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August 5, 1998

Dr. Christopher G. Whipple, Chairperson
TSPA Peer Review Panel
ICF Kaiser Engineers, Inc.
2101 Webster Street, Suite 1000
Oakland, CA 94612

Dear Dr. Whipple:

Subject: Review of the Total System Performance Assessment (TSPA) Peer Review Panel's Third Interim Report

The Civilian Radioactive Waste Management System Management and Operating Contractor (CRWMS M&O) has completed a preliminary review of the TSPA Peer Review Panel's Third Interim Report. The purpose of this letter is to request clarification about some of the comments and recommendations that are contained in this report. We believe the Panel's comments and recommendations can be broadly categorized into three categories: (1) technical comments that can be addressed and resolved; (2) generalizations that are supported by a specific example, but could be interpreted to be widely applicable; and (3) comments that are based on the assumption that the reference design for the Viability Assessment (VA) will be carried forward unchanged as the reference design for the site recommendation/license application. We believe it would be useful to review these categories with the Panel during our upcoming meeting and would be interested in the Panel's feedback, specifically to comments in categories 2 and 3. Each category is summarized below.

1. Technical comments

The Third Interim Report provided many useful technical comments that will be evaluated and resolved. As an example, the Panel believes that TSPA-VA has not fully addressed the potential effects associated with a number of processes. Examples provided were: 1) coupled processes such as chemical and mechanical interactions in thermohydrologic analyses; 2) degradation of the drift with time and the effects this may have on waste package performance; and 3) dispersion and dilution of radionuclides in the groundwater, especially at early times when small source areas may be more likely.

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We understand the Panel did not have the opportunity to review the full set of supporting documentation developed for the VA and believe some of the concerns are addressed in this work. [Note: the final VA Technical Basis Document is just being completed and so was unavailable for review by the panel.] As you know, bounding-type sensitivity analyses of the potential effects of these processes were completed for the TSPA-VA. For example, bounding analyses of the effects of coupled processes were performed by varying the fracture characteristics of the rock mass around the drift opening. The chemical degradation of the drift liner was examined (Section 5.3) as were the mechanical effects associated with drift degradation (Section 4.4.3). Specific analyses, such as the effect of drift collapse on seepage, have not yet been performed. However, the extent to which drift degradation may be important to waste package performance will depend on whether backfill is included in the reference design for the site recommendation and license application. With or without backfill, the role of drift degradation will be investigated as we proceed with the next iteration of TSPA.

We agree with the Panel that the degree of dispersion and dilution in the transport modeling should be related to the fraction of the area of the repository represented by degraded packages. This issue will be addressed in the analyses planned for site recommendation and license application.

2. Generalizations

The Third Interim Report contains some broadly stated criticisms that we believe may have been intended to point to specific problem areas rather than global problems. For example, on page 47, the panel states that "one of the striking features of the TSPA-VA analysis is the lack of use of site-specific data." Examples cited in the report include lack of data in the saturated zone from Forty Mile Wash, on colloid transport, and on radionuclide plant uptake factors. The report also states that experimental data are needed to confirm the processes that control neptunium solubility and that data are insufficient to support selection of the materials for use in the final waste package design.

While we recognize that some of the TSPA-VA analyses are based on limited data, other analyses completed for TSPA-VA used a wealth of site-specific data, results of laboratory experiments, and information from the published literature. The unsaturated zone flow model was based on extensive surface-based geological and hydrologic testing, in-situ observations of thermal, chemical, and hydrologic indicators of water movement, and laboratory studies of the fundamental processes affecting water movement in fractured unsaturated media. In addition, a significant amount of laboratory testing has been conducted to evaluate the degradation characteristics and rates of

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degradation for the materials that have been proposed as candidate materials for the waste package.

We will carefully evaluate the Panel's comments on the availability of data, but we do not believe that the overall TSPA-VA analysis suffers from a lack of site-specific data as could be implied from the broader statement in the report. Moreover, additional site-specific data will be collected to enhance the current understanding in those factors that are considered most important to long term performance prior to development of the TSPA for the site recommendation/license application. These activities are identified in Volume 4 of the VA, which also was not available to the Panel for review.

We are concerned that these types of broad statements do not accurately reflect the overall quality of the TSPA-VA. The TSPA-VA was intended to provide a status of performance assessment activities and does not present licensing arguments. This leads to our third category of comments.

