

April 19, 2010

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Subject: *Central and Eastern United States Seismic Source Characterization for Nuclear Facilities: Feedback on CEUS SSC Preliminary Model dated April 7, 2010.*

Dear Carl and Walter,

Thank you for your letter summarizing the Participatory Peer Review Panel's review of the Preliminary SSC Model for the CEUS SSC project. The letter reflects the Panel's continuing review of both the technical and process aspects of the project. In the spirit of a participatory peer review process, we welcome timely, insightful, and constructive reviews and suggestions that will assist the TI team in achieving a successful conclusion.

To provide the PPRP with insights into our intentions relative to the specific recommendations made in the letter, we provide below a response to the recommendations that have been underlined in your letter to draw attention to their priority. We also value the perspectives provided in other parts of the letter, and these will be given serious consideration during the course of the project activities leading up to and including the development of the project report.

#### **“General Observations**

We commend the Project Manager and TI Team leader for their continuing effective leadership of the Project. This leadership continues to stimulate and maintain productive interactions among TI Team members and between the Project Team and the Panel. Actions required to complete the Project identified in “Path Forward” discussed at the end of the meeting appear to be well formed and achievable. The Panel noted, however, that the actions do not include a feedback interaction following completion of the Panel's review of the Draft Project Report to be delivered on September 1, 2010. We recommend that a process for resolving the Panel's comments and recommendations aimed at completing the Final Project Report be identified and scheduled.”

***We agree that a process for resolving the Panel's comments and recommendations on the Draft Project Report should be identified and scheduled. The process will be developed in consultation with the PPRP.***

#### **“Specific Comments and Recommendations**

2. *Differences Between Seismic Source Zones*: The TI Team stated that the conceptual approach used to define distributed seismic sources, specifically those defined on a seismotectonic basis, focused on four key factors: (1) earthquake recurrence rates; (2) maximum magnitude; (3) expected earthquake characteristics; and (4) tectonics. The

Data Evaluation Tables provide information on some of these factors indicating some differences between seismic source zones. However, because the TI Team had not completed development of the final earthquake catalog, implementation of the approach to defining maximum magnitude and spatial smoothing of earthquake recurrence rates for each of the distributed seismic sources had not been finalized. As a result it is difficult for the PPRP to have high confidence that the preliminary seismic source characterization model captures the center, body, and range of the ITC. While some significant differences between distributed seismic sources may be anticipated (e.g., Mmax differences between Non-Extended crust relative to differences between the Illinois Basin Extended Basement (IBEB) and Mid-continent Crust seismic sources), it is not intuitive that such differences will fully support the seismotectonic zones that subdivide the Mesozoic Extended crust, and as a result the conceptual approach used to define distributed seismic sources. The PPRP had expected that the Hazard Input Document would have included information to justify the approach being used. The PPRP recommends that the TI Team provide this information for PPRP review concurrent with providing hazard input to the project's hazard analyst.

We recommend the following with respect to maximum magnitude: (1) The TI Team should describe how paleoliquefaction evidence was used to define seismic source likelihood functions. (2) The TI Team should provide specific likelihood functions and posterior distributions for each of the Hybrid and Seismotectonic source zones, for each of the prior assumption cases considered.

With respect to the application of the smoothed seismicity approach, we recommend that the PPRP be provided with sufficient activity rate maps for each hybrid and seismotectonic source zone (such as for  $M = 5$ ) to appreciate the significance of recurrence rate differences between seismic sources.”

***The TI Team will provide the HID for the Final SSC Model to the PPRP at the time that it is provided to the hazard analyst for calculations. The HID will include the Mmax distributions for all sources as well as the earthquake recurrence rates that are derived from spatial smoothing. For each seismic source, the largest observed event that defines the likelihood function will be identified, including those derived from paleoseismic data and historical seismicity data. An appropriate display of earthquake recurrence rate spatial variation will also be provided.***

“3. *Organization of the Logic Trees:* We note that there are significant changes in the organization of the logic trees of the current CEUS SSC from previous PSHAs of the region. The Panel is generally supportive of these changes, but we recommend that the documentation of the design of the logic trees include a clear and detailed explanation of the reasoning involved in making the changes from previous studies. For example, the magnitude of the largest observed events (both historical and inferred from paleoliquefaction) is a major factor in isolating source zones for detailed characterization (the RLMEs), while regions of moderate to intense earthquake activity without moment magnitudes that exceed mid-5 values such as eastern Tennessee, northeastern Ohio, the

Humboldt fault zone (Nemaha Ridge), and the Ramapo fault that have been included in earlier studies are not called out as specific seismic zones.

Furthermore, we have the sense that some lines of evidence used by the ITC in identifying and characterizing the seismic source zones of the CEUS have not received the attention in the current study that they have been given by some members of the ITC and in former PSHAs of the region. For example, contrary to the present study, some investigators place considerable emphasis on recent strain (GPS) measurements and others give considerable weight to tectonic features of the CEUS that have been mapped directly or indirectly in the identification and characterization of seismic source zones. The project would be well served by documented justification of the reasoning supporting minimization of these elements by the TI team in their decisions—and we recommend that the Draft Technical Report include such documentation.”

