



DECISION TIME FOR DIABLO CANYON:

Should California reverse its 2018 decision to close the aging reactors by 2025?

A briefing for the citizens of California, the Legislature, and the Governor on important new data and analyses since passage of S.B. 846

San Luis Obispo Mothers for Peace

December 14, 2023

INTRODUCTION. This briefing paper by San Luis Obispo Mothers for Peace (MFP) provides current data and high-level expert analysis to answer key questions posed by the California Legislature in 2022 when it passed S.B. 846, emergency legislation to allow continued operation of the Diablo Canyon nuclear plant (DCPP) for five years or more past their expiration dates of 2024 (Unit 1) and 2025 (Unit 2).

And it explains why today's decision by the California Public Utilities Commission (CPUC) conditionally approving continued operation is contradicted by new data and analyses showing that continued operation of DCPP is not necessary, cost-effective, or safe; and furthermore, that it would undermine the State's goal of a 100% renewable electric energy economy.

BACKGROUND. S.B. 846 reversed a 2018 decision by the CPUC to approve Pacific Gas & Electric's (PG&E's) proposal to close DCPP on the reactors' retirement dates in favor of less expensive and more modern power sources. Concerned by power shortages caused by abnormal weather and fire conditions in 2021-22, the Legislature passed S.B. 846 to "preserv[e] the option of continued operation of the Diablo Canyon powerplant for an additional five years beyond 2025." The Legislature also offered a \$1.4 billion forgivable loan for the project.

As directed by S.B. 846, during the summer/fall of 2023, the CPUC conducted a rulemaking and took evidence and legal briefing on issues related to the prudence or imprudence of continuing to operate DCPP. MFP submitted detailed expert evidence on the following questions:

- 1) *Is extended operation of DCPP prudent or imprudent?*
- 2) *Is DCPP extended operation needed to avoid summer blackouts?*
- 3) *Is extended operation of DCPP consistent with the State's goal of reaching a 100% renewable electric energy economy?*
- 4) *What will DCPP cost Californians in comparison to alternative zero carbon electricity sources? And who will pay?*
- 5) *Is safety assured during extended operation of DCPP? And if so, what will it cost?*

As demonstrated in this briefing paper, new data and analyses, not considered by the CPUC, show that these questions cannot be answered in the affirmative. Therefore, continued operation of DCPD is imprudent and unjustified.

DISCUSSION

1) Is extended operation of DCPD prudent or imprudent?

Answer unknown. See Attachment 1, THE PRUDENT COURSE ON CONTINUED OPERATION OF DIABLO CANYON NUCLEAR POWER PLANT: TAKE THE OFFRAMP NOW a report by Peter Bradford, CEO of Bradford Brook Associates.

Astonishingly, the CPUC has failed to answer this question. Never in the history of U.S. utility regulation has a regulated project of this multi-billion dollar magnitude (to say nothing of major safety issues affecting a significant area of the state) been allowed to go forward without the requisite finding of the relevant regulatory agency.

There is only one actual CPUC determination about the prudence of operating DCPD, and that determination was made in 2016 by the CPUC to approve the on-time retirement of the reactors. The CPUC agreed with PG&E's prediction that the continued operation of Diablo Canyon beyond 2025 would exacerbate over-generation, requiring curtailment of renewable generation. The CPUC also agreed with PG&E that there is no need to replace Diablo Canyon in order to maintain system reliability.

From 2016 until today, PG&E never deviated from that conclusion. It has yet to notify the CPUC that it has changed its 2016 conclusion, and it has yet to file any studies that would support such a changed conclusion. If the Company had changed its view in light of the weather and fire-driven stresses to its system before mid-2022, it would have been under a clear duty to inform the CPUC. It did not do so. This evidence as to what a prudently managed utility in PG&E's circumstances would have done could not be clearer.

2) Is extended operation of DCPD necessary to avoid blackouts?

No. See Attachment 2, WE HAVE ENOUGH POWER TO KEEP THE LIGHTS ON WITHOUT DCPD, a report by Rao Konidena, Rakon Energy LLC, former Midcontinent ISO (MISO) Principal Advisor for Policy Studies.

