

COMMISSION BRIEFING SLIDES/EXHIBITS

MEETING WITH ACNW

MARCH 20, 2002



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

March 12, 2002

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

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

SUBJECT: ADVISORY COMMITTEE ON NUCLEAR WASTE MEETING WITH THE
U. S. NUCLEAR REGULATORY COMMISSION, MARCH 20, 2002 –
SCHEDULE AND BACKGROUND INFORMATION

The ACNW is scheduled to meet with the NRC Commissioners between 9:30 a.m. - 11:30 a.m. on Friday, March 20, 2002, to discuss the items listed below. Background materials related to these items are attached.

	<u>ESTIMATED TIME</u>
INTRODUCTION — NRC Chairman, Dr. Richard A. Meserve	5 Minutes
PRESENTATIONS — Advisory Committee on Nuclear Waste	
INTRODUCTION — ACNW Chairman, Dr. George M. Hornberger	5 Minutes
1. Issue Resolution and Sufficiency Review Dr. George M. Hornberger	10 Minutes
2. KTI Program Status Dr. George M. Hornberger	25 Minutes
3. TSPA-SR Dr. B. John Garrick	10 Minutes
4. Review of NRC-Sponsored Research Dr. Raymond Wymer	10 Minutes

CLOSING REMARKS

***NOTE:** Estimated times are for presentation only and do not include time for Commission Questions and Answers.

Attachments: As stated

cc: ACNW Members
ACNW Staff

ADVISORY COMMITTEE ON NUCLEAR WASTE MEETING WITH NRC COMMISSIONERS

**G. M. Hornberger
March 20, 2002**

INTRODUCTION

- **Focus on high-level waste issue resolution program and key technical issues (KTIs)**
- **Highlights from recent letters**

INTRODUCTION (Cont'd)

- **ACNW'S perspective on KTIs**
- **Observations from review of NRC research program**

ISSUE RESOLUTION AND SUFFICIENCY REVIEW

ACNW REVIEW

- **Features vertical slice reviews of U. S. Department of Energy's (DOE) site recommendation (SR) for Yucca Mountain**
- **Evaluates staff's tools, guidance, and capability**

MAIN MESSAGE

- **ACNW agrees with staff's findings**
- **ACNW concerns relate to adequacy of information for possible License Application**
 - **Additional information is needed from DOE**

OBSERVATIONS

- **Staff is well-equipped to conduct reviews of DOE products, including possible License Application**
- **Issue resolution process is sound**

OBSERVATIONS (Cont'd)

- **Documentation needed on how risk insights were used**
 - **Publication of Yucca Mountain Review Plan and Integrated Issue Resolution Status Report**

OBSERVATIONS (Cont'd)

- Illustration that Yucca Mountain Review Plan is risk – informed**
- Clarification on use of conservatism**



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

September 28, 2001

The Honorable Richard A. Meserve
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: ACNW COMMENTS ON NRC STAFF'S ISSUE RESOLUTION PROCESS FOR RISK-INFORMING ITS SUFFICIENCY REVIEW OF DOE'S TECHNICAL BASIS DOCUMENTS FOR THE YUCCA MOUNTAIN SITE RECOMMENDATION

The *Nuclear Waste Policy Act* (NWPA) requires the U. S. Department of Energy (DOE) to include in its site recommendation to the President preliminary comments from the NRC as to whether DOE's at-depth site characterization and waste form proposal for the proposed high-level waste (HLW) repository seem to be sufficient for inclusion in a possible license application. In this letter, we provide our observations and recommendations regarding the issue resolution process that the NRC staff used in its sufficiency review of DOE's technical basis documents pertaining to the site recommendation for the proposed Yucca Mountain, Nevada, HLW repository.

In summer of 2000 the Advisory Committee on Nuclear Waste (ACNW) initiated a vertical slice review of the NRC staff's issue resolution process and DOE's technical basis documents for the Yucca Mountain site recommendation. The purpose of our vertical slice review was to evaluate the NRC staff's tools, guidance, and technical capability for evaluating sufficiency and, if needed, an eventual license application. Primary objectives of our review were to evaluate: (1) whether the NRC's sufficiency review comments and issue resolution process are transparent, traceable, and defensible, and (2) whether the NRC's issue resolution agreements and information requested of DOE reflect a risk-informed and performance-based (RIPB) approach and are appropriate and realistic. In planning our vertical slice review, we selected four technical areas that correspond to one or more key technical issues (KTIs). The four areas were: (1) high-level waste chemistry, (2) saturated zone flow and transport, (3) thermal effects on flow, and (4) total system performance assessment and integration. Because we have not yet seen the staff's sufficiency comments, our observations are predicated solely on the issue-resolution process. The staff has informed the Committee that the information gleaned from technical exchange meetings and the agreements that stemmed from them formed the basis for the staff's sufficiency comments.

On the basis of our selected reviews, we make several observations and recommendations:

- The staff appears to be well equipped with analytical tools, technical capability, and guidance for conducting the sufficiency review and an eventual license application (LA) review, particularly in light of the staff's ongoing upgrades to the TPA code for analyzing

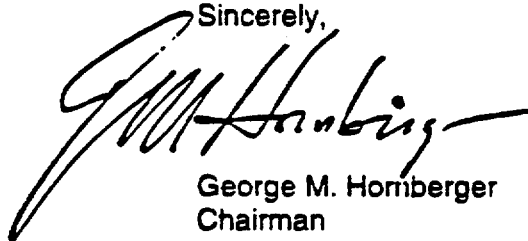
the waste package and source term. It is not obvious, however, whether or how the staff used information and performance assessment tools to focus its sufficiency review on the most risk-significant issues, and whether or how it used its TPA code to develop risk insights to support the sufficiency review.

