

# Independent Peer Review Panel

*A multi-agency panel of seismic hazard specialists  
established by the California Public Utilities Commission*

**CALIFORNIA COASTAL COMMISSION, CALIFORNIA GEOLOGICAL SURVEY,  
CALIFORNIA ENERGY COMMISSION, CALIFORNIA PUBLIC UTILITIES COMMISSION,  
CALIFORNIA SEISMIC SAFETY COMMISSION, COUNTY OF SAN LUIS OBISPO, GOVERNOR'S  
OFFICE OF EMERGENCY SERVICES**

The Independent Peer Review Panel (IPRP) was established by the California Public Utilities Commission (CPUC) in 2010. It was tasked with providing expertise to the CPUC while also assuring the public that Diablo Canyon Power Plant (DCPP) seismic studies were being performed in an appropriate manner. Members of the IPRP include representatives from the CPUC, the California Energy Commission, the California Coastal Commission (CCC), the Governor's Office of Emergency Services (OES), the California Geological Survey (CGS), the California Seismic Safety Commission (SSC), and the County of San Louis Obispo (SLO).

Under Senate Bill 846 (SB 846) of 2022, the IPRP was tasked with reviewing the seismic assessment for the Diablo Canyon Power Plant (DCPP) in a consulting role for the Diablo Canyon Independent Safety Committee (DCISC) (see Public Utilities Code § 712.1(e)(1)).<sup>1</sup> In February 2023, the DCISC approved its Fact Finding Team (FFT) reports covering the last quarter of calendar year 2022 as well as their DCPP visits on January 31, 2023 and February 1, 2023. Several key issues were covered in the FFT reports including a seismic safety review report for DCPP.

In accordance with Public Utilities Code § 712.1(e)(1) as part of its consulting role under SB 846, the IPRP submits the following comments to the DCISC for its consideration. While all IPRP members have reviewed the DCISC's Fact Finding Reports approved at its February 2023 meeting, since different IPRP members have different areas of expertise, for transparency and clarity, the comments below are attributed to the specific members who provided those comments.

## **IPRP Comments and Questions for the November Fact Finding Report approved by the DCISC at its February 15-16, 2023 meeting**

– **(CGS)** The DCISC reports the following in the November 2022 fact finding report:

- Since "PG&E's most recent seismic study, the Diablo Canyon Probabilistic Seismic Hazard Analysis" (PSHA) study published in 2015 (Reference 6.4.2) ...

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<sup>1</sup> PUC 712.1 § (e)(1) states: "In addition to the duties and responsibilities set forth in commission decisions, the Independent Safety Committee for Diablo Canyon shall do both of the following: (1) Consult with and incorporate into its assessments and recommendations the independent peer review panel established pursuant to Section 712."

was completed, additional research has been completed to supplement that study which provides additional valuable information. (p. D5-9)

- PG&E, through their LTSP studies, continues to develop new information about several technical topics within the broader scope. (p. D5-12)
- Concerning the impact of any recent new information that would supplement the previous work, the DCISC concludes that there is nothing in any recent new information on either seismic hazard or seismic ground motion that would change the broader understanding of those topics as embedded in the earlier 2015 PG&E report (Reference 6.4.1) ... That work is beneficial and continues, but it does not affect any existing conclusions or insights. (p. D5-13)
- As with the seismic-hazard analyses, PG&E reported to the FFT that those earlier analyses are still valid today ... as with the other areas, PG&E reported to the FFT that in the systems-modeling area nothing new has emerged of importance... (p. D5-14)

– **(CGS)** The above items fall under the purview of the IPRP's role in technical evaluation of seismic hazard assessment, specifically the seismic hazard [seismic sources] and seismic ground motions (noted in Section 3.4.3 c) of the November 2022 report). However, the IPRP has not undertaken any evaluation of these analyses and has not been provided with any technical documentation with which to do so. As a result, we cannot assess the validity of the conclusion drawn by PG&E, and concurred with by the DCISC, that there is nothing new or different of importance to the seismic safety of the facility.

– **(CGS)** The IPRP will review the recent new seismic hazard studies the DCISC has mentioned once complete reports including implications for the seismic hazard evaluation and design ground motions are provided by PG&E.

– **(CCC)** Nuclear safety (that is, the prevention of dangerous releases of radioactive materials during and after an earthquake) is the most important consideration with respect to seismic hazards at the site, and the IPRP agrees it should be the primary consideration of DCISC oversight. That said, the language of SB 846 appears to envision a broader review that considers both nuclear safety and the continued safe operation of the plant. With this in mind, is it within the DCISC's purview to also consider the seismic safety and performance of structures, facilities and components that are not crucial for nuclear safety, but are nonetheless necessary for plant operation? A broader-scope review of this sort would be of value to permitting agencies and the public if it is within DCISC's authority and capacity; if it is not, the DCISC should explain why.

