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PG&E Letter DCL-15-136

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Docket No. 50-275, OL-DPR-80
Docket No. 50-323, OL-DPR-82
Diablo Canyon Units 1 and 2
Response to Requests for Information Related to the Environmental Review of the Diablo Canyon Power Plant, Units 1 and 2 License Renewal Application – Severe Accident Mitigation Alternatives (TAC MF4019 and MF4020)

References:
1. PG&E Letter DCL-09-079, "License Renewal Application," dated November 23, 2009
2. PG&E Letter DCL-15-027, "Update to the Diablo Canyon Power Plant License Renewal Application (LRA), Amendment 49 and LRA Appendix E, 'Applicant's Environmental Report – Operating License Renewal Stage, Amendment 2,'" dated February 25, 2015
3. PG&E Letter DCL-15-080, "Diablo Canyon Power Plant License Renewal Severe Accident Mitigation Alternatives Analysis Evaluation of the 2015 Seismic Hazard Results," dated July 1, 2015
4. NRC letter, "Requests for Additional Information Related to the Environmental Review of the Diablo Canyon Power Plant, Units 1 and 2 License Renewal Application – Severe Accident Mitigation Alternatives (TAC Nos. MF4019 and MF4020)," dated October 23, 2015

Dear Commissioners and Staff:

By Pacific Gas and Electric Company (PG&E) Letter DCL-09-079, "License Renewal Application," (Reference 1), dated November 23, 2009, PG&E submitted an application to the U.S. Nuclear Regulatory Commission (NRC) for the renewal of Facility Operating Licenses DPR-80 and DPR-82, for Diablo Canyon Power Plant (DCPP) Units 1 and 2, respectively. The application included the License Renewal Application (LRA) and LRA Appendix E, "Applicant's Environmental Report – Operating License Renewal Stage."

PG&E Letter DCL-15-027, "Update to the Diablo Canyon Power Plant License Renewal Application (LRA), Amendment 49 and LRA Appendix E, 'Applicant's Environmental Report – Operating License Renewal Stage, Amendment 2,'" (Reference 2), dated February 25, 2015, provided updates to LRA Appendix E, Chapter 7, "Alternatives to the Proposed Action," Chapter 8, "Comparison of Environmental Impacts of License Renewal With the Alternatives," Section 9.2, "Alternatives," and Attachment F, "Severe Accident Mitigation Alternatives" (SAMA).

PG&E Letter DCL-15-080, "Diablo Canyon Power Plant License Renewal Severe Accident Mitigation Alternatives Analysis Evaluation of the 2015 Seismic Hazard Results," (Reference 3), dated July 1, 2015, provided an evaluation of the March 2015 DCPP seismic hazard update on LRA, Appendix E, Attachment F that was submitted in Reference 3. The evaluation updated the licensing basis for the LRA, Appendix E, Attachment F, SAMA Analysis.

NRC letter, "Requests for Additional Information Related to the Environmental Review of the Diablo Canyon Power Plant, Units 1 and 2 License Renewal Application – Severe Accident Mitigation Alternatives (TAC Nos. MF4019 and MF4020)," (Reference 4), dated October 23, 2015, requested additional information related to the environmental review of the DCPP LRA SAMA.

Enclosed is PG&E's response to Reference 4.

PG&E makes no regulatory commitments (as defined by NEI 99-04) in this letter. This letter includes no revisions to existing regulatory commitments.

If you have any questions regarding this submittal, please contact Mr. Terence L. Grebel, License Renewal Project Manager, at (805) 458-0534.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on November 12, 2015.

Sincerely,

Barry S. Allen

Barry S. Allen
Vice President, Nuclear Services

gwh/50815664
Enclosure

cc: Diablo Distribution
cc/enc: Marc L. Dapas, NRC Region IV Administrator
Thomas R. Hipschman, NRC, Senior Resident Inspector
Siva P. Lingam, NRR Project Manager
Richard A. Plasse, NRC Project Manager, License Renewal (Safety)
Michael J. Wentzel, NRC Project Manager, License Renewal (Environmental)

Pacific Gas and Electric Company's Response to October 23, 2015, Nuclear Regulatory Commission Request for Additional Information Related to the Environmental Review of the Diablo Canyon Power Plant, Units 1 and 2 License Renewal Application – Severe Accident Mitigation Alternatives

The following information updates previous information provided in Pacific Gas and Electric Company (PG&E) Letter DCL-15-027, "Update to the Diablo Canyon Power Plant License Renewal Application (LRA), Amendment 49 and LRA Appendix E. 'Applicant's Environmental Report- Operating License Renewal Stage,' Amendment 2," dated February 25, 2015, and PG&E Letter DCL-15-080, "Diablo Canyon Power Plant License Renewal Severe Accident Mitigation Alternatives Analysis Evaluation of the 2015 Seismic Hazard Results," dated July 1, 2015,

RAI 1

Provide the following information regarding the Level 1 Probabilistic Risk Assessment (PRA) used for the Severe Accident Mitigation Alternative (SAMA) analysis. Basis: Applicants for license renewal are required by Title 10 of the Code of Federal Regulations (10 CFR) 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Diablo Canyon Power Plant (DCPP) SAMA analysis, the U.S. Nuclear Regulatory Commission (NRC) staff is evaluating Pacific Gas and Electric's (PG&E's) treatment of internal events and calculation of core damage frequency (CDF) in the Level 1 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the sufficiency of PG&E's Level 1 PRA model for supporting the SAMA evaluation.

RAI 1.a

Environmental Report (ER), Amendment 2, Section F.2 (p. F-12) states:

"The CDF values for the models presented in Section F.2.1 are all point estimate values. The evaluation of base case benefits was based on point estimate values."

The CDF values given for a number of the PRA models in subsequent subsections (F.2.1.6, p. F-23; F.2.1.7, p. F-26; F.2.1.8, p. F-29; F.2.1.9, p. F-32; and F.2.1.10, p. F-36) are indicated to be mean values. Please clarify.

PG&E Response to RAI 1.a

The core damage frequency (CDF) values given in the following subsections F.2.1.6, p. F-23; F.2.1.7, p. F-26; F.2.1.8, p. F-29; F.2.1.9, p. F-32; and F.2.1.10, p. F-36 are point estimate values. The caption for tables will be revised to remove the term "mean" and a note will be added to indicate that the CDF values are point estimate values.

RAI 1.b

Section F.2.1 describes the shared systems and/or the systems that can be cross-tied between Units 1 and 2. Discuss the treatment of the unavailability of Unit 2 components due to test, maintenance and refueling in the Unit 1 model. Discuss the potential for and the modeling of initiating events that can impact both Units 1 and 2.

PG&E Response to RAI 1.b

In the modeling of Unit 2 systems in the Unit 1 model, for example, the Unit 2 auxiliary saltwater (ASW) system and the Unit 2 diesel generators (DGs) includes the unavailability of the systems due to tests and maintenance (planned and corrective). The Unit 2 ASW system equipment and DG unavailability due to scheduled maintenance during the Unit 2 refueling outage is also included in the calculation of the total unavailability of the Unit 2 ASW system and DGs, respectively.

The initiating events that can impact both Unit 1 and Unit 2 include the loss-of-offsite-power (LOOP) event and seismic events. Impacts of these initiating events on unit cross-tie capability are modeled. In addition common cause failures of equipment belonging to the ASW system and the DGs across both units are also modeled.

RAI 1.c

Section F.2.1.10 of the ER indicates that the DC03 Fire PRA includes the Westinghouse low leakage shutdown seals and an upgrade of the hot shutdown panel that are to be implemented in the future. Table 4 of PG&E Letter DCL-15-080 (p. 34) indicates that while the fire portion of the DC03SA model, and some steam generator tube rupture (SGTR) scenarios, include credit for the planned installation of the shutdown seals at DCPP, the seals are not credited in the DC03 internal events model. Provide the status of the hot shutdown panel in all of the DC03SA models and of the low leakage seals in the internal flooding and seismic models, particularly with respect to the SGTR scenarios. Describe the differences between the current and new seals and the features of the hot shutdown panel upgrade and their qualitative impact on the PRA models, the identification and scope of relevant potential SAMAs, and the SAMA cost-benefit analysis.

PG&E Response to RAI 1.c

Only the fire portion of the DC03SA model includes credit for the planned installation of the Westinghouse GEN III SDS reactor coolant pump (RCP) seals. The fire model also takes credit for planned upgrades to the hot shutdown panels (HSDPs) at the Diablo Canyon Power Plant (DCPP). If credit were applied for the shutdown seals in the entirety of the internal events portion of the DC03SA model, the seal loss-of-coolant accident (LOCA) scenarios related to the SE4 split fraction would no longer be risk significant contributors. This is discussed in PG&E Letter DCL-15-080, Table 4.

The Westinghouse GEN III SDS RCP seals and upgrades to the HSDP are not credited in the internal events model, including the steam generator tube rupture (SGTR) scenarios, the internal flooding model, or the seismic model.

The Westinghouse GEN III SDS RCP seals are another layer physically added to the existing Westinghouse seals, improving the reliability and seal leakage characteristics of the overall RCP seal system.

The probabilistic risk assessment (PRA) modeling of the GEN III SDS seals includes the following assumptions;

(1) Upon the loss of all RCP seal cooling (i.e., loss of both thermal barrier cooling and seal injection) and the reactor coolant system (RCS), the temperature in the GEN III seal region increases above its actuation temperature, the GEN III seal ring closes onto the RCP shaft, which limits the seal leakage to less than 1 gallons per minute (gpm).

(2) The reliability (or failure-to-actuate) of the GEN III SDS RCP seal is approximately 9.6E-03, which is based on the results of the testing performed by Westinghouse.

(3) If the GEN III SDS RCP seal fails to actuate, it will essentially function the same way as the previous number 1 RCP seal. The PRA modeling of the existing RCP seals is based the consensus WOG2000 model.

(4) The successful function of both the GEN III SDS RCP and number 1 seal requires a timely tripping of the RCPs.

Installation of the Westinghouse GEN III SDS RCP seals reduces the importance of seal cooling and RCS makeup functions. The potential benefit of severe accident mitigation alternatives (SAMAs) that involve seal cooling and RCS makeup functions would be reduced as a result of adding Westinghouse GEN III SDS RCP seal modeling and would not be cost beneficial.

The HSDP provides the: (1) decay heat removal via two steam generators (SGs); (2) the RCS inventory controls via the high pressure injection system, and (3) emergency shutoff of the RCS power operated relief valves (PORVs) as well as necessary instrumentation to support the safe shutdown capability during a fire-induced abandonment of the main control room (MCR). The HSDP upgrade ensures electrical separation of equipment such that a fire in either MCR or in the cable spreading room will not damage equipment or associated circuits of the safe shutdown functions provided at the HSDP. The MCR abandonment fire scenarios are modeled in the fire PRA model crediting the recovery action at the HSDP. With this credit of the HSDP, the fire risk contribution from MCR abandonment scenarios becomes insignificant and no SAMA is identified associated with the MCR abandonment fire scenarios.

RAI 1.d

The original 2009 SAMA analysis submittal and responses to NRC staff requests for additional information (RAIs) were based on PRA models DC01A and DC01B. These two models are not described in Section F.2.1 of the ER, but the seismic initiating event frequencies are cited in the discussion of the DC03 interim model. Briefly discuss these models. Also, clarify any differences between the descriptions and/or results and that provided in the 2009/2010 submittals and the current models such as the statement in the 2009 ER Section F.2.1.9 that the charging pumps were replaced with centrifugal pumps, which is not mentioned in the current submittal.

PG&E Response to RAI 1.d

Models DC01A, DC01B, and DC03 Interim (i.e., SAMA application models) are a set of interim models (versus model of record), specifically developed to be used for the SAMA analysis and/or its requests for additional information (RAIs) based on the latest PRA models at the time of the SAMA or RAI preparation.

DC01A was an interim model developed based on Model-of-Record DC01 to support PG&E Letter DCL-09-079, "License Renewal Application," Appendix E, "Applicant's Environmental Report – Operating License Renewal Stage," dated November 23, 2009. DC01A modeling included one new air-cooled centrifugal charging pump per unit. These new pumps, which are designed for normal charging injection, replace the original positive displacement pumps. The updated model takes credit for the fact that each new pump is air cooled and does not require component cooling water (CCW). Because the new pumps could continue to provide RCP seal injection in scenarios where a loss of CCW has occurred, the contribution from RCP LOCA scenarios is significantly reduced. DC01A uses the same seismic initiating event frequencies from the original Long Term Seismic Program (LTSP) PRA model. A more detailed description was provided as part of PG&E Letter DCL-09-079.

DC01B was based on DC03A, modified to address the Nuclear Regulatory Commission (NRC) RAIs on PG&E Letter DCL-09-079. This model included updated seismic hazard information that accounts for new seismic data including the Shoreline fault and use of an updated methodology. In PG&E Letter DCL-15-027, Section F.2.1, the description of DC01A and DC01B was not provided because Section F.2.1 was intended to provide description (or history) of the models-of-record leading to the PRA model used to support PG&E Letter DCL-15-027. The information in DC01A, specifically related to the new air-cooled centrifugal charging pumps was incorporated into the subsequent Model-of-Record DC02, for which a description is provided in Section F.2.1. The discussion and seismic information provided in DC01B was included in PG&E Letter DCL-15-027 model DC03 Interim.

<u>*RAI 1.e*</u>

The initiating event contributors to the internal events CDF shown in Figure F.2-1 do not include loss of offsite power (LOOP). Provide the CDF due to LOOP initiators. If included in the "otherscategory (which would appear to indicate that LOOP contributes less than 2 percent to the total internal events CDF), explain why it is so low. Note that the 2010 SAMA analysis indicated that the CDF due to grid-related LOOP was 8.9E-07/year which corresponds to 8 percent of the current internal events CDF (excluding internal flooding).

<u>PG&E Response to RAI 1.e</u>

The contributions from the LOOP initiating events from the DC03 model are as follows:

LOOP Initiating Event	Initiating Event Freq.	CDF/year
LOOPGR (grid related)	6.32E-03	1.40E-07
LOOPSW (severe weather related)	3.10E-03	9.99E-08
LOOPSR (switchyard related)	5.17E-03	9.12E-08
LOOPPC (plant centered)	6.00E-04	9.62E-09
Total LOOP		3.41E-07
% of Total Internal Events CDF		3.0%
Total Internal Events CDF		1.12E-05

The contribution from the "other" initiating event group in Figure F.2-1 is about 11 percent, which includes the 3 percent LOOP contributions.

The contribution of the grid-related LOOP in the DC03 model is much lower than the contribution reported in PG&E Letter DCL-09-079, SAMA analysis (from model DC01A) because:

(1) The frequency of the grid-related LOOP event in the DC03 (6.32E-03/year) is lower than the frequency value in the DC01A model, which was 1.40E-02/year.

(2) The unavailability of the DGs is lower in the DC03 model compared to that in the DC01A model.

The change in LOOP CDF is driven by the data update to the DG system and LOOP initiating events. No other plant design changes or PRA modeling changes contribute significantly to the difference in the DC01A and DC03 results.

RAI 1.f

Provide the station blackout and anticipated transient without scram contributions to the internal events and internal flooding CDFs for the DCPP PRA used for the SAMA analysis.

PG&E Response to RAI 1.f

The contributions from station blackout (SBO) from LOOP initiators and consequential LOOP and from anticipated transient without scram (ATWS) events are provided below:

Initiating Group	CDF from Internal Events and Internal Floods	% of Internal Events and Internal Floods
SBO	2.57E-06	23.1%
ATWS	5.24E-08	0.5%

A flood-induced ATWS event is considered a low-frequency event and its risk contribution should be negligible. The basis for not considering a flood-induced ATWS event is the same as that used in the elimination of fire-induced sequences associated with ATWS as discussed in Section 2.5 of NUREG/CR-6850. Therefore flood-induced ATWS events are not included in the Internal Floods PRA model. The ATWS CDF in the table above, therefore, represents the risk contribution only from the Internal Events.

RAI 1.g

Provide the "freeze date" or the date which corresponds to the DCPP design and operation incorporated into the DCPP PRA used for the SAMA analysis. Identify any design or operational (including fuel cycle) changes that have been made, or, are planned, since this freeze date that might impact the SAMA analysis.

