERMINATION ACTIVITIES

Allen G. Croff

Objectives

- **Provide advice on the Standard Review Plan so that its use in reviewing waste determinations will be risk informed**
- **Evaluate emerging technologies and approaches related to waste determination**

FY 2005 Activities

- NMSS presentation (November 2004)
- Attended interagency workshop on cement materials performance (June 2005)
- Organized public waste determination working group meeting (August 2005)
- Savannah River site visit (August 2005)
- Attended tank waste retrieval technology demonstration (September 2005)

FY 2006 Activities to Date

- Attended NAS meeting on the performance of engineered barriers (October 2005)
- West Valley ACNW meeting (October 2005)
- Attended NMSS Standard Review Plan public scoping meeting (November 2005)
- Letter on Standard Review Plan (December 2005)

Standard Review Plan-I

- Single document integrating all criteria
- Consistent, risk-informed interpretation of waste determination criteria
- Evaluate adequacy of radionuclide removal and ALARA in context of surrounding risk

Standard Review Plan-II

- Anticipate improvement in radionuclide removal technology
- Encourage risk-informed performance assessment
- Expect state-of-the-art monitoring to be incorporated during design
- Look to NRC regulations and guidance on similar subjects for insights

Planned Activities

- Review draft Standard Review Plan
- Working group meeting on cement performance (engineered barriers)
- Review implementation of Standard Review Plan
- Other activities as requested by the Commission

ACNW LETTERS

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

December 9, 2005

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

SUBJECT: DEVELOPMENT OF A STANDARD REVIEW PLAN FOR U.S. DEPARTMENT OF ENERGY WASTE DETERMINATIONS

Dear Chairman Diaz:

The U.S. Department of Energy (DOE) is expected to pursue a number of determinations that certain wastes are not high-level waste as a prerequisite to allowing disposal. DOE is required or expected to request that the U.S. Nuclear Regulatory Commission (NRC) perform technical reviews of the Department's waste determinations and, in some cases, its disposal and monitoring plans for the wastes.[1] The NRC staff is currently developing a Standard Review Plan (SRP) for these reviews. In this letter the Advisory Committee on Nuclear Waste provides its recommendations on the development of the SRP based on information obtained from the following activities:

- The Committee held a 2-day public working group meeting on waste determination August 2 - 3, 2005, during its 162nd meeting. The working group meeting included background presentations by DOE and NRC staff; 12 presentations by experts from academia, research institutions, and private enterprise; three panel discussions involving these same experts and staff from the NRC Office of Nuclear Regulatory Research; and input from State agencies and public stakeholders.

- Three Committee members, ACNW staff, the Director of the Division of Waste Management and Environmental Protection in the Office of Nuclear Material Safety and Safeguards (NMSS), and a member of the public made a 1-day visit to the Savannah River Site (SRS) on August 10, 2005. They toured the tank farms, tank waste processing facilities, waste vitrification facilities, and equipment development facilities. The participants also benefitted from formal and informal discussions with SRS staff about their approach to tank cleanup and waste determinations.

- Members of the Committee, ACNW staff, and NRC staff toured the West Valley Demonstration Project (WVDP) site, participated in a working group meeting, and heard input from the public on October 18 - 20, 2005.

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[1] Section 3116 of the Ronald Reagan National Defense Authorization Act (NDAA) of Fiscal Year 2005 (Public Law 108-375-October 28, 2004) makes the NRC responsible for providing technical consultation to DOE on waste determinations in the States of South Carolina and Idaho and, in coordination with the concerned State, for monitoring DOE disposal actions.

- A Committee member who is also a member of a National Research Council committee addressing issues related to waste determinations visited DOE's tank waste storage sites at SRS, Hanford, and Idaho National Laboratory.

- An ACNW staff member attended a demonstration of waste retrieval technologies in Mooresville, North Carolina on September 7, 2005.

- An ACNW staff member attended a briefing to the National Research Council's Nuclear & Radiation Studies Board on previous and ongoing studies of issues related to waste determinations held in Washington, D.C., on September 12, 2005.

Based on the information obtained from these activities, the Committee developed the observations and recommendations provided in this letter. The observations and recommendations are organized as follows:

- Section 1 concerns the overall scope of the SRP.

- Section 2 addresses the overall consistency among criteria for waste determinations as well as the consistency of performance objectives and key phrases in the criteria, and the consistency of the criteria with other NRC regulations and guidance.

- Section 3 provides insights concerning evaluation of two key components of waste determinations: the status of radionuclide removal technology and performance assessment.

- Section 4 addresses how to evaluate whether wastes have been removed to the "maximum extent practical" and whether doses are "as low as reasonably achievable (ALARA)."

- Section 5 addresses technical considerations regarding NRC guidance on monitoring of waste determined to not be high-level waste to assess compliance with the performance objectives of Subpart C to 10 CFR Part 61.

