

February 4, 2002

The Honorable Spencer Abraham
Secretary of Energy
Washington, D.C. 20585

Dear Secretary Abraham:

On behalf of the U.S. Nuclear Regulatory Commission (NRC) I am providing comments on the Department of Energy's (DOE's) final environmental impact statement (FEIS) for the Yucca Mountain site. Under Section 114(a)(1)(D) of the Nuclear Waste Policy Act of 1982, as amended, any recommendation by the Secretary of Energy to the President with regard to a repository for the disposal of spent nuclear fuel and other high-level radioactive waste (HLW) at the Yucca Mountain site is to include "... a final environmental impact statement prepared for the Yucca Mountain site ... together with comments made concerning such environmental impact statement by ... the Commission...." This letter constitutes NRC's comments in fulfillment of the statutory provision.

These comments were developed on the basis of reviews by the NRC staff of DOE's draft environmental impact statement (DEIS) for Yucca Mountain (Enclosure 1), the supplement to the DEIS (Enclosure 2), and the FEIS. These reviews were supported by extensive pre-licensing interaction among the NRC staff, DOE, and various stakeholders, including the State of Nevada, Indian Tribes, affected units of local government, representatives of the nuclear industry, and interested members of the public. These interactions also supported our comments on DOE's Viability Assessment (Enclosure 3) and our recent comments on the adequacy of at-depth site characterization analysis and waste form (Enclosure 4).

Based on the knowledge gained from these activities, the NRC believes that the FEIS contains sufficient information regarding the environmental impacts of the Proposed Action as to provide a foundation for a site recommendation for the following reasons.

1. The FEIS addresses comments the staff made in conjunction with its reviews of the DEIS and the supplement to the DEIS.
2. Based on the current knowledge of the details of the Proposed Action in the FEIS, including transportation, the analyses provided in the FEIS appear to bound the range of impacts. Staff expects that DOE's commitment to refine the repository design and to define transportation modes and routes will allow for more precise estimates of impacts, which of course could result in revisions to the National Environmental Policy Act (NEPA) analyses.
3. We agree with DOE that in some areas additional NEPA reviews may be necessary. We expect that these additional reviews will be completed in support of the submission of a license application for a geologic repository at Yucca Mountain.

Secretary Abraham

-2-

If DOE decides to proceed with a site recommendation for the Yucca Mountain site and if the President and Congress approve, NRC would continue to interact with DOE to resolve outstanding technical and environmental issues, as needed. Nonetheless, the Commission has not reached any conclusion concerning the suitability of the site and any final determination of the acceptability of the Yucca Mountain site can only be made after completion of the licensing process by the NRC.

If you have any questions or comments, please contact me.

Sincerely,

/RA/

Richard A. Meserve

Enclosures: 1) Letter from Bill Kane, NRC, to Ivan Itkin, DOE, February 22, 2000
2) Letter from Martin Virgilio, NRC, to Lake Barrett, DOE, June 29, 2001
3) Letter from Carl Paperiello, NRC, to Lake Barrett, DOE, June 2, 1999
4) Letter from Richard Meserve, NRC, to Robert Card, DOE, November 13, 2001

cc: Robert G. Card

February 22, 2000

Dr. Ivan Itkin, Director
Office of Civilian Radioactive Waste Management
U.S. Department of Energy, Headquarters
1000 Independence Avenue, S.W.
Washington, DC 20585

SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION COMMENTS ON THE U.S. DEPARTMENT OF ENERGY DRAFT 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

Dear Dr. Itkin:

On August 13, 1999, the U.S. Department of Energy (DOE) published a notice of availability in the Federal Register of its draft environmental impact statement (DEIS) for a geologic repository for the disposal of spent nuclear fuel and high-level radioactive waste at Yucca Mountain, Nye County, Nevada. In the context of the Nuclear Waste Policy Act, as amended, DOE is the lead agency for considering the environmental impacts for the proposed repository, and the U.S. Nuclear Regulatory Commission (NRC) is to adopt the DOE Final Environmental Impact Statement (FEIS) to the extent practicable as part of NRC's licensing actions for the repository. Consistent with its responsibilities, the NRC has promulgated, in 10 CFR Part 51, criteria it will use to adopt the FEIS. With respect to the DEIS, the NRC is a commenting agency. The NRC comments are enclosed.

In reviewing the DEIS, the NRC based its comments on its judgment regarding environmental issues, guided by: 1) the Council on Environmental Quality (CEQ) regulations (40 CFR Part 1500) implementing the National Environmental Policy Act; 2) guidance prepared by CEQ and the U.S. Environmental Protection Agency; and 3) NRC's criteria in 10 CFR Part 51 for adopting the FEIS.

The enclosed staff comments are organized into three categories. The first category is comprised of four comments that the NRC believes should be addressed by DOE to make the FEIS complete. These four comments concern broad issues in the DEIS, specifically: integration of the Proposed Action, cumulative impacts, transportation, and mitigative measures. When DOE submits an application for a license for the repository, the FEIS should contain sufficient information to allow a reasonable evaluation of the environmental impacts of that Proposed Action.

The remaining comments apply to more specific topical areas within the DEIS. The second category of comments (comments 5 through 8) also addresses issues related to completeness, albeit less directly than those in the first category. Those four comments have less significance than the first four comments, but DOE should address all eight comments to make the FEIS complete. The final five comments (9 through 13) are offered for DOE's consideration. In

I. Itkin

-2-

preparing the FEIS, NRC also requests that DOE consider relevant technical comments previously submitted by the NRC. The NRC has provided such technical comments in reports on specific technical issues and in comments on DOE's Viability Assessment in June 1999.

The comments on the Viability Assessment also address the issue of quality assurance (QA). DOE's application of a rigorous and effective QA program is crucial to its ability to demonstrate the validity of its findings and analyses in any license application. The NRC staff will continue to evaluate DOE's efforts to implement an effective QA program.

We are available to meet with your staff to discuss our comments and recommendations. Please contact Charlotte Abrams, Team Leader, Environmental Review Team, if you have any questions regarding this letter or the enclosure. Ms. Abrams can be reached at (301) 415-7293.

Sincerely,

[M.J. Virgilio for]

William F. Kane, Director
Office of Nuclear Material Safety
and Safeguards

Enclosure: U.S. NRC's Comments on U.S. DOE's
Draft 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

cc w/encl: See attached list

Wendy R. Dixon, EIS Project Manager
Yucca Mountain Site Characterization Office
Office of Civilian Radioactive Waste Management
U.S. Department of Energy
P.O. Box 30307, Mail Stop 010
North Las Vegas, NV 89036-0307

Letter to Ivan Itkin, U.S. DOE dated: _____ 2/22/00

cc: R. Loux, State of Nevada
S. Frishman, State of Nevada
L. Barrett, DOE/Wash, DC
A. Brownstein, DOE/Wash, DC
S. Hanauer, DOE/Wash, DC
C. Einberg, DOE/Wash, DC
D. Shelor, DOE/Wash, DC
N. Slater, DOE/Wash, DC
R. Dyer, YMPO
S. Brocoum, YMPO
R. Clark, YMPO
A. Gil, YMPO
G. Dials, M&O
J. Bailey, M&O
D. Wilkins, M&O
M. Voegelé, M&O
S. Echols, M&O
B. Price, Nevada Legislative Committee
J. Meder, Nevada Legislative Counsel Bureau
D. Bechtel, Clark County, NV
E. von Tiesenhausen, Clark County, NV
J. Regan, Churchill County, NV
H. Ealey, Esmeralda County, NV
L. Fiorenzi, Eureka County, NV
A. Remus, Inyo County, CA
T. Manzini, Lander County, NV
E. Culverwell, Lincoln County, NV
J. Wallis, Mineral County, NV
L. Bradshaw, Nye County, NV
M. Murphy, Nye County, NV
J. McKnight, Nye County, NV
N. Stellavato, Nye County, NV
D. Kolkman, White Pine County, NV
D. Weigel, GAO
W. Barnard, NWTRB
R. Holden, NCAI
D. Morgan, NIEC
R. Arnold, Pahrump County, NV
J. Lyznicky, AMA
R. Clark, EPA
F. Marcinowski, EPA
R. Anderson, NEI
R. McCullum, NEI
S. Kraft, NEI
J. Kessler, EPRI
G. McKnight, Pahrump, NV
R. Wallace, USGS
R. Craig, USGS
W. Booth, Engineering Svcs, LTD
S. Trubatch, Winston & Strawn

**U.S. Nuclear Regulatory Commission's Comments on
U.S. Department of Energy's Draft 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**

This enclosure provides comments by the U.S. Nuclear Regulatory Commission (NRC) staff on the draft environmental impact statement (DEIS) prepared by the U.S. Department of Energy (DOE) for a geologic repository for the disposal of spent nuclear fuel (SNF) and high-level radioactive waste (HLW) at Yucca Mountain, Nye County, Nevada. The DEIS addresses a wide range of possible impacts of this complex project. A significant amount of information, including multiple options for key components of the Proposed Action, is presented in the DEIS. The NRC believes it to be desirable that DOE more clearly define a Proposed Action comprised of a preferred option for each component or a bounding analysis that gives a better understanding of the potential impact of each component. The NRC recognizes the utility of DOE's preserving, to the extent possible, repository design flexibility. Nevertheless, in the interest of improving the focus of its National Environmental Policy Act (NEPA) analysis, the NRC requests DOE to prepare, in the final environmental impact statement (FEIS), an in-depth analysis of a clearly defined Proposed Action, or, at the least, to provide sufficient information and analysis of the various options that it has retained as to demonstrate that the environmental impacts of the repository are bounded. A number of the attached NRC comments relate to the value in defining an integrated Proposed Action.

The assessment of long-term radiological impacts is based on the results of site characterization and the development of models describing repository performance. NRC and DOE have had extensive pre-licensing consultations concerning site characterization and NRC staff has provided comments on these matters. Staff's comments in these areas were provided to DOE in reports on specific technical issues (e.g., Issue Resolution Status Reports for Key Technical Issues) and in comments on DOE's viability assessment (VA). These technical comments should be considered during the development of the FEIS.

The enclosed staff comments are organized into three categories. The first category is comprised of four comments that the NRC believes should be addressed by DOE to make the FEIS complete. These four comments concern broad issues in the DEIS, specifically: integration of the Proposed Action, cumulative impacts, transportation, and mitigative measures. When DOE submits an application for a license for the repository, the FEIS should contain sufficient information to allow a reasonable evaluation of the environmental impacts of that Proposed Action.

The remaining comments apply to more specific topical areas within the DEIS. The second category of comments (comments 5 through 8) also addresses issues related to completeness, albeit less directly than those in the first category. Those four comments have less significance than the first four comments, but DOE should address all eight comments to make the FEIS complete. The final five comments (9 through 13) are offered for DOE's consideration. In preparing the FEIS, NRC also requests that DOE consider relevant technical comments previously submitted by the NRC. The NRC has provided such technical comments in reports on specific technical issues and in comments on DOE's Viability Assessment in June 1999.

COMMENTS

Category 1 -- Comments That Should be Addressed to Ensure the Completeness of the FEIS

INTEGRATION

1. **Comment:**

The DEIS discusses five components relating to: 1) construction of the repository and waste handling facilities; 2) preparation of SNF and HLW at 77 sites for transport; 3) transportation of the SNF and HLW to Yucca Mountain by use of a National transportation network and a transportation network in the State of Nevada; 4) repository operations, including packaging, waste emplacement, monitoring and closure; and 5) mitigation and monitoring. The NRC recognizes the utility in DOE preserving, to the maximum extent practicable, design flexibility and therefore understands why DOE has presented a number of options for public consideration for each of these components. However, the DEIS does not identify a preferred option for each component. Further, it does not provide an integrated description of a clearly defined Proposed Action (comprised of the various components) and of the direct, indirect, and cumulative environmental effects of the integrated action. As a result, it is not clear that DOE has bounded the environmental impacts that could arise from the repository. As it prepares the FEIS, we request that DOE prepare an in-depth analysis of a clearly defined Proposed Action, or, at the least, to provide sufficient information and analysis of the various options that it has retained as to demonstrate that the environmental impacts of the repository are bounded.

Basis:

The DEIS describes numerous options for the various components of the repository system. For example, in Appendix F, two potential configurations of waste packaging for shipment were analyzed: uncanistered and canistered. In Chapter 6, two "National-level" transportation scenarios were analyzed (mostly truck and mostly rail) and eleven Nevada transportation alternatives were considered. Additionally, three potential thermal load scenarios and three waste volume options for the repository were considered in Chapters 4 and 5.

Given the number of components and options within those components, the repository system could consist of one of the numerous possible permutations. The DEIS does not select among the various options to identify a single, integrated Proposed Action. Moreover, the DEIS does not present an integrated overall description and impact assessment of any complete combination for the Proposed Action, and it is not clear that the analyses of the various components presented in the DEIS bound the impacts that could result from the Proposed Action, once one is selected. Instead, descriptions and impacts are treated separately, discussed separately, with conclusions drawn separately. Although NRC recognizes the importance of DOE's retaining flexibility to make changes in its design, and of obtaining public input in the selection among the available options, the FEIS should contain sufficient information and analysis of the

various options to cover the Proposed Action that is ultimately selected and to allow a reasonable assessment of the impacts of that Proposed Action.

Concerns identified in this comment are linked to comments on cumulative impacts (see Comment 2), transportation in Nevada (see Comment 3), and mitigation (see Comment 4).

Recommendation:

In the interest of improving its analyses, the NRC recommends that, to the extent choices among options have been refined, DOE identify its Proposed Action in the FEIS. Further, the NRC suggests that DOE use its refined description of the Proposed Action to complete the assessment of the direct, indirect, and cumulative effects of the Proposed Action, making bounding assumptions when necessary or appropriate. At the least, if DOE chooses to retain flexibility in the FEIS, it should show that the indirect, direct and cumulative impacts of the eventual selection have been bounded by the assessments presented in the FEIS.

CUMULATIVE IMPACTS

2. Comment:

The assessment of cumulative impacts in the DEIS does not fully address the impacts associated with past, present, and reasonably foreseeable future actions relating to groundwater use, land use, and cultural and biological resources.

Basis:

A "cumulative impact" is an impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions (40 CFR 1508.7). A complete cumulative impacts assessment would provide an understanding of whether the Proposed Action (see Comment 1) might push a resource, ecosystem, or human community beyond a critical threshold and preclude sustainability (CEQ, 1997, page 7). Therefore, the FEIS should assess the additional, incremental impacts from the action at hand when added to impacts from past, present, and reasonably foreseeable future actions (40 CFR 1508.7).

Section 4.1.3 (Environmental Consequences of Repository Construction, Operation and Monitoring, and Closure — Impact to Hydrology) acknowledges that repository construction and operation will impose water demands on the available supplies at Yucca Mountain and the surrounding area. Similarly, Section 6.3.2.1 (Impacts Common to Nevada Branch Rail Line Implementing Alternatives) acknowledges that water withdrawal will be required to support construction of a branch rail line. These demands could create impacts on water resources, particularly in light of other possible future uses. Creation of a Timbisha Shoshone Tribal Homeland with agricultural water rights is a reasonably foreseeable action that could contribute to exceeding the sustainable yield in the Death Valley National Park region (Buqo, 1999, p. 25). Further, it is foreseeable

that the continued growth of Clark, Nye, and Lincoln Counties and Las Vegas, Pahrump, and Beatty will impact available groundwater resources. An increased cumulative demand for water, particularly when coupled with reduced water supplies resulting from land withdrawal and Federal land acquisition, could lead to aquifer overdrafting, increased pumping costs, and associated socioeconomic impacts. The cumulative impacts on groundwater resources stemming from the Proposed Action and these other actions are not adequately considered in the DEIS.

The cumulative impacts assessment also needs to further evaluate combined impacts to other specific resources (e.g., the desert tortoise, land use, cultural resources). The cumulative impacts of a Proposed Action, coupled with other Federal actions in the area (e.g., activities at NTS, Nellis Air Force Range (AFR)) and impacts from extensive growth in Nye, Lincoln, and Clark Counties, on the ranges and habitats of local fauna, such as the desert tortoise, should be documented. In addition, land withdrawal by DOE in conjunction with Department of Interior limitations on land use in Ash Meadows may result in cumulative impacts related to land use that have not yet been fully assessed. Similarly, the impact that private projects such as the Cortez Gold Mine Pipeline projects and the Apex Bulk Commodities Intermodal Transfer Station have on resources (e.g., biological and cultural resources) may not have been fully considered.

Recommendation:

DOE should complete its analysis of cumulative impacts for resources, ecosystems, and human communities by augmenting analyses already performed for individual components for the proposal. The analysis should consider all past, present, and reasonably foreseeable future actions, both Federal and non-Federal, within appropriate spatial and temporal boundaries.

References:

Buqo, T.S. *Nye County Perspective: Potential Impacts Associated with Long Term Presence of a Nuclear Depository at Yucca Mountain, Nye County, Nevada.* June 1999.

Council on Environmental Quality, *Considering Cumulative Effects Under the National Environmental Policy Act*, CEQ, January 1997.

TRANSPORTATION

3. Comment:

In the absence of a preferred route and mode of transportation, it is unclear whether the non-radiological impacts related to transportation of SNF and HLW within Nevada, including impacts from construction and operation of intermodal transfer stations and rail lines, have been bounded.

Basis:

The DEIS identifies the transportation of SNF and HLW as one of the components necessary for a repository. As such, transportation is a connected action (40 CFR 1508.25(a)(1)) and should be considered an integral part of the Yucca Mountain project. The NRC understands that DOE would like to benefit from public input, through comments on the DEIS, when considering preferred transportation modes and routes. However, an integrated impact assessment that connects transportation to disposal needs to be included as part of any evaluation of the Proposed Action in the FEIS.

The current analysis for transportation within the State of Nevada provides a general discussion of impacts, but does not fully assess the non-radiological impacts. Further, it is not apparent that the transportation analysis in the DEIS bounds the non-radiological impacts (e.g., socioeconomic impacts and impacts to air quality, cultural and biological resources, and land and water use). Moreover, although DOE has identified a number of options, it has not clearly defined which options (e.g., rail line construction, mode of transportation, need for intermodal transfer stations, preferred routing within the State of Nevada, and type of trucks) it will use to support the Proposed Action.

As noted in Comment 1, the FEIS should show that, once decisions on transportation routes and modes are made, no new information or circumstances exist that could result in significant changes to the impacts assessed in the FEIS.

Recommendation:

Transportation impacts (including non-radiological and cumulative impacts) should be discussed in sufficient detail to support selection of a Proposed Action. The FEIS should contain either a complete, integrated assessment of the connected transportation actions or sufficient information and analyses on the various options to show that the impacts of the Proposed Action have been bounded.

MITIGATION OF ACTIONS

4. **Comment:**

The DEIS does not include a thorough discussion of mitigative measures or of long-term environmental monitoring to measure the impacts on the environment.