PG&E Response to RAI 1.g

The freeze date for the DC03 interim model corresponds to September 9, 2014. Since the freeze date, no significant design or operational changes were made to the plant or are planned that could impact the conclusions of PG&E Letter DCL-15-027 SAMA analysis.

<u>RAI 1.h</u>

The discussion in Section F.2.3.1 (p. F-47) of the ER regarding the PRA maintenance and update procedures states:

> *"These procedures delineate the responsibilities and guidelines for updating the full power internal events PRA models at the Diablo Canyon Power Plant."*

Although guidelines for full power, internal and external events are mentioned, it is not clear whether these are included in the cited procedures or other documentation. Clarify the applicability of the cited procedures to other than internal events PRA models and if not applicable, identify the procedures that are applicable.

<u>PG&E Response to RAI 1.h</u>

The cited procedures, TS3.NR1 and AWP E-028, are both applicable to all PRA models including, internal events, internal floods, seismic events, and internal fires.

<u>RAI 1.i</u>

Section F.3.2.2 (p. F-48) lists the dates of the peer reviews of the various DCPP PRAs. Identify the specific model revisions listed in Section 2.1 reviewed by each of the peer reviews, the scope of each review and the number of findings and Facts and Observations (F&Os)) for each peer review. If the PRA model reviewed is not described in Section 2.1, provide the CDF and large early release frequency (LERF) for the model reviewed and how the model differs from the prior model.

<u>PG&E Response to RAI 1.i</u>

The table below lists the PRA models presented to the peer review team at each peer review and the PRA Standards used against for the reviews. The results (e.g., number of supporting requirements (SRs) either Not MET or MET at Capability Category (CC) II and associated facts and observations (F&Os)) of these peer reviews are discussed in detail in Attachments U and V of PG&E Letter DCL-13-065, "License Amendment Request 13-03, License Amendment Request to Adopt NFPA 805 Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants (2001 Edition)," dated June 26, 2013, as noted in NRC's RAI 1.i and only the summary of the results from those Attachments are reproduced below.

Hazard Group	Review Date	Model Associated with Review	Scope
Internal Fire	January 2008	Fire PRA in development (Note 1)	Per ANSI/ANS 58.23-2007, "Fire PRA methodology," American Nuclear Society, November 2007.
Internal Fire	December 2010	Fire PRA as of December 2010	Per Section 4 of ASME/ANS RA-Sa-2009
Internal Events	December 2012	DC02	Per Section 2 of ASME/ANS RA-Sa-2009
Internal Floods	December 2012	DC02	Per Section 3 of ASME/ANS RA-Sa-2009
Seismic Events	January 2013	DC02A (Note 2)	Per Section 5 of ASME/ANS RA-Sa-2009

Note 1: As stated in Section 1.3 of the 2008 Internal Fire Peer Review report (Westinghouse Letter, LTR-RAM-II-08-019), the peer review team recognized that the DCPP fire PRA as it existed at the time of 2008 peer review was still in development.

Note 2: DC02A is an interim model based on Model-of-Record DC02. It included the latest turbine building fragility and seismic hazard curves at the time of the seismic peer review.

Internal Fire

The 2008 peer review was conducted against the requirements of the American Nuclear Society (ANS) Standard "FPRA Methodology," ANSI/ANS-58.23-2007. At the time of this first peer review, certain technical elements of the fire PRA had not been completed, and it was agreed that the second phase of the peer review would be performed when all the technical elements of the fire PRA were completed. Because the model was in an incomplete state at the time of the peer review and was not quantifiable, it is not possible to report the corresponding CDF and large early release frequency (LERF) results.

In December 2010, the Pressurized Water Reactor Owner's Group fire PRA peer review team performed a follow-on peer review. The scope of the follow-on peer review covered:

(1) technical elements that were not reviewed in 2008,

(2) SRs that were judged to not meet the Standard,

(3) SRs associated with Findings-category F&Os issued in the 2008 review, and

(4) SRs that were not exited in the Standard used in the 2008 peer review (ANSI/ANS-58.23-2007) but added in the revised Standard used in the

2010 peer review (American Society of Mechanical Engineers (ASME)/ANS-RA-Sa-2009).

The 2010 fire PRA peer review resulted in 31 total F&Os with 17 findings, 10 suggestions, and 4 best practices.

According to the 2010 peer review, the DCPP fire PRA met CC II or better in all SRs but two (SRs CF-A1 and FSS-D7).

The fire PRA model presented to the fire PRA peer review team in 2010 is not described in Section F.2.1 because it is not considered as an official model of record. For the purpose of the peer review at that time, the model was frozen for the peer review but not officially certified as the model of record as it was being developed for a specific licensing application (i.e., National Fire Protection Association (NFPA) 805 transition) with credits for "yet-to-be" installed plant modifications (the model was not as-built/as-operated). The CDF and LERF results of the fire PRA model presented to the peer review team are:

fire CDF = 4.51E-05/year (yr).
fire LERF = 5.31E-06/yr.

This fire PRA model is considered as a completely new model compared to previous individual plant examination of external events (IPEEE) fire PRA model from both inputs (e.g., fire frequencies, fire induced failure probabilities, etc.) and methodology perspective.

Therefore description of "incremental" change to previous fire PRA model is meaningless and not provided as part of this response.

Internal Events and Internal Floods

PG&E conducted an internal events and internal floods peer review in December 2012. The full-scope peer review that included internal events and internal floods portions of the DCPP PRA was performed in accordance with Regulatory Guide (RG) 1.200, Revision 2, and ASME/ANS RA-Sa-2009. The peer review found that overall the DCPP PRA meets the ASME PRA Standard at CC II and can be used to support risk-informed applications.

The review provided F&Os regarding the model and identified 94 supporting requirements within the internal events and internal floods portions of the model that did not meet a minimum CC II. The peer review team issued 89 F&Os, including 16 "Suggestions," 72 "Findings," and 1 "Best Practice."

Model DC02 presented to the internal events and internal flood peer review team is described in Section F.2.1.

Seismic Events

PG&E conducted a seismic PRA Peer Review in January 2013. The full-scope peer review that also included a review of seismic hazard and fragility analyses was performed in accordance with RG 1.200, Revision 2, and ASME/ANS RA-Sa-2009. At the time of this review, all building analysis and fragility tasks had not been completed. The peer review team agreed that the review should be reperformed when all elements of the analysis are complete.

The DCPP seismic PRA model uses the internal events model as its basis. The internal events model of record, DC02, was peer-reviewed in December 2012, as discussed above. The seismic hazard and fragilities were being updated at the time of the seismic Event PRA Peer Review. Fragilities have been first updated for the turbine building because initial estimates (U.S. NRC to PG&E Letter, "Review of Diablo Canyon Individual Plant Examination of External Events (IPEEE) Submittal (TAC Nos. M83614 and M83615)," dated December 4, 1997, Reference 6.88) suggest that it is the single most risk significant structure from a seismic standpoint. The peer review team reviewed the methodologies used in the hazard and fragility analyses and found them to be acceptable. The seismic CDF (LERF) at the time of the peer review was 1.81E-05/yr (1.33E-06/yr). The seismic CDF from the model used for PG&E Letter DCL-15-080 is 1.27E-05/yr. This reduction in CDF is primarily due to the updated hazard curves used for the SAMA submittal.

Section 5 of the ASME/ANS Combined PRA Standard contains a total of 77 SRs under 3 technical elements. As a result of this peer review, a total of 60 F&Os were generated. These included 5 "Best Practices," 18 "Suggestions," and 37 "Findings."

RAI 1.j

Confirm that no changes have been made to the DCPP PRA model used in the SAMA analysis since the peer reviews that would constitute an upgrade as defined by ASME/ANS RA-Sa-2009, as endorsed by Regulatory Guide 1.200, Revision 2.

PG&E Response to RAI 1.j

No change has been made to the DCPP PRA model used in the SAMA analysis since the peer reviews that would constitute an upgrade as defined by ASME/ANS RA-Sa-2009, as endorsed by RG 1.200, Revision 2.

RAI 1.k

Section F.2.3.5 of the ER, Conclusion Regarding PRA Capability for SAMA Identification and Evaluation, discusses and concludes that the DCPP PRA Model DC03 results are suitable for use as a resource in the SAMA identification process.

Clarify why the discussion and conclusion does not address the suitability of the PRA model for the SAMA cost-benefit evaluation process.

PG&E Response to RAI 1.k

The SAMA cost-benefit evaluation is an integral part of the SAMA identification process. Therefore, PG&E's conclusion that the DCPP PRA model is suitable for use in the SAMA identification process implies that the DCPP PRA model is suitable also for the cost-benefit evaluation. To clarify this point, PG&E revises its licensing basis (Section F.2.3.5, Conclusions Regarding PRA Capability for SAMA Identification and Evaluation) to state, "The DCPP PRA model DC03 results are suitable for use as a resource in the SAMA identification and evaluation process."

RAI 1.l

With regard to ER, Amendment 2, Addendum 1:

i. *For the first item "Internal flooding -NRC IN 98-31 ISER 3-98, A0468801" confirm that this has not been closed in the DC02 update of internal flooding and if not provide more information on the basis for the conclusion that no direct impact on the current model is anticipated.*

ii. *For the fourth item, "Address anchorage of relay panels in cable spreading rooms," confirm that the requested analysis has been performed or otherwise justify that this is only a documentation issue.*

iii. *For the fifth item, "Address potential for d/g lockout from cardox," provide the basis for the conclusion that the impact of this issue is expected to be minor.*

PG&E Response to RAI 1.l

Item l.i

Model DC02 includes a major update to the internal floods analysis, which is based on EPRI 1019194, "Guideline for Performance of Internal Flooding Probabilistic Rick Assessment." In this update, the impacts of failure of the fire protection system including its pipe failure or spray effect of wet suppression system are incorporated into the Internal Floods PRA. With that, this item should be no longer considered as an "open" issue.

Item l.ii

The only true relay racks in the cable spreading room are auxiliary relay racks A and B (RNARA and RNARB). The fragility analysis for these racks was performed as part the original seismic PRA effort in 1988. The anchorage of RNARA and RNARB was specifically addressed in this fragility analysis.

Item I.iii

The statement of a low risk contribution due to a failure of emergency DGs (EDGs) from a seismically failed CO_2 system is based on a low combined probability/frequency of two CO_2 isolation valves in series between the CO_2 storage tank and the CO_2 discharge heads in the EDG rooms spuriously opening from their normally closed position, given a seismic event. In addition, the bi-metallic temperature sensors used to actuate CO_2 to the EDG rooms are considered mechanically actuated contacts and are not susceptible to seismically induced chatter.

RAI 1.m

The figures in ER Amendment 2 presenting the contributors to the internal fire and internal flood CDF and LERF (Figures F.2-5 through F.2-8) indicate that the contributions are by initiating event. Confirm that the contributions are by initiating event rather than fire or flood zone or if not, provide the correct description. Also, note that in Figure F.2-5, the contribution from 3BB115, while included in the figure itself, it is not included in the description table. Please add this to the table.

PG&E Response to RAI 1.m

The labels in Figures F.2-5 through F.2-8 in Environmental Report (ER) Amendment 2 are incorrect. The contributions, both for the internal flooding and internal fire models, are presented by fire area, rather than by initiating event. The percent contribution for each fire area represents the total contribution of all non-screened scenarios that are initiated in that fire area.

An updated version of Figure F.2-5 is provided in Attachment 1 to this Enclosure and includes the label for fire area 3BB115.

RAI 2

Provide the following information relative to the Level 2 PRA analysis. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the DCPP SAMA analysis, the NRC staff is evaluating PG&E's treatment of accident propagation and radionuclide release in the Level 2 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the adequacy of PG&E's Level 2 PRA model for supporting the SAMA evaluation.

RAI 2.a

Section F.2.2 of the ER describes the Level 1 to Level 2 mapping and the need for plant damage states (PDSs) and key plant damage states (KPDSs). Is the transfer of information from Level 1 to Level 2 transferred directly in the logic models or are the numerical PDS frequency results of the Level 1 analysis added and input into the Level 2 analysis (the containment event trees (CETs) as a frequency?

PG&E Response to RAI 2.a

In the original DCPP PRA, the key plant damage states (KPDSs) and their frequency values were input into the containment event tree (CET) for the quantification of the frequency of the release categories. In the PRA models used for the SAMA analysis, the CET is linked to the Level 1 PRA event tree models in the quantification of the release category frequency. Each of the accident/event sequences was quantified starting with an initiating event, through all the linked event trees and ending in the release categories. Therefore the transfer of information from Level 1 to Level 2 is done directly via the logic rules in the models.

RAI 2.b

Section F.2.2.3 of the ER discusses the development of the KPDSs and Table F.2-3. This table presents the ranking of PDSs based on PRA model DCPRA-1991 and states that "the relative ranking of PDSs and therefore the definition of KPDSs is not expected to change significantly from DCPRA-1991 to DC03." Provide further support for the final statement and discuss the role of relative ranking in the definition of KPDSs. Discuss if all PDSs that result from the Level 1 analysis assigned to a KPDS or are some grouped together as a remainder group and if so how is the remainder considered in the Level 2 analysis?

PG&E Response to RAI 2.b

In the original PRA, the KPDSs were defined to facilitate and simplify the quantification of the CETs. The definition of the KPDS was based on the top 14 plant damage states (PDSs) and two additional PDSs leading the containment bypass. This was done to ensure that the impacts of important core damage scenarios on the containment performance as modeled in the CET are captured. Analyses were performed to fully understand progression of accidents for scenarios associated with these KPDSs. Instead of defining KPDSs based on the new relative ranking of the PDS of the PRA models used in the SAMA analysis, the original KPDSs were retained for the following reasons:

(1) The characteristics of the accident scenarios associated with each KPDS are known and the impact of each KPDS on the top events of the CET has been established.

(2) The KPDS has the most severe impact on plant risk of all the PDS mapped to it; therefore, any re-ordering of the PDS frequencies would not impact the KPDS definition.

As discussed in Section F.2.2.2, the complete PDS matrix shown in Table F.2-2 contains a total of 384 PDSs. However some of the PDSs were not defined in the Level 1 analysis because some were precluded by DCPP design features, by the type of initiating event, modeling assumptions and simplification, or any combination of these reasons.

Core damage sequences not mapped to the modeled PDSs, especially those PDSs screened due to modeling assumptions and simplification were captured as a "remainder" group. The relative core damage frequency contribution of the remainder group is less than one percent of the total core damage sequences. Since the core damage sequences in the remainder group are not specifically mapped to any PDS, no KPDS was assigned to the remainder group. However these sequences were still included in the Level 2 analysis, by conservatively assigning them to the Large Early Release Category (i.e., ST1).

This modeling simplification (that is, use of a default group to capture core damage sequences that were not mapped to pre-defined PDSs and therefore to KPDSs) would not change the conclusions of the SAMA analysis, including the SAMA identification and cost-benefit analysis as: (1) the relative frequency contribution from this remainder group is small (less than 1 percent), (2) the modeled PDSs are defined to capture core damage sequences important to the Level 2 analysis, and (3) the core damage sequences in the remainder group were conservatively assigned to a release category with the second largest consequences in the model.

This can be demonstrated in a bounding manner by applying the ST5 dose-risk and offsite economic cost–risk results to the entire ST1 release category, rather than just the fraction risk related to the "remainder" group. As shown in Table 2.b-1, this bounding assessment would not result in the identification of any additional potentially cost beneficial SAMAs even when the 95th percentile PRA results are applied in conjunction with the binning of the "truncated frequency" to ST5.