3. Assuming the VA reference design is the basis for the site recommendation/license application

The TSPA for the VA analyzes the probable behavior of the current reference design for the engineered components of the repository in the expected natural conditions at the Yucca Mountain site. It also includes sensitivity and uncertainty analyses to illustrate the relative importance of the various components and parameters in the TSPA, given the reference design for the VA. Over the next year, selection of the preliminary reference design for site recommendation/license application will include the evaluation of a broad set of alternative design concepts coupled with over 20 independent design features that could improve the performance of one or more of the design concepts.

In Volume 4 of the VA, the work planned between the VA and site recommendation/license application is prioritized based on a systematic review of the TSPA results to determine 1) the importance of each element of the repository system to performance, 2) the current confidence in that element, and 3) the potential confidence, or confidence goal, that could be obtained at site recommendation/ license application. Given this goal, the priority for additional work is established by comparing the current confidence to the potential confidence. This approach focuses the science and engineering work on those areas where substantial increases in confidence can be gained before submittal of the license application. However, as noted above, alternative designs are under consideration and some uncertainties may be accommodated through design solutions

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A Panel comment relative to this topic is found on page 14 – “there is a critical need to reduce the uncertainties associated with unsaturated zone flow and thermohydrology” If design features, such as a drip shield or ceramic coatings on the waste packages, are selected, this could limit the amount of liquid water contacting the waste packages and, consequently, the importance of reducing the uncertainties associated with unsaturated zone flow. The importance of thermohydrologic processes will ultimately depend on the thermal load selected for the design for site recommendation and license application. Therefore, the critical need to reduce uncertainties in thermohydrology will depend on the selected design.

As we move forward with the selection of the reference design for site recommendation and license application in May of 1999, the potential for compensating for uncertainties in process models for natural barriers by including additional engineered features, such as drip shields or ceramic coatings on the waste package, will be evaluated. A determination of the importance of each element of the repository system, as was conducted in Volume 4 of the VA, will be performed as part of the evaluation of the design to be carried forward to the site recommendation and license application. Additionally, the potential for enhanced performance through inclusion of such features was evaluated through sensitivity analyses in Volume 3 of the VA.

While we believe that the panel continues to provide evaluations that will improve the TSPA, the above discussions should give you a general impression of some concerns with this report. We believe that some of the comments that fall in categories 2 and 3 give a very negative impression of the analyses in the TSPA-VA. We would appreciate some clarification from the Panel on the intent of the comments and recommendations that fall in these categories.

Sincerely,

E.M. Weaver for
Jack N. Bailey, Director
Regulatory and Licensing
Management and Operating Contractor

Enclosure:

Selected Comments and Recommendations
in Categories 2 and 3

Selected Comments and Recommendations in Categories 2 and 3

Category 2 – Generalizations *

II-1. On balance, the Panel thinks that the overall degree to which the TSPA VA is non-conservative or conservative cannot be determined from the available information. (page 9)

IV-1. The Panel has observed that most members of the TSPA-VA staff appear to be well qualified, they are dedicated to the work they are doing, and Panel members have benefited from interactions with them. Unfortunately, for some issues, the same types of interactions do not appear to be taking place between the scientific staff that is providing input into the analyses and the staff that is developing the TSPA-VA. (page 45)

IV-2. The Panel is concerned that aspects of the repository program appear to be fragmented. For some issues, even in those cases where important scientific data are available, they sometimes do not seem to find their way into the TSPA system. (page 45)

IV-3. As in its previous reports, the Panel finds that the TSPA analysts are superficial in their consideration of coupled phenomena. A primary example is the treatment of chemical and mechanical interactions in the thermohydrological analysis. A more comprehensive consideration and analysis of the potential effects of such interactions is needed to confirm whether this approach can be justified. (page 46)

IV-7. One of the striking features of the TSPA-VA analysis is the lack of use of site-specific data, as well as an absence of adequate efforts to fill these voids. (page 47)

IV-10. Where the TSPA-VA staff has attempted to fill some of the existing voids through the conduct of experiments, there are questions in the approach and interpretation of the results. (page 48)

IV-11. The Panel notes that there are insufficient data and analyses to support fully or discard any alternative for a final waste package design from among the options being considered. (page 48)

IV-12. Compounding these problems is the over-reliance on the use of data generated by scientists working on the project, and only limited use of published literature. (page 48)

IV-15. An abstracted model should be applied only if the process-level model confirms that its use is justified. The Panel also recommends that reviews be conducted to assure the adequacy of the abstraction process as applied to the TSPA-VA analysis. (page 49)

IV-17. A key to the success of the TSPA-VA will be to integrate properly the abstracted models developed by the separate groups. On the basis of the reviews conducted to date, the Panel has reason to question whether this requirement is being met and whether the abstracted models accurately simulate the system they are supposed to represent. (page 50)

