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May 16, 2007

The Honorable Dale Klein, Chairman  
The Honorable Edward McGaffigan, Jr.  
The Honorable Jeffery Merrifield  
The Honorable Gregory Jaczko  
The Honorable Peter Lyons  
US Nuclear Regulatory Commission  
Washington, DC 20555-0001

Dear Chairman Klein and Commissioners:

On March 29 and April 10, 2007, I wrote to Chairman Klein to express a serious concern about whether NRC Staff's review of the Yucca Mountain Total Systems Performance Assessment (the so-called "TSPA-LA"), to be included in DOE's license application, could possibly be adequate given the apparent inability of any third party, including NRC Staff, to execute it independently. The Chairman delegated the response to NRC's Director of NMSS, Michael F. Weber, and he replied on May 7, 2007.

Mr. Weber confirmed our worst fears that NRC Staff was preparing to abdicate its review responsibilities over the TSPA and accept the system simply as DOE's black box. He responded by explaining that NRC Staff's review of the TSPA-LA will focus only on confirming that adequate scenarios were evaluated, that models and data represent repository performance, and that resulting dose estimates are statistically stable and consistent. Further, NRC Staff will conduct in-depth examinations of scientific and engineering information used in the TSPA-LA model abstractions. While these are all suitable and very important review activities, Mr. Weber went on to state that "the capability of a third party [presumably including the NRC] to execute the TSPA computer code independently is not a prerequisite for developing an adequate understanding of the DOE performance assessment." Mr. Weber is very seriously wrong.

While NRC Staff's TPA will provide a *basis* for a limited model inter-comparison study, there will undoubtedly be differences in the results obtained given the model

complexities, and it will be difficult if not impossible to determine whether these differences arise from different process representations, coding errors, or other sources. Models and data can be examined by reviewing the reports (e.g., AMRs) describing their characteristics, but this would not address whether the models have been implemented correctly. A review of whether the TSPA-LA dose estimates are statistically stable and consistent, while important, addresses the TSPA-LA output and not its internal workings.

Many (maybe most) of the TSPA-LA mathematical models and their underlying mathematical implementations have been moved almost directly from the research organizations to the formal safety assessments in the TSPA-LA. Large software implementations like those being used in the TSPA-LA are typically released with errors, which are then fixed with updates and patches, but the TSPA-LA is apparently being developed and implemented at the same time and, importantly, there will be no extended period of use before the License Application is filed. Thus, it is virtually certain the TSPA-LA will contain a variety of coding and numerical errors. Only by scrutiny at a detailed level, including scrutiny of the internal coding of the TSPA-LA, will NRC Staff be able to identify and resolve these errors and fully evaluate whether the TSPA-LA is, in fact, fit for its intended use. These and other reasons why NRC Staff and Nevada must execute DOE's TSPA-LA computer code independently are explained in more detail in the attached report from Nevada's TSPA expert, Dr. Michael C. Thorne.

In promulgating 10 C.F.R. Part 63, the Commission abandoned sub-system performance requirements for the post-closure assessment period in favor of a total system approach, with no explicit requirement for any particular amount of safety redundancy. This action placed enormous weight on DOE's TSPA-LA, which is a completely custom model that runs on a custom system, and which cannot be validated in actual use because of the very long time periods during which the repository system must perform to isolate nuclear waste. This makes the TSPA-LA uniquely important in the history of NRC regulation. This uniqueness requires a special level of NRC review in order to protect the public health and safety.

It appears that NRC Staff' reply was driven, at least in important part, by its excessively narrow interpretation of the Yucca Mountain Review Plan, NUREG-1804, which was extensively reviewed by the Commission. Perhaps, given the level of Commission involvement in the Plan, Mr. Weber was reluctant to commit to a level of review that he believed exceeded what that Plan appeared to contemplate. Because of the need for a special NRC review of the TSPA-LA, as explained above, I ask you to direct NRC Staff to reconsider its May 7, 2007 reply and, in doing so, advise NRC Staff that, if necessary, it should not consider itself constrained by NUREG-1804.

