Yucca Mountain Site Characterization Project

Management Plan for the Development of the License Application for a High-Level Waste Repository at Yucca Mountain

YMP/97-02

Revision 0

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CHANGE HISTORY

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CONTENTS

1.0 INTRODUCTION

The U.S. Department of Energy (DOE) plans to file a license application with the U.S. Nuclear Regulatory Commission (NRC) pursuant to 10 CFR 60, *Disposal of High-Level Radioactive Wastes in Geologic Repositories* (10 CFR 60). The NRC, in accordance with 10 CFR 60, will evaluate DOE's application to receive and possess source, special nuclear, and byproduct material at a geologic repository operations area (hereafter referred to as the "License Application"), and the accompanying Environmental Impact Statement, before issuing an authorization to construct the proposed geologic repository. The NRC will issue a license to DOE under Part 60 only after construction of the geologic repository operations area is substantially complete and the initial License Application has been updated in accordance with 10 CFR 60.24.

This document provides guidance for managing the process for filing a License Application under 10 CFR 60 that will enable the NRC to issue DOE a construction authorization pursuant to 10 CFR 60.31.

1.1 PURPOSE AND SCOPE OF THE LICENSE APPLICATION MANAGEMENT PLAN

The purpose of this document, hereafter called "the Management Plan," is to provide direction for development of a License Application, in compliance with 10 CFR 60.21, sufficient to receive authorization from NRC to construct a high-level radioactive waste repository at Yucca Mountain. The License Application consists of general information and a Safety Analysis Report. It is to be accompanied by an Environmental Impact Statement. (Because the Environmental Impact Statement is a companion to, but not part of the License Application, it is not covered by this Management Plan.) This Management Plan primarily describes the process to be used for developing the License Application, outlines the information to be provided in the License Application, and establishes a format for presenting the information. Revisions to this Management Plan will provide guidance for developing and submitting updates to the License Application that will be required before NRC issues DOE a license under 10 CFR 60.

Specific objectives of the Management Plan include:

- Explain the development process for the License Application, including the DOE and Management and Operating Contractor (M&O) review and comment resolution.
- Explain the management framework and oversight process for License Application development.
- Describe responsibilities of key personnel in the License Application development effort.
- Provide guidance for the mechanics of development of the License Application.
- Provide guidance for the identification and traceability of data and reference documents that support the License Application.
- Provide guidance for selection and qualification of License Application development team members.

- Provide for integration of information from previous activities on the Yucca Mountain Site Characterization Project (YMP) into the License Application.

- Explain how operating experience information from similar nuclear and/or industrial facilities is to be incorporated into the License Application development process.

- Specify the License Application-associated records to be captured and retained and the process for capture and retention.

- Explain quality assurance requirements applicable to the License Application and its supporting references and data.

The Management Plan and the License Application will be DOE-controlled documents. Copies of the Management Plan will be issued to Yucca Mountain Site Characterization Office (YMSCO) offices (as assigned by the YMSCO Assistant Manager for Licensing); DOE Headquarters; M&O management (to the Office Manager level); each License Application Section Manager, lead author, support author, reviewer, technical leads; and other individuals requesting a copy. Copies of the License Application, including the Working Draft, will be issued to YMSCO offices (as assigned by the YMSCO Assistant Manager for Licensing), DOE Headquarters, M&O management (to the Office Manager level), and to other users as designated by the YMSCO Assistant Manager for Licensing and by the M&O Licensing Manager. Distribution of paper copies of the License Application will be limited because of the great size of the completed License Application. It is expected that the License Application submitted to the NRC will be widely available in electronic form to persons inside and outside the Project.

Future revisions to the Management Plan will be made when considered necessary by the YMSCO Assistant Manager for Licensing.

The scope of the Management Plan includes guidance for all the above activities and general guidance for License Application development. Specific requirements or guidance provided in this document may be waived at the discretion of the YMSCO Assistant Manager for Licensing or as otherwise noted in this document. Such waivers shall be documented as decisions pertinent to License Application development in accordance with Section 3.3.

The Management Plan was developed under the requirements of DOE/RW-0333P, *Quality Assurance Requirements and Description* (DOE 1997). Implementing procedures were YAP-5.1Q, *Submittal of Documents for Development, Change, Review, and Deliverable Acceptance*, and YAP-5.8Q, *Technical Document Preparation*. This document has been determined to not be quality affecting, and is therefore not subject to quality assurance controls. Review of the document was performed in accordance with QAP 6.2, *Document Review*.

1.2 BACKGROUND

The Management Plan is one of three YMP products being developed in direct support of licensing the proposed high-level waste repository at Yucca Mountain in Nevada. The other two products are the *License Application Plan* (YMP in prep), which provides specified information on Project activities and costs required to obtain necessary information and support successful completion of the License Application; and the *Technical Guidance Document for License Application Preparation* (YMP in prep.) (Technical Guidance Document) which provides content and acceptance criteria guidance for development of the License Application.

DOE plans to submit the License Application to the NRC in 2002. Under the Nuclear Waste Policy Act of 1982, as amended (the NWPA), this submittal is contingent upon the Secretary of Energy sending a recommendation to the President that he approve the site for the development of a repository, the President recommending the site to Congress, and the designation of the site then becoming effective under Section 115 of the NWPA. The DOE has 90 days from the date that the site designation becomes effective to submit the License Application to the NRC. This Management Plan provides the framework to ensure that the License Application is developed on schedule and with adequate content to be submitted to the NRC in accordance with the NWPA.

2.0 LICENSE APPLICATION DEVELOPMENT

This chapter describes the mechanics of how the License Application will be controlled, developed, reviewed, and approved.

2.1 RESPONSIBILITIES

This section describes the responsibilities of specific individuals during development of the License Application.

2.1.1 YMSCO Assistant Manager for Licensing

The YMSCO Assistant Manager for Licensing is responsible to the Manager, YMSCO for successful and on-time development of the License Application. Because the License Application will be developed by the M&O, the YMSCO Assistant Manager for Licensing is responsible for oversight of the M&O development work for the License Application. The Assistant Manager for Licensing or designee is also responsible for coordinating review and approval of the License Application and the Working Draft License Application (discussed in Section 2.4.1) within the DOE.

The YMSCO Assistant Manager for Licensing is specifically responsible for the following activities, which may be delegated to the M&O while retaining responsibility:

- Developing and approving technical requirements and acceptance criteria to support licensing.
- Developing, approving, and implementing schedules to support licensing.
- Developing and approving budgets to support licensing.
- Reviewing and approving the License Application.
- Submitting the License Application to the Program Director for subsequent processing and transmittal to the NRC on schedule and in appropriate form and content to support docketing and subsequent issuance of a construction permit.
- Ensuring personnel assigned to develop and review the License Application are properly trained and qualified.
- Ensuring the quality of data and information to be provided and referenced in the License Application, as required by DOE/RW-0333P, *Quality Assurance Requirements and Description* (DOE 1997).
- Informing cognizant DOE Headquarters management of issues that could impact the success or timeliness of the License Application development process, and addressing such issues to minimize potential impacts.

2.1.2 M&O Licensing Manager

The M&O Licensing Manager is the M&O manager responsible for activities associated with the development of the License Application and for implementation of the Management Plan. The Licensing Manager is responsible for the development process and is responsible for providing periodic status updates to YMSCO and M&O management.

The responsibilities of the M&O Licensing Manager include:

- Supervising development of the License Application.
- Working with M&O management to achieve assignment of appropriate personnel as License Application section managers and lead authors for each License Application section.
- Ensuring appropriate controls are implemented such that data and information presented in the License Application are appropriately consistent throughout the document.
- Developing a schedule for completion of the License Application and ensuring compliance with that schedule.
- Tracking the License Application development process and providing the License Application status to YMSCO.
- Coordinating the License Application development process with YMSCO staff designated to coordinate the License Application development, and serving as the primary interface between the M&O and YMSCO for the License Application development.
- Providing Licensing Department staff support (or support from other M&O personnel as necessary) for facilitating training, as necessary, on the License Application development, and iterative reviews and regulatory consultation to the License Application lead and support authors.
- Reviewing regulatory documents, technical materials, reports, requirements, studies, and the License Application chapters in progress; and providing comment and feedback to authors.
- Coordinating final consolidation and editing of the License Application for YMSCO review and approval.
- Ensuring appropriate records are processed as required by AP-17.1Q, *Record Source Responsibilities for Inclusionary Records.*
- Convening and coordinating the activities of the License Application Consulting Board as discussed in Section 2.3.8 and ensuring that the recommendations of the Board are appropriately addressed.

- Providing a list of designated M&O License Application development team members to M&O Training and Development, and working with M&O Training and Development to ensure that all designated team members are qualified and that qualification is properly documented.

2.1.3 The License Application Coordinator

The License Application Coordinator is the person in the M&O Licensing Department responsible to the M&O Licensing Manager for coordinating development of the License Application.

The responsibilities of the License Application Coordinator include:

- Ensuring that the License Application is developed on schedule in a form acceptable to the NRC for docketing.
- Ensuring that the License Application is developed in compliance with this *Management Plan* and with the *Technical Guidance Document for License Application Preparation* (YMP in prep.) (Technical Guidance Document).
- Informing cognizant M&O and YMSCO management (including the License Application Section Managers) of issues that could impact the success or timeliness of the License Application development process, and addressing such issues to minimize potential impacts.
- Coordinating the efforts of licensing chapter coordinators and lead authors to support successful development of the License Application.
- Ensuring required records are created and submitted in accordance with AP-17.1Q.

2.1.4 Licensing Chapter Coordinators

The licensing chapter coordinators are individuals assigned by the M&O Licensing Manager to coordinate development of assigned License Application chapters.

The responsibilities of the licensing chapter coordinators include:

- Being responsible to the License Application Coordinator and the M&O Licensing Manager for monitoring the status of assigned chapter development.
- Working with associated lead and supporting authors to ensure that assigned chapters are developed with adequate content to support the License Application submittal and on time.
- Providing appropriate licensing perspective to the associated lead authors and support authors.
- Editing the assigned draft chapters and sections for content, compliance with regulatory requirements, format, and consistency with other chapters and sections.

- Monitoring development status of assigned chapters and taking appropriate action to ensure that issues and problems with development of assigned chapters are expeditiously addressed so as not to adversely impact product quality or schedule.

- Ensuring that the License Application Coordinator and M&O Licensing Manager are informed of chapter development status and of any issues that could impact successful, on-time development of assigned chapters and sections, and expeditious resolution of such issues.

2.1.5 The License Application Section Managers

The License Application section managers are the M&O personnel selected by M&O senior management to have the overall responsibility for the technical content and timely development of the License Application chapters and sections.

The responsibilities of the License Application section managers include:

- Functioning as the ultimate technical authorities for the development of the License Application chapters assigned to their respective organizations.

- Assigning lead authors and support authors, if necessary, for each License Application section, as appropriate.

- Ensuring, in cooperation with the M&O Licensing Manager, that each lead and support author within respective organizations is qualified and trained to the applicable procedures, and submitting training and qualification documentation to the M&O Training and Development Manager as specified in Section 2.3.3.

- Coordinating development of the License Application text, reviews, and comment resolution for assigned sections of the License Application. Reviews are performed by the M&O, YMSCO, and the DOE Headquarters organizations.

- Ensuring that all data and records utilized in the License Application are available and traceable as discussed in Section 3.5.

- Ensuring that source materials are correctly cited as references.

- Providing draft texts of the License Application sections as they are developed to the M&O Licensing Manager for review and comment.

- Submitting completed sections of the License Application for review in accordance with the License Application development schedule and in accordance with Section 2.4.

- Providing the License Application section and chapter development status information as requested by the M&O Licensing Manager.

- Informing the M&O Licensing Manager of problems impacting the deliverable due dates.

- Ensuring that all alternative interpretations, supported by regional and site data, and analyses and conclusions relevant to the License Application are clearly discussed.

Ensuring that any assumptions, the data, interpretations, alternative hypotheses, and a preferred hypothesis are clearly differentiated so that an independent reviewer can review the information and reach an independent conclusion. In addition, ensuring that 1) the rationale for disagreeing with all or parts of the data, analyses, or conclusions is provided, 2) the extent to which these alternative interpretations and this literature impact the YMP data and conclusions is discussed, and 3) the impact, if any, these alternative interpretations would have on repository performance is discussed.

2.1.6 Lead Authors

Lead authors are knowledgeable qualified individuals from the M&O staff assigned by the License Application Section Manager to develop specific chapters or sections. These individuals have the primary responsibility for the quality of the technical content of assignments.

The responsibilities of the lead authors include:

- Developing assigned sections and chapters of the License Application in accordance with this Management Plan and with the Technical Guidance Document.
- Working with the licensing chapter coordinator(s) for chapters assigned to the lead author in whole or in part to ensure draft License Application text material incorporates appropriate regulatory perspective.
- Working with support authors, where assigned, to develop assigned sections of the License Application per the guidance presented in this Management Plan.
- Ensuring that all alternative interpretations, supported by regional and site data, and analyses and conclusions relevant to the License Application are clearly discussed. Ensuring any assumptions, the data, interpretations, alternative hypotheses, and a preferred hypothesis are clearly differentiated so that an independent reviewer can review the information and reach an independent conclusion. In addition, ensuring that 1) the rationale for disagreeing with all or parts of the data, analyses, or conclusions is provided, 2) the extent to which these alternative interpretations and this literature impact the YMP data and conclusions is discussed, and 3) the impact, if any, these alternative interpretations would have on repository performance is discussed. While section managers, lead authors, and support authors share this responsibility, it is expected that lead and support authors will actually incorporate the discussion in the License Application text.
- Ensuring that references or data to be provided in assigned chapters and sections meet applicable requirements discussed in Section 3.5.
- Ensuring that data and information presented in assigned chapters or sections are appropriately consistent with other places in the License Application in which such data and information are presented or used.
- Ensuring that, when expert judgement is used formally in assigned sections/chapters of the License Application, it is documented in accordance with YMP procedures and sufficient documentation is provided in the License Application.

- Accessing data from the Geographic nodal Information Study and Evaluation System (GENISES) or Reference Information Base databases to support the License Application development.

- Submitting data to the GENISES or Reference Information Base databases as required by Project procedures. The lead author shall also ensure that the data and its supporting documentation have been submitted to the Office of Civilian Radioactive Waste Management (OCRWM) Records Processing Center for indexing and maintenance.

- Identifying and reviewing YMP and external documents for use and incorporation in preparing assigned sections of the License Application.

- Informing the pertinent License Application section manager and licensing chapter coordinator of problems and issues that could impact successful, on-time development of assigned chapters and sections, and expeditious resolution of such issues.

- In the case of the Quality Assurance chapter of the License Application, working closely with the DOE Office of Quality Assurance during development of the chapter to ensure its acceptability to that organization.

2.1.7 Support Authors

Support authors are M&O personnel assigned by the License Application Section Manager to assist the lead authors in developing parts of specific sections of the License Application.

The responsibilities of the support authors include:

- Being responsible to the pertinent lead author for development of assigned sections or subsections in accordance with the License Application development schedule, this Management Plan, and the Technical Guidance Document.

