APPENDIX B: PPRP CLOSURE LETTER TO PROJECT SPONSOR

March 10, 2015

Mr. Kent S. Ferre
Project Manager
Pacific Gas & Electric Company
245 Market St.
San Francisco, CA 94177

SUBJECT: Diablo Canyon Seismic Source Characterization SSHAC Project Participatory Peer Review Panel Closure Letter

Dear Mr. Ferre,

The Participatory Peer Review Panel (PPRP, the "Panel") for the Diablo Canyon Seismic Source Characterization (SSC) SSHAC Project (the "DCPP SSC Project") is pleased to issue this PPRP Closure Letter containing our findings with respect to the project. The four Panel members (Kevin J. Coppersmith, Steven M. Day, Neal W. Driscoll, and Thomas K. Rockwell) participated in the Project in a manner fully consistent with the SSHAC Guidance[1] for a SSHAC Level 3 study. The Panel was actively engaged in all phases and activities of the Project's implementation, including the development of the Project Plan, review of analyses performed by the Technical Integration (TI) Team to support the evaluation and integration processes, review of interim products, and review of the draft project report and the final project report.

Consistent with regulatory guidance for SSHAC projects, the role of the PPRP is to conduct a review of both the *process* followed and the *technical* assessments made by the TI Team. Accordingly, this letter documents the activities that the PPRP has undertaken in its review of the Project, its review of the adequacy of the process followed, and its findings relative to the technical adequacy of the resulting SSC model.

Consistent with SSHAC Guidance, the Panel was fully engaged in peer-review interactions with the DCPP SSC TI Team throughout the entire project performance—from development of the Project Plan through finalization the Project Report. The participatory peer review process entails the continual review of a project from its start to its completion. Thus, proper implementation requires adequate opportunity during the conduct of the study for the PPRP to understand the data, models, and methods being evaluated; the analyses performed for the study; the TI Team's integration activities that lead to SSC models and uncertainties; and the completeness and clarity of the technical

[1] Budnitz, R.J., G. Apostolakis, D.M. Boore, L.S. Cluff, K.L. Coppersmith, C.A. Cornell, and P.A. Morris (1997). *Recommendations for Probabilistic Seismic Hazard Analysis: Guidance on Uncertainty and the Use of Experts* (known as the "Senior Seismic Hazard Analysis Committee Report", or "SSHAC Guideline"), NUREG/CR-6372, U.S. Nuclear Regulatory Commission, TIC; 235076, Washington, D.C.

NRC (2012). *Practical Implementation Guidelines for SSHAC Level 3 and 4 Hazard Studies*, NUREG-2117, U.S. Nuclear Regulatory Commission, Washington, D.C.

justifications given in the documentation. Participatory review also involves opportunities for the PPRP to provide its reviews and comments in written and verbal form during the conduct of the project, such that the suggestions and recommendations made by the Panel can be considered by the TI Team in a timely fashion prior to completion of the work.

The meetings attended and observed by the PPRP for the DCPP SSC project are summarized in the table below. The PPRP assumed an active participant role in Workshop #3 and the PPRP Briefings.

Meeting Type	Date(s)	Topic(s)
Kick off meeting	August 25, 2011	Kick off meeting
Workshop	November 29 - December 1, 2011	Workshop #1
Working Meeting	March 28, 2012	Characteristic earthquake review
Working Meeting	April 11, 2012	Logic tree and sensitivity for magnitude PDF and earthquake recurrence
Working meeting	May 14, 2012	SSC work plan review, overall logic tree structure
Working Meeting	June 19-20, 2012	Project and Workshop #2 planning, logic tree structure, sensitivity analyses, Hosgri, Los Osos, San Luis Bay, and Shoreline logic trees
Working Meeting	October 25-26, 2012	Workshop #2 planning, logic tree sensitivity review
Workshop	November 6-8, 2012	Workshop #2
Working Meeting	December 11, 2012	Review Workshop 2, 2013 plan, data needs table
Working Meeting	February 20, 2013	2013 Schedule and Assignments, Offshore seismic stratigraphy project PE presentation
Working Meeting	September 20, 2013	Alternative fault model evaluation
Working Meeting	November 5-6, 2013	Presentation of draft SSC Model V2
Working Meeting	March 5, 2014	Rupture Models, Sam Johnson PE presentation, Recurrence model
Workshop	March 25-27, 2014	Workshop #3
Working Meeting	June 23-24, 2014	Modifications to Preliminary Fault and Deformation models, open items following Preliminary SSC Model
PPRP Briefing	July 24-25, 2014	DCPP SSC Model Final PPRP Briefing, Part 1
PPRP Briefing	October 31, 2014	DCPP SSC Model Final PPRP Briefing, Part 2, Time Dependency Model

The PPRP, collectively and individually, understood fully the SSHAC Guidance for a structured participatory peer review and the requirements for a SSHAC Level 3 project; had full and frequent access to information and interacted extensively with the TI Team throughout the project; provided peer-review comments at multiple stages; and, as documented within the final report, was fully engaged to meet its peer-review obligations in an effective way. The Panel concludes that its ongoing review and

feedback interactions with the TI Team during the conduct of the DCPP SSC project activities fully met the expectations for a SSHAC Level 3 study.