IV-19. There are several examples within the TSPA VA in which models have been applied without recognition of their limitations. One is the recent major change in the approach being used by the TSPA-VA staff to address flow in the Saturated Zone.....for many of the models, the required input data are either in question or non-existent. As a result, one could readily question the usefulness of the outcomes on any types of sensitivity and uncertainty analyses that are being conducted. (page 50)

IV-34. One of the primary problems in the TSPA, as now being developed, is that the analysts have "lumped" many types of uncertainty (e.g., data base, conceptual models, and boundary conditions over time and space). The net result is that the outcomes of the analyses may be inappropriately insensitive to some aspect of the actual behavior of the repository system. (page 54)

IV-38. The Panel has observed hesitancy on the part of the project to undertake supporting research in those cases where it may require several years to complete. A good example is the need for studies of the solubilities of neptunium-237, which is estimated to be one of the more important contributors to doses to offsite populations in the long time frame. Another example, more relevant to the performance within 10,000 years, is the interaction of technetium-99 with waste package corrosion products. This type of information is needed and the necessary research should not be delayed. The history of the repository project has clearly demonstrated that lack of adequate time is not a justifiable reason not to undertake research. (page 56)

IV-39. It has become increasingly clear to the Panel that, regardless of the approach, much of the necessary data will not be available in time to support the analyses required for the TSPA-LA. This is especially true in terms of certain important items relative to colloid behavior, canister corrosion, performance of irradiated cladding, solution chemistry, and certain aspects of the repository system, for example, the near field geochemistry. For this reason, the Panel believes that the TSPA staff should begin planning now on changes that need to be made to take these data needs into consideration. (page 56)

Category 3 – Assumption that the VA reference design is the basis for the site recommendation/license recommendation

III-A2. The Panel believes that there is a critical need to reduce the uncertainties associated with UZ flow and thermohydrology. (page 14)

III-B1. The Panel believes a comprehensive analysis of the coupled effects of the thermomechanical interactions surrounding the repository is needed to confirm that the TSPA staff can continue to neglect these effects. (page 17)

III-C1. The Panel notes that there will be important boundary effects due to the interaction of the in-drift chemistry with rock units immediately adjacent to the adit walls, probably extending for some meters into the repository rock. The thermal-

mechanical-hydrological-chemical interactions within this boundary are probably not captured by simply "handing off" output from the NFGC models to the UZ models. (page 19)

III-C2. The project staff should direct far more attention to gaining a better understanding of the near-field environment. An improved understanding of this environment could help them develop defensible limits for the source term, based on dissolution rates, solubility limits of dissolved species, or transport mechanisms (such as, release from partially corroded canisters). (page 20)

III-E1. It is essential that the project determine the dominant process(es) (precipitation, coprecipitation, sorption, etc.) which control Np concentration. This will necessarily require that the Np-bearing phases be identified in experiments. (pages 28-29)

III-E2. The Panel notes that at present there are only limited data on the structures and stabilities of the phases that form as alteration products of UO_2 . (page 30)

III-H1. The Biosphere section of the draft TSPA-VA does not provide answers to the fundamental questions that the Panel expected it to address. (page 39)

IV-8. Analysts do not appear to have attempted to use readily determined characteristics of the soil, such as the pH and clay content, as a mechanism for estimating site-specific K_d s. The Panel recommends that more effort be directed to identifying the likely chemical nature of specific radionuclides in the groundwater under Yucca Mountain and the specific values that should be assigned to the K_d s under the anticipated circumstances. (page 47)

IV-9. Although a significant effort has resulted in data on local (i.e., site-specific) food production and consumption, there is a lack of site-specific data for important parameters required for estimating doses. Lacking specific data on radionuclide uptake by various plants, careful analyses of the soils in the Amargosa Valley would provide the basic information for estimating such uptake factors. More effort should be made to obtain site-specific data, for example, on soil to plant uptake factors. . . . careful analyses of the soils in the Amargosa Valley would provide the basic information for estimating such uptake factors. These types of approaches need to be explored. (page 47)

IV-32. On the basis of its review, the Panel has concluded that the current treatment of SZ flow and transport in the TSPA-VA is not satisfactory. (page 54)

IV-35. The TSPA-VA staff has not recognized, or at least they have not provided adequate consideration of, the uncertainties associated with the multitude of factors necessary for estimating dose rates to the public. (page 55)

* Please note that the identifiers assigned to the various comments and recommendations (i.e., II-1; III-H1; IV-15; etc.) are not intended to run in sequence. Those category 2 & 3 comments and recommendations listed above were extracted from the overall suite of issues identified within the report, each of which was assigned a unique identifier to assist in coordinating the overall M&O response.