UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE OFFICE OF NUCLEAR REACTOR REGULATION

In the matter of	
Pacific Gas and Electric Company	Docket Nos. 50-275, 50-323
Diablo Canyon Nuclear Power Plant	
Units 1 and 2	Seismic Shutdown Petition

DECLARATION OF DR. PETER BIRD IN RESPONSE TO PROPOSED DIRECTOR'S DECISION UNDER 10 CFR 2.206

Under penalty of perjury, I, Peter Bird, declare as follows:

I. INTRODUCTION

1. My name is Peter Bird. For 49 years, I have been a Professor of Geophysics and Geology at the University of California at Los Angeles (UCLA). I now serve as Professor of Geophysics and Geology, Emeritus at UCLA. I am qualified by training and experience as an expert in the fields of geology and geophysics with a focus on tectonophysics and seismicity, including plate motion and plate deformation. A full statement of my professional qualifications is provided in the declaration I submitted to the U.S. Nuclear Regulatory Commission (NRC) on March 4, 2024 in support of a petition by San Luis Obispo Mothers For Peace, Friends of the Earth and Environmental Working Group (hereinafter the "Petitioners") to shut down the Diablo Canyon nuclear power plant (DCPP) for posing an unacceptable risk of a seismic core damage accident. *See* Declaration of Peter Bird, Ph.D. (hereinafter "Bird March 4, 2024 Declaration") and Petition by San Luis Obispo Mothers for Peace, Friends of the Earth and Environmental Working Group for Shutdown of Diablo Canyon Nuclear Power Plant Due to Unacceptable Risk of Seismic Core Damage Accident (ML24067A066) (hereinafter "Petition").

2. I have been retained by the Petitioners to prepare a technical response to the Proposed Director's Decision Under 10 C.F.R. 2.206 (Apr. 10, 2025) (hereinafter "Proposed Decision") (ML24302A148). As discussed below, in my expert opinion, the Proposed Decision is incomplete and erroneous in fundamental respects that render it inadequate to support the proposed conclusion that no enforcement action is warranted. As stated in my March 4, 2024 Declaration and subsequent submissions to the NRC, I continue to hold the view that the risk of a serious earthquake-caused accident at DCPP is unacceptable and that immediate shutdown is warranted under NRC's existing guidelines.

II. BACKGROUND

3. As stated in the Proposed Decision, on March 28, 2024, the NRC's Petition Review Board (PRB) denied Petitioners' request for emergency shutdown of DCPP but

commenced a review of the Petition under 10 C.F.R. § 2.206. Early in the review process, by email dated May 15, 2024 (ML24088A238) (hereinafter "Initial Assessment"), the PRB informed Petitioners of its "initial assessment" that the Petition should be rejected because the issues raised by the Petitioners had been reviewed previously in PG&E's 2015 Seismic Source Characterization (SSC) Report and its 2024 Updated SSC Report and Petitioners had not raised any significant new information.

4. The Initial Assessment summarized some of my technical concerns and stated the PRB's reasons for rejecting each of them. The PRB's summary of my concerns was as follows:

> *1. Thrust faulting is neglected by [PG&E's] 2012 Seismic Source Characterization (SSC) model, because the model assumes that a majority of large earthquakes affecting Diablo Canyon are strike-slip and disregards the significant contribution of thrust faulting earthquake sources under the Diablo Canyon site and the adjacent Irish Hills. In addition, PG&E did not use a hanging-wall term for the modeling of potential ground motions from the Los Osos and San Luis Bay thrust faults.*
>
> *2. The magnitude 7.5 (moment magnitude) January 2024 earthquake centered in the Noto Peninsula (Japan), with an average slip of 2 meters on the fault, is analogous to future potential thrust mechanism earthquakes beneath Diablo Canyon. Based on the slip rate of the Irish Hills adjacent to Diablo Canyon and the slip of the Noto earthquake, large thrust fault earthquakes will occur, on average, every 715 years near the Diablo Canyon site.*
>
> *3. Uplift rates for the Irish Hills should be several times higher than the rates used by PG&E in its SSC model in 2012.*
>
> *4. Seismic core damage frequency (SCDF), estimated by PG&E in 2018 to be 3×10^{-5}, should be 1.4×10^{-3} per year (about once every 715 years) based on this higher recurrence rate for thrust earthquakes.*[1]

5. I responded to the Initial Assessment with a detailed declaration, "Supplemental Declaration of Peter Bird" (June 7, 2024) (ML24162A079) (hereinafter "Bird June 7, 2024 Supplemental Declaration"). I stated that the PRB's first, second, and fourth summaries of my concerns were accurate, and corrected inaccuracies in the PRB's third summary of my concerns. I also identified and explained major deficiencies in the accuracy and logic of the PRB's response to each concern.

6. Subsequently, on July 17, 2024, the PRB held a meeting attended by multiple NRC staff members, representatives of Pacific Gas & Electric Co. (PG&E), and representatives of interested state agencies. During that meeting, I made an oral

[1] Initial Assessment at 1.

presentation and discussed a (submitted) PowerPoint presentation, "Correcting 4 False Assumptions in PG&E's Seismic Source Characterization [2015] and Update [2024] that Caused PG&E to Seriously Underestimate Seismic Hazard at Diablo Canyon Nuclear Power Plant" (ML24198A105) (hereinafter "Bird July 17, 2024 Presentation").

7. In late October, I also shared with the PRB a summary report that I prepared at the request of the Diablo Canyon Independent Safety Committee (DCISC) on October 30, 2024, "High Seismic Hazard and Risk at Diablo Canyon Power Plant Due to Thrust Faulting Under the Irish Hills" (ML24305A187) (hereinafter "Bird October 30, 2024 Report").

8. My three supplemental documents – the Bird June 7, 2024 Supplemental Declaration; the Bird July 17, 2024 Presentation; and the Bird October 30, 2024 Report – provided substantial additional information and analyses in support of my original contention in my March 4, 2024 Declaration that DCPP poses an unacceptable risk of seismic core damage accident. The October 30, 2024 Report provides a good summary of this additional information and analyses. As summarized there, the "fault geometry models" used by PG&E as the basis for their 2015 SSC Report and 2024 Updated SSC Report are *"not technically defensible"* (in the language of Senior Seismic Hazards Analysis Committee (SSHAC) guidance documents) because:

    i. Their assumption that the Irish Hills have been uplifted as a rigid block is contradicted by both geologic and geophysical data;
    ii. Their assumption that thrust faults can dip at any angle (up to 80°) from the horizontal plane is contradicted by both friction theory and laboratory experiments showing that new thrust faults dip at ~25°; and
    iii. The rate of horizontal shortening (in the SSW-NNE direction) across the Irish Hills shown by Global Positioning System data (2.0 mm/yr) is far greater than the very small rates predicted by any of PG&E's alternative "fault geometry models."