Basis:

As noted in Comment 1, the DEIS does not identify what options will be combined for a Proposed Action. Public comments on the DEIS can be used by DOE to help in the selection of those options that will form the Proposed Action, refine its analysis of environmental impacts, and evaluate the need for particular mitigative measures. In this connection, it is important to ensure that all environmental impacts have been identified or bounded in order to provide a basis for decisions for mitigative measures. Mitigative strategies currently address dust suppression, the desert tortoise, and occupational health and safety. In addition, the FEIS needs to evaluate the need for mitigative

strategies for water use, economic, social, cultural, biological, or public health and safety impacts.

For example, the discussion in Chapter 9 (Management Actions to Mitigate the Potential for Environmental Impacts) of the DEIS does not fully address mitigative measures for Native American interests, including several measures presented by the AIRD (American Indian Writers Subgroup, 1998), such as ways to alleviate the severity of the effects on Native American cultural, religious, subsistence, recreational, ceremonial and associated uses of Yucca Mountain. The suggested mitigation actions in the AIRD include providing emergency preparedness training, establishing emergency medical facilities, and providing controlled access to sacred or ceremonial areas or resources.

Further, it is not apparent that a complete monitoring program for mitigative strategies has been clearly defined. The FEIS should include monitoring as a way of evaluating the effectiveness of any mitigative measures, such as measures to reduce impacts from transportation or waste handling at intermodal or site surface-based facilities (40 CFR 1505.2(c)).

Recommendation:

The FEIS should provide reasonable mitigative strategies to address potentially significant adverse impacts from the Proposed Action. Mitigative measures which comprise these strategies should be implementable and effective in reducing environmental impacts. Moreover, the FEIS should discuss monitoring to assess the environmental impacts and the effectiveness of planned mitigative measures. As appropriate, this monitoring could be integrated with DOE's long-term performance confirmation monitoring.

References

American Indian Writers Subgroup. *American Indian Perspectives on the Yucca Mountain Site Characterization Project and the Repository Environmental Impact Statement*. American Indian Resource Document MOL 19980420.0041. Las Vegas, NV: American Indian Writers Subgroup, Consolidated Group of Tribes and Organizations. 1998.

Category 2 -- Additional Comments Related to Completeness

ENVIRONMENTAL JUSTICE

5. Comment:

The DEIS discussion of the impacts on minority and low income communities is restricted to the Bureau of the Census block group data. The discussion does not provide sufficient specificity with respect to community locations within the relevant census block groups or adequately identify potentially unique community characteristics. This information would facilitate the assessment of any potential for disproportionately

high and adverse human health and environmental effects of the Proposed Action upon these communities.

Basis:

The discussion of Environmental Justice in the DEIS does not specifically identify where minority or low-income communities are located within each census block group. This problem is compounded by the relatively large geographic size of the Nevada census block groups analyzed in the DEIS. Determining the specific locations of the potentially affected communities in each relevant census block group would facilitate evaluation of the disproportionate impacts of the Proposed Action. DOE may find that state, local, and tribal governments possess demographic information relevant to the location of these communities.

DOE's conclusion that the Proposed Action will have no significant impact on the general population, and thus no significant impact on minority and low-income communities, appears not to address the possibility that cultural, social, historical, or economic factors associated with minority and low income communities may amplify the effect of the Proposed Action and produce disproportionately high and adverse impacts upon these communities. The FEIS should discuss whether such factors exist and whether the consideration of such factors leads to the identification of significant effects that would otherwise be diluted by examination of the general population. This information could also be useful in identifying appropriate mitigative measures to address any disproportionate impacts resulting from the Proposed Action.

The NRC also notes that Section 3.1.13 (Environmental Justice) of the DEIS identifies Native Americans as having concerns about disproportionate impacts. The NRC's analysis of census data has found that there may also be African American and Hispanic minority groups in the affected area. It is not clear from the analysis in the DEIS whether these other minority groups were considered in determining if the Proposed Action has a potential disproportionate impact upon these communities.

Recommendation:

The FEIS discussion of environmental justice should identify the location and unique characteristics of minority and low income communities with sufficient specificity to enable a complete assessment of any disproportionate impacts upon those communities resulting from the Proposed Action.

WATER USE

6. **Comment:**

DOE should correct areas of discrepancy in water use data and provide clarifying information regarding the potential for and impacts from overdrafts of groundwater in the FEIS.

Basis:

Table 3-11 notes that the figures for current water appropriations do not include Federal reserved water rights (FRRs) for the NTS and Nellis AFR. These FRRs should be added to the total appropriations for a more accurate measure of committed resources.

Table 3-11 and DEIS Section 3.1.4.2.1 (Affected Environment - Regional Groundwater) suggest that ample water is available for new appropriations to support the Proposed Action because average annual withdrawals (actual use) are well below the appropriation limits. Although the use of average withdrawals may be appropriate, it is possible that this could be misleading because users are entitled to withdraw or sell their full appropriations.

When discussing the water demands expected during performance confirmation in Section 4.1.3.1 (Environmental Consequences of Repository Construction, Operation and Monitoring, and Closure - Impacts to Hydrology from Performance Confirmation) the DEIS omits mention of NTS and Nellis AFR wells in the area. The pumpage from those wells should be added to that from J-11 and J-12 and the C-well complex in the proposed land withdrawal area for an improved estimate of the water demand. The wide range in the perennial yield figures (880 to 4000 acre-feet for Area 227a) should be explained. The perennial yield and committed resources figures for Area 227a in Nevada Division of Water Planning (1992) do not agree with Table 3-11. DOE should provide additional justification for the perennial yield figures, considering the variance from information in other sources, to support its assessment of potential overdraft in the region.

The discussion of water demand during construction, operation and monitoring, and closure in Section 4.1.3.3 (Environmental Consequences of Repository Construction, Operation and Monitoring, and Closure - Impacts to Groundwater from Construction, Operation and Monitoring, and Closure) of the DEIS also should be clarified. This discussion should make clear where the water will be obtained to meet the combined water demand for the repository, the NTS, and Nellis AFR. Under one scenario, the perennial yield of Area 227a would be exceeded. The text should be clarified to explain the impacts of any possible overdraft.

The discussion in DEIS Section 4.1.3.3 (Environmental Consequences of Repository Construction, Operation and Monitoring, and Closure - Impacts to Groundwater from Construction, Operation and Monitoring, and Closure) includes at least one scenario where the Jackass Flats basin would be in overdraft status. In addition, Table 3-11 presents the Amargosa Desert Area 230 in a potential overdraft situation. DOE (1996) confirms that historic data show that DOE withdrawals at Yucca Flats have annually exceeded the perennial yield. The potential impacts of these overdrafts should be discussed.

Recommendation:

DOE should correct discrepancies in water-use discussions and data in the FEIS. The evaluation of groundwater use during construction, operation, and monitoring should include a discussion of the potential for overdrafts.

References:

Nevada Division of Water Planning. *Nevada Water Facts, 1992*. 241353. Carson City, NV: Nevada Division of Water Planning. 1992.

U. S. Department of Energy. *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada*. DOE/EIS-0243-F,239895. Las Vegas, NV: U. S. Department of Energy. 1996.

LAND USE

7. **Comment:**

Although flexibility exists in the amount of land that is to be withdrawn for the geologic repository operations area and the post-closure controlled area, the extent of the land withdrawal influences the type and magnitude of impacts that should be considered in the impact statement. The DEIS does not provide a clear basis for determining the extent of the proposed land withdrawal nor does it assess the full range of impacts associated with the land withdrawal (e.g., socioeconomic, water use, cultural).

Basis:

According to DEIS Section 1.4.1 (Purpose and Need for Agency Action—Yucca Mountain Site), the area needed for development of the surface repository is approximately 3.5 km² with up to approximately another 600 km² set aside as a buffer zone. However, the severity of impacts is dependent on the area to be withdrawn.

The FEIS should include an assessment of the potential impacts of removing a large area (e.g., 600 km² is used as the size of the potential land withdrawal on pages 2-1 and 2-2 of the DEIS) from other possible uses. The withdrawal would preclude or limit use of the land at any time for other purposes by the public or by Native Americans. Development of water resources on this land by private individuals, businesses, industry, or the State of Nevada might also be prohibited. These impacts are not fully assessed in the DEIS.

Recommendation:

The impacts associated with the land withdrawal should be discussed systematically in the FEIS, including impacts on cultural resources and land use.

BIOLOGICAL RESOURCES

8. Comment:

The DEIS may not adequately bound the uncertainty in the predictions of heat generated from radioactive decay during long-term repository performance and the potential effects of this heat generation on fauna.

Basis:

Although most vertebrate species have genetically fixed sex determination, it is now known that chelonians (tortoises and turtles) undergo temperature dependent sex determination (TSD). Spotila (1994) shows that the desert tortoise (*Gopherus agassizii*), a federally listed threatened species of the Mojave Desert, is subject to this effect. Research shows that the temperature that produces a 50:50 sex ratio is 31.8 °C. Desert tortoise eggs have good hatching success between 28 and 33 °C, but suffer high mortality at temperatures below 26 or above 35.3 °C. Temperatures between 26.0 and 30.6 °C produce mostly males (temperatures 28 °C and below produce 100 percent males) and temperatures between 32.8 and 35.3 °C produce mostly females (temperatures above 33 °C produce 100 percent females) (Spotila et al., 1998). Lewis-Winokur and Winokur (1995) confirm that the pivotal temperature is between 31 and 32 °C and indicated that a lowering of 1.6 °C (from 31 to 29.4 °C) resulted in all male hatchlings.

The modeling of surface soil temperature for the proposed site produces uncertain results. TRW Environmental Safety Systems, Inc. (1999, page 44) states "...current predictions are somewhat uncertain due to uncertainties in the thermal properties of the soil, particularly thermal conductivity and, hence, thermal diffusivity." This source further states that "analyses based on conventional soil heat-conduction models indicate that the original time scale of the measurements collected at the site (weekly to monthly) could not be used to accurately estimate the soil thermal conductivity for the sampling depths chosen (15, 30 and 45 cm)." However, substantial temperature effects on desert tortoise sex determination have been shown to occur within a range of plus or minus 3 °C. Therefore, it is important for the FEIS to clarify the range of soil temperatures associated with the geologic repository and discuss impacts, if any, on protected or endangered species.

Recommendation:

The assessment of the contribution of thermal loading on increased soil temperature should be refined in the FEIS. Soil temperature modeling should take into account the substantial uncertainties in thermal conductivity in Yucca Mountain soils thereby enabling an assessment of the potential impacts to the desert tortoise from increased soil temperatures.

References:

- Lewis-Winokur, V., and R.M. Winokur. *Incubation temperature affects sexual differentiation, incubation time, and posthatching survival in desert tortoises [Gopherus agassizi (sic)]. Canadian Journal of Zoology* 73(11): 2091–2097. 1995.
- Spotilla, J.R., L.C. Zimmerman, C.A. Binckley, J.S. Grumbles, D.C. Rostal, A. List, Jr., E.C. Beyer, K.M. Philips, and S.J. Kemp. *Effects of incubation conditions on sex determination, hatching success, and growth of hatchling desert tortoise, Gopherus agassizii. Herpetological Monographs* 8: 103–116. 1994.
- TRW Environmental Safety Systems, Inc. *Impact of Radioactive Waste Heat on Soil Temperatures*. BA0000000–01717–5700–00030. Revision 0. Las Vegas, NV: TRW Environmental Safety Systems, Inc.: 37–44. 1999.

Category 3 -- Less significant Issues

DOCUMENTATION OF QUALITATIVE JUDGMENTS ON IMPACTS AND INCONSISTENCIES

9. **Comment:**

Additional documentation or analysis should be provided in the FEIS to support the characterization of impacts and the description of environmental parameters in some areas of the FEIS.

Basis:

Additional documentation or analyses would be useful in the following areas:

- The DEIS assessments of impacts on faunal resources in Section 4.1.4 (Environmental Consequences of Repository Construction Operation and Monitoring and Closure—Impacts to Biological Resources and Soils) that are classified as “low,” “very small,” or “minimal and largely undetectable” are not supported by quantitative data. Individuals of a population that occur near the edge of its range (e.g., desert tortoises in the vicinity of Yucca Mountain) are living in marginal conditions, and therefore environmental stressors caused by the Proposed Action might have amplified effects in these edge areas.
- Section 4.1.6.2.1 (Environmental Consequences of Repository Construction, Operation and Monitoring, and Closure—Impacts to Employment), page 4-41 states “[i]f the present economic growth continued in the region of influence, it could absorb declines in the repository workforce.” To assess the adequacy of this statement, the assumptions used to generate the Regional Economic Models, Inc. (REMI) (Treyz et al., 1992) baseline results should be provided. The conclusion appears to require the assumption that the skills of displaced workers are compatible with the employment growth and needs of other sectors.

- Section 6.3.2.2.1 (Environmental Impacts of Transportation—Caliente Rail Corridor Implementing Alternative—Socioeconomics) states “[t]he projected length of the corridor—513 kilometers—is the most important factor for determining the number of workers (560) that would be required.” This statement is repeated for all corridors, but more specific information is needed to support this conclusion. Terrain and other factors might have significant impact, because productivity per worker (km/worker) varies considerably by route (e.g., 1.04 km/worker on the Carlin route, 0.53 km/worker on the Jean route).
- Section H.2.1.3 (Potential Repository Accident Scenarios: Analytical Methods and Results—External Events) of the DEIS concludes that 3 cm is the maximum thickness of volcanic tephra that could be deposited on repository facilities from a basaltic volcano that erupts within the area around the proposed repository site. The basis for this conclusion is a statement (DOE, 1998) that 3 cm of volcanic tephra is the worst-case event being considered. The conclusion appears not to be supported by data or analyses.

Recommendation:

The FEIS should improve the documentation and support for qualitative conclusions or assumptions related to impacts, as appropriate.

References:

- Treyz, G.I., D.S. Rickman, and G. Shao. The REMI economic-demographic forecasting and simulation model. *International Regional Science Review* 14(3): 221–253. 1992.
- U. S. Department of Energy. Viability assessment of a repository at Yucca Mountain. *Volume 2: Preliminary Design Concept for the Repository and Waste Package*. DOE/RW–0508. Washington, DC: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. 1998.

CULTURAL RESOURCES

10. **Comment:**

Documentation and analyses for the assessment of impacts to cultural resources are incomplete.

Basis:

Some DEIS conclusions regarding cultural resource impacts lack supporting analyses or reference material. Moreover, methods used to conduct the analyses and reach conclusions are not presented. The following are examples:

- Section 3.1.6.1 (Affected Environment—Archeological and Historic Resources) states that a field survey of a 44-km² (11,000 acres) parcel was conducted.

Clarifying information needs to be provided, including (i) the type of survey (e.g., walk-over); (ii) the percentage of coverage for the 44-km² area; (iii) the relationship of the survey area to the entire land withdrawal area; (iv) the relationship of this survey to the “additional archaeological surveys” conducted in Midway Valley, Yucca Wash, and lower Fortymile Canyon; (v) the extent and techniques used for these additional surveys; (vi) specification of the total survey area; and (vii) the extent to which sites have been identified for the complete land withdrawal area.

- Section 3.1.6.1 (Affected Environment—Archeological and Historic Resources) of the DEIS states that “826 archeological sites have been discovered in the analyzed land withdrawal area.” This statement requires clarification. It is not clear whether the entire 600 km² parcel has been surveyed or whether the number of sites is on a smaller parcel of land. It is difficult to assess site density and cultural resources impacts without knowing the extent of the land area that has been surveyed.
- Section 3.1.6.1 (Affected Environment—Archeological and Historic Resources) states that limited test excavations were conducted at 29 sites. Clarification is required regarding the criteria used to select sites for testing and the representativeness of these sites for the potentially affected area.
- The Western Shoshone occupied the Yucca Mountain region into historic times and were engaged in mining, ranching, and other activities. The DEIS is unclear whether any of the historic sites are associated with the Western Shoshone or Paiute peoples or whether these sites are considered to be related only to non-Native American occupation activities.

Recommendation:

The FEIS should provide additional data and descriptions of methods used to assess impacts on cultural resources, including a description of the area of study used in assessing the distribution and types of cultural resources. If the entire land withdrawal area or the entire potential disturbed area was not surveyed for cultural resources, the rationale for not doing so should be presented.

LONG-TERM REPOSITORY PERFORMANCE

11. Comment:

The methodology for estimating the environmental impacts from the release and transport of toxic materials should be well documented in the FEIS. The estimates should incorporate the current waste package materials and design.

Basis:

The release and transport of toxic materials (chromium (Cr) and molybdenum (Mo)) from waste package corrosion to a receptor group was modeled using the EQ6

geochemical speciation code (Figure I-1). It is unclear how this code was used to estimate the corrosion products or the corrosion rate for toxic materials.

The assumed dissolution rates and mineral formation kinetics are critical to substantiating the claim that release and eventual exposure of a receptor group to the potentially toxic waste package corrosion products (e.g., chromate, molybdate) is minimal as stated in Section 5.6 (Environmental Consequences from Long-Term Repository Performance—Consequences from Chemically Toxic Materials).

We understand that DOE is expected to select Enhanced Design Alternative II (EDA-II) for the potential license application in the near term (TRW, 1999). EDA-II includes an outer overpack of 5 cm thick Alloy-22. The DEIS design includes a 2 cm thick inner overpack of Alloy-22, so the quantities of Alloy-22 will more than double, even assuming constant numbers of waste packages, if the EDA-II design is used. Because Alloy-22 is approximately 56 percent Ni by weight, the volume of Ni present in the repository is considerably more than the amount of Cr and Mo present. In addition, nickel (Ni) will also likely dissolve at roughly the same rate as Cr and Mo during corrosion. The FEIS should document that Ni does not pose a health risk.

Recommendation:

The discussion of toxic materials should be consistent with the current waste package design at the time of the FEIS. DOE should provide the technical basis for waste package corrosion rates, and should provide technical support for claims that exposure to potentially toxic materials released by waste package corrosion is minimal.

Reference

TRW Environmental Safety Systems, Inc. *License Application Design Selection Report*. B00000000-01717-4600-00123. Revision 01. Las Vegas, NV: TRW Environmental Safety Systems Inc. May 28, 1999.

REPOSITORY CONSTRUCTION, OPERATION AND MONITORING, AND CLOSURE

12. **Comment:**

Inconsistencies concerning the appropriate range for ²²²Rn concentration should be remedied and impacts of thermal loading on radon release and worker safety should be explained in the FEIS.

Basis:

The median and range of ²²²Rn concentrations used for radiological impact calculations are not consistent throughout the DEIS. Sections 3.1.8.2 (Affected Environment—Radiation Environment in the Yucca Mountain region) and F.1.1.6 (Human Health Impacts Primer and Details for Estimating Health Impacts to Workers from Yucca Mountain Repository Operations—Exposures from Naturally Occurring Radionuclides in the Subsurface Environment) of the DEIS report that radon

concentrations in the Exploratory Studies Facility (ESF) during working hours (with active ventilation) range from 0.22 to 72 pCi/L, with a median concentration of 6.5 pCi/L. Sections 4.1.2.2.2 (Environmental Consequences of Repository Construction, Operation and Monitoring, and Closure—Radiological Impacts to Air quality from Construction) and G.2.3.1 (Air Quality—Release of Radon-222 and Radon Decay Products from the Subsurface Facility) of the DEIS report that radon concentrations in the ESF during working hours with the ventilation system on range from 0.65 to 163 pCi/L, with a median concentration of 24 pCi/L. The difference is a factor of 2-3 in the range and a factor of approximately 4 for the median.