Table 2.b-1: Bounding Impact of Binning the Unmapped Frequency to ST5 Instead of ST1

SAMA ID	Implementation Cost (per unit)	Averted Cost Risk (DC03SA, Trunc. Freq. to ST5, 95th Percentile, base source terms)	Net Value (DC03SA, Trunc. Freq. to ST5, 95th Percentile, base source terms)	Averted Cost Risk (DC03SA, Trunc. Freq. to ST5, 95th Percentile, ST5 also applied to ST1)	Net Value (DC03SA, Trunc. Freq. to ST5, 95th Percentile, ST5 also applied to ST1)	Change in Cost Effectiveness?
SAMA 1	$3,020,424	$2,013,102	-$1,007,322	$2,025,372	-$995,052	No
SAMA 2	$17,492,616	$1,391,844	-$16,100,772	$1,417,311	-$16,075,305	No
SAMA 3	$376,342	$2,703,105	$2,326,763	$3,468,411	$3,092,069	No
SAMA 5	$3,133,404	$117,048	-$3,016,356	$117,045	-$3,016,359	No
SAMA 6	$9,993,910	$1,080,687	-$8,913,223	$1,286,277	-$8,707,633	No
SAMA 7	$10,616,468	$1,193,169	-$9,423,299	$1,205,439	-$9,411,029	No
SAMA 8	$1,072,493	$543,492	-$529,001	$561,891	-$510,602	No
SAMA 9	$25,520,160	$289,614	-$25,230,546	$301,881	-$25,218,279	No
SAMA 10	$22,572,878	$3,354,510	-$19,218,368	$4,647,003	-$17,925,875	No
SAMA 12	$13,560,218	$3,354,510	-$10,205,708	$4,647,003	-$8,913,215	No
SAMA 14	$5,620,896	$902,535	-$4,718,361	$1,018,530	-$4,602,366	No
SAMA 16	$372,788	$738,450	$365,662	$821,913	$449,125	No
SAMA 17	$9,610,440	$535,269	-$9,075,171	$541,401	-$9,069,039	No
SAMA 20	$11,173,059	$2,700,003	-$8,473,056	$4,102,353	-$7,070,706	No
SAMA 21	$256,817	$4,980,264	$4,723,447	$6,118,092	$5,861,275	No
SAMA 22	$13,083,120	$150,897	-$12,932,223	$215,031	-$12,868,089	No
SAMA 23	$491,021	$7,062	-$483,959	$7,062	-$483,959	No

RAI 2.c

The discussion of release category binning in Section F.2.2.4.1 of the ER includes the statement:

> *"For early-small containment failures, the medium pressure sequences are binned with the high pressure sequences because containment pressures may be greater later in the event and high RCS (reactor coolant system) retention then becomes a liability."*

Table F.2-5 indicates that for small early release categories, the medium pressure sequences are binned with the low pressure sequences. In addition, Table F.3-11 of the ER describes the Modular Accident Analysis Program (MAAP) case RC16U as low pressure core melt while the description of the small early release category in Section F.2.2.4.2 states "Other cases within this release category group would either have medium to low RCS pressure..." Explain this binning and the selection of the representative MAAP case for the small early release category.

PG&E Response to RAI 2.c

PG&E revises its licensing basis for SAMA Report, Section F.2.2.4.1, to state:

> "For early-small containment failures, the medium pressure sequences are binned with the ~~high~~ low pressure sequences because ~~containment pressures may be greater later in the event and high RCS retention then becomes a liability~~ less retention in the RCS becomes a liability."

For early release sequences regardless of the size of existing containment failure (i.e., small or large), a lower RCS pressure could result in release of a higher fraction of radionuclides (i.e., less retention) than a higher RCS pressure at the time of the reactor vessel failure. Therefore, grouping early release sequences of the medium RCS pressure with the low pressure sequences is conservative.

The Modular Accident Analysis Program (MAAP) case (RC16U) is selected for core damage sequences in which all coolant injection, auxiliary feedwater (AFW) supply, and containment spray are lost. The initial RCS pressure is high at core damage and drops to low pressure due to hot leg creep rupture before vessel breach due to core melt-through. There are no other containment failure modes due to the initial small preexisting leak which prevent containment over-pressurization from occurring. Releases are through the preexisting leak path(s).

RAI 2.d

Table F.3-11 of the ER identifies the representative MAAP case for ST3 as RC10 and describes it to include "CS OK." RC10 is indicated in Table F.2-5 to not have containment sprays available. The Section F.2.2.4.2 description of ST3 indicates that containment fails due to prolonged core-concrete interaction, while RC10 is indicated to have coolable debris. Please clarify.

PG&E Response to RAI 2.d

The representative MAAP case for ST3 (RC10) does not model containment sprays. Table F.3-11 should indicate that containment sprays are not available. However, following vessel breach, there is enough water ejected from the vessel and accumulators to maintain coolable debris for the duration of the scenario. Section F.2.2.4.2 should indicate that the ST3 representative MAAP case results in containment failure due to overpressure caused by steam generation, not prolonged core concrete interaction (CCI). Prolonged CCI does not occur in the representative MAAP scenario.

Approximately 60 percent of the ST3 release categories result in successful debris coolability and 73 percent of the category results in a small containment failure. Additionally, the general characteristics of a late release include substantial time available for passive removal of fission products within the containment such that the source term is significantly reduced. This additional time to containment failure also provides time for additional resources to be brought onsite. This assumption is supported by the U.S. nuclear industry's FLEX strategy. Portable site equipment in addition to readily available offsite resources following a severe accident lend credibility to the likelihood that containment or reactor pressure vessel (RPV) injection can be provided to cool core debris in a reasonable time period if containment failure occurs within the "late" timeframe.

RAI 2.e

Section F.2.2.4.2 of the ER provides a discussion of assigning non-isolated SGTR with Auxiliary Feedwater (AFW) success to the interfacing system loss of cooling accident (ISLOCA) release category. Provide a further discussion of these sequences and the basis for this assignment. The discussion includes the statement "RC18 was reviewed to see if there are any sequences with AFW successful that should be allocated to the Containment Bypass group. None were found." Since RC18 is composed of ISLOCAs it is not clear why AFW availability is relevant. Explain.

PG&E Response to RAI 2.e

The statement should read:

> "However, the non-isolated SGTR (SGTRN) initiated sequences with**out** AFW success can also end up in RC18 which are better characterized as ISLOCA with regard to Level 2 offsite release."

Note that core damage sequences initiated by a SGTRN are assumed to lead to a large early release. However, SGTRN core damage sequences without a failure of the feedwater function have sufficient secondary side inventory to scrub fission products to the extent that they can be considered small releases. Guidance in Section P.2.3 of Reference 1 indicates that, "releases to the environment (for SGTR) can be substantially reduced by flooding the break location in the SG and allowing the accumulated water pool to scrub the release." Section V.2 of Reference 1 also indicates that, "Water is a very effective scrubbing media providing a DF (decontamination factor) of 10 or greater with limited water depths, even when the water is essentially saturated," and, "The deeper the water over the release point into the pool, the greater the decontamination factor. However, a submerged depth of a few meters is essentially an infinite depth." Therefore assigning SGTRN sequences with AFW to the release category RC17 and SGTRN sequences without AFW to release category RC18 is reasonable.

The statement: "RC18 was reviewed to see if there are any sequences with AFW successful that should be allocated to the Containment Bypass group. None were found." will be deleted from the text as the availability of AFW is not relevant to ISLOCA sequences.

Reference:

1. EPRI TR-1025295-V2, Final Report, "Severe Accident Management Guidance Technical Basis Report – Volume 2: The physics of Accident Progression," October 2012

RAI 2.f

Table F.2-7 of the ER gives the frequency of RC17 as 3.59E-06/year and the frequency of RC18 as 1.28E-08/year. Fifty percent of RC17 yields 1.79E-06/year for the frequency of ST4, in agreement with the frequency for ST4 in Table F.3-13. Fifty percent of RC17 added to the above value for RC18 yields 1.8E-06/year which is different from the value for ST5 given in Table F.3-13 of 2.97E-06/year. Explain this difference and describe the basis for the 50 percent value.

PG&E Response to RAI 2.f

The value for ST5 given in Table F.3-13 of 2.97E-06/yr includes the frequency of RC18 (1.28E-08/yr), 50 percent of RC17 (1.80E-06/yr), and the seismic frequency of greater than 4.0 g (1.16E-06/yr). As discussed in Section F.2.1.10, the seismic initiating frequencies were updated including a new seismic initiating event category for greater than 4.0 g event. The treatment of this new seismic initiator is discussed in Section F.2.2.4.2. Considering the severity of such high group acceleration level (i.e., high conditional core damage probability (CCDP)), the frequency of the seismic initiator with greater than 4.0 g is allocated to the ISLOCA group (i.e., ST5).

The 50 percent of RC17 allocated to ST5, as mentioned above, is based on a calculation of the frequency contribution to RC17 sequences from the initiator SGTRN. Those sequences initiated by a SGTRN are conservatively binned to ST5 based on their release characteristics. These are sequences in which feedwater is not available in the SG to provide scrubbing of the releases.

RAI 2.g

Provide an updated version of Table F.2-7 of the ER based on the results of the DC03SA PRA.

PG&E Response to RAI 2.g

The following table is Table F.2-7 updated with model DC03SA PRA results. Note that since greater than 4g seismic events are not modeled in the seismic PRA, this frequency is binned to ST5 for interfacing system LOCA.

Table F.2-7
Based on DC03SA PRA Results
Mapping between Release Category Group, Individual Release Category, and Key Plant Damage State

Release Category Group Name	Release Category Group	Release Category	Frequency	KPDS (note 1)
ST1	Large, Early Containment Failures	RC01	3.73E-10	SXYAI
		RC01U	8.26E-11	SXYAI
		RC02	5.19E-06	SXNNS
		RC02U	7.96E-11	SXYCI
		RC03	8.46E-11	SXYAI
		RC03U	1.40E-09	SXYAI
		RC04	1.26E-06	HAYDI
		RC04U	9.08E-08	HAYDI

Table F.2-7
Based on DC03SA PRA Results
Mapping between Release Category Group, Individual Release Category, and Key Plant Damage State

Release Category Group Name	Release Category Group	Release Category	Frequency	KPDS (note 1)
ST2	Small, Early Containment Failures	RC13	6.20E-13	SXYAI
		RC13U	1.02E-13	Note 2
		RC14	3.37E-06	SXNNS
		RC14U	9.88E-07	SXNNS
		RC15	0.00E+00	Note 2
		RC15U	3.05E-12	SXYAI
		RC16	2.79E-10	HANNS
		RC16U	2.33E-06	SXNNS
ST3	Late Containment Failures	RC05	9.66E-11	SXYAI
		RC05U	0.00E+00	Note 2
		RC06	8.72E-06	HAYDI
		RC06U	2.37E-06	HANNI
		RC07	1.83E-11	SXYAI
		RC07U	0.00E+00	Note 2
		RC08	1.82E-08	HAYDI
		RC08U	3.69E-06	HAYDI
		RC09	0.00E+00	Note 2
		RC09U	0.00E+00	Note 2
		RC10	2.73E-05	HAYDI
		RC10U	7.34E-06	HANNI
		RC11	0.00E+00	Note 2
		RC11U	0.00E+00	Note 2
		RC12	6.50E-08	HAYDI
		RC12U	1.08E-05	HAYDI
		RC21	2.16E-06	INYCI
ST4	Containment Bypass	RC17[4]	1.76E-06	INNGB
ST5	Interfacing System LOCA	RC18	4.00E-06[5]	INNGV
ST6	Long-Term Containment Intact	RC19	8.63E-07	Note 3
		RC20	1.24E-06	SXYAI

Note 1: The assignment of a representative key plant damage state (KPDS) to each release category is based on Table 4.7-4 of the individual plant examination (IPE) submittal.
Note 2: No KPDS is assigned because of zero or very low release frequency.
Note 3: Non-severe Core Damage Sequence
Note 4: The frequency of sequences initiated by STGR with containment not isolated (SGTRN) are allocated to ST5. SGTRN contributes approximately 50% to the frequency of ST4, the remainder is moved to ST5.
Note 5: Total interfacing system LOCA includes > 4 g seismic frequency.

RAI 2.h

Table F.3-11 of the ER provides the MAAP run times for each of the release category source term cases. Justify that the source term release fractions from these run durations represents the maximum release whenever the run end time is less than 48 hours after the declaration of general emergency.

PG&E Response to RAI 2.h

Table 2h-1 below provides justification of the MAAP scenarios with run durations less than 48 hours after the General Emergency is declared. It is noted that release fractions for CsI and CsOH are primary contributors to offsite early dose (i.e., CsI) and offsite long term dose and cleanup costs (i.e., CsOH) in the MACCS2 analysis. Therefore these release fractions are specifically noted for the evaluated MAAP cases.

Table 2h-1
MAAP Scenario Adequacy Assessment

Release Category / Representative MAAP Scenarios	Time After SCRAM When General Emergency (GE) is Declared (Hours)	Scenario End Time (Hours)	Scenario End Time Justification
LEARLY/RC04U	2.6	48	The LEARLY MAAP case results in catastrophic failure of containment and a plateau of release fractions by t=5 hours. From t=5 hours to t=48 hours there is a negligible increase in CsI and CsOH release fractions. Given the stable trend of the release fractions after 5 hours, no additional significant releases would be expected to occur out to 48 hours after the General Emergency.
SMEARLY / RC16U	2.8	48	The SMEARLY MAAP case results in failure of containment and a plateau of release fractions by t=9 hours. From t=9 hours to t=48 hours there is a negligible increase in CsI and CsOH release fractions. Given the stable trend of the release fractions after 9 hours, no additional significant releases would be expected to occur out to 48 hours after the General Emergency.

Table 2h-1
MAAP Scenario Adequacy Assessment

Release Category / Representative MAAP Scenarios	Time After SCRAM When General Emergency (GE) is Declared (Hours)	Scenario End Time (Hours)	Scenario End Time Justification
BYPASS w AFW / RC17 W AFW	36	72	The BYPASS w AFW MAAP case represents a SGTR at t=0 with AFW available. The General Emergency declaration for this case is assumed to occur at t=36 hours. The CsI and CsOH release fractions exhibit a plateau and AFW is maintaining the water level in the steam generators above the tubes at the end of the run. Given a relatively low containment pressure at this time, continued operation of AFW, a release pathway through the SGTR that is submerged under water, a decreasing debris temperature, and a plateau in the CsOH and CsI release fractions, additional releases out to 48 hours after the General Emergency are expected to be negligible. Additionally, resources would likely be available prior to the scenario end time of 72 hours. This assumption is supported by the U.S. nuclear industry's FLEX strategy. Portable site equipment in addition to readily available offsite resources following a severe accident lend credibility to the likelihood that containment or RPV injection can be provided to cool core debris in a reasonable time period if the scenario length is 72 hours.
ISLOCA / RC18	1.1	48	The ISLOCA MAAP case results in a failure of containment integrity with nearly all the release occurring within by t=10 hours. There is a plateau of release fractions by t=40 hours. The release fractions of CsI (0.87) and

Table 2h-1
MAAP Scenario Adequacy Assessment

Release Category / Representative MAAP Scenarios	Time After SCRAM When General Emergency (GE) is Declared (Hours)	Scenario End Time (Hours)	Scenario End Time Justification
			CsOH (0.85) indicate most of the CsI and CsOH has been released by this time. From t=40 hours to t=48 hours there is negligible increase in any radionuclide release fraction. Given the very large release of CsI and CsOH and the stable trend of the radionuclide release fractions after 40 hours, no additional significant releases would be expected to occur out to 48 hours after the General Emergency.
INTACT / RC20	6.9	48	The INTACT MAAP case represents a containment intact scenario following core damage. The only releases to the environment are those associated with postulated technical specification containment leakage. At the end of the scenario the core is being maintained in a safe, stable state via injection and containment heat removal is active so further radionuclide release out to 48 hours after the General Emergency would remain negligible (i.e., containment is intact and release is limited to technical specification design limits).

RAI 2.i

i. It is noted that the sum of DC03 model release categories ST1 and ST5, both leading to a large early release, is 1.02E-05 per year while the quoted value for LERF for Unit 1 is 1.20E-05 per year. Explain the reasons for the difference. If this is due to Level 2 model changes compared to a LERF only model, describe the changes from the peer reviewed LERF model to the current full Level 2 model.

<u>PG&E Response to RAI 2.i</u>

The containment bypass core damage sequences due to SGTRN (Release Category RC17, or group ST4) are also (conservatively) treated as large early release sequences in addition to the interfacing system LOCA (Release Category RC18, or group ST5) sequences and the release category group ST1 sequences in the DC03 PRA model. Therefore the Unit 1 total LERF value of 1.20E-05/yr reported in Section F.2.10 for Model DC03 (Interim) includes the frequencies from Release Category Groups ST1, ST4, and ST5.