III. DISCUSSION

A. Concern 1

9. The Proposed Decision repeats and responds to virtually the same description of "Concern 1" as the Initial Assessment:

> *Thrust faulting is neglected by [PG&E's] 2015 Seismic Source Characterization (SSC) model, because the model assumes that a majority of large earthquakes affecting Diablo Canyon are strike-slip and disregards the significant contribution of thrust faulting earthquake sources under the Diablo Canyon site and the adjacent Irish Hills. In addition, the hazard characterization performed*

by PG&E did not use a hanging-wall term for the modeling of potential ground motions from the Los Osos and San Luis Bay thrust faults.[2]

10. In my June 7, 2024 Supplemental Declaration, I did not object to the PRB's statement of Concern 1 in its Initial Assessment of May 15, 2024. At this point in the review process, however, the PRB's description of Concern 1 is deficient because it does not incorporate the substantial additional information, analyses, and clarifications presented in my three supplemental submissions of June 7 (pages 3-4), July 17 (slides 1-23), and October 30 (pages 1-7).

11. Considering the substantial additions I provided after the Initial Assessment, an accurate summary of Concern 1 would now be:

    The "fault geometry models" used by PG&E as the basis for their 2015 and 2024 Seismic Source Characterizations are *"not technically defensible"* (in the language of the SSHAC guidance documents) because:

    a) Their assumption that the Irish Hills have been uplifted as a rigid block is contradicted by both geologic and geophysical data;
    b) Their assumption that thrust faults can dip at any angle (up to 80°) from the horizontal plane is contradicted by both friction theory and laboratory experiments showing that new thrust faults dip at ~25°; and
    c) The rate of horizontal shortening (in the SSW-NNE direction) across the Irish Hills shown by Global Positioning System data (2.0 mm/yr) is far greater than the very small rates predicted by any of PG&E's alternative "fault geometry models."

12. The critical import of this re-stated Concern 1 is that PG&E's 2015 SSC Report and 2024 Updated SSC Report are not scientifically or logically convincing; therefore, PG&E's work provides only a lower bound of the true seismic hazard. Because the seismic hazard at DCPP is unbounded on the high side by PG&E's two SSC reports, my alternative estimates of hazard require serious consideration. Unfortunately, because these very strong and relevant arguments were omitted from the PRB's summary of Petitioners' concerns, the Proposed Decision fails to even address them, let alone rebut them. Instead, the PRB unquestioningly repeats assertions by PG&E that I have demonstrated to be factually incorrect or analytically indefensible.

13. The PRB's other substantial omissions and errors with respect to Concern 1 are described below.

[2] *Id.* at 2. The only difference is that the Proposed Decision refers to the date of PG&E's Seismic Source Characterization as 2015, not 2012.

14. The PRB's description of the tectonic setting of DCPP is so simplistic as to be ludicrous. According to the Proposed Decision:

> *The current tectonic setting for the region around Diablo Canyon is a transform plate boundary that accommodates horizontal relative motions consisting of strike-slip faults with transpressional deformation, resulting in localized areas of uplift and folding alongside the major fault zone.*[3]

This might be a reasonable characterization for the Pacific-North America plate boundary as a whole, but it does not apply to the Irish Hills. (It is like arguing that "New York State is largely rural, so Manhattan must be full of forests and farms.") In fact, there is no geologic or geophysical evidence for strike-slip tectonics within the Irish Hills. The SSW-NNE direction of compressive stress (shown by the World Stress Map dataset) and of compressive strain-rate (shown by relative GPS velocities) is incompatible with strike-slip, and indicates pure thrusting.[4] This mischaracterization of the tectonics of the Irish Hills (originating with PG&E) is fatal to a clear understanding of the rates of thrust fault slip and the true seismic hazard.

15. The PRB affirms PG&E's assumption that the Irish Hills behave as a rigid block, without addressing any of the information or analysis I have provided to show that the assumption is unfounded. According to the Proposed Decision:

> *PG&E modeled the uplift of the Irish Hills, located in the San Luis Range adjacent to Diablo Canyon, assuming rigid block uplift resulting from reverse faulting on the moderate to steeply dipping (45 to 80 degrees) Los Osos and San Luis Bay faults rather than from folding deformation on a low-dip angle (25 degrees) "inferred" offshore thrust fault, as postulated by the petitioners. Thrust faulting is a type of reverse faulting with a dip angle of 45 degrees or less. To develop the SSC model, PG&E used recently acquired offshore and onshore two- and three-dimensional seismic reflection data, multibeam bathymetric data, geodetic data, and an updated seismicity catalog to better define the location, geometry, and slip rate of the faults in the area around Diablo Canyon. Modeling the uplift of the Irish Hills as a rigid block is based on this extensive geologic field*

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[3] *Id.* at 5.

[4] PG&E'S 2015 SSC Report did include speculation that the Los Osos fault might have oblique slip, with a strong right-lateral component. However, further on in the same report, PG&E stated that a contracted study of offset geomorphic features along the onshore part of the Los Osos thrust fault trace found no strike-slip component, only thrusting: *"LIDAR and field-reconnaissance-based evaluation of streams, crossing lineaments, and faults associated with the Los Osos fault zone along the northeastern margin of the Irish Hills concluded that there was no evidence of a strike-slip component to the Los Osos fault zone (see discussion in Section 8.5)."* PG&E [2015] SSC at 4-7. Thus, the incorrect speculation should have been edited out of the report.

work and geophysical surveys, which PG&E has been supporting for many years going back to the 1980s.[5]

At the outset, in endorsing PG&E's "extensive field work and geophysical surveys," the Proposed Decision fails to acknowledge that my criticisms of PG&E's work are based to a significant extent on the same geologic map, structure section, and isostatic gravity map that PG&E developed and published. Thus, by itself, the fact that PG&E used this data does not make their work any more persuasive.