SSHAC *Process* Review

Fundamentally, the question of whether or not a project follows a proper SSHAC Level 3 process is answered by comparing the process used with the process outlined generally in the SSHAC implementation guidance issued by the NRC. NRC (2012, Table 4-1) identifies the essential steps in a SSHAC Level 3 study that define the minimum required activities:

1. Select SSHAC Level
2. Develop Project Plan
3. Select project participants
4. Develop project database
5. Hold workshops (minimum of three, focused on available data, alternative models, and feedback)
6. Develop preliminary model(s) and Hazard Input Document (HID)
7. Perform preliminary hazard calculations and sensitivity analyses
8. Finalize models in light of feedback
9. Perform final hazard calculations and sensitivity analyses
10. Develop draft and final project report
11. Participatory peer review of entire process

Review of the project documentation, as well as ongoing participatory peer review throughout the project, leads to the conclusion that the essential steps of a SSHAC Level 3 process have been followed in the DCPP SSC Project. For example, a Project Plan was issued at the start of the project that outlined the project activities and the roles and responsibilities of all project participants; a major effort was devoted to developing a project database that was accessible to the TI Team; three topical workshops were held to identify available data, to discuss alternative methods and models, and to present feedback based on preliminary interpretations; preliminary models were developed and seismic hazard calculations conducted to provide additional feedback to the TI Team; draft and final reports were developed that documented the process followed and the technical assessments made; and a peer review process was conducted that included both participatory aspects and late-stage reviews (e.g., review of the draft report).

In light of due consideration of the essential elements of a SSHAC process and the specific manner in which the DCPP SSC Project was conducted, the Panel concludes that the project performed all essential steps consistent with current state-of-practice guidance for a SSHAC Level 3 process.

As explained in NUREG-2117 (NRC, 2012), the SSHAC process consists of two important activities, described as follows:

"The fundamental goal of a SSHAC process is to carry out properly and document completely the activities of evaluation and integration, defined as:

- *Evaluation*: The consideration of the complete set of data, models, and methods proposed by the larger technical community that are relevant to the hazard analysis.
- *Integration*: Representing the center, body, and range of technically defensible interpretations in light of the evaluation process (i.e., informed by the assessment of existing data, models, and methods)."

These activities are essential to any SSHAC study and the Panel has followed the DCPP SSC Project closely to ensure that both activities have been adequately conducted. A third key activity of a SSHAC process is the *documentation* phase, which ensures that all evaluation and integration activities are properly supported and captured in the written record.

During the *Evaluation* phase of the DCPP SSC Project, the TI Team considered new data, models, and methods that have become available in the technical community in recent years. Importantly, the TI Team evaluated the wealth of onshore and offshore data that have recently been collected as part of the AB 1632 studies required by the State of California, as well as numerous data collection activities conducted by federal and state researchers such as the USGS and California Geological Survey. Workshop #1 was devoted to reviewing these disparate datasets and to identifying which data could be used to develop the SSC model. Continuing the *evaluation* process, Workshop #2 focused on alternative methods and models that pertain to the hazard-significant SSC issues. Significant representation of these alternative viewpoints was made by the participation of resource and proponent experts at the workshop. The Panel concludes that the TI Team conducted an adequate evaluation process.

The *Integration* phase of the project entails the building of the SSC model to capture current knowledge and uncertainties. Care was given in the model-building process to appropriately distinguish between epistemic uncertainties and aleatory variability. The TI Team conducted multiple working meetings and other interactions to ensure that the center, body, and range of technically defensible interpretations were included in the SSC model. Importantly, the Team also received appropriate communications from the Project Technical Integrator (PTI) regarding the required elements of the SSC model needed for consistency with the ground motion models being developed in parallel as part of the Southwest United States Ground Motion Characterization Project. A preliminary SSC model was developed prior to Workshop #3 and hazard calculations were conducted for purposes of sensitivity analysis feedback. At Workshop #3, the PPRP was given the opportunity to provide their feedback on the preliminary model and to challenge the TI Team with respect to the technical justifications for their SSC model assessments and associated uncertainties. The TI Team used the feedback gained from the hazard calculations and PPRP comments to prioritize their efforts in the final SSC model development process. The tectonic complexity of the DCPP study region requires a complex SSC model to completely and appropriately capture current

knowledge and uncertainties. Efforts were made to simplify the models when it could be shown that detailed characterization would not lead to significant differences in the hazard results. The Panel concludes that such simplifications were justified and appropriate.