1. STANDARD REVIEW PLAN SCOPE

The principal purposes of an SRP are to enhance the quality and uniformity of staff reviews and to present a well-defined base from which to evaluate proposed changes in the scope and requirements of reviews. The NRC has experience in developing and implementing SRPs in program areas related to waste determination reviews. The most relevant technical information can be found in NUREG-1200, "Standard Review Plan for the Review of a License Application for a Low-Level Radioactive Waste Disposal Facility," Revision 3, April 1994; NUREG-1757, "Consolidated NMSS Decommissioning Guidance," September 2003 along with draft Supplement 1, issued for public comment in September 2005; and NUREG-1573, "A Performance Assessment Methodology for Low-Level Radioactive Waste Disposal Facilities: Recommendations of NRC's Performance Assessment Working Group," October 2000.

Guidance on risk-informed, performance-based approaches helpful to the development of the SRP can be found in NUREG-1549, "Decision Methods for Dose Assessment to Comply with Radiological Criteria for License Termination-Draft Report for Comment," July 1998, and the June 1998 SRM-SECY-98-144 on the staff's white paper on risk-informed and performance-based regulation.

Developing the SRP for waste determinations is complicated by the diversity of radioactive materials to be considered, the existence of multiple sets of criteria for developing and reviewing waste determinations, and the NRC's role as consultant instead of statutory regulator.

Recommendation: The SRP should be a single document that provides integrated guidance to NRC staff on risk-informed reviews of waste determinations and implicit guidance to DOE on the information to be provided in the waste determination. The waste determination SRP should build on the generic format, content, and implementation of existing SRPs and on relevant information in existing SRPs. The Committee believes the integration will enhance uniformity and efficiency of the reviews.

2. CONSISTENCY

2.1 Criteria for Determinating of Waste Classification

The criteria for preparing and reviewing a waste determination depend on the specific waste and site:

- Section 3116 of the NDAA is applicable to some waste determinations at Savannah River and Idaho.

- NRC Decommissioning Criteria for the West Valley Demonstration Project (M-32) at the West Valley Site, Final Policy Statement [64 FR 67952, December 3, 1999] are applicable to some waste determinations there.

- DOE Order 435.1, "Radioactive Waste Management," and the supporting documents DOE M 435.1-1, "Radioactive Waste Management Manual," and DOE Guide 435.1-1, "Implementation Guide for use with DOE Manual 435.1-1," issued in 1999 and reissued in 2001, may be used as a basis for some waste determinations.

Recommendation: The SRP should adopt a consistent technical interpretation of similar criteria in the three sets of criteria.

2.2 Subpart C Performance Objectives

The Committee notes that under Section 3116 NRC staff must review waste determinations to assess conformance with 10 CFR Part 61 Subpart C performance objectives. The other two sets of criteria allow disposal to meet safety objectives comparable to the objectives stated in Subpart C. The Committee believes that the SRP should focus on confirming that DOE's proposed safety objectives are essentially identical to those in Subpart C.

Recommendation: The SRP should accept use of Subpart C performance objectives per se in all sets of criteria. If DOE chooses to use a different set of objectives, the SRP should expect DOE to provide a compelling technical justification to show that the objectives are as protective as those in Subpart C.

2.3 "Highly Radioactive" and "Key" Radionuclides

DOE Manual 435.1 and the WVDP criteria use the phrase "key radionuclides" in addressing radionuclide removal, whereas the Section 3116 criteria use the phrase "highly radioactive radionuclides." "Highly radioactive" commonly refers to relatively short-lived radionuclides, particularly if they emit penetrating radiation. The Committee notes that this common interpretation would not lead to a risk-informed approach because (a) it excludes long-lived radionuclides that should be removed to the maximum extent practical because they are important to risk in many situations (e.g., Tc-99, Np-237) and (b) it is based on an inherent property of a radionuclide (its decay characteristics) instead of the risk posed by the waste of which the radionuclide is a part. The Committee believes a risk-informed interpretation of "highly radioactive" and "key" radionuclides can best be accomplished by analyzing the results of a risk-informed performance assessment for the radionuclides that are the dominant contributors to dose.

Recommendation: The SRP should adopt a risk-informed interpretation of "highly radioactive radionuclides" by defining it to mean the same as "key radionuclides," i.e., radionuclides potentially important to meeting the Subpart C performance objectives.

2.4 Other NRC Regulations and Guidance

After removal, processing, and conversion to a solid form, tank waste will be disposed of in much the same way as is waste at a commercial low-level waste (LLW) disposal facility. A grout and cap approach is typically planned for in-place isolation of residual waste in tanks. This approach has similarities to site decommissioning. Existing NRC regulations and guidance in these two areas reflect years of experience. Examples of such guidance documents for performance assessments are NUREG-1573, NUREG-1757, and NRC staff "Technical Position on Waste Form", Revision 1, January 1991.

Recommendation: Existing NRC regulations and guidance documents should be used as a source of insights for developing the SRP.

3. TECHNOLOGY AND PERFORMANCE ASSESSMENT

3.1 Technology for Removal of Radionuclides

The Committee notes that DOE has many waste retrieval and radionuclide separation technologies available and has been relatively successful in its completed retrieval efforts. However, the Committee believes DOE will continue to face technical challenges in radionuclide removal because it has retrieved only a small portion of the waste that will eventually require retrieval and most of this waste has been retrieved from DOE's less complex tanks. Furthermore, DOE has separated radionuclides from only a fraction of the retrieved waste. The Committee observes that DOE continues to improve its radionuclide removal

technologies and adopt new technologies to address challenges as they arise.