On a broader note, it is disheartening to see NRC Staff abdicate this critical issue so needlessly and quickly. NRC certainly ought to have a keenly high interest in and need for understanding what will be the core feature of DOE's Yucca Mountain safety assessment so that it is not simply accepting the results of some black box in the most important licensing proceeding in NRC's history. That Staff feels it is unnecessary for it to run DOE's TSPA, or that it is artificially constrained from doing so by some internal

review document, is disturbing enough. Equally disturbing is the apparent attempt by the staff to decide the level of participation for Nevada in the proceeding by saying that Nevada doesn't need to execute the DOE TSPA code to gain an adequate understanding of the DOE performance assessment. While the staff may decide, incorrectly in our view, that they don't intend to execute the TSPA computer code to independently understand DOE's performance assessment, please be advised that Nevada believes that it is essential for our understanding of the performance assessment, and further that it is our right under NRC regulations. We cannot fulfill our role in the proceeding without gaining access to the model and obtaining the ability to run it. The TSPA effectively *is* the Yucca Mountain licensing proceeding.

NRC can of course order physical access to the locations where the TSPA hardware is located, and can direct access to the TSPA codes pursuant to the Commission's Rules of Practice in 10 C.F.R. §§ 2.1018(a)(1)(ii), 1018(b)(1), and 2.1020 in this pre-licensing phase of the NRC proceeding. We expect the agency to do so.

Sincerely,



Robert R. Loux  
Executive Director

Enclosure:

cc: ACNW  
TRB  
DOE  
Nevada Congressional Delegation

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### **EXTERNAL MEMORANDUM**

**Date:** 11 May, 2007  
**From:** Dr. M. C. Thorne  
**To:** R. R. Loux, Executive Director, Nevada Agency for Nuclear Project  
**Subject:** Department of Energy's Total System Performance Assessment

Thank you for providing me with a copy of the letter from Michael F. Weber, NRC, dated May 7, 2007 and responding to your letters dated March 29, 2007 and April 10, 2007 to NRC Chairman Dale E. Klein. In my view, that response does not address a major issue raised in your letters that was originally identified by scrutiny of information relating to the DOE Total System Performance Assessment (TSPA) by technical experts acting for the State of Nevada.

The response from Michael F. Weber identifies that the NRC review of DOE's performance assessment will focus on confirming that:

- Adequate scenarios were evaluated in the TSPA;
- Models and data credibly represent repository performance;
- Resulting dose estimates are statistically stable and consistent.

He further states that the NRC will support this review with in-depth evaluation of the scientific and engineering information used in the TSPA model abstractions.

All of these are suitable review activities, but they do not address the question of whether the TSPA has been properly implemented. The review of scenarios should cover the issue of whether appropriate cases have been defined to address the various relevant safety related issues. I would not expect it to address the issue of whether the consequences of those scenarios have been computed correctly. A wide variety of models and data are used within and outside the TSPA to address various aspects of repository behavior. Those models and data can be scrutinized by reviewing reports describing their characteristics, but this does not address whether they have been implemented correctly. Correct implementation of models is checked in a variety of ways, *e.g.*, by comparison of results against analytic solutions, where such solutions exist.

Other methods of checking include benchmark comparisons against other implementations of the same model or implementations of other models, *e.g.*, in model inter-comparison studies. In such comparisons, limitations, deficiencies and errors in model formulation and implementation are brought to light. Although some of the models that are used to provide input to the TSPA are widely used, and the GoldSim system in which the TSPA is implemented has a wide variety of applications both within and outside the field of solid radioactive waste management, it should be recognized that the TSPA is a unique, extremely complex, computer model that has been developed and used only by the DOE and its contractors. Indeed, it is so tailored to the specific context of proposed radioactive waste disposal at Yucca Mountain that it would be of little interest to organizations studying radioactive waste disposal in any other context. Finally, the review of whether resulting dose estimates are statistically stable and consistent addresses evaluation of the output from the TSPA and not its internal workings. If the models included in the TSPA were inappropriate or were implemented incorrectly, it would still be perfectly possible to obtain statistically stable and internally consistent results. It is just that those results would be wrong.