California has enough power to keep the lights on without the 2,200 MW generated by DCPD – even during extreme heat events. Data from the CPUC and California Energy Commission (CEC) show that the California Independent System Operator (CAISO) now has more than 8,500 MW of energy storage capacity (with more being added each year), plus up to 5,000 MW of demand response – more than sufficient to ensure grid reliability during extreme weather conditions. Inexplicably, while the CPUC has acknowledged the significant growth in renewables and the significant quantity of available demand response, it arbitrarily chose to rely on smaller estimates.

Further, running DCPD 24/7 for an additional 5 years would actually *increase* the risk of blackouts. This is illustrated by the 2022 rolling blackouts, when CAISO had to keep 2,200 MW in reserve just in case DCPD unexpectedly went offline during the two-hour peak demand. This 2,200 MW was *in addition to* the 6% reserve margin that CAISO must maintain at all times, putting a great strain on the CAISO system and increasing the likelihood of blackouts. Because reserve requirements are determined by the size of the largest potential power loss on the system, reliance on the large range of smaller, flexible, low-cost renewable and storage energy sources that are now available in ample supply would reduce blackout likelihood.

3) *Is extended operation of DCPD cost-effective? And who will pay?*

No. See Attachment 3, EXTENDED OPERATION OF THE DIABLO CANYON NUCLEAR PLANT: WHAT WILL IT COST AND WHO WILL PAY FOR IT? a report by Mark Cooper, President of Citizen Research.

California is slouching toward an economic mistake of epic proportions. The CPUC has followed the lead of Governor Newsom and the Legislature in reversing its decision to replace DCPD with an assortment of less costly resources far more compatible with a 21st century electric power grid. Running DCPD for an additional 5 years harms customers immediately, and each dollar wasted on keeping DCPD online also makes California's goal of transitioning to a carbon-free, reliable and safe grid more difficult and expensive.

Consumers and ratepayers will bear a significant cost. The cost to customers of continuing to operate the Diablo Canyon nuclear power plant past the reactors' operating license expiration dates in 2024 and 2025 are significant, even taking into account a \$1.4 billion taxpayer subsidy from state and federal funds. The CPUC has stated that while complete costs are unknown, they are expected to exceed \$6 billion.

The estimated \$6 billion minimum cost of continued operation of DCPD exceeds \$500 for every family of four in the state -- a sobering sum. The CPUC has said that all customer classes will bear a part of this cost burden, although the CPUC lacks the information needed to calculate its basic responsibility, *i.e.*, what the bill impacts will be. Some of the costs will of course show up in the price of goods and services rather than in electric bills. PG&E ratepayers will certainly be harmed. The cost burden will also be spread to other (non-PG&E) ratepayers, but exactly how large their share will be is also unclear.

Given the potentially large size of the costs of running DCPD for another 5 years or more, it is irresponsible to make a decision to go ahead without reckoning with those costs. In any event, it is clear today that adding significant total costs to ratepayer bills and consumer pocketbooks is unjustified now -- and will raise costs in the future by curbing the growth of cheaper renewables.

4) *Is extended operation of DCPD consistent with the State's goal of reaching a 100% renewable electric energy economy?*

No. See Attachment 2 (Konidena Report) and Attachment 3 (Cooper Report). Keeping DCPD online will crowd out and slow down the development of alternatives (wind, solar,

storage, efficiency, demand response). And it will depress the State's growing renewable market, thus causing collateral economic effects and undermining the State's goal of converting to an entirely renewable energy budget. Thus, each dollar that is wasted in keeping DCPD online also makes the eventual transition to renewables more difficult and expensive.

5) Is safe operation of DCPD assured during extended operation?

No. Significant questions about seismic safety and the integrity of the Unit 1 pressure vessel remain unaddressed. Upgrades could cost millions of dollars – and if the risks go unaddressed, the effects of a radiological accident could cost more.

See Attachment 4, PG&E SIGNIFICANTLY UNDERESTIMATES SEISMIC RISK TO DCPD, a report by Dr. Peter Bird, Professor of Geophysics and Geology, Emeritus at the University of California at Los Angeles.

As explained by Dr. Bird, California residents should be greatly concerned about the significantly underestimated risk of an earthquake-caused accident at DCPD during extended operation. Seismic studies by PG&E fail to consider recent data and analyses by well-respected experts showing that seismic risk to DCPD is considerably greater than estimated by PG&E.