Section 4.1.7.3.1 [Environmental Consequences of Repository Construction, Operation and Monitoring, and Closure—Occupational Impacts (Involved and Non-Involved Workers)] of the DEIS states that “radiological health impacts to surface workers would be independent of the thermal load scenarios.” However, it is not apparent whether there was any consideration of higher heat loadings increasing the radon release rate from the wall surfaces. Table G-48 of the DEIS reports that the annual average radon releases during the 24-yr operation period are expected to be 880 Ci, 1000 Ci, and 1900 Ci for the high, intermediate, and low thermal loads. It also appears that these source terms did not take into account the relative volume of the repository under each heat loading alternative.

Recommendation:

The FEIS should explain or address inconsistencies related to the appropriate range for ²²²Rn concentration. The FEIS should also discuss the effects of the various heat loading scenarios on total radon release and provide a technical basis for the conclusion that radiological health impacts are independent of thermal load scenarios.

NO ACTION ALTERNATIVE

13. **Comment:**

The DEIS presents two scenarios, both of which DOE recognizes as unlikely, as a baseline to address the uncertainty associated with the management of SNF and HLW in the absence of a Yucca Mountain repository. Scenario 1 is a status quo of maintaining storage facilities continuously for the next 10,000 years. Scenario 2 proposes that these storage facilities would be maintained for 100 years, after which the 77 sites would be left without further management. Scenario 2 is not reasonable and, therefore, DOE should explain that it includes this scenario only to allow comparison with the analysis of the postclosure performance of the potential repository, which similarly is based on the highly unlikely and unreasonable assumption that institutional controls will be maintained only for 100 years.

Basis:

Scenario 2 assumes that, after a 100 year period, the Federal Government would permit SNF and HLW to be abandoned. This is not a reasonable assumption. The Federal

Government would continue to control licensed material and HLW under its authority for as long as necessary for public health and safety considerations.

Recommendation:

DOE should explain the basis for its identification of Scenario 2 as a potential no-action alternative.

June 29, 2001

Mr. Lake H. Barrett, Acting Director
Office of Civilian Radioactive Waste Management
U.S. Department of Energy, Headquarters
1000 Independence Avenue, S.W.
Washington, DC 20585

Dear Mr. Barrett:

As you know, the U.S. Department of Energy (DOE) published a notice of availability, in the Federal Register on May 4, 2001, of a supplement to its draft environmental impact statement (DEIS) (hereafter referred to as the SDEIS), for a proposed geologic repository for the disposal of spent nuclear fuel and other high-level radioactive waste (HLW) at Yucca Mountain in Nevada. In the context of the Nuclear Waste Policy Act (NWPA), as amended, DOE is the lead agency for developing the proposed repository and considering potential environmental impacts. For its part, NRC is to adopt DOE's final environmental impact statement (FEIS), to the extent practicable, as part of any potential NRC licensing action related to the repository.

Consistent with its NWPA responsibilities and its role as a DEIS commenting agency, the NRC provided comments to DOE on its DEIS in a letter dated February 22, 2000. NRC's comments on the recently published SDEIS are enclosed. The enclosed comments and NRC's February 2000 comments on the DEIS are provided to ensure that the FEIS is more complete.

Please contact Charlotte E. Abrams, of my staff, if you have any questions about this letter or the enclosure. Ms. Abrams can be reached at (301) 415-7293.

Sincerely,

/RA/

Martin J. Virgilio, Director
Office of Nuclear Material Safety
and Safeguards

Enclosure:

"U.S. NRC's Comments on U.S. DOE's Supplement to the Draft 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"

cc: Dr. Jane R. Summerson

See attached list

Letter to L.H. Barrett from M. Virgilio dated: June 29, 2001

cc:

R. Loux, State of Nevada	R. Massey, Lander County, NV
S. Frishman, State of Nevada	J. Pitts, Lincoln County, NV
L. Barrett, DOE/Washington, DC	M. Baughman, Lincoln County, NV
A. Brownstein, DOE/Washington, DC	A. Funk, Mineral County, NV
S. Hanauer, DOE/Washington, DC	J. Shankle, Mineral County, NV
C. Einberg, DOE/Washington, DC	L. Bradshaw, Nye County, NV
J. Carlson, DOE/Washington, DC	M. Murphy, Nye County, NV
N. Slater, DOE/Washington, DC	J. McKnight, Nye County, NV
L. Desell, DOE/Washington, DC	B. Price, Nevada Legislative Committee
E. Turner, DOE/Washington, DC	D. Weigel, GAO
D. Kim, DOE/Washington, DC	W. Barnard, NWTRB
S. Gomberg, DOE/Washington, DC	I. Navis, Clark County, NV
A. Gil, YMPO	E. von Tiesenhausen, Clark County, NV
R. Dyer, YMPO	L. Lehman, T-Reg, Inc
S. Brocoum, YMPO	R. Holden, NCAI
R. Clark, YMPO	A. Collins, NIEC
S. Mellington, YMPO	R. Arnold, Pahrump County, NV
C. Hanlon, YMPO	J. Larson, White Pine County
T. Gunter, YMPO	R. Clark, EPA
K. Hess, BSC	F. Marcinowski, EPA
D. Krisha, BSC	R. Anderson, NEI
S. Cereghino, BSC	R. McCullum, NEI
M. Voegele, BSC/SAIC	S. Kraft, NEI
S. Echols, Winston & Strawn	J. Kessler, EPRI
J. Curtiss, Winston & Strawn	D. Duncan, USGS
J. Meder, Nevada Legislative Counsel Bureau	R. Craig, USGS
A. Kalt, Churchill County, NV	W. Booth, Engineering Svcs, LTD
G. McCorkell, Esmeralda County, NV	N. Rice, NV Congressional Delegation
L. Fiorenzi, Eureka County, NV	T. Story, NV Congressional Delegation
A. Johnson, Eureka County, NV	J. Reynoldson, NV Congressional Delegation

A. Remus, Inyo County, CA

S. Joya, NV Congressional Delegation

M. Yarbrow, Lander County, NV

J. Pegues, City of Las Vegas, NV

2001-04-09

**U.S. NUCLEAR REGULATORY COMMISSION'S COMMENTS
ON THE U.S. DEPARTMENT OF ENERGY'S
"SUPPLEMENT TO THE DRAFT 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"**

This enclosure provides comments, by the U.S. Nuclear Regulatory Commission (NRC) staff, on the May 2001 supplement to the draft environmental impact statement (DEIS) (hereafter referred to as the SDEIS) prepared by the U.S. Department of Energy (DOE) for a proposed geologic repository for the disposal of spent nuclear fuel (SNF) and other high-level radioactive waste (HLW) at Yucca Mountain (Nye County), Nevada.

In its review of the SDEIS, NRC has four comments, as noted below, that address the following areas: identification of a Proposed Action; impacts from the design options; new or modified facilities associated with the Science and Engineering Report (S&ER) flexible design; and the assessment of radiological impacts associated with the S&ER flexible design.

Comment No. 1

Consistent with its February 2000 comments on the DEIS, the NRC staff believes that DOE's final environmental impact statement (FEIS) should more clearly define a Proposed Action for each component of the proposed activity.

Basis:

The environmental impact statement development process is intended to address a wide range of possible impacts of this complex geotechnical project. A significant amount of information, including multiple options for key components of the Proposed Action, was presented in the August 1999 DEIS (U.S. Department of Energy, 1999). However, as noted in its February 2000 comments on the DEIS, the NRC staff continues to believe that DOE's final environmental impact statement (FEIS) should more clearly define a Proposed Action comprised of: (i) a preferred option for each component; or (ii) a bounding analysis that provides a better understanding of the potential impact of each component, as well as their combined impacts. NRC recognizes the utility of DOE's preserving, to the extent possible, repository design flexibility, as outlined recently in the S&ER supporting the DEIS and the SDEIS. However, the DEIS did not identify a preferred option for each component of a possible geologic repository and the SDEIS does not define a preferred option for the design of a repository. Consequently, it is not clear that environmental impacts that could arise from a repository have been bounded.

Recommendation

In the interest of improving the focus of its National Environmental Policy Act analysis in its FEIS, DOE should prepare an appropriate analysis of a clearly defined Proposed Action, or provide sufficient information and analysis of the various operational approaches to demonstrate that the environmental impacts of the proposed repository are bounded.

Enclosure

Comment No. 2

The SDEIS provides several new design and operational features proposed to meet thermal criteria. DOE should ensure that sufficient information is provided to enable assessment of the direct, indirect, and cumulative impacts.

Basis

In the SDEIS, DOE describes two thermal operational approaches to control temperature at the drift pillars and the waste package surface. For the high-temperature operation mode, at least some portion of the drift pillars would have temperatures above the boiling point of water. The low-temperature operating mode is designed to ensure temperatures below the boiling point at all times and waste package surface temperatures below 85 degrees Centigrade. To achieve either temperature scenario, DOE describes five potential operational approaches: increased drift spacing, increased preclosure ventilation, surface aging of commercial fuel, fuel blending, and variable line loading. Depending on the approaches selected, the operational and monitoring period may extend beyond 300 years, with as long as 50 years allowed for waste emplacement.

NRC recognizes the value of maintaining flexibility in selecting operational approaches to enhance repository performance. However, many combinations of the operational approaches are likely to achieve the overall thermal goals, and each combination is likely to have a different set of impacts. For example, lower rates of ventilation may require larger spacing between waste packages, which may, in turn, lead to a larger repository with a greater volume of excavated rock and an expansion of the repository closer to key features such as the high ground-water gradient area to the north and across an additional fault zone. Similarly, the flexible pre-closure ventilation design could increase radon release through the use of forced ventilation. Without a clear description of the preferred option or without estimating impacts explicitly for each option, there is no basis for concluding that the full range of impacts has been presented in the DOE analyses.

Several of the flexible design operational approaches include new features not considered in the DEIS. In some instances, the SDEIS analyses multiply DEIS impacts by a proportionality constant to obtain impacts associated with the S&ER flexible design. Because many of the impacts cited in the SDEIS are the result of new design features (e.g., surface-aging facility, titanium drip shields) and altered time frames in the various flexible operational approaches, an adequate technical basis is required for use of the proportionality constants. For example, it is not clear that the thermal effects imposed by the flexible design would be linear and therefore amenable to quantification based on a proportionality constant. Similarly, impacts from constructing and operating the surface-aging facility may be spread over as many as 50 years, and include the construction of concrete pads covering 200 acres, and fabricating and placing up to 4500 dry-storage canisters and casks on these pads (Mattsson, 2000; U.S. Department of Energy, 2001a, Table 3-11). These new features are substantive modifications of the DEIS design and individual and cumulative impacts may not scale in a linear fashion .

The full range of impacts of the new operational approaches are not addressed. Waste package emplacement is discussed in detail in the SDEIS (Section 2.3.3.3), but certain potential activities are not discussed. They include, for example: (i) loading dry storage canisters and casks for the SNF aging facility; (ii) removing pallets and waste packages for repair and re-emplacment; (iii) maintaining drifts, waste packages, and other engineered barriers; (iv) moving waste packages to adjust thermal load; (v) retrieving waste packages;

(vi) installing and maintaining drip shields; and (vii) constructing and using performance-confirmation drifts. It is also not clear whether the impact assessments include off-normal events, accidents, or other events outside of the base case. For example, the impacts from manufacturing and shipping as much as 60,000 metric tons of fabricated titanium drip shields are not fully addressed, nor is the potential for worker injury or exposure during drip-shield emplacement. The drip shield is a new design feature and is not addressed in the offsite impact analyses included in the DEIS.

Recommendation

The FEIS should include an analysis of impacts associated with all potential operational activities related to a preferred design option. As an alternative, the FEIS could estimate impacts separately for a suite of proposed operational approaches. The specific environmental concerns associated with each primary impact indicator should be identified. The FEIS should also provide a technical basis to demonstrate that the full range of direct, indirect, and cumulative impacts has been included in the analyses. In addition, the FEIS should improve the technical justification for the use of linear thermal load proportionality factors.

Comment No. 3

The S&ER flexible design includes new or modified facilities, land uses, and changes in infrastructure. Environmental impacts from construction and operation of these repository features are not included in the SDEIS. A more thorough impact assessment is necessary for major changes incorporated in the S&ER flexible design.

Basis

The SDEIS (Table S-2) indicates that environmental impacts associated with the S&ER flexible design include potentially significant changes in ground use, radon release, peak electrical power requirements, fossil fuel requirements, construction and demolition debris, and waste generation. Although the SDEIS provides a relatively thorough description of the different approaches to the potential design and operating bounds of the proposed S&ER flexible design, a detailed description of these new facilities and analyses of their environmental impacts has not been included.

Foremost among the new facilities is the proposed separate, at-surface fuel-aging area. As part of the lower-temperature, flexible-design operating mode, DOE has proposed placing younger fuel in a surface-aging area, to allow heat dissipation before underground disposal, as a method of controlling repository temperatures (U.S. Department of Energy, 2001a, p. 2-8). This facility would age as much as 40,000 MTHM (metric tons of heavy metal) of SNF (or about 60 percent of repository-destined waste) over a 50-year period (*Id.*). Aging time is directly related to potential impacts associated with surface storage of SNF; however, only limited impact analysis of this new design feature has been provided in either the SDEIS or the S&ER. There is a similar concern regarding the proposed blending pool in the waste-handling building with a proposed design capacity of 5000 MTHM (p. 2-15). It is not apparent that DOE has prepared an impact analysis of this major new design feature.

Other examples of new design features that lack adequate descriptions and impact assessments (i.e., land and water use, impact on ground-water quality) include the solar power generating facility, and the wind farm. The environmental impacts of all features of a proposed design, as well as alternatives, need to be identified and evaluated.

Recommendation

DOE should expand the description and environmental impact analyses for major new features of the S&ER flexible design in the FEIS.

Comment No. 4

Estimates of the radiological impacts of the flexible design require additional technical basis.

Basis

The SDEIS (U.S. Department of Energy, 2001a, Section 3.1.7) states that "[e]xposed workers include both radiation workers and some general employees.... DOE used the total number of exposed worker-years to estimate potential impacts from the radiation dose received from this exposure, namely the number of latent cancer fatalities...." The SDEIS does not define the number of general employees, the lengths of their exposures, or the exposure levels associated with different phases of operation that were applied in estimating latent cancer fatalities.

In addition, the lower-temperature design option may require preclosure ventilation for a period beyond 300 years. Ensuring that the emplacement drifts remain clear and unobstructed from rockfall or drift collapse during this period is therefore important. The SDEIS does not appear to address the impacts of drift support system maintenance on worker exposure.

Recommendation

The FEIS should provide a more complete assessment of the radiological impacts of the flexible design, including maintenance activities associated with an extended preclosure period.

References

Mattsson, C.G., "Repository Surface Design Engineering Files Letter Report – Non-Boiling Repository Surface Facilities Conceptual Design," Letter from C.G. Mattsson (Civilian Radioactive Waste Management System Management and Operating Contractor) to K.J. Skipper (DOE/Yucca Mountain Site Characterization Office), July 21, 2000.

U.S. Department of Energy, "Draft 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," DOE/EIS-0250D, North Las Vegas, NV: Office of Civilian Radioactive Waste Management, U.S. Department of Energy, 1999.

U.S. Department of Energy, "Supplement to the Draft 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," DOE/EIS-0250D-S, North Las Vegas, NV: Office of Civilian Radioactive Waste Management, U.S. Department of Energy, 2001a.

U.S. Department of Energy, "Yucca Mountain Science and Engineering Report: Technical Information Supporting Site Recommendation Consideration. DOE/RW-0539. Washington, DC: Office of Civilian Radioactive Waste Management, U.S. Department of Energy, 2001b.

U.S. Nuclear Regulatory Commission, "U.S. Nuclear Regulatory Commission's Comments on U.S. Department of Energy's Draft 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," Washington, DC: U.S. Nuclear Regulatory Commission, 1999.

DISTRIBUTION: (G20010176)

Central File	DWM r/f	NMSS Dir Off r/f	HLWB r/f	EDO r/f
PUBLIC	EPAB r/f	SWastler	CLui	ACNW
CNWRA	KCyr	PLohaus	FMiraglia	WTravers
Ptressler	CPoland	LSS	OGC	OCA
OIG	SECY-LTR-01-0101			

* SEE PREVIOUS CONCURRENCE Approved by Commission 6/27/01.

ADAMS ACCESSION NO: ML011590087 Package: ML011590111

DOCUMENT NAME: S:\DWM\HLWB\MPL\sdeis_2.wpd

OFC	EPAB*		Tech Editor*		EPAB*		EPAB*	
NAME	MLee		EKraus		CAbrams		TEssig	
DATE	06/07/01		06/07/01		06/07/01		06/07/01	
OFC	HLWB*		DWM*		OGC*		NMSS	
NAME	WReamer		JGreeves		STreby		MVirgilio	
DATE	06/07/01		06/07/01		06/11/01		06/13/01	
OFC	DED0		EDO		OCM			
NAME	CPaperiello		WTravers		RMeserve			
DATE	06/14/01		06/15/01		06/27/01			

OFFICIAL RECORD COPY



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

June 2, 1999

Mr. Lake H. Barrett, Acting Director
Office of Civilian Radioactive Waste Management
U.S. Department of Energy, Headquarters
1000 Independence Avenue, S.W.
Washington, DC 20585

**SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION STAFF REVIEW OF THE U.S.
DEPARTMENT OF ENERGY VIABILITY ASSESSMENT FOR A HIGH-LEVEL
RADIOACTIVE WASTE REPOSITORY AT YUCCA MOUNTAIN, NEVADA**

Dear Mr. Barrett:

In December 1998, the U.S. Department of Energy (DOE) completed its viability assessment (VA) for a potential high-level radioactive waste repository at Yucca Mountain, Nevada. Although the VA is a management tool to provide DOE with a basis for making an informed assessment of the feasibility of proceeding with site characterization and the process of potential licensing and construction of a repository at Yucca Mountain, the U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the VA as part of its precicensing consultation with DOE under the Nuclear Waste Policy Act of 1982 (NWPAct). It is believed that the results of the review will facilitate DOE's development of a complete and high-quality license application (LA). NRC staff believes that DOE's analyses are adequate to make an informed decision whether to continue with site characterization of Yucca Mountain in anticipation of a potential site recommendation, and staff agrees with DOE's decision to continue site characterization.

Staff interactions with DOE over the past 18 months have facilitated the NRC staff review of the VA. These interactions focused on elements of DOE's ongoing work that formed the basis for the VA. The VA reflects substantial progress by DOE in focusing its program on the issues that need to be addressed prior to a licensing decision. It describes significant DOE progress in areas such as data collection, data synthesis, performance assessment modeling, and documentation of results. There is general agreement that DOE's planned work appears adequate in several technical areas including: mechanical disruption of waste packages; spatial and temporal distribution of flow; distribution of mass flux between fracture and matrix; and dilution of radionuclides in soil.