- Ensuring that all alternative interpretations, supported by regional and site data, and analyses and conclusions relevant to the License Application are clearly discussed. Ensuring any assumptions, the data, interpretations, alternative hypotheses, and a preferred hypothesis are clearly differentiated so that an independent reviewer can review the information and reach an independent conclusion. In addition, ensuring that 1) the rationale for disagreeing with all or parts of the data, analyses, or conclusions is provided, 2) the extent to which these alternative interpretations and this literature impact the YMP data and conclusions is discussed, and 3) the impact, if any, these alternative interpretations would have on repository performance is discussed. While section managers, lead authors, and support authors share this responsibility, it is expected that lead and support authors will actually incorporate the discussion in the License Application text.

- Ensuring that references or data to be provided in assigned License Application chapters/sections meet applicable requirements in Section 3.5.

- Ensuring that data and information presented in assigned chapters or sections are appropriately consistent with other places in the License Application in which such data and information are presented or used.

- Ensuring that, when expert judgement is used formally in the License Application, it is documented in accordance with YMP procedures and sufficient documentation provided in the License Application.

- Accessing data from the GENISES or Reference Information Base databases to support the License Application development.

- Submitting data to the GENISES or Reference Information Base databases as required by Project procedures. The supporting author shall also ensure that the data and its supporting documentation have been submitted to the OCRWM Records Processing Center for indexing and maintenance.

- Identifying and reviewing YMP documents for use and/or incorporation in preparing sections of the License Application.

- Informing the pertinent lead author of problems and issues that could impact successful, on-time development of assigned chapters and sections, and expeditious resolution of such issues.

2.1.8 M&O Training and Development Manager

The M&O Training and Development Manager is responsible for facilitating qualification and training of M&O personnel involved in development of the License Application in accordance with this Management Plan and procedure QAP-2-1, *Indoctrination and Training*.

The M&O Training and Development Manager is specifically responsible for:

- Ensuring that qualification of M&O License Application development team members designated by the M&O Licensing Manager is documented in accordance with this Management Plan. This task includes providing M&O Licensing and the section managers a list of qualified License Application lead and support authors before document production begins and informing M&O Licensing and the section managers in writing of any subsequent changes to the list.

- Working with M&O Licensing and with the License Application section managers to ensure training of designated lead and support authors is completed.

- Working with M&O Licensing to develop training materials and present training to support qualification of M&O Licensing personnel, and the License Application lead and support authors.

2.1.9 The License Application Reviewers

The responsibilities of the License Application reviewers are defined in QAP 6.2.

2.1.10 License Application Consulting Board

The License Application Consulting Board will be convened to provide input to the License Application development process from persons outside the Project who are experienced and knowledgeable in the licensing process for an NRC-licensed facility. As discussed in

Section 2.3.8, the Board will convene several times per year during License Application development and will provide advice to the Project on topics such as the development process itself, management, and regulatory interactions.

2.2 LICENSE APPLICATION DOCUMENT TABLE OF CONTENTS

In accordance with 10 CFR 60.21, the License Application contains general information and the Safety Analysis Report. Consistent with DG-3003, *Format and Content for the License Application for the High-Level Waste Repository* (NRC 1990), the planned License Application will contain general information in Chapter 1. Chapters 2 through 14 comprise the Safety Analysis Report.

The proposed basic License Application Table of Contents is contained in the *Technical Guidance Document for License Application Preparation* (YMP in prep.). Additional subsections may be used at the discretion of the lead authors or as provided in the *Technical Guidance Document for License Application Preparation* (YMP in prep.), as discussed in Appendix B to the Technical Guidance Document. Minor wording changes to the chapter, section, and subsection titles may be made at the discretion of the M&O Licensing Manager or YMSCO Assistant Manager for Licensing without revising the *License Application Management Plan*, as long as the intent of the guidance in the Technical Guidance Document is not affected.

The document organization shown in the Technical Guidance Document is the result of the DOE review of NRC guidance such as that contained in DG-3003 and in NUREG-1323, *License Application Review Plan for a Geologic Repository for Spent Fuel and High-Level Radioactive Waste* (NRC 1995), that is applicable to the repository. It is also based on review of other NRC documents such as NUREG-0800, *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants* (NRC 1987). A License Application format was selected, based on these reviews, that is believed to most clearly and effectively present a cogent safety case. Because this format does not exactly match the format in any of the NRC guidance documents, the DOE will work with the NRC to explain the format chosen and the rationale for it.

2.3 DOCUMENT PREPARATION

This section describes the process for the License Application preparation, including the mechanics of the preparation process as well as guidance for format, content, and style.

2.3.1 Controlling Procedures

The License Application will be developed by the M&O for the DOE under the requirements of DOE/RW-0333P, *Quality Assurance Requirements and Description* (DOE 1997). Implementing procedures are planned to be YAP-5.1Q and YAP-5.8Q. Review of the License Application will be performed in accordance with QAP 6.2.

2.3.2 Preparation Process

The License Application will be developed by a multi-disciplinary M&O project team over a period of several years. The process begins with development and approval of this Management Plan and the Technical Guidance Document by the DOE. The Management Plan provides guidance for the process of developing the License Application, while the Technical Guidance

Document provides guidance on the required content of the License Application chapters and sections.

Development of this Management Plan will be complete prior to beginning development of the License Application. Although the Technical Guidance Document will be published prior to commencement of the License Application development, it is expected that revisions to that document will occur before and during the License Application development as repository design proceeds, site information continues to be refined, and to incorporate the effects of any changes to regulations or regulatory guidance. The Project plans to issue at least two such revisions after initial approval of the Technical Guidance Document. Each revision will include clear delineation of new guidance as well as guidance in the previous revision that has been deleted in the new revision. If the revisions affect previously developed text for the License Application, the affected lead author will revise the draft text to incorporate guidance changes from the Technical Guidance Document.

At the appropriate time in accordance with the License Application development schedule, the development team will be designated, and training for the team members on the License Application and its development process will occur. After an introductory meeting for the License Application development, production of the License Application chapters will begin. Actual text production will vary from chapter to chapter based on availability of information and resources. Text production will need to support the Working Draft of the License Application and acceptance reviews, which are discussed below. Detailed schedules for License Application chapter production will be developed through the Project planning process in Fiscal Year 1998.

The format of the License Application will be guided by the basic License Application Table of Contents, which is provided in the Technical Guidance Document. The Technical Guidance Document will also provide content guidance for the License Application.

The License Application will be prepared in an electronic format that is expected to allow sharing of information by all YMP personnel. The electronic format is expected to allow inclusion of tables and graphics. The format, including text processing software, will be determined in the future and promulgated to License Application authors. The document review process may also be electronic in format. If so, appropriate guidance for this review will be provided. Only the License Application Coordinator, the lead and support authors, and the licensing chapter coordinators will be able to revise the License Application text; all others will have "read only" access.

At approximately 60-day intervals during the License Application development, informal status meetings will be held. The principal purpose for these meetings will be to brief 10 to 15 YMSCO, DOE Headquarters, and M&O senior- and mid-level managers directly involved with the License Application development on the status of the project and to provide these managers the opportunity for feedback and course correction to the License Application project team. The License Application Coordinator, selected licensing chapter coordinators, and selected lead authors or designees will attend these meetings. The room for most of these meetings will be selected to limit attendance to fewer than 30 persons to facilitate discussion among key personnel. Every third meeting will be opened to wider attendance to facilitate broader Project awareness of the License Application development status. The License Application Coordinator will start each meeting with a briefing on the License Application development project status with regard to schedule compliance. Then each designated lead author will brief the status of development of assigned chapters or sections, such briefings to be normally less than five

minutes in length and with limited visual aids. These limits are intended to discourage managers and presenters from expending excessive resources on preparation for the briefings.

As described in Section 2.3.8, the M&O will convene a License Application Consulting Board. This Board, planned to be comprised of three to four "experts" on the subject of successful NRC licensing of nuclear facilities, will provide advice and recommendations prior to and during the License Application development process. It is expected that the Board will convene three to four times per year and that the Board will provide recommendations in writing. The License Application Coordinator and the M&O Licensing Manager will review and sort the recommendations of the Board to ensure that those recommendations are provided to the appropriate lead author/section manager, and will track and coordinate disposition of the recommendations. Recommendations generically applicable to the License Application will normally be addressed by the License Application Coordinator and/or the licensing chapter coordinators. This same process will be used to track and coordinate disposition of comments pertinent to License Application development from outside organizations such as the DOE Office of Quality Assurance and the Nuclear Waste Technical Review Board.

In view of the relatively long development period for the License Application, a Working Draft License Application will be developed to allow an interim review of the progress in document development and to provide timely incorporation of new data, revised interpretations, and correction of technical or other problems (such as integration) that may exist. The working draft will be reviewed by DOE and approved for distribution to controlled document holders.

At the appropriate time to support the submittal of License Application to the NRC, an M&O acceptance review of the draft License Application will be performed, followed by a DOE acceptance review that will involve YMSCO and DOE Headquarters. These reviews will be coordinated by M&O Licensing and will be timed such that the License Application will be approved by the DOE on or before the expected date the site designation is expected to take effect. After approval of the document by the OCRWM Director, M&O Licensing will submit the License Application to the Document Control organization within Technical Publications Management for distribution within the Project.

License Application development will continue after the DOE acceptance. The DOE is required by the NWPA to submit the License Application within 90 days after the Presidential Site Recommendation takes effect. During this 90-day period, M&O Licensing will coordinate a pre-submittal verification review by the M&O and the DOE, if, in the judgment of DOE, technical or management developments warrant a review. The purpose of this review will be to ensure that the document is current, technically correct, and consistent with Program and Project policies. In addition, updates to the DOE-accepted License Application to add additional detail and information as it becomes available will be made in a timely manner as required by 10 CFR 60.

Planning for the License Application preparation will be a collective YMSCO and M&O activity. The M&O will prepare all drafts of the License Application and its chapters. The YMSCO, the DOE Headquarters, and the M&O will review the License Application draft documents. The DOE will review and accept the License Application for submittal to the NRC.

2.3.3 Qualification of the License Application Development Team Members

All M&O License Application lead and support authors, section managers, the M&O Licensing Manager, the License Application Coordinator, and the licensing chapter coordinators shall be qualified and the qualification shall be documented. This qualification shall include meeting all requirements of DOE/RW-0333P, *Quality Assurance Requirements and Description* (DOE 1997), Section 2.2.12. With regard to requirement H (indoctrination and training for a specified task), M&O Licensing shall provide a list of designated personnel for these positions to M&O Training and Development, and M&O Training and Development shall then ensure that all proposed lead and support authors have the following documentation of qualification:

- Documented quality assurance indoctrination.
- Written certification by management as being technically proficient in the topic or discipline for which authorship is designated.
- Documented training on the purpose of the License Application, the Technical Guidance Document, the NRC licensing process, and this Management Plan.

The Licensing Manager shall coordinate resolution of development team member training deficiencies prior to beginning production of the License Application. They shall work with M&O Training and Development to ensure that appropriate training and documentation occur. If a replacement is needed for a development team member identified in this subsection or the need for an additional such team member is identified, the Licensing Manager is responsible for informing the newly designated member of the needed documentation/training, working with M&O Training and Development to schedule the training, if applicable, and ensuring the resulting documentation is properly dispositioned. M&O Training and Development shall provide M&O Licensing and the section managers a list of qualified License Application development team members before document production begins and shall thereafter inform M&O Licensing and the section managers in writing of any subsequent changes to the list.

Additional training on licensing related activities or documents may be conducted at the discretion of the M&O Licensing Manager, should changes occur in the pertinent documents. All qualified License Application development team authors will be required to complete such training.

2.3.4 Content and Level of Detail Guidance

Content and level of detail guidance for the License Application is provided in YMP/97-03, *Technical Guidance Document for License Application Preparation* (YMP in prep.).

2.3.5 Acceptance Criteria

Acceptance criteria for the License Application are provided in YMP/97-03.

2.3.6 Writing and Style Guidance

Writing and style guidance for the License Application is contained in Appendix B to the Technical Guidance Document. All authors should comply with this guidance unless authorized in writing to deviate by the M&O Licensing Manager. M&O Licensing will communicate any

approved deviations to all lead authors to encourage consistency among the License Application chapters and sections.

2.3.7 Incorporation of Documents, Position Papers, Policies, and Other Information

Various documents developed within and outside the Project are available to support development of the License Application. General requirements for use of such documents are provided in sections 3.4 through 3.7. Additional guidance for use of several specific, potentially important document types is provided in this section.

2.3.7.1 License Application Annotated Outline

Lead authors should review the *Mined Geologic Disposal System License Application Annotated Outline*, Revision 0 and Draft Revision 1 for assigned sections to ensure useful and valid information is extracted for use in the License Application. Information obtained from the *Mined Geologic Disposal System License Application Annotated Outline* is subject to the requirements provided in sections 3.4 through 3.7.

2.3.7.2 Operating Experience Information

Operating experience information is information systematically obtained and analyzed for lessons learned to prevent problems, which have occurred elsewhere, from occurring at the repository. Examples of such information include descriptions of waste handling events and operator errors obtained from sources such as other DOE projects, commercial nuclear facilities, and mining activities.

Each lead author should briefly describe how such information has been used in the activities relevant to assigned text. This discussion would normally not exceed a sentence or two for a topic. The operating experience discussion should include a short general description of how operating experience information was used to support a broad area, e.g., repository design or the radiation protection program, and a more specific discussion as applicable on how operating experience was used in more specific areas, e.g., design of a specific piece of equipment. For example: "Design of the (whatever) equipment reflects lessons learned from (a specified document or event) in that (explain how the review of the operating experience item affected the design of the equipment)." The License Application may also contain a summary section that would describe how operating experience information has been used in support of repository design and operations concepts. This summary section will describe in general how the information was obtained and how its relevance was determined.

The responsibility for obtaining and using operating experience information will be specified in other Project documents. This Management Plan only provides for how the use of such information is to be discussed in the License Application. All the License Application lead authors will ensure familiarity with how operating experience is used to support the subjects of assigned chapters and sections to include them in the License Application discussions.

2.3.7.3 Topical Reports

Topical reports are intended to obtain NRC acceptance of approaches to resolving certain key issues. This acceptance, in accordance with the NRC procedures for reviewing topical reports, would be provided in conjunction with a preliminary evaluation report to be issued by the NRC

that could be referenced in the License Application. The NRC-accepted approach could be used in support of the License Application and hopefully could reduce the time required to both develop the License Application case for resolution of the issue and the NRC time required to review the issue as part of the License Application review (the NRC reserves the right to readdress any issues covered in the topical report should new, relevant information indicate the need to do so). If the topical report on an issue provides the approach to addressing an issue rather than the resolution of the issue, follow-on reports may be used to apply the approach described in the topical report to actually address or resolve the issue. The License Application lead authors should, to the extent feasible, refer in the License Application to NRC-accepted topical reports and their follow-on reports in lieu of providing detailed discussions of the resolution approach in the License Application. Reference should be made to the NRC document that has accepted the topical report, and any context of or limitations on that acceptance should be described.

Topical reports developed and submitted to the NRC but not yet accepted may also be referenced in the License Application. Referencing such a document is no different from referencing any other technical document that has not been specifically reviewed and accepted by the NRC.

2.3.7.4 Other Documents

Other Project documents, such as position papers, technical reports, or systems studies may be referenced or discussed in the License Application, subject to the requirements of sections 3.4 through 3.7. The substance of these documents and their significance to licensing should be addressed in the License Application. Documents developed outside the Project, such as industry standards and technical reports, may also be referenced or discussed, subject to the same requirements. Use of such documents will be as specified in the Technical Guidance Document; additional documents beyond those specified may be referenced at the discretion of the lead authors.