- The NRC staff should continue to use its TPA code in conducting sensitivity analyses to explore important contributors to risk at the sub-issue level. We also encourage the staff to continue to enhance its use of the TPA code to allow for greater realism in its analyses and to conduct its own risk-informed assessments to quantify the uncertainties associated with the important risk contributors. We believe this will allow the staff to meet the Commission's intent of having a risk-informed analysis, refine its understanding of the potential risks associated with the proposed Yucca Mountain repository, focus its licensing review, and better justify its request for information and detailed analyses from the DOE.
- Through its issue resolution process, the staff appears to be addressing the issues that are likely to be important for conducting an LA review for the proposed Yucca Mountain repository.
- The technical exchange meetings have proven very valuable in resolving issues and establishing substantial and essential communication between NRC and DOE staffs.
- The NRC staff used the ongoing issue resolution process efficiently and effectively to conduct its review in a timely fashion.
- The staff seems to be doing an excellent job of tracking issue resolution as the emphasis shifts from KTIs to integrated sub-issues (ISIs). The ISI format appears to effectively capture and integrate material from the KTIs.
- In the areas where the Committee focused its vertical slice review, the staff's issue resolution process is logical, defensible, and well documented in the issue resolution status reports (IRSRs).
- DOE's inconsistent use of conservatism throughout the TSPA-SR models makes it difficult to identify issues that are important to risk, and precludes a risk-informed analyses of the proposed repository on the basis of the evidence.
- The NRC staff should clarify and publish in its YMRP how it will tailor its licensing review of the abstractions (ISIs) on the basis of their importance to safety. We are concerned that the staff's technical exchange agreements may be challenged if the staff does not document how it is focusing on the most risk-significant issues. The Committee believes that the staff is on its way toward making the YMRP an RIPB guidance document, but still faces a significant challenge in making its issue resolution process and possible LA review RIPB and documenting how this was achieved.
- The staff should clarify in the YMRP how to use "conservatism" appropriately to treat uncertainty, while providing a risk-informed analysis and understanding of the risks associated with the proposed repository.

- According to the staff, the issue resolution agreements that emerged from the technical exchange meetings formed the basis for the staff's sufficiency comments. However, the existing IRSRs do not reflect the most current information supporting the recent agreements. This discrepancy will make it difficult to trace the bases and criteria that the staff used to develop its sufficiency comments. We understand that the staff intends to update the IRSRs to reflect the most recent information and acceptance criteria in the integrated IRSR, but this document is still under development and may not become publically available for some time. The traceability, clarity, and transparency of the sufficiency comments will not be complete without this integrated IRSR. Therefore, we recommend that the staff release this document to the public as soon as feasible.

The ACNW developed a "template" containing a set of questions to guide its review toward achieving the desired objectives. Our answers to the template questions and additional background information for our review are provided in the attachment to this letter.

Sincerely,

A handwritten signature in black ink, appearing to read "G. M. Homberger", with a long horizontal flourish extending to the right.

George M. Homberger
Chairman

Attachment: Advisory Committee on Nuclear Waste's Vertical Slice Review Approach

Attachment

Advisory Committee on Nuclear Waste's Vertical Slice Review Approach

In Summer 2000, the Advisory Committee on Nuclear Waste (ACNW) initiated a vertical slice review of the NRC staff's sufficiency review of the technical basis documents prepared by the U.S. Department of Energy (DOE) for the site recommendation regarding the high-level waste (HLW) repository at Yucca Mountain, Nevada. The ACNW's approach for this review is one element of our larger strategy for evaluating the staff's overall licensing review capability. Other elements of the strategy include ongoing evaluation of the staff's key technical issue KTI resolution program, specific KTIs, the staff's performance assessment (PA) tools and capability, and the staff's overall regulatory framework for HLW. The Committee briefed the Commission on its overall strategy in March 2001.

Background

During its March 2000 meeting, the Committee heard a briefing from the NRC staff on its draft strategy to conduct the Yucca Mountain sufficiency review, and subsequently received a copy of the draft sufficiency review strategy in September 2000.

In a letter to the Commission dated June 29, 2000, the Committee conveyed that the staff's approach appeared to be well thought out, logical, and consistent with the risk-informed and performance-based (RIPB) strategy outlined in the proposed draft 10 CFR Part 63.

In July 2000, at the Commission's request, several Committee members informally provided feedback on the staff's draft proposed Yucca Mountain Review Plan (YMRP), which the staff developed for conducting an RIPB review of an eventual license application (LA). The staff also developed and provided to the ACNW a copy of the draft YMRP implementing guidance for conducting the sufficiency review. The Committee has not yet received a briefing on the draft YMRP or its implementing guidance and has not yet reviewed these documents in detail.

During its August 2001 meeting, the Committee heard a briefing from the NRC staff on its sufficiency review and DOE's supplemental science and performance analysis (SSPA). However, we have not reviewed the SSPA and have not considered it in our evaluation of the staff's sufficiency review. Finally, the Committee members also gained insights into the staff's issue resolution process over the past year by participating in informal interactions with the NRC staff and by attending DOE-NRC technical exchange meetings for resolving technical issues.

NRC Staff's Sufficiency Review

The purpose of the NRC staff's sufficiency review was to evaluate whether the DOE has enough data and conceptual understanding of the Yucca Mountain HLW repository system to develop a safety case for a potential license application. Consequently, the scope of the sufficiency review was narrower than it would be for an LA review. For example, the staff will not make estimated dose comparisons relative to 10 CFR Part 63, and it will not make findings regarding the correctness of the site recommendation in relation to DOE's siting guidelines in 10 CFR Part 963. Rather, the staff will provide preliminary comments on where data and analyses appear to be sufficient or insufficient, what additional data and analyses are needed and within what time frame, whether conceptual models are supported by sufficient data, and

the status of DOE's quality assurance (QA) efforts. The staff's sufficiency review will also document the status of the KTI issue resolution process, in addition to reporting on progress in the DOE's program. The staff informed us that the DOE-NRC KTI technical exchange meeting agreements formed the basis for its sufficiency review, and that it used the issue resolution process and IRSRs to risk-inform and document the basis for its sufficiency review.

Similar to the way the ACNW conducted its review of the DOE's viability assessment in its letter dated April 8, 1999, each Committee member informally met with the NRC staff one or more times to exchange ideas and information related to their technical area. The Committee used the staff's IRSRs and agreements from the ongoing NRC-DOE technical exchange meetings to focus its review on relevant portions of DOE's technical basis documents. Other source material for the review included DOE's process model reports (PMRs), analysis model reports (AMRs), science and engineering report, TSPA-SR, DOE's repository safety strategy (RSS), and (to a very limited extent) SSPA. The Committee provided a separate report on its vertical slice review of HLW chemistry in its letter dated August 13, 2001 and the TSPA-SR in its letter dated September 18, 2001.