Staff comments on the VA are intended to facilitate DOE's efforts to focus its program and develop a high-quality LA. The staff reviewed the preliminary design concept, total system performance assessment (TSPA), and LA Plan. Supporting documents such as the TSPA-VA Technical Basis Document were also examined. In formulating our comments, the staff took into account supporting information, importance to performance or licensing, and DOE's plans for addressing these topics, as documented in the LA Plan. The comments developed by the staff are not new and have been the subject of earlier public meetings and NRC staff documents.

The staff notes that in the TSPA-VA, DOE placed heavy reliance on engineered barriers (e.g., waste package performance, cladding credit, etc.) to achieve isolation. In addition, the discussion of "defense-in-depth" in the LA Plan considers additional engineered features (drip shields, backfill, ceramic coatings) to compensate for uncertainty and provide a margin of safety. In the Statement of Considerations for proposed 10 CFR Part 63, the Commission stated its expectation that natural and engineered barriers would each make a definite contribution to the isolation of waste in order to provide reasonable assurance that the overall safety objective would be met. In any future LA, DOE is expected to demonstrate that natural barriers and the engineered barrier system work in combination to enhance overall performance of the geologic repository. Additional attention needs to be given to how this demonstration will be made.

The staff comments in the enclosure cover the reference design, technical topics related to the data or models associated with several aspects of DOE's TSPA (i.e., performance of the waste package, seepage into the drifts, saturated zone flow, and analysis of the consequences of volcanism), and the LA plan. More detailed comments on the VA will be provided to DOE through updates to Issue Resolution Status Reports, interactions, and correspondence, as appropriate. The staff will continue to evaluate these topics, interact with DOE, and provide timely feedback. It is important for the precicensing consultations to proceed in order for a possible LA to be of sufficient quality that the staff will be able to complete its review in the time frame required by the NWPA.

Enclosed, along with the staff evaluation, is a copy of a letter dated April 8, 1999, to Chairman Jackson/NRC, from B.J. Garrick/Advisory Committee on Nuclear Waste, on the DOE VA. This letter is being provided for your information only.

Sincerely,



Cari J. Paperiello, Director
Office of Nuclear Material Safety
and Safeguards

Enclosures: As stated

cc: See attached list (w/encl)

Letter to L. Barrett from C. Paperiello dated: June 2, 1999

cc: R. Loux, State of Nevada
S. Frishman, State of Nevada
L. Barrett, DOE/Wash, DC
A. Brownstein, DOE/Wash, DC
S. Hanauer, DOE/Wash, DC
C. Einberg, DOE/Wash, DC
S. Rousso, DOE/Wash, DC
N. Slater, DOE/Wash, DC
R. Dyer, YMPO
S. Brocoum, YMPO
R. Clark, YMPO
A. Gil, YMPO
S. Echols, M&O
B. Price, Nevada Legislative Committee
J. Meder, Nevada Legislative Counsel Bureau
D. Bechtel, Clark County, NV
E. von Tiesenhausen, Clark County, NV
J. Regan, Churchill County, NV
T. Cain, Esmeralda County, NV
L. Fiorenzi, Eureka County, NV
B. Mettam, Inyo County, CA
T. Manzini, Lander County, NV
E. Culverwell, Lincoln County, NV
J. Wallis, Mineral County, NV
L. Bradshaw, Nye County, NV
M. Murphy, Nye County, NV
J. McKnight, Nye County, NV
N. Stellavato, Nye County, NV
D. Kolkman, White Pine County, NV
D. Weigel, GAO
W. Barnard, NWTRB
R. Holden, NCAI
A. Mitre, NIEC
R. Arnold, Pahrump County, NV
J. Lyznicky, AMA
R. Clark, EPA
F. Marcinowski, EPA
R. Anderson, NEI
R. McCullum, NEI
S. Kraft, NEI
J. Kessler, EPRI
G. McKnight, Pahrump, NV

**U.S. Nuclear Regulatory Commission's Staff Evaluation of
U.S. Department of Energy's Viability Assessment**

The U.S. Nuclear Regulatory Commission (NRC) staff reviewed the U.S. Department of Energy's (DOE's) Viability Assessment (VA) for a potential high-level radioactive waste (HLW) repository sited at Yucca Mountain, Nevada (YM). This review was conducted as part of the staff's precicensing activities and included the preliminary design, total system performance assessment (TSPA), and License Application (LA) Plan. Based on this review, the staff identified several challenges for DOE to assemble a complete and high-quality LA within the time frame envisioned in the LA Plan.

The review of the VA indicates that DOE has made significant progress in a number of areas such as: data collection, data synthesis, performance assessment (PA) modeling, and documentation. However, additional work will be needed in order for DOE to be able to prepare a complete and high-quality LA. The LA Plan provides a high-level description of where DOE believes progress is required and the priority that DOE is assigning to particular objectives.

The TSPA will be an important element in DOE's LA. The staff conducted concurrent reviews of the TSPA-VA and the LA Plan. Through these reviews, the staff identified a set of technical comments regarding the supporting data and models within the TSPA. These comments address key elements of DOE's PA, and -- based on the review of the LA Plan -- may represent challenges for DOE to develop a complete and acceptable LA. There are areas where the staff does not have major comments at this time. These areas include: mechanical disruption of waste packages (WPs); radionuclide release rates and solubility limits; spatial and temporal distribution of flow in the unsaturated zone (UZ); distribution of mass flux between fracture and matrix in the UZ; retardation in fractures in the UZ; retardation in water-production zones and alluvium; dilution of radionuclides in groundwater from well pumping; airborne transport of radionuclides; dilution of radionuclides in soil; and location and lifestyle of the critical group. The most significant staff comments are summarized below.

Repository Design

Comment:

The reference repository design presented in VA keeps open numerous options such that the overall concept remains fluid. Significant changes in the repository design may affect the timely availability of data and well developed supporting information to be used for repository PA that is necessary for developing a complete and defensible LA. Although appreciating the importance and need for flexibility in design, the lack of a more focused design may not permit DOE sufficient time to address all pertinent issues and prepare a complete LA within its current schedule.

Importance:

Many aspects related to the repository design, especially the thermal load and temperature alternatives; option for backfilling the emplacement drifts and its timing; ground support options and maintenance of underground facility; selection of emplacement stratum; and ventilation alternatives may be important to understanding repository performance. Design alternatives being considered by DOE could result in substantially different approaches than the current reference design. Design options being considered (U.S. Department of Energy, 1998) include different thermal loads, backfilling of the emplacement drifts, continuous pre-closure ventilation, timing of repository closure, type of ground support systems, near-field rock treatment, and repository horizon elevation. Additional enhancement features such as drip shields and Richard's barrier are also being studied. Adequate documentation of design development and traceability of design changes are very important to the completeness and defensibility of the DOE LA. It is important to establish that the data being gathered and the suite of analyses being performed are sufficient to cover all the design alternatives under consideration. It is equally important to develop analytical tools that can make quantitative comparisons of alternatives so that the preference of one over the rest could be established on a rational basis and in a transparent manner.

Status of Resolution:

The NRC has to date concentrated on the design control process being employed by the DOE to document design changes for the exploratory studies facility. However, the staff has yet to review the DOE process for the design of the repository. The staff has been observing many DOE meetings and workshops where design alternatives are being discussed and compared based mostly on engineering judgment or qualitative criteria. NRC recognizes the importance of allowing for certain design improvements and data gathering during the pre-closure period that could improve repository safety and reduce uncertainties in the predicted performance of the repository. However, it must also be recognized that the LA and supporting information must be well developed to allow NRC to make a finding of reasonable assurance of safety. DOE plans to complete the selection of the LA design in May 1999 and the final design in November 2000 (U.S. Department of Energy, 1998).

Additional Background:

None.

Basis:

DOE presented its first conceptual design for the proposed repository at Yucca Mountain in its Environmental Assessment (in 1984) and then again in its Site Characterization Plan (in 1987). Over the years, the initial design concepts have undergone several iterations with many minor and some major changes to reflect newly acquired information as well as to respond to comments raised by oversight and regulatory bodies. At present, DOE is considering several design alternatives and design options that could significantly affect the repository performance; generate new demands for data and model development; and raise associated uncertainties. For example, depending on the thermal load option selected for final consideration, the technical issues that need to be addressed by DOE and evaluated by NRC could be different. Backfilling the emplacement drifts can change the WP degradation and disruption scenarios to a large extent. Considering the current DOE schedules for addressing the issue of design alternatives, there is a risk that data, models, and analysis results will not be sufficient for a complete and high-quality LA. This might result in NRC requesting additional information at the time of LA review and thus prolong the review period.

References:

McKenzie, III, D.G. 1998. Alternative repository designs. Presented to the *Drift Stability Workshop*. North Las Vegas, NV: U.S. Department of Energy, Office of Civilian Radioactive Waste Management.

U.S. Department of Energy. 1998. *Viability Assessment of a Repository at Yucca Mountain, Volume 4: License Application Plan and Costs*. North Las Vegas, NV: U.S. Department of Energy, Office of Civilian Radioactive Waste Management.

Waste Package Corrosion

Comment:

It is unclear whether DOE will be able to acquire sufficient data, applicable to conditions at the proposed repository, in time to demonstrate compliance with NRC requirements. This comment is applicable to the VA design of the waste package (WP) and other aspects of the Engineered Barrier System (EBS).

Importance:

Container life is an important factor in limiting the dose to the critical group and in providing defense-in-depth for the repository system. For example, DOE sensitivity analyses in the TSPA-VA show that by decreasing the corrosion rate of the inner overpack material by a factor of 60, the annual dose at 10,000 years decreases from 2 mrem to less than 10^{-3} mrem. The corrosion rate of the inner overpack material is one of the many WP parameters affecting the prediction of WP lifetime in the TSPA-VA. Several WP parameters have been defined based on expert elicitation rather than long-term test data, especially those for the corrosion-resistant material (CRM). Even if the design were fixed today, only very limited data will be available to substantiate the adequacy of the waste package design for LA.

The continued consideration of alternate designs (in all areas including the EBS and repository) further complicates this subject. It will be even more difficult to gather sufficient and applicable data in the far shorter time-frame between the next design decision (May 1999) and LA. In addition to the time required for testing new materials and concepts, and developing the appropriate modeling when different failure modes may be involved, fabrication issues -- including the problem of closure welding -- will require time for development and evaluation prior to completing the LA.

Status of Resolution:

DOE has testing programs in place for many WP parameters, particularly those relating to the CRM. NRC and DOE staff have had ongoing discussions and interactions regarding these programs and the validity of the values selected by expert elicitation. DOE has described an ambitious testing program in the LA Plan.

DOE has continued the evaluation of alternative designs for WPs, and a decision is expected in May 1999. One alternative to the current design includes the use of Alloy-22 as an outer barrier and titanium Grade 7 or 16 as an inner barrier. Other options include a three-wall design in which nuclear grade stainless steel (i.e., 316 NG) will be used to provide structural integrity. The reverse design of that proposed in VA, consisting of Alloy-22 as an outer barrier and the steel as an inner barrier providing structural integrity, is also being considered. The issues related to the performance of the alternate designs, including data collection and fabrication issues, are currently being reviewed by NRC and will be addressed in the next revision of the Issue Resolution Status Report (IRSR) on Container Life and Source Term (CLST).

Additional Background:

There are a number of ancillary subjects associated with data collection. In addition to data sufficiency and applicability to the repository environment, there are issues associated with the qualification of data. Another issue is the appropriate role of data collected during the performance confirmation period, relative to data available at the time of Construction Authorization. Although it is appropriate for DOE and NRC to take into consideration more long-term data at later times (i.e., license to receive and possess, repository closure), sufficient data must be available to support the LA. Finally, the bulk of the long-term data used in the TSPA is gathered from expert elicitations and literature reviews, rather than measured under the environmental conditions at Yucca Mountain; including water chemistry, gamma radiation, and the variation of temperature with time.

Basis:

Sensitivity analyses indicate that the lifetime of the WPs has a significant effect on dose to the receptor group. Consequently, corrosion performance of the WPs is a critical factor that may be affected by detrimental interactions between different materials and/or prompted by a specific fabrication process. Additional testing may be required to provide support for any new design. In particular, DOE has recognized in VA that "the primary weakness of the [waste package] model is the overall reliance on expert elicitation rather than on long-term test data of corrosion rates for corrosion-resistant material."

References:

U.S. Nuclear Regulatory Commission, *Issue Resolution Status Report (Key Technical Issue: Container Life and Source Term, Revision 0)*, Washington DC: U.S. Nuclear Regulatory Commission, 1998a.

Quantity and Chemistry of Water Contacting Waste Packages and Waste Forms

Comment:

The data and models used in the VA to calculate the quantity and chemistry of water dripping on WPs are inadequate to describe the process and extent of potential dripping under ambient and thermally-altered conditions. This is an issue because both DOE and NRC PA analyses indicate that the fraction of WPs contacted by water is the most important factor affecting dose for the groundwater pathway. Further, NRC staff considers that the current DOE testing and modeling plans are not sufficient to resolve the issue prior to LA. There are activities that DOE could complete prior to LA that would provide additional support for addressing this issue.

Importance:

The quantity and chemistry of water contacting the WP are the major factors in determining the lifetime of the WP. Radionuclide release rates from breached WPs are also dependent on the quantity and chemistry of water contacting the WPs and, subsequently, the waste forms. Degradation of WPs by corrosion and alteration of waste forms is accelerated in the presence of water and certain dissolved aqueous species. Differences in the amount of seepage into the emplacement drifts and onto WPs lead to calculated radionuclide releases that vary by several orders of magnitude.

Status of Resolution:

DOE recognizes that there are few data -- and the need for additional data -- regarding seepage into drifts, the effects of heat and excavation on flow at the drift scale dripping onto WPs, and the chemistry of water on WPs. In addition, DOE has recognized that its current PA models do not adequately capture the effects of coupled processes on the quantity and chemistry of water contacting WPs. DOE has assigned a high priority to both the data collection and modeling efforts, and is conducting a peer review on drift seepage to guide its pre-licensing scientific activities. The range of activities outlined in the LA Plan are unlikely to provide an adequate licensing basis for assessing the quantity and chemistry of water contacting WPs and waste forms. For instance, it was noted at the Drift Seepage Peer Review Meeting on January 11-13, 1999, that the niche studies that have been conducted and proposed to be completed prior to license application, do not provide an adequate basis to support the seepage abstraction (Hughson, 1999). However, two activities were suggested by members of the peer review panel (Hughson, 1999). It is likely that they could be completed prior to LA and would lead to a more defensible approach for addressing the quantity and chemistry of water contacting the WPs and waste forms. First, systematic air permeability measurements conducted in horizontal boreholes in the three repository host rock units could provide data on the scales of variability and heterogeneity in rock properties that are necessary to describe seepage. Second, additional model development efforts should focus on explaining the observed patterns of seepage in the niche experiments.

Additional Background:

The data and processes necessary to describe the quantity and chemistry of water contacting the WPs and waste forms through abstraction in a PA have been addressed in several IRSRs (U.S. Nuclear Regulatory Commission, 1998a, 1998b, 1998c, and 1998d). In addition, the importance of characterizing thermal perturbations to UZ flow fields during the heating phase and considering coupled thermal-hydrologic-chemical-mechanical processes in PAs was raised in letters to DOE (U.S. Nuclear Regulatory Commission, 1997, 1998e).

Basis:

An ongoing peer review of the DOE drift seepage approach has identified inadequacies in the data, experiments used to collect the data, the models used to describe the seepage process, and the methods used to abstract seepage into performance assessments (Hughson, 1999). Both laboratory scale heater tests and analog site heater tests have indicated the potential for liquid water to contact a heat source under heterogenous or transient boiling conditions. Both: (1) the potential for gravity-driven refluxing during the thermal period and other coupled processes; and (2) the importance of these processes for adequately describing WP performance has been presented to DOE (U.S. Nuclear Regulatory Commission, 1997, 1998c). Drift collapse may also significantly alter effective parameters describing moisture retention characteristics of the fracture continuum, and thus result in more seepage for a given percolation flux. On the very small scale of a drift wall, the presence of surface irregularities and conducting fractures that dead-end at the drift crown will result in less capillarity and thus less diversion of percolation flux around the drift (Hughson, 1999). Many alteration products of tuff and engineered materials are likely to affect the chemistry of water contacting WPs, which in turn can affect corrosion rates, waste form alteration rates, and radionuclide solubility and speciation (U.S. Nuclear Regulatory Commission, 1998d). Although an effort was made to address this subject, there are many limitations in the data used and the extent of phases considered. Additional data and analysis of seepage under both isothermal and thermal conditions will be required for a complete LA. The amount of data required for the LA, and the need to confirm expected performance of the evolving repository system, will depend on the importance of the quantity and chemistry of water contacting WPs and waste forms to the DOE safety case.

References:

Hughson, D., *Drift Seepage Peer Review*, Trip Report, Las Vegas, Nevada, January 11-13, 1999, Center for Nuclear Waste Regulatory Analyses, San Antonio, TX, 1999.

U.S. Nuclear Regulatory Commission, *Comments on the Department of Energy Thermohydrology Testing and Modeling Program*, letter dated January 23, 1997, from M.J. Bell, U.S. Nuclear Regulatory Commission, to S.J. Brocoum, U.S. Department of Energy, 1997.

U.S. Nuclear Regulatory Commission, *Issue Resolution Status Report (Key Technical Issue: Total System Performance Assessment and Integration, Revision 1)*, enclosure to letter dated December 8, 1998, from M.J. Bell, U.S. Nuclear Regulatory Commission, to S.J. Brocoum, U.S. Department of Energy, 1998a.

U.S. Nuclear Regulatory Commission, *Issue Resolution Status Report (Key Technical Issue: Unsaturated and Saturated Flow Under Isothermal Conditions, Revision 1)*, enclosure to letter dated October 7, 1998, from M.J. Bell, U.S. Nuclear Regulatory Commission, to S.J. Brocoum, U.S. Department of Energy, 1998b.

U.S. Nuclear Regulatory Commission, *Issue Resolution Status Report (Key Technical Issue: Thermal Effects on Flow, Revision 1)*, enclosure to letter dated October 1, 1998, from M.J. Bell, U.S. Nuclear Regulatory Commission, to S.J. Brocoum, U.S. Department of Energy, 1998c.

U.S. Nuclear Regulatory Commission, *Issue Resolution Status Report (Key Technical Issue: Evolution of the Near-Field Environment, Revision 1)*, enclosure to letter dated August 28, 1998, from N.K. Stablein, U.S. Nuclear Regulatory Commission, to S.J. Brocoum, U.S. Department of Energy, 1998d.

U.S. Nuclear Regulatory Commission, *U.S. Nuclear Regulatory Commission Comments on the U.S. Department of Energy Total System Performance Assessment*, letter dated July 6, 1998, from M.J. Bell, U.S. Nuclear Regulatory Commission, to S.J. Brocoum, U.S. Department of Energy, 1998e.