2.3.8 License Application Consulting Board

The M&O will convene a License Application Consulting Board to support the development of the License Application. Its intent will be to provide input to the License Application development process from "experts" (such as ex-NRC staff) in the field of obtaining NRC licenses for nuclear facilities. These individuals would not be employed by the repository project except in this consulting role. The Board will be constituted such that it can provide advice on a wide spectrum of License Application topics, such as the development process, management, and regulatory interactions. It will also include an industry licensing expert. Though the Board will not primarily be concerned with specific technical and other issues, it is expected that Board members will possess expertise to review and provide advice on broad technical issues that may impact licensing.

It is expected that the Board would be asked to convene three to four times per year and to provide its recommendations in writing. The Board may be asked to review the working and/or acceptance drafts of the License Application. The M&O will request some topics be reviewed by the Board. The Board may also independently determine topics for which its consideration and advice would be helpful. The License Application Coordinator and the M&O Licensing Manager will review, track, and disposition the recommendations of the Board.

The M&O will plan to convene the Board for the first time early in FY 1999. The Board will not provide advice to DOE. It will advise and support the M&O under individual consulting agreements.

The M&O Licensing Manager will budget for the services of the Board and will coordinate the effort to identify and obtain the services of highly experienced and qualified persons to serve as Board members.

2.4 REVIEWS

The subsections that follow describe how reviews of the License Application are to be conducted. There will be six basic review types:

- Reviews that occur during the initial development of the License Application (Section 2.4.1).
- M&O acceptance review (Section 2.4.2).
- DOE acceptance review (Section 2.4.3).
- Verification review to support submittal of the License Application to the NRC (Section 2.4.4).
- Reviews to support post-acceptance or post-submittal License Application updates (Section 2.4.5).

2.4.1 Reviews During License Application Development

In view of the relatively long development period for the License Application, a Working Draft License Application will be developed to allow an interim review of both the progress in document development and to provide timely correction of technical or other problems that may exist. The working draft will contain the document number of the License Application and will be labeled as "Draft Revision A."

The working draft will be reviewed by the M&O and by the DOE in accordance with QAP 6.2 and YAP-30.12, *Publications Review, Approval, and Distribution.* M&O Licensing will coordinate the review under the direction of the YMSCO Assistant Manager for Licensing. Section Managers will ensure that chapters and sections are reviewed and that comments are addressed and resolved in accordance with the License Application development schedule. The M&O review will include a review by M&O Licensing for content and consistency. Reviewers will be reminded of the incomplete nature of the document at the time of review and will be asked to comment in that context. Upon review and incorporation of comments and concurrence by the DOE, the Working Draft License Application will be issued to designated controlled document holders.

It is also expected that the section managers will ensure that periodic informal, in-house reviews of respective License Application sections are performed during the writing process. These reviews should verify the technical accuracy of the document, as well as the correctness of the content and format per the Technical Guidance Document. These reviews also should focus on the presentation of data and analyses to reach a conclusion or to present a compelling argument.

These reviews should verify that data used in the License Application sections under review meet applicable quality assurance requirements. In addition, M&O management will review the License Application sections informally during the License Application development process. The Licensing Chapter Coordinator for each chapter will also review the progress of chapter development periodically and will provide licensing perspective to help ensure that the chapter and the sections within the chapter are being developed in a manner supportive of making the licensing case for that chapter. The reviewer qualification requirements referenced in Section 2.4.6 do not apply to reviews discussed in this paragraph.

2.4.2 M&O Acceptance Review

An M&O acceptance review of the License Application will be performed to support submittal of the License Application to DOE for approval and to NRC in accordance with the NWPA, this Management Plan, and the License Application development schedule. This review will be timed such that it and the DOE acceptance review (see Section 2.4.3) will be completed prior to the effective date of site designation. The License Application development process and other Project activities will be timed such that the License Application that goes into this review will be considered to make an effective safety case for authorization to construct the repository.

CRWMS M&O reviewers will be chosen by CRWMS M&O management direction based on qualifications and technical competence in the subject area. M&O Licensing will review the draft License Application, as will the M&O legal staff. M&O Licensing will provide written instructions for the review prior to the beginning of the review and will coordinate the review. The License Application Section managers will ensure that for each chapter and section assigned to them, draft text is compiled by the respective lead authors and provided to M&O Licensing for transmittal to identified M&O reviewers. They will ensure that comments received on their assigned sections are resolved. Review criteria will include those in QAP 6.2, as appropriate, and the additional criteria below.

- Is the safety case in the License Application easily understood, or should it be clarified or reorganized to be more consistent or logical?
- Is the demonstration of compliance with waste containment and isolation requirements easily understood?
- Does the License Application comply with criteria in NUREG-1323: *License Application Review Plan for a Geologic Repository for Spent Nuclear Fuel and High-Level Radioactive Waste* (NRC 1995)?
- Are all supporting details necessary and sufficient?
- Do the graphics such as maps, tables, and graphs specify the minimum information required and are they properly referenced and interpreted in the text?
- Do the graphics contain the appropriate information such that they support the text as referenced (i.e., do they contain and clearly illustrate the supporting data)?
- Are the assumptions, interpretations, data and references presented clearly so that an outside reviewer can reach a similar conclusion independently?

- Is the safety case in the License Application easily understood, or should it be clarified or reorganized to be more consistent or logical?
- Is the demonstration of compliance with waste containment and isolation requirements easily understood?
- Does the License Application comply with criteria in NUREG-1323: *License Application Review Plan for a Geologic Repository for Spent Nuclear Fuel and High-Level Radioactive Waste* (NRC 1995)?
- Are all supporting details necessary and sufficient?
- Do the graphics such as maps, tables, and graphs specify the minimum information required and are they properly referenced and interpreted in the text?
- Do the graphics contain the appropriate information such that they support the text as referenced (i.e., do they contain and clearly illustrate the supporting data)?
- Are the assumptions, interpretations, data and references presented clearly so that an outside reviewer can reach a similar conclusion independently?
- Is the qualification status of the inputs identified? Have unqualified data directly relied upon to address safety and waste isolation issues been qualified?
- Are alternative interpretations of data and alternate conceptual models discussed and evaluated?
- Are anomalous data discussed and evaluated?
- Have the computer programs referenced in the License Application been qualified as required by DOE/RW-0333P, *Quality Assurance Requirements and Description* (DOE 1997) Supplement I?
- Are electronic versions of calculations properly documented?
- Are necessary tolerances and parameters provided for data?
- Is the License Application consistent with existing regulatory and other Project commitments? Have commitments applicable to the License Application been appropriately addressed?
- If the License Application makes any commitment or addresses a topic of regulatory interest, is it consistent with OCRWM and Project policy? Are all commitments clearly identified and captured in the Project's commitment tracking process?
- Does the License Application adequately address all applicable regulatory requirements in a traceable manner?
- Are the applicable requirements and acceptance criteria of the Technical Guidance Document adequately identified and addressed in the License Application?

The YMSCO Assistant Manager for Licensing will publish written instructions for the review prior to initiation of the review, including designation of proposed DOE reviewers. Qualification of reviewers is referenced in Section 2.4.6. The review will include a review by DOE Headquarters. In addition, a review by the DOE Office of the General Counsel and other non-OCRWM DOE organizations (as designated by the YMSCO Assistant Manager for Licensing) will occur at the same time. The YMSCO Assistant Manger for Licensing will coordinate the distribution of chapters/sections for review and comment within the DOE and organizations outside the CRWMS M&O structure, unless the DOE delegates this responsibility to M&O Licensing. Records of the review will be assembled by the DOE or M&O Licensing and submitted to the Records Processing Center in Las Vegas.

M&O section managers and lead authors will coordinate resolution and incorporation of the comments. The License Application section manager will coordinate comment resolution meetings as necessary.

After the License Application has been reviewed and comments have been appropriately incorporated, M&O Licensing will submit the document for DOE acceptance. When that acceptance is obtained, M&O Licensing will coordinate distributing the complete License Application document within the Project as Revision 0. A YAP-30.12 review will be conducted to obtain approval for external release of the License Application.

2.4.4 Pre-Submittal Verification

If, in the judgment of DOE, technical or management developments warrant a review, a verification review of the License Application will be performed. The purpose of this review is to verify that the information in the License Application remains technically correct and is in accordance with Program and Project policy. The YMSCO Assistant Manager for Licensing will designate in writing the reviewers for this review prior to the site designation becoming effective. The list of reviewers may include reviewers from YMSCO, DOE Headquarters, the M&O, the Management and Technical Services Contractor, and the United States Geological Survey. The review will be conducted in accordance with QAP 6.2. It will have specific review criteria to focus the review and ensure it can be completed and comments addressed in the 30-day period immediately following the date that the site designation is effective. A YAP-30.12 review will be conducted to obtain approval for external release of the License Application. M&O Licensing will then coordinate production of the License Application to be submitted and will submit the License Application to the DOE for signature by the designated signature authority. This version will be Revision 1. Once the signature authority approves the License Application, it will be submitted to the NRC, and copies will be distributed as appropriate.

2.4.5 Post-Submittal Updates

After site designation and the License Application submittal to the NRC, the License Application may need to be revised to incorporate additional or new information or to address NRC requests for additional information. Information appropriate for inclusion in an update would include new information that affects the licensing case made in the License Application. It would also include confirmatory information that addresses requirements for additional information as indicated in Section 11.11 of the License Application. Also, in order for the NRC to consider issuing a license to receive and possess radioactive materials, 10 CFR 60.24 requires the DOE to update the License Application "in a timely manner" to permit the NRC to review additional information obtained during construction, results of confirmatory studies, and other information

bearing on license issuance not available at the time of original submittal of the License Application. These updates will be reviewed in accordance with QAP 6.2 and will be on a "change page" basis. This process, with proper planning and Technical Guidance Document guidance, is expected to result in a satisfactory license application to receive and possess radioactive waste at the proper time in the construction process. The License Application originally submitted for construction authorization, updated after original submittal to reflect constantly supplemental site and performance information, will evolve into the updated license application to receive and possess radioactive materials.

This version of the License Application will be reviewed in the same manner as previous updates and using the same controls. After approval by the DOE and when the conditions stated in 10 CFR 60 have been met, this version will be submitted to the NRC to seek the license to receive and possess radioactive materials. A future revision to the Management Plan will provide additional guidance for development and submittal of the updated application for a license to receive and possess radioactive materials.

After the license to receive and possess radioactive materials is issued pursuant to 10 CFR 60.41, updates to the Safety Analysis Report portion of the License Application will continue to occur at least annually, or more frequently if considered appropriate by the YMSCO Assistant Manager for Licensing.

2.4.6 Qualifications of Reviewers

All DOE, M&O, Management and Technical Services Contractor, and United States Geological Survey reviewers for the formal reviews specified in section 2.4 shall meet the requirements in section 5.1.2 of QAP 6.2.

3.0 PROJECT MANAGEMENT AND CONTROL

This chapter describes the management and administrative process that will govern development of the License Application.

3.1 ESTABLISHMENT AND MAINTENANCE OF THE PROJECT DEVELOPMENT TEAM

At least 180 days prior to scheduled commencement of the License Application development project, M&O Licensing shall have identified and obtained approval from the DOE Assistant Manager for Licensing of the section managers for the License Application who are responsible for development of assigned chapters and sections.

At least 60 days prior to scheduled commencement of the License Application development project, the tentative list of lead and support authors shall have been designated by the section managers and published by M&O Licensing. The selection of lead authors and contributing authors is at the discretion of the section managers, as long as the qualification requirements of Section 2.3.3 are met. However, to the extent feasible, these individuals should have substantial Project experience and strong written communications skills.

3.2 COMMITMENT MANAGEMENT AND TRACKING

Commitments are written "promises" made by the Project to outside organizations. The Project has generally clearly delineated commitments in communications with the outside organization to whom the commitment is made. Commitments made by the Project to outside organizations, especially the NRC and EPA, could become a licensing issue prior to or after the License Application is submitted. In addition, it is considered prudent to perform a review of past correspondence that may have resulted in de facto commitments or that may have not been captured in the commitment tracking data base. As part of the License Application development effort, the Project will review Project records for past commitments that relate to licensing issues. M&O Licensing will coordinate identifying the commitments and will ensure that they are dispositioned by Project management and are entered into the commitment tracking data base to be maintained by M&O Licensing. Each commitment will be linked to the appropriate section(s) of the License Application. Disposition will include determinations whether commitments apply to licensing, whether the Project has plans in place to appropriately meet the commitment, and determination of corrective action where the commitment may not be met. The data base will be maintained throughout the life of the repository through closure to keep track of commitments and actions taken and/or planned to address the commitments. M&O management will review the data base and ensure that failure to properly address commitments does not delay the License Application submittal and docketing or construction authorization approval.

3.3 DECISION MANAGEMENT AND TRACKING

The License Application, required to be filed in close proximity to the date the site designation is effective, is the primary focus of Project resources for the period from completion of the 1998 Viability Assessment to issuance of the construction authorization by the NRC. If the President recommends the Yucca Mountain site for development, the success of the Project over that period will be determined by the successful docketing of the License Application and subsequent NRC issuance of the construction authorization. Given the importance of this effort and the scrutiny to which it will be subjected, it is necessary that all significant Project management,

technical, and policy decisions with regard to this effort be made in a careful, controlled manner; and that all such decisions be documented.

Decisions made with regard to the License Application will be documented in accordance with DOE procedures for decision documentation that will be in place before license application development begins. The YMSCO Assistant Manager for Licensing is responsible for developing a plan for documenting decisions and for managing the implementation and control of the process to be developed. Decision documentation procedures will be incorporated into the License Application by reference.

3.4 REQUIREMENTS FOR REFERENCES, DATA, AND ASSUMPTIONS

The License Application will reference many documents, generated both within the Project and outside the Project. The referencing of a document in the License Application does not by itself create an explicit Quality assurance or other control requirement on the reference. Lead and support authors are responsible for the selection of technically valid and defensible references and must recognize the likelihood that many of the License Application references will be challenged at various stages of document development and during the licensing process. Therefore, references must not only be valid but must be capable of being demonstrated to be valid. In addition, lead and support authors are responsible for ensuring that references in assigned chapters and sections meet applicable requirements discussed in Section 3.5.

The License Application will also contain large amounts of used or referenced data, which will be subject to identical considerations discussed in the previous paragraph and which must be documented as discussed in Section 3.5.

Assumptions, unproven assertions upon which conclusions may be based, which are included in the License Application must be clearly identified as such. Conclusions based wholly or partly on assumptions must be presented in a manner that will show the extent to which they depend on the assumption and the sensitivity of the conclusion to the accuracy or validity of the assumption. As unproven assertions, assumptions are inherently open to question and challenge; therefore, lead and support authors should consider alternatives. Where assumptions are necessary, the assumption should be justified. In addition, when feasible, the assumption should be supported with sensitivity analyses that show that the associated conclusions are relatively insensitive to the accuracy of the assumption. Authors should not state conclusions for which there are no supporting technical bases.

As discussed in greater depth in the Technical Guidance Document, the License Application must also include documentation of alternative models and interpretations of data that were not used in the licensing case. Reasons for not choosing the alternatives should be provided in this discussion.