16. Further, the PRB fails to engage my extensive discussion of the reasons that PG&E's model of a rigid block [argument (a) of restated Concern 1 in paragraph 11 above], adopted unquestioningly by the PRB, is false. As stated in my October 30, 2024 Report:

> *The geologic map (Figure 1) shows tight folding of Late Miocene sedimentary rocks has occurred since 6~5 Ma. Therefore, the Irish Hills are not rigid, and additional blind thrust faults are active in the interior.*
>
> *The Pismo syncline is the primary structural feature exposed in the Irish Hills [PG&E, 2014]. Here beds have been rotated ~45°, which angle is supported by both mapped surface dips in outcrops (geologic map, ibid), and by the overall dip of unit Tmo Tertiary Miocene Obispo Formation in the borehole-controlled cross-section of Figure 13-17 of the PG&E [2015] SSC. This folding began after deposition of the youngest strata in the core of the fold (Tmpm), and prior to deposition of the Squire Member of the (Pliocene) Pismo Formation (Tpps), probably ~5 Ma. This folding implies upper-crustal strains of ~0.8, and mean strain-rates of ~0.8 / 5 Ma = 5×10^{-15} per second (/s). This is ~10× faster than rates of "off-modeled-fault" (or "continuum") deformation that are typical in the long-term neotectonics of the western US [5×10^{-16} /s per Bird, 2009]. This high rate of permanent straining implies a high rate of faulting and of earthquakes, even if the relevant thrust fault traces are not always exposed.*
>
> *Also, rigid-body uplift would not produce crustal thickening. Therefore, if the Irish Hills were a rigid block, they would have a positive isostatic gravity anomaly. However, gravity data (Figure 2) shows a negative isostatic gravity anomaly, indicating more than simple Airy compensation by crustal roots (more than the typical Airy ratio of 6:1).*
>
> *THEREFORE:*
>
> *The Irish Hills are being deformed by numerous unmapped and/or blind thrust faults in addition to the 2 thrust faults modeled by PG&E. …*

[5] *Id.* at 5.

The crustal "basement" under the folded sedimentary rocks of the Irish Hills is mainly Franciscan Complex, which contains numerous Cretaceous-Paleogene thrust faults available for reactivation. Slip on those thrust faults would not reach the surface (allowing for mapping) because such slip would encounter and fold the layered Neogene sedimentary rocks of the Pismo syncline. Thus, there are an unknown number of "blind" thrust faults active, such as those that produce devastating earthquakes under the Zagros Mountains of Iran, or in Nepal.[6]

The PRB fails entirely to address this information and analysis.

17. The Proposed Decision also fails to address long-standing friction theory and laboratory rock mechanics results showing that PG&E assumed unrealistic dip angles for thrust faults [argument (b) of restated Concern 1 in paragraph 11 above]. In particular, the Proposed Decision ignores the following evidence and analysis in my October 30, 2024 Report:

125-year-old Mohr/Coulomb friction theory shows that thrusts never form at dips steeper than 45°, and most commonly dip at ~25° for rock friction coefficient of 0.85 [Byerlee, 1978; Figure 4]. This result comes from the simple formula:

$$\textit{(thrust dip)} = \textit{(1/2)}\ \arctan\textit{(1/f)}$$

where f is the coefficient of friction. This equation is derived from classic Mohr's-circle analysis of shear stress and effective normal stress acting on all possible planes within a uniform rock material, which predicts the orientation of the plane(s) that should break first.

THEREFORE:

Dips of 50° or 80° are mechanically impossible; such faults would not slip under the present horizontal compressive stress regime. Instead, some new thrust fault would form with dip ~25°. There are also important implications for the metric "seismic potency rate" (per m of fault trace) which is defined as = (slip rate) × (down-dip width of the seismogenic portion of the fault). This important measure of earthquake generation varies as $1/\sin^2\textit{(dip)}$ *when throw-rate is held constant (as in these 2 SSC studies, where it is fixed at the marine terrace uplift rate). Compared to reasonable estimates (obtained with dip of 25°), an assignment of 50° dip reduces seismic potency rate by a factor of 3.3×. An assignment of 80° dip reduces seismic potency rate by factor of 5.4×. Thus, PG&E*

[6] *Id.* at 4-5.

underestimated seismic potency of these 2 thrusts (which were the only ones they modeled) by large factors.[7]

The PRB utterly fails to rebut this demonstration that the dips proposed by PG&E and assumed in the Proposed Decision are mechanically impossible and therefore not technically defensible.

18. The Proposed Decision also fails to address my evidence and analysis demonstrating that the rate of horizontal shortening (in the SSW-NNE direction) across the Irish Hills shown by Global Positioning System data (2.0 mm/yr) is far greater than the very small rates predicted by any of PG&E's alternative "fault geometry models." [This is argument (c) of restated Concern 1 in paragraph 11 above.] This GPS evidence for 2 mm/yr of horizontal shortening appears in my October 30, 2024 Report, as follows:

Seismicity has been successfully forecast using only strain-rates from GPS velocity data (onshore) and plate-tectonic models (offshore), both in southern California [Shen et al., 2007] and globally [Bird et al., 2010; Bird & Kreemer, 2015; Figure 9]. Therefore, GPS data are very useful for forecasting continental seismicity. Any deformation model used in SSC should fit GPS strain-rate constraints (within their uncertainties).

Furthermore, the problem of unavailable GPS velocities offshore is less serious in the case of thrust faults that dip away from the coast; theoretical models of dislocation patches in elastic half-spaces show that most of the interseismic strain occurs above the hanging wall, which in this case means on-land.

And, even if a GPS velocity profile across the Irish Hills does not record all of the interseismic heave rate, it still provides a useful lower limit on the rate of crustal shortening.

THEREFORE:

Models of neotectonic deformation, informed and guided by GPS velocity data, should be used in the estimation of seismic hazard. Specifically, Shen & Bird [2022] computed a suite of kinematic finite-element (F-E) models of neotectonics across the western US based on geodetic, geologic, & stress data with program NeoKinema. Their preferred model, which has been incorporated into the 2024 update of the USGS National Seismic Hazard Model, shows long-term-average convergence of crustal blocks on both sides of the Irish Hills/San Luis Range region at velocities of ~1 mm/a, for a total of ~2 mm/a of local horizontal convergence rate.[8]

[7] *Id.* at 5.

[8] *Id.* at 6-7.