<u>RAI 2.j</u>

Provide a discussion of the development of the Level 2 model, particularly the CETs, the basis for the CET split fractions, and updates since the individual plant examination to represent the current state of the art.

<u>PG&E Response to RAI 2.j</u>

The PG&E response to RAI 2.a provided in PG&E Letter DCL-10-106, "Response to NRC Letter dated July 6, 2010, Request for Additional Information for the Applicant's Environmental Report – Operating License Renewal Stage," dated August 27, 2010, is still valid and there were no Level 2 changes made in the DC03 and DC03SA model used in support of PG&E Letter DCL-15-027 and PG&E Letter DCL-15-080 SAMA updates.

<u>RAI 3</u>

Provide the following information with regard to the treatment and inclusion of external events in the SAMA analysis. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the DCPP SAMA analysis, the NRC staff is evaluating PG&E's treatment of external events in the PRA models. The requested information is needed in order for the NRC staff to reach a conclusion on the sufficiency of PG&E's PRA models for supporting the SAMA evaluation.

<u>RAI 3.a</u>

Provide the total seismic CDF and LERF for the DC03SA model and the contribution to the seismic CDF by initiating event. Include the contribution from the new initiating event for ground motion accelerations greater than 4.0g for both the DC03 as well as DC03SA models.

PG&E Response to RAI 3.a

The following table provides the seismic initiating event (seven contributors and six model initiators) contribution to CDF and LERF in the DC03SA model. Note that the contribution from acceleration greater than 4g is not explicitly modeled in the PRA. In the SAMA analysis the entire frequency from greater than 4g is assumed to go directly to core damage and large early release.

Seismic IE Contribution to CDF

Initiating Event	Spectral Acceleration Range (g)	DC03 CDF	DC03SA CDF
Seis1	0.2 - 1.25	1.43E-06	7.56E-07
Seis2	1.25 - 1.75	1.82E-07	9.12E-08
Seis3	1.75 - 2.0	8.33E-07	2.78E-07
Seis4	2.0 - 2.5	2.97E-06	1.93E-06
Seis5	2.5 - 3.0	3.78E-06	3.02E-06
Seis6	3.0 - 4.0	4.11E-06	4.43E-06
n/a	> 4g	1.16E-06	2.23E-06
Total		1.45E-05	1.27E-05

> 4g Contribution to CDF by Model

Model	> 4g Frequency
DC03	1.16E-06
DC03SA	2.23E-06

The total DC03SA seismic LERF is 5.84E-06.

RAI 3.b

Section F.2.3.2 of the ER indicates that a peer review of the seismic events model was conducted in January 2013 and states:

> *"The update of the seismic fragilities of PRA SSCs is currently in progress. Once the update is completed in 2015, the seismic F&Os will be resolved followed by the update of the Seismic model."*

Page 1 of the PG&E Letter DCL-15-080 submittal states:

> *The DC03SA model uses the same fragilities as the DC03 model. The Long Term Seismic Program (LTSP) fragility curves are acceptable for use in DC03SA because no scaling is necessary for use with the updated hazard spectral information from the March 2015 50.54(f) response.*

RAI 3.b.i

The first statement indicates that changes to seismic fragilities were being made subsequent to the DC03 (interim) model, yet the second statement indicates that no changes were made from those used in the LTSP. Explain.

PG&E Response to RAI 3.b.i

As stated in the PG&E Letter DCL-15-080 SAMA update, the fragilities in the DC03SA model are from the original LTSP analysis with the exception of the updated turbine building fragility. In addition, as part of the DCPP IPEEE seismic PRA update, PG&E updated the fragilities for the following components/systems:

- 230-kV system
- safety related block walls
- diesel generator control panel contact chatter
- containment spray system

PG&E is developing updates to the seismic fragilities of PRA structures, systems, and components (SSCs) as part of the ongoing Section 50.54(f) seismic PRA update. The updated seismic PRA will be peer reviewed.

RAI 3.b.ii

The first statement implies that the only seismic F&Os unresolved involve the seismic fragilities. Confirm that all the findings from the 2013 peer review have been resolved.

PG&E Response to RAI 3.b.ii

PG&E conducted a seismic PRA peer review in January 2013. This full-scope peer review was performed in accordance with RG 1.200, Revision 2, and ASME/ANS RA-Sa-2009. At the time of this review, all building analysis and fragility tasks had not been completed. However, the reviewers concluded that the methodologies used in the probabilistic seismic hazards analysis (PSHA), fragility analysis and plant logic modeling were sufficient for the purposes of the seismic PRA.

As part of the required 10 CFR 50.54(f) update to the seismic PRA, the seismic PRA will be peer reviewed and PG&E expects to address all remaining 2013 seismic PRA peer review F&Os. A new full scope seismic PRA peer review is scheduled following the completion of the update.

<u>*RAI 3.b.iii*</u>

Page 1 of the PG&E Letter DCL-15-060 submittal provides a comparison of the LTSP uniform hazard spectrum with the updated spectral information indicating that in one frequency range the shapes may differ by plus or minus 14 percent. Provide an additional discussion of this comparison and of the potential impact of a 14 percent difference in spectral shapes on seismic risk in general and the SAMA analysis in particular.

<u>PG&E Response to RAI 3.b.iii</u>

As discussed in PG&E Letter DCL-15-080 for PRA model DC03SA, the frequency range which may differ by plus or minus 14 percent is the 3-8.5 Hz range. A sensitivity analysis was performed (DC03SAS1 Sensitivity Case) by decreasing the median capacity of the components sensitive to frequencies less than 5 Hz where the spectral shape difference is most pronounced. The only PRA modeled components with fundamental frequencies in this region are the 4-kV and 480-V transformers as well as the containment structure. This sensitivity analysis concluded that a 15 percent decrease in the median capacity of these components yields a 7 percent increase (change in CDF of 9.09E-07) in seismic CDF.

As shown in PG&E Letter DCL-15-080 and PG&E Response to RAI 3.a, the total seismic CDF decreased approximately 12 percent from 1.45E-05 (DC03) to 1.27E-05 (DC03SA) when PRA model DC03 was updated with the most current seismic hazard. The total seismic CDF for the sensitivity analysis (DC03SAS1 Sensitivity Case) is 1.36E-05 which is less than the DC03 total seismic CDF of 1.45E-05. This sensitivity analysis conservatively ignores the effect of the lower spectral shape of the GMRS versus the LTSP hazard at frequencies above 5 Hz.

A comparison of the DC03SA averted cost risk values from the most conservative sensitivity case (truncated frequency/95th percentile) to the implementation costs shows that there is a good deal of margin for those SAMAs that are not already cost beneficial. Because of the amount of margin and the relatively small increase in CDF for the fragility sensitivity case (7 percent of seismic CDF, which correlates to approximately 1.1 percent of the total CDF), the impact of the different spectral shape will not impact the conclusions of the SAMA analysis.

PG&E is developing updates to the seismic fragilities of PRA SSCs as part of the ongoing Section 50.54(f) seismic PRA update.

<u>*RAI 3.b.iv*</u>

The PG&E Letter DCL-15-080 discussion indicates that at other hazard levels relevant to the PRA model (1E-03 to 1E-05) the shape does not differ significantly from the shape at 1E-04 hazard level. Since the new (greater than 4.0 g) seismic *initiating event has a frequency on the order of 1E-06, are the conclusions in the ER concerning the spectral shape at this lower hazard level?*

PG&E Response to RAI 3.b.iv

A comparison of the 1E-06 hazard level spectral shape was made to the LTSP uniform hazard shape. It was found that the 1E-06 spectral shape is approximately 21 percent higher at 1.5 Hz. This difference in spectral shape is not expected to have a significant impact on the results of the seismic PRA for the following reasons:

(1) There are no structures or components modeled in the seismic PRA with fundamental frequencies less than 3 Hz where the spectral shape difference is most pronounced.

(2) Although the spectral shape difference is more pronounced for the 1E-06 hazard level than for lower hazard levels, the impact of spectral shape on CDF for seismic initiating events greater than 4.0 g is not significant since the CCDP for this level of ground motion is very close to 1.0.

Accordingly, any change in component or structural fragility values as a result of this difference in spectral shape will not significantly impact the CDF or by extension the SAMA results.

RAI 3.c

Provide a further description of the development of the fire PRA used for the SAMA analysis, including its relationship to the individual plant examination – external events (IPEEE) model and the model revision(s) that incorporated the guidance of NUREG/CR-6850.

PG&E Response to RAI 3.c

The model used for the IPEEE submittal has been revised several times since the late 1990s. The subsequent revisions involved changes identified through periodic review of operating procedures, design changes, etc. The fire PRA models DC03 and DC03SA used for the SAMA analysis completely replaced the IPEEE fire PRA model, and was developed based on the guidance of NUREG/CR-6850 and other NRC-endorsed or approved documents (e.g., NFPA 805 Fire PRA FAQs).

RAI 3.d

Discuss the inclusion in the fire PRA used in the SAMA analysis of the changes resulting from and/or required by the NRC review of transition to NFPA 805 application. If not included, provide the CDF and LERF results by hazard class from

PG&E's response to the NFPA 805 transition integrated analysis RAI and discuss the reasons for any differences in results between the models and their impact on the SAMA analysis.

PG&E Response to RAI 3.d

During preparation of the PG&E Letter DCL-15-027 SAMA update, PG&E Letter DCL-13-065 (the NFPA-805 License Amendment Request) was still being reviewed by the NRC and PG&E was in the process of preparing responses to NFPA-805 RAIs. The fire PRA model used for the PG&E Letter DCL-15-027 SAMA update included changes reflecting responses to some of the RAIs as they became available and routine PRA model updates performed as discussed in Section F.2.1.10 of the 2009 SAMA analysis. No plant modification was introduced since the PG&E Letter DCL-15-027 SAMA update that could significantly affect the risk profile of the PRA model used for the PG&E Letter DCL-15-027 SAMA analysis. At the time of this writing, PG&E has incorporated responses to all NFPA-805 RAIs in the PRA models frozen to support the NFPA-805 transition integrated analysis (i.e., NFPA-805 PRA RAI-03). The difference between the SAMA model and the NFPA 805 transition integrated analysis will not impact the SAMA analysis.

The table below provides the CDF and LERF results of the PRA models used to support the integrated analysis by hazard class and unit.

Unit 1 CDF and LERF results of the integrated analysis model by hazard class

	Internal Event	Internal Floods	Internal Fire	Seismic Event
CDF (per year)	1.13E-05	7.91E-06	4.83E-05	2.62E-05
LERF (per year)	1.70E-06	2.93E-07	2.45E-06	2.71E-06

Unit 2 CDF and LERF results of the integrated analysis model by hazard class

	Internal Event	Internal Floods	Internal Fire	Seismic Event
CDF (per year)	1.13E-05	5.59E-06	5.24E-05	2.62E-05
LERF (per year)	1.70E-06	2.14E-07	2.17E-06	2.71E-06

The changes in the seismic risk are mostly due to changes to the seismic hazard information.

The small changes in fire risk are due to incorporation of additional NFPA-805 RAIs, mostly from fire PRA modeling refinements.

RAI 3.e

PG&E's flood hazard evaluation of March 11, 2015 in response to the 10 CFR 50.54(f) request includes in Section 3.6.4.2 the statement

"Based on the above assumptions, the probability of a large marine vessel arriving at the DCPP breakwater and impacting the intake structure was determined to be 3.1E-05 events per year."

Provide support for the continued use of the IPEEE ship impact CDF considering the 3.1E-05 events per year value given in the flood hazards report and/or an updated value of CDF that is appropriate for the conditions associated with flood hazard impact frequency. Discuss the effect of any changes in the ship impact CDF value on the results of the SAMA analysis.

PG&E Response to RAI 3.e

The CDF value was calculated based on: (1) the frequency of the ship impact, 3.1E-05 event per year, provided in the PG&E Flood Hazard Evaluation, and (2) the same CCDP value of 1.27E-02 used in the IPEEE is 3.94E-07 per year as compared to the CDF value of 1.90E-08 per year used in the SAMA analysis.

The External Event (EE) Multiplier based on the IPEEE CDF value of 1.90E-08 per year and used to calculate the EE maximum averted cost-risk (MACR) is 1.03 as shown in Section F.4.5.2 of the SAMA analysis. The EE multiplier would increase to 1.04 if the IPEEE CDF value (1.90E-08 per year) for the ship impact is replaced with that (3.94E-07 per year) based on using the frequency in the flood hazard evaluation. This translates into an increase of approximately $93,600 for the total MACR (from $9,640,262 to $9,733,857). This small increase in the total MACR does not change the conclusions of PG&E's Phase 1 SAMA analysis, Phase 2 SAMA analysis, or SAMA Uncertainty analysis including 95th percentile sensitivity analysis.

The potential averted cost-risk (PACR) for the ship impact will also increase from $2,100, which is the base ship impact PACR calculated for the DC03SA model, to $43,538. The PACR dollar value of $43,538 for the ship impact is still below the review threshold of $100,000. Even at the PACR dollar value of $43,538, no potentially cost beneficial SAMA(s) for the ship impact risk are expected. Therefore, using a higher CDF value for the ship impact based on PG&E Flood Hazard Evaluation has insignificant impact on the MACR and PACR dollar values and will not change the conclusion of the SAMA analysis as submitted in PG&E Letter DCL-15-080.

RAI 4

Provide the following information relative to the Level 3 PRA analysis. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the DCPP SAMA analysis, the NRC staff is evaluating PG&E's analysis of *consequences in the Level 3 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of PG&E's Level 3 PRA model for supporting the SAMA evaluation.*

RAI 4.a

In Section F.3.1 of the ER, it is stated that "The MACCS2 code is being used in a slightly updated fashion ..." Clarify what is meant by 'updated fashion'.

PG&E Response to RAI 4.a

The full sentence from Section F.3.1 states:

> "The MACCS2 code is being used in a slightly updated fashion to support the current state-of-the-art reactor consequence analysis (SOARCA) being performed by the NRC."

The "slightly updated fashion" statement in this sentence is meant to refer to the development and use of WinMACCS in the NRC's SOARCA study. This section of the ER is intended to show the pedigree of the MACCS2 code and its continued use by the NRC for state of the art applications. As indicated in Section F.3.1 of the ER, the use of the MACCS2 code is consistent with NEI 05-01, as endorsed by the NRC in LR-ISG-2006-03.4. The DCPP MACCS2 model was developed in accordance with NEI 05-01.

RAI 4.b

In Section F.3.1 of the ER, uncertainty is discussed. Briefly describe/expand why the mean consequence is expected to be minor (e.g., there are no single contributing effects that could significantly impact the mean).

PG&E Response to RAI 4.b

The full sentence from Section F.3.1 states:

> "While the uncertainty band associated with the consequence results for any single release could be postulated to be greater due to the complex terrain (e.g., a mountain valley channeling a release to a population center), the effect on the mean consequence results is expected to be minor."

In the DCPP SAMA analysis, releases are postulated to occur throughout the year based on weather bin sampling, and in all directions (i.e., use of wind-shift with rotation) for an analysis distance of 50 miles. The result is that the MACCS2 mean results for a given release category are based on thousands of individual postulated releases. The potential impact of very local geographic features are generally expected to have a small impact on the mean because such features are generally expected to only influence a small portion of the total releases analyzed. Therefore, the mean consequence results are judged to adequately capture potential uncertainty with the MACCS2 model.

Additionally, sensitivity analyses in the report examined inputs such as deposition velocity, meteorological data, economic inputs, and radionuclide release characterizations and found that the uncertainty associated with these inputs is well within the uncertainty range associated with the 95th percentile PRA sensitivity. Additionally, realistically bounding values for the base MACCS2 model inputs and the sampling methodology employed for incorporating uncertainty with meteorological data ensures that the mean consequence value is appropriate to represent the SAMA study.

RAI 4.c

In Section F.3.2 of the ER, it is stated that "Individual growth rates were calculated for each grid element based on the county growth rate and the proportion of land in each grid element associated with the applicable counties." Clarify that this is the county population averaged over the county area, and the population is then partitioned to the spatial elements by the land fraction. Also, address whether there were any high population density regions near the edges of a spatial element that could distort the spatial assessment.