3.5 IDENTIFICATION AND TRACEABILITY OF REFERENCES, DATA, AND ASSUMPTIONS

All references in the License Application must be available either as an OCRWM record in the OCRWM Records System, as a document in an OCRWM Technical Information Center, or in the public domain and available at or through a public university library or the NRC reading room. The OCRWM Records Management System is the controlled source of OCRWM-generated information, and any reference material that is an OCRWM record is to be verified

against this source to ensure that (1) it has been captured in the reference system, (2) the copy of the reference used is an exact duplicate of the copy in the record system, and (3) it has not been supplemented or superseded. License Application authors are responsible for providing copies of references to the Technical Information Center or the Records Processing Center. References that are records in accordance with AP-17.1Q (and are therefore not copyrighted) shall be provided to the Records Processing Center. In accordance with AP-17.1Q, a list of copyrighted documents shall be provided to the Technical Information Center, which will obtain copies and copyright clearances. Appropriate guidance for copyrighted clearance of electronic media references will be developed.

Data provided in the License Application shall include reference cites to the data source. Assumptions included in the License Application shall be clearly identified as such.

Data collected, acquired, or developed by the Project that is used and/or referenced in the License Application must have been submitted for inclusion in the GENISES and the Reference Information Base if required by Project procedures. Reference documents that are not records and are not copyrighted shall also be provided to the Technical Information Center. Lead and support authors are responsible for ensuring all such information used or referenced in chapters/sections has been properly submitted for inclusion in these data bases as required by procedure. A data tracking number must be included with the reference.

3.6 QUALITY ASSURANCE REQUIREMENTS

The License Application writing activity has been determined to be a quality affecting activity. Primarily, this designation is based on the importance of the License Application to the successful licensing of the proposed repository and on the extremely large amount of information that will be presented in the License Application.

Implementing procedures under which the License Application will be developed and reviewed are listed in Section 2.3.1.

3.7 RECORDS

The License Application, as noted in Section 2.3.1, will be controlled under the DOE quality assurance procedures. Records generated during preparation of the License Application will be controlled in accordance with AP-17.1Q and DOE/RW-0333P.

There are no quality assurance or inclusionary records generated by this plan.

4.0 SCHEDULE AND MILESTONES FOR LICENSE APPLICATION DEVELOPMENT

Yucca Mountain Site Characterization Project planning documents will provide the schedule for License Application development.

5.0 REFERENCES

5.1 REFERENCES

DOE (U.S. Department of Energy) 1997. *Quality Assurance Requirements and Description*, DOE/RW-0333P. Rev. 07. Washington, D.C.: Author.

NRC (U. S. Nuclear Regulatory Commission) 1987. *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants*. NUREG-0800. Washington, D.C.: U.S. Government Printing Office.

NRC 1990. *Format and Content for the License Application for the High-Level Waste Repository*. DG-3003. Washington, D.C.: U. S. Government Printing Office.

NRC 1995. *License Application Review Plan for a Geologic Repository for Spent Fuel and High-Level Radioactive Waste*. NUREG-1323. Washington, D.C.: U. S. Government Printing Office.

YMP (in prep.). *Technical Guidance Document for License Application Preparation*. YMP/97-03. Las Vegas, Nevada: Yucca Mountain Site Characterization Office.

YMP (in prep.). *License Application Plan*.

5.2 CODES AND STANDARDS

10 CFR 60. *Disposal of High-Level Radioactive Wastes in Geologic Repositories, LWR Edition*. Washington, DC: U.S. Government Printing Office.

Nuclear Waste Policy Act of 1982, as amended. Public Law 97-425, 42 U.S.C. 10101-10226. Washington, DC: U. S. Government Printing Office.

5.3 PROCEDURES

AP-17.1Q, *Record Source Responsibilities for Inclusionary Records*.

QAP-2-1, *Indoctrination and Training*.

QAP 6.2, *Document Review*.

YAP-5.1Q, *Submittal of Documents for Development, Change, Review, and Deliverable Acceptance*.

YAP-5.8Q, *Technical Document Preparation*.

YAP-30.12, *Publications Review, Approval and Distribution*.

APPENDIX A

ACRONYMS AND ABBREVIATIONS

APPENDIX A

ACRONYMS AND ABBREVIATIONS

DOE	U.S. Department of Energy
GENISES	Geographic Nodal Information Study and Evaluation System
M&O	Management and Operating Contractor
NRC	U.S. Nuclear Regulatory Commission
NWPA	Nuclear Waste Policy Act of 1982, as amended
OCRWM	Office of Civilian Radioactive Waste Management
YMP	Yucca Mountain Site Characterization Project
YMSCO	Yucca Mountain Site Characterization Office

TRW Environmental
Safety Systems Inc.

1180 Town Center Drive
Las Vegas, NV 89134
702.295.5400

WBS: 1.2.5.4.3
QA: N/A

Contract #: DE-AC01-91RW00134
LV.RO.JAM.11/97-059

November 13, 1997

Stephan J. Brocoum
Assistant Manager for Licensing
U.S. Department of Energy
Yucca Mountain Site Characterization Office
P.O. Box 30307
North Las Vegas, NV 89036-0307

Attention: Technical Publications Management

Dear Dr. Brocoum:

Subject: Resubmittal of Pending Deliverable for Milestone SL230B1D, "Total System Performance Assessment - Viability Assessment (TSPA-VA) Methods and Assumptions," Summary Account TR541FB2

Enclosed is the second edition of the subject deliverable, which is being resubmitted to complete Milestone SL230B1D. The text has been revised to incorporate review comments from the U.S. Department of Energy and Management and Technical Support Services.

If you have any questions, please contact Robert Andrews at (702) 295-5549.

Sincerely,

Jean L Younker

Jean L. Younker, Manager
Regulatory Operations
Management & Operating Contractor

Enclosures:
1. Deliverable Acceptance Review (YAR)
2. Responses to Review Comments
3. Preliminary Draft -"Total System Performance Assessment - Viability Assessment Methods and Assumptions"

cc w/encl 3:
R. D. Snell, M&O, Las Vegas, Nevada
L. R. Hayes, M&O, Las Vegas, Nevada
R. W. Andrews, M&O, Las Vegas, Nevada
A. E. Van Luik, DOE/YMSCO, Las Vegas, Nevada
H. A. Dockery, M&O/SNL, Albuquerque, NM
J. A. Gauthier, M&O/SNL, Albuquerque, NM
J. A. McNeish, M&O, Las Vegas, Nevada
S. D. Sevougian, M&O, Las Vegas, Nevada
J. T. Sullivan, DOE/YMSCO, Las Vegas, Nevada
M. L. Wilson, M&O/SNL, Albuquerque, NM

cc w/o encls:
S. L. Klapproth, M&O, Las Vegas, Nevada
K. K. Shrivastava, M&O, Las Vegas, Nevada

November 7, 1997

PA Response to
MTS Review of
Total System Performance Assessment - Viability Assessment (TSPA-VA)
Methods and Assumptions, August 13, 1997

Note: The PA response to MTS comments is provided in "bold italics".

GENERAL

1. The document would be easier to read if the figures followed their first citation in the text, rather than being grouped together at the end of each chapter. Surely, document production methods would allow for this courtesy to the readers.
   Good suggestion, however, it won't be implemented in this version.

2. Several portions of Chapter 7 would be better towards the front of the document (perhaps in Chapter 5). Several of the Chapter 7 sections are introductory type material (Information Flow, Treatment of Uncertainty and Variability, Weighting of Alternative Conceptual Models, TSPA-VA Base Case and Most Probable Behavior). The Alternative Design Case should also be moved towards the front and split into two parts: The Reference Design and Alternative Designs that will be considered in TSPA-VA. This would better inform the reader as to why the Sections in Chapter 6 are constructed as they are. The discussion of Sensitivity Analysis for TSPA-VA should also be moved up front.
   The reference design section will be moved forward as suggested. As far as Ch. 5 vs Ch.7, Ch. 5 is intended to be general in nature and Ch 7 is intended to provide more detail.

The TSPA-VA Methods and Assumptions Document was reviewed from an engineering perspective to determine the degree to which TSPA-VA will utilize waste form and EBS/WP data consistent with and relevant to the VA Design and associated analyses.

3. <u>Reference and Alternative Design Concepts</u>:

The Document should summarize and reference the baseline and alternative EBS/WP design concepts to be analyzed for TSPA-VA including thermal loading, materials, dimensions, relevant features, and quantities of waste packages, inverts, drip shields, etc.
To the extent we have compiled this information, it is included. Some details have not been worked out, so we acknowledge there is some information missing.

The Methods and Assumptions Document will eventually have to clearly state (or reference) which EBS/WP parameters and values will be used in TSPA, to the extent the data are available,

and demonstrate (or reference) consistency between this information and the VA Design Product. *No additional comment required.*

4. Criticality:

According to the Document, TSPA-VA will evaluate the dose-related consequences of criticality events for (a) degraded SNF within the waste package, (b) accumulated fissile material in the repository block (near-field), and (c) accumulation of fissile material outside the repository block (far-field). The criticality scenarios are part of a larger sensitivity analysis of repository performance to disruptive events.

The Document should note that 10 CFR 60.131(h) precludes criticality "unless two unlikely, independent, and concurrent or sequential changes have occurred in the conditions essential to criticality safety". The Document should also note that the criticality scenarios developed for TSPA-VA are somewhat contrived for the purposes of studying the consequences of a criticality event rather than resulting from conditions predicted by TSPA-VA analyses.
Added explanation of 10 CFR 60.131(h)

EXECUTIVE SUMMARY

5. The executive summary should include some discussion of the Interim YMP Requirement and Goal (discussed on page 5-2). *Done*

6. Page ES-5, first paragraph, second line: constructed is misspelled.
Corrected

1.0 VIABILITY ASSESSMENT FOR YUCCA MOUNTAIN

7. p. 1-1, 1st para, line 8 - The EPA and NRC set regulatory standards, not "objectives." Change word to reflect that these are not *objectives* that we'd like to meet, but *standards* that we must meet. *NO CHANGE, the word "objective" is commonly used in this context.*

8. P. 1-1, 3rd para, line 9 - The NWPA requires the first repository to contain no more than 70,000 tons of fuel, not 70,000 tons exactly. Suggest the wording be clarified to reflect the language on which this statement is based. *CHANGE TO "no more than 70,000 tons"*

9. Section 1.1.2 Title - Regulations are not guidance, the establish legal requirements. Call this "Evolution of Regulatory Requirements" or something like that. Don't suggest that the regulations are only guidance. ***NO CHANGE, guidance is appropriate in this context, defined as "to regulate, to give direction".***

10. P. 1-2, 1st full paragraph - This description of the 960 siting guidelines does not accurately portray the Guidelines. The conditions are "favorable" and "potentially adverse" - not "unfavorable." The quotation marks suggest that this text quotes the regulation verbatim. ***Take Quote Marks out***

    The discussion of higher- v. Lower-level findings is probably less important that the structure of the guidelines in terms of favorable and potentially adverse conditions, qualifying and disqualifying conditions, and technical v. system guidelines. Since the ESSE (described only as "Younker etal") was never accepted as a DOE document, the recommendations are unsupportable as DOE findings. Keep the discussion to the EA higher-level findings and current status. ***NO CHANGE, I believe leaving this information out is unreasonable. The section simply states what is in the document. None of the TSPA's are DOE documents, either, but we still make decisions based on their results.***

    Test Prioritization - the formal rituals that the Project has gone through to prioritize testing have not, generally speaking, born fruit. Moreover, TSPA itself seems generally recognized as the best and most effective prioritization engine that the Project has. My suggestion, I realize, boils down to emphasizing why and how TSPA is used to prioritize information needs and guide testing (the feedback to site & design), rather than dredging up decision analysis and other schemes that have tried to fill the same role. This discussion would get to the heart of what we do with TSPA results and where one of the roles of TSPA leads. ***The project has spent time and effort on these other methods, and they, in turn, used PA to help guide their decision, to some extent. The intent of this discussion was to provide a historical perspective.***

11. P. 1-2, 2nd paragraph - The LA would not have followed a formal suitability determination, the site recommendation process would have, then the LA. Moreover, following the description of ESSE, it sounds like a formal suitability determination can't or won't be made. This description of the regulations either needs to be more focused and clearer, or deleted from this document. The discussion of the Part 60 requirements, as the next paragraph acknowledges, includes the 40 CFR 191 requirements that no longer apply to YM. Suggest this be condensed into a discussion of the relevant

requirements, as best as we know them. In number (3), don't say "ensures" Part 60 is very clear on the use of "reasonable assurance" as opposed to any form of complete assurance. ***Modification made to text for clarification.***

12. P. 1-3, Section 1.1.3 - Because these interim requirements are purely an internal convenience for designers and have no real legal standing, suggest that this section be deleted. TSPA itself needs no standards to proceed and some audiences may be confused by the discussion of pseudo-standards. ***Paragraph rewritten to accomodate essence of the comment.***

13. Page 1-3, Section 1.1.3: What will be compared to the Interim YMP requirement of 25 mrem/yr (e.g., the best estimate peak dose, the 95th percentile)?
Described in Subsequent Chapters

14. Section 1.2 - The SCP does not require anything, it proposes. The Project did not stop following the SCP strategy, particularly in 1996. DOE is still obligated to manage the SCP program. The strategy was revised in the 1996 Program Plan before it became the 1996 Program Plan. Include a full discussion of the evolution of the Program Plans.
Change word Requires to Proposes

15. Section 1.2, 1st para. - It also makes no sense to reference "efforts" made to prioritize the "massive number of recommend studies. First, this contradicts the statement about the SCP *requiring* completion of activities. Second, since these efforts sound like they were generally failures, why bring them up at all? If one or more of them succeeded, explain which one, and how. ***Change Wording, Put Period after "Scp", Change next Sentence to Read "Several large scale activities were undertaken to help re-prioritize the massive number of studies recommended by the SCP, using updated information.***

16. Section 1.2, 2nd para. - Be very careful with discussions of recent funding. The FY96 decreased and the "expectation of lower future funding" mainly in comparison to the outlandish requests from the 1994 program plan. ***Funding wording removed***

17. P. 1-4, 1st para, last line - It's hard, after nearly 20 years, to think of the VA as an "early" step on the path to LA. ***Early step wording removed***

2.0 TSPA-VA

18. Page 2-1, Section 2.1, first paragraph: What defines the "appropriate level of complexity?" It is stated better on page 2-3, first line.
Forward reference to section 2.3.1 added.