I believe that it is because of considerations such as those outlined above that the NRC Staff has developed its own Total-system Performance Assessment (TPA) model. As Michael F. Weber comments, the role of this model is as a review tool developed to assist the Staff in pre-licensing activities and the review of a potential license application. I take this to mean that the Staff will run their TPA model to investigate matters such as the sensitivity of the system to particular process assumptions or parameter value combinations, so that appropriate questions can be formulated to DOE requesting clarification of how it has addressed these matters. However, this does *not* constitute effective scrutiny of the performance of the TSPA model. In principle, the TSPA and TPA models could be run on the same problem and results compared. This would be a limited code inter-comparison exercise of the type mentioned above. However, given the complexities of the models, there will undoubtedly be differences in the results obtained. Without detailed examination of the internal coding of the TSPA model, it would be difficult to determine whether those differences arose, for example, from a different, more appropriate process representation in the TSPA or from a less appropriate process representation or a coding error in the TSPA.

In considering the level of scrutiny that should be accorded to the TSPA, it should be kept in mind that it constitutes a unique computer model of a unique physical system. Thus, the novelty of the concept that is being assessed is compounded by the novelty of the tool that is being used for the assessment. In turn, this means that many of the underpinning mathematical models and their mathematical implementations have been moved almost directly from the research laboratory to the safety assessment context. It should also be kept in mind that large software implementations, be they operating systems or real-world simulators, are typically released with errors. These are then corrected in updated versions, through bug fixes and patches. In the case of the TSPA, it is understood that model development and implementation is ongoing at the present time. Therefore, the TSPA will be used in support of DOE's License Application without an extended period of prior use by the DOE and its contractors. Furthermore, any

calculations undertaken are likely to be highly focused on generating results for use in the License Application. It seems unlikely that there will be a concerted effort to error-test the TSPA by running calculations designed to identify inadequacies and errors.

A further reason for giving particular attention to the issue of whether the TSPA is performing as intended is that it constitutes the *sole instrument* by which compliance with key regulatory criteria will be evaluated. Those criteria are expressed in terms of some measure of central tendency (mean or median) of the results from the TSPA. Thus, notwithstanding all the other important aspects of the review process, the evaluation of compliance is ultimately determined by the output from a set of TSPA calculations.

Whereas the NRC Staff can gain some insight into the performance of the TSPA by running calculations with their own TPA model, this is not the situation for other parties, such as the State of Nevada. Those parties would gain little by examining the TPA, since that is not the tool used to demonstrate compliance. Rather, it is both appropriate and necessary for Nevada to examine the TSPA directly to determine whether it is fit-for-purpose. This examination can be conducted at two different levels, as was done for TSPA-SR cases that were provided to me and to Serco Assurance Limited for evaluation. At the first level, the TSPA is loaded using an appropriate version of GoldSim and the structure of the model is examined. This is a time-consuming process, as all the various elements of the model have to be examined down to the level of the specific equations used and the parameter values adopted. Our experience was that the TSPA-SR was extremely difficult to scrutinize by this procedure, as apparently identical elements implemented subtly different equations and not all the data used were readily accessible or traceable.

Although evaluation at the first level is useful, in a complex model it is unlikely to be comprehensive. At the second level of examination, the model is run and various outputs are examined. It is emphasized that such runs do not attempt to reproduce compliance calculations. Rather they are used to generate outputs that are diagnostic of correct performance. Specifically, it may be more useful to undertake a set of deterministic calculations, rather than to perform a probabilistic simulation, and to examine intermediate outputs rather than overall dose estimates.

It is with these considerations in mind that I have substantial doubts as to the appropriateness of the TSPA implementation proposed by the DOE for the License Application. It is not clear that any party other than the DOE will have effective access to the coding of the TSPA within GoldSim. It is surprising that the NRC Staff would not demand full and complete access to the TSPA. Furthermore, given the complexity of the TSPA, its on-going development, and the time pressure involved in producing results in support of the License Application, it seems likely that the version used in support of the License Application will contain a variety of coding and numerical errors. Only by effective scrutiny at a detailed level by NRC Staff and other interested parties, such as the technical experts retained by the State of Nevada, is there a reasonable likelihood of such errors being identified and resolved.