19. Additional relevant analysis of GPS data can be found in the Bird October 30, 2024 Report, as follows:

> *Our national-scale GPS-based deformation models (cited above) produced estimates of ~2 mm/a of long-term-average horizontal crustal shortening across the Irish Hills. Therefore, total thrust fault slip rate under the Irish Hills would be (~2 mm/year) / cos(25°) = ~2.2 mm/year.*
>
> *Since NeoKinema models are complex (although well-accepted), another approach is to look directly at the GPS site velocities. This means looking at interseismic relative velocities, not the long-term-average velocities which are provided by modeling. Interseismic velocities are always spatially smoother, so there is a possibility that they may not capture the full rate of tectonic deformation when the dataset is spatially limited by an adjacent shoreline. I apply this approach to the geodetic dataset that was used as input by Shen & Bird [2022] and all other USGS-sponsored modelers who participated in the 2022 Update to the National Seismic Hazard Model.*
>
> *Using these raw GPS velocities, we see that station DCAN (Diablo Canyon) is converging at 0.4 mm/a with respect to DAPK (Prefumo Cyn., mid-Irish Hills) and converging at 1.1 mm/a with respect to CHOR (on Hwy 1, NNE of DCAN). Alternatively, site 2110 (slightly NNE of Point San Luis) is converging at 1.7 mm/a with respect to DAPK (half-way across the Irish Hills), and converging at 2.4 mm/a with respect to CHOR (across the full width of the Irish Hills). One way to summarize these results is to note that the average of the DCAN-CHOR interseismic shortening rate with the 2110-CHOR interseismic shortening rate is 1.8 mm/a. Allowing for the bias that interseismic rates may underestimate near a coastline, these interseismic rates tend to support the long-term-average shortening rate of 2 mm/a across the Irish Hills that the Shen & Bird [2022] NeoKinema model predicts.*[9]

Again, the PRB does not address, let alone rebut, this evidence and analysis.

20. In contrast to my evidence and analysis, the fault geometry models that formed the basis for PG&E's 2015 SSC Report and 2024 Updated SSC Report would only produce horizontal shortening by slow slip on the "steeply-dipping" Los Osos and San Luis Bay faults. I will illustrate as follows: Assume (as PG&E does) a vertical offset rate (throw rate) for each of these 2 faults equal to the Quaternary uplift rate for the Irish Hills: 0.2 mm/yr. Then, using PG&E's modeled dips of 45° to 75° for the San Luis Bay thrust fault, its contribution to horizontal shortening would be only 0.05-0.2 mm/yr. Similarly, the horizontal shortening contributed by the Los Osos fault would be

[9] *Id.* at 8-9.

only 0.04-0.35 mm/yr. Even on cross-sections that include both faults, PG&E's fault geometry models never predict total horizontal shortening rates of more than 0.55 mm/yr. Thus, both PG&E and the PRB ignored GPS evidence that the horizontal shortening rate was at least 4 times higher than in any of their models. Such a gross mismatch makes PG&E's fault geometry models "not technically defensible" under the SSHAC's standard. Therefore, the geometry models inserted an unacceptable basis into PG&E's 2015 SSC Report and 2024 Updated SSC Report.

21. By the same token, the PRB blindly endorses PG&E's fault geometry models in the 2015 SSC Report and the 2024 Updated SSC Report without addressing any of the substantial criticisms described above. Instead, the Proposed Decision provides an extensive factual description of PG&E's development of the 2015 and 2024 reports. Because it fails to address my evidence and analysis of PG&E's fault geometry models, this description is unnecessary. By its sheer length, the description also gives the misleading appearance of an independent review rather than what it is: the unquestioning repetition of PG&E's assertions.

22. The Proposed Decision also erroneously implies that my views were previously considered and rejected after I participated in a 2012 SSHAC Workshop.[10] Of course, this discussion ignores the fact that the workshop was 13 years ago and that I have added significant evidence and analyses in support of my views that were not considered by the TI team in 2012-2015. Decisions allegedly taken by PG&E's TI team in 2012 cannot bind my present estimates, which are based on far more evidence and carefully-argued analyses.

B. Concern 2

23. The PRB lacks any support for rejecting the validity of my comparison between DCPP and the Noto Peninsula Earthquake of 1 January 2024. According to the Proposed Decision:

> *In contrast to the Noto Peninsula tectonic regime of compression, the tectonic setting for the region surrounding Diablo Canyon is a transform plate boundary that produces horizontal relative motions along strike slip faults with transpressional deformation.*[11]

As discussed above in par. 14, the PRB's reasoning is fallacious. Both the Noto Peninsula and the Irish Hills are currently sites of pure thrust tectonics.

24. The PRB also accepts PG&E's estimates of slip rates on thrust faults based on assumed angles of dip that are not credible. As stated in the Proposed Decision, PG&E's SSC model estimates slip rates on the Los Osos reverse fault as 0.2 to 0.4

[10] *Id.* at 7.

[11] *Id.* at 10.

mm/yr and slip rates on the San Luis Bay reverse fault as 0.1 to 0.3 mm/yr.[12] As repeatedly explained in my submissions to the PRB, however, the inferred slip rates on thrust (or "reverse") faults are geometrically dependent on their assumed angle of dip (when the geologic constraint is on the throw rate), and the steep dip angles assumed by PG&E are not physically possible. As summarized in my October 30, 2024 Report:

> *Dips of 50° or 80° are mechanically impossible; such faults would not slip under the present horizontal compressive stress regime. Instead, some new thrust fault would form with dip ~25°.*
> *There are also important implications for the metric "seismic potency rate" (per m of fault trace) which is defined as = (slip rate) × (down-dip width of the seismogenic portion of the fault).*
> *This important measure of earthquake generation varies as $1/\sin^2(\text{dip})$ when throw-rate is held constant (as in these 2 SSC studies, where it is fixed at the marine terrace uplift rate).*
> *Compared to reasonable estimates (obtained with dip of 25°), an assignment of 50° dip reduces seismic potency rate by a factor of 3.3×. An assignment of 80° dip reduces seismic potency rate by factor of 5.4×.*
> *Thus, PG&E underestimated seismic potency of these 2 thrusts (which were the only ones they modeled) by large factors.*[13]

25. In addition, the PRB makes a misleading comparison between Diablo Canyon and the Noto Penninsula, claiming that "*the historical rate for large earthquakes in the vicinity of Diablo Canyon is much smaller than the rate for the Noto Peninsula*."[14] The comparison is inapt because it is oversimplistic. All parties agree that the horizontal shortening rate in the Noto Peninsula is higher than in the Irish Hills. My estimate for Noto was 10 mm/yr; the Proposed Decision cites a determination of 14-16.5 mm/yr (far away along the same plate boundary) from *Ito et al.* [2019].[15] In contrast, the horizontal shortening rate in the Irish Hills is 2.0 mm/yr (our model) or some lower figure (per PG&E's fault geometry models). Therefore, in comparison to Diablo Canyon, earthquakes in the Noto Peninsula have much shorter recurrence times, and the instrumentally-recorded seismicity of Noto is much higher. This acknowledged contrast in rates does not imply any failure of the analogy as to rupture geometry, slip distance, stress drop, or resulting Peak Ground Acceleration (PGA).[16]

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[12] *Id.* at 11.