19. Page 2-1, Section 2.1, second paragraph: "... the assessments can be used to advise licensing efforts." I though TSPA would be more of an integral part of licensing, rather than just advising licensing. Won't the TSPA-VA results be used to direct future testing/studies and ultimately be used as the safety case in the license application. ***NO CHANGE. TSPA will only be a part of the what directs future work.***

    Fine, I only thought that TSPA would be a very important part of the licensing effort. I was only suggesting re-wording so as not to sell TSPA short. ***Minor change made to text to refer to site recommend-ation and assisting in licensing.***

20. Page 2-1, Section 2.1, fourth paragraph: "... YMP TSPA analyses *correspond* to key elements in the WCIS." I believe that *correspond to* should be replaced with *support*. This gives me an impression that the models used in TSPA are based on the WCIS, rather than the TSPA analyses will support the statements in the WCIS. ***NO CHANGE***

    I still do not agree with the sentiment of this paragraph as written. How can individual components of the TSPA analyses correspond to the key elements of the WCIS? To me, it reads like the models are being fixed based on what is in the WCIS. For example, it reads as if the models will 1) have low seepage flux, 2) have long-lived waste containers 3) have slow releases, 4) have slow/dispersed migration through the EBS, 4) and have slow/dispersed migration through the natural barriers regardless of what process level models indicate, but rather because that is what the WCIS says. ***Text modified to clarify. Elements changed to "attributes", which are specifically defined in the WCIS.***

21. Page 2-2, Section 2.3, first paragraph: I wouldn't use the word risk, rather I would state when the design/data is to be frozen for TSPA-VA and say that it may be possible that the most current information as of Sept. 30, 1998 is not included in TSPA-VA. ***Changes made to clarify.***

22. Page 2-2, Section 2.3, second paragraph: The definition of "probable behavior" needs expanding. From a PA modeler's perspective, this implies "best estimate" rather than a range of likely behavior based on uncertain data/models/etc. ***Explained in later chapter***

    Shouldn't it be defined here as it is the first place it is mentioned? It sure would make the document easier to follow. ***Current section 2.2 moved after 1.3. Text added to old 2.2 to bolster definition of probable.***

23. Page 2-4, first full paragraph: With respect to the preliminary chapters. In Figure 2.3-1 these are level 3 deliverables. As such, won't DOE get the opportunity to review and provide comments in addition to those from the M&O? ***FIGURE CHANGED***

24. Page 2-4, Section 2.3.2, TSPA Status and Documentation: Who comprises the internal audience to which the results and preliminary interpretation of the base case analyses will be presented, M&O or M&O and DOE? ***We don't know who will be there, of course DOE will. This type of information is in the planning system.***

25. Section 2.4, Importance of the TSPA-VA to the Nation. - Delete this section. Aside from the self-aggrandizement for the PA organization, this section presumes, based on preliminary comments, to know how the NRC and NWTRB will view the VA (and TSPA-VA) when it is finished. The YMP PA organization's "cognizance" of TSPA-VA's "high visibility" may reflect well in internal documents, but should be taken for granted by external audiences. Attempting to anticipate and downplay reactions from "concerned citizens" does not bolster the notion that PA is "actively soliciting" comments from a national audience. The schedule dates ("currently scheduled") offer too much detail about planning that is sure to change. This type of information is inappropriate to this type of document. ***Section title changed to reduce significance. Other minor changes made for clarification.***

26. Pages 2-8 and 2-9, Figures 2.3-1 and 2.3-2: Are the base case results going to be presented (1/30/98) before the preliminary chapters are completed (before 2/28/98)? I'm concerned that an understanding of the results will not be possible without an understanding of the models. ***NO CHANGE REQUESTED, however the schedule is as noted. Preliminary information/understanding of individual components must be developed prior to base case finalization, though final text isn't completed until later.***

3.0 HISTORY OF YMP PA ACTIVITIES

27. P. 3-1, 3rd para. - This discussion of design evolution seems out of place and potentially confusing to the reader. Specifically, it does nothing to explain the reasons for these changes or provide documentation or references. Section 3.1 should focus on PA history and not try to capture broader changes within the Project. ***DISAGREE, NO CHANGE***

28. Page 3-1, Section 3.1, third paragraph: Is a common mode failure of multiple waste packages possible? This process is not discussed anywhere else in this document. ***Common-mode failures will be addressed as the scenario analyses indicate their importance. A statement to that effect will be added to section 7.4 (or the new design section)***

29. P. 3-2, 1st full para - "If the new regulations, when repromulgated...." - Basing technical (TSPA) or regulatory compliance strategies on presumed regulatory changes does not

seem to be a defensible way to argue C-14 releases. Changing TSPA models and analyses to reflect expected standards again seems to presume too much. In terms of regulatory compliance, it is probably better to explain that TSPA can and will accommodate possible changes in the terms of the standards (releases, doses, risk). Delete this paragraph. ***DISAGREE, NO CHANGE***

4.0 COMPONENTS OF TSPA

30. Page 4-1, Second paragraph: I would suggest separating the geosphere and biosphere elements into two. ***Ok - done***

31. Page 4-3, First full paragraph: I may be wrong, but won't TSPA-VA include some DOE fuels and navy fuel? If so, this should be discussed in here and further in Section 6.5. ***OK - done***

32. Page 4-3, Section 4.1.2, second paragraph: Will the drip shield delay the initiation of corrosion? I would think that humid air corrosion would initiate regardless of whether a drip shield is present or not. ***Can delay aqueous corrosion, not humid air. No change.***

33. Page 4-4, third paragraph: Does the assumption that seepage into the drift will be a small fraction of the total flux account for drift collapse? ***Yes, some text added to state so.***

    Are you sure that when the drift collapses that this assumption will be valid? ***We are reasonably certain in how the system will work after collapse, but clearly there is large uncertainty.***

34. Page 4-5, second paragraph: Should discussions of potential colloid facilitated transport and fast transport pathways be included? ***No - discussion is very general. Detailed issues like colloids discussed in Chapter 6.***

    I agree that this is a general discussion, but these are hot issues. I believe that it may be better to inform the reader that these processes are being considered in a general type discussion rather than making them read through the details in Chapter 6. ***Additional text to note these 2 factors.***

35. Page 4-5, last paragraph: Inhalation and direct exposure should also be identified as biosphere pathways. ***OK - sentence added***

36. Page 4-7, Section 4.2.2, first paragraph: presence is misspelled. ***OK***

37. Page 4-8: A good discussion regarding the failure of the waste package is provided in this section. Then the beneficial attributes of ceramic coating and drip shields is presented. Should a discussion of the failure mechanisms for these components be presented. I realize that they are in the preliminary stage of investigation, but equal weight is warranted in the discussion. ***No - discussion is very general & focused on the reference design. Design alterations are simply mentioned.***

Fine, but it just begs the question of how these wonderful barriers may degrade and approximately how long they will last. ***No need for further change, per M. Nutt.***

38. Page 4-9, first full paragraph: Again, does the low probability of seepage into the drifts account for drift collapse. ***Yes, text added to respond to comment 33.***

Are you sure that when the drift collapses that this assumption will be valid? ***See additional response to comment 33.***

39. Page 4-12, first paragraph: I wouldn't refer to disruptive events as "unexpected." Rather, I think the words "disturbed" and "undisturbed" or something similar may be better (although it could be confused with the disturbed condition resulting from waste emplacement). I don't believe that "unexpected" is the proper term. Just because they have a low probability does not imply that they are unexpected. ***We wanted to indirectly note probability. We have disturbances we do consider (e.g. T/H, T/C). We will keep "reported" and "unexpected"and solicit feedback from NRC.***

It's semantics and I really don't have a problem with it. I was trying to make life easier for the reader. Its just that I have never read or heard of a disruptive event being termed as "unexpected." I have seen the terms credible or incredible used to identify the level of probability, but not "expected" vs. "unexpected." I've always seen nominal vs. disturbed behavior used. I'm also leary that "expected" can take on too many meanings. ***Added "low probability" after "unexpected".***

40. Page 4-14: "... which are applicable for undisturbed/nominal/"expected" performance." I would pick "undisturbed" as discussed in the previous comment. ***Wording modified to equate nominal and "expected".***

Fine, see above comment

5.0 TSPA-VA GENERAL APPROACH AND METHOD

41. Page 5-2, first paragraph: Should ceramic coating be included in this discussion along with the drip shield. It is elsewhere. ***Ok - done.***

42. Page 5-2: Is there a probability level associated with the Interim requirement and goal? I don't think the DOE defined one, so will the TSPA-VA assume one?
"Expected" assumes 50% probability. TSPA-VA will not define one, though we expect the summary of VA products may.

Now I'm confused. It seems to me that either best estimate runs are going to be compared to the interim goal or that nothing will be compared to the goal. The former seems to indicate that only expected value runs will be compared to the standard. This raises some issues such as uncertainty is neglected and how "expected" is the "expected" peak dose. If the latter is used, then who gets to determine how well the repository is performing. I believe that DOE and M&O should work together to identify a probability level. ***No additional change requested at this time, per M. Nutt.***

43. Page 5-2, last paragraph: goal is misspelled. ***Ok***

44. Page 5-3: I would delete the phrase "... and the rationale for deciding when sufficient analyses have been performed to allow us to proceed to the next activity." I could not find the rationale in the subsequent sections. Will sufficient analyses ever be conducted for such a project? In some instances I would bet that the rationale is either a deadline or not enough resources. ***Ok - done.***

45. Page 5-3, footnote: I seem to remember seeing the word *abstraction* before here. Shouldn't this footnote be at the first location that this word appears? ***No - it's ok to be slightly repetitive.***

This isn't repetition. I'm saying that the footnote should be where the word abstraction first appears. The reader shouldn't have to get to chapter 5 to read the definition of abstraction. ***Footnote copied to original section 2.3.***

46. Page 5-4, Section 5.2.1: Regarding expert elicitation, should the document state that all expert elicitations were conducted in accordance with the NRC BTP? ***No - that's a detailed discussed in expert elicitation documents.***

Fine, but it's an easy sentence to alleviate a potential question. ***Sentence & reference added.***

47. Page 5-4, Section 5.2.2, first paragraph: Again, from a PA modelers perspective the

words "probable behavior" mean "best estimate." ***Agree in principal, but "probable" is placed in quotes to acknowledge the uncertainty that must be qualified.***

The quotes didn't imply that to me. I understand what your reference case is, but outside readers may not. There are pseudo-standard terms that are used throughout PA (besides this project). Some have even been defined by YM work. I suggest using these phrases consistently throughout this and the remainder of the VA documentation so external readers can understand what we mean. ***No additional change required, per M. Nutt.***

48. Page 5-4, Section 5.2.2, second paragraph: A discussion regarding the uncertainty in the models themselves is warranted. ***This discussion occurs later and throughout Chapter 6.***

A simple sentence in this section would have sufficed. You are talking about process level models. Simply state they are uncertain as well. This is a general discussion section, so only a general statement is warranted. Don't make the reader have to wade through the details in Chapter 6. ***Additional text on conceptual model uncertainty was added.***

49. Page 5-5, Section 5.2.3, second paragraph: Again, I would stick with "disturbed" and "undisturbed" as discussed in previous comments. ***No - want to make distinction based on low probability.***

Disagree, but its only semantics. See previous discussions. ***No change required, per M. Nutt.***

50. Page 5-8, second paragraph: See previous comments regarding the words "probable behavior" and "expected." ***That's why we use quotes to distinguish this is not simply the 50th percentile of the 50 percentile models, parameters, etc.***

The quotes don't imply this. They may to you, but it doesn't to me, and I'm inside the project. It will (and does) read as expected value runs to others. ***Added phrase to reference "probable behavior" to VA objectives.***

51. Page 5-13, fourth paragraph: The word "parameterize" warrants a definition. ***Ok - done.***

52. Page 5-14, last full paragraph: I don't believe that the inclusion of spatial variability necessarily makes the analysis less transparent. If processes vary spatially and the variability can be quantified/modeled, then it should be included. All that really needs to be documented is to state why the variability exists, describe the variability, and describe

how it is being modeled. *Agree - but confidently quantifying the variablility in a manner that stands up to public/regulatory scrutiny is the test for transparency, that is a difficult task.*

53. Page 5-15, Section 5.5, first paragraph: See previous comments regarding the word "probable behavior." *Again quotes indicate we are not looking at 50 percentile behavior.*

See above discussions. *Modification in chapter 2 defined probable behavior. No additional change here except reference to VA objectives.*

6.0 SUMMARY OF MODEL ABSTRACTIONS IN TSPA-VA

54. Section 6.1, Unsaturated Zone Flow: I have concerns with using TOUGH 3-D flow fields directly in the TSPA-VA and the use of the FEHM particle tracking algorithm. These have previously been identified and are discussed in subsequent comments. *No response called for. Concerns are detailed in following comments.*

55. "The major UZ-flow assumption for TSPA is that the LBNL model (Bodvarsson et al., 1997) is an adequate representation of flow in Yucca Mountain" (page 6-7, Major assumptions). What is an adequate representation? If a 3-D representation is important, what value is the model if data is not sufficient to obtain a calibration in 3-D. Calibrated to what? With limited or no data available, the uncertainty is less if the model is very simple. More uncertainty is introduced in the results through the use of a complex model based on mental images with little information to evaluate one mental image against another. The use of a complex model in this situation appears to be a false sense of security and a weak link in the overall modeling chain. *A multipart comment:*

"What is an adequate representation?" A representation of UZ flow that fits the available data and can encompass the important uncertainties.

In my opinion, this can be done with a much more simpler model. *"[W]hat value is the model if data is not sufficient to obtain a calibration in 3-D." We do have calibration to the available data. Insufficiency of data means that the calibration is not unique. This is discussed in the text.*

So, how will this be treated in TSPA space? This is definately modeling uncertainty. How is this type of modeling uncertainty to be modeled. If you stick completely with the LBL UZ flow fields, it cannot be included. How is the recommendations in the UZ transport deliverable regarding transport in the Calico Hills being entirely in the fractures

with the current data set going to be addressed? Will flow fields be developed where hydrologic properties in the Calico Hills are varied going to be provided with a still calibrated model? ***"Calibrated to what?" A list of types of data that are available and that go into the UZ-flow model is given in the first paragraph of Section 6.1.3.***

But, the calibrations are limited to matrix properties and pneumatics. There is an awful lot to the model that is not calibrated. ***"...the uncertainty is less if the model is very simple." This statement is certainly not true. How can uncertainty be reduced by modeling assumptions? If this statement were true, perhaps we could use the simplest possible model and have no uncertainty left! What is true is that a very simple model is easier to understand. However, it is not necessarily easy to implement. That is, frequently the input parameters in a simple model are quantities that are not easily obtainable. They can be obtained from runs of a more complex model, in which case you might as well just use the complex model. Or they can be obtained by some sort of expert judgment, in which case your model is another step farther removed from actual data.***

Poor statement on my part. What was implied was that with sparse data, complex models do not always result in more "accurate" answers. I believe that a simple UZ flow/transport model would be significantly easier to implement in TSPA space, would bound and adequeately "describe" (there's that bad word again) UZ flow and transport. The input parameters for such a simple model are based on process level model results, with uncertainty explicitly included. Remember, process level models themselves are abstraction to reality and alternative conceptual models exist. The inputs to these process level models are themselves uncertain and not well known. The last statements in this response are exactly what is being done with the rest of the TSPA models. ***The thrust of this comment and others seems to be that it would be better for PA to remain distant from site characterization and the models being developed by the site-characterization organization. However, we have put a considerable amount of effort into integrating PA with site characterization, and it is to the good of the project. In order to gain acceptance from the outside scientific community, first we are going to have to gain the acceptance of our own scientific community—the data gatherers and modelers in the site-characterization organization. As much as you or I might like 1-D models, they have always been deeply skeptical of them. And if we expect their help in defending the TSPA results (and we do), then we need to take their concerns seriously. While it is true that a complex computer model is not that easy to understand, "transparency" is really better served by using it rather than having a proliferation of models. The LBNL model has been and will be reviewed by outside experts, published in the scientific literature, etc., so it is more "transparent" to just use it. (With appropriate caution—for PA, we need to think more about uncertainties and alternatives than most scientists are used to.)***