PG&E Response to RAI 4.c

Individual county growth rates are based on county growth averaged over the county area, and the growth is partitioned to the spatial elements based on the land fraction of the county inside each element. Figure 2.8-1 of the ER Appendix E depicts the land use for the 50-mile radius and shows that the land is primarily rural. There are no large high population-density regions that are judged to skew the population growth distribution in a spatial element to be non-conservative. Additionally, per Appendix E, Section 2.6.1 of the ER:

> "The population distribution within a 50-mile radius of DCPP is generally considered rural. Minor exceptions to this are Atascadero (21 miles north-northeast), San Luis Obispo (12 miles east-northeast), Five Cities encompassing Arroyo Grande, Grover Beach, Pismo Beach, Oceano, and Shell Beach (15 miles southeast) and Santa Maria (29 miles southeast)..."

As indicated by the text and Figure 2.8-1, all of these population centers are completely contained within the 50-mile radius of the plant. The 50-mile radius of the plant does not intersect any major metropolitan area so distortion of grid element growth factors would be insignificant.

RAI 4.d

In Section F.3.2 of the ER, it is stated that projected populations were obtained from the California Department of Finance. Identify the date the data was accessed. Also, confirm that the population projections were taken directly from the California Department of Finance projections and not separately estimated by PG&E.

PG&E Response to RAI 4.d

The DCPP SAMA analysis utilizes county population projections from the California Department of Finance (http://www.dof.ca.gov/research/demographic/reports/projections/P-1/), accessed August 28, 2014. This population projection data includes population estimates for the year 2045, the end year for the DCPP license extension. Growth rates were derived from this data by calculating growth from the year 2010 to the year 2045. No extrapolation of this data was required to determine growth rates.

RAI 4.e

In Section F.3.3 of the ER, what is the "year 2012 CPI"?

PG&E Response to RAI 4.e

The annual consumer price index for the year 2012 was estimated by the U.S. Bureau of Labor Statistics (BLS) to be 229.6. This information is available on http://data.bls.gov.

RAI 4.f

In Sections F.3.5 and F.4.5 of the ER, the original SAMA analysis used an electrical net power output of 1138 megawatt electric (MWe) and thermal output of 3411 megawatt thermal (MWt). The current SAMA analysis uses an electrical net power output of 1180 MWe and thermal output of 3411 MWt. Discuss why the thermal power is not increased with the increased electrical output. If the thermal power should be increased, address the potential impact on the core inventory and the SAMA analysis results.

PG&E Response to RAI 4.f

A net electrical power output of approximately 1138 MWe was the design output at full load for Unit 1 before its thermal output uprate to 3411 MWt to bring it in alignment with Unit 2 capability. In recent years, the non-safety low pressure turbines of both units were retrofitted with an improved turbine design. The subsequent secondary cycle efficiency gain increased the design electrical power output to 1190 MWe at the same thermal output of 3411 MWt. Due to daily electrical power output fluctuations resulting from changes in power cycle efficiency, DCPP assumed a value of 1180 MWe for the SAMA analysis. PG&E has no plans to request a license amendment to increase the allowable DCPP thermal power output.

<u>*RAI 4.g*</u>

In Section F.3.6 of the ER, it is stated that "An additional 15 minutes is added to the ETE evacuation times to account for processing time by offsite officials." Briefly describe the processing required by offsite officials.

<u>PG&E Response to RAI 4.g</u>

It is assumed that once the site declares a General Emergency, this information will be communicated promptly to offsite decision-makers (county or state officials). The 15-minute window of time between the site declaration of the General Emergency and the initiation of Alert Notification (sirens) and coincident Advisory to Evacuate is conservatively added to account for the following:

(1) time between GE declaration from the site and decision-maker awareness of situation

(2) time to obtain clearance within the offsite organization(s) chain of command to issue proceed with the Alert Notification Advisory to Evacuate notice

(3) time to physically implement the Alert Notification (sirens)

<u>*RAI 5*</u>

Provide the following information with regard to the selection and screening of Phase I SAMA candidates. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the DCPP SAMA analysis, NRC staff is evaluating PG&E's basis for the selection and screening Phase I SAMA candidates. The requested information is needed in order for the NRC staff to reach a conclusion on the adequacy of PG&E's Phase I SAMA selection and screening process for the SAMA evaluation.

RAI 5.a

Section F.5.1.2 of the ER indicates that the types of strategies called for in the DCPP Severe Accident Mitigation Guidelines to mitigate and recover from severe accidents are not included as SAMAs because they are already implemented at the site. Discuss if credit for these strategies included in the current DCPP PRA model (DC03SA).

PG&E Response to RAI 5.a

The actions listed in Section F.5.1.2 of the ER are not credited in DCPP PRA model DC03SA.

RAI 5.b

Review of Importance analysis

RAI 5.b.i

In a number of the discussions of potential SAMAs from review of importance lists, phrases such as "In most of the scenarios...", "The significant sequences..." or "Some of the larger contributors..." are used. Discuss in general terms what is meant by these phrases and the possibility of identifying potential SAMAs from the portion of the event impact that is not included in "most of the scenarios", "the significant sequences" or "some of the larger contributors."

PG&E Response to RAI 5.b.i

The review of the split fractions was generally performed by examining a spreadsheet containing the top 1500 sequences (those with frequencies with CDF above 1E-09/yr). Because of the format of the material, there was not a straightforward way to obtain percent contributions for different sets of contributors, and estimations were made about the relative contributions of the events of interest. Specific definitions were not created to support the terms identified in this question.

It is estimated that the term "most of the scenarios" was used to characterize a condition in which the operator action to trip the "deadheaded" residual heat removal (RHR) pumps was present in the sequences comprising 80 percent or more of the frequency total of sequences including split fraction PRB1A.

The terms "significant sequences" and "some of the larger contributors" were applied to cases in which a split fraction was present in the top sequences, which were two or more times larger than any other sequence not containing the split fraction, but were otherwise split with other contributors. The contributors on which the SAMAs were based are estimated to represent over 60 percent of the risk.

Because the SAMA identification process is based on a review of important split fractions ranked by their risk reduction worth (RRW) values, important contributors would be assessed separately by their own split fraction assessment if they were not directly addressed by the process above. In addition, there is significant overlap in the sequence review so that if a particular fractional contributor did not appear to warrant a SAMA in relation to one split fraction, there would likely be other opportunities to consider the contributor. The potential for identifying a SAMA related to the portion of risk not directly linked to a SAMA for the cases identified in this question is low. Further, if any such SAMA were found, it would not be considered to address a dominant risk contributor (as defined in Section F.5.1.1 of the ER).

<u>*RAI 5.b.ii*</u>

For events PRB1A and PRC1A (PG&E Letter DCL-15-080, Table 4, pp. 10 and 19), both involving fire induced loss of cooling accidents (LOCAs), would additional fire barriers be a feasible SAMA to limit the impact of the relevant fires?

<u>PG&E Response to RAI 5.b.ii</u>

This split fractions PRB1A and PRC1A are each associated with multiple fire scenarios such that multiple fire barriers would have to be installed to eliminate the risk associated with these split fractions. For PRB1A, there are at least five different scenarios with comparable contributions that would require action: Z1APM45F1, Z1APM53F1, Z1APM57F1, Z1APM49F1, and Z1ATS8F1. The four panel fires (those with "PM" in the event designators) are in close proximity to one another. For fires initiated in panels with PORV cables running over the panels, it is necessary to wrap the conduit above the panels to prevent cable damage. Similarly, if a fire is initiated in a panel next to a panel that contains PORV cables that are not in the initiating panel, it is necessary to install a barrier between the panels to prevent cable damage (i.e., if the panel with the ignition source contains PORV 455C cables and the adjacent panel also contains PORV 455C cables, there is no benefit of installing a barrier between the panels, but if the panel with the ignition source does not contain PORV 455C cables, then installation of a barrier would be required). The transient fire scenario would present fire source locations that are potentially different than those from adjacent panels and separate measures would likely be required to mitigate these events.

For PRC1A, the risk is split between scenarios Z1APM125F1 and Z1ASP3JF1, which also require protection of nearby cable conduits and panels to prevent damage to PORV 456.

Because neither split fraction could be addressed by mitigating a single fire scenario, SAMA 1 was considered to be a more appropriate means of addressing the fire events. However, fire barrier installation is technically feasible.

The potential benefit for the fire barriers can be conservatively estimated by assuming the largest risk RRW value associated with the split fraction is proportional to the MACR. For PRB1A, the largest RRW for the DC03SA model is 1.081 from Table 6, which correlates to $2,167,052 when the 95th percentile PRA results are considered (using the 95th percentile multiplier of 3 documented in PG&E Letter DCL-15-027) (($9,640,262- $9,640,262/1.081)* 3 = $2,167,052). Plant personnel estimated the low end cost of the fire barrier installation for the scenarios related to PRB1A to be $2.9 million per unit, which implies that a strategy of installing fire barriers to mitigate the risk associated with the PRB1A split fraction would not be cost beneficial.

For PRC1A, the largest RRW associated with the split fraction is 1.033 from Table 6, which correlates to $923,897 using the same method (($9,640,262- $9,640,262/1.033)* 3 = $923,897). Plant personnel estimated the low end cost of the fire barrier installation for the scenarios related to PRC1A to be $2.45 million per unit, which implies that a strategy of installing fire barriers to mitigate the risk associated with the PRC1A split fraction would not be cost beneficial.

When fire barrier installations for both PRB1A and PRC1A are considered together, there are potential savings that would result in a combined low end implementation cost of $4.1 million per unit, which is less than the cost of installing the fire barriers for PRB1A and PRC1A separately. The total benefit for PRB1A and PRC1A would be the sum of the two benefit values developed above, which is $3,090,949 ($2,167,052 + 923,897 = $3,090,949). Even when accounting for the potential cost savings associated with implementing the fire modifications together, the change would not be cost beneficial.

RAI 5.b.iii

For event RF3Z (PG&E Letter DCL-15-080, Table 4, p. 12), Fire: switchover to recirculation after small LOCA degraded instrumentation, SAMA 7 to automate the switchover is proposed. Discuss if the fire procedures provide guidance specific to these fires and if they do not, the potential for developing these procedures as a viable alternative SAMA.

PG&E Response to RAI 5.b.iii

The DCPP fire procedures identify the safe shutdown equipment potentially impacted by fires for each fire area, including instrumentation impacts. The instrument critical to diagnosing the need for transfer to recirculation mode is the refueling water storage tank (RWST) level indicator, which is one of the instruments tracked in the fire procedures. For the fires including the split fraction RF3Z, the fire procedures identify the areas in which there is a potential for loss of the RWST level indicator, and the procedures make the operators aware that an alternate means of RWST level monitoring would be required (e.g., local monitoring). Additional procedure changes would not improve the reliability of the action transfer to recirculation mode.

Review of the human reliability analysis (HRA) for the transfer to recirculation operator action indicates that no credit is taken for a warning in the procedures about the potential for cues to be different than those in the procedure. However, the fire procedure is written to address fire induced failures and to deal with potential spurious equipment operation. In addition, as identified above, the procedure identifies the safe shutdown equipment that may be damaged on a fire area specific basis. Given this procedure structure, the HRA for this action could be viewed as conservative.

RAI 5.b.iv

SAMA 9, identified to mitigate event AW4, support for both motor-driven (MD) pumps unavailable (PG&E Letter DCL-15-080, Table 4, p. 14), includes spray barriers to protect the turbine-driven (TD) AFW pump as well as MD pumps that can operate submerged. Discuss the potential and effectiveness for a SAMA that would only include the TD pump spray barriers.

PG&E Response to RAI 5.b.iv

The PRA model split fraction AW4 accounts for the internal flooding induced failure of the motor-driven (MD) AFW pumps and a random failure of the turbine-driven (TD) AFW pumps. The flooding analysis documentation for the flooding initiators associated with the AW4 split fraction describes scenarios in which pipe breaks lead to water spray induced failure of the MD AFW pumps, but further review of the scenarios identified that the MD AFW pumps could also be damaged by room flooding through ventilation ducts. While the TD AFW pumps were not susceptible to spray damage in these scenarios, an additional flood path that would fail TD AFW was identified that was not explicitly accounted for in the PRA sequences that included the AW4 split fraction. Flood barriers to protect the TD AFW pumps were proposed as part of SAMA 9 to ensure they would not be failed by flood water in these scenarios. The main benefit derived from the PRA in these cases, therefore, is associated with protecting the MD pumps (because the TD AFW pumps are not assumed to be failed by the flood in the PRA for these cases).

Based on the results of the DC03SA model quantification for SAMA 9 documented in PG&E Letter DCL-15-080, the 95th percentile averted cost risk associated with protecting a means of SG makeup for the flood scenarios associated with split fraction AW4 is only about $290,000. Review of the cost estimate for SAMA 9 indicates that a single line item related to waterproofing the TD AFW function would be $1,000,000. Therefore, there are no potentially cost effective changes associated with protecting either the TD AFW pumps or the MD AFW pumps for the relevant flood scenarios.

RAI 5.b.v

SAMA 11, to install a swing residual heat removal (RHR) pump, is proposed to mitigate events LA1 and LB2 (PG&E Letter DCL-15-080, Table 4, pp. 15 and 16), involving failure of RHR pumps to start and run which results in loss of recirculation capability and containment heat removal. Consider improvements in the feed and bleed capability and other, less expensive means for providing containment heat removal capability.

PG&E Response to RAI 5.b.v

Improvements to feed and bleed capability are not adequate substitutes for SAMA 11. A large majority of the sequences that include LA1 and/or LB2 are related to small LOCAs or catastrophic seal LOCA initiating events for which the feed and bleed function is successful, if required. Core damage subsequently occurs because there is no way to move the heated water in the containment sump through the RHR heat exchangers for heat removal and return back to the RPV for core coverage and decay heat removal.

Consideration was given to using the containment spray pumps as an alternate means of moving water from the containment sump through the RHR heat exchangers (via cross-tie), but there would not be adequate net positive suction head (NPSH) to support such a configuration (containment spray pumps are located at the 78-foot elevation versus the 58-foot elevation of the RHR pumps).

Note that the core damage based RRW values of the LA1 and LB2 split fractions are 1.033 and 1.032, respectively. They are below 1.05 for the Level 2 groups reviewed. In most cases, the split fractions occur together, which implies that the benefit of providing an alternate RHR pump-like capability would reduce core damage by closer to 3 percent than 6.5 percent. Even if such an enhancement were assumed to reduce overall plant risk by 4 percent, this would correlate to only about $1.1 million when the 95th percentile PRA results are considered for the DC03SA model ($9,610,440 * 3 * 0.04 = $1,153,253). Providing the capability to remove decay heat from the containment while also providing a means of supplying adequate RPV makeup requires a major plant change and no low cost means of mitigating the RHR pump failures has been identified. The relatively simple hardware change associated with installing a bypass line around the RHR heat exchange outlet valves (SAMA 1) was estimated to cost $3,020,424, which is nearly three times the potential 95th percentile averted cost risk of $1,153,253 estimated above.

RAI 5.b.vi

SAMAs 2 and 18, both involving engine driven pumps, are identified to mitigate fire induced failures of 4 kV Bus F (event AZAF3, PG&E Letter DCL-15-080, Table 4, p. 16). Discuss the potential for SAMAs to directly impact the causes or severity of the relevant fires.

PG&E Response to RAI 5.b.vi

There are at least five different fire areas in the top 1500 sequences that contribute to the risk associated with split fraction AZAF3, and within some of those areas, there are different fire scenarios with diverse source and propagation characteristics. It may be possible to prevent damage to certain components in some of these fire areas, but because the risk for AZAF3 is distributed among these fire areas, multiple fire area/scenario specific enhancements would be required to "impact the causes" of the fires, which is a strategy that would not be cost effective. Because of the diversity of the risk associated with AZAF3, SAMAs 2 and 18 were devised to provide alternates sources of the capabilities failed by the fires.

As noted in Table F.5-3 of PG&E Letter DCL-15-027, the engine driven SG makeup pump is an element of the DCPP FLEX strategy that will be implemented for reasons unrelated to the SAMA cost benefit analysis.

RAI 5.b.vii

For event AWFZ (PG&E Letter DCL-15-080, Table 4, p. 18), no support for AFWP2, AFWP3 and fire impacts AFWP1, discuss the potential for additional fire barriers as a SAMA to limit the impact of the relevant fires?