***We agree that the project documentation must provide a detailed discussion of the criteria that were used to identify seismic sources and a justification for all logic tree branches and weights. To the extent that it helps the explanation, this discussion will be made in the context of previous seismic source characterizations for PSHA and the evolution of the technical community. Elements of emerging issues within the technical community that have not yet seen routine incorporation into SSC for PSHA, such as the use of geodetic strain data, will be discussed in the project report if they were evaluated for potential use by the TI Team in the SSC Model. It is important to note that the “informed technical community” that is being represented in the SSC Model is the hypothetical community of seismic source characterizers for purposes of PSHA, who are assumed to have been through the same interactive process that the TI Team has been through. As such, there is often a difference between the issues being considered by the larger research community and those that find their way into the SSC Model for a PSHA.***

“4. *Clarity of terms in the Master Logic Tree:* In labeling and discussing branches of the Master Logic Tree, clarity can be improved. The TI Team may want to consider another term for “hybrid” at the very front end of the tree. The term is a vestige from labeling a former three-branch node (now collapsed to two), and many readers would expect a hybrid branch to be a combination of two other branches. Referring to “zoneless” seismicity sources is confusing insofar as these sources lie within demarcated areas of differently affected Mesozoic crust. In general, we recommend that the TI Team examine jargon that has evolved in their internal discussions and evaluate whether terms used in their working discussions now help or hinder clear communication to others. Labeling of Iapetan Extended/Non-extended as a different case from Mesozoic Extended/Non-extended may be confusing to those unfamiliar with the arcane term “Iapetan.” Labeling of “Inter-event Times” as a Recurrence Method for the RLME logic tree branches is confusing because the method used in fact involves the use of both inter-event and event-interval paleoearthquake data. In source geometry branches for RLME sources (e.g., Figures 15 and 17 in the HID), “extended trace” should be used instead of just “extended” to avoid confusion with crustal extension.”

***The terminology used in the Master Logic Tree will be re-examined and revised to assist the reader.***

*“5. Assigning Weights to the Logic Trees: As mentioned during the Briefing Meeting, we recommend that TI Team describe the overall approach to assigning weights to the logic trees, and that this written description be included in the Draft Technical Report. In some cases these weights represent an explicit statistical assumption or distribution while in other cases these weights are the TI’s evaluated judgment of the informed technical community views. In these cases it would be useful to have an understanding of how the TI assigned weights from a generic perspective.”*

***A description of the overall approach to assigning weights to the logic tree will be provided in the Draft Project Report.***

*“6. Spatial Smoothing: Conceptually, the PPRP endorses the direction the TI team is taking with respect to spatial smoothing approach and implementation. However, thus far there has been no written documentation provided to us that: (1) describes the method in detail as it is being applied in this project, (2) describes the bases for choices of parameters of the model, or (3) justifies reliance entirely on the penalized likelihood method. We recommend that the eventual documentation not only describe the adopted technique in detail but also document any perceived advantages of this technique relative to simpler kernel techniques. Some discussion of “floor” values in regions of very low rates should also be included. It would benefit our review to receive this section for review as soon as is practicable.”*

***A discussion of the spatial smoothing approach and its technical basis are planned for inclusion in the Draft Project Report. The discussion will include a comparison to kernel smoothing approaches as well as the issue of a “floor” on recurrence rates in regions lacking seismicity. Every effort will be made to provide the written discussion in advance of the delivery of the Draft Project Report.***

*“7. ALM Area Characterization: The TI Team presented its independent evaluation of published field data, including original field copies of trench logs and field photographs of features that Randy Cox had described in WS #2 and interpreted as liquefaction features. “Project-specific Criteria for Identifying Earthquake-Induced Liquefaction Features Used in Development of Paleoseismicity Chronologies” were used to perform the evaluation. Discussions during the TI Team’s presentation identified that these criteria are current state of practice for determining whether observed features are earthquake-induced liquefaction features or properly explained as depositional or due to another geologic process. First, given that the criteria are identified as representing the state of practice of the informed technical community, the “project-specific” qualification is confusing and misleading. We recommend that these criteria be clarified or removed.*

*Second, the Team’s evaluation appears to reasonably support their conclusion that the features do not satisfy the informed community’s criteria for reasonably assessing that the features are earthquake-induced. However, this evaluation appears inconsistent with the*

highly qualified ALM area model assessment conclusion: “the paleoliquefaction data from the ALM region are immature and highly uncertain and, at the present time, do not provide strong evidence for a source of RLME in the ALM area.” This highly qualified conclusion clearly conveys a level of uncertainty that would support giving some assessed weight to an interpretation that the ALM should be modeled as a RLME. Perhaps what is meant is that the information in the current dataset, when assessed using the criteria for determining whether features are indeed liquefaction features consistent with current state of practice, does not support the interpretation that these are paleoliquefaction features. We strongly support the TI Team’s decision, as stated during the discussion, to revisit and clarify this assessment—and we recommend that the TI Team do so.