[13] *Id.* at 5.

[14] Proposed Decision at 12.

[15] *Id.* at 9.

[16] This specious argument by the PRB may have been copied from the Lettis Consultants International (LCI) Report (provided by PG&E) which is refuted in Appendix B of my October 30, 2024 Report at page 13.

C. Concern 3

26. The PRB mistakenly assumes that all thrust faults must have a surface trace; however, by its very nature, a blind thrust fault would not. The PRB claims there is a "*lack of evidence from the recently acquired offshore and onshore two- and three-dimensional seismic reflection data and multibeam bathymetric data*" to support the existence of an "*inferred*" offshore fault capable of producing an M_w 7.5 earthquake similar to the 2024 M_w 7.5 Noto Peninsula earthquake.[17] I have proposed that the San Luis Bay thrust fault continues northwest to connect to the Hosgri fault as a blind thrust fault ("Inferred Coastline thrust"), and that these two segments would naturally rupture together in a large event. It is not at all surprising that no fault trace of the ICt is seen in seismic reflection and/or bathymetric data because the thrust is blind, terminating in a forced monoclinal fold in the covering sedimentary rock layers.[18]

27. In any event, it is <u>not</u> critical to seismic hazard to DCPP whether our proposed Inferred Coastline thrust exists, for two reasons:

    a) High-quality digital seismograms from the Noto Peninsula earthquake showed that core-breaking PGA values of 2.3 g occurred up to 42 km from the earthquake rupture. Thus, a large thrust earthquake on the Los Osos fault, or any other low-angle thrust fault under the Irish Hills, could be equally devastating.
    b) My analysis showing that the total slip rate on all low-angle thrust faults under the Irish Hills is 2.0-2.8 mm/yr is <u>not</u> dependent on the list of active thrust faults.[19] This total stands, whether or not the Inferred Coastline thrust is included in the list of active faults.

28. The PRB relies too much on the biased and defective Local Area Source model in PG&E's 2015 SSC Report and 2024 Updated SSC Report. The PRB cites PG&E's Local Area Source Model for the proposition that PG&E has adequately accounted for "*the possibility of earthquakes occurring on previously unidentified faults."*[20] According to the PRB*,* "*PG&E developed a background seismic source zone for its SSC model that includes 18 virtual offshore and onshore faults with lengths of 50 km, magnitudes as high as Mw 7.1, and activity rates based on the regional seismicity catalog."*[21] As I have previously stated, however, this Local Area Source model is

[17] Proposed Decision at 12.

[18] Notably, many famous examples of blind thrusts terminating in forced monoclinal folds are exposed in the Colorado Plateau, although these became inactive ~35 Ma [*Bird*, 1998].

[19] Bird 30 October 2024 Report, Section III at 7-9.

[20] Proposed Decision at 12-13.

[21] *Id.* at 13.

biased low by two orders of magnitude (in terms of frequency of core-damaging PGA).[22]

29. As explained in more detail in my Testimony to the California Public Utilities Commission (CPUC) (June 2023):

> *The Local (Areal) Source Region (p. 13-9 to 13-19): according to Fig. 2.2.2-2 of the enclosure summary SSC, this is the second most important source of acceleration (after the Hosgri fault) in the critical part of the hazard recurrence curve around (1 g, 1E-4 /year). Also, the spatial disaggregation of spectral acceleration hazard in Figure 14-3 of the SSC for DCPP shows that most of the hazard with annual frequency of 1E-4/year originates with 10 km of the plant. Therefore, the reliability of the Local Source SSC is critical to determining the utility of the whole 2015 SSC. Unfortunately, this part of the source model is based on three errors, all of which combine to underestimate the hazard.*
>
> *First, PG&E estimated the long-term seismic moment rate of the Local Source Region by using moment rates from the instrumental seismic catalog (p. 13-10 to 13-17), instead of moment rates from a tectonic deformation model. This resulted in very low assigned slip-rates of 0.01~0.14 mm/a for the virtual thrust faults (Table 13-10, p. 13-25). But, because seismicity has a power-law frequency/magnitude distribution and is clustered on all scales in space and time, this method is known [Geist & Parsons, 2004; Zaliapin et al., 2005] to have a high probability of yielding a serious underestimate. (If this method were applied to the San Andreas fault, its failure would be obvious. In fact, one could argue that the entire SSHAC PSHA process was invented to prevent this particular kind of error.)*
>
> *Second, faulting in the Local Source Region was modeled as 70% strike-slip and 30% thrusting (p. 13-19 to 13-22, based on a complex algorithm of Hardebeck applied to only a few years of microseismicity), but there is no geologic reason to expect anything but pure horizontally-compressional thrusting and folding within the Irish Hills.*
>
> *Third, the maximum magnitude in the Local Source Region was arbitrarily set at 6.6~7.1 (p. 13-22 to 13-23, based on the arbitrary lengths of the imaginary virtual faults); however, Bird & Kagan [2004] showed that the corner magnitude (a similar measure) in Continental Convergent Boundaries is 8.46, with a likely range from 8.07 to 8.67.*

[22] *See* Bird October 30, 2024 Report, Appendix A at 12.