– **(CPUC)** The DCISC Seismic Safety Review as given to the IPRP should explain that it is based upon the experience and judgement of the authors and not a specific set of regulations or guidance documents such as a specific set of NUREG publications. This is important to note since this text will be in the public record. An explanation should be added that clarifies how the DCISC's Seismic Safety Review differs from the NRC regulatory review.

- **(CPUC)** The DCISC should explain the difference between the SSE, DBE, and an OBE, and seismic safety, reliability, and regulatory issues and goals. The text should then highlight in the Introduction that the DCISC review was focused on safety and not regulatory issues or reliability goals and issues.
- **(CPUC)** There is no engineering or safety analysis included in the text. The reader is directed to references instead of the DCISC including the analysis in the text of the seismic safety report or as an appendix. DCISC should include the text directly in the Seismic Safety Review Report and state the analysis was done by others and reviewed and concurred with by the DCISC.
- **(CPUC)** Specific SSCs that were reviewed for the seismic safety analysis are not included in this report.
- **(CPUC)** There is no geologic or seismological information included in the text for the IPRP to review. In addition, the most recent dates of the last documents are not clarified in the text: has anything more recent than PG&E's SPRA been reviewed in the DCISC Review? The report should clarify this point.
- **(CPUC)** A section should be included on the difference in the NRC regulations at the time that the DCPD was built and now (2023).
- **(CPUC)** There is no mention of reactor coupons in the body of the November 2023 FFT with respect to seismic safety. This ought to be considered as it is a subject of interest.
- **(CCC)** In section 3.4.5(a), a brief discussion of key findings of the "recent new information" mentioned at the end of this section and why it doesn't change (i.e., why it reinforces) the broader understanding of seismic hazards and ground motion at DCPD would be helpful, both for agencies tasked with reviewing the proposed extension of operations at DCPD and for the public at large. Similarly, a more specific accounting of where uncertainties have been reduced and what areas need further study would be useful for agencies (and for the public) in trying to understand the current status of seismic hazards research at the site.
- **(CCC)** In section 3.4.6, it would be helpful to have some mention of the several information gaps and remedial actions identified in the 2015 and 2018 seismic hazards assessments (Ref. 6.4.1 and 6.4.2), and confirmation that these have been addressed/carried out in the interim.
- **(CCC)** Can the "DBE" mentioned in section 3.10 in the response and discussion of Question 2 be specifically identified as the Hosgri Earthquake (HE) scenario, since multiple DBEs, with different associated PGAs, have been identified and used in prior reports and analyses? For example, in some prior reports, the original "DBE" is an event with a PGA of only 0.2g.

– **(SSC)** In section 3.4.4 of the November Report, the DCISC summarizes its review of the Seismic Probabilistic Risk Assessment (SPRA)<sup>2</sup> submitted by PG&E in April 2018, finding it “to have been of excellent quality.” The documents available for independent full-scope peer reviewers and NRC audits are not currently available to the IPRP except for PG&E Letter DCL-18-027 which contains high level information on the inputs and methods used as well as the evaluations performed. The following questions/comments on the 2018 SPRA are intended for PG&E to provide clarifications to hopefully aid IPRP’s and DCISC’s understanding of the future seismic study pertinent to SB 846 requirement especially if only high-level reports are available:

- The SPRA states at page 27 that “some SSCs that were credited in the internal events model were included on the SEL, but were assumed to fail for any seismic initiator because they lack seismic qualification and are dependent on offsite power”. Is offsite power assumed lost for Seismic Core Damage Frequency (SCDF) or Seismic Large Early Release Frequency (SLERF)? If yes, should the criteria be “they lack seismic qualification or are dependent on offsite power” for the equipment dependent on the offsite power?
- The SPRA at page 27 also states “[b]uildings or structures that either house Seismic Equipment List (SEL) components or whose failure could impact PRA components were selected for inclusion on the SEL.” In the “29th Annual Report, Volume II, Exhibit B6, Minutes of the Diablo Canyon Independent Safety Committee’s, February 27-28, 2019 Public Meeting”, there is a discussion on seismic qualification of switchgear room wall: “Dr. Budnitz observed that, were these walls to fail in an earthquake, the electrical onsite power for the EDGs and the switchgear could be compromised and the walls are also necessary to protect the EDGs from fire”. How are the impacts of the failure of these walls on Emergency Diesel Generator (EDG)s and switchgear considered in SPRA?
- At page 28 of the SPRA: “[c]ontacts were identified that may have undesired consequences if chatter were to occur. The panels that house these contacts were then identified and the functional fragility of the panel was calculated as the bounding fragility of all the subcomponents whose function has been modelled in the SPRA. The functional fragility is evaluated considering the shake table testing of the original panel and any subsequent shake table testing of replacement subcomponents.” Is contact chatter part of the functional fragility evaluation by the shake table testing of the original panel and subsequent replacement sub-components?
- For the SPRA’s fragility evaluation of water storage tanks such as the Refuelling Water Storage Tank and Fire Water Storage Tank, how are sloshing effect considered?
- Is the main turbine thrust bearings seismic capacity part of the SPRA’s fragility evaluation?