PG&E Response to RAI 5.b.vii

There are two main fire initiators associated with split fraction AWFZ, one in fire area 6-A-5 and one in area 8G.

The scenario in fire area 6-A-5 is a full room burn up. For these types of scenarios, there are no details available that could be used as a basis for assuming a fire barrier would be an effective measure to protect required equipment.

For fire area 8-G (safeguards room), the primary contributor including split fraction AWFZ is the fire initiating event Z8GTRNAF0, which represents a fire that starts in the Train A solid state protection system cabinet. For these fires, multiple functions are damaged and in some cases, there are multiple components damaged that support the function such that protecting the function would require the installation of more than one barrier. For secondary side heat removal, the TD AFW steam line valves fail due to fire induced spurious operation. The cables associated with these valves could potentially be protected; however, these fire scenarios also include induced LOCAs and preservation of the TD AFW pump alone is not a success path.

Fire induced LOCAs occur for different reasons, including the spurious operation of pressurizer heaters and also from uncontrolled charging flow. In order to prevent fire induced LOCAs, additional barriers or cable wrap would be required to protect the pressurizer heaters and the charging system components.

The cost of these types of enhancements is specific to the equipment that must be protected, but in general, the costs are not low. Using SAMA 8 as an example, the cost of protecting a limited set of RHR cables in two areas was estimated to be $1,073,000. Even if all of the components could be protected in these fire scenarios to prevent fire induced LOCAs and loss of TD AFW, the 95th percentile averted cost would be less than the cost of SAMA 8. The RRW importance of AWFZ is 1.028 based on CDF and 1.039 for LERF in the DC03SA PRA model (from PG&E Letter DCL-15-080). For this assessment, it is assumed that overall plant risk could be reduced by 4 percent (from the LERF RRW) if the risk associated with AWFZ could be eliminated. However, based on a review of the frequency distribution between the 6-A-5 and 8-G fire areas, about 50 percent of the risk is associated with fire area 6-A-5, for which fire barrier credit is not justified. The implication is that installation of fire barriers in fire area 8-G could potentially reduce plant risk by only 2 percent. This correlates to $576,626 when the 95th percentile PRA results are considered ($9,610,440 * 3 * 0.02 = $576,626). While it may be possible to use fire barriers to protect required equipment in some cases, this type of enhancement would not be a cost effective change.

<u>*RAI 5.b.viii*</u>

For events SDS1, reactor coolant pump (RCP) shutdown seals fail to actuate (PG&E Letter DCL-15-080, Table 4, p.23), SAMA 18, consisting of engine driven high pressure RCS and steam generator (SG) injection pumps is evaluated. For event SPCET3 (PG&E Letter DCL-15-080, Table 5, p. 35), RCP seal cooling unavailable, SAMA 2, an engine driven SG injection pump is evaluated. Consider a SAMA that provides only alternative seal cooling for mitigating both of these events.

<u>PG&E Response to RAI 5.b.viii</u>

For the contributors including split fraction SDS1, 68 percent of the contributors also include fire induced LOCAs (e.g., from a stuck open relief valve due to fire induced charging imbalance or from spurious pressurizer heater actuation). Providing an alternative seal cooling capability would not mitigate a large majority of the risk associated with the scenarios that include SDS1. Using the largest RRW value associated with SDS1 (1.021) and the assumption that the cost risk is proportional to RRW, the remaining 32 percent of the risk that could potentially be mitigated by preventing an RCP seal LOCA correlates to $190,350 when the 95th percentile PRA results are considered (($9,640,262 -$9,640,262/1.021) * 3 * 0.32 = $190,350). Plant enhancements to mitigate these contributors would not be expected to be cost beneficial considering that even the relatively simple hardware change to improve the connection between the fire protection system and the charging pumps for alternate cooling (SAMA 23) is over 2.5 times greater than this estimated benefit.

Split fraction SPCET3 represents the fraction of the core damage frequency from key plant damage state HANNI that includes loss of seal cooling and subsequent seal LOCAs with leakage rates greater than 21 gpm. However, the split fraction was developed using a model that did not take credit for the impact of the low leak shutdown seals. If the SPCET3 split fraction were to be recalculated assuming implementation of the shutdown seals, the split fraction would be greatly reduced and plant changes to address the risk associated with the loss of seal cooling would have limited benefit. This is demonstrated by the calculation above, which shows that changes to address seal LOCA scenarios after the installation of the shutdowns seals is credited will yield a relatively low benefit (split fraction SDS1 is associated with the fire model, in which the shutdown seals are modeled).

Regarding the potential to mitigate the fire induced LOCAs, the cost of providing only the independent RCS makeup capability can be estimated by subtracting the cost of SAMA 2 from SAMA 18. The result is $31,980,960 ($49,473,576 - $17,492,616 = $31,980,960), which implies the enhancement could not be cost beneficial because it is greater than the 95th percentile MACR for the DC03SA model of $28,920,786 ($9,640,262 * 3 = $28,920,786). The estimated implementation cost is considered to be a lower bound for a system that could mitigate the fire induced LOCA scenarios because it is not clear that a portable RCS injection system could be aligned in time to prevent core damage. A permanent system that could be more rapidly aligned may be required, which would be a more costly improvement.

RAI 5.b.ix

Event OR1 (PG&E Letter DCL-15-080, Table 4, p.23), operator cooldown and depressurize RCS, indicated to be associated with SGTRs combined with failure to isolate the ruptured SG, and Event OX1 (Table 5, p. 36), operator decides to isolate the ruptured SG, are both mitigated by SAMA 19 to install primary side SG isolation valves. Consider a SAMA for improving the procedures and training or automating the ruptured SG isolation function.

PG&E Response to RAI 5.b.ix

The operator action to perform a cooldown in a SGTR scenario is dominated (85 percent) by the execution error, meaning that errors such as selecting an incorrect control, or turning the control in the wrong direction are primarily responsible for failing this highly practiced cooldown process. The human error probability (HEP) is driven by the relatively large number of steps modeled in the cooldown action

(15 steps), which are each assigned a failure probability related to the nature of the control used and the type of manipulation that is required. These failures are recovered by a "self-review" check with the relatively large failure probability of 0.23. For a highly visible process such as plant cooldown, it is not always easy to model all of the recovery factors that would realistically be available in the control room, and the HRA methodology can yield results that could be characterized as conservative. Review of the HRA did not reveal any specific weaknesses in the procedures that could be changed to realistically improve the reliability of the cooldown action. The HRA Notebook documents that between classroom and simulator sessions, the cooldown action is trained 13 times per requalification cycle. No quantifiable benefit would be associated with instituting additional training for this action.

Similarly, the highly trained isolation action is driven more by the execution error (73 percent) associated with the eight modeled steps than by any factor that could be mitigated with a procedure improvement. The cognitive error contribution is mostly associated with the analyst's interpretation that the procedure does not provide all of the required information for the action. However, the application of the HRA methodology in this way appears to be related to the fact that SG blowdown samples are required to confirm the identification of the ruptured SG and that because this information will take time to collect, it is not immediately available to the operators. This is not a weakness in the procedures and it is not an issue that that could be "improved" with a procedure change.

No procedure changes or training enhancements have been identified that would significantly improve the cooldown or isolation actions.

The OX1 split fraction representing the failure to isolate the secondary side of the SGs occurs in conjunction with the failure to perform RCS cooldown; so in these scenarios the RCS remains at high pressure. In these cases, improving the reliability of the SG isolation action would neither prevent core damage nor prevent a release of radionuclides to the environment. High RCS pressure would force primary side inventory through the ruptured tubes to the secondary side of the SGs, where it would be released to the environment through the atmospheric dump valves or safety valves. A SAMA to automate the isolation function, therefore, would not significantly impact plant risk and the change would not be cost beneficial.

RAI 5.b.x

The top contributor to Event CD1FL (PG&E Letter DCL-15-080, Table 4, p. 31) is described as a flood sequence from reactor water storage tanks (RWST) breaks in the fuel handling building. SAMA 18, portable engine driven high-pressure RCS and SG injection pumps, is identified to mitigate this event. Consider the potential for alternative SAMAs involving use of flood barriers and alternate supplies to make up for the loss of RWST.

PG&E Response to RAI 5.b.x

Review of the top 1500 sequences indicates that while the top contributor for split fraction CD1FL is associated with a flooding scenario that includes a break in a line from the RWST (Y31FWLP2B), that scenario accounts for only 23 percent of the split fraction's risk. In addition, only a portion of the Y31FWLP2B flood scenario is associated with RWST pipe breaks; the others are related to condensate storage tank (CST) failures that would not result in RWST inventory loss. The remaining 77 percent of the CD1FL risk is related to the fire protection system breaks, which are addressed by SAMA 17. Even if all of the risk associated with Y31FWLP2B is assumed to be related to breaks that would deplete the RWST, the potential averted cost risk related to this scenario is small, and changes to install flood barriers and provide alternate suction sources for the systems that rely on the RWST would not be cost beneficial. Assuming that the potential averted cost risk is proportional to the CDF based RRW value for CD1FL (1.012) and that the entire portion of the 23 percent of the CD1FK risk associated with scenarioY31FWLP2B could be mitigated by the changes proposed in this question, the potential averted cost risk would only be $78,875 when the 95th percentile PRA results are considered [(($9,640,262 – $9,640,262/1.012) * 0.23 * 3) = $78,875]. Even the relatively minor change to provide a hard piped connection between the fire protection system and the charging pump cooling water line was estimated to cost $491,021 (SAMA 23), which is over six times larger than the potential averted cost risk of $78,875 calculated above.

RAI 5.b.xi

The top contributors to Event GXH (PG&E Letter DCL-15-080, Table 5, p. 48) are described as flooding events in the AFW rooms. Consider the potential for flood barriers to mitigate these floods.

PG&E Response to RAI 5.b.xi

Review of the top 1500 sequences indicates that there are three different flooding scenarios related to intermediate split fraction GXH (Y3Q1FWLP2A, Y31FWLP2A2, Y31FWMP2C1), all of which include pipe breaks within the AFW pump rooms as well as breaks external to the AFW pump rooms. For a pipe break within an AFW pump room, flood barriers would not prevent the loss of the pump(s) within the room because the pumps would become submerged (i.e., for a pipe break in the TD AFW pump room, a flood barrier would not protect the TD AFW pump). There are currently fire damper penetrations 12 inches off the floor that would allow communication between the AFW pump rooms such that flooding in one room would lead to flooding in the other room. In order to eliminate this flood path such that a single flood would not fail all AFW pumps, significant work would be required to change the ventilation configuration. For floods external to the AFW pumps rooms, a different set of flood barriers would be required. Some of the same elements addressed in SAMA 9 related to the flood propagation paths would have to be addressed. Assuming the cost of the "flood barriers" identified in this question can be estimated by the line item in the SAMA 9 cost estimate related to making the AFW pump room "waterproof", the cost of implementation would be $5,000,000.

Based on the frequency distribution of the top 1500 sequences, the flooding scenarios represent about 75 percent of the risk associated with GXH. If all of the risk associated with the flooding contributors is assumed to be mitigated by the flood barriers, the change would not be cost beneficial. Assuming that the potential averted cost risk is proportional to the CDF based RRW value for GXH (1.029 for CDF from Table of PG&E Letter DCL-15-080) and that the entire portion of the 75 percent of the GXH risk associated with flooding scenarios could be mitigated by the changes proposed in this question, the potential averted cost risk would be $611,299 when the 95th percentile PRA results are considered [(($9,640,262 – $9,640,262/1.029) * 0.75 * 3) = $611,299].

<u>*RAI 5.c*</u>

The discussion in Section F.5.1.3.7 of Grand Gulf Nuclear Station (Grand Gulf) SAMA 59 indicates that, except for the third non-safety centrifugal charging pump, high head injection and low pressure pumps are dependent on the component cooling water (CCW) system. Also Figure F.2-1 indicates that loss of the CCW leads to 13 percent of the internal events CDF. Consider a SAMA similar to Grand Gulf's SAMA 59, Increase operator training for alternating operation of the injection and low pressure pumps for loss of CCW scenarios in addition to the alternate means described for DCPP.

<u>PG&E Response to RAI 5.c</u>

For Loss of CCW scenarios, most of the DCPP risk is associated with seal LOCA events that ultimately lead to core damage due to the lack of a means of providing containment heat removal. In these cases, cycling the emergency core cooling system (ECCS) pumps will not provide a significant risk reduction.

Low pressure ECCS pumps: For seal LOCA sequences, the RCS pressure could remain high for an extended time, unless operators manually depressurize the RCS. The risk reduction contribution of a low pressure injection system is limited for this type of scenario. Even if low pressure ECCS pump failure could be prevented, once the water in the sump becomes saturated, lack of adequate NPSH would prevent the pumps from delivering water to the RCS and core damage would occur.

High pressure ECCS pumps: The high pressure centrifugal charging pumps (CCPs), which provide RCP seal injection, depend on CCW for lube oil cooling. Assuming that the number of pump starts required in the cycling process would not damage the pumps, it may be possible to cycle the two CCW cooled CCPs to extend the time window for aligning fire water for alternate lube oil cooling. Maintaining the CCPs available would have the potential effect of preventing an RCP seal LOCA; however, there are at least two major factors that would preclude this type a change from having a significant impact on plant risk:

(1) The loss of CCW/seal LOCA scenarios are internal events model scenarios for which credit has not been taken for the RCP shutdown seals. If the shutdown seals are credited in the internal events model in the same way as they have been in the fire model, the contribution of the loss of CCW scenarios would be greatly reduced.

(2) A large portion of the seal injection cooling failure contribution in the loss of CCW scenarios is related to seal injection path failures. Extending the CCP run time by cycling the pumps would not mitigate the seal injection path failures.

Finally, the “recovery time” for the operator actions to align fire water for alternate CCP lube oil cooling is over 40 minutes and the HEPs are not driven by timing issues. The HEPs are dominated by the execution errors related to the large number of steps modeled for the local, temporary hose manipulations.

When the impact of the planned installation of the DCPP RCP shutdown seals is considered, providing training and/or procedure changes to cycle the ECCS pumps on loss of CCW would not provide a significant risk benefit for the site and this enhancement would not be cost effective.

RAI 5.d

For SAMA 10, provide an alternate direct current (DC) generator, discuss the availability of such a generator as part of other programs such as B.5.b and Diverse and Flexible Coping Capability (FLEX).

PG&E Response to RAI 5.d

The SAMA was designed to provide a direct current (DC) power source to critical loads to mitigate failures “downstream” of the 480-V alternating current (AC) source that is providing power to the battery chargers. The types of events addressed include battery charger failure, battery failure, and DC bus failure. The intent of the DC power source is to support the required instrumentation, valve movements, and equipment control functions so that after selected DC distribution panels are energized, additional field actions would not be required. The Overall Integrated Plan (FLEX) for DCPP is based on the assumption that the DC system failures have not occurred such that long term DC power can be supported by providing 480-V AC power to the station battery chargers. Therefore, implementation of FLEX will not directly address the types of failures targeted by SAMA 10.

Similarly, the B.5.b capabilities are for a narrow scope of applications related to providing power for local instrument operation. The capacity of the B.5.b equipment is too limited to support the loads targeted by SAMA 10, and the B.5.b equipment could not be used in place of the DC generator proposed in SAMA 10.

RAI 5.e

For a number of the Phase I SAMAs included in Table F.5-3, the statement "This SAMA is addressed by elements of the DCPP FLEX strategy." Discuss the implications of this relative to the inclusion of credit for this in the DCPP PRA, the cost of and further consideration of the associated SAMAs.

PG&E Response to RAI 5.e

This term was used to help identify cases where there were similarities in the risk mitigation strategies proposed for SAMAs and those currently included in the DCPP FLEX approach (SAMAs 2, 4, 12, 15, and 18). The notation facilitates the consideration of potential changes that could be made to the FLEX design to address a broader range of risk while minimizing resource expenditures.