> *If all these errors were corrected, the tornado plots of hazard sensibility would look very different, and it is likely that the Hosgri fault would no longer be dominant.*[23]

30. The PRB also confuses and conflates two distinct concerns that I have raised: (1) that the total slip rate on all gently-dipping thrust faults under the Irish Hills is 2.0-2.8 mm/yr and (2) that the Inferred Coastline thrust is an unmapped and unmodeled blind extension of the San Luis Bay thrust system. This confusion/conflation can be seen in the following statement:

> *The PRB concludes that the stratigraphic profile, gravity anomalies, and GPS modeling used by the petitioners do not provide adequate evidence to support the existence of a major "inferred" offshore thrust fault that extends beneath the Irish Hills with a fault length of 70 to 100 km and a slip rate between 2.0 to 2.8 mm/yr.*[24]

The PRB fails to recognize that my first concern as stated above would remain valid even if my second were to be proven untrue in the future. My model of the total thrust seismicity of the Irish Hills does not depend on the existence of the Inferred Coastline thrust; the same total could be met by combined activity on the Los Osos thrust, the San Luis Bay thrust, and other unmapped and unmodelled thrust faults in the basement Franciscan Complex. Also, I never suggested that this entire total slip rate should be assigned to the Inferred Coastline thrust.

31. The PRB wrongly suggests (probably based on input from PG&E) that the very large vertical offset (throw) on geologic map unit Tmo, that I cite as evidence of extensive Pliocene-Quaternary thrust faulting, could alternatively be explained by Early Oligocene normal faulting. As stated in the Proposed Decision:

> *The location, thickness, and offset of rock formations across these basins is highly uncertain, especially for the older formations such as the Obispo Formation. Therefore, the use of the vertical offset of the Obispo Formation across multiple basins to determine the slip rate on a previously unidentified "inferred" thrust fault beneath the Irish Hills is questionable.*[25]

However, while Oligocene normal faults (*e.g.*, Edna fault) are documented in some parts of the Irish Hills, there is no normal fault of any age on the geologic map or geologic cross section in question within the bracket provided by the two offset ends

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[23] Opening Testimony of Dr. Peter Bird on Behalf of San Luis Obispo Mothers For Peace on Phase 1 Track 2 Issues at 14-15 (June 30, 2023) (accessible at: https://docs.cpuc.ca.gov/PublishedDocs/SupDoc/R2301007/6411/512708102.pdf).

[24] *Id.* at 13.

[25] *Id.* at 14.

of unit Tmo. Thus, the offset cannot be caused by a normal fault, and this alternative explanation fails, and the throw on unit Tmo must be explained by Pliocene-Quaternary thrust faulting.

32. The PRB wrongly reasons that evidence for a uniform uplift rate in the Irish Hills would disprove my model, when actually it tends to <u>disprove the PG&E fault geometry models</u>. As stated in the Proposed Decision:

> *The Pismo syncline forms the core of the San Luis-Pismo block. Lettis et al. state that elevations of dated marine terraces show rigid[26] uplift at a near constant rate of 0.1 to 0.2 mm/yr during the late Quaternary in the northwestern part of the block. This geologic evidence of block uplift of the Irish Hills is not consistent with the petitioners' hypothesis of ongoing low-angle faulting over the past 5 to 6 million years on an "inferred" offshore thrust fault."*[27]

But it is the "fault geometry models" proposed by PG&E in 2015 and 2024 that are inconsistent with uniform uplift rate, because their modeled thrust faults (Los Osos and San Luis Bay) do not surround the Irish Hills; they have a conspicuous gap along the southwestern margin. Such models would predict less (or zero) uplift along the southwestern margin near DCPP. In contrast, Petitioners' model (including the Inferred Coastline thrust) completes the ellipse of active thrust fault traces around the Pismo syncline and the Irish Hills, allowing for the possibility of uniform uplift!

33. The PRB falsely implies that that my argument about the isostatic gravity anomaly in the Irish Hills is based <u>only</u> on one outdated meeting abstract by stating: *"The gravity profile[28] that the petitioners use to support their claim of an extensive crustal root beneath the Irish Hills is from an American Geophysical Union meeting abstract. . . ."*[29] It is true that when I first raised the issue of the negative isostatic gravity anomaly, I referred to a low-resolution national map shown at a scientific convention in 2008. However, this motivated PG&E to reveal their own high-resolution isostatic gravity anomaly map of the Irish Hills area, as Figure 6-2 of their 2024 Updated SSC Report.[30] Since then, we have been pleased to be able to refer to this updated high-

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[26] As used here, the word "rigid" is misleading. Data on rates of uplift along the coast only constrain the vertical component of crustal motion, and do not constrain the two horizontal components. Therefore, they cannot test whether the Irish Hills block is "rigid" as PG&E asserts, or deforming as I assert. A more accurate replacement for the term "rigid uplift" would be "uniform uplift."

[27] *Id.* at 15.

[28] The term "profile" is incorrect because measurements are displayed across the whole 2-D area of the Irish Hills regions. The correct term for the document is "map."

[29] *Id.* at 16.

[30] The credit stated for this map was *"modified from Langenheim et al., 2008 and PG&E, 2011, Figure E-2.*"

resolution map. Both maps agree that there is a negative isostatic gravity anomaly under the Irish Hills.

34. Despite the fact that PG&E's own high-resolution isostatic gravity anomaly map shows a negative isostatic gravity anomaly under the Irish Hills, the PRB dismisses that finding by citing *Langenheim et al. [2013].* But the PRB's dismissal is demonstrably illogical. According to the PRB:

> *Langenheim et al. [2013] provides their interpretation for the gravity low previously shown in the gravity map at the American Geophysical Union (AGU) meeting. Langenheim et al. combines gravity data together with aeromagnetic data to conclude that the gravity low across the Irish Hills originates from rock density contrasts within the upper 10 to 15 km of the crust rather than a deep extensive crustal root extending into the mantle. Specifically, the authors conclude that the gravity low across the Irish Hills is due to the density contrast between the low density (D=2270 kilograms per cubic meter (kg/m3)) younger sedimentary rock that overlies the higher density (D=2710 kg/m3) older basement rock. This conclusion is also supported by the aeromagnetic data gathered over the Irish Hills that shows "fairly" magnetic rocks underlie the upper younger sedimentary rocks. Figure 9, from Langenheim et al., shows the gravity and magnetic models across the Irish Hills along with a geologic cross-section that provides the density and magnetic susceptibility values for each of the rock units. The low likelihood of a massive crustal root beneath the Irish Hills is further supported by the conclusions of Lowry and Pérez-Gussinyé, which use a coherence analysis of gravity and topography to estimate an effective elastic thickness of 10 to 15 km along central coastal California. Under the simple Airy isostatic model, the crust has no flexural rigidity, and its effective elastic thickness is assumed to be zero.*[31]

The PRB's illogical reasoning is reflected in a misinterpretation of my argument and the significance of Langenheim's findings. In two respects, the PRB erroneously assumes that it is not necessary to consider how the structure of the Irish Hills (and the isostatic gravity anomaly) have developed over time:

a) My argument for high rates of thrust-faulting is based on the <u>increases</u> in crustal thickness needed to isostatically compensate (or overcompensate) for the <u>increases</u> in Irish Hills elevation since 5 Ma. The densities of surface sedimentary rocks have not changed during that time, so this new compensation (or overcompensation) must be due to crustal thickening. This is true even if the crust in this area started at an anomalously low thickness 5 m.y. ago, so that it is just coming up to normal thickness today.