Saturated Zone Flow and Transport

Comment:

In NRC sensitivity studies, flow in the saturated zone has been shown to be an important component of the natural barrier. At this time, the saturated zone (SZ) has not been sufficiently characterized from the repository out to the proposed 20-km receptor location to adequately assess its contribution to performance. This is an issue because it creates uncertainty about the SZ flow and transport models and the SZ representation in the TSPA. Furthermore, it may render the LA incomplete because the SZ remains an integral part of the DOE repository safety strategy.

Importance:

The SZ is the primary pathway for radionuclide transport from the repository to the receptor location, and is an integral part of the DOE repository safety strategy. The SZ has been identified in the TSPA-VA as one of 19 "principal factors" affecting postclosure performance. In its 1998 report to Congress, the Nuclear Waste Technical Review Board (NWTRB) stated that it believes that the SZ "is an essential natural component of a defense-in-depth repository design for Yucca Mountain" (NWTRB, 1998, PP 45).

DOE indicates that radionuclide travel time in the SZ constitutes a significant fraction of the 10,000 year compliance period (DOE, 1998a: Vol 3, pp 6-16). In addition, sensitivity analyses performed by DOE (DOE, 1998a: Vol 3, pp 4-71-80; 5-40-43) indicate that all three SZ attributes examined in the analyses (SZ dilution, method of combining flow in the SZ flowtube model, and the alluvium fraction in the SZ flow path) have some measure of importance to repository performance, and that SZ dilution is an important parameter affecting the calculated dose for the 10,000-year simulation. Sensitivity analyses by NRC and Center for Nuclear Waste Regulatory Analyses (CNWRA) staff suggest that the SZ is a relatively important subsystem for overall repository performance (Jarzemba et al., 1998).

Status of Resolution:

DOE has low "current confidence" and a low "confidence goal" in the SZ flow and transport representation in the TSPA (DOE, 1998a: Volume 4, pp 2-20, 2-38). DOE plans to conduct additional SZ work activities to improve confidence in the SZ representation in the TSPA for the LA (DOE, 1998a: Vol 4, pp 2-47; pp 3-15, 3-16). In cooperation with DOE, Nye County will implement an "Early Warning Drilling Program," involving installation and testing of shallow and deep wells downgradient of the repository. These wells are expected to provide data about the hydraulic and transport properties of the aquifers along the flow path downgradient from the repository. The scope of the drilling program is limited, however, and may not adequately characterize the SZ, especially the alluvial aquifer. According to DOE (DOE, 1998a: Volume 4, pp 2-39, 3-13), the scope of the planned SZ work was constrained by the available time before the site recommendation (SR) decision and the LA submittal. Furthermore, DOE has assigned a relatively low priority to the planned SZ work (DOE, 1998a: Volume 4, pp 2-20, 2-39).

In addition, some of the planned work activities will extend beyond the cutoff dates for the planned refinement and update of the site-scale and regional SZ flow models. These include (DOE, 1998: Vol 4, pp 3-16): (1) downgradient alluvial hydraulic and tracer testing; (2) K_d determination of alluvium samples obtained from the Nye County wells; and (3) downgradient hydraulic and tracer testing of the volcanic rocks in the area between 5 and 20 km from the repository. DOE states that data obtained from the first two activities and early data from the third activity will be available for use in the TSPA for the LA, but it is not clear how this will be achieved.

It may be possible for DOE to implement, in a relatively short time prior to the LA, some additional field work independent of the Nye County drilling program, possibly including exploratory drilling and surface geophysical investigations to specifically delineate and characterize the alluvium along the flowpath downgradient from the repository. However, DOE currently has no plans to address this.

Additional Background:

The M&O (1998) and DOE (1998a) suggest that the SZ flow system in the YM vicinity has not been adequately characterized. There are very limited field data to characterize the SZ flow between about 5 km and 20 km downgradient from the repository (DOE, 1998a: Volume 4, pp2-38), and limited data to define the SZ transport along the SZ flow path from the repository to the receptor location (DOE, 1998a: Vol 3, pp6-36). In addition, conceptual uncertainties associated with SZ flow and transport have also been reported by the U.S. Geological Survey and others (Luckey et. al., 1996; Czarniecki et., el., 1997; D'Agnes, et., al., 1997; DOE: 1998b; Geomatrix Consultants, Inc., 1998; Gelhar, 1998; and NWTRB, 1998).

The uncertainties about SZ flow and transport at YM have been documented in two IRSRs (NRC, 1998a,b). The flow rate in water production zones has been identified by NRC staff as a key element of subsystem abstraction (KESA) in the TSPA models, and the acceptance criteria are in the Unsaturated and Saturated Flow Under Isothermal Conditions IRSR (NRC 1998a,b).

Basis:

The presence of alluvium along the SZ flow path is expected to significantly delay the arrival of radionuclides at the receptor location due to enhanced sorption and dilution; however, the location of the water table transition from tuffs to alluvium is not yet reasonably characterized. There is uncertainty as to where SZ flow enters the alluvium along the flowpath from the repository or even if flow occurs within the alluvium within 20 km (DOE, 1998a: Volume 3, pp 6-24). This is especially important considering the potentially higher sorption coefficients of some radionuclides which are key contributors to dose, such as neptunium in the alluvium (DOE, 1998a: Volume 3, pp 6-24 - 6-25).

The flow rate in water production zones is affected by the basin scale groundwater flow and may, therefore, be controlled by high permeability features or channelized flow pathways in the aquifer. The presence of preferential and/or fast pathways, due to geologic structural controls, could significantly reduce the transport time. In the YM vicinity, the faults locally control groundwater flow and may represent pathways for upward flow from the deeper carbonate

aquifer (Fridrick et al., 1994; Bredehoeft, 1997; Geomatrix Consultants, 1998). Such flow channeling along preferred pathways is common in fractured and faulted rock (Tsang and Neretnieks, 1998). Interpretation of aquifer borehole tests indicate that permeability at YM is anisotropic (Geldon, 1996). The anisotropic permeability due to structural features downgradient of YM may result in more southerly-directed flow paths than currently modeled by the DOE. The radionuclides in this southerly flow path could remain in the volcanic tuff aquifer all the way to the receptor location at 20 km, since there is no alluvium or a much reduced alluvium fraction in this direction (Frizzel and Shulters, 1990).

DOE has characterized the uncertainties in SZ flow and transport to the TSPA as "moderate", but states that the uncertainty could increase as the model more realistically accounts for processes that reduce radionuclide concentration (DOE, 1998a: Volume 4, pp 2-38). Furthermore, a "moderate" ranking of the SZ uncertainties appears inconsistent with the results of the sensitivity analyses performed by either DOE or NRC/CNWRA.

References:

Bredehoeft, J.D. 1997. *Fault permeability near Yucca Mountain*. Water Resources Research 33: 2,459-2,463.

Civilian Radioactive Waste Management System Management and Operating Contractor. 1998. *Total System Performance Assessment-Viability Assessment Analyses Technical Basis Document*. Las Vegas, NV: TRW Environmental Safety Systems, Inc.

Czarnecki, John B., Claudia C. Faunt, Carl W. Gable, and George A. Zyvoloski, 1997. *Hydrogeology and Preliminary Calibration of a Preliminary Three-Dimensional Finite-Element Ground-Water Flow Model of the Site Saturated-Zone, Yucca Mountain, Nevada*.

D'Agnes, Frank A, Claudia c. Faunt, A. Keith Rurner, and Mary C. Hill, 1997a. *Hydrogeologic Evaluation and Numerical Simulation of the Death Valley Regional Ground-Water Flow System, Nevada and California*. Water-Resources Investigations Report 96-4300. Denver, Colorado: U.S.Geological Survey.

Fridrich, C.J., W.W. Dudley, Jr., and J.S. Stuckless. 1994. *Hydrogeologic analysis of the saturated-zone ground-water system, under Yucca Mountain, Nevada*. Journal of Hydrology 154: 133-168.

Frizzel, V.A., Jr., and J. Shulters, 1990. *Geologic Map of the Nevada Test site, Southern Nevada; U.S. Geological Survey Miscellaneous Investigations Series Map I-2046, Scale: 1:100,000*.

Geldon, A.L. 1996. *Results and interpretation of preliminary aquifer tests in boreholes UE-25c #1, UE-25c #2, and UE-25c #3, Yucca Mountain, Nye County, Nevada*. U.S. Geological Survey Water-Resources Investigations Report 94-4177.

Gelhar, Lynn W., 1998. *Report on U.S. Nuclear Waste Technical Review Board Winter Meeting, 20-21 January 1998, Amargosa Valley, NV*. Massachusetts Institute of Technology.

Geomatrix Consultants, Inc., 1998. *Saturated Zone Flow and Transport Expert elicitation Project*. Prepared for the U.S. Department of Energy, Yucca Mountain Site Characterization Office., North Las Vegas, Nevada.

Jarzemba, M., R. Codell, L. Deere, J. Firth, C. Liu, S. Mohanty, K. Poor, and J. Weldy. 1998. *NRC Sensitivity and Uncertainty Analyses for a Proposed HLW Repository at Yucca Mountain, Nevada Using TPA 3.1, Volume II: Results and Conclusions*. NUREG-1668. Washington, DC: Nuclear Regulatory Commission.

Luckey, Richard R., Tucci, Patrick, Faunt, Claudia C., Ervin, Elisabeth M., Steinkampf, William C., D'Agnesse, Frank A., and Patterson, Gary L., 1996, *Status of Understanding of the Saturated-Zone Ground-Water Flow System at Yucca Mountain, Nevada, as of 1995*, U.S. Geological Survey. Water-Resources Investigation Report 96-4077, U.S. Geological Survey, prepared in cooperation with the Nevada Operations Office, U.S. Department of Energy, Denver, CO.

Nuclear Waste Technical review Board, 1998. *Report to The U.S. Congress And The U.S. Secretary of Energy*.

Tsang, C., and I. Neretnieks. 1998. *Flow channeling in heterogeneous fractured rocks*. *Reviews of Geophysics* 36(2): 275-298.

U.S. Nuclear Regulatory Commission. 1998a. *Issue Resolution Status Report (Key Technical Issue: Total System Performance Assessment and Integration)*. Revision 1. Washington, DC: Nuclear Regulatory Commission.

U.S. Nuclear Regulatory Commission. 1998b. *Issue Resolution Status Report (Key Technical Issue: Unsaturated and Saturated Flow under Isothermal Conditions)*. Revision 1. Washington, DC: Nuclear Regulatory Commission.

U.S. Department of Energy. 1998a. *Viability Assessment of a Repository at Yucca Mountain: Total System Performance Assessment, December 1998*. DOE/RW-0508. Las Vegas, NV: U.S. Department of Energy, Office of the Civilian Radioactive Waste Management.

U.S. Department of Energy. 1998b. *Peer Review of the Total System Performance Assessment-Viability Assessment: Third Interim Report, June 1998*. Las Vegas, NV: U.S. Department of Energy, Office of the Civilian Radioactive Waste Management.

Volcanic Disruption of the Waste Package

Comment:

DOE concludes in the TSPA-VA that there are no risks from volcanism during a 10,000 yr post closure period, based on models assuming waste package resilience and limited HLW entrainment during a volcanic eruption (CRWMS M&O, 1998). NRC staff review concludes (i) these analyses are based on assumptions of physical conditions that are not representative of Yucca Mountain basaltic volcanism, (ii) data are insufficient to evaluate waste package and HLW behavior under appropriate physical conditions, and (iii) model assumptions are incongruent with those used elsewhere in the TSPA-VA, for example, in enhanced source-term analyses.

Importance:

TSPA-VA analyses may underestimate the contribution to risk associated with future igneous activity at the proposed repository site. Current NRC calculations suggest that the probability-weighted risk from volcanic disruption of the proposed repository is low (on the order of 1 mrem), however this value has sizeable model and parameter uncertainty. DOE has not identified in the VA plans to conduct additional investigations necessary to support igneous activity risk assessment. Unavailability of acceptable consequence models to support igneous activity risk assessment is an issue, in that a process with a potential to be an important contributor to total system risk would not be supported adequately in the LA.

Status of Resolution:

While the VA License Application Plan (DOE, 1998b) indicates no planned activities to resolve these issues, recent informal staff interactions, including participation at DOE workshops, suggest that workplans are being developed which, if implemented, could resolve them. These plans are expected to be completed in late March. The staff will review these plans as they become available and discuss their implementation with DOE in future DOE/NRC Technical Exchanges and other interactions (DOE, 1998a, Section 6.5.3.8) to determine if the issues can be resolved at the staff level prior to licensing. In addition the staff is critically evaluating its modeling of volcanism to confirm that it does not include excessive conservatism. The staff will continue to work closely with DOE to resolve the issue of volcanism. The staff position will be well documented in future IRSRs.

Additional Background:

The issues associated with the DOE igneous activity program, including the relationship to TSPA modeling, have been raised in comments on DOE study plans 8.3.1.8.1.1 (Holonich, 1994a), 8.3.1.8.1.2 (Holonich, 1994b), 8.3.1.8.5.1 (Holonich, 1994c), numerous interactions with DOE at Technical Exchanges, Appendix 7 Meetings, meetings and workshops with the Advisory Committee on Nuclear Waste and the NWTRB, interactions associated with the DOE Probabilistic Volcanic Hazard Assessment, and most recently through detailed comments in the

Igneous Activity Issue Resolution Status Reports (NRC, 1997, 1998). Acceptance criteria contained in the IA IRSR (NRC, 1998) delineate an acceptable technical basis for evaluating risks associated with future igneous events.

Basis:

In the TSPA-VA, it is assumed that a waste package with >50 percent of the original corrosion resistant material thickness (i.e., >1 cm) will not fail when exposed to the extreme physical conditions of a volcanic eruption except through occasional end-cap failure. This assumption precludes any direct HLW entrainment or release from any volcanic event occurring within the first 100,000 yr post-closure (CRWMS M&O, 1998). This assumption is based on extrapolation of limited data from <430 °C to likely magmatic temperatures around 1100 °C. In contrast, similar data are used to conclude that an intact waste package will fail mechanically when exposed to magma intruded into repository drifts (i.e., enhanced source-term analysis), even when temperatures significantly below expected intrusion temperatures are used in the analysis (CRWMS M&O, 1998). The TSPA-VA analysis of waste-package resilience also does not address the dynamic force imposed on a waste package entrained into a volcanic conduit. As outlined in the IA IRSR (NRC, 1998), staff analyses of limited available data conclude waste-package breach is likely under volcanic eruption conditions. Models proposing waste-package resilience during igneous events are nonconservative and will need robust support through analyses and data that examine physical, chemical, and thermal conditions representative of likely future igneous activity in the YM region.

Another key assumption in the TSPA-VA that is not supported by available information is that magma particle sizes or particle velocities are insufficient to entrain HLW fragments (CRWMS M&O, 1998). Although the expansion of dissolved volatiles in ascending magma may be sufficient to form a two-phase flow regime at repository depths, the fragmented particles are still at temperatures around 1100 °C. Particles will be larger average size than observed at completely cooled and fragmented fall deposits, and will impact HLW fragments elastically. In addition, assumed HLW particle sizes do not account for the extreme physical conditions associated with igneous disruption. As outlined in the IA IRSR (NRC, 1998), staff concludes that HLW particle sizes will be reduced substantially when exposed to the physical, thermal, and chemical environment associated with YM igneous events. Models proposing a lack of entrainment in potential repository-penetrating igneous events will need support through analyses and data.

References:

- CRWMS M&O. 1998. *Total System Performance Assessment Viability Assessment (TSPA-VA Analyses Technical Basis Document, Chapter 10, Disruptive Events*. B00000000-0171704301-00010 REV 01. North Las Vegas, NV: U.S. Department of Energy, Yucca Mountain Site Characterization Office.
- Holonich, J.J. 1994a. Letter (February 8) to D.E. Shelor (DOE) on review of U.S. Department of Energy Study Plan "Probability of Magmatic Disruption of the Repository," Revision 2. Washington, DC: U.S. Nuclear Regulatory Commission.

Holonich, J.J. 1994b. Letter (May 21) to D.E. Shelor (DOE) on review of U.S. Department of Energy Study Plan "Characterization of Volcanic Features." Washington, DC: U.S. Nuclear Regulatory Commission.

Holonich, J.J. 1994c. Letter (September 14) to R.A. Milner (DOE) on review of U.S. Department of Energy Study Plan "Physical Processes of Magmatism and Effects on the Potential Repository." Washington, DC: U.S. Nuclear Regulatory Commission.

Nuclear Regulatory Commission. 1997. *Issue Resolution Status Report, Key Technical Issue: Igneous Activity, Revision 0*. Washington, DC: U.S. Nuclear Regulatory Commission.

Nuclear Regulatory Commission. 1998. *Issue Resolution Status Report, Key Technical Issue: Igneous Activity, Revision 1*. Washington, DC: U.S. Nuclear Regulatory Commission.

U.S. Department of Energy. 1998a. *Viability Assessment of a Repository at Yucca Mountain, Volume 3: Total System Performance Assessment*. DOE/RW-0508/V3. North Las Vegas, NV: U.S. Department of Energy, Yucca Mountain Site Characterization Office.

U.S. Department of Energy. 1998b. *Viability Assessment of a Repository at Yucca Mountain, Volume 4: License Application Plan and Costs*. DOE/RW-0508/V4. North Las Vegas, NV: U.S. Department of Energy, Yucca Mountain Site Characterization Office.

Quality Assurance

Comment:

Although NRC staff has reviewed and accepted the DOE Quality Assurance (QA) program, DOE has consistently had problems implementing the program. Deficiencies identified during DOE audits and surveillance of its suppliers raised the issue of whether the data/products produced by these suppliers will be acceptable and appropriately qualified for licensing. DOE audits have identified that some data in the Management and Operating Contractor's (M&O's) technical data base are not traceable to their origins and could not be ensured to be applicable, correct and technically adequate. The Technical Basis Document, which supports the TSPA-VA, indicates that a major portion of the data supporting VA is not qualified. DOE's LA Plan does not recognize the current situation with regard to implementation of its QA program and the activities needed to address it.

Importance:

To obtain authorization to construct a HLW repository, DOE must be able to demonstrate in its LA that data, analysis, and designs of barriers and systems important to safety or waste isolation meet QA requirements of Appendix B to CFR Part 50.

The QA program applies to all systems, structures, and components important to safety and waste isolation, including: design and characterization of barriers important to waste isolation; activities such as site characterization, facility and equipment construction; facility operation; performance confirmation; permanent closure; and decontamination and dismantling of surface facilities. Confidence in the adequacy of data, data analyses, construction activities, and other items and activities associated with the LA is obtained through a QA program.

Status of Resolution:

DOE recognizes the need to improve the implementation process to qualify data, models, and codes and has assigned a high priority to these activities based on questionable data in the M&O technical data base and its associated references. DOE has also issued Yucca Mountain Administration Procedure YAP-SIII.1Q, Revision 3, ICN0 to improve the process of qualifying unqualified data.