The Template Questions

1. Are the NRC staff's tools, guidance, and capability sufficient to conduct a sufficiency review or LA review?

In general, the NRC staff appears to be well equipped to conduct a sufficiency review and an LA review. The staff has its own analytical tools [e.g., total-system performance assessment (TPA) code and more detailed codes] to use in reaching conclusions about DOE's ability to meet regulatory requirements for licensing.

The NRC staff and the staff of the Center for Nuclear Waste Regulatory Analyses (CNWRA) have impressive expertise in the areas that the ACNW evaluated, (i.e., repository chemistry, TSPA, saturated zone, and thermal effects on flow). The Committee also commented in its chemistry vertical slice review report that the NRC and CNWRA staff seem to be well positioned to deal with the impacts of evolutionary repository design changes.

However, as noted in the chemistry report, we believe that deficiencies may exist in some engineering areas and that the staff lacks the computing capability to run DOE's Goldsim TSPA code in a Monte-Carlo mode. We also noted in the chemistry report that DOE's and NRC's treatment of coupled chemical processes is inadequate as a result of their complexity and difficulty in incorporating them in the modeling. In addition, the Committee noted that the staff needs to more fully address in-package chemistry issues as it develops an integrated chemistry model to be implemented in the NRC's TPA code, and that it is essential to develop an appropriate source term model for the TPA code. We are pleased to note that the NRC and CNWRA staffs are in the process of updating the TPA code to address the above deficiencies and to allow for more realistic assessments of the waste package, source term, and coupled processes.

2. Is there sufficient evidence to support the results of DOE's TSPA, process model, or model abstraction?

On the basis of our collective reviews, more evidence may exist for treating the saturated zone in the TSPA model than for treating repository chemistry and thermal effects on flow. For the latter areas, we believe that DOE's understanding of system behavior may be derived more from modeling than from data. We also observed that neither the evidence supporting the TSPA-SR modeling assumptions, nor the importance of the assumptions to performance are made transparent. For example, DOE cites a variety of assumptions as "conservative." This is a concern because: (1) use of multiple "conservative" assumptions masks the risks posed by the repository and compromises the opportunity for a risk-informed analysis on the basis of the evidence, and (2) in many cases, assumptions are labeled as conservative without the supporting evidence. We also observed that verification and qualification of data and models are inconsistent and sometimes lacking.

3. Is the staff's approach adequate for using the TPA code to review the TSPA, process models, and/or model abstractions?

Although the staff's TPA code lacks the detail and sophistication of DOE's Goldsim TSPA code, we believe that the staff is well positioned and equipped with its own, independent code to review information contained in a possible LA. A possible advantage of the simpler TPA code (compared to DOE's Goldsim code) is that it should be conducive to more realistic, scenario-based approaches that may be useful for verifying DOE's analysis.

It is not obvious, however, whether or how the staff used information and performance assessment tools to focus its sufficiency review on the most risk-significant issues, and whether or how it used its TPA code to develop risk insights to support the sufficiency review.

4. Is the issue resolution process sufficient, given review of the integrated sub-issue (ISI)? Has integration between KTIs and ISIs been achieved?

The staff's public technical exchange meetings were organized around KTIs and their sub-issues, while the staff's sufficiency review is structured around the ISIs. The Committee believes that the ISI format effectively captures and integrates material from the KTIs, and appears to have enabled the staff to integrate technical information across various KTIs in conducting its sufficiency review. Overall, the staff seems to be doing an excellent job of tracking issue resolution as the emphasis shifts from KTIs to ISIs.

5. Is the relative risk of the sub-issue (ISI) known or understood by the NRC? By DOE? Is it a principal factor?

In the case of saturated zone flow, the staff recognizes the saturated zone as a geological barrier that is important to the safety case. The saturated zone flow regime itself is not a principal factor; however, because radionuclide transport relies on groundwater flow as input, the flow path ISI is seen to be important to both the NRC and

DOE. In the areas of repository chemistry and thermal effects on flow, the NRC's understanding of the relative risk is less apparent and was not documented in the corresponding IRSR.

We observed that DOE tends to use very "conservative" assumptions in some cases but not in others, and does not integrate the differing approaches in a consistent way. The inconsistent use of conservatism throughout the TSPA-SR models makes it difficult to identify issues that are important to risk and to ascertain if particular errors or problems are significant to overall performance. The complexity of the TSPA-SR model and code make it difficult to evaluate the individual contributors to risk. We discuss our review of the TSPA-SR in more detail in the September 18, 2001 letter.

6. Does NRC's YMRP/Guidance reflect an RIPB approach?

Although the Committee has not yet reviewed the draft YMRP, several Committee members perused the draft document last year at the Commission's request and offered comments to the staff on how to better meet the Commission's expectations for making the document RIPB. Until we are briefed on the YMRP, we cannot assess how the staff might use the YMRP to conduct an RIPB review by taking advantage of such factors as risk insights derived from previous PAs, results of the TPA code, and sensitivity analyses.

The Committee believes that the staff is on its way toward making the YMRP an RIPB guidance document, but still faces a significant challenge in making its issue resolution process and possible LA review RIPB and documenting how this was achieved.

7. Are the KTIs consistent with the issues that the PA identified as being important?

As part of the issue resolution process, the original 10 KTIs have now been subsumed into the 14 ISIs. It would appear that the KTIs remain important issues for determining repository performance. In addition, the staff effectively uses the KTIs to highlight important issues in interactions with DOE, and the KTI-IRSR process has proven to be a flexible framework for identifying significant technical issues.

8. Are the staff's IRSRs and agreements logical, defensible, and focused on the most risk-significant issues?

DOE and the NRC appear to have covered the important issues, but it is not obvious whether the NRC staff has made a concerted effort to focus on the most risk-significant issues. Although the staff appears to be in the process of identifying the most important issues, the discovery process is still underway. We are concerned that the defensibility of the staff's issue resolution process and technical exchange agreements may be challenged if the staff does not document how it is focusing on the most risk-significant issues. Although it was beyond the scope of our vertical slice review, a Committee member observed a technical exchange meeting on preclosure that caused him to question the defensibility of the NRC's agreements and request for information from the DOE. However, we believe that if the staff succeeds in making the YMRP an RIPB

document and uses it to guide its LA review, the conclusions reached should be logical, defensible, and focused on the most risk-significant issues.