See also Attachment 5, EMBRITTLEMENT OF REACTOR PRESSURE VESSEL AT DIABLO CANYON UNIT 1 POSES AN UNACCEPTABLE SAFETY RISK DURING CURRENT AND EXTENDED OPERATION, a report by Dr. Digby Macdonald, Professor in Residence, Departments of Nuclear Engineering, University of California at Berkeley.

Dr. Macdonald concludes that the current operation and proposed extended operation of DCPD Unit 1 pose an unreasonable risk to public health and safety due to serious indications of an unacceptable degree of embrittlement in the reactor pressure vessel (RPV), coupled with a lack of information to establish otherwise. In Dr. Macdonald's expert opinion, the reactor should be closed unless and until PG&E obtains and analyzes additional data demonstrating that Unit 1 is safe to operate. But so far, neither PG&E nor the federal regulator, the U.S. Nuclear Regulatory Commission, has taken any steps to assess the current condition of the Unit 1 RPV.

CONCLUSION. Instead of approving continued operation of DCPD, the CPUC should order that the reactors should be retired on schedule and that the State should proceed with replacement of DCPD with renewable energy sources as approved by the CPUC in 2018.

ATTACHMENT 1

The Prudent Course on Continued Operation of Diablo Canyon Nuclear Power Plant: Take the Offramp Now

Prepared by Peter Bradford, CEO of Bradford Brook Associates¹
on behalf of San Luis Obispo Mothers for Peace
December 14, 2023

One of the safeguards in S.B. 846 for proceeding with extended operation of the DCPD reactors is potential suspension of the \$1.4 billion loan agreement between the state and Pacific Gas and Electric Company (PG&E) in the event of “a determination by the Public Utilities Commission that the extension of the Diablo Canyon powerplant is...imprudent”. To bypass this offramp, the California Public Utilities Commission (CPUC) must be satisfied that the decision to extend DCPD operation is not imprudent. However, as I have [testified](#) to the CPUC, the CPUC decision does not reach this essential conclusion.

The CPUC’s decision to allow continued operation of DCPD without making a prudence finding is astonishing. Never in the history of U.S. utility regulation has a regulated project of this multi-billion dollar magnitude (to say nothing of major safety issues affecting a significant area of the state) been allowed to go forward without the requisite finding of the relevant regulatory agency.

The ingredients of a prudent course of action are very different. The would-be builder and/or operator spends years preparing thorough and independent analyses documenting the economic and reliability justification for the project. Such a review includes numerous detailed assessments of projected costs of the preferred project as well as the alternatives, forecasts of fuel costs and of the cost of capital. Comparable safety analyses are also prepared. Within the Company, dozens of skilled executives trained and experienced in the relevant disciplines oversee this work, which takes many months.² The Board of Directors is periodically briefed and gives its approval. Public consultations in the affected areas are held.

¹ Peter Bradford is a former utility regulator and consultant on energy policy. For 19 years, he served on the New York State Public Service Commission (NYPS&C) and the Maine Public Utilities Commission (MPUC), including 8 years as chair of the NYPS&C and 6 years as chair of the MPUC. His statutory duties for each state included assuring a fully adequate electric supply at just and reasonable rates. He also participated in more than 10,000 utility proceedings, including decisions involving the prudence of nuclear power operations and construction. Between 1971 and 1983, including the time of the Three Mile Island accident, Mr. Bradford served as a commissioner of the U.S. Nuclear Regulatory Commission (NRC). Since leaving utility regulation, Mr. Bradford has taught, written, and consulted on regulatory issues and abroad, and he has testified in multiple state regulatory proceedings on costs of nuclear reactor construction and operation.

² “The accuracy of each of these forecasts is critically dependent upon the accuracy of assumptions concerning future economic conditions in the world, the nation, and the geographic area served by the utility, as well as the accuracy of assumptions concerning the future relationship between macroeconomic variables and conditions in specific markets for each form of energy.... It is hard to imagine a more difficult and risky decision. Even forecasts of only a few of these factors made by well qualified specialists and covering much shorter time periods have often proven extremely unreliable.” Richard J.