During the NRC/DOE QA meeting of December 9, 1998, DOE committed to the development of an overall data qualification strategy/plan by December 21, 1998. The plan should include: 1) identification of unqualified data sets approved for qualification; 2) methods of qualification and rationale; 3) technical disciplines required; 4) data evaluation criteria including size of sample to be tested, statistical method to be used, and identification of computer codes to be used; 5) criteria for changing data status from "non-qualified" to "qualified;" and 6) a schedule for completing the work. NRC staff is currently reviewing the "Data, Model and Code Qualification/Validation and Control Plan."

Meanwhile, an NRC QA Task Force was formed to conduct an independent and objective review of the DOE HLW QA program and its implementation. A Task Force review of the "DOE

Management Plan and Responses to Corrective Action Request (CAR) and Status of Implementation of Corrective Actions" document, dated January 25, 1999, is underway. The Task Force will also review, and formally comment on, the Root Cause Analysis/Corrective Action Report conducted by DOE.

Additional Background:

None.

Basis:

The NRC On-Site Representative's reports (ORRs) and Observation Audit Reports (OARs) on the Yucca Mountain Project are documented to alert NRC staff, managers and contractors to information on DOE programs for site characterization, repository design performance assessment, and environmental studies that may be of use in fulfilling NRC's role during pre-licensing consultation. As noted in the ORRs and the OARs, deficiencies have been identified questioning the accuracy, qualification and traceability of data.

References:

NUREG-1298 - Generic Technical Position (GTP) on "Qualification of Existing Data for High-Level Nuclear Waste Repositories," dated February 1998.

YAP-SIII.1Q, Revision 3, ICN0 - Yucca Mountain Administration Procedure on "Qualification of Unqualified Data," dated November 13, 1998.

"Data, Model and Code Qualification/Validation and Control Plan," dated December 1998.

"DOE Management Plan and Responses to Corrective Action Request (CAR) and Status of Implementation of Corrective Actions," dated January 25, 1999.



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

April 8, 1999

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Chairman Jackson:

**SUBJECT: COMMENTS ON THE DEPARTMENT OF ENERGY'S VIABILITY
ASSESSMENT FOR THE PROPOSED HIGH-LEVEL RADIOACTIVE
WASTE REPOSITORY AT YUCCA MOUNTAIN, NEVADA**

In this letter, the ACNW offers comments on the Viability Assessment (VA) of a Repository at Yucca Mountain, which was released by the U.S. Department of Energy (DOE) on December 18, 1998. The ACNW reviewed the primary VA reports, the technical basis document supporting the Total System Performance Assessment for the VA (TSPA-VA), the Repository Safety Strategy, and the most recent NRC Issue Resolution Status Reports. The Committee heard presentations on the VA from DOE representatives at its 105th and 106th ACNW meetings. In addition, the Committee heard a presentation from the NRC staff at the 106th meeting on its preliminary review comments on the VA. The Committee also had the benefit of observing presentations to the Commission on the VA by representatives of a variety of organizations and groups.

A summary of our recommendations follows. These recommendations can be implemented as part of guidance development or made part of the 10 CFR Part 63 rulemaking.

Recommendations

1. The NRC should require DOE to provide a total system performance assessment (TSPA) model of sufficient technical clarity (transparency) so that the staff can readily determine the interrelationships among all modules of the system. This recommendation could be implemented as part of the 10 CFR Part 63 rulemaking.
2. The NRC should require DOE to provide, in the license application (LA) data and information packages, the supporting evidence to the performance assessment (PA) at the module level. This recommendation could be implemented as part of the 10 CFR Part 63 rulemaking.

Enclosure 2

3. The NRC should provide guidance in the Yucca Mountain License Application Review Plan on what constitutes sufficient supporting data, acceptable model assumptions and abstractions, and acceptable expressions of parameter uncertainty.
4. The NRC staff should be prepared to evaluate engineering designs proposed by DOE. This evaluation will require additional NRC staff with geotechnical, engineered barrier, and waste package design experience.
5. The NRC should outline steps in the licensing process between initial submission of the safety case and final closure of the repository. This recommendation could be implemented as part of the 10 CFR Part 63 rulemaking or guidance development.
6. As part of guidance development for 10 CFR Part 63, the staff needs to identify explicitly the attributes of defense in depth (DID) that apply to waste repositories.

Background

The ACNW framed its review within the overall context of Risk-Informed, Performance-Based Regulation. The foundation for licensing a repository for high-level radioactive waste and spent fuel is expected to be an Environmental Protection Agency standard based on risk (or dose) and a set of implementing NRC regulations (10 CFR Part 63 and other applicable regulations) and guidance.

Demonstrating compliance with the standard will be based principally on a PA that uses a risk-based performance measure (i.e., the expected dose to the average member of the critical group at a specified location). The results from the PA should be expressed as a risk curve (i.e., a complementary cumulative distribution function [CCDF], sometimes referred to as a risk exceedance curve), that shows the likelihood of exceeding different radiation dose levels. The PA, in principle, considers all reasonable mechanisms for failure of the repository to limit appropriately the dose of radiation to the critical group for the required time of compliance.

The VA offers the NRC a chance to assess how DOE's presentation of license supporting material may need to be improved to meet requirements of risk-informed, performance-based criteria in the regulation and how the NRC staff may have to adapt to be able to perform their mission efficiently and effectively. It is within this framework that the ACNW conducted its review.

The ACNW's review of the VA improved our understanding of DOE's approach for moving from the VA to the site recommendation and the LA for the Yucca Mountain repository. The objective of the review was to evaluate the technical capability, tools, and guidance that the NRC staff will need to conduct a defensible review of the Yucca Mountain LA.

The ACNW focused on the technical basis of the safety case made in the VA, including the ability of DOE to demonstrate the following:

- The design would limit the access of water to the waste packages;
- The waste packages (and cladding) will have long lifetimes relative to the compliance period;
- The release of radionuclides after canisters are breached would be slow;
- The transport of radionuclides in the unsaturated zone could be estimated;
- The transport and dilution of radionuclides in the saturated zone will provide significant buffering of doses; and
- The uptake of radionuclides by biota and the dose to humans could be represented in an acceptable way.
- In addition, to be credible, DOE must present a clear, integrated, probabilistic PA.

The ACNW believes that the most important issues are limiting water access to the waste packages and the need for DOE to present a clear, integrated, probabilistic PA. It is critical that considerable work be done on these issues before submitting a credible LA. The PA is the framework within which all of these issues are put in context for licensing decisionmaking; it is the logic engine for demonstrating the safety of the repository.

Observations and Recommendations

The ACNW is impressed with the improvements in-depth and presentation of the TSPA-VA over previous versions of TSPA. Continued improvements are necessary to make future TSPAs more credible. The description and PA of the geological repository system require much data and many assumptions combined into a complex set of models. The results shown in the VA are sufficiently opaque so that it is often difficult to make reasonable judgments on the adequacy of either the computations or their underlying database.

Observation

The presentation of the VA results continues to need major improvements. More emphasis is needed on a top-down presentation of the total model that clearly traces the critical path of the computation of the performance measure; namely, the radiation risk to a member of the critical group. The components of a traceable path of the radiation risk assessment that need greater visibility and discussion include the hierarchy of the total model, the model components (modules, interfaces, inputs, outputs, etc.), and clearer

visibility of the continuity and traceability of the performance measure calculation throughout the model.

The ACNW's goal of a top-down presentation is to reveal explicitly the connection and dependence between the performance measure and each component of the model (i.e., rainfall on the site, infiltration to the repository, waste package degradation, radionuclide mobilization, transport through the geosphere and the biosphere, and biological uptake). Refinements are needed in presenting the propagation of uncertainty from the component and subsystem level to total system results. To a certain extent, such results are buried in the VA, but they need to be made more visible to facilitate the mapping of component and subsystem performance to the overall performance of the repository. To be complete, the mapping must be performed in a probabilistic framework to display the role of uncertainty in the process. The Committee believes that employing such techniques will contribute greatly to increasing confidence in the TSPA as it evolves toward a licensing basis.

Recommendation

- 1) The NRC should require from DOE a "transparent" PA that is sufficiently clear to determine the interrelationships among all modules of the system. Requirements for such a presentation can be incorporated into guidance or made part of the 10 CFR Part 63 rulemaking.

Observation

In addition to improving the technical clarity of the PA, the linkages to the underlying supporting evidence must be presented in a way that facilitates review. The database and other supporting evidence for the VA are voluminous and include system (natural and engineered) reliability data, scientific literature, laboratory results, field studies, special analyses, the laws of physics, the principles of chemistry, the abstraction process, and the results of expert elicitation. A major contributor to technical clarity includes the process for choosing conceptual models because both information and models are major sources of analysis uncertainties.

Future TSPAs should provide the rationale for choosing conceptual models for each module, including the process of assembling the modules into the total system model. It is essential that future TSPAs also be specific about what has been synthesized from the various sources and that data and information packages be developed to facilitate the search for supporting information. This is especially true for the major contributors to the performance measures and the associated uncertainties. A special category of evidence comes from the process of expert elicitation. It is not enough to attribute a result to the judgment of an expert; it must be possible to examine the underlying evidence used by the experts in forming their judgments.

Recommendation

- 2) The NRC should require from DOE the traceable linkage of the supporting evidence (data and information packages) to the PA at the module level. Data references must be explicit and, preferably, have electronic links that can be followed easily. Inputs based on expert elicitation must be linked to the supporting evidence for the information provided to and by the experts. Requirements for such a presentation can be incorporated into guidance or made part of the 10 CFR Part 63 rulemaking.

Observation

The case for the safety of a geological repository over tens to hundreds of thousands of years cannot be expressed in absolute terms; as previously stated, the basis for measuring performance must be a risk curve. The ACNW is concerned that the inherent uncertainties in an analysis for such extended periods drive critics to demand that the most conservative assumptions, conceptual models, and parameters be selected at every juncture of the analysis. We very strongly disagree with such an approach. We believe that conservatism is appropriate in regulating nuclear facilities of all kinds, but the appropriate place for conservatism is in the choice of a probability of exceedance of a risk standard.

In the case of a PA for a geological repository, we believe that the analysis should be performed with as nearly realistic assumptions, models, and parameters as possible, including the uncertainty involved. The resultant CCDF derived from the PA would show explicitly the probability that a standard would be exceeded. Increased *conservatism* may be achieved by requiring that the probability of exceeding the standard be less than, say, 1 in 10^6 as opposed to a requirement that it be less than, say, 1 in 10^3 . Obviously, a licensing decision would not be based exclusively on the probability (i.e., the regulation is risk-informed rather than risk-based), but the decision about conservatism is made with the clearest view of the issues after the best information available has been used in an analysis.

Recommendation

- 3) The NRC should provide guidance in the Yucca Mountain License Application Review Plan on what constitutes sufficient supporting data, acceptable model assumptions and abstractions, and acceptable expressions of parameter uncertainty. ACNW recommends that the guidance not require DOE's "complete understanding," but rather reflects the philosophy that even simple approaches may be realistic as long as the full range of uncertainty is captured. The guidance should allow DOE and others to establish relatively clearly when enough data or model support has been attained. The guidance would be most useful if conditions for an acceptable risk exceedance were discussed.

Observation

The VA demonstrates that the ability to restrict the amount of water contacting the waste packages is a critical part of the safety strategy. The extreme importance of limiting the contact of water with waste has led to DOE's increasing emphasis on elements of the engineered barrier system; this would include all aspects of tunnel design as well as the canisters and their contents. The ACNW remains convinced that the NRC staff must acquire expertise in engineering design.

Recommendation

- 4) The NRC staff should be prepared to evaluate engineering designs proposed by DOE. This step implies augmenting the NRC staff with engineers with geotechnical, engineered barrier, and waste package design experience. Part-time consultants with such design experience could be a valuable aid to NRC full-time staff in preparing for and evaluating the LA.

Observation

In listening to presentations from DOE and to some concerns expressed by the NRC staff about the time required for evaluations, the ACNW believes that a potential exists for misunderstanding among the parties. DOE has indicated that some aspects of the repository design likely will change up to and beyond the submission of the LA. An adaptive design strategy is essential to achieve the best results. NRC must be prepared to allow design flexibility and probably will have to adopt a plan of phased licensing. The preclosure period is anticipated to range from 50 to 300 years. During this entire period, the waste will be in storage underground, under active, continuous surveillance; and will be fully retrievable. The final decision on the suitability of the repository for waste disposal will not be made until the end of the preclosure period. New materials, new technical methods, and new societal needs can be expected to arise in this period.

Certain design improvements, such as drift location, support type, waste package design, water diversion strategies, and chemically tailored backfill, are all possible during the preclosure period. Active (and natural) ventilation can be used to remove heat from the waste and reduce adverse thermal effects on the rock and waste package. Also, extensive data can be gathered during the preclosure period to reduce uncertainties in the predicted performance of the repository. On the one hand, it would be irresponsible not to allow such improvements in repository safety. On the other hand, NRC cannot approve the licensing of the repository if the LA and supporting information are not sufficiently well developed to allow the NRC to make a finding of reasonable assurance of safety. A serious evaluation of the competing needs of flexibility and design stability is required.

Recommendation

- 5) The NRC should outline in the 10 CFR Part 63 rulemaking or guidance the steps in the licensing process between initial submission of the safety case and final

closure of the repository. Particular attention should be given to the definition of "reasonable assurance" as applied to repository licensing. This definition will provide early guidance to DOE and others on the level of completeness of design (data, model development, and confirmatory observations) that will be necessary at different phases of the project. The outline would provide guidance on the nature of the process but would not dictate how the licensing boards or the Commission would make decisions.

Observation

DOE continues to develop methods for demonstrating defense in depth (DID). The ACNW remains convinced that the key requirement for DID in a repository is an analysis that clearly quantifies the contribution of multiple barriers, including the uncertainty associated with each barrier to the containment of radionuclides (see ACNW letter of October 31, 1997, "Recommendations Regarding The Implementation of the Defense-in-Depth Concept in the Revised 10 CFR Part 60"). In particular, the multiple barriers of the engineered system and the geological system must be shown to offer protection. We note that it would be imprudent to require a specific percentile contribution from either the geological or the engineered systems because this requirement could lead to impairment of overall performance. That is, if the geological system were required to contribute a certain fraction (say 50%) of the total performance, the applicant might degrade the design of the engineered system to boost the fraction of contribution from the natural system. The ACNW maintains that the appropriate way to judge the case for repository safety is to look at overall performance, as long as there is a clear, quantitative presentation of contributions of individual barriers.

Recommendation

- 6) The NRC staff is committed to developing further guidance on implementing the multiple-barriers approach required in 10 CFR Part 63. As part of this guidance development, the staff should identify clearly the attributes of DID that apply to waste repositories in relation to a risk-informed strategy. In addition, DOE and NRC should develop approaches and methodologies that clearly and transparently identify the contributions of different barriers to the overall performance of the repository.

Technical Concerns About the VA

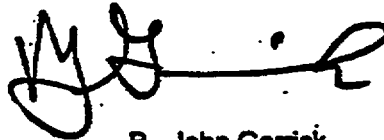
In general terms, the ACNW shares the staff's concerns on specific technical issues; that is, the adequacy of the database and models in the areas of seepage into drifts, corrosion of alloy-22, failure of fuel cladding, and dissolution of fuel. (The Committee presented details of some of these topics in its letter of September 9, 1998, on the "Issues and Recommendations Concerning the Near-Field Environment and the Performance of Engineered Barriers at Yucca Mountain.") The planned experiments by DOE on seepage into drifts are potentially important, as are continued experiments on corrosion and other phenomena. The ACNW also agrees that data are needed on the saturated zone between Yucca Mountain and Amargosa Valley for the sake of credibility.

ACNW disagrees with the staff's concern about the need for more work on Igneous Activity. The Committee has repeatedly asked the staff for analyses that justify the staff's concerns about volcanic activity as a major component of risk at Yucca Mountain, but has yet to see a detailed justification.

Summary

The Committee was impressed with the PA discussion contained in DOE's VA. The material was very professionally written in terms of both text and graphics. The Committee believes that a great deal of excellent work has been performed on the Yucca Mountain TSPA. Confidence in the results is seriously undermined, however, by TSPA's overwhelming size and complexity. ACNW hopes that the recommendations presented in this letter will assist in improving the credibility and transparency of future safety analyses.

Sincerely,

A handwritten signature in black ink, appearing to read 'B. Garrick', with a long horizontal flourish extending to the right.

B. John Garrick
Chairman



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

November 13, 2001

Mr. Robert G. Card, Under Secretary
Energy, Science, and Environment
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585-0001

Dear Mr. Card :

As required by Section 114(a)(1)(E) of the Nuclear Waste Policy Act of 1982, as amended (42 U.S.C. 10134(a)(1)(E)), I am providing you with the preliminary comments of the U.S. Nuclear Regulatory Commission (NRC) regarding a possible geologic repository at Yucca Mountain, Nevada. These comments concern "...the extent to which the at-depth site characterization analysis and waste form proposal for such site seem to be sufficient for inclusion in any application to be submitted by the Secretary for licensing of such site as a repository." As described in more detail below and in the enclosures to this letter, the NRC 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.

There are two important constraints related to NRC's preliminary comments. First, in making these comments, the NRC is making no conclusions concerning the actual site suitability of the Yucca Mountain site. Rather, the NRC comments address whether sufficient information will exist to begin a potential licensing review should DOE submit a license application. Second, NRC's licensing decisions, in terms of a potential repository at Yucca Mountain, will not occur until DOE submits a high-quality license application, the staff completes its independent safety review and issues a safety evaluation report, NRC provides an opportunity for a hearing, and NRC makes its final determination of whether the DOE license application meets NRC regulations. Any NRC licensing decision will be based on all the information available at the time of decision.

The NRC's preliminary comments reflect many years of extensive pre-licensing interaction among the NRC staff, DOE, and various stakeholders, including the State of Nevada, Indian Tribes, affected units of local government, representatives of the nuclear industry, and interested members of the public. NRC staff activities included: (1) engaging DOE in an issue resolution process on key technical issues including obtaining DOE's agreement to provide acceptable responses by the time of the submission of any license application; (2) issuing numerous publicly available technical and program status reports, over the last several years, that reviewed DOE's ongoing site characterization, waste package and waste form, and preliminary design work, and identified additional information that DOE would need to provide in any license application; and (3) interacting with representatives of the State

of Nevada and affected units of local government on technical information collected in their oversight role.

Based on its interactions with DOE and other stakeholders, the NRC provides the following preliminary comments:

1. DOE has or has agreed to obtain sufficient at-depth site characterization analysis and waste form proposal information required for a possible license application.

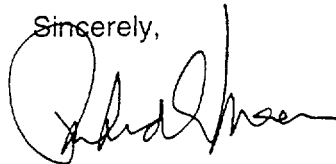
2. Although significant additional work is needed prior to the submission of a possible license application, we believe that agreements reached between DOE and NRC staff regarding the collection of additional information provide the basis for concluding that development of an acceptable license application is achievable.

3. DOE is exploring a flexible design concept to allow for the possibility of operating the repository over a range of thermal conditions. If DOE were to adopt a lower temperature operating mode or the approach used in the FY01 Supplemental Science and Performance Analyses, NRC believes that additional information would be needed for a potential license application.