9. Are the staff's agreements well documented, transparent, and traceable?

The Committee believes that the NRC staff's issue resolution process is well documented in the IRSRs. However, the existing IRSRs do not reflect the most current information supporting the recent agreements; this discrepancy will make it difficult to trace the bases and criteria that the staff used to develop its sufficiency comments.

10. How has uncertainty been evaluated? Are the issues treated with bounding assumptions, or are they realistically assessed?

In the chemistry area, DOE handles uncertainty with differing degrees of realism, largely depending on what information is available. In the area of thermal effects on flow, it appears that DOE uses bounding assumptions together with probability distributions, but uses more bounding assumptions (taken to be "conservative") than "best estimates" by about 10:1. We believe that sensitivity analyses that are founded on bounding values for parameters (rather than on best estimates) are of questionable value and are more likely to be misleading than informative.

A recurring theme in ACNW's review is that reliance on bounding analyses or "conservative" assumptions can obscure a true performance assessment. Although "sufficiency" relates only to the adequacy of the evidence (and not to performance per se), the staff must make a judgment about whether the philosophy behind the information-gathering process is adequate to support realistic performance for a license application. ACNW maintains that the use of conservatism upon conservatism makes a risk-informed approach impossible.

EDO RESPONSE



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

November 20, 2001

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

**SUBJECT: RESPONSE TO THE ADVISORY COMMITTEE ON NUCLEAR WASTE
 LETTER DATED SEPTEMBER 28, 2001**

Dear Dr. Hornberger:

I am responding to your letter dated September 28, 2001, on the U.S. Nuclear Regulatory Commission (NRC) staff's issue resolution process for risk-informing its sufficiency review of the U.S. Department of Energy's (DOE's) technical basis documents for the Yucca Mountain, Nevada, site recommendation. In the letter, the Advisory Committee on Nuclear Waste (ACNW) made a number of specific observations and recommendations to the NRC staff. The following is the NRC staff's response to the ACNW's observations and recommendations. Please note that in some instances the observations and recommendations have been grouped together.

Observation/Recommendation 1 and 2:

The staff appears to be well equipped with analytical tools, technical capability, and guidance for conducting the sufficiency review and an eventual license application (LA) review, particularly in light of the staff's ongoing upgrades to the Total-system Performance Assessment (TPA) code for analyzing the waste package and source term. It is not obvious, however, whether or how the staff used information and performance assessment tools to focus its sufficiency review on the most risk-significant issues, and whether or how it used its TPA code to develop risk insights to support the sufficiency review.

The NRC staff should continue to use its TPA code in conducting sensitivity analyses to explore important contributors to risk at the subissue level. We also encourage the staff to continue to enhance its use of the TPA code to allow for greater realism in its analyses and to conduct its own risk-informed assessments to quantify the uncertainties associated with the important risk contributors.

NRC Staff Response:

The NRC staff agrees with the ACNW that it has the necessary tools and technical capabilities to conduct the sufficiency and potential license application reviews. The NRC staff used the issue resolution meetings and the agreements reached during the meetings as the basis for the staff's sufficiency comments. In preparation for the issue resolution meetings, the NRC staff used information from the NRC and DOE performance assessment analyses (e.g., risk insights); DOE documents; independent investigations; and outside literature, to focus its

comments and concerns on the most risk-significant issues, including those associated with DOE's at depth site characterization and waste form proposal. The agreements reached during the meetings form the basis for staff's sufficiency review and the path forward, and represent those items where the NRC staff believes that it needs additional information or documentation to conduct a detailed license application review. Although the logic behind deciding what additional information the staff believes it needs for license application may not be explicit in all cases, the staff did use results from NRC and DOE performance assessment analyses (i.e., risk insights) in both the issue resolution and sufficiency review processes. For example, the level of detail was developed for the NRC staff's review of the waste package environment was based on TPA insights.

The NRC staff plans to complete a risk-insights report that will address: (1) the risk insights that have been determined by DOE and the NRC staff; and (2) how the NRC staff could use these risk insights during future reviews, for both pre-closure operations and post-closure performance. This work is scheduled to be completed during fiscal year 2002. The NRC staff would like to discuss, with the ACNW, during the next presentation on performance assessment and NRC's TPA code, how to make risk insights that are used in the NRC staff reviews, such as the sufficiency review, more transparent.

The NRC staff agrees with the ACNW recommendations on the importance of conducting further sensitivity studies and to continue enhancing the TPA code. The staff will document sensitivity studies it has completed and plans to publish the results in a NUREG in 2002. The staff intends to use the TPA code to conduct future analyses, as it prepares to review a potential license application.

The next version of the TPA code will be influenced by the comments from the external peer review of TPA version 3.2, by the desire (consistent with the performance goal to make NRC activities and decisions more effective, efficient, and realistic) to increase realism in the TPA code, where appropriate, and by the goal of improving the usefulness of the TPA code during a potential licensing review.

Observation/Recommendation 3-7:

Through its issue resolution process, the staff appears to be addressing the issues that are likely to be important for conducting a license application review for the proposed Yucca Mountain repository.

The technical exchange meetings have proven very valuable in resolving issues and establishing substantial and essential communication between NRC and DOE staffs.

The NRC staff used the ongoing issue resolution process efficiently and effectively to conduct its review in a timely manner.

The staff seems to be doing an excellent job of tracking issue resolution as the emphasis shifts from key technical issues to integrated subissues. The integrated subissue format appears to effectively capture and integrate material from the key technical issues.

In the areas where the Committee focused its vertical slice review, the staff's issue resolution process is logical, defensible, and well documented in the issue resolution status reports.

NRC Staff Response:

The NRC staff agrees that the NRC/DOE issue resolution meetings have been very valuable in addressing the technical issues associated with the proposed repository at Yucca Mountain. As discussed earlier in this letter, the NRC staff used information from the NRC and DOE performance assessment analyses (i.e., risk insights), DOE documents, independent investigations, and outside literature in preparation for the issue resolution meetings. The information was used by the NRC staff to emphasize the most important issues and to assess whether additional information or documentation may be needed. The agreements reached during the meetings form the basis for the path forward and represent those items that the staff believes are needed to allow a detailed review of the potential license application. The NRC staff is tracking the agreements and is currently reviewing those DOE documents that have already been provided to assess whether the documents address the underlying staff questions or comments.