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These are some of the ingredients of a prudent decision-making process by which a state decides to commit to a decision like California's September 2022 reversal of course on its decision to close DCPD by mid-2025. All are lacking in this case.

PG&E and the CPUC had it right in 2018. The most basic standard for evaluating what a prudently managed utility would have done is the conduct of other utilities in comparable circumstances. As to this topic, decisionmakers never have evidence as clear as that which is available in this case. PG&E reviewed the need for continued operation of Diablo Canyon at length before concluding in 2016 that the plant was not needed, that indeed it was an impediment to California's making the optimal transition to its future electric system. As the CPUC summarized PG&E's position in its 2018 decision approving Diablo Canyon shutdown in 2024-25, "In fact, PG&E believes that the continued operation of Diablo Canyon beyond 2025 would exacerbate over-generation, requiring curtailment of renewable generation. (*Id.* at 16-17; Ex. PG&E-1 at 2-20.) PG&E's analysis indicates that there is no need to replace Diablo Canyon in order to maintain system reliability".

From 2016 until today, PG&E never deviated from that conclusion. It has yet to notify the CPUC that it has changed its 2016 conclusion, and it has yet to file any studies that would support such a changed conclusion. If the Company had changed its view in light of the weather and fire-driven stresses to its system before mid-2022, it would have been under a clear duty to inform the CPUC. It did not do so. This evidence as to what a prudently managed utility in PG&E's circumstances would have done could not be clearer.

The expensive history of nuclear imprudence. The S.B. 846 requirement that the CPUC find continued DCPD operation not to be imprudent was a wise one in light of the expensive history of nuclear power imprudence. In 1985, Forbes Magazine called nuclear power "the largest managerial disaster in business history, a disaster on a monumental scale. ... Only the blind or the biased can now think that the money has been well spent." In the 21st century, at least another \$20 billion has been wasted on the costs of canceled plants and cost overruns while a dozen older reactors have closed down because they couldn't compete.

Imprudent actions and decision making were at the heart of many of these expensive failures. The symptoms of that imprudence are now manifesting themselves in many aspects of the DCPD proceeding. Conclusions of immense importance are being reached in a rushed manner. Required studies by the Energy Commission have not been done. Approvals to move ahead are being given while serious problems are deferred for future consideration. This pattern of pushed power plants and postponed problems is as old as nuclear power itself, which is why spent fuel canisters with no place for disposal remain on the sites of every US nuclear power plant.

In this proceeding, we see this phenomenon in the potential costs of seismic reassessment, pressure vessel repair and the myriad of other events that have resulted in reactor shutdowns of a year or more at some 50 US sites. We see it also in the failure to test the California power

Pierce, *The Regulatory Treatment of Mistakes in Retrospect: Canceled Plants and Excess Capacity*, University of Pennsylvania Law Review, vol. 137, 497, p. 499 (1984).

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markets for less expensive alternatives to DCPD or to use the state's Integrated Resource Planning process to guide the S.B. 846 proceeding.

One invariable consequence of such imprudence is that benefits to those furthering the power plants are locked in, through approvals to proceed immediately and through nonbypassable charges, must-take operating arrangements at assured prices, foreclosing of vigorous competition and the spreading of costs over a range of customers and taxpayers large enough to foreclose political backlash.

Meanwhile, the measures needed to protect customers from unanticipated costs or operational errors or the subverting of customer choice are given lip service but deferred to future proceedings. The rhetoric assures that those proceedings will have the power to make things right if major intervention is needed, but in fact they almost never do.

Unlike a prudently managed utility assessing its situation as it evolved over time, S.B. 846 was the product of a few days of deliberation during the hectic closing hours of the summer 2022 Legislative session. But the Legislature wisely wrote in offramps in the event that more deliberate processes revealed again what PG&E (and the CPUC) had long ago decided after thorough review, that DCPD was not the prudent answer to the need for reliable, clean and economic electric service in PG&E's territory.

Conclusion. To make a long, sad story short, imprudent decision-making where nuclear power plants is concerned is dangerous – certainly economically and sometimes to public health. The American landscape is littered with dozens of nine-figure nuclear economic accidents, most of which could have been avoided. The CPUC should call out the obviously imprudent decisionmaking that has been foisted onto its agenda and the public's electric bill. That's the only way for it to play the independent expert role in protecting all Californians that the Legislature had in mind.