The enclosures to this letter provide additional background information on the scope and conduct of NRC's review. In addition, we provide, for your information, the NRC staff's assessment of the quality of documentation supporting DOE's possible site recommendation.

If you have any questions or comments, please contact me.

Sincerely,



Richard A. Meserve

Enclosures:

1. Background Information Supporting the NRC's Preliminary Comments on the Sufficiency of U.S. Department of Energy Information for Inclusion in a License Application for a possible Geologic Repository at Yucca Mountain, Nevada
2. NRC's Views on the U.S. Department of Energy Quality Assurance

cc: See enclosed distribution list.

Letter to R. Card from R. Meserve dated:

cc:

R. Loux, State of Nevada
S. Frishman, State of Nevada
L. Barrett, DOE/Washington, DC
A. Brownstein, DOE/Washington, DC
S. Hanauer, DOE/Washington, DC
C. Einberg, DOE/Washington, DC
J. Carlson, DOE/Washington, DC
N. Slater, DOE/Washington, DC
A. Gil, YMPO
R. Dyer, YMPO
S. Brocoum, YMPO
R. Davis, YMPO
S. Mellington, YMPO
C. Hanlon, YMPO
T. Gunter, YMPO
K. Hess, BSC
D. Krishna, BSC
S. Cereghina, BSC
N. Williams, BSC
M. Voegele, BSC/SAIC
R. Henning, BSC
B. Price, Nevada Legislative Committee
J. Meder, Nevada Legislative Counsel Bureau
I. Navis, Clark County, NV
E. von Tiesenhausen, Clark County, NV
A. Kalt, Churchill County, NV
G. McCorkell, Esmeralda County, NV
L. Fiorenzi, Eureka County, NV
A. Johnson, Eureka County, NV
A. Remus, Inyo County, CA
R. Massey, Lander County, NV
J. Pitts, Lincoln County, NV
M. Baughman, Lincoln County, NV
A. Funk, Mineral County, NV
J. Shankle, Mineral County, NV
L. Bradshaw, Nye County, NV
M. Murphy, Nye County, NV
J. McKnight, Nye County, NV
D. Weigel, GAO
W. Barnard, NWTRB
R. Holden, NCAI
A. Collins, NIEC
R. Arnold, Pahrump Paiute Tribe
J. Larson, White Pine County
R. Clark, EPA
F. Marcinowski, EPA
R. Anderson, NEI
R. McCullum, NEI
S. Kraft, NEI
J. Kessler, EPRI
D. Duncan, USGS
R. Craig, USGS
W. Booth, Engineering Svcs, LTD
J. Curtiss, Winston & Strawn
S. Echols
N. Rice, NV Congressional Delegation
T. Story, NV Congressional Delegation
J. Reynoldson, NV Congressional Delegation
S. Joya, NV Congressional Delegation
J. Pegues, City of Las Vegas, NV

M. Yarbrow, Lander County, NV
I. Zabarte, W.S.N.C.
C. Anderson, Las Vegas Paiute Tribe
J. Birchim, Yomba Shoshone Tribe
L. Jackson, Timbisha Shoshone Tribe
C. Meyers, Moapa Paiute Indian Tribe
V. Miller, Fort Independence Indian Tribe
A. Bacock, Big Pine Paiute Tribe of
the Owens Valley
R. Quintero, Inter-Tribal Council of Nevada
(Chairman, Walker River Paiute Tribe)
M. Bengochia, Bishop Paiute Indian Tribe
J. Egan, Egan & Associates, PLLC

L. Lehman, T-REG, Inc.
R. Bahe, Benton Paiute Indian Tribe
C. Bradley, Kaibab Band of Southern Paiutes
R. Joseph, Lone Pine Paiute-Shoshone Tribe
L. Tom, Paiute Indian Tribes of Utah
E. Smith, Chemehuevi Indian Tribe
J. Charles, Ely Shoshone Tribe
D. Crawford, Inter-Tribal Council of Nevada
H. Blackeye, Jr., Duckwater Shoshone Tribe
D. Eddy, Jr. Colorado River Indian Tribes
J. Leeds, Las Vegas Indian Center
W. Briggs, Ross, Dixon & Bell

**BACKGROUND INFORMATION
SUPPORTING THE NRC'S PRELIMINARY
COMMENTS ON THE SUFFICIENCY OF
U. S. DEPARTMENT OF ENERGY
INFORMATION FOR INCLUSION IN A
LICENSE APPLICATION FOR A POSSIBLE
GEOLOGIC REPOSITORY AT YUCCA
MOUNTAIN, NEVADA**

INTRODUCTION

The Nuclear Waste Policy Act of 1982, as amended in 1987 (i.e., the Act), requires the U.S. Nuclear Regulatory Commission (NRC) to provide preliminary comments in connection with any site recommendation on the proposed geologic repository at Yucca Mountain, Nevada. The objective of the preliminary comments is to address the extent to which the U.S. Department of Energy's (DOE's) at-depth site characterization analysis and waste form proposal seem to be sufficient for inclusion in any license application for the site. DOE must include NRC's preliminary comments as part of any site recommendation to the President of the United States. As noted below, NRC's comments are based on many years of extensive prelicensing interactions and issue resolution activities.

We make no site suitability conclusions in these preliminary comments. Rather, our comments focus on whether enough information exists to begin a potential licensing review, should a license application be submitted by DOE. Further, because our preliminary comments are based on informal interactions and review, in advance of a potential license application, we make no licensing determinations, nor do our comments, in any way, affect NRC authority if DOE files a license application. Moreover, the comments are without prejudice to any such determinations, which can only be made after a thorough safety review by the NRC staff on any DOE license application. The views expressed in this report remain subject to consideration if NRC receives a license application for Yucca Mountain.

BACKGROUND

The roles and responsibilities of Federal agencies involved in the disposal of high-level radioactive waste in a geologic repository are defined in the Act. DOE is responsible for conducting the site characterization activities at Yucca Mountain, Nevada. DOE is also responsible for conducting a site recommendation process, should the Secretary of Energy determine that the site is suitable for recommendation to the President. NRC, among other things, is required to interact with DOE during the site characterization phase of the geologic repository program.

After the Act was amended in 1987, NRC and DOE began prelicensing interactions relating to DOE's characterization of Yucca Mountain as a potential repository site and DOE's design of associated facilities. During this same period, the Commission began examining ways to focus its regulatory programs on those areas and issues most significant to risk and licensee performance. Accordingly, NRC staff worked to identify those features, events, processes, and design concerns that were most important to potential repository performance. This activity was integrated with the development of performance-based regulations specific to the Yucca Mountain site which began in the early 1990s and concluded in November of this year with the issuance of 10 CFR Part 63.

The NRC's risk-informed, performance-based approach to high-level waste disposal made use of results from NRC and DOE laboratory and field experiments, natural analog studies, expert elicitations, and performance assessments. Over time, these activities led to the identification in 1996 of what the NRC staff termed "key technical issues" that were important to performance. The NRC staff emphasized these key technical issues in the prelicensing interactions with DOE.

As understanding of the site, the potential design, and the key technical issues evolved through precicensing interactions with DOE and through results from NRC confirmatory studies, the individual key technical issues were refined into subissues that more clearly specify important areas that the NRC staff wanted DOE to address. In the process, NRC published numerous publicly available technical and program status reports that reviewed DOE's site characterization and design work and identified additional information that DOE would need in any license application. The NRC staff consistently emphasized that a key to the preparation of an acceptable license application was the extent to which DOE addressed the key technical issues in preparing any safety case for Yucca Mountain.

To address and document the key technical issues, the NRC staff initiated a formal issue resolution process as part of the precicensing interaction that was specified in the Act. The NRC issue resolution process includes reviewing DOE documents, interacting with DOE in public technical meetings, and identifying the information that DOE will need to provide in any potential license application. In this context, issues are defined to be resolved when there are no further questions at the staff level; however, issue resolution does not signify that a licensing decision has been reached. Pertinent additional information (e.g., changes in DOE design parameters) could raise new questions or comments regarding a previously resolved issue. The bases for the issue resolution process are acceptance criteria developed by the NRC staff that consider risk information and significance to performance. These acceptance criteria are the measurement by which the NRC staff judges the acceptability of DOE information for a possible license application. NRC has developed these acceptance criteria and their technical bases over the past several years and has documented them in a series of publicly available issue resolution status reports. A subset of the acceptance criteria provides the basis to judge the sufficiency of DOE's information in these preliminary comments, and these preliminary sufficiency comments have been prepared in consideration of, and as an integrated activity with, the issue resolution process.

Consistent with this issue resolution process, NRC staff intensified its precicensing interactions with DOE over the last two years to address and resolve remaining current questions and concerns. Since August 2000, DOE and NRC have held 16 technical exchanges focused specifically on issues relevant to these preliminary comments. These multi-day public meetings with DOE were used to discuss the status of issue resolution. Results from this increased precicensing interaction have been presented to DOE through formal letters and through public meetings between NRC and DOE. Finally, agreements that document additional work that DOE will need to complete before submitting any potential license application were reached. All this activity is summarized in Table 1. In areas covered by the agreements, NRC believes DOE's plans and schedules to get information represent a reasonable approach. Further, based on the agreements, NRC has reasonable confidence DOE will assemble the information before filing a possible license application. NRC has not, however, prejudged the outcome of a licensing review. Reliance on DOE's agreements to complete this work forms the basis for many conclusions regarding the sufficiency of information.

NRC's licensing decisions, in terms of a potential repository at Yucca Mountain, will not occur until DOE submits a high-quality license application, the staff completes its independent safety review and issues a safety evaluation report, NRC provides an opportunity for a hearing on issues raised by the parties, and NRC makes its final determination of whether the DOE

license application meets NRC regulations. Any NRC licensing decision will be based on all the information available at that time.

SCOPE OF THE NRC's EVALUATION

Our comments concerning DOE's "at-depth site characterization analysis" are based on our examination of the DOE information on events and processes that occur below the ground surface, even if their effects are seen at the surface, and DOE's investigation of features within the geosphere. Our comments on DOE's "waste form proposal" reflect our review of DOE information on the waste form, fuel cladding, waste package, drip shield, drift, and other engineered barriers.

We have evaluated repository safety for both the period of operations prior to permanent closure (i.e., preclosure) and after permanent closure (i.e., postclosure). The preclosure evaluation includes the staff's examination of the extent to which the DOE at-depth site characterization analysis and the waste form proposal seem to be sufficient to support the preclosure safety analysis. For safety after permanent closure (i.e., postclosure) period, we examined the extent to which DOE's at-depth site characterization analysis and waste form proposal support its scenario analysis and model development that would form the basis for any assessment of repository performance.

The DOE documents that we reviewed as the basis for our preliminary comments are the "Yucca Mountain Science and Engineering Report" and supporting technical basis documents; the "Preliminary Preclosure Safety Assessment for Monitored Geologic Repository Site Recommendation"; the "Total System Performance Assessment for the Site Recommendation"; and the "FY01 Supplemental Science and Performance Analyses." The supporting DOE technical documents include the DOE analysis and model reports and process model reports.

It should be noted that there are areas beyond the scope of at-depth site characterization analysis and the waste form proposal that any DOE license application would need to include. With respect to repository safety for the period of operations prior to permanent closure (i.e., preclosure), areas beyond the scope of these preliminary comments include the preclosure safety analysis and the design of the surface and subsurface geologic repository operations area and its structures, systems, and components important to safety. NRC continues to conduct preclosure issue resolution interactions with DOE on preclosure topics that are beyond the scope of these comments.

With respect to repository safety for the period after permanent closure (i.e., postclosure), areas beyond the scope of these preliminary comments include climate and infiltration, redistribution of radionuclides in soil, the lifestyle of the reasonably maximally exposed individual, and demonstration of compliance with the performance objectives.

Notwithstanding the above, issue resolution addresses all areas of repository safety. NRC believes DOE has, or has agreed to obtain, sufficient information in all postclosure areas.

ALTERNATIVE REPOSITORY DESIGNS

DOE is exploring a flexible design concept to allow for the possibility of operating the repository over a range of thermal conditions. The DOE "Yucca Mountain Science and Engineering Report" describes the flexible design concept. The DOE "FY01 Supplemental Science and Performance Analyses" describes exploratory and scoping evaluations to support the proposed range of thermal operating modes. NRC has reviewed these evaluations and met with DOE to discuss a list of additional information needs. If the DOE were to adopt a lower temperature operating mode or the approach used in the FY01 Supplemental Science and Performance Analyses, then NRC will meet again with DOE to discuss specific additional information needs required for a potential license application. If additional information becomes available before any DOE site recommendation, NRC reserves the right to supplement these preliminary comments.

VIEWS OF THE ADVISORY COMMITTEE ON NUCLEAR WASTE

Finally, it is also worthwhile noting that the Commission's perspective on the adequacy of at-depth site characterization analysis and waste form proposal information is consistent with the NRC's Advisory Committee on Nuclear Waste. Specifically, in letters of September 18, 2001, and September 28, 2001, the Committee appears to agree with the NRC staff's approach to issue resolution and its use of analytical tools as a means to conduct the sufficiency review. The Committee did note, similar to the NRC staff, that substantial additional work by DOE is needed prior to the submission of a potential license application. However, it is our understanding that the issues raised in the Committee's letters are focused on the adequacy of a possible license application and that resolution of its concerns can be achieved in the intervening period between a possible site recommendation and a possible license application.

CONCLUSIONS

NRC's preliminary comments are that DOE has obtained or has agreed to obtain sufficient at-depth site characterization analysis and waste form proposal information required for a possible license application. DOE will continue to develop information needed for a license application. DOE and NRC have reached numerous agreements, representing a broad scope of additional work DOE will complete before any license application. NRC believes the plans and schedules to collect more information represent a reasonable approach. Based on the agreements with DOE, the NRC has reasonable confidence DOE could assemble the information needed for a possible license application.

TABLE 1. DESCRIPTION OF DOE STATUS ON RESOLUTION OF KEY TECHNICAL ISSUES AND PRECLOSURE ISSUES

Key Technical Issue	Agreement Topics	Significance of Agreement Topics
<p>Container Life and Source Term – This Key Technical Issue deals with the containers and waste form as the primary engineered barriers, and the source term resulting from their degradation, as well as other design features including the drip shield. The following are the associated subissues:</p> <p>Open:¹ None.</p> <p>Closed:² None.</p> <p>Closed-Pending:³</p> <ul style="list-style-type: none"> • Subissue 1: Effects of corrosion processes • Subissue 2: Effects of phase instability and initial defects • Subissue 3: Rate of radionuclide release from spent nuclear fuel • Subissue 4: Rate of radionuclide release from waste glass • Subissue 5: Effect of in-package criticality • Subissue 6: Effects of alternative design features 	<p>Documentation of corrosion processes, waste package design and operating environments, laboratory data, fabrication processes and effects of fabrication on materials stability, corrosion, and mechanical failure. Information required for waste package, containers, waste forms, drip shield, and other engineered features, including evaluation of in-package criticality.⁴</p>	<p>This information is required to assess the susceptibility of the engineered barriers to potential degradation processes. The waste package is relied on to minimize the release of radionuclides for the first several 1,000 years following emplacement.</p>

Key Technical Issue	Agreement Topics	Significance of Agreement Topics
<p>Evolution of the Near Field Environment – This Key Technical Issue examines the effects of coupled thermal-hydrologic-chemical processes on seepage and flow, waste package chemical environment, chemical environment for radionuclide release, radionuclide transport through engineered and natural barriers, and potential for nuclear criticality. The following are the associated subissues:</p> <p>Open:¹ None.</p> <p>Closed:² None.</p> <p>Closed-Pending:³</p> <ul style="list-style-type: none"> • Subissue 1: Effects of coupled thermal-hydrologic-chemical processes on seepage and flow • Subissue 2: Effects of coupled thermal-hydrologic-chemical processes on the waste package chemical environment • Subissue 3: Effects of coupled thermal-hydrologic-chemical processes on the chemical environment for radionuclide release • Subissue 4: Effects of coupled thermal-hydrologic-chemical processes on radionuclide transport through engineered and natural barriers • Subissue 5: Effects of coupled thermal-hydrologic-chemical processes on potential criticality in the near field 	<p>Documentation of coupled process models, crushed tuff experiments, effects of dust on salts analysis, laboratory solution chemistry, data used for model calibration and model validation, bounding colloid transport. Evaluation of sources of model and data uncertainty.</p> <p>Technical basis required for trace element concentrations, effects of engineered materials on hydrologic properties, suppression of mineral precipitation, low relative humidity modeling, range in water composition, treatment of reaction kinetics, use of bulk chemistry rather than local chemistry, and colloid treatment. ^{5,6}</p>	<p>This information is required to support reviews of waste package and drip shield performance and evaluations of parameters that could affect the quantity and chemistry of water contacting the waste package or waste forms and resulting thermal-mechanical effects on hydrologic properties. It also supports evaluation of the waste package environment and its effect on performance, including model and parameter uncertainties.</p>

Key Technical Issue	Agreement Topics	Significance of Agreement Topics
<p>Igneous Activity – This Key Technical Issue predicts the consequence and probability of igneous activity, such as volcanic eruptions or intrusions, potentially affecting the repository. The following are the associated subissues:</p> <p>Open:¹ None.</p> <p>Closed:² None.</p> <p>Closed-Pending:³</p> <ul style="list-style-type: none"> • Subissue 1: Probability of igneous activity • Subissue 2: Consequences of igneous activity 	<p>Development of igneous process models. Documentation of sensitivity analyses of igneous processes, analysis of new site aeromagnetic data, confirmation of model parameter ranges, incorporation of analog data, verification of model assumptions and any bounding analyses, validity of process models.^{7,8,9}</p>	<p>This information is required to derive the appropriate scenarios for consideration in postclosure performance assessment and for evaluating the processes and potential effects of igneous processes interacting with the repository.</p>

Key Technical Issue	Agreement Topics	Significance of Agreement Topics
<p>Repository Design and Thermal Mechanical Effects – This Key Technical Issue reviews the design, construction, and operations of a geologic repository considering both preclosure and postclosure activities. The following are the associated subissues:</p> <p>Open:¹ None.</p> <p>Closed:²</p> <ul style="list-style-type: none"> • Subissue 1: Design control process • Subissue 4: Design and long-term contribution of repository seals to performance <p>Closed-Pending:³</p> <ul style="list-style-type: none"> • Subissue 2: Seismic design methodology • Subissue 3: Thermal-mechanical effects 	<p>Provide preliminary seismic design input data sets, site-specific properties of the host rock, modeling of drift and ground support performance, ventilation tests. Provide the technical basis for longevity of ground-support materials, effects of thermal and seismic loading on drift stability, rockfall size distribution, sustained loading on intact rock strength, rock movement in the invert, rock joint representation, and stress measures used for drip-shield and waste-package analyses. Provide verification of drift-degradation analysis, and a sensitivity analysis of thermal-mechanical effects on water flow.^{10,11}</p>	<p>This information is required to evaluate potential degradation and mechanical disruption of repository components and engineered barriers. The assessments consider fabrication processes and the evolution of the environment as well as natural events such as earthquakes and rockfall.</p>