After the release of the Yucca Mountain Review Plan (YMRP), the NRC staff plans to emphasize the integrated subissues in subsequent issue resolution meetings. By focusing on the integrated subissues, the NRC staff hopes to align its efforts with the YMRP more effectively and to continue to integrate the contribution of the specific technical disciplines associated with the key technical issues.

Observation/Recommendation 8:

DOE's inconsistent use of conservatism throughout the Total System Performance Assessment for Site Recommendation (TSPA-SR) models makes it difficult to identify issues that are important to risk, and precludes a risk-informed analyses of the proposed repository on the basis of the evidence.

NRC Staff Response:

This ACNW observation/recommendation parallels a comment that was made in the ACNW's letter of September 18, 2001, on DOE's TSPA-SR. As discussed in the NRC staff response to that letter, the staff recognizes that if DOE introduces conservatism into their performance assessment, then DOE may have difficulty making optimal design decisions and communicating the risk associated with their design, because they would not have their best estimate of the risk. The staff also recognizes and agrees with the ACNW that the inconsistent use of conservatism may make it difficult to identify the importance of particular issues to risk (i.e., that in this respect the analyses are not "risk-informed," as used by the ACNW). However, objective regulatory decisions can be – and have been – made based on the results of performance assessments that include conservatism.

The NRC/DOE agreements resulting from the issue resolution meetings will lead to information that will help the NRC staff conduct a risk-informed review of DOE's license application, should one be submitted. Specifically, a number of the agreements address: (1) the use of conservatism; (2) representation of uncertainty; (3) the process used to develop abstracted models from detailed models; and (4) the need to consider the effects of non-linear models when judgements are made to use conservatism to address uncertainty.

Observation/Recommendation 9:

The NRC staff should clarify and publish in its YMRP how it will tailor its licensing review of the abstractions (integrated subissues) on the basis of their importance to safety.

NRC Staff Response:

Now that 10 CFR Part 63 has been finalized, the NRC staff plans to submit the YMRP (revised to be consistent with 10 CFR Part 63) to the Commission for review. The staff will document how it will risk-inform its licensing review, based on repository risk insights, in the review plan. In addition, as previously mentioned, the staff intends to complete a risk insights report, where the staff will document the risk insights that are being used by the staff and how the staff plans to use risk insights to focus its review of a potential license application. This report will provide a baseline that may change as new information becomes available.

Observation/Recommendation 10:

The staff should clarify in the YMRP how to use "conservatism" appropriately to treat uncertainty, while providing a risk-informed analysis and understanding of the risks associated with the proposed repository.

NRC Staff Response:

NRC has developed regulations that are risk-informed and performance-based. DOE is able to use the flexibility afforded by the regulations to develop a realistic performance assessment or to introduce conservatism. As part of the issue resolution process, the staff reached agreements with DOE that are expected to result in the information necessary to conduct a risk-informed review of the potential license application, whether DOE uses analyses that are realistic or conservative.

The NRC staff agrees that how DOE uses conservatism in its analyses is an important issue. The NRC staff has recently completed its review of the pre-closure safety assessment, the TSPA-SR, and the supporting documentation for each. The staff will use lessons learned from its pre-closure operations and post-closure performance reviews to evaluate whether future changes are needed in the YMRP. We anticipate that some changes to the YMRP will be made to clarify the use of conservatism.

Observation/Recommendation 11:

According to the staff, the issue resolution agreements that emerged from the technical exchange meetings formed the basis for the staff's sufficiency comments. However, the existing Issue Resolution Status Reports (IRSRs) do not reflect the most current information supporting the recent agreements. This discrepancy will make it difficult to trace the bases and criteria that the staff used to develop its sufficiency comments. We understand that the staff intends to update the IRSR to reflect the most recent information and acceptance criteria in the integrated IRSR, but this document is still under development and may not become publicly available for some time. The traceability, clarity, and transparency of the sufficiency comments will not be complete without this integrated IRSR. Therefore, we recommend that the staff release this document to the public as soon as feasible.

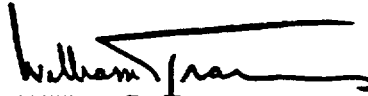
NRC Staff Response:

The materials presented at the issue resolution meetings and the agreements reached during the meetings did form the technical bases for the staff's sufficiency comments. The materials, agreements, and discussions at the meeting, which are documented in the associated meeting summaries, are publicly available now. The criteria that the NRC staff used to develop its sufficiency comments are contained in the existing IRSRs and were discussed in the public issue resolution meetings. The NRC staff is preparing an Integrated IRSR that will formally document the status of issue resolution. In this document, NRC plans to integrate the information discussed during the issue resolution meetings into the 14 specific post-closure integrated subissues, as well as the pre-closure issues. The staff is currently incorporating the information provided during the recent Pre-Closure Safety, Total System Performance Assessment and Integration, Igneous Activity, and Range of Operating Temperature meetings into the Integrated IRSR. The NRC staff will release the document, as soon as it can after incorporating the new information and completing an internal review.

NRC Staff Conclusion Related to Sufficiency Review

As discussed above and consistent with the NRC Chairman's letter to DOE dated November 13, 2001, the NRC staff believes that sufficient at-depth site characterization analysis and waste form proposal information, although not available now, will be available at the time of a potential license application such that development of an acceptable license application is achievable.

Sincerely,



William D. Travers
Executive Director
for Operations

cc: Chairman Meserve
Commissioner Dicus
Commission Diaz
Commissioner McGaffigan
Commissioner Merrifield
SECY

KTI PROGRAM STATUS

MAIN MESSAGE

- **Major issues confronting repository licensing identified**
- **Areas requiring backup information identified**
- **Integration across KTIs still of concern**

KTI AGREEMENTS

- **293 agreements but only few significant issues**
- **Agreements vary greatly in scope**
- **Issue resolution process is working**

MOST IMPORTANT KTIs

- **Container Life and Source Term**
- **Igneous Activity**
- **Unsaturated and Saturated Flow under Isothermal Conditions**
- **Total System Performance Assessment (TSPA) and Integration**

TOTAL SYSTEM PERFORMANCE ASSESSMENT

B. J. Garrick

VERTICAL SLICE REVIEW BASIS

- **Principal drivers of performance**
- **Extent to which results are risk informed and evidence-based**
- **Transparency, traceability, and defensibility of the results**

MAIN MESSAGE

- **Backbone of safety case**
- **Risk informs licensing process**
- **Ensures integration between various KTIs**

MAIN MESSAGE (Cont'd)