To support this last point, it would be helpful if the discussion of the criteria include not only what the specific criteria are but the scientific and technical basis of each criterion. This would support not only this assessment, but would provide a valuable tool for projects in the future when datasets are not clear, or even as new information becomes available in the ALM area.”

***The criteria used to evaluate the paleoliquefaction in the CEUS, including the ALM area, will be clearly stated and defended technically in the Draft Project Report. Also, the terminology used in the evaluation of paleoliquefaction in the ALM area will be revised to more accurately reflect the assessment made.***

“8. *Data Summary and Evaluation Tables*: The Panel finds the Data Summary and Data Evaluation tables to be highly important in supporting and annotating the decisions regarding identification and characterization of the seismic source zones of the CEUS. Every effort should be made to include in these tables documentation for the current, complete center, body, and range of the ITC by seeking feedback from appropriate current investigators prior to finalizing the tables. A full description is warranted of the procedures used in selecting material for the Data Summary table. Additionally, both tables are essential in reviewing the basis for, and the assessments regarding, seismic source zones—but there remains the need for a full narrative that will allow the user of the CEUS SSC Model to completely understand the data evaluations that support the assessments made by the TI Team. We recommend that the Draft Technical Report include such a full narrative for the Data Summary and Data Evaluation tables.”

***The Draft Project Report will include a discussion of the purpose and content of the Data Summary and Data Evaluation tables. The tables are intended to support the discussions of the characterization of the seismic sources, which will also be included in the Draft Project Report.***

“10. “*Other*” *Reviews of the CEUS SSC Model*: At the Briefing Meeting, the Project Manager showed tracking milestones including “Review of Draft [Technical] Report by PPRP, USGS, and Sponsor Reviewers—August 2, 2010 to September 1, 2010.” It seems appropriate to call attention to the following statement in Implementation of the SSHAC

Guidelines for Level 3 and 4 PSHAs—Experience Gained from Actual Applications  
(USGS Open-File Report 2009-1093, p. 35:

The PPRP is the only legitimate review panel recognized by the SSHAC Guidelines; there is only one PPRP for a SSHAC Level 3 or 4 study, and its sole and unique obligation is to provide on-going commentary to TI/TFI as the project develops. All other “review panels” should be considered as observers, unless the project leadership agrees in advance to a different role/format for them.

The Panel recognizes the prerogative of the Project Sponsors to request comments on the Draft Technical Report from other parties of its choosing for its own purposes. However, we recommend—and believe it is essential—that any comments on the CEUS SSC Model provided to the TI Team that result from a TI Team request be made available to the PPRP for its awareness and consideration.”

***We agree that within the context of a SSHAC process, the PPRP is the only group with standing to review the technical and process aspects of the project. As noted, the Sponsors, as observers, may carry out their own reviews of the Draft Project Report and provide comments to the TI Team for consideration.***

“11. *Comments on Draft Report Outline:* We recognize that the Draft Report Outline dated March 9, 2010, is preliminary (in its present form, the outline is a mix of topical phrases and explanations of what specific subsections will contain). As such, a detailed review is premature, and we only offer some general comments (not exhaustive). We recommend that the PPRP have another opportunity to review the Draft Report Outline after the TI Team finalizes it. This could avoid some late-stage criticisms of the content of the Draft Technical Report during our August review.”

***We appreciate the comments made on the preliminary Draft Report Outline and, as requested, the final draft outline will be sent to the PPRP for their review.***

#### **“Closing Comment**

The Panel is aware that, at the request of the Project, the USGS is preparing to deliver to the TI team independent feedback on the Project Earthquake Catalog and on the draft HID focusing on completeness of datasets, models, and tools being used in the CEUS SSC assessment. Based on telephone discussions between the PPRP and the Project Team on April 5, 2010, we understand that the TI Team will evaluate the USGS comments and will consider them in its final assessment and in its development of the final HID for the Project. We further understand that the TI Team’s evaluation of the USGS comments will be finalized as part of its final working meeting scheduled to be held on April 12-13, 2010, in which one or more PPRP members will participate as observers.”

***As noted, the USGS was asked to provide their comments on two review products, and they responded in letters dated April 8, 2010 and April 9, 2010, which was provided to the PPRP on April 9, 2010. We have responded to the USGS letter in a letter dated April 9, 2010, which was***

*provided to the PPRP on April 9, 2010. Working Meeting #8 on April 12-13, 2010 provided the opportunity to ensure that all comments are addressed.*

Thanks again for your insightful review comments, and we are convinced that they will assist us in developing a better product. If you have any questions regarding this letter, please feel free to contact us.

Sincerely,

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