Wrong. I believe that the PA models must be absolutely based on process level modeling, data, expert judgement, and a fundamental understanding of the system. Site

characterization information and process level modeling build the foundation of a good and defensible PA model. They help to understand and describe the performance of the system. Anybody who thinks that the LBL flow model is reality is not seeing the forest through the trees. It provides the best interpretation of UZ flow given the models and information we have now. But, this process model is an abstraction, the information is limited and so our understanding is uncertain. I have no technical problems associated with creating a very complex PA model. I believe it will give adequate answers based on the information available. However, I strongly believe that it is overkill, and that it will create more problems than it will solve. A properly abstracted simple model can be developed which the scientists will defend. This is being done in all other areas. I can see that continuing down this path will result in using a climate prediction model to calculate infiltration. TOUGH being used to generate flow fields (including the thermal pulse) for FEHM UZ tranpsort, followed by FEHM SZ flow and transport. WAPDEG will be used to calculate waste package degradation. WAPDEG will be linked both to both TOUGH and EQ3/6 to obtain temperature, relative humidity and geochemistry. This will feed a process level wasteform degradation model, which will feed an process level EBS transport model. Finally, at the end, GENII will be used to calculate the doses. A year to build the model, a year to run the model, a year to process the results, a year to document, and a year to explain. This does not sound very transparent to me. However, I believe a simple model could be developed to do this. This all revolves around a difference of technical opinion. As I said above, I have no technical problems with the approach (just overkill). I wish the M&O the best of luck in developing this model. However, I feel the approach is risky. ***We understand the comments, and are addressing them using an alternative approach, Plan B, to model the UZ which does not require use of FEHM directly.***

56. One of the values of using an abstraction model is to obtain a large number of results in a short amount of time in order to influence decisions. "An important consequence of using a complex 3-D flow model is that the number of different cases that can be run is limited-" (page 6-8, last paragraph). Are we missing something here? The idea to not use an abstraction model could *be shooting us in the foot. In the eyes of many in the scientific community, the choice boils down to many runs of an incorrect model vs. a few runs of a correct model. The many runs of the incorrect model are useless. The approach laid out in this report is intended to combat such perceptions.*

See above discussion. I'm not convinced that the process level model is correct or that an abstracted model will be incorrect. Process level models themselves are abstractions and you are using abstractions for all other aspects of TSPA. Are you implying that these abstractions are incorrect? Consider UZ TH. Is using center and edge conditions as the representation of the entire repository truly correct? Probably not, but if it is shown to be

an adequate abstraction, use it. Is WAPDEG correctly going to model waste package degradation? Probably not, but bounding abstractions can be made. ***No additional response necessary, per M. Nutt.***

57. Regarding the phrases "descriptive" PA, which seems to get a lot of negative press in this document, "... the degree of complexity increases. While this is a desirable trait...," and other such phrases in the document.

Given the complexity of the geologic system, the long time frames involved, and the associated uncertainties, it will never be possible to "explain" the performance of the system. The best we will ever be able to do is attempt to understand the system, describe its performance, and bound the expected range of performance. Site characterization data and the associated process level modeling are vital tools in helping us to understand sub-system performance. However, at present, they cannot "explain" the performance of the mountain. Lets take unsaturated zone flow for an example, although this relates to other processes as well. How does the model work? First of all, a conceptual model of UZ flow must be chosen. However, there are presently several alternative conceptual models and I would bet that there will be more in the future. In addition, a conceptual model, in itself, is an abstraction of reality and is a means to apply mathematical techniques to *evaluate* and *estimate the performance* of a real system. Secondly, the model is calibrated to a limited amount of site specific data. As stated in Section 6.1.3, "there is not enough data to identify a unique calibrated model - it is possible to fit the available data with multiple calibrated models." In addition, the degree of calibration is dependent on the analyst (i.e., no calibration standard exists) and the interpretation of the site characterization data. Additional site characterization data and/or different interpretations of that data could lead to widely different "calibrated" models. In my opinion, the process level models should serve to help identify what is truly important given the large degree of uncertainty that exists. These models should then used to identify bounds of sub-system performance and the dependence of sub-system performance on the truly important factors. From this abstracted TSPA models can be developed which include only the truly important factors and conservatively bound sub-system behavior. This approach is being done for the majority of the sub-systems included in the TSPA-VA (but not for UZ flow and transport).

I am also of the opinion that increasing the complexity of the models or the inclusion of detailed process level models (or their results) directly into a TSPA may not always be a desirable trait. First of all, given the system being analyzed, a highly complex model does not necessarily imply that the "right" answer will be produced (see above discussion). What it does imply is that "more horsepower" is being thrown at the problem. I'm not sure that such an approach would be all that transparent either. I believe

that a description of the process including the truly important factors, how the factors are inter-dependent, and a description of a simplified abstraction which is demonstrated to be bounding is far more transparent than stating "flow fields were calculated using TOUGH, which were input to a FEHM particle tracking algorithm which was linked to RIP." I think the former would convey to the audience that we truly understand how the sub-system performs taking uncertainty into account while the latter would raise more questions regarding the computer codes and models that were used. ***See responses to comments 55 and 56.***

58. Page 6-8, Abstraction approach: I am not convinced that this is the appropriate abstraction approach. In fact, for the most part I agreed with the approach taken in TSPA-95. I believe that the proposed approach could potentially decrease the level of transparency, could limit the flexibility of the TSPA model, increase the computational resources required to conduct the TSPA, and reduce the ability to analyze parameter sensitivity.

See comment above regarding transparency. As far as flexibility, consider this as a what-if question. What is the impact on performance if the actual fraction of flow in fast pathways is higher than that modeled? This would require that a TOUGH model be developed which increases the flow in the fast pathway (or a massaging of the flow fields from TOUGH to increase the fast pathway flow). This can be time consuming, as stated on page 6-8. The resulting flow fields would then have to be linked to the FEHM-RIP model and the code executed. This could potentially require a significant amount of time and coordination between LBL and PA personnel. With a RIP model similar to the TSPA-95 model and including a fast pathway pipe system, all that would have to be done is change one parameter (the fraction of flow going into the fast pathway). This would require at most 5 minutes to accomplish followed by execution of a fast PA tool.

It appears that roughly 10-20 flow fields may be generated. I don't believe that parameter sensitivity could be truly analyzed. Consider the example where three flow fields are generated where the only varying parameter is the infiltration rate. Given that only three points for infiltration rate will be sampled over a 100+ realization execution, would enough statistics exist to identify sensitivities? In addition, what parameters could be analyzed (infiltration rate, fracture/matrix interaction, some hydrologic properties)? Would it be possible to get at parameters that have typically been looked at in the past (i.e., percolation flux, matrix flux, fracture flux)?

Although only 10-20 flow fields may be sampled, wouldn't the TSPA analyses be conducted over at least 100 realizations? This would require that the transport calculations be conducted for the same number of realizations. I would suggest that:

1. the number of realizations required for a fully probabilistic simulation be estimated.

2. the number of radionuclides that will be tracked be estimated.

3. the time to conduct a fully probabilistic simulation using the coupled FEHM-RIP model be estimated (for the number of realizations and radionuclides from items 1 and 2).

4. the number of full simulations that will be needed for TSPA-VA be estimated, allowing for the likely occurrence of having to re-execute the code due to errors.

Based on this, an estimate of the computing time needed to conduct the TSPA-VA analyses can be developed. This can be compared to the available and projected computing resources to see if the TSPA-VA schedule will be impacted. ***See responses to comments 55 and 56.***

With regard to the example given, it is certainly true that a simple model can be more flexible and easier to examine a number of "what-if" questions. There is a place for such a tool, but there is also a place for more complex tools. TSPA-VA is the next-to-last step on the way to the license application. Is there really any reason that THE final set of calculations of repository performance for the license application should be quick and easy to do? It seems not unreasonable to me that THE final set of calculations might take months to run. Why skimp on the license application? TSPA-VA is an important step in that direction. If a simpler tool is needed, then let's develop it, too, but not to the exclusion of the kind of models we need to gain scientific acceptance.

I agree with the idea of developing a simple model in tandem. Perhaps you should consider it for VA. For LA, you won't want to run a bunch of cases as will be done for VA and between VA and LA. I believe a simple model will make your life a lot easier. I'm sure that you will be running your highly complicated VA model a lot between VA and LA and may need some rapid turn-around. Would a month of run-time cut it? As discussed above, I believe that the scientific community can accept a simple model if it truly captures the important processes. That is what you are doing with everything else. ***With regard to the comment about numbers of realizations vs. numbers of flow fields, our intent is to span the range of uncertainty with our limited number of flow fields. If resources were available to do more extensive sampling, we would only fill in the middle more completely, but not increase the range. Without being able to run large numbers of cases, we may not be sure that this is really true and we haven't overlooked something, but it is what we are trying to accomplish.***

All I was saying that is your senstivitity studies may not indicate much with a limited number of flow fields. Sampling at the extreme ends of a range may not provide an indication of how sensitive the performance is to flow parameters. Consider a scatter plot with the points at two ends of a range. It may be difficult to see any dependencies on such a plot. Statistical methods may not yield much information also. ***With regard to the suggestion that computing time be estimated, various estimates have been made, but we do not yet have the final models or know how long they will take to run.***

Surely you have a preliminary estimate of how long your executions may take. Apparently it is not going to impact your schedule? ***Comment noted, but no additional change required at this time.***

59. Seepage into the drifts is the result of a weak hydraulic connection between fracture flow in the TSw and the drift materials and a low flux through the host material. "There are no data available to calibrate such a model.." (page 6-9, second paragraph). Where is the reality check on the results of investigating the conditions under which water will seep into the drift? Are we going around in circles? ***The "reality check" on the seepage model will come from future testing activities. There is a short discussion of some of those activities in Section 6.1.4. There is nothing we can do about the lack of data other than try to cover the range of uncertainty in our modeling.***

Agreed. This model will drive system performance and will be an abstraction. Based on the above discussion, it will be incorrect. That I don't agree with. I hope it will have huge uncertainty bounds to capture the correct model. ***No additional change required, per M. Nutt.***

60. Page 6-16, first paragraph: Concerning the liquid phase flow fields below the repository during the thermal period. Should there be an explicit assumption in Section 6.7 which states that by the time the waste packages fail the thermal pulse will have passed or should a discussion be included as to how the TOUGH flow fields will be modified by the results from UZ TH (i.e. far field multipliers as defined on page 6-21)? The former assumption may not be entirely accurate while the second could serve to reduce transparency. ***It would not be appropriate to assume that no waste packages will fail during the thermal period, though certainly it is expected that very few (if any) would fail that early. We will certainly attempt to be "transparent" when we develop and describe the TH far-field multipliers.***

Then there should be some discussion in the UZ flow section regarding this. ***Text added concerning far field multiplier.***

At the top of page 6-16, change "The far-field information will be used to account for the effects of the thermal disturbance during the radionuclide-transport calculations."

To "The far-field information can be used to account for the effects of the thermal disturbance during the radionuclide-transport calculations."

Change the next-to-last paragraph on page 6-21 to:

Mountain-scale TH calculations will provide the gas-phase flow rate and air mass fraction at representative "center" and "edge" repository locations. Mountain-scale calculations might also be used to provide liquid-phase flow-field multipliers for the thermal period at locations beneath the repository to the saturated zone. These multipliers would be used to approximately correct ambient UZ flow fields for TH effects (for example, fracture flux would be increased when there is condensate drainage or decreased during a dry-out period). The TOUGH2 computer program (Pruess, 1991) is being used for mountain-scale TH calculations.

Lastly, a tie-in to UZ flow and transport. The last response from the MTS said that there should be some discussion in the UZ-flow section, whereas the original comment referred to section 6.7 (UZ radionuclide transport). On page 6-7, under the bullet "Steady-state flow", add the following:

Perturbations to flow caused by repository heating might also be included by means of a series of steady-state flows, with the flow perturbation modeled by multipliers to the ambient UZ flow, as described briefly in Section 6.2.5. Such thermohydrologic perturbations will probably be considered only in sensitivity cases, because the waste packages are expected to last through the period when flow is strongly perturbed.

61. Page 6-16, second paragraph: In the last sentence, besides changing the thermal properties of the drifts, rockfall could change the hydraulic properties of the drift. *OK, "and hydraulic" added.*

62. Page 6-18, first full paragraph: Delete the hyphen in per-meability. *OK*

63. Page 6-22, second full paragraph: Drift seepage is one example where a vitally important process is going to be modeled by a simplified abstraction (response surface) rather than by including a detailed process level model. It's not that I disagree with this approach, however it seems out of balance with the approach for UZ flow (which is equally as important and as uncertain). *One important difference is that a detailed far-field UZ-flow model has been developed by the project and is available for use. Detailed near-field modeling of UZ flow and seepage is in its infancy. Also, the probabilistic aspect of seepage is acknowledged even in the drift-scale process models, which are using geostatistical methods to describe the small-scale variability.*

Difference of technical opinion. In the end, I wouldn't be surprised if UZ flow doesn't make a whole lot of difference and drift seepage is a key process. ***No additional change required, per M. Nutt.***

64. Page 6-22, second full paragraph: This comment is in regards to drift seepage and also pertains to Section 6.1 (UZ flow) and Section 6.7 (WP degradation) as well. It appears to me that the assumption throughout is that rock fall will be more of an "event" rather than a process. In fact, rockfall is being treated as a sensitivity study in most cases. Discussions with an engineer within MTS has lead me to believe that within 500 to 1000 years, rock fall will be extensive. Thus, it seems to me that rock fall should be considered more as a process, in the baseline, rather than a postulated event considered only in sensitivity analyses. Are detailed studies of rock fall being conducted (or have they been) to quantify this process? Are detailed studies being conducted to investigate the impacts of rock fall on drift seepage and waste package degradation beyond those needed for sensitivity studies? It is apparently being included in the analyses of the thermal response (page 6-23). ***It is stated in Section 6.2.6 (as mentioned in the comment) that the drifts are only expected to last at most a thousand years, after which they will be filled with rockfall rubble. This concept is included in our "base case". However, we will probably simplify and approximate the filling of the drifts as a sudden event rather than a process that takes some amount of time. We are not aware of detailed studies of rockfall, other than calculations that have been done to determine how large a rock can fall on a waste package before it breaks. There are no detailed studies of impacts of rockfall on drift seepage or waste-package degradation. The effects of rockfall will have to be estimated by relatively simple methods, such as those used by Gauthier et al. (1996) (see the reference list for Section 6.10).***

Fine, I just wanted to make sure it was being considered. ***No additional response required, per M. Nutt.***

65. Page 6-23, second paragraph: I am unclear regarding the 101.5 kW/acre and the 90 kW/acre APDs. Is the former for the design basis and the latter for the average? ***As stated, the APD is 101.5 kW/acre, of which 90 kW/acre is from the commercial spent fuel. Therefore, the HLW glass has a heat output of about 11.5 kW/acre.***

You should have stated this and made life easier. ***Text modified for clarification.***

Change paragraph at bottom of page 6-22 and top of page 6-23 to the following:

The base-case subsurface design is specified for an areal mass loading (AML) of 85

MTU/ acre. This value remains constant in time. This mass-loading value included only the commercial spent nuclear fuel (CSNF). The defense high-level waste (DHLW) and DOE spent nuclear fuel (DSNF) are simply placed in between CSNF packages (M&O, 1997c). However, their heat output is included in t the TH calculations. The total amount of waste in the repository is 70,000 MTU, in CSNF, 4667 MTU in DHLW, and 2333 MTU in DSNF. (Include the rest of the paragraph unchanged).