- **Gain understanding of differences between the NRC and DOE analyses – Enhance Public Confidence**

ACNW Supports TSPA

Provided:

- **Performance measures are well-defined**
- **Analysis models are realistic**
- **Results, including uncertainties, are quantified**
- **Quantification is evidence-based**

CONCLUSIONS

- **NRC's Total-system Performance Assessment (TPA) code is adequate as a confirmatory tool**
 - **Simplicity of the code allows evaluation of scenario-based approaches**

CONCLUSIONS (Cont'd)

- **DOE's TSPA complexity inhibits confidence in the results:**
 - **Inconsistent assumptions**
 - **Mix of conservative and non-conservative elements**

CONCLUSIONS (Cont'd)

- Linkage between assumptions and supporting evidence lacks transparency**
- Margins of safety not known**

CONCLUSIONS (Cont'd)

- **DOE's TSPA-SR — Does not answer “What is the Risk?”**
- **Post TSPA-SR documents indicate more realistic performance assessment**

RECOMMENDATIONS

NRC ensure that DOE:

- **Performs realistic analyses (evidence-based)**
- **Improves traceability**
- **Abstracts a simplified model**

RECOMMENDATIONS

(Cont'd)

NRC Uses TPA Code for:

- **Sensitivity analyses**
- **Enhancing realism**
- **Quantifying uncertainties**



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

September 18, 2001

The Honorable Richard A. Meserve
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Chairman Meserve:

SUBJECT: TOTAL SYSTEM PERFORMANCE ASSESSMENT-SITE RECOMMENDATION (TSPA-SR)

This letter documents the findings of the Advisory Committee on Nuclear Waste's (ACNW's) vertical slice review of the TSPA-SR. The Department of Energy's (DOE's) Supplemental Science and Performance Analysis (SSPA) Report following the TSPA-SR, addressed a number of the issues that the Committee identified in its vertical slice review. Because our vertical slice review of the TSPA-SR preceded the SSPA, this letter addresses only some of the SSPA changes. It should be noted, however, that the Committee has not yet reviewed the SSPA report, although we do currently have access to it.

In conducting its vertical slice review of the TSPA-SR, the Committee adopted an approach to: (1) determine the principal drivers of the assessed repository performance (including the supporting evidence) working from the final results, and (2) examine the extent to which the assessment achieves a risk-informed result.

Review Findings

In developing the TSPA-SR, DOE performed an extensive amount of modeling, and the results and supporting technical bases are reasonably well displayed in the context of the models employed. However, based on the Committee's vertical slice review, the principal findings are that the TSPA-SR does not lead to a realistic risk-informed result, and it does not inspire confidence in the TSPA-SR process. In particular, the TSPA-SR reflects the input and results of models and assumptions that are not founded on a realistic assessment of the evidence. The consequence is that the TSPA-SR does not provide a basis for estimating margins of safety.

Discussion

The Committee's principal concerns with the TSPA-SR are that: (1) modeling is guided by an inconsistent set of assumptions, including a mixture of conservative and nonconservative bounding assumptions, that do not represent realistic conditions; (2) the TSPA-SR relies on many assumption-based computations and analyses that do not support or link the assumptions with the available evidence; and (3) the TSPA-SR does not provide a sequence model of dominant dose contributors, therefore, it is not transparent or well-integrated.

The following paragraphs summarize representative examples of the problems that the Committee's vertical slice review identified in the TSPA-SR, along with the Committee's recommendations.

The TSPA-SR relies on modeling assumptions that mask a realistic assessment of risk.

Among such assumptions are those having to do with such phenomena as radionuclide solubilities, in-package chemistry (including the formation of secondary mineral phases), cladding unzipping, decoupling of the drip shield model from the waste package model, and transport of radionuclides through the geosphere. Other assumptions that mask a realistic assessment and reasonableness have to do with mixing conservative and nonconservative bounding analyses and the general treatment of uncertainty. While the TSPA-SR analysts clearly recognize the masking problem and the modeling inconsistencies with respect to realistic assumptions, they fail to convey the expected risk, based on the available evidence.

The Committee believes that the TSPA-SR is driven more by an attempt to demonstrate compliance with the standards than by the need to provide an assessment designed to answer the question: What is the risk? The result is that the assessment does not really risk-inform the safety of the repository even in the spirit of DOE's own words, "... the goal of performance assessment is to provide decisionmakers with a *reasonable* estimate of the *realistic* future performance of the disposal system and a clear display of the extent to which uncertainty in the present understanding of the system affects that estimate." (The italics are added.)

The stated DOE practice is to choose parameter distributions that are "deliberately conservative" where uncertainty distributions "cannot be adequately justified based on available information." To suggest that the distributions are conservative implies some knowledge about the underlying processes, and how the results are affected by parameter values. While this approach may be suitable under some circumstances, when modeling involves linear systems and independent processes, the application of this approach to the high-level waste (HLW) repository at Yucca Mountain may be flawed. This is because the underlying processes in the near field of the repository, for example, are not entirely linear or independent. To the contrary, significant coupling is expected among nonlinear hydrological, chemical, and thermal processes. Determining what is conservative and what is not under these conditions is neither intuitive nor straightforward.

The masking of realism in the TSPA-SR precludes providing a clear basis to estimate the margins of safety, or making an objective regulatory decision that is in the best public interest.

We note that the SSPA report prepared following the TSPA-SR addresses both information and modeling uncertainties, describes how simplified and bounding models in the TSPA-SR, in some cases, were replaced in the SSPA with more detailed and representative models, and compares supplemental model results with those from the TSPA-SR. The Committee has not reviewed the SSPA and cannot comment on the quality of its results at this time. Nonetheless, there are some notable differences between the results of the SSPA and TSPA-SR models. In particular, the calculated doses for late times have significantly decreased in the SSPA models compared to the TSPA-SR models in the nominal case scenario, and increased for the disruptive case scenario. DOE claims that the differences between the supplemental SSPA

model and TSPA-SR have essentially no impact on conclusions that might be drawn with respect to comparisons with the dose standard.