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<sup>2</sup> Available at <https://www.nrc.gov/docs/ML1812/ML18120A201.pdf>.

- On Page 41 of the SPRA: “[n]ote that the fragility analyses for Structure, System and Component (SSC)s are based on a full range of frequencies, and the DCPD control point GMRS, unlike Central and Eastern United States plants, does not include peaks in the high frequency range (frequencies greater than 10 Hz). Therefore, separate ‘high-frequency capacity’ evaluations of SSCs, including relays, as described in Section 6.4.2 of the Screening, Prioritization and Implementation Details (SPID) are not applicable to DCPD.” Is the highest frequency considered in SPRA 33 Hz? Are there any SSCs whose dynamic characteristics make them sensitive to frequencies higher than 33 Hz?
- Starting at SPRA page 46: “5.1.4 Seismic Structure, System, and Component Response Correlation -- Full correlation was modelled between identical components within the same system located on the same elevation within the same building. Zero correlation was modelled between all other components”. Section 5.7.12 states “removing correlation in the seismic failure of components results in a reduction in risk.” How are dependencies among components considered in SPRA, if the functionality of one depend on another being functional even though they might not be located at the same elevation?
- With regard to SPRA Table 5.4-5 (SCDF Importance Measures Ranked by Fussell-Vesely (F-V) for Top Operator Actions), the Base Event with highest F-V is FLEX Action: Operator Fails to Shed Battery Loads on Extended Loss of AC Power- Seismic High. The DCISC Committee Report on Fact-Finding Meeting at DCPD on January 31 and February 1, 2023, page D.7-18, explains the FLEX strategy is for operators “inside the plant to tie Direct Current (DC) Busses together in order to extend the life of batteries needed to supply control power to the Turbine-Driven Auxiliary Feedwater Pump for greater than 24 hours during a Loss of All Alternating Current (AC) Power (offsite and onsite) event. This Loss of All AC Power scenario could come from a Turbine Building collapse which damaged multiple AC power sources, and which could be caused either by a beyond design basis major fire or by a mid-level seismic event.” Would technologies such as Earthquake Early Warning (EEW) increase the reliability value of the operator action to implement the FLEX strategy?
- SPRA page 83, section 5.7.9 Hazard Bins for Conditional Large Early Release Probability: modifying the bin size for Seismic Initiator 15 & 16 appears to increase SLERF from  $5.4E^{-6}$  to  $6.4E^{-6}$ . Does this mean the SLERF is sensitive to the size of the bin at the tail-end of the hazard curve? If yes, was there any consideration to reduce the size of the bins at the tail-end to see how much SLERF can be further reduced or is SLERF  $5.4E^{-6}$  low enough to make the effort not worthwhile?
- In PG&E Letter DCL-91-178, Enclosure 2, PG&E replaces the previous commitment with the following: "PG&E consistent with its Long Term Seismic Program (LTSP) commitments (DCL-91-178) and SSER-34 conclusions, will continue to assess the future plant additions and modifications to verify that the plant seismic risk remains acceptable (i.e. lowered or no significant increases),

using the insights from the updated hazard and SPRA." How are "significant increases" defined and evaluated?