Change the following paragraph (the first full paragraph on p. 6-23) to:

Waste package design specifies the base-case waste-stream information as well as an incorporation of the hotter "design basis" fuels for emplacement into the repository (M&O, 1997d). The design-basis fuels have much higher thermal outputs that the average waste package at the time of emplacement into the repository. Based on the decay characteristics of the base-case waste stream, the areal power density (APD) can be computed. The total initial APD is approximately 99 kW/acre, with 90 kW/acre in CSNF and 9 kW/acre in DHLW and DSNF. (Included the rest of the paragraph unchanged.)

66. Page 6-24, first full paragraph: Should this document discuss the EIS assumptions and analyses? If not, this paragraph should be deleted. ***It was decided by Bob Andrews that we should point out the additional design alternatives that will done for the EIS.***

Fine from my perspective. ***OK.***

67. Page 6-43, first paragraph: Is it assumed for NFGE that the invert is concrete (see Figure 6.3-3)? If so, is this assumption being considered in other models (i.e., EBS transport)? ***This is not really an assumption. It is a QAP-3-12 design input from Repository Design. Other PA models also use this design input, such as thermohydrology and EBS transport.***

Good, just checking for consistency. ***OK.***

68. Page 6-44: With respect to colloids. Won't colloids also effect radionuclide mobility in the EBS through higher "apparent" solubility limits. Will the affects of colloids be treated in either the Waste Form Mobilization and/or the EBS transport models as well? ***Colloids will not be treated as a dissolved species, but as a separate phase. We are explicitly accounting for the dissolved and colloidal components of radionuclide transport. At the time this document was written, colloids were to be considered as a sensitivity case in the various submodels, such as UZ transport, EBS transport, and***

waste-form mobilization (see Sections 6.6 and 6.7). If found to be important to performance, they may be included in the base case analyses.

Then add this to the document. All you say in this section is that colloids will be handled primarily in the UZ transport activities. I thought an elaboration such as the one provided in your response would be in the document. *The colloid case of the sensitivity analyses described in Section 6.6, was expanded slightly.*

69. Page 6-44: delete the extra period in the 17th line. *OK.*

70. Page 6-55: The section 6.4 title is Waste Package and Drip Shield Degradation. Yet there is no discussion of drip shield degradation what so ever. Since the drip shield is discussed several places in the document, a discussion of how drip shield degradation is going to be modeled should be included. In addition, since ceramic coatings are also discussed several places in the document, a discussion on how it is going to be modeled is also warranted in this section. I realize that these degradation models are only preliminary (if existent at all), but if they are going to be included in the TSPA-VA their modeling approach should be described. *Included paragraph on drip shield degradation, and ceramic coating degradation and how they will be modeled in sensitivity case description.*

71. Page 6-5, General Role: Figure 6.4-1 refers to the important components of the EBS at *emplacement*. Figure 6.4-1 appears to be how the drift will look after a long period of time after emplacement. Either the sentence or the figure should be modified. *Text modified to indicate the figure represents conditions after some degradation.*

72. Page 6-57, Section 6.4.3: I had a very hard time understanding what is in the current WAPDEG model, and what will be included in the version constructed for TSPA-VA. In addition, I'm assuming that the new corrosion models will be based on literature data, expert judgement, and the LLNL corrosion test results. This was not clearly stated in this section. *Section has been rewritten to clarify what is currently in WAPDEG and what is expected for TSPA-VA modeling.*

73. Page 6-58, fourth paragraph: A discussion of drip shield and ceramic coating modeling is warranted here. *Text added.*

74. Page 6-59, Carbon Steel Outer Barrier Corrosion: How will "pit" size be modeled? I seem to remember that this barrier would not truly "pit." Won't the size of the "pit" be important in determining galvanic protection of the inner barrier? *Some description is*

provided here, but document was not modified. Localized corrosion of the outer barrier is modeled in two different ways dependent on pH of water contacting the outer barrier: 1) high aspect ratio pits (here, the pits are true pits) when pH >= 10, and 2) crater-like variations of general corrosion fronts when 4 <= pH < 10.

For Case #1, the localized corrosion will be moded either with high "pitting factor (PF)" values (i.e., PF=1 to 10?) or pit growth power law (depth = k t^n, where k=constant, t=time, and n=constant from 0.3 to 0.7?). In this case, pit density, pit size, and their distributions will be modeled explicitly. For Case #2, the crater-like localized variations of the outer barrier corrosion will be modeled using the PF approach, but with much lower values (i.e., PF=1 to 1.5 or 2?), and pit sizes are not considered.

For Case #2, galvanic protection of the inner barrier by the outer barrier is not expected because the "throwing" power or distance of cathodic current from the corroding carbon steel to support the galvanic protection would be limited to short distances (up to about 1-2 cm according to WPDEE). For Case #1, galvanic protection of the inner barrier is expected because the "throwing" distances would be greater than the diameter (or width) at the bottom of the pits, but the duration of the galvanic protection would be from a few tens to a few hundreds of years according to WPDEE. So, in either case, the galvanic protection of the inner barrier would be marginal.

Thanks for the description regarding pitting of the CAM. My question wasn't aimed at the pitting model. All I wanted to know was whether the pit area would be provided. I think you answered it in saying that galvanic is not really expected and therefore pit size of the CAM won't matter. *OK.*

75. Page 6-60, Corrosion Resistant Inner Barrier: Define the three generic zones discussed in the key hypotheses. *Text added to clarify.*

76. Page 6-60, Corrosion Resistant Inner Barrier: Will the area of the failed waste container as a function of time and other factors be provided as an input to TSPA-VA? This is important for EBS transport. *Yes.*

Was this added to the document as an input to TSPA-VA? *It was already listed in "Output" in Section 6.4.1 and on Figure 6.4.2. Phrase added for clarification.*

77. Page 6-64, Waste Package Degradation Expert Elicitation: The phrase "expected to provide information" is used in the second and third paragraphs. I believe that the word "expected" should be changed to "will" as is in the first paragraph. *OK.*

78. Page 6-65: Will the pit size be a function of time? This is important for EBS transport. *No.*

So, a pit is being modeled as a cylinder? Will this area be constant or uncertain? *Text added in Section 6.4.6 to describe this.*

79. Page 6-66, Section 6.4.6, third paragraph: Some justification for moving away from the aqueous corrosion humidity cutoff should be provided. This is a different methodology than presented in TSPA-95 and should be justified. *The justification is that we are trying to more realistically implement an aqueous condition for corrosion by tieing it to the dripping, rather than tieing it simply to a certain relative humidity.*

I think the justification needs to be in this document. Note: not all experts concluded exactly this. Some provided a distribution of RH versus aqueous switch while others stated that salt deposits may be needed. How will these differences of expert opinion be considered? *Aqueous corrosion will also be initiated by RH threshold. Text added in Section 6.4.6 to clarify.*

80. Page 6-66, Section 6.4.6, fourth paragraph: This discussion should describe the number of waste package groups that will be modeled and should be consistent with the discussion presented in the UZ thermohydrology section (Section 6.2.5, page 6-21). *The number of waste package groups has not been fully defined, so can't be explicitly stated in this document.*

Then do something to be consistent with page 6-21 where there is a statement that TSPA will likely consider three packages of differing heat load. *No need for additional change, per M. Nutt.*

81. Page 6-67: A discussion on the treatment of waste package variability in the base case is needed. *This information is provided in the 4th paragraph of the base case discussion.*

I should have been a bit clearer. I meant variability on a waste package, not package-to-package variability. *No more change required.*

82. Page 6-67, second paragraph: This paragraph should be deleted. It could possibly give the reader the impression that the models being included in TSPA-VA are un-satisfactory. *Disagree. This information provides important caveats on the quality of the waste package modeling. It is a work in progress, not completed yet. Perhaps by LA, more robust models will be developed.*

Then there needs to be such caveats in this document for every model being considered. Nothing of this sort is mentioned for the other processes (i.e. drift seepage). I agree caveats are needed, but this type of statement seems to imply that this model is no good at treating variability. ***No more change required.***

83. Page 6-68: A sensitivity analysis, at least, needs to be conducted to quantify the effects of rock fall on corrosion. ***This is included in the mechanical effects of rockfall evaluation.***

84. Page 6-75, Table 6.4-2: The assumptions listed in this table should be referenced or just stated TBD as is done in Table 6.6-2. I don't believe that this document is where detailed modeling assumptions should be presented. ***Disagree. These are the planned inputs as far as we know them, and should be included in this document.***

Then reference where the distributions came from. ***Reference to WPDEE in table 6.6.4.***

85. Page 6-75: There are two pages for 6-75. One should be deleted. ***OK.***

86. Page 6-80, second paragraph: Should this document discuss the EIS assumptions and analyses? If not, this paragraph should be deleted. ***Yes, in recognition that the EIS study is going on concurrently with TSPA-VA.***

87. Page 6-82, Section 6.5.3: Should the ANL spent fuel dripping experiments be mentioned here? ***Steward is using this information in developing his model. Add sentence.***

I know, but others don't. I believe that mentioning ANL drip test data is being used will alleviate any questions from others. ***OK. Text added.***

88. Page 6-82, Section 6.5.3: Will the cladding model include the treatment of failed pins received from the reactors. ***Yes. Text has been added to clarify this.***

89. Page 6-84, Section 6.5.5: Clad failure is one example where a vitally important process is going to be modeled by a simplified abstraction rather than by including a detailed process level model. It's not that I disagree with this approach, however it seems out of balance with the approach for UZ flow (which is equally as important and as uncertain). ***We always try to do the best we can with the available data. Should we reduce all models to the lowest common denominator, i.e., should all models of all processes be reduced in complexity because we lack data on one particular model? The clad model is in a primitive state of development compared with the UZ flow model, thus we use a more simplified model due to lack of detailed process-level information.***

Fine, but again a difference of opinion regarding UZ flow modeling for PA. I think you will find that this model is vitally important. ***No need for additional response.***

90. Page 6-84, Section 6.5.5: It should be made clear that the "wetted surface area" in the fourth paragraph is equivalent to the "fuel surface exposure over time" in the second paragraph. ***They are not the same if the fuel is not wet.***

Do you mean to tell me that if the fuel surface area is exposed, you are assuming that it may not necessarily be wet? ***No need for additional change, per, M. Nutt.***

91. Page 6-85, first paragraph: The first sentence does not appear to be worded correctly.

Should radionuclide concentrations be replaced with radionuclide solubility limit? ***No, it's correct as is.***

Then I don't understand what you are trying to say. ***Text rearranged to clarify.***

92. Page 6-85, second paragraph: ANL should be defined as Argonne National Laboratory. The document should be checked to see that all such acronyms are properly defined. ***Corrected, and hopefully we caught them all.***

93. Page 6-86: Define 202 glass. ***Savannah River Laboratory 202 glass.***

94. Page 6-87, Section 6.5.6: Both the base case SNF and DHLW models need expanding. It was not possible to see how the information presented in Section 6.5.5 will be included in the base case. ***Section revised.***

95. Page 6-87, Section 6.5.6, last bullet: How is basket collapse going to be modeled? This was not discussed anywhere in this document. ***Text revised. Basket collapse will be modeled as degenerate failure of the cladding at a specified time.***

96. Page 6-100, Section 6.6.5: Although no abstraction of an external process level model is needed with this approach, a significant amount of information needs to be abstracted (i.e., flow rates, diffusion coefficients, porosities, diffusion connection lengths, cell volumes). This should be clearly stated. ***This information is shown in Table 6.6.2.***

97. Page 6-101, second bullet list, second bullet: Will these areas be provide by the waste package degradation model? ***Yes.***

Has it been added to your list? ***Text added to indicate will be evaluated in sensitivity***

study.

98. Page 6-102, first paragraph: Will the solubility limits on dissolved radionuclides be determined for all environments (i.e. in the waste package, in the degraded waste package material, in the invert)? A discussion of where solubility constraints will be applied is needed. ***Yes. Text added.***

99. Page 6-103, Waste package seepage: With regards to the drips on waste package model. Will this be considered to be applicable for an entire simulation. I could envision that after a period of time, sufficient degradation of the waste package would cause the corrosion products to lose their "barrier" effectiveness, resulting in a drips on waste form scenario. Is this being considered? ***Yes, time dependent "protection" from the waste package will be evaluated.***
Was this added to the document? ***Text added to base case description.***

100. Page 6-104, EBS material sorption properties: Will the sorption coefficients for dissolved radionuclides be determined for all environments (i.e. in the waste package, in the degraded waste package material, in the invert)? A discussion of where sorption constraints will be applied is needed. ***Yes. The paragraph indicates that these properties will be developed for all EBS materials.***

101. Page 6-110, Table 6.6-2: Solubility limit and partition factor assumptions should be listed on this table. ***Note added to table.***

102. Page 6-113, Section 6.7: I have concerns with the abstraction approach. I have expressed my concerns previously and additional discussion is provide in another comment. In addition, will this approach permit the evaluation of individual components of the UZ. For example, will it be possible to easily quantify the performance of the zeolite layer or to quantify the amount of mass transported through fast transport pathways?
Your concerns have been answered above. Also, this approach <u>will</u> allow us to quantify performance from individual layers and fast pathways—more accurately than an abstracted approach, since it is based more directly on the site-scale model.

I hope so and am looking forward to seeing how. Difference in technical opinion. ***No further change required.***

103. Page 6-113, Input: Shouldn't fracture/matrix interaction for radionuclides be listed as an input to the UZRT model? ***Text added.***

104. Page 6-114, Unsaturated Zone Flow: "... the base case flow model will encompass a

range of these parameters..." It should be stated that this range will be limited (i.e., only 10-20 flow fields will be provided. ***The range is not necessarily limited by the number of realizations. Two realizations are enough to encompass the range; only the data sampling within the range might be limited. We intend to cover the entire range—see our response to comment #58.***
OK, but your sensitivity analyses may not yield good information. Discussed above. ***No further change required.***

105. Page 6-114, Unsaturated Zone Flow: A good portion of this section (essentially all that is in brackets) should be placed in Section 6.1. ***Disagree. It is placed here to indicated that the DKM model for UZ flow is driven by the DKM transport model, i.e., the need to represent fast transport in fractures.***

This discussion is all about flow and should be in the flow section. Transport is in the fractures because flow is there. If flow could be represented adequately by ECM, then you would have an ECM transport model. Likewise, if in the end, a discrete fracture

model is needed for flow, a discrete fracture model is needed for transport. ***Text moved to 6.1.***

Take out the entire statement in brackets in the paragraph in question (the "Unsaturated-Zone Flow" paragraph on page 6-114) and add the following sentences to the end of the paragraph at the bottom of page 6-2 and the top of page 6-3:

The DKM conceptual model has the flexibility to represent almost the entire range of possible flow behavior, since by altering its parameter values the predicted behavior can change continuously from the ECM (which is dominated by matrix flow) to flow almost entirely within the fracture network. Also, rivulet flow within the fractures can be captured by means of the fracture-matrix coupling parameter, which is discussed briefly below.