Recommendation: The NRC staff should review the approaches to waste retrieval and radionuclide separation in each waste determination in the context of relevant existing and projected technologies. The staff should expect DOE to have considered existing relevant technologies or technologies being developed by domestic and international organizations.

3.2 Performance Assessment

Historically, variability and uncertainty in performance assessments for near-surface waste disposal were addressed by selecting one or two different values for parameters believed to be important and observing how much the estimated dose from a deterministic performance assessment changes. Exclusion of probabilistic performance assessments has been justified by using conservative approaches in the deterministic performance assessment.

The Committee believes that assumptions such as the duration of effective institutional controls and selection of conceptual models such as those for groundwater flow can dominate the magnitude of the estimated dose from near-surface waste disposal facilities. Many assumptions such as those about institutional control cannot be validated because they involve predictions of the future behavior of people and there is a growing body of literature citing experience which raises concerns about the reliability of such controls. Conceptual models of physical systems are theoretically amenable to validation through analysis or testing, but many situations are so complex that validation may not be practical.

The Committee notes the extensive use of cementitious materials as structural barriers and solid matrixes for isolating, in near-surface disposal facilities, wastes determined to not be high-level waste. Assumptions about the rates at which the beneficial properties of cementitious materials degrade are therefore important to the results of performance assessments for such facilities.

Recommendation: The SRP should specify a preference for probabilistic performance assessments using best estimates with explicit analysis of uncertainties. Exceptions should include documentation of how uncertainties were addressed.

Recommendation: The SRP should recognize that some important performance assessment assumptions are incapable of validation. Such assumptions should be based on realistic consideration of empirical evidence to the extent such evidence exists and should be subjected to uncertainty analyses.

Recommendation: The SRP should provide guidance to the NRC staff on reviewing improvements in technical bases for assumptions concerning the long-term degradation rate of cementitious materials in waste disposal applications. The NRC staff should maintain the capability to review justifications for performance assessment assumptions based on cutting-edge research concerning cementitious materials.

4. "MAXIMUM EXTENT PRACTICAL" AND ALARA

All three sets of criteria require that the amount of radionuclides in a waste be reduced to the "maximum extent practical" or the "maximum extent technically and economically practical," and that doses to workers or the public be ALARA. All of these goals are functionally the same: they require that factors such as the capability of technologies, costs, and risks associated with competing radionuclide removal alternatives be evaluated as a basis for deciding how much risk reduction (i.e., waste retrieval and processing, and use of engineered barriers) is enough. The potential importance of risks posed by other nearby waste disposal areas and contaminated environmental media is a factor to be considered in making this decision.

The Committee observes that complex decisions are likely to require consideration of stakeholder values and demands as well as technical issues. The waste determination decisionmaking process and the process for developing the SRP should be transparent and allow stakeholder participation. The November 10, 2005, NMSS public scoping meeting[2] to obtain input on the development of the SRP, was a good start toward achieving this goal.

Recommendation: The information necessary to support DOE's determination that radionuclides have been removed to the maximum extent practical or maximum extent technically and economically practical, and that estimated doses are ALARA should be the same for all sets of criteria.

Recommendation: A risk-informed evaluation of ALARA or radionuclide removal to the maximum extent practical or maximum extent technically and economically practical should be done in the context of the surrounding risk.

5. MONITORING TO ASSESS COMPLIANCE WITH PERFORMANCE OBJECTIVES OF SUBPART C

Under provisions of Section 3116, the NRC, in coordination with the host State, is required to monitor DOE disposal actions for the purpose of assessing compliance with the Subpart C performance objectives. The Committee believes compliance monitoring should be considered in the design of a system to isolate waste and the associated performance assessment. The Committee further believes that the types and quantities of waste likely to be disposed of onsite should be considered in selecting monitoring approaches and systems.

Recommendation: NRC staff activities to determine compliance with Subpart C performance objectives should review the design of barriers to radionuclide release to ensure that provisions have been made for future monitoring activities. Engineered barrier design has already been completed for some waste determinations. For these cases, the NRC will have to rely on reviewing the adequacy of the designs and determining whether improvements are necessary or feasible.

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[2] Attended by Committee Vice-Chairman Allen Croff and Committee staff member Latif Hamdan

Recommendation: Far-field and near-field monitoring, engineered barrier monitoring, and performance assessment are key elements of performance confirmation. The SRP should provide guidance to the NRC staff on these topics that includes information on how waste disposal facilities can be designed to facilitate monitoring.

The Committee looks forward to reviewing the draft SRP as the document evolves. As a result of the future opportunities for the Committee to provide its input, it does not expect a formal response to this letter from NRC staff in favor of allowing them to focus their energies on preparing the draft SRP.