[31] *Id.* at 16 (footnotes omitted).

b) Given that Langenheim was also first-author on the high-resolution isostatic gravity anomaly map that we now rely on [*see* footnote 30 above] it is reasonable to assume that he incorporated his knowledge of low surface rock densities into that isostatic calculation. However, that local structure did not erase the present-day negative isostatic gravity anomaly of the Irish Hills.

35. The PRB falsely implies that isostatic models are irrelevant to tectonics in the Irish Hills, stating:

> *The low likelihood of a massive crustal root beneath the Irish Hills is further supported by the conclusions of Lowry and Pérez-Gussinyé, which use a coherence analysis of gravity and topography to estimate an effective elastic thickness of 10 to 15 km along central coastal California. Under the simple Airy isostatic model, the crust has no flexural rigidity, and its effective elastic thickness is assumed to be zero*.[32]

By juxtaposing these two sentence, the PRB implies that isostatic models are not relevant in places where an upper-crustal *"elastic"*[33] layer is present, and that my computation of a lower limit on the rate of tectonic crustal thickening in the Irish Hills is somehow invalid. However, any such simplistic dismissal merely reflects poor understanding of the isostatic concept and its actual use in geophysics, in the following respects:

> **First**, the Irish Hills are not unusual in having a strong upper-crustal elastic/frictional layer; every surface point on Earth's continents has a similar layer. Two simple proofs: (a) Presence of high deviatoric stresses is indicated by earthquakes (of any size) and/or by borehole measurements by hydrofacture, overcoring, *etc*.; (b) Continents, plateaus, and mountains persist for millions of years without collapsing into the sea, as a viscous glacier of ice does immediately.
>
> **Second**, the idealized isostatic model is <u>not</u> incompatible with a strong upper-crustal layer. It merely assumes that vertically-directed tractions on vertical planes have relaxed ($\sigma_{r\theta} = 0 = \sigma_{r\varphi}$) so that vertical compressive stress σ_{rr} is equal to the weight of overburden (per unit area). But this only restricts 3 of the 6 independent components of the stress tensor. Components $\sigma_{\theta\theta}$, $\sigma_{\varphi\varphi}$, and $\sigma_{\theta\varphi}$ remain free to take on large values; and it is these 3 components that can drive normal faulting, thrust faulting, and/or strike-slip faulting (depending on their relative values).
>
> **Third**, reference to the idealized isostatic model is useful even where these assumptions do not hold. Computation of the isostatic gravity anomaly (which is relative to the gravity expected in the ideal isostatic state) indicates whether and how the real state departs from this ideal. If the isostatic gravity anomaly is

[32] *Id.* at 16-17.

[33] As used here, the term "elastic" is inadequate to describe the mechanical behavior of the cool upper crust. The correct term is "elastic/frictional."

positive, then the lithospheric vertical section has more mass (than the isostatic model with the same surface elevation), and is said to be under-compensated (meaning deficient in crustal roots). If the isostatic gravity anomaly is negative (as in the Irish Hills) then the lithospheric vertical section has less mass, and is said to be over-compensated (indicating crustal roots that are deeper than expected).

Fourth, the factor which is critical to our analysis is the long-term rate of increase in crustal thickness, not the absolute thickness or the present size of crustal roots. It is quite possible that the region of the future Irish Hills had abnormally low crustal thickness following Oligocene extension, and that Pliocene/Quaternary thrust faulting is just now bringing crustal thickness back into the normal range.

Therefore, contrary to the assertion of the PRB, my computations are solid. They show that the lower limit on the rate of tectonic crustal thickening in the Irish Hills is about 6 times the rate of surface uplift. From this we derive one estimate of the total slip rate of all shallow-dipping thrust faults under the Irish Hills, which is 2.8 mm/yr.

36. The PRB incorrectly asserts that I made GPS-based calculations of total horizontal shortening rate based on incomplete information:

> *Finally, the petitioners use modeling of GPS data in the region to develop a third independent estimate for the total thrust fault slip rate beneath the Irish Hills. This estimate is not based on actual GPS measurements near Diablo Canyon as only the direction of shortening or compression (N15°E) is known in the region near the site. Despite this limitation, the petitioners used deformation modeling to determine a shortening rate of 2.0 mm/yr across the Irish Hills.*[34]

This is a garbled and inaccurate statement about data availability. The complete set of GPS horizontal-velocity vectors (both lengths and azimuths, with uncertainties) in the western conterminous United States was available to us and we accessed it. The data were provided by USGS experts to all deformation modelers participating in the 2023 Update to the National Seismic Hazard Model, including *Shen & Bird* [2022]. The PRB may have been confused by our previous comment that PG&E did not choose to share the magnitude of crustal shortening measured by GPS with either the NRC or the public, in either their 2015 SSC Report or their 2024 Updated SSC Report. (The 2015 SSC Report quoted and displayed the direction of crustal shortening, but not the rate. The 2024 Updated SSC Report did not mention GPS data at all.) This may be a confusing situation, but the confusion is entirely due to PG&E's attempts to divert attention from this damning evidence, not to any mis-statements by Petitioners.

37. The PRB incorrectly asserts that I assigned particular slip-rates to particular faults in the Irish Hills, when actually I computed the total crustal shortening rate on all shallow-dipping thrust faults. According to the PRB:

[34] *Id.* at 17.