ATTACHMENT 2

California has enough power to keep the lights on without DCPP.

Prepared by Rao Konidena, Rakon Energy LLC¹
On Behalf of San Luis Obispo Mothers for Peace
December 14, 2023

Summary of Key Points

- **California has enough power (including storage) to keep the lights on** – without the 2,200 MW of Diablo Canyon Power Plant (DCPP) – **even during extreme heat events.**
 - **The California Independent System Operator (CAISO) now has more than 8,500 MW of energy storage capacity** (with more being added each year), **plus up to 5,000 MW of demand response, which is more than sufficient to ensure grid reliability.**
 - Even if we focus only on “have already been constructed and interconnected” by the end of 2023, as does the Proposed Decision in the California Public Utilities Commission Rulemaking (October 26, 2023), **California has at least 931 MW of excess capacity by the end of 2023.**
 - **California** continues to add renewables every year and **is projected to have at least 7,000 MW more by 2026, three times the capacity of DCPP.**
- This data comes from the CPUC and the California Energy Commission (CEC), reliable sources. Inexplicably, however, the CEC staff’s draft September report omitted over 10,000 MW of renewables from its analysis of whether continued operation of the DCPP is needed to ensure grid reliability.
- The CEC staff’s erroneous analysis is bad for California’s clean energy future because:
 - DCPP’s high cost and inflexibility hinders deployment of more renewables and storage.
 - Favoring DCPP as an inflexible electricity supplier will drive out flexible renewables **and thereby increase the danger of blackouts.**

Technical Analysis

In June 2023, I [testified](#) in a CPUC proceeding that the retirement of DCPP in 2024 and 2025, as previously planned, will not have an adverse impact on local reliability of San Luis Obispo and that it would impede the development of other low or zero-carbon alternatives. Since then, two reports from the CPUC and the CEC show that California’s renewable electricity capacity has continued to grow at an unprecedented and unexpected rate, such that California has enough power to keep the lights on – without the 2,200 MW of DCPP – even during extreme heat events. These two reports are the following: **First**, from the Joint Agency (CPUC + CEC) report “Joint Reliability Planning Assessment - Fourth Quarterly Report” issued in December 2023², it is clear that the need for contingency resources did not worsen since March 2023:

¹ Mr. Konidena is an independent energy consultant, focusing on wholesale market practices and policy. From 2003 to 2018, he was employed by the Midcontinent Independent System Operator (MISO), where he used a range of software tools for resource forecasting and planning, including MISO’s Planning Resource Auction and Module E Capacity Tracking (MECT) tool and the Electric Generation Expansion Analysis System (EGEAS). Before leaving MISO in 2018, his title was Principal Advisor in Transmission Asset Management.

² Yee Yang, Chie Hong (CEC) and Sarah Goldmuntz (CPUC). December 2023. Joint Agency Reliability Planning Assessment. California Energy Commission. Publication Number: CEC-200-2023-015.

“Through summer 2023, analysis indicates that the state maintained surplus capacity under average weather conditions. Under extreme weather conditions, such as those witnessed in the August 2020 heat wave (2020 equivalent event) and the September 2022 heat wave (2022 equivalent event), projected need for contingency resources did not worsen compared to the February 2023 first quarterly report.”³

Even though the report projects a shortfall of 2,606 MW for a 2022 equivalent extreme event⁴, that can be easily handled by the 2,444 MW of available contingency reserves⁵, plus 4,800 MW of demand response⁶.

Additionally, Table 1, which is copied from the Joint Agency report, estimates the addition of 5,499 MW as a “net qualifying capacity” in September 2023.