Sincerely,

Michael T. Ryan
Chairman

DECOMMISSIONING

James H. Clarke

Recent Activities License Termination Rule

- Participated in decommissioning workshop (April 2005)
- Held working group meeting (June 2005)
- Issued letter on decommissioning guidance (August 2005)

Committee Recommendations

- Site-specific factors important for partial restricted release and intentional soil mixing
- Long-term control license preferred over restrictive covenants
- Additional guidance needed on use of engineered barriers and risk-informed decisionmaking

- **"Resident farmer" scenario only as a screening tool**
- **Lessons learned--design with the end in mind**

West Valley Demonstration Project

- Working group meeting in October 2005
- Focus on performance assessment methods
- Received update on site status
- Stakeholder participation
- Issue letter on WVDP (December 2005)

West Valley Site
Major Observations and Recommendations

- The West Valley site provides a useful model for decommissioning of complex sites
- Staff approach is technically sound and enables a risk-informed review

- **Erosion modeling and analysis will be critical to remedial decision making**
- **Subsurface characterization data should be used to verify groundwater modeling**

Future Activities

- **Working group meeting to review proposed decommissioning guidance under the License Termination Rule**
- **Working group meeting on modeling and monitoring for decommissioning activities**

ACNW LETTERS

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, DC 20555 - 0001

ACNWR-0226

August 12, 2005

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

Dear Chairman Diaz:

SUBJECT: DRAFT REVISED DECOMMISSIONING GUIDANCE TO IMPLEMENT THE LICENSE TERMINATION RULE

The NRC staff is developing revised decommissioning guidance to implement the License Termination Rule (LTR). In support of this effort, NRC staff and the ACNW (the Committee) have participated in two meetings. The first was an April 2005 decommissioning workshop organized by the NRC staff. The entire Committee attended this workshop. The second was a 1-day working group meeting on June 15, 2005, during the 160th meeting of the Committee.

In its working group meeting, the Committee had the benefit of discussions with the NRC staff and five invited experts selected to provide the perspective of experienced practitioners.[1] During the meeting, the Committee provided comments and suggestions that the staff is considering while developing the draft guidance. Since the staff participated in the working group meeting and subsequent Committee deliberations, the Committee is confident that its comments and suggestions have been conveyed.

The working group discussed a range of guidance revisions in several different areas. The Committee has not seen the revised document since it is still being developed. However, observations and recommendations that have been discussed with the staff are provided in the rest of this letter.

OBSERVATIONS AND RECOMMENDATIONS

- The Committee supports the issuance of generic guidance implementing the LTR. However, site-specific factors are especially important to consideration of partial restricted release under the long-term control (LTC) license and intentional soil mixing.

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[1] The invited experts were Eric Abelquist, Director of the Radiological Assessments and Training Program, Oak Ridge Institute for Science and Education; Virgil Autry, Consultant, Department of Health and Environmental Control, State of South Carolina; Eric Darois, Radiation Safety and Control Services in New Hampshire; Tracy Ikenberry, Associate and Senior Health Physicist, Dade Moeller & Associates; and Thomas Nauman, Vice President, Shaw Environmental and Infrastructure.

In these cases, the Committee recommends that the NRC staff develop criteria and a demonstration process to enable site-specific decisions on a case-by-case basis.[2]

- The staff presented an approach to classifying restricted-use sites as either lower or higher risk and a graded approach to selecting institutional controls. The Committee believes that this approach is appropriate and risk informed.

- Durable controls will be needed for higher risk restricted-use sites. NRC staff reported that the guidance will provide two options: an LTC license and a legal agreement/restrictive covenant (LA/RC) with the NRC. The second option, while potentially attractive to a site owner, may present uncertainties with respect to the survivability of the long-term controls. The staff prefers the LTC approach, and the Committee concurs with this preference.

- The staff asked the Committee for its input on the merits of partial restricted release. The staff indicated a preference for including the entire site under the LTC license, and the Committee agrees. However, there may be site-specific factors that merit consideration, and the Committee recommends a case-by-case approach to partial restricted release.

- Existing guidance on the use of engineered barriers is limited. The Committee concurs with the staff's assessment that the agency needs expanded generic guidance on the barrier design options and more performance experience that can be tailored to specific sites. The breadth and depth of this guidance should be sufficient to enable risk-informed decisionmaking.

- The staff prefers robust engineered barriers. However, the experience base for the performance of currently favored designs goes back only a few decades. Very long-term performance (centuries to millennia) has not yet been demonstrated, and there is no basis for concluding that current systems will perform for very long times without continuing periodic maintenance. The Committee concurs with the staff's assessment that monitoring will be needed to confirm performance.

- The Committee recommends that the conventional upper bound resident farmer scenario be used only as a screening tool and that realistic scenarios be used to evaluate risk. The revised guidance will address the use of more realistic scenarios for projected land use. Many decommissioning sites can achieve unrestricted release using the very conservative and unrealistic resident farmer scenario, but guidance is needed on more realistic exposure scenarios, especially for complex materials sites.

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[2] The ACNW recommended a case-by-case approach to requests for intentional mixing of contaminated soil in its letter of July 30, 2004, "Review of the LTR Analysis - Intentional Mixing of Contaminated Soil." The Committee notes that the working group expert panel was divided with respect to the merits of permitting intentional mixing of contaminated soils.

- Groundwater monitoring should be a prime consideration in the revised guidance and should address ways to determine the requirements for subsurface characterization and monitoring. The guidance should also address subsurface characterization, monitoring plans, and contingency plans should groundwater contamination occur.