Key Technical Issue	Agreement Topics	Significance of Agreement Topics
<p>Radionuclide Transport – This Key Technical Issue evaluates processes controlling contaminant migration. The following are the associated subissues:</p> <p>Open:¹ None.</p> <p>Closed:² None.</p> <p>Closed-Pending:³</p> <ul style="list-style-type: none"> • Subissue 1: Radionuclide transport through porous rock • Subissue 2: Radionuclide transport through alluvium • Subissue 3: Radionuclide transport through fractured rock • Subissue 4: Nuclear criticality in the far field 	<p>Documentation of expert judgements used to derive transport parameter values.</p> <p>Documentation of nuclear criticality analysis methodology. Plans for and results from field-based (e.g., alluvium) and laboratory testing of radionuclide transport.</p> <p>Documentation of the technical basis and supporting sensitivity analyses for effective porosity, flow paths below the repository, the alluvium transport path, colloid transport, and laboratory/field analog tracer data.^{5,12}</p>	<p>This information is required to evaluate the distribution and rate of radionuclide transport, and the contribution of various radionuclides to repository performance.</p>

Key Technical Issue	Agreement Topics	Significance of Agreement Topics
<p>Structural Deformation and Seismicity – This Key Technical Issue evaluates the geology in and around the candidate repository that results from tectonic activity, such as earthquakes. The following are the associated subissues:</p> <p>Open:¹ None.</p> <p>Closed:²</p> <ul style="list-style-type: none"> • Subissue 4: Tectonic framework of the geologic setting <p>Closed-Pending:³</p> <ul style="list-style-type: none"> • Subissue 1: Faulting • Subissue 2: Seismicity • Subissue 3: Fracturing and structural framework of the geologic setting 	<p>Information required for the approach to evaluation of seismic fragility, technical justification for use of median versus mean, “fracture-informed” Enhanced Characterization of the Repository Block long-term test and Alcove 8 Niche 3 test, and review of Fracture Geometry Analysis and Modeling Report. Updates to features, events, and processes analysis and modeling reports and other reports relating to structural deformation and seismicity. Documentation of ground motion expert elicitation, excavation-induced fractures, and pre-test predictions for Alcove 8 Niche 3 test.¹³</p>	<p>This information is required to assess seismic effects on the engineered barriers and to establish boundary conditions, material properties, design criteria.</p>

Key Technical Issue	Agreement Topics	Significance of Agreement Topics
<p>Thermal Effects on Flow – This Key Technical Issue examines processes that could affect the performance of the repository and considers changes to flow paths of water in the unsaturated zone that are important to degradation of engineered barriers. The following are the associated subissues:</p> <p>Open:¹ None.</p> <p>Closed:² None.</p> <p>Closed-Pending:³</p> <ul style="list-style-type: none"> • Subissue 1: Features, events, and processes related to thermal effects on flow • Subissue 2: Thermal effects on temperature, humidity, saturation, and flux 	<p>Information required for representation of full model and parameter variability/uncertainty in results of thermal effects on flow simulations and abstractions, consideration of mass and energy losses through bulkhead of drift-scale test or incorporation of uncertainty caused by these losses, representation of cold-trap effect in appropriate models, comparison of analytical solution for refluxing with results from numerical model, Multi-Scale Thermohydrologic Model input and output files, detailed test plan for Phase III of ventilation test, updates to features, events, and processes database, and analysis and modeling reports relating to thermal effects on flow, and various analysis and modeling reports and process model reports supporting thermal effects on flow. Documentation relating to ventilation model and testing.¹⁴</p>	<p>This information is required to assess engineered barrier performance and the influence of thermal effects on hydrologic properties that affect seepage into repository drifts or transport properties to the saturated zone.</p>

Key Technical Issue	Agreement Topics	Significance of Agreement Topics
<p>Total System Performance Assessment and Integration – This Key Technical Issue describes an acceptable methodology for conducting assessments of repository performance and uses these assessments to demonstrate compliance with the performance objectives. The following are the associated subissues:</p> <p>Open:¹ None.</p> <p>Closed:² None.</p> <p>Closed-Pending:³</p> <ul style="list-style-type: none"> • Subissue 1: System description and demonstration of multiple barriers • Subissue 2: Scenario analysis • Subissue 3: Model abstraction • Subissue 4: Demonstration of compliance with the performance objectives 	<p>Document the technical basis for barrier capability, including parameter and model uncertainty, and spatial and temporal variability. Provide the technical basis for screening of features, events, and processes, and support the statement that the considered list of features, events, and processes is comprehensive. Provide the technical basis for the abstraction of waste package performance, in-package chemistry, near-field environment, hydrologic flow paths, diffusion, geochemical conditions, radionuclide transport, biosphere and dose calculations. Documentation of consistent use of abstractions, software qualification, alternative conceptual model results, and stability of overall total system performance assessment results.^{15,16}</p>	<p>This information is required to verify that barrier capabilities are technically justified; that appropriate screening of features, events, and processes has occurred to support scenario analysis; and to ensure that data collection, model development, and treatment of uncertainties are adequate to provide a basis for performance assessments.</p>

Key Technical Issue	Agreement Topics	Significance of Agreement Topics
<p>Unsaturated and Saturated Zone Flow Under Isothermal Conditions – This Key Technical Issue assesses processes and features associated with the movement of water throughout the natural system. The following are the associated subissues:</p> <p>Open:¹ None.</p> <p>Closed:²</p> <ul style="list-style-type: none"> • Subissue 1: Climate change • Subissue 2: Hydrologic effects of climate change <p>Closed-Pending:³</p> <ul style="list-style-type: none"> • Subissue 3: Shallow infiltration • Subissue 4: Deep percolation • Subissue 5: Saturated zone • Subissue 6: Matrix diffusion 	<p>Documentation for Monte Carlo simulation of infiltration, field tests, geochemical data used to support the flow field below the repository, and comparative modeling studies. Provide justification for seepage fraction and seepage flow, and parameters used for infiltration analysis. Provide test plans for and results from underground laboratory experiments on flow, well data, alternative conceptual model results, sensitivity analysis of matrix diffusion, updated regional saturated flow model, and the updated site scale hydrologic framework model.^{17,18}</p>	<p>This information is required to evaluate important aspects of the site-scale saturated zone model for identification of flow paths to the saturated zone and to assess hydrogeologic, thermal, chemical, and mechanical effects on seepage into repository drifts and on transport pathways from the proposed repository horizon to the underlying aquifer.</p>

Key Technical Issue	Agreement Topics	Significance of Agreement Topics
<p>Preclosure Safety – This area has not been identified as a Key Technical Issue; however, it addresses repository operations prior to permanent closure. The following are topics that will continue to be addressed in the issue resolution process:</p> <ul style="list-style-type: none"> • Site description • Description of structures, systems, components, equipment, and operational process activities • Identification of hazards and initiating events • Identification of event sequences • Consequence analyses • Identification of structures, systems, and components important to safety; safety controls; and measures to ensure availability of the safety systems • Design of structures, systems, and components important to safety and safety controls • Meeting 10 CFR Part 20 as low as is reasonably achievable requirements for normal operations and category 1 event sequences • Plans for retrieval and alternate storage of radioactive wastes • Plans for permanent closure and decontamination, or decontamination and dismantlement of surface facilities 	<p>Information required for hazard analysis of aircraft crash on surface facilities, hazard analysis of tornado missile, waste package finite element analysis, and Integrated Safety Analysis Guide. Updates to Pre-Closure Criticality Analysis Process Report and Quality Assurance Procedure QAP 2-3. Demonstration of acceptable waste package mechanical properties after fabrication and closure. Demonstration that nondestructive evaluation methods are adequate for detecting defects in the Alloy 22 and type 316 nuclear grade plates and disposal container closure welds. Justification that mechanical properties of disposal container fabrication and waste package closure welds are adequately represented.^{10,19}</p>	<p>This information is required to support assessments of the design and stability of surface and underground facilities, the design of the waste form and waste packages, and the preclosure safety analysis.</p>

¹Open means NRC has identified questions regarding the DOE approach or information, and the DOE has not yet acceptably addressed the questions or agreed to provide the necessary additional information in a potential license application.

²Closed means the DOE approach and available information acceptably address staff questions such that no information beyond what is currently available will likely be required for regulatory decision making at the time of any initial license application.

³Closed-pending means the NRC staff has confidence that the DOE proposed approach, together with any DOE agreements to provide the NRC with additional information (through specified testing, analysis, etc.), acceptably addresses the NRC's questions such that no information beyond that provided, or agreed to, will likely be required at the time of initial license application.

⁴U.S. Nuclear Regulatory Commission. "Summary Highlights of U.S. Nuclear Regulatory Commission/U.S. Department of Energy Technical Exchange and Management Meeting on Container Life and Source Term, September 12–13, 2000." Letter from C. William Reamer (NRC) to Dennis R. Williams (DOE). Washington, DC: NRC. 2000. [Agencywide Documents Access Management System, Accession Number: ML003760884]

⁵U.S. Nuclear Regulatory Commission. "Summary Highlights of U.S. Nuclear Regulatory Commission/U.S. Department of Energy Technical Exchange and Management Meeting on Criticality." October 23–24, 2000. Letter from C. William Reamer (NRC) to Dennis R. Williams (DOE). Washington, DC: NRC. 2000. [Agencywide Documents Access Management System, Accession Number: ML003765266]

⁶U.S. Nuclear Regulatory Commission. "Summary Highlights of U.S. Nuclear Regulatory Commission/U.S. Department of Energy Technical Exchange on Evolution of the Near-Field Environment, January 9–11, 2001." Letter from C. William Reamer (NRC) to Dennis R. Williams (U.S. Department of Energy). Washington, DC: NRC. 2001. [Agencywide Documents Access Management System, Accession Number: ML010600181]

⁷U.S. Nuclear Regulatory Commission. "Summary Highlights of U.S. Nuclear Regulatory Commission/U.S. Department of Energy Technical Exchange and Management Meeting on Igneous Activity, August 29–31, 2000, Las Vegas, Nevada." Letter from C. William Reamer (U.S. Nuclear Regulatory Commission) to Dennis R. Williams (U.S. Department of Energy). Washington, DC: U.S. Nuclear Regulatory Commission. 2000. [Agencywide Documents Access Management System, Accession Number: ML003763285]

⁸U.S. Nuclear Regulatory Commission. "Summary Highlights of U.S. Nuclear Regulatory Commission/U.S. Department of Energy Technical Exchange and Management Meeting on Igneous Activity, June 21-22, 2001." Letter from C. William Reamer (U.S. Nuclear Regulatory Commission) to Dennis R. Williams (U.S. Department of Energy). Washington, DC: NRC. 2001. [Agencywide Documents Access Management System, Accession Number: ML011840178]

⁹U.S. Nuclear Regulatory Commission. "Summary Highlights of U.S. Nuclear Regulatory Commission/U.S. Department of Energy Technical Exchange and Management Meeting on Igneous Activity, September 5, 2001." Letter from C. William Reamer (U.S. Nuclear Regulatory Commission) to Dennis R. Williams (U.S. Department of Energy). Washington, DC: NRC. 2001. [Agencywide Documents Access Management System, Accession Number: ML012560423]

¹⁰U.S. Nuclear Regulatory Commission. "Summary Highlights of U.S. Nuclear Regulatory Commission/U.S. Department of Energy Technical Exchange and Management Meeting on Range of Thermal Operating Temperatures, September 13-14, 2001." Letter from C. William Reamer (U.S. Nuclear Regulatory Commission) to Dennis R. Williams (U.S. Department of Energy). Washington, DC: NRC. 2001. [Agencywide Documents Access Management System, Accession Number: To-Be-Determined]

¹¹U.S. Nuclear Regulatory Commission. "Summary Highlights of U.S. Nuclear Regulatory Commission/U.S. Department of Energy Technical Exchange and Management Meeting on Repository Design and Thermal-Mechanical Effects, February 6-8, 2001." Letter from C. William Reamer (NRC) to Dennis R. Williams (U.S. Department of Energy). Washington, DC: NRC. 2001. [Agencywide Documents Access Management System, Accession Number: ML010300165]

¹²U.S. Nuclear Regulatory Commission. "Summary Highlights of U.S. Nuclear Regulatory Commission/U.S. Department of Energy Technical Exchange and Management Meeting on Radionuclide Transport, December 5-7, 2000." Letter from C. William Reamer (U.S. Nuclear Regulatory Commission) to Dennis R. Williams (U.S. Department of Energy). Washington, DC: U.S. Nuclear Regulatory Commission. 2000. [Agencywide Documents Access Management System, Accession Number: ML003778752]

¹³U.S. Nuclear Regulatory Commission. "Summary Highlights of U.S. Nuclear Regulatory Commission/U.S. Department of Energy Technical Exchange and Management Meeting on Structural Deformation and Seismicity, October 11-13, 2000." Letter from C. William Reamer (NRC) to Dennis R. Williams (DOE). Washington, DC: NRC. 2000. [Agencywide Documents Access Management System, Accession Number: ML003765232]

¹⁴U.S. Nuclear Regulatory Commission. "Summary Highlights of U.S. Nuclear Regulatory Commission/U.S. Department of Energy Technical Exchange and Management Meeting on Thermal Effects on Flow, January 8-9, 2001." Letter from C. William Reamer (U.S. Nuclear Regulatory Commission) to Dennis R. Williams (U.S. Department of Energy). Washington, DC: U.S. Nuclear Regulatory Commission. 2001. [Agencywide Documents Access Management System, Accession Number: ML010290382]

¹⁵U.S. Nuclear Regulatory Commission (NRC). "Summary Highlights of U.S. Nuclear Regulatory Commission/U.S. Department of Energy Technical Exchange and Management Meeting on Total System Performance Assessment and Integration - Features, Events, and Processes, May 15-17, 2001." Letter from C. William Reamer (U.S. Nuclear Regulatory Commission) to Dennis R. Williams (U.S. Department of Energy). Washington, DC: NRC. 2001. [Agencywide Documents Access Management System, Accession Number: ML011510147]

¹⁶U.S. Nuclear Regulatory Commission. "Summary Highlights of U.S. Nuclear Regulatory Commission/U.S. Department of Energy Technical Exchange and Management Meeting on Total System Performance Assessment and Integration, August 6-10, 2001." Letter from C. William Reamer (U.S. Nuclear Regulatory Commission) to Dennis R. Williams (U.S. Department of Energy). Washington, DC: NRC. 2001. [Agencywide Documents Access Management System, Accession Number: ML012410202]

¹⁷U.S. Nuclear Regulatory Commission. "Summary Highlights of U.S. Nuclear Regulatory Commission/U.S. Department of Energy Technical Exchange and Management Meeting on Unsaturated Zone Flow Under Isothermal Conditions, August 16-17, 2000, Berkeley, California." Letter from C. William Reamer (U.S. Nuclear Regulatory Commission) to Dennis R. Williams (U.S. Department of Energy). Washington, DC: U.S. Nuclear Regulatory Commission. 2000. [Agencywide Documents Access Management System, Accession Number: ML003751891]

¹⁸U.S. Nuclear Regulatory Commission. "Summary Highlights of U.S. Nuclear Regulatory Commission/U.S. Department of Energy Technical Exchange and Management Meeting on Saturated Zone Flow under Isothermal Conditions, October 31-November 2, 2000, Albuquerque, New Mexico." Letter from C. William Reamer (U.S. Nuclear Regulatory Commission) to Dennis R. Williams (U.S. Department of Energy). Washington, DC: U.S. Nuclear Regulatory Commission. 2000. [Agencywide Documents Access Management System, Accession Number: ML003778791]

¹⁹U.S. Nuclear Regulatory Commission. "Summary Highlights of U.S. Nuclear Regulatory Commission/U.S. Department of Energy Technical Exchange and Management Meeting on Pre-Closure Safety, July 24-26, 2001." Letter from C. William Reamer (U.S. Nuclear Regulatory Commission) to Dennis R. Williams (U.S. Department of Energy). Washington, DC: NRC. 2001. [Agencywide Documents Access Management System, Accession Number: ML012290017]

NRC'S VIEWS ON THE U.S. DEPARTMENT OF ENERGY QUALITY ASSURANCE

INTRODUCTION

This enclosure addresses the quality of the documentation supporting a possible site recommendation. The quality of DOE's collection of data; qualification and validation of software and models; and the various analyses supporting at-depth site characterization analysis and the waste form proposal is an important process element encompassing all of the key technical issues addressed by the preliminary comments. Further, because DOE has experienced problems implementing its quality assurance programs, we have included a discussion of DOE's path forward to correct its quality assurance problems before any potential license application.

QUALITY OF DOCUMENTS SUPPORTING SITE RECOMMENDATION

During our prelicensing interactions, DOE discussed the results of its reviews to verify the quality of the documents supporting a possible site recommendation, including the "Yucca Mountain Science and Engineering Report"; the "Total System Performance Assessment for the Site Recommendation"; and the "FY01 Supplemental Science and Performance Analyses." DOE performed vertical, horizontal, and technical reviews of these documents using, in some cases, personnel independent of the Yucca Mountain project. DOE also used independent personnel to perform an analysis for determining the root causes of the errors found in these documents. Although the NRC staff has not independently verified them, the staff believes that the reviews performed by DOE were necessary and appropriate to verify the quality of the documents supporting a possible site recommendation. Further, the NRC staff believes that the reviews did not reveal any significant errors or problems that would impact the conclusions in the "Total System Performance Assessment for the Site Recommendation" portion of the potential site recommendation.

Although DOE has not yet fully qualified data and software used in the "Total System Performance Assessment for the Site Recommendation" portion of the site recommendation, it has a reasonable approach to do so. Further, DOE has indicated that if the information contained in the "FY01 Supplemental Science and Performance Analyses" is used to support, or be a part of a possible license application, the information would be fully qualified and subjected to the same qualification controls as used for the "Total System Performance Assessment for the Site Recommendation." The staff accepts DOE's intention to fully qualify all data, software, and models if they are used in a potential license application.

If the data, software, and models supporting the possible license application are fully qualified before any license application, as agreed to by DOE, there will be sufficient basis for accepting the quality of the information encompassed in DOE's at-depth site characterization analysis and waste form proposal, and for the NRC to conduct its licensing review.

DOE'S PATH FORWARD TO CORRECT ITS QUALITY ASSURANCE PROBLEMS

DOE stated that it will develop a comprehensive corrective action plan that will address the causes of problems and a plan to improve the level of performance of its quality assurance program implementation. This plan will consider and address items such as: 1) results of DOE's reviews of the documents supporting the site recommendation; 2) root-cause analysis for the various quality assurance problems; 3) lessons learned from past corrective action

plans; 4) accountability; 5) performance measures; 6) upgrading and enhancing procedures; and 7) audits, surveillances, self assessments, and management oversight to confirm that the corrective actions are being implemented and are effective. Based on the above, the staff considers that:

- DOE's corrective action plan elements and approach appear reasonable. However, DOE has had problems implementing previous corrective action plans.
- Among the areas warranting management attention is improving the safety conscious work environment in the Yucca Mountain Project.
- The staff will continue to provide oversight of the implementation of DOE's quality assurance program, and review and follow the implementation of DOE's latest action plan to correct quality assurance problems before any potential license application.