106. Page 6-118, third paragraph: "... UZ transport will have to consider these uncertainties by investigating the effects of flow and transport parameter ranges and alternative conceptual models." Only very few flow parameter ranges will be sampled due to the limited number of flow fields. This could impact sensitivity analyses. What alternative conceptual models of UZ transport are being considered (none are presented)? ***As mentioned above, we intend to sample the entire ranges. Text added with respect to thermal models.***

I'm still concerned that your sensitivity analyses may not yield good information.

Discussed above. ***No further change required.***

107. Page 6-118, Section 6.7.4: In the first line "near-field geochemical environment" should be replaced with "unsaturated zone radionuclide transport." ***OK.***

108. Page 6-119, Section 6.7.5: Will the coupled FEHM-RIP model be able to handle changes in the elevation of the water table? ***Yes.***

Then the document should state such. I assume that you will have to have a number of UZ grids with associated flow fields in order to model water table rise. ***This is already stated in 6.7.5, under Transient Flow & Transport.***

109. Page 6-121, first paragraph: The sensitivity studies regarding transient flow and transport will be evaluated over 10,000 years and will include Np-237 (sorbing) and Tc-99 (non-sorbing). Is 10,000 years sufficient to identify any sensitivity for sorbing radionuclides? ***Text changed to reflect the fact that 1,000,000-year simulations will be run.***

110. Page 6-121, first paragraph: Has an alternative been considered if the abstraction that quasi-steady state approximations of long term transient conditions are not bounding? ***It seems that quasi-steady state is a good assumption. See Section 8.11 in YMP Milestone SP25BM3, August 29, 1997: "The Site-Scale Unsaturated Zone Transport Model of Yucca Mountain," by Robinson et al.***

I agree that using a quasi-steady state assumption is fine for using FEHM directly. My question is aimed more at the abstraction approach (convolution integral). Didn't Bruce have an action item from the Natural Systems status meeting to check to see if his convolution integral approach could handle climate change (and radionuclide chains)? What is the status of this? ***It's still in development.***

111. Page 6-123, Coupling of FEHM to RIP, first paragraph: In the discussion, it was stated that many TOUGH runs were conducted as a function of uncertainty in the flow parameters to support the abstractions for TSPA-95. Yet for TSPA-VA, the plan is to go with only a few TOUGH flow fields. It seems that rather than increasing the level of detail going into the analyses, it is being reduced. ***Text added to indicate that the TOUGH2 flow fields were generated in 1-D.***

112. Page 6-123, Coupling of FEHM to RIP, second paragraph: Every other model within the TSPA-VA will be descriptive and will be based on abstractions from process level modeling. For example, solubilities and sorption coefficients will be uncertain ranges, rather than detailed calculations based on the local geochemical environment. To me, the

sentiment in this paragraph is that such an approach may not be adequate. This may set a precedence for future TSPA analyses that if process level models are going to be applied for UZ flow and transport, they should be applied to all sub-systems. ***In calling RIP a "descriptive" model rather than a process-based or mechanistic model, I am referring to a quote from the RIP 4.05a Theory Manual that says " (RIP) describes rather than explains system behavior." This is based on the "top-down" modeling approached described in the RIP Manual. We are attempting to include a more bottoms-up approach as described in our responses to your comments 55-58. I do not agree that every other model in TSPA-VA will be descriptive. ("Descriptive" may be a poor choice of words.) For example the thermohydrology model is process-based. It is not run simultaneously with RIP, but because of the coupling that is possible when using "domain-based" abstractions (see Section 7.2.1.1) we may its output to the other domain models in the form of a response surface. The SZ model is not descriptive. It is a viable analytical model based on a convolution abstraction or simplification to the finite-element model. The EBS transport model is mechanistic model using the "cells" in the new RIP. As we approach LA and the greater scientific and public scrutiny it***

will entail, and as computers become faster, more and more process-based models become feasible and necessary for the various subsystems.

I disagree. Every other model in TSPA-VA will be descriptive. The convolution integral is descriptive: its just a breakthrough curve based on a process level model. You could do the same thing with the UZ. I believe that you could do the same thing with the RIP model as is being done with the convolution approach. UZ TH is also descriptive. You will be describing the temperature and humidity in the repository. You are not explaining it. The RIP cells approach is also an descriptive abstraction. Do you think that mixing cells are reality? Any response surface, distribution, etc. fed into PA is simply a description of the process. You are not explaining the process, only describing what its effects are. But, these descriptions should absolutely be grounded in process level modeling and data. As I've said before, throwing more horsepower, or going to a bottom-up approach, doesn't necessarily imply that you have a better answer or understand system performance any better. It only implies for sure that you have used a lot more CPU time to get to your answer. ***No additional change required.***

113. Page 6-123, Coupling of FEHM to RIP, third paragraph: I'm not convinced that the NRC had problems with the Markovian approach. It seems to me is that the issue was a difference in modeling approach. Whereas TSPA-95 allowed fracture/matrix interaction within a hydrogeologic unit, the NRC approach did not. This lead to conservative radionuclide transport velocities reported by the NRC as compared to the TSPA-95 base case. In my opinion, the NRC failed to consider the other scenarios presented in TSPA-

95 where fracture/matrix interaction was reduced considerably. In fact, if the NRC still has issues regarding fracture/matrix interaction, the FEHM particle tracking algorithm with matrix diffusion will not alleviate this concern. I could not find anywhere in the 1996 NRC annual progress report (NUREG/CR-6513) any recommendations that the TSPA needed to consider detailed flow fields. The NRC did recommended that additional realizations be conducted with the process level UZ flow model (which is not being done). As far as lateral flow goes, this is not an artifact of the RIP Markovian approach, but rather how the RIP flow system is put together by the analyst (i.e., a RIP model can include lateral flow if it is identified as existing in process level models). ***You said it: "if it is identified as existing in process-level models." Again this is the whole point of using a more process-based approach. Lateral flow in the RIP model can only be justified if found in the process models, which must be run first! That is what we are doing and incorporating directly in the TSPA-VA model. With respect to your statement "if the NRC still has issues regarding fracture/matrix interaction, the FEHM particle tracking algorithm with matrix diffusion will not alleviate this concern", I don't see your point. The particle tracker in FEHM can model any degree of matrix diffusion by changing the matrix diffusion coefficient. (Of course, we are still lacking on data to support the correct matrix diffusion in the UZ.)***

I never said that process level models do not need to be ran. They absolutely do and provide part of the foundation for a defensible PA model. It is the approach you are taking with every other abstraction. As far as the NRC goes, if they don't agree with the treatment of fracture/matrix interaction (i.e., don't believe that credit should be taken) FEHM will not address the problem. The issue is whether to take credit for fracture/matrix interaction at all. In their last IPA, it appears that the NRC did not assume fracture matrix coupling within a layer. You can use any matrix diffusion term with FEHM and still not satisfy the NRC if they claim that fracture/matrix interaction within a layer does not exist. ***No additional change required.***

114. Page 6-124, Coupling of FEHM to RIP: As stated in a previous comment, how will the thermally altered flow fields be treated? ***Please see Section 6.2.5, which describes the use of a multiplier on the ambient flow field.***

What I meant in this comment is that this is a good point to discuss how you will go about it. In Section 6.2.5 you state that the TH model will provide multipliers. This seems a good point to discuss how the flow fields will be manipulated when input to the RIP-FEHM model. ***No additional change required.***

115. Page 6-124, If the 3-D flow fields are impractical, then they must be reduced to 2-D. This, in itself, is an abstraction and in my opinion would reduce the level of benefit that is

claimed by directly using flow fields. ***Point noted, but it is an opinion, as stated.***

If you go to a 2-D representation, all of your above arguments and those presented in the document become moot. ***No additional change required.***

116. Page 6-135, second paragraph: The location of the water well is not defined by regulatory guidance. It is designated at 20 km by the YMP interim requirement and goal. ***Text changed***

117. Page 6-135, third paragraph: system is misspelled in the fourth line. ***Done***

118. Page 6-135, fourth paragraph: The punctuation in the first line needs corrected. ***Done***

119. Page 6-135, fourth paragraph: Delete the last sentence as this is discussed at length in the biosphere section. ***No changes; some repetition is OK.***

It is a biosphere issue, not an SZ issue. ***No additional change required.***

120. Page 6-135, fifth paragraph: I suggest that the second sentence be reworded. To me it reads as "disruptive events can potentially alter the saturated flow system. However, we don't know much about what will happen, so we are neglecting it." This is contrary to how PA should be applied. Potential altered systems should be postulated and their effects on the overall performance of the system should be quantified through sensitivity studies. ***We agree that all potentially significant alterations to the geosphere system should be evaluated to assess impacts to performance to the extent possible. However, our level of understanding of some of these potential alterations is so limited at this point that quantification of the impacts would be almost entirely speculative. Any meaningful evaluation of durable changes to the SZ system from thermal/chemical effects requires additional process-level understanding than is presently available.***

I agree, but just thought that the sentence needed reworded. It seems to have a negative connotation. ***No additional change required.***

121. Page 6-136, Section 6.8.5: I agree with the abstraction approach described for SZ flow/transport. However, it may be somewhat less transparent than utilizing a RIP "pipes" system that bounds the detailed SZ flow/transport calculations. It will also provide information at discrete points and a significant amount of time and resources could be involved in generating break through curves at different locations (i.e., Franklin Lake Playa during pluvial conditions). Some specific questions: How many flow fields

will be generated (i.e., over what range will a specific parameter be varied, will two or more provide sufficient resolution for sensitivity analyses)? Will varied well pumping rates be assumed to quantify their impacts on the flow system? Will the convolution integral account for radioactive decay chains? How will alternative conceptual models and modeling uncertainty be treated? How much time will be required to develop the breakthrough curves for every radionuclide being considered in TSPA-VA? ***The convolution method is not nearly as "transparent" as the one-dimensional methods used in previous TSPA analyses with the RIP code. However, a three-dimensional method is necessary to realistically assess dilution in the SZ transport process without making ad hoc, and, ultimately, indefensible, assumptions about mixing of groundwater.***

Developing the convolution integral follows basically the same approach that would have to be done for a RIP pipes model. What you are trying to do is develop a breakthrough curve based on a 3-D model. Rather than abstracting to 1-D, you will be essentially abstracting to 0-D. ***No additional change required.***

It is not presently known how many realizations of the SZ flow system will be required for TSPA analyses. The number of realizations depend on the distributions of input parameters that are still being developed. An estimate for the number of realizations is in the range of 100 to a few 100's. Varied well pumping rates will be considered in dilution at wellheads as described in the last paragraph of Section 6.8.5. The convolution method should be suitable for calculating decay chains; however, it may be possible to ignore ingrowth of radionuclides in SZ transport. Alternative conceptual models (e.g., transport in fractures only vs. matrix diffusion) will be incorporated in the distributions of parameters employed in the TSPA analysis. Breakthrough curves for various radionuclides can be developed simultaneously because multiple components can be traced in a single transport simulation.

122. Page 6-145, last line: Precipitation is not an event. *Reworded*

123. Page 6-149, second full paragraph: What source of information will be used to determine the various uptake factors (i.e., water to plant - plant to beef) and the dose conversion factors. I see the source of the DCFs discussed later, but it should also be presented here. ***Pointer added to a reworded Section 6.9.6***

124. Page 6-150: A considerable amount of care should be taken when using a probabilistic biosphere. Remember, the biosphere is the last model and all uncertainties in the biosphere relate directly to uncertainty in the reported dose. For example, an order of magnitude uncertainty in a certain biosphere uptake parameter will result in an order of

magnitude uncertainty in the dose for that specific pathway. This could potentially mask smaller variations resulting from other uncertain parameters. It may be difficult to discern any dependencies in models that are "deeper in the system" (i.e., EBS or geosphere models). *Noted.*

125. Page 6-150, Section 6.9.6, second paragraph: I thought that dilution at the well will be provided by the SZ flow and transport efforts (see page 6-137). *Yes. Pointer to previous section included.*

126. Page 6-151, second paragraph: The uptake of plants by animals also needs to be included. *Done*

7.0 IMPLEMENTATION OF THE BASE-CASE MODEL IN THE TSPA-VA CODE

127. Page 7-11, Details of EBS Source Term in RIP: The treatment of heterogeneous release within a waste package was not discussed in Section 6.6. I think it would be very hard to justify such a heterogeneous release model over long time frames. Is the waste package degradation model going to track the specific information needed for such a model? I did not get that indication from Section 6.4. *The exact details have not been worked out. The WP degradation model will be able to track such information, though we may not use it, if sensitivity analyses show the heterogeneous release is unjustified over long time frames as you suggest. Text added to the end of Section 6.6.3.*

128. Page 7-12, second paragraph: With regards to the drips on waste package model. Will this be considered to be applicable for an entire simulation. I could envision that after a period of time, sufficient degradation of the waste package would cause the corrosion products to lose their "barrier" effectiveness, resulting in a drips on waste form scenario. Is this being considered? *Footnote added. We intend to have a time-dependent EBS model which shifts to dripping through the WP at late time to account for barrier degradation.*

129. Page 7-13, first full paragraph: The statement applies to SZ flow and transport "However, calling the 3D FEHM finite-element model for each RIP realization requires too much computational time, therefore, an abstraction will be made." But, isn't this the approach that is being applied to UZ transport. Why the contrast? *The particle tracking algorithm (in UZ transport) is much faster than the finite-element numerical solution algorithm (in SZ transport) for transport.*

I thought SZ modeling used the particle tracker. Why not use FEHM particle tracker in the SZ as well? *Current plans are to use SZ ad-disp model with FEHM. Plan B is to*

use the cell approach in RIP.

130. Page 7-16, Will WAPDEG and the modified version of AREST-CT be verified? Will the saturated zone convolution integral routine be placed under sofware QC? *Yes.*

Then state it. While I'm at it, what about the code MING? *MING, MCNP, & GENII discussion added. SZ convolution may be under FEHM CMS, WAPDEG/AREST-CT may not be verified by TSPA-VA.*

131. Page 7-19, third paragraph: The current plan is not to create a continuous distribution of flow models, but rather to use a discrete number of flow fields. *Very true. However, the flow fields that are created will represent a range of behavior spanning the behavior predicted by a Weeps model to the behavior predicted by a matrix-flow dominated model. In other words, the DKM model being used for the UZ flow fields is flexible enough to simulate the various different behaviors of some of the models that have been called alternative conceptual models. Also, the conceptual issues being discussed in Section 7.3 have to do with discrete cases that have no basis for probabilistic weighting. If there is a conceptual probability distribution, even if it is composed of a finite number of discrete points (rather than being continuous), then there is obviously a basis for weighting. For example, we will have a limited number of infiltration cases, but weights for them will be defined, based on the UZFM expert elicitation. We might in fact end up with some flow cases that are kept separate and unweighted, but that is not yet decided.*

All I was looking for was a text fix. Still, you do not have a continuous distribution of flow models. You will have discrete points. You said above that you are only going to look at the ends of ranges. *No change required, per M. Nutt.*

132. Page 7-20, The definition of the Base Case and the Most Probable Behavior: This section was quite confusing. I really could not see what the base case will include. Won't the base case have uncertain parameters built in (e.g., critical humidity for corrosion initiation, varying infiltration, differing degrees of fracture/matrix interaction, etc.)? My impression of this is that the base case will have "the most likely or probable repository behavior." This sounds like a best-estimate PA run to me. I can understand and agree with leaving some alternative conceptual models and disturbed conditions out of the base case. However, I think the definition of the base case needs to be clear that uncertainty will be included. *Text changed for clarification. Table added to section for clarification.*