- The Committee recognizes that the lessons learned from decommissioning projects provide valuable information for designing new facilities (designing with the end in mind). In addition to developing protocols and mechanisms for information collection and dissemination, the staff will need to devise a process to evaluate the accuracy and reliability of the information that is disseminated.

The Committee has participated in the staff's information-gathering activities for the revised decommissioning guidance to be published at the end of September 2005. Therefore, the staff need not respond to the issues discussed in this letter. The Committee has discussed these issues with the staff and plans to interact with the staff again after the draft guidance is published. The Committee believes that these early and ongoing interactions have helped the Committee and the staff meet their respective obligations on schedule.

The Committee plans to comment on the draft guidance when it is published.

Sincerely,

/RA/

Michael T. Ryan
Chairman

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Sincerely,

Michael T. Ryan
Chairman

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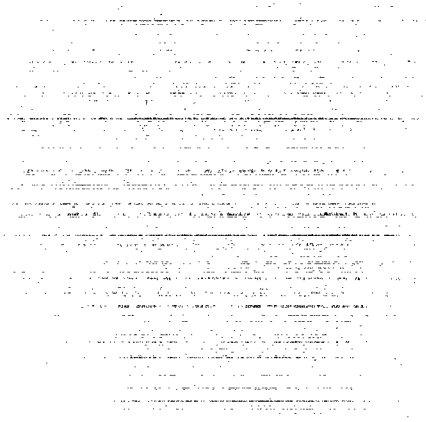
IGNEOUS ACTIVITY

William J. Hinze



Status

- Evaluation of volcanism required
- Potentially important contributor to dose
- Significant progress in developing process scenarios and exploring technical aspects, but differences based on professional judgment are recognized

Recent ACNW Activities

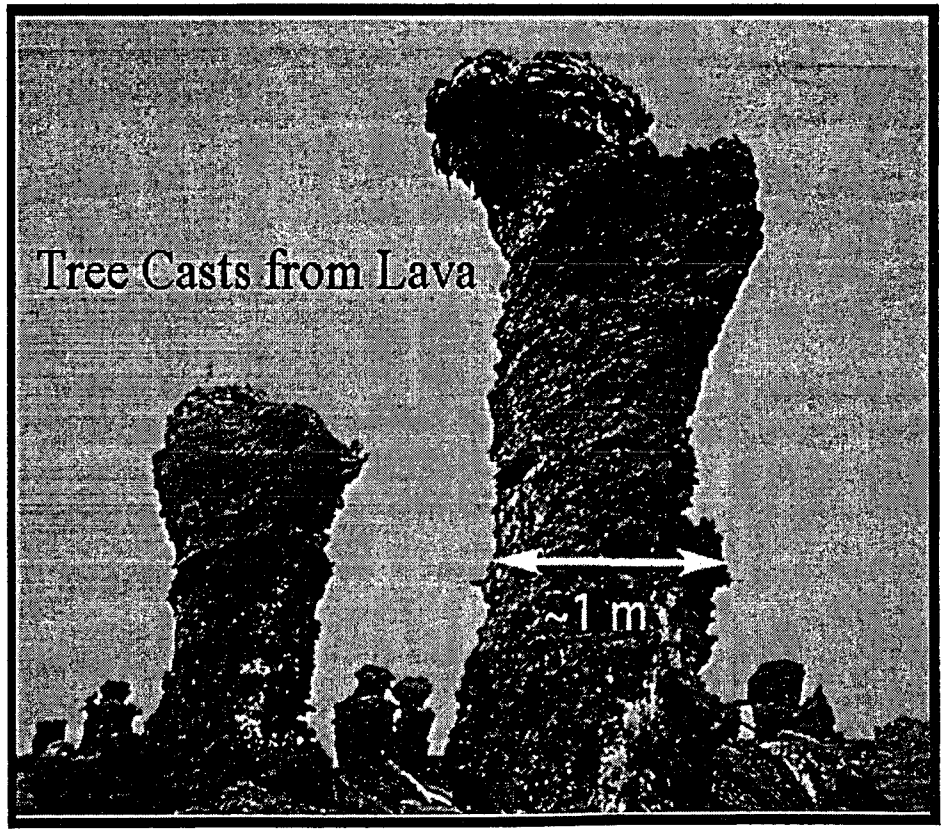
- Discussed CNWRA activities (April 2005)
- Continued document review and discussions with NMSS
- Observed DOE's expert elicitation of probability
- Issued letter report (December 2005)

Major Topics of Letter Report

- Alternative scenario regarding interaction of magma and repository
- Exposure scenario describing impact of volcanic ash on dose
- Probability of a volcanic event

Interaction Between Magma and Tunnels/Waste Packages

Alternative scenario involving rapid solidification in tunnels



Alternative scenario suggests:

- **Waste package may not suffer loss of integrity**
- **Waste released from containers may be protected**
- **Magma unlikely to flow significant distance into tunnel**
- **Magma unlikely to cause secondary vents from tunnel**
- **Lack of consideration of rapid magma solidification may lead to unduly conservative assessment**

Recommendation:

Analysis needs to address:

- **solidification of magma in tunnels and on waste containers**
- **impact of solidification on consequences**

Exposure Scenario

- Progress made in updating exposure from contaminated ash
- Health physics assumptions are reasonable

Recommendation:

- Need to justify and document all parameters, processes, and assumptions

Probability of an Igneous Event

Recommendation:

- **Use a range of values rather than a single value**
- **Alternatively, document how single-value estimate supports a risk-informed review and its consequences**

Path Forward

Committee will:

- **Continue to interact on igneous activity consequence issues**
- **Review and comment on igneous activity consequence reports when released**

ABBREVIATIONS

ALARA	as low as reasonably achievable
BEIR	Biological Effects of Ionizing Radiation, Committee on the
CNWRA	Center for Nuclear Waste Regulatory Analyses
DOE	Department of Energy
HLW	high-level radioactive waste
ICRP	International Commission on Radiological Protection

ABBREVIATIONS (cont'd)

LLW	low-level radioactive waste
LTR	License Termination Rule
NAS	National Academy of Sciences
NMSS	Office of Nuclear Material Safety and Safeguards
NRC	U.S. Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
RES	Office of Nuclear Regulatory Research
SRP	standard review plan

ACNW LETTERS

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

March 25, 2005

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

SUBJECT: STATUS OF HIGH-SIGNIFICANCE AGREEMENTS ASSOCIATED WITH THE PROPOSED HIGH-LEVEL WASTE REPOSITORY AT YUCCA MOUNTAIN

Dear Chairman Diaz:

During the 157th meeting of the Advisory Committee on Nuclear Waste on February 23–25, 2005, the Committee was briefed by the NRC staff on the status of the key technical issue (KTI) agreements associated with the proposed high-level waste repository at Yucca Mountain. A total of 293 KTI agreements had been established to address data and analysis needs pertaining primarily to post-closure repository performance. As a result of these meetings and agreements, DOE committed to provide the information necessary to ensure a quality license application (LA) and efficient LA review by the NRC.

The Committee has been proactive with regard to the issue resolution process and related topics for several years. The Committee was briefed by DOE and NRC representatives during its 121st, 122nd, and 123rd meetings, September 19–21, October 17–19, and November 27–29, 2000, respectively, on progress toward resolution of KTIs (Reference 1). During its 133rd meeting March 19-21, 2002, the NRC staff briefed the Committee on the development of methods for performing sensitivity analyses as part of the total system performance assessment review (Reference 2). During its 143rd meeting June 24–25,2003, the NRC staff briefed the Committee on ranking agreements by risk significance and using risk information to resolve issues (Reference 3). The ACNW has also reported on other activities for risk-informing the issue resolution process (Reference 4).

At the 157th meeting, the staff informed the Committee that responses have been received from DOE for all 293 agreements, and reviews related to 224 agreements have been completed. Information concerning the remaining 69 agreements is currently under review. These reviews are expected to be completed by April 15, 2005.

According to the staff, most of the agreements, including the agreements currently under review, are of low or medium risk significance. The staff has identified only 41 high-significance agreements and finished reviewing the information on these agreements. Based on these reviews, the staff concluded DOE has fulfilled its obligation to provide information regarding 32 high-significance agreements. Resolution of most of the remaining high-significance agreements is not expected to be problematic as resolution of these agreements is pending DOE's release of information to the public and some model clarifications. The staff, however, has categorized a few high-significance agreements as "difficult issues," (e.g., agreements on volcanism and aircraft hazards).

The Committee offers the following comments and observations:

- The staff noted that though agreements were "closed" at this pre-license application stage, any issue or topic would be fully evaluated during the review of a license application and that "closing" an agreement does not preclude additional review of an issue or topic after a license application is submitted.

- The NRC staff's agreement resolution process has been efficient and risk-informed, and the staff has completed reviews in a timely but deliberate manner.

- The pre-licensing technical exchanges and reviews have resulted in agreements on many technical issues. Other issues were identified as needing additional attention. The KTI resolution process should improve the quality of a potential DOE LA and the efficiency of the NRC staff's licensing review.

The Committee recommends that the staff continue using its pre-licensing KTI resolution process. In addition, because the KTI agreements are focused on the post-closure issues and only a small number of pre-closure issues were covered by the agreements, the Committee believes that the staff should also now focus on pre-closure issues. The Committee will proactively interact with the staff on the difficult issues that have been identified by the agreement resolution process, including issues associated with volcanism and aircraft hazards.

Sincerely,

Michael T. Ryan
Chairman

References:

1. Letter dated February 8, 2001, from B. John Garrick, Chairman, Advisory Committee on Nuclear Waste, to Richard A. Meserve, Chairman, U.S. Nuclear Regulatory Commission, transmitting ACNW recommendations and concerns pertaining to the NRC high-level radiative waste issue resolution process. The letter is based on briefings by DOE and NRC representatives during the 121st, 122nd, and 123rd meetings of the Advisory Committee on Nuclear Waste September 19–21, October 17–19, and November 27–29, 2000, respectively, on progress toward resolution of the KTIs.