> *Despite the low resolution of the model grid, the petitioners allocate all the 2.0 mm/yr of shortening across the Irish Hills to the "inferred" offshore thrust fault to determine a total thrust fault slip rate of 2.2 mm/yr beneath the Irish Hills. The amount of shortening (2.0 mm/yr) as well as the allocation of all the shortening across the Irish Hills to a single "inferred" thrust fault is questionable as there are other known active faults in the region that could accommodate the shortening.* [35]

This is also garbled and inaccurate. I do use the GPS shortening rate of 2.0 mm/yr to infer a total slip rate of 2.2 mm/yr for all active thrust faults of shallow dip under the Irish Hills. [The conversion is simply 2.2 mm/yr = (2.0 mm/yr) / cos(25°).] However, I have never assigned any specific portion of this total slip rate to the Inferred Coastline thrust. I agree that some part of the total slip rate occurs on the Los Osos thrust, some on the San Luis Bay-Inferred Coastline thrust system, and some on additional unmapped and unmodeled thrust faults within the Franciscan Complex basement. Based on the areal extent of core-damaging PGA values observed in the Noto Peninsula earthquake [*e.g.*, up to 2.3 g at 42 km from the rupture], such a division is not critical to my conclusion that SCDF at DCPP is between once per 1000 years and once per 715 years.

38. In concluding that "*[T]he stratigraphic*[36] *profile, gravity anomalies, and GPS modeling used by the petitioners do not provide adequate evidence to support the existence of a major "inferred" offshore thrust fault that extends beneath the Irish Hills with a fault length of 70 to 100 km and a slip rate between 2.0 to 2.8 mm/yr,"*[37] the PRB utterly ignores the substantial evidence and analyses I have presented for a total thrust fault slip rate of between 2.0 to 2.8 mm/yr. The PRB also misrepresents my position. I never claimed that all (or more than half) of the computed total slip rate occurs on the Inferred Coastline thrust. Instead, I have focused my analyses on determining the total of the slip-rates on all shallow-dipping thrust faults under the Irish Hills. But this is only marginally relevant to the conclusion of high seismic hazard and risk at DCPP, because the example of the 2024 Noto Peninsula earthquake in Japan shows that core-damaging values of PGA extend much further from the source that the width of the Irish Hills. Thus, any and all shallow-dipping thrust faults under the Irish Hills pose similar danger to DCPP.

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[35] *Id*.

[36] As used here, the term "stratigraphic" is inappropriate because vertical positions in a stratigraphic section are arbitrary, and selected for the convenience of the illustrator. The correct term is "structural."

[37] *Id.* at 18.

D. Concern 4

39. As correctly noted in Concern 3, my analysis leads to a range of possible total slip rates for all gently-dipping thrust faults under the Irish Hills: 2.0 to 2.8 mm/yr. Taking the mean slip in the Noto Peninsula earthquake to be 2.0 m = 2000 mm, this implies recurrence times of 715 to 1000 years for similar thrust earthquakes under the Irish Hills. The PRB's statement of Concern 4 is deficient because it only mentions the shorter recurrence time and thus does not recognize my range of uncertainty.

40. In discussing Concern 4 and summarizing their conclusion, the PRB wrongly concludes that PG&E's seismic analysis is acceptable because it considered thrust-faulting, without addressing the question of whether it did so competently. According to the Proposed Decision, "*[T]he seismic models developed by PG&E do not neglect the potential for thrust or reverse faulting beneath Diablo Canyon."*[38] Obviously, PG&E'S's 2015 SSC Report and 2024 Updated SSC Report did "consider" hazard due to thrust faulting under the Irish Hills, but the PRB ignores the demonstrated fact that they calculated it incompetently. The critical problem is that PG&E's hazard estimates were biased extremely low (by ~2 orders of magnitude in terms of SCDF) by reliance on PG&E's fault geometry models and Local Area Source Model which are not technically defensible, as stated above in paragraphs 16-19 and 28-29.[39]

41. In addition, the PRB wrongly reasserts their previous false conclusion that strike-slip faulting is important in the Irish Hills, asserting that: *"[T]he tectonic setting along central coastal California differs substantially from that for the Noto Peninsula."*[40] This false conclusion has been rebutted in paragraph 14 above.[41] The only relevant difference between the Noto Peninsula and the Irish Hills is that crustal shortening in the Noto Peninsula is much faster; however, I have properly taken that into account, producing estimated SCD recurrence times for DCPP based on the relevant crustal shortening rates in the Irish Hills.

42. Further, the PRB wrongly assumes that our analyses showing high seismic risk at DCPP would be invalidated if the Inferred Coastline thrust fault does not exist. According to the Proposed Decision: "*[T]he existence of a 70- to 100-km long "inferred" offshore thrust fault with a slip rate greater than 2 mm/yr is highly unlikely."*[42] As explained above in paragraphs 30, 32, 37, and 38, the PRB's reasoning is erroneous in two respects:

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[38] *Id*.

[39] *See also* the Bird June 7, 2024 Supplemental Declaration at 3-4; the Bird July 17, 2024 Presentation at slides 1-23; and the Bird October 30, 2024 Report at 1-7.

[40] *Id.* at 18.

[41] *See also* Bird October 30 2024 Declaration, Appendix B at 13.

[42] *Id.* at 20.

a) The PRB mischaracterizes my work. I never assigned all the crustal shortening rate of the Irish Hills to the Inferred Coastline thrust fault; and

b) The PRB fails to recognize that even if the Inferred Coastline thrust fault does not exist, the other active thrust faults (Los Osos, San Luis Bay, and others unmapped and unmodeled in the basement) are close enough to DCPP to cause seismic core damage, based on the geographic spread of high PGA values observed in the 2024 Noto Peninsula earthquake.

IV. CONCLUSION

43. For the reasons discussed above, the PRB's proposal to reject the Petitioners' claims should be reversed. The NRC should accept the shutdown Petition, because the seismic hazard model provided by PG&E is not technically defensible, while our alternative computations (often based on data developed and reported by PG&E) have survived all challenges. Further, the risk of a seismic core damage accident is high enough to demand immediate intervention by NRC's own standards.

44. Finally, given the number and significance of technical errors and omissions by the PRB, it seems that the PRB could benefit from the assistance of impartial outside experts in understanding and evaluating Petitioners' arguments. Such a review is currently underway, authorized by the Diablo Canyon Independent Safety Committee (DCISC) of the CPUC. The DCISC has retained a Seismic Review Team of 3 highly-respected and impartial experts on plate tectonics, fold/thrust belt tectonics, GPS geodesy, and their implications for seismic hazard. The PRB may wish to request a copy of the report of this Seismic Review Team as soon as it is ready. (That report will necessarily be a public document, based on DCISC protocols.)

Under penalty of perjury, I declare that the foregoing factual statements are true and correct to the best of my knowledge, and that the statements of opinion are based on my best professional judgment.

Executed in Accord with 10 C.F.R. 2.304(d) by
Peter Bird

Date: May 15, 2025

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