- Based on "Diablo Canyon Power Plant, Unit Nos. 1 And 2 - Staff Review of Seismic Probabilistic Risk Assessment Associated with Re-evaluated Seismic Hazard Implementation of The Near-Term Task Force Recommendation 2.1: Seismic (EPID NO. L-2018-JLD-0006)<sup>3</sup>, January 22, 2019 , Enclosure 3 NRC Staff SPRA Submittal Detailed Screening Evaluation," the purpose seems to identify potential modifications within reason to reduce SCDF or SLERF for DCCP by  $1.0 \times 10^{-5}$  per reactor-year (/rx-yr) and  $1.0 \times 10^{-6}$ /rx-year. The DCCP SPRA report provides Fussell-Vesely (F-V) importance measures, which were converted to Risk Reduction Worth (RRW) and staff determined the RRW threshold from the SCDF-based Maximum Averted Cost-Risk (MACR) to be 1.149 for both Units. There were no single SCDF contributors that exceeded the RRW threshold for SCDF, while a single SPRA model element or contributor exceeded the RRW threshold for SLERF. This element was seismically-induced failure of the containment exterior shell structure resulting in core damage, which has an SLERF RRW of 1.789 and an SLERF contribution of  $2.3 \times 10^{-6}$ /rx-yr. The implementation cost of modifications to the containment building sufficient to eliminate the seismic risk from a seismically-induced containment failure or to substantially reduce the probability of containment failure substantially exceed the calculated MACR for this detailed screening. NRC staff also considered combinations of basic events in accordance with the SPRA Screening Guidance. A review of these model elements reveals that any modification or set of modifications to achieve a SCDF reduction of at least  $1.0 \times 10^{-5}$  /rx-yr will have to mitigate or prevent multiple failure types (e.g., seismically-induced failures, random failures, and failure of operator actions) and failure modes (e.g., seismically-induced structural failures of multiple SSCs and seismically-induced functional failures of multiple SSCs). The cost of eliminating the seismic risk from these types of plant improvements would substantially exceed the calculated MACR for this detailed screening. Similarly, any modification or set of modifications to achieve a SLERF reduction of at least  $1.0 \times 10^{-6}$ /rx-yr will have to mitigate or prevent multiple unrelated seismically-induced SSC failure modes and the cost of eliminating the seismic risk from these types of plant improvements would substantially exceed the calculated MACR for this detailed screening. The staff further notes that based on the RRW values and the detailed screening described below, the staff's decision remains unchanged even if an extended operating life of 20 years is considered. This statement might be relevant in the SB 846 context, however, the data used to develop MACR is based on DCCP's License Renewal Application in 2009. DCCP's latest license renewal application document might provide an insight on if and how MACR changes.

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<sup>3</sup> Available at <https://www.nrc.gov/docs/ML1825/ML18254A040.pdf>.

- The SPRA indicates that the mean SCDF is  $2.8 \times 10^{-5}$  per reactor-year (/rx-yr) and the mean SLERF is  $5.4 \times 10^{-5}$  per reactor-year (/rx-yr). How do they compare with the existing regulation's thresholds to maintain the level of protection necessary to avoid undue risk to public health and safety regardless of cost, if such thresholds exist for seismic events?
- Per the DCISC Report on Fact-Finding Meeting at DCPD on January 31 and February 1, 2023, page D.7-26: "The FFT also inquired regarding the threshold that would be used to determine the significance of any new information on the seismic hazard at DCPD, and the staff responded that the [SPRA] would be the primary guidance in helping to evaluate the significance of new information. In this manner, the threshold for evaluating seismic safety can be based on a quantitative assessment of risk and not on any discrete regulatory standards." Are the definitions of "new and significant" similar to the criteria outlined in the document "Model SLR New and Significant Assessment Approach for SAMA"<sup>4</sup> or has NRC provided a quantitative methodology for interpreting the above definition of "new and significant information"?

**IPRP Comments and Questions for the January/February Fact Finding Report approved by the DCISC at its February 15-16, 2023 meeting**

– (CCC & CPUC) Section 3.14: The language of SB 846 suggests that the State is concerned both with nuclear safety and plant operation in relation to seismic hazards. Will the seismic hazards review focus only on nuclear safety (i.e., the seismic safety of the DCPD reactors and spent fuel pools), or will it also cover the seismic safety of other structures and components that are not critical to *nuclear* safety, but which are nonetheless important for the operation of DCPD and its ability to transmit power to the grid?

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<sup>4</sup> Available at: <https://www.nrc.gov/docs/ML1621/ML16211A186.pdf>.

The IPRP approved for submission to the DCISC in accordance with PUC § 712.1(e)(1) the above comments and questions presented at the meeting held on **May 5, 2023**, by the following members:

**California Coastal Commission:**

Joseph Street

**California Energy Commission:**

Justin Cochran

Michael Turner

**California Geological Survey:**

Rui Chen

Tim Dawson

Gordon Seitz

Judith Zachariasen

**California Public Utilities Commission:**

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Nathan Ortiz