2. Letter dated August 7, 2002, from George M. Hornberger , Chairman, Advisory Committee on Nuclear Waste, to Richard A. Meserve, Chairman, U.S. Nuclear Regulatory Commission, transmitting ACNW recommendations pertaining to parametric sensitivity and uncertainty analysis. The letter is based on briefings by NRC representatives during the 133rd meeting of the Advisory Committee on Nuclear Waste, March 19–21, 2002, on high level waste performance assessment sensitivity studies.

3. Letter dated August 13, 2003, from B. John Garrick, Chairman, Advisory Committee on Nuclear Waste, to Richard A. Meserve, Chairman, U.S. Nuclear Regulatory Commission, transmitting ACNW comments including recommendations on the NRC staff's issue resolution process for risk-informing the sufficiency review of DOE's technical basis documents for the Yucca Mountain site recommendation.

4. Letter dated September 28, 2001, from George M. Hornberger , Chairman, Advisory Committee on Nuclear Waste, to Richard A. Meserve, Chairman, U.S. Nuclear Regulatory Commission, transmitting ACNW comments and recommendations on the NRC staff's issue resolution process for risk-informing the NRC sufficiency review of DOE's technical basis documents for the Yucca Mountain site recommendation.

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

December 9, 2005

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

SUBJECT: REVIEW OF THE NRC PROGRAM ON THE RISK FROM IGNEOUS ACTIVITY AT THE PROPOSED YUCCA MOUNTAIN REPOSITORY

Dear Chairman Diaz:

The Advisory Committee on Nuclear Waste (the Committee) has met several times to discuss the risk from igneous activity at the proposed Yucca Mountain repository. In September 2004, the ACNW held a Working Group Meeting on this topic, and summarized its conclusions and recommendations in a November 4, 2004 letter report. The Center for Nuclear Waste Regulatory Analyses (CNWRA) staff updated members of the Committee on NRC's current studies on volcanism in April 2005.

Subsequent meetings, review, and analysis of recently published documents of the NRC and its contractors, and discussions with the NRC and CNWRA staffs have resulted in the following observations and recommendations regarding potential igneous activity at the repository. Several of the ACNW's observations and recommendations are related to the NRC staff's use of assumptions in their analysis that appear to be conservative rather than realistic. Excessive conservatism can foster misperceptions of the performance of the proposed Yucca Mountain repository and conceal attributes of processes that should receive the attention of the NRC staff. The Committee believes continued investigation of potential scenarios will better prepare the staff to evaluate assumptions and approaches in a potential license application. The Committee looks forward to understanding how the staff has used risk-informed thinking throughout the analysis of igneous activity at the proposed Yucca Mountain repository.

INTERACTION BETWEEN INTRUDING MAGMA AND REPOSITORY DRIFT AND WASTE PACKAGES

The Committee believes that resolution of questions about the interaction between intruding magma and the repository drift and waste packages could be better risk informed by considering alternative interaction scenarios and their potential influence on consequences. Specifically, the effects on repository performance of rapid magma cooling with attendant increases in viscosity and solidification of magma should be considered in analyzing the magma/drift/waste package interactions in scenarios in which the intruding dike vents to the surface as a volcano. The alternative scenarios and their implications include the following:

1. Magma characteristics influence production of different materials when an igneous intrusion intersects a repository drift. If the volatile content of magma is relatively large, as anticipated from available evidence, volcanic ash could erupt into the drift at the point of dike/drift intersection. Only after the entrained gases have escaped from the magma due to eruption processes would magma enter the repository drift as a lava flow rather than as ash. The Committee has been provided information that either ash or lava will likely solidify near the entry point into the repository drift.

2. Key factors in the rate of solidification of the magma and self-sealing of the drift are the delivery rate of magma, latent heat of crystallization, volatile content of the magma, and thermal conductivity of drift walls and waste packages. As a result, the magma would likely interact with a few waste packages near the point of entry. Rapid solidification would likely prevent the formation of secondary (flank) vents from the rising magma flowing into repository drifts and subsequently venting to the surface.

3. Solidification of magma entering a repository drift is an important topic to consider regarding the integrity of waste packages. At present, both the Department of Energy (DOE) and the NRC staff assume that the contents of a relatively small number of waste packages directly involved in the dike intrusion are completely destroyed by interaction with invading magma and that all the included waste is entrained in the magma and becomes airborne after eruption. In contrast, Electric Power Research Institute (EPRI) modeling indicates that waste packages are sufficiently robust that invading magma will not destroy the packages (EPRI, 2004). Information presented to the Committee suggests that quenching of magma on an intact canister could provide a protective barrier, thereby isolating and protecting the waste from the intruding magma. Thus, even if a few waste packages are entrained within a cone-forming volcanic conduit, the NRC staff's alternative approach that assumes complete destruction of the waste canisters may lead to incorrect assumptions and parameterization in performance assessment. Undue conservatism also may lead to a distorted view of the risks posed by the repository.

4. Waste packages will be most resistant to degradation and therefore to igneous thermal/physical effects during the first few thousand years of repository life. This is the time interval over which peak doses may occur from igneous activity, because beyond that period potential doses will diminish significantly due to the decay of shorter-lived radionuclides in the few waste packages involved in the volcanic activity (Mohanty et al., 2004). Even if the waste is directly exposed to magma because of package degradation after a long time period, quenching of the magma can produce a protective rind on the waste particles.