Computations and analyses are assumption-based, not evidence-supported. The TSPA-SR seems to rely more on assumption-based computations and analyses than on the available evidence. This has resulted in limitations that concern the Committee, especially as they relate to: (1) coupled processes, (2) waste package failure, and in-package physical and chemical processes leading to mobilization of the waste, (3) uncertainty in amounts and rates of radionuclides released, and (4) uncertainty in the source term for radionuclide transport. A specific example of relying on assumptions without supporting evidence is an attempt in the TSPA-SR to compare "degraded" and "enhanced" scenarios to provide an indication of the impact on results of two different assumption sets. The idea is a good one and greatly facilitates the understanding of the impact of different assumptions. Nonetheless, the analysis lacks the linkage between the assumption sets and the supporting evidence. The real issue is what the evidence supports, not what are the possibilities? Working from 5th and 95th percentiles of bounding parameter uncertainties in the TSPA-SR does not have much to do with "pessimistic" and "optimistic" results. It would have been much more informative if the TSPA-SR provided sensitivity analyses with respect to parameter values that are probabilistic, but also realistic, reasonable, and supported by evidence. The idea is to move in the direction of "evidence-supported" analyses and away from "assumption-based" analyses.

An alternative approach would be to select several performance scenarios for each of the nominal and disruptive cases, and emphasize the evidence supporting each individual scenario. The three peak-dose models (scenarios) considered in the TSPA-SR represent the beginning of such an approach, but fail to discriminate among the scenarios in terms of their likelihood and supporting evidence. Clearly defined scenarios can greatly facilitate the general question of what the evidence may or may not support.

A dominant sequence model has not been developed. There is a need to abstract a simple model for the dominant dose contributors to the critical group that clearly illustrates how the major modules of the TSPA-SR are integrated and assembled from the detailed models that make up the TSPA-SR. The absence of a simple model for the dominant dose contributors greatly handicaps verification and confidence in the performance assessment results. This is particularly true with regard to evaluating the roles of the different components of the repository system.

In the reactor risk assessment field, the industry has had considerable success in developing simplified risk models based on the dominant contributors to risk (sometimes referred to as a dominant sequence model). These models have contributed to better understanding of the real risk and the contributing factors. They lend themselves to repetitive calculations for checking results. They have also greatly facilitated the review process by allowing simple tradeoffs to be made in assumptions and design conditions while building confidence in the results. There does not appear to be a counterpart to these models in the performance assessment models employed in the TSPA-SR.

The complexity of the TSPA-SR model compromises the ability to comprehend and develop confidence in the results. There are few radionuclides (Tc, I, Np, and Pu) that are driving the risk, suggesting a great opportunity to abstract a simple model. One interpretation of a simple

model would be to simply trace the radionuclide Tc for early dose results (say up to 40,000 years) and Np dose calculations for late and peak doses (10^5 to 10^6 years). The adoption of "pinch points" by the DOE investigators is a move in the right direction to show continuity in the analysis and to modularize the models for greater transparency. The problem for the TSPA-SR is that the idea was implemented too selectively to facilitate putting all the pieces of the model together.

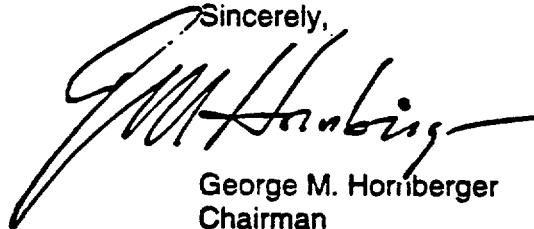
Recommendations

On the basis of its vertical-slice review of the TSPA-SR, the Committee recommends that the NRC staff take the necessary action to be assured that:

- The performance assessment of the proposed Yucca Mountain repository is, in fact, risk-informed.
- DOE has adopted an evidence-supported approach and realistic modeling assumptions for use in the TSPA-SR while reducing the dependence on parameter bounding and conservatism to overcome uncertainty and increase the reliance on such available evidence as site-specific field and laboratory data, natural analogs, and expert knowledge.
- The NRC staff's review of the TSPA-SR adequately emphasized waste package failure and in-package processes to assure the staff that the waste package can perform as DOE claims and to inspire confidence in the characteristics of the source term for radionuclide transport.

The Advisory Committee on Nuclear Waste is prepared to discuss these issues with the NRC staff.

Sincerely,

A handwritten signature in black ink, appearing to read "G. M. Hornberger", with a long horizontal flourish extending to the right.

George M. Hornberger
Chairman

EDO RESPONSE



UNITED STATES
NUCLEAR REGULATORY COMMISSION

WASHINGTON, D.C. 20555-0001

November 29, 2001

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US NRC

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

**SUBJECT: RESPONSE TO THE ADVISORY COMMITTEE ON NUCLEAR WASTE
LETTER DATED SEPTEMBER 18, 2001, ON TOTAL SYSTEM
PERFORMANCE ASSESSMENT—SITE RECOMMENDATION (TSPA-SR),
WHICH PROVIDED RECOMMENDATIONS TO THE U.S. NUCLEAR
REGULATORY COMMISSION STAFF**

Dear Dr. Hornberger:

I am responding to your letter, dated September 18, 2001, providing us with the Advisory Committee on Nuclear Waste's (ACNW's) comments on the U.S. Department of Energy's (DOE's) Total System Performance Assessment—Site Recommendation (TSPA-SR). The ACNW made three specific recommendations to the U.S. Nuclear Regulatory Commission (NRC) staff. In responding to your letter, the NRC staff has relied upon its understanding of the ACNW's concerns, gained from the many discussions with the ACNW on these topics, and your September 28, 2001, letter on the NRC staff's issue resolution process, as it relates to NRC's sufficiency review.

In addition, it should be noted that consistent with the NRC Chairman's letter to DOE dated November 13, 2001, the NRC staff believes that sufficient at-depth site characterization analysis and waste form proposal information, although not available now, will be available at the time of a potential license application such that development of an acceptable license application is achievable.

Recommendation 1:

Take the necessary action to be assured that the performance assessment of the proposed Yucca Mountain repository is, in fact, risk-informed.

NRC Staff Response:

The NRC staff has taken actions to be assured that the performance assessment for the proposed repository will be risk-informed. These actions include developing a risk-informed, performance-based regulation. In this context, DOE is required to provide risk information arising from its need to:

- (1) Explicitly consider a broad set of potential challenges to safety,
- (2) Explicitly identify and quantify sources of uncertainty, and
- (3) Have a means to test the sensitivity of the results to key assumptions.