In support of the *Documentation* phase of the project, the TI Team developed a comprehensive Draft Report that was provided to the PPRP for detailed review. To ensure that schedule constraints for the project were met, the report was provided to the PPRP in major installments consisting of multiple chapters and appendices. The role of the Panel's review was specifically to ensure that all *evaluation* and *integration* activities were described completely, and that the SSC model was adequately justified technically. Written comments were provided by the PPRP to the TI Team and, after revision of the report in light of those comments, written responses by the Team were provided to the PPRP to ensure proper closure of each comment.

Based on the review of the *evaluation* and *integration* activities conducted by the TI Team, as well as the *documentation* of these activities in the PSHA report, the PPRP concludes that the SSHAC process has been adequately conducted.

SSHAC *Technical* Review

The role of the PPRP in the review of the technical aspects of the project is specified in NUREG-2117 (USNRC, 2012) as follows:

> "The PPRP fulfills two parallel roles, the first being technical review. This means that the PPRP is charged with ensuring that the full range of data, models, and methods have been duly considered in the assessment and also that all technical decisions are adequately justified and documented.
>
> The responsibility of the PPRP is to provide clear and timely feedback to the TI/TFI and project manager to ensure that any technical or process deficiencies are identified at the earliest possible stage so that they can be corrected. More commonly, the PPRP provides its perspectives and advice regarding the manner in which ongoing activities can be improved or carried out more effectively. In terms of technical review, a key responsibility of the PPRP is to highlight any data, models or proponents that have not been considered. Beyond completeness, it is not within the remit of the PPRP to judge the weighting of the logic-trees in detail but rather to judge the justification provided for the models included or excluded, and for the weights applied to the logic-tree branches."

Consistent with this NRC guidance, the PPRP reviewed at multiple times during the project the TI Team's evaluations of data, models, and methods, as well as the Team's development and technical justification for the SSC model. These reviews

included conference calls, post-workshop meetings, written comments, and the review of drafts of the PSHA report. Through these reviews, the PPRP communicated feedback to the TI Team regarding data and approaches that did not appear to have been considered, suggestions for methods being used within the technical community that should be evaluated by the Team, and recommendations for ways that the documentation could be improved to strengthen the discussion of the technical bases for the assessments.

Requirements for a successful *integration* or model-building phase of a SSHAC Level 3 process are that it is informed by a complete evaluation of all relevant data, models, and methods during the *evaluation* phase of the project, that all assessments are technically defensible, and that the developed models are thoroughly documented so as to be transparent to users. During the course of the integration process, the TI Team found that the available set of methods or model elements were not sufficient to properly and completely represent current knowledge and uncertainty in some components of the model. In those cases, the TI Team developed a refined set of model elements or concepts that—although they are not radically different from current practice—provide approaches that the Team concluded were more effective in modeling technical aspects than available tools. For example, the SSC model includes a series of fault geometry models and rupture sources that span the range of credible interpretations of available data. Key aspects of these rupture sources are assessed based on a consideration of constraints from geologic, geomorphic, geophysical, and seismological data.

A strong requirement of the SSHAC Guidance is that all elements of the SSC model must be completely documented and adequately justified technically. This is particularly true of new model elements that have not enjoyed the benefit of use on multiple projects or that have not been subject to peer review within the larger technical community. Particularly in those cases, the PPRP must ensure that the model elements are sufficiently justified and adequately defended in the project documentation. This has been the case in the DCPP SSC Project. Examples of new approaches include the use of a slip rate allocation approach to characterizing rupture sources, incorporating new magnitude frequency distributions, and the adoption of a non-Poisson temporal model. To review these concepts and applications to the SSC model, the PPRP was present as observers at workshops where these concepts were presented, provided written comments in response to those workshops, asked questions and provided feedback in a workshop environment regarding the adequacy of the technical justification for the models, participated in briefings and conference calls related to the topics, and provided detailed written comments related to the draft project report. Based on this process of participatory review throughout the course of the project, the PPRP concludes that the bases for the SSC model elements are technically defensible, and that the technical assessments and process for arriving at the model elements are adequately documented.

Throughout the course of the PPRP review, the TI Team was responsive to the questions, comments, and suggestions made by the PPRP relative to the technical aspects of the project. Therefore, the Panel concludes that the technical aspects of the

projects have been adequately addressed and all written comments provided by the Panel, including those made following each workshop and those pertaining to the Draft Report, are hereby considered to be closed.

Conclusion

Based on our observation of the completeness and professional standard by which the evaluation and integration activities were conducted, the Panel concludes that the data, models, and methods within the larger technical community have been properly evaluated, and that the center, body, and range of technically defensible interpretations have been appropriately represented in the SSC model. Accordingly, the Panel concludes that both the process and technical aspects of the DCPP SSC assessment fully meet accepted guidance and current expectations for a SSHAC Level 3 study.

We appreciate the opportunity to provide our review of the project.

Sincerely,

DCPP PPRP Members

Kevin J. Coppersmith, Chair

Steven M. Day

Neal W. Driscoll

Thomas K. Rockwell