In most cases, the scope of the FLEX strategy is not completely consistent with that of the SAMAs or with the success criteria and the mission time of the DCPP PRA such that implementation of FLEX would not necessarily mitigate all of the risk factors targeted by the DCPP SAMAs. For example, SAMA 2 and the FLEX strategy for secondary side makeup both include the use of diesel driven pumps, but the FLEX deployment strategy is based on a response to extended loss of AC power scenarios, which may not mitigate some of the more rapidly evolving scenarios targeted by SAMA 2 that include loss of SG makeup. Changes to the storage location, transportation strategy, hose connection types and locations, and supporting procedures may allow the FLEX equipment to be used to address the same scope of events that would be addressed by SAMA 2.

The existence of the FLEX strategies would not reduce the PG&E implementation costs of the SAMAs because PG&E must purchase the equipment whether it is for FLEX or for the license renewal effort. The implementation costs considered for SAMA may actually increase if the scope of the FLEX equipment extends beyond what is required only for the SAMA (i.e., rather than purchasing equipment that does only what is required for the SAMA, it may be necessary to purchase more robust equipment if it must be capable of responding to the range of events addressed by both FLEX and the SAMA).

In the event that FLEX is implemented without regard of the SAMA scope, some portion of the risk targeted by the SAMAs would be mitigated. The specific impact on each of the net values for each of the SAMAs would require detailed analysis, but because none of the SAMAs identified as sharing elements of the FLEX design were potentially cost beneficial, there would be no impact on the conclusions of the analysis.

RAI 5.f

The table in Section F.5.1.7 (page F-91) uses the term "site" in the column headings. Explain the use of "site" in this table.

PG&E Response to RAI 5.f

The approach taken to analyze the "other" external events contributors in PG&E Letter DCL-15-027 is different than what was used in PG&E Letter DCL-09-079. In the original analysis, the external events CDF and PACR values were both considered at the site level (i.e., accounting for both units). In PG&E Letter DCL-15-027, the external events review was performed on a "per-unit" basis to be consistent with the rest of the analysis. However, the column headings in the table in Section F.5.1.7 were not updated to reflect the change. The headings should read "Estimated CDF (per yr, unit)" and "PACR (unit)."

It should be noted that the PACRs documented in Section F.5.1.7 are based on the external events CDF from the IPEEE, which do not account for recent and planned plant enhancements. The risk associated with the high winds and external flooding contributions would likely be mitigated by implementation of FLEX, (including the shutdown seals, portable generators, and pumps). It is also expected that the B.5.b changes would be applicable to the accidental aircraft impact scenarios. As noted in both PG&E Letter DCL-09-079 and PG&E Letter DCL-15-027, the dominant hazardous chemical release is now considered to be a negligible contributor at DCPP because the ammonium hydroxide spill hazard was eliminated by replacing the chemical with ethanolamine. The residual risk associated with the "other" external events hazards is low, and no additional plant changes are considered to be warranted to further reduce these risks.

RAI 6

Provide the following information with regard to the Phase II cost-benefit evaluations. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to *consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the DCPP SAMA analysis, the NRC staff is evaluating PG&E's cost-benefit analysis of Phase II SAMAs. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of PG&E's cost estimations for individual SAMAs and cost-benefit evaluation.*

RAI 6.a

Provide further information regarding the RISKMAN software quantification options mentioned on page 4 of PG&E Letter DCL-15-080, including the option originally used for SAMAs 2, 9, 10 and 12 and the option used in the updated results.

PG&E Response to RAI 6.a

The baseline models DC03 and DC03SA used in the SAMA analyses use a database of initiating event frequencies stored by the user in the model for quantification. The software provides an option to overwrite these frequencies with initiators results developed from system models and quantified via binary decision diagram (BDD). It is not desired to overwrite the initiating event frequencies since not all the initiators are best represented with BDD quantification results. Once the base model has been developed and released, the practice at DCPP is to always use the stored values not the BDD values from the system models. When a quantification case is setup, the overwrite option is always checked and it is up to the user to uncheck this box for each run. The box was not unchecked in the case of the original runs for SAMAs 2, 9, 10 and 12.

RAI 6.b

PG&E Letter DCL-15-080, describes a revised evaluation of the benefit of SAMA 8 "Protect RHR cables in fire areas 6-A-2 and 6-A-3." It is understood that the revised evaluation eliminates credit taken in the original evaluation for preventing damage to equipment not protected by SAMA 8. It is noted that the revised evaluation appears to include additional fire impact deletions from the base case model (changes to ELECPWR and FELECPWR) than the original analysis. This would be expected to increase rather than decrease the averted cost-risk. Provide a further discussion of the revised evaluation including the differences in model changes that lead to the reduced credit.

PG&E Response to RAI 6.b

One of the important differences in the revised modeling approach used for PG&E Letter DCL-15-080 is that the RHR heat exchanger CCW cooling valves, which are modeled via top events ZRCA and ZRCB, are no longer protected. In the PG&E Letter DCL-15-027 SAMA update, the SAMA 8 modeling approach protected these valves in conjunction with the RHR pumps themselves. In PG&E Letter DCL-15-080, these valves were determined to be outside of the range of components protected by the SAMA. The valves are available in many cases, but were allowed to fail in those scenarios where a fire would normally fail them since these "non-RHR components" were not included in the scope of the cost estimate. One additional change in PG&E Letter DCL-15-080 was to ensure that the power supplies for the RHR components protected by this SAMA remained available by making additional electric power "deletions" in the model.

In summary, the model change description in PG&E Letter DCL-15-080 does identify additional electric power changes to the event trees that would tend to increase the benefit of the SAMA, but when combined with the change to remove the credit for the RHR heat exchanger CCW cooling valves, the net effect is a reduction in the SAMA's benefit.

RAI 6.c

Section F.6.3 of the ER indicates that SAMA 5 reduces the CDF by 0.7 percent. This SAMA is identified in Table F.5-1 (p. F-178) to mitigate Event ZTDPHD which has a risk reduction worth (RRW) of 1.05. Since this RRW corresponds to a CDF reduction of approximately 5 percent, SAMA 5 would appear to not be very effective in mitigating this event. Discuss the reasons for this benefit quantification result and the potential for more effective SAMAs for this event.

PG&E Response to RAI 6.c

One of the issues related to the low impact for SAMA 5 is that a split fraction commonly paired with ZTDPHD was misinterpreted during the SAMA development process. The split fraction for feed and bleed, OB1Z2: "Fire - Loss of Instrument Air (HEP successful) and Instrumentation Degraded," is actually dominated by the failure of the operator action to initiate feed and bleed. Based on the description of split fraction OB1Z2, it was erroneously considered to represent cases in which the feed and bleed function was failed due to the loss of the instrument air supply. As a result, implementing SAMA 5 to improve the reliability of the PORV air supply had only a small impact on plant risk.

The fire PRA model used for the SAMA analysis, as discussed in Section F.2.1.10, was in the process of refinement in support of transitioning the DCPP fire protection program to NFPA 805. This interim model contained conservative screening values for some of the split fractions (i.e., Events) such as ZTDPHD (with a value of 0.1). The split fraction RRW value of 1.05 was based on this conservative split fraction value. In the more current fire PRA model, which has been updated (and is still in the process of being refined), the split fraction value of Event ZTPHD has been updated to 3.8E-03. Its split fraction RRW value based on this updated split fraction is approximately 1.003, which would have been screened during SAMA Phase 1 analysis as it is below the RRW screening criteria of 1.01.

RAI 6.d

The evaluation of SAMA 9 in Section F.7.2.1.4 (p. F-119) of the ER indicates that protecting the pumps is simulated by removing the fire initiators from the impacted areas. Discuss how this simulates providing spray barriers and waterproof pumps. If this is due to flooding due to fire protection system initiation in response to a fire, discuss the potential for flooding due to fire protection system ruptures in these areas.

PG&E Response to RAI 6.d

The wording in Section F.7.2.1.4 is incorrect and should read as follows: "Flooding initiators for the fire areas identified in Section F.7.2.1.4, not fire initiators, were chosen to be removed from impacting the AFW motor-driven and turbine-driven pumps. This is the best way to simulate the installation of spray barriers for the turbine-driven pump and water proofing the motor-driven pumps. The initiators include large firewater system flooding and fire water system spray damaging the motor-driven pumps and spray damage to the AFW autostart feature equipment."

RAI 6.e

Section F.7.4 states of the ER states: "In order to assess the impact on the Phase 2 screening, the truncated frequency was assumed to be proportional to the CDF, and for each SAMA quantification, the truncated frequency was likewise binned to the ST5 release category." Provide further information on this process including the assumed reduction in ST5 release category frequency caused by a SAMA. Illustrate with a numerical example.

PG&E Response to RAI 6.e

In the baseline case, the entire truncated CDF of 1.18E-06/yr was added to the ST5 release category. For each SAMA evaluation, the ST5 release category was assigned the ST5 frequency from the SAMA quantification plus the product of 1.18E-06 multiplied by the ratio of the CDF with the SAMA implemented to the base case CDF.

ST5_SAMA(X)_Sens = ST5_SAMA(X) + Trunc_Freq * CDF_SAMA(X)/CDF_BASE

For example, in the nominal evaluation, the ST5 frequency is 4.00E-06 for the "base case" and 3.81E-06 for SAMA 1. For the sensitivity case in Section F.7.4, the "base case" ST5 frequency is 5.18E-06 (4.00E-06 + 1.18E-06) while the SAMA 1 ST5 frequency is 4.87E-06 (3.81E-06 + 1.18E-06 * 7.59E-05 / 8.47E-05).

Consideration was given to using the percent reduction in the ST5 release category frequency as a scaling factor rather than the percent reduction in the CDF, but in all cases, the use of the percent reduction in the CDF was larger than or equal to that for the ST5 release category. Because the use of the percent reduction in the CDF yields a larger risk benefit, it was chosen for the sensitivity analysis to increase the likelihood that a SAMA would be shown to be potentially cost beneficial.

RAI 6.f

As indicated in ER, Amendment 2, Section 4.20, the original SAMA found that when the 95th percentile PRA results were considered, SAMAs 12, 13, 24, and 25 were potentially cost beneficial. These original analysis SAMAs are:

- *SAMA 12: Improve fire barriers for auxiliary saltwater and component cooling water equipment in the Cable Spreading Room*
- *SAMA 13: Improve cable wrap for the power operated relief valves in the Cable Spreading Room*
- *SAMA 24: Prevent clearing of reactor coolant system Cold Leg Water Seals*
- *SAMA 25: Fill or maintain filled the Steam Generators to scrub fission products*

Discuss the current relevance of these SAMAs and their potential for being cost-beneficial in the updated analysis. If appropriate, identify plant or modeling changes that made these SAMAs no longer applicable.

PG&E Response to RAI 6.f

A summary of the status and relevance of these SAMAs is provided below:

- SAMA 12: This SAMA was developed for scenarios in which the loss of ASW and CCW control in the MCR led to an RCP seal LOCA via the loss of RCP thermal barrier cooling and seal injection. The current DCPP plant configuration includes a high pressure pump that can provide RCP seal injection without CCW support, and the fire model credits the RCP shutdown seals. These capabilities reduce the risk of an RCP seal LOCA and reduce the importance of the loss of ASW and CCW in the cable spreading room fire scenarios. The split fractions that SAMA 12 was linked to in the original SAMA analysis (FEF6 and FRE3) now have RRW vales of 1.000 and a SAMA to protect the ASW and CCW components is no longer necessary.
- SAMA 13: This SAMA was related to cable spreading room fires that led to spurious opening of the pressurizer PORVs. The modifications and procedure changes implemented as part of the NFPA 805 transition include

the capability to perform an emergency closure of the pressurizer PORVs at the hot shutdown panel. Credit for the capability to close the PORVs at the hot shutdown panel makes the SAMA to protect the PORV control cables unnecessary. The split fractions associated with SAMA 13 (i.e., FHS1, FPR1, and FEF7) have RRW values of 1.000 in the DC03SA PRA model, which implies that further plant enhancements to address spurious opening of the pressurizer PORVs during cable spreading room fires would not be cost beneficial.

- SAMA 24: This SAMA has been implemented. DCPP procedures currently include guidance to prevent RCP start on high core exit temperatures when SG levels are inadequate to prevent thermally induced SGTR events.

- SAMA 25: This SAMA is implemented at DCPP. Current plant procedures direct operators to fill the ruptured SG(s) in SGTR scenarios to provide scrubbing of a potential release.

RAI 6.g.i

Section F.6 of the ER states that plant personnel developed DCPP-specific implementation cost estimates for each of the SAMAs. Address the following:

i. Provide a description of: the process PG&E used to develop the SAMA implementation costs, the level of detail used to develop the cost estimates (e.g., general cost categories such as hardware design, procurement, installation, and testing, as well as procedure development, quality assurance and licensing support, etc.), and how the calculations are documented.

PG&E Response to RAI 6.g.i

The general cost estimation process described in the response to RAI question 6.a in PG&E Letter DCL-10-106 accurately characterizes the cost estimation process used for PG&E Letters DCL-15-027 and DCL-15-080. While the SAMA numbers and the specific costs documented in that response have been updated, the same approach was used to perform the cost estimates for PG&E Letters DCL-15-027 and DCL-15-080.

RAI 6.g.ii

Provide the details of the cost estimates for SAMAs 5, 10, 12, and 22.

PG&E Response to RAI 6.g.ii

The following cost estimates, as described in the response to RAI 6.a.i, were developed in the same manner as those for the original DCPP SAMA analysis submitted in 2010. Note that the total costs are provided for implementation at both units; to obtain the per-unit costs that would be used in the SAMA analysis, the total cost would be divided by two. All costs provided below are in 2014 Dollars. No escalation beyond 2014 dollars or allowance for funds used during construction has been included.

SAMA 5: Backup Air System for PORV PCV 474

Description: Provide backup air (nitrogen tanks) to PCV-474. Design similar to systems on PCV 455C and PCV-456.

Description	Qty.	Unit	Unit $	Total
Engineering	1	LS	$ 750,000	$ 750,000
Procedure Revisions	1	LS	$ 125,000	$ 125,000
Planning	1	LS	$ 150,000	$ 150,000
800# N2 Bottles	3	Ea	$ 50,000	$ 150,000
N2 Regulator / Manifold - Class 1	1	Ea	$ 100,000	$ 100,000
Solenoid Valves	1	Ea	$ 20,000	$ 20,000
Actuator	1	Ea	$ 20,000	$ 20,000
Relays	1	Ea	$ 20,000	$ 20,000
S/S Tubing	1	LS	$ 250,000	$ 250,000
Check Valve	1	Ea	$ 35,000	$ 35,000
Tie-In to Air System	1	Ea	$ 20,000	$ 20,000
Seismic Bottle Support/Rack	1	Ea	$ 150,000	$ 150,000
Power and Control Wiring	1	LS	$ 60,000	$ 60,000
Surveillance Testing	1	LS	$ 50,000	$ 50,000
Sub-Total				$ 1,900,000
Sub-Total per Unit X 2 Units	2	Units	$ 1,900,000	$ 3,800,000
Capital Overheads (Mat'l 30% X 12.25% Mat'l Burden) + (70% Lab X 40% PGE Lab X 14.3% Capital A&G)	7.68%			$ 291,840
Contingency	20.00%			$ 818,368
Escalation on 2009 Dollars to 2014 @ 5%/Yr	28%		$ 4,910,208	$ 1,356,600
Total				$ 6,266,808

SAMA 10: Alternate DC Generator

(This cost estimate has been revised to remove costs for control room indication and simulator modifications.)