For example, DOE must:

- (1) Provide the technical basis for its performance assessment, including how the assumptions, models, and parameters affect the resulting time and magnitude of the resulting radiological exposures
- (2) Account for the effect of uncertainties in parameters and models on the performance of the repository, and
- (3) Describe the capabilities of each barrier of the repository system.

DOE is able to use the flexibility afforded by the NRC's risk-informed, performance-based regulations to develop a realistic performance assessment or to introduce conservatism; as long as their approach is able to demonstrate compliance, the staff has no basis to require DOE to use any particular approach. In some cases, DOE may decide that adopting a conservative approach can be an effective and efficient method for demonstrating compliance (e.g., when uncertainties may be large and data collection is difficult). In pre-licensing interactions, the staff has emphasized the expectation that DOE will provide a transparent, traceable, and technically supported assessment of repository performance in any licensee application submitted to NRC. The staff will continue efforts to have DOE provide the information necessary to allow a risk-informed review and to facilitate effective, efficient, and realistic regulatory decisions.

We recognize that if DOE introduces conservatism into their performance assessment, then DOE may have difficulty making optimal design decisions and communicating the risk associated with their design, because they would not have their best estimate of the risk. We also recognize and agree with the concern that was described explicitly in your September 28, 2001, letter: namely, that DOE's use of conservatism makes it difficult to identify the importance of particular issues to risk (i.e., that it is not "risk-informed" as the term is used by the ACNW). Objective regulatory decisions (e.g., whether public health and safety will be adequately protected) can be — and have been — based on the results of performance assessments that include conservatism. One example that illustrates where conservative performance assessments have been used to make objective regulatory decisions is the application of the DandD screening code for site decommissioning decisions.

NRC and DOE held 18 technical exchanges addressing topics related to post-closure performance between June 6, 2000, and September 10, 2001. The agreements resulting from these meetings will lead to information that will help the NRC staff conduct a risk-informed review of DOE's license application, should one be submitted. Some of these agreements address issues of concern that were specifically expressed in your September 18, 2001, letter such as:

- Use of conservatism,
- Representation of uncertainty,
- The process used to develop abstracted models from detailed models, and
- The need to consider the effects of non-linear models when judgments are made to use conservatism to address uncertainty.

Recommendation 2:

Take the necessary action to be assured that DOE has adopted an evidence-supported approach and realistic modeling assumptions for use in the TSPA-SR while reducing the dependence on parameter bounding and conservatism to overcome uncertainty and increase the reliance on such available evidence as site-specific field and laboratory data, natural analogs, and expert knowledge.

NRC Staff Response:

The NRC staff agrees with the ACNW that there should be a clear link between the evidence and the performance assessment modeling.

As indicated in the discussion of Recommendation 1, above, the NRC staff shares aspects of the ACNW's perspective on the treatment of conservatism, in general, and the manner in which DOE should address conservatism in any performance assessment supporting a potential future license application. In particular, the staff recognizes the value of making modeling choices that are reasonable and realistic, but are supported by evidence. As I have indicated above, the NRC staff have reached a number of agreements with DOE, where some of these agreements call for DOE to improve support for assumptions, parameter ranges, and models used in the performance assessment that DOE would use to support a potential license application. In addition, there are agreements that specifically address DOE's approach to conservatism and its use to address uncertainty. These agreements will lead DOE to:

- (1) Strengthen, or clarify, the links of future performance assessments to the supporting data; and
- (2) Improve the consistency, in their approach to conservatism, including the approach used to assert that particular assumptions, models, or parameter distributions are conservative.

Recommendation 3:

Take the necessary action to be assured that the NRC staff's review of the TSPA-SR adequately emphasized waste package failure and in-package processes to assure the staff that the waste package can perform as DOE claims and to inspire confidence in the characteristics of the source term for radionuclide transport.

NRC Staff Response:

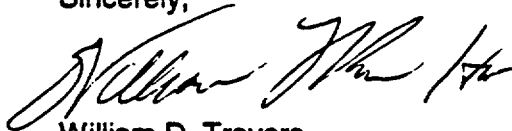
The NRC staff agrees with the ACNW on the importance of the waste package and source term to the evaluation of repository safety. The NRC staff has emphasized processes related to waste package failure and in-package chemistry in completing the review of the TSPA-SR and supporting Analysis/Model Reports. As a consequence of this review, the NRC staff sought, and reached, agreements with DOE pertaining to DOE's assertions of waste package performance and the characteristics of the source term.

Dr. G. Hornberger

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The NRC staff believes that the agreements reached with DOE will help address the ACNW's concerns expressed in your letter. The staff recognizes the need for continuing work to assure that DOE provides the information that will be needed to conduct a risk-informed review of the potential license application. The staff will remain cognizant of your views on: (a) realism versus conservatism in performance assessment; and (b) the need for a clear link between the performance assessment modeling and the supporting evidence.

Sincerely,

A handwritten signature in black ink, appearing to read 'William D. Travers', with a stylized flourish at the end.

William D. Travers
Executive Director
for Operations

cc: Chairman Meserve
Commissioner Dicus
Commissioner Diaz
Commissioner McGaffigan
Commissioner Merrifield
SECY

4

RESEARCH

R. G. Wymer

INTRODUCTION

- **2002 ACNW Annual Report is based on:**
 - **staff presentations**
 - **expert panel report**
 - **discussions with Center for Nuclear Waste Regulatory Analyses**
 - **ACNW-sponsored workshop**

FOCUS OF PROGRAM

- **Office of Nuclear Regulatory Research (RES) -sponsored work emphasizes modeling of flow and radionuclide transport**
- **Office of Nuclear Material Safety and Safeguards (NMSS) - sponsored work focused on proposed Yucca Mountain Repository**

PRIORITIZATION

- **Allocation of resources between reactors and waste arenas needs a high-level policy decision**

PRIORITIZATION

- **Framework for prioritization process should utilize formal decision theory methodology**
- **Analytical Hierarchy Process is a useful innovation but needs to be improved**

OBSERVATION

- **RES radionuclide transport plan prepared**
- **RES program needs modest component of long-term anticipatory research**

RESEARCH WORKSHOP

- **Use lessons learned at closed facilities**
- **Consider research by others**
- **Leverage resources by collaboration**
- **Peer review the research**

CONCLUSION

- **RES-supported work is very high quality and appropriate**
- **NMSS-supported work at CNWRA is well managed, very high quality, and addresses important issues**