By not including the effects of magma solidification and quenching in the extrusive event scenario, important processes may not be adequately understood (e.g., those involved in entrainment and eruption of waste), and both the overall consequences and the risk of the package disruption process may be evaluated incorrectly. DOE's choice to use a conservative scenario to describe magma/waste package interactions does not justify overlooking insights gained by using a more realistic scenario.

Recommendation 1. Analysis of the consequences of an igneous dike intersection with a repository drift would be better risk informed by assessing the effects of

magma solidifying upon entering a drift and quenching on the waste packages and any waste released from them. These studies could have an impact on conclusions regarding the number of waste packages that could be affected by a dike intrusion and the occurrence of secondary (flank) eruptions. This in turn would impact the amount of waste distributed in a resulting ash plume, the reasonably maximally exposed individual (RMEI) dose, and understanding of processes important to the total igneous activity effects.

EXPOSURE SCENARIO FROM CONTAMINATED EXTRUSIVE VOLCANIC MATERIALS

The NRC staff has updated the exposure scenario model incorporating particle size measurements from analogous volcanic eruptions. The revised and updated performance assessment model assumes a particle size distribution of dispersed contaminated ash with a median aerodynamic diameter of 10 microns and a minimum aerodynamic diameter of about 0.1 microns, thus including particulate matter that is not only inhalable but respirable.

The NRC staff's view, as presented to the Committee, is that long-term resuspension of contaminated fluvially dispersed ash and ash deposited on the surface can contribute to an inhalation dose to the RMEI. Consistent with this view, the NRC staff has selected parameter values for particle size distribution, dispersion, and long-term resuspension based on direct observation of volcanic ash at sites of recent volcanic activity. The Committee notes that these assumptions seem reasonable. Nonetheless, the Committee believes a more fully integrated analysis of the processes, parameters, and assumptions used in modeling this scenario would be helpful in making the staff's approaches transparent.

Recommendation 2. The parameters and assumptions presented to date regarding the exposure scenario associated with igneous activity appear reasonable. However, in order to be adequately prepared for the license application review, the NRC staff should integrate all risk-significant aspects of the scenario by clearly justifying the processes, parameters and their values, and assumptions. The Committee believes the staff should use risk-informed approaches, including sensitivity studies, and other techniques to study and justify its choices.

PROBABILITY OF AN IGNEOUS DIKE INTERSECTING THE REPOSITORY

The NRC staff's single-valued estimate of the probability of an igneous intrusion, 10^{-7}/yr over the next 10,000 years, is at the higher end of the range of published estimates for dike intrusion on the order of 10^{-8}/yr to 10^{-7}/yr, authored by the NRC staff, their contractors, and the ACNW staff (Connor et al., 2000, Coleman et al., 2004).

Recommendation 3. The NRC staff should reevaluate the use of a single value for probability of a volcanic intersection of the proposed Yucca Mountain repository, and should consider a range of estimates on the order of 10^{-7}/yr to 10^{-8}/yr based on studies published by NRC and previous ACNW views. If the staff decides to use a single-point value approach, the staff should document how this decision will support a risk-informed review of the consequences of an igneous event in a potential license application. Further evaluation of this range of probabilities should include consideration of new information being assembled for, and the results of, DOE's ongoing expert elicitation on Probabilistic Volcanic Hazard Assessment.

The Committee recognizes that some differences in views on volcanism between the ACNW and the NRC staff are a matter of professional judgment. The Committee appreciates the ongoing dialogue and offers its views as complementary to the staff's views. Consideration of these views may help the staff better risk inform their analyses of an igneous event during the potential Yucca Mountain license application review and related decisionmaking.

Work in progress by the NRC, which is unavailable to the Committee, may at least in part respond to the concerns addressed in this letter. Accordingly, the Committee plans to continue its dialogue with the NRC staff to better understand the bases of the staff's positions and to assess issues as additional information becomes available.

Sincerely,

Michael T. Ryan
Chairman

References:

1. Coleman, N.M., B.D. Marsh, and L. Abramson. Testing Claims about Volcanic Disruption of a Potential Geologic Repository at Yucca Mountain, Nevada, Geophys. Res. Lett., doi:10.1029/2004GL021032, 2004.

2. Connor, C.B., J. Stamatakos, D. Ferrill, B. Hill, G. Ofoegbu, F. Conway, B. Sagar, and J. Trapp. Geologic Factors Controlling Patterns of Small-volume Basaltic Volcanism: Application to a Volcanic Hazards Assessment at Yucca Mountain, NV, J. Geophys. Res., 105, 417–432, 2000.

3. EPRI. Potential Igneous Processes Relevant to the Yucca Mountain Repository: Extrusive Release Scenario: Analysis and Implications. EPRI Report 1008169. Electric Power Research Institute: Palo Alto. 2004.

4. Mohanty, S., et al. System-level Performance Assessment of the Proposed Repository at Yucca Mountain Using the Tpa Version 4.1 Code. NRC accession no. ML041350316. 2004.