Description: Provide a portable 120-VDC DG set to power 120-VDC loads

- 100 kW DG set + fuel tank for 24 hours
- Seismic/weather proof location
- Run on 85-foot elevation
- Supply cables and manual connection switches at each DC distribution panel (3 per unit)

Description	Qty.	Unit	Unit $	Total
Engineering	1	LS	$ 2,500,000	$ 2,500,000
Procedure Revisions	1	LS	$ 500,000	$ 500,000
Planning	1	LS	$ 300,000	$ 300,000
100 kw DG set + fuel tank for 24 hours	1	LS	$ 450,000	$ 450,000
Conduit & Wire to DC Busses	1,000	LF	$ 1,000	$ 1,000,000
Manual Connection Switches	3	Ea	$ 75,000	$ 225,000
Switches to DC Panel Installations	3	Ea	$ 25,000	$ 75,000
Mods to Eq & Switchgear to allow for direct connection	0.50	Per Unit	$ 10,000,000	$ 5,000,000
Weatherproof Enclosure	0.50	Per Unit	$ 3,000,000	$ 1,500,000
Indicators in the control room		LS	$ 1,000,000	$ -
New test procedures	1	LS	$ 175,000	$ 175,000
Simulator Modifications		Per Unit	$ 800,000	$ -
Rev Operator Training Program	0.50	Per Unit	$ 125,000	$ 62,500
Sub-Total				$ 11,787,500
Sub-Total per Unit X 2 Units	2	Units	$ 11,787,500	$ 23,575,000
Capital Overheads (Mat'l 30% X 12.25% Mat'l Burden) + (70% Lab X 40% PGE Lab X 14.3% Capital A&G)	7.68%			$ 1,810,560
Contingency	20.00%			$ 5,077,112
Escalation on 2009 Dollars to 2014 @ 5%/Yr	28%		$ 30,462,672	$ 8,416,275.00
Total				$ 38,878,947

SAMA 12: Use an Alternate EDG to Support Long Term AFW Operation and a 480V AC Self-Cooled PDP for Primary Side Makeup

Description: EDG for SG level indication and 480-V PDP (200 hp)

Description	Qty.	Unit	Unit $	Total
Engineering	1	LS	$ 2,500,000	$ 2,500,000
Procedure Revisions	1	LS	$ 300,000	$ 300,000
Planning	1	LS	$ 500,000	$ 500,000
30 HP Portable DG set + fuel tank for 24 hours	1	LS	$ 175,000	$ 175,000
300 kw DG set + fuel tank for 24 hours	1	LS	$ 650,000	$ 650,000
200 HP Positive Displacement Pump: Basis CCP at 50% of $10M per Unit Actual Cost 2008	1	LS	$ 5,000,000	$ 5,000,000
Fresh Air Intake w/ louvers, etc.	800	LF	$ 600	$ 480,000
Exhaust to Exterior w/ Muffler, etc	800	LF	$ 600	$ 480,000
Fuel Oil System w/ pumps, controls, etc.	1	Ea	$ 400,000	$ 400,000
Conduit & Wire to Battery Chargers	1,000	LF	$ 1,000	$ 1,000,000
Conduit & Wire to new 300HP PDP	1,000	LF	$ 1,000	$ 1,000,000
Miscellaneous Switches & Equipment	3	Ea	$ 75,000	$ 225,000
Piping System for pump	1,000	LF	$ 600	$ 600,000
Suction Piping	3,000	LF	$ 600	$ 1,800,000
Discharge to Make Up Water Hdr outside of containment	600	LF	$ 600	$ 360,000
Indicators in the control room	1	LS	$ 650,000	$ 650,000
Simulator Modifications	1	LS	$ 250,000	$ 250,000
Rev Operator Training Program	1	LS	$ 75,000	$ 75,000
Sub-Total				$ 16,445,000
Capital Overheads (Mat'l 30% X 12.25% Mat'l Burden) + (70% Lab X 40% PGE Lab X 14.3% Capital A&G)	7.68%			$ 1,262,976
Contingency	20.00%			$ 3,541,595
Escalation on 2009 Dollars to 2014 @ 5%/Yr	28%		$ 21,249,571	$ 5,870,865
Total				$ 27,120,436

SAMA 22: Install Containment Combustible Gas Igniters

Description: Install automatic, battery-powered igniter system.

Description	Qty.	Unit	Unit $	Total
Engineering	1	LS	$ 3,500,000	$ 3,500,000
Procedure Revisions	1	LS	$ 125,000	$ 125,000
Hydrogen Igniters	5	Ea	$ 50,000	$ 250,000
Hydrogen Sensors	30	Ea	$ 25,000	$ 750,000
Batteries	5	Ea	$ 100,000	$ 500,000
Controls	1	LS	$ 250,000	$ 250,000
Conduit & Wire To Aux Board.	5	Ea	$ 200,000	$ 1,000,000
Conduit & Wire To Containment Dome Class 1	1	LS	$ 2,500,000	$ 2,500,000
Scaffolding to Containment Dome (Up & Down) Incl. Mat'l Handling in and out of Containment.	1	LS	$ 750,000	$ 750,000
Igniter Conduit & Wire Thru Containment Pen	1	Ea	$ 500,000	$ 500,000
Sub-Total				$ 10,125,000
Sub-Total per Unit X 2 Units	2	Units	$ 10,125,000	$ 20,250,000
Capital Overheads (Mat'l 30% X 12.25% Mat'l Burden) + (70% Lab X 40% PGE Lab X 14.3% Capital A&G)	7.68%			$ 1,555,200
Contingency	20.00%			$ 4,361,040
Total				$ 26,166,240

<u>*RAI 7*</u>

For certain SAMAs considered in the DCPP Environmental Report, there may be lower cost or more effective alternatives that could achieve much of the risk reduction. In this regard, provide an evaluation of the following SAMAs. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the DCPP SAMA analysis, the NRC staff is evaluating additional SAMAs that may be more effective or have lower implementation costs than the SAMAs evaluated by PG&E. The requested information is needed in order for the NRC staff to reach a conclusion on the adequacy of PG&E's determination of cost-beneficial SAMAs.

RAI 7.a

For SAMA 1, install a minimum CCW cooling flow line around the RHR heat exchanger outlet valve, consider a modification to the outlet valve internals to allow a minimum CCW flow even when the valve is closed.

PG&E Response to RAI 7.a

This proposed modification would require the valve vendor to do a special modification to the four valve internals (two valves per Unit) to allow a minimum leakage flow in the range of 100 to 400 gpm.

For both options (original SAMA 1 and the proposed alternative), engineering analyses would be required to:

- assess the flows through the CCW heat exchangers to determine the required minimum leakage flow rate to adequately cool the RHR pump, including localized heat exchanger flow characteristics and heat transfer performance.

- determine if the new steady-state increased normal CCW flow rate conflicts with any design basis requirements associated with single CCW pump operation.

Modification of the valve internals would present technical and operational difficulties that would not exist for the design proposed in SAMA 1 as discussed below:

- Concerns with long-term valve reliability such as erosion and increased failure rates due to vibration, and increased valve maintenance.

- Modification work will need to be completed in a refueling outage. This requires extensive system clearing and refilling. Based on post-installation testing, this modification may not achieve acceptable results and may require the internals to be removed or replaced, which would result in increased system clearance and refueling outage costs. The modification cost estimate would need to have a high contingency factor to consider this risk to be performed in the outage.

- To ensure the flow rate is consistent with the above required engineering analyses, flow measurements are necessary. Flow measurements to verify achieving required flow range may be a problem in a large diameter pipe that requires measurement of approximately 10 percent of system flow. Flow measurement would require a special flow measuring device to provide assurance that required flow measurement is achieved.

The technically-preferred option to provide the minimum CCW flow capability is with an engineered flow control orifice, a local flow meter, and an isolation valve to allow flow adjustments and testing, as proposed in SAMA 1. If the proposed alternative to SAMA 1 were to be implemented, however, the cost of the enhancement would exceed the potential averted cost-risk associated with the change, just as it does for the original SAMA 1 design. A plant-specific cost estimate of $2,662,496 per-unit was developed for the alternative modification, which exceeds the potential averted cost-risk of $2,025,372 reported for SAMA 1 in the response to question 2.b (which accounts for the use of the 95th percentile PRA results, the binning of the "truncated" frequency to ST5, and the use of the ST5 source term for ST1).

RAI 7.b

SAMA 2, provide an engine-driven SG makeup pump, is proposed to mitigate event AWR1, Failure to supply water from fire water storage tank or raw water reservoir (non-seismic). This SAMA is screened in Phase I as having a cost well in excess of maximum averted cost-risk. Discuss the potential for less expensive SAMAs such as procedure changes, automating the backup water supply or increasing the capacity of the condensate storage tank.

PG&E Response to RAI 7.b

The AWR1 split fraction accounts for both operator alignment errors as well as failures of valves in the alternate suction source flow paths. Based on the cause table for AWR1, 88 percent of the failure contribution is related to valve failures while only about 12 percent is related to operator error. Because of this distribution of risk, SAMAs that address operator action reliability will have only limited benefit in scenarios that include the AWR1 split fraction.

Regarding low cost procedure changes, the reliability of the alignment action is already high and there are no procedure changes that would significantly improve the reliability of AWR1.

Regarding a SAMA to automate the alignment of the alternate suction source, there are several factors that would prevent such a change from being cost beneficial. The first consideration is that the logic for the AWR1 split fraction itself is simplified in that the failure of either the fire water storage tank or the raw water reservoir suction path is conservatively modeled as a failure of the entire alternate AFW suction source function. In reality, there is more separation between these alternate suction paths and if the model were enhanced to reflect the "as-built" configuration, the importance of AWR1 would be greatly reduced.

A second consideration is that the DCPP model does not credit other available means of supplying water to the AFW pumps and/or providing makeup directly to the SGs. For example, procedures exist for aligning the transfer tank to the AFW pump suction line, and for scenarios in which initial cooldown and depressurization has succeeded, guidance exists for using an onsite fire engine to pump water from a fire hydrant directly to the SG. Accounting for these capabilities would again reduce the importance of the AWR1 split fraction.

A third consideration is that the current top contributors to AWR1 are low probability events, including manual valve failures and suction strainer clogging. A SAMA to automate the alternate suction source alignment function would require the replacement of manual valves with motor operated valves that would have higher failure rates than the valves that they would be replacing, so a direct replacement of the existing manual valves with motor-operated valves would result in a risk increase. To avoid this, a new, parallel suction path would have to be installed, which is not a low cost alternative.

Finally, increasing the CST capacity has already been done once at DCPP (internal baffles over non-safety penetrations), so there is limited margin in the existing tank available for accommodating additional water. A new CST would be very expensive and would not be cost beneficial.

For the reasons presented above, no alternate SAMA is considered to be required to address the risk associated with AWR1 and the alternate plant enhancements presented in this question would not be cost beneficial.

RAI 7.c

SAMA 4, provide a seismically qualified response system, is proposed to mitigate a number of sequences involving seismic alternating current (AC) and/or DC system failures. Consider the potential for strengthening the weakest link in these systems to provide at least one source of AC and/or DC power at a considerably lower cost than SAMA 4.

PG&E Response top RAI 7.c

Increasing the seismic capacity of one source of AC and/or DC power by itself at its weakest link will not provide enough risk improvement to overcome its implementation cost because other potential seismic weak links could exist in other parts of required mitigating systems, such as piping, water supply, heat exchangers, etc. The cost of improving the seismic capacity of one source of AC and/or DC power might be lower than the cost of SAMA 4, but proportionally the risk improvement will be lower as well.

A primary reason SAMA 4 was developed (originally "SAMA 26" in PG&E Letter DCL-10-106) was because the SAMA that was originally devised to address specific seismically induced failures for severe seismic initiating events (SAMA 18) yielded a very limited benefit of $608,000 using the 95th percentile PRA results due to the existence of failures in other plant systems and modeling assumptions. The SAMA 18 quantification strategy was revised for the PG&E Letter DCL-10-106 RAI 3.c response (as described in the 6.c and 6.d responses of the same document) to assume availability of the TD AFW and charging pump functions, without regard for their support systems, to force their availability during seismic events. The resulting 95th percentile averted cost-risk was much larger, at about $4.7 million. In PG&E Letter DCL-15-080, SAMA 12 does approximately the same thing by ensuring availability of the AFW and primary side makeup functions (RCP seal LOCA is not a large contributor, so the primary side pump is focused on makeup rather than seal cooling). As shown in the response to RAI 2.b, the averted cost-risk for SAMA 12 is $4,647,003 (which accounts for the use of the 95th percentile PRA results, the binning of the "truncated" frequency to ST5, and the use of the ST5 source term for ST1); however, the seismic CDF reduction only accounts for 17.6 percent of the SAMA 12 CDF reduction, which correlates to about $818,000 in averted cost. This value is considered to be an upper bound on the potential risk reduction related to protecting the AC and/or DC functions for seismic events. Therefore, from the cost-benefit perspective, a SAMA with the narrow focus of addressing the "weakest link" in the AC and/or DC power systems would provide a limited reduction in plant risk and would most likely not be cost beneficial.

<u>*RAI 7.d*</u>

SAMA 9 and 17, install spray barriers to protect the TD AFW pump and install a waterproof AFW pump, and install flood sensors to mitigate fire protection system pipe breaks. As a low cost alternative for flooding in general, discuss the potential for using mobile sump pumps (including hose/pipes and power supply).

<u>PG&E Response to RAI 7.d</u>

For the risk significant flooding scenarios associated with the SAMAs identified, there are several factors that would preclude the use of mobile sump pumps as a viable means of mitigation.

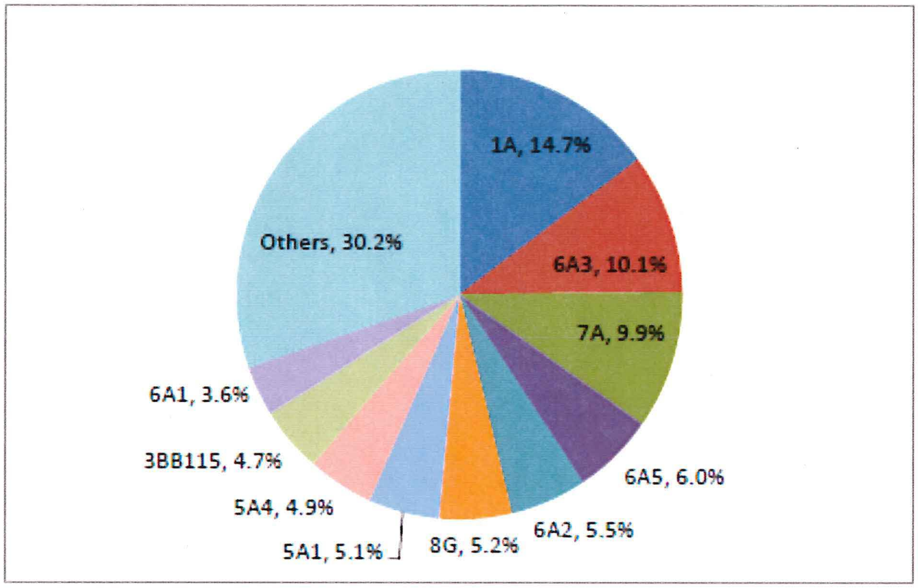
For those cases in which credit is taken for operator action to terminate the flood in time to prevent equipment damage, human dependency issues would preclude significant credit for an additional operator action to align portable pumps to mitigate the flood. The preferred action would be to terminate the event by tripping a pump or isolating a valve in the flow path. If this relatively simple mitigating step fails, there is no basis for crediting a more complex, longer evolution to terminate the flood when it would be governed by the same cues and procedures.

In pipe break scenarios where operator actions are not already credited to mitigate the flood, the alignment of mobile sump pumps would require operators to enter a flooded area containing energized equipment, which would endanger the operators. For the AFW pump rooms, there are no sumps, and the operators would have to open a door to an area in which there is an active flood source to begin the de-watering process. Even if it is assumed that it would be possible to safely access the flood zone, it is not clear that there would be adequate time to retrieve the mobile sump pumps from a safe storage location, set them up in the active flood zone, and initiate them.

For the non-spray events (i.e., those related to SAMA 17), it is also noted that the flow rates of the flood scenarios are large and that "mobile" sump pumps would not have the capacity to prevent equipment damage.

For spray events, once the motors are wet and turbine controls are wet, it is debatable as to whether or not the equipment could function.

The use of mobile sump pumps is not considered to be viable replacement for SAMAs 9 or 17.



Fire Area	Description
1A	Containment
6A3	Vital Battery Charger Room Bus H
7A	Cable Spreading Room
6A5	P250 Room
6A2	Vital Battery Charger Room Bus G
8G	SSPS Room
5A1	Vital 480VAC SWGR Room
5A4	Non-Vital 480VAC Bus SWGR and MCC Room
3BB115	Containment Penetration Area, 115' Elevation
6A1	Vital Battery Charger Room Bus F
Others	Remaining Unit 1 Fire Areas

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Figure F.2-5
DC03 Fire Contribution to Unit 1 CDF by Fire Area