Table 1: Cumulative Resource Additions, January 2020 Through August 30, 2023

Technology Type	Nameplate Capacity (MW)	Estimated Sept. Net Qualifying Capacity (NQC) MW	Number of Projects ⁺
Storage	4,919	4,556	69
Solar	3,993	345	64
Hybrid (Storage/Solar)	1,034	464	17
Wind	783	103	20
Geothermal	41	31	1
Biogas, Biomass, Hydro	36	1	9 (2,3,4)
Subtotal SB 100 Resources, In-California Independent System Operator	10,806	5,499	180
Natural Gas, incl. Alamitos & Huntington Beach	1,477	1,474	12
Total Resources, In-California Independent System Operator	12,282	6,973	192
New Imports, Pseudo-Tie ² or Dynamically Scheduled	1,689	727	13
Total Resources, Including Imports	13,971	7,701	205

Source: CPUC staff³

This 5,499 MW additional capacity includes 4,556 MW of energy storage available during the top summer demand hours, reducing the risk of blackouts in California. But this number is too low. In fact, CAISO has released a statement⁷ that CAISO has more than 5,000 MW of energy storage capacity as of July 2023. This 5,000 MW of energy storage will be available to reduce the blackout risk in California due to wildfires or other issues.

³ Executive Summary, Ibid.

⁴ Table 5, Ibid.

⁵ Table 6, Ibid.

⁶ <https://www.canarymedia.com/articles/nuclear/california-faces-big-power-challenges-even-if-diablo-canyon-stays-open>

⁷ “Storage surpasses 5,000 MW on the CAISO grid.” <http://www.caiso.com/about/Pages/Blog/Posts/Storage-surpasses-5000-MW-on-the-CAISO-grid.aspx>

I also note that, according to the “California Energy Storage System Survey” results posted on the CEC website⁸, CA now has 6,600 MW of battery storage capacity, of which 843 MW is from the residential customer, 540 MW from the commercial customer and 5,234 MW from the utility customer sector. The Survey notes an additional 1,900 MW is still planned to come online by the end of 2023. Hence, as of December 31, 2023, the CEC projects that California will have 8,500 MW total of energy storage capacity available to reduce the blackout risk, with more coming online every year.

Additional tables in the Joint Agency report show the quarter-by-quarter estimate of new resources coming online in California based on the CPUC data. I have compiled the data from these tables into Table A below, which shows that California added 2,076 MW by August 1, 2023, and will add nearly 5,000 MW more before June 1 every year during 2024-2026 for a total of 18,500 MW by June 2026. This is greatly in excess of the 11,500 MW required by the CPUC in Decision D.21-06-035 (2021). Thus, California is overbuilding renewable capacity by at least 7,000 MW, three times the capacity of DCPD.

Table A- California is overbuilding capacity by at least 7,000 MW.

Required Date	D.21-06-035 Requirements (PG&E recommended baseline)	SB 846 Fourth Quarterly Report	Extra Capacity Built
August 1, 2023	2,000 MW	2,076 MW (Source – Table 3, 2023 Q3 value)	76 MW
June 1, 2024	6,000 MW	5,398 MW (Source – Table 3, 2024 Q2 value of 7,474 MW minus 2,076 MW)	-602 MW (deficit)
June 1, 2025	1,500 MW	4,800 MW (Source – Table 4, 2025 Q2 value of 10,198 MW minus 5,398 MW)	3,300 MW
June 1, 2026	2,000 MW	6,226 MW (Source – Table 4, 2026 Q2 value of 11,026 MW minus 6,226 MW)	4,226 MW
Total	11,500 MW	18,500 MW (Sum of 2076, 5398, 4800, and 6226)	7,000 MW

⁸ <https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/california-energy-storage-system-survey>

Second, after the Joint Agency third quarterly report was issued in August⁹, the CEC staff issued a draft report¹⁰ in September. In addition to the Joint Agency report that documented an expectation of 10,230 MW of renewable capacity to be online by 2026, the draft CEC report shows an improved resource picture due to acknowledgment of the role of demand response in keeping the lights on. The CEC staff estimated additional potential for 3,600 MW of demand response by 2025. While I believe this figure is too low by 1,200 MW (see below), the combined significant volume of new renewable capacity predicted by the Joint Agency and the significant demand response predicted by the CEC staff greatly increase California's likelihood of staying reliable during peak summer conditions. See Table B below.

*Table B - Expected Cumulative New September Net Qualifying Capacity (MW)
from Joint Agency Fourth Quarterly report.*

Resource Type	2023 Q1	2023 Q2	2023 Q3	2023 Q4	2024 Q1	2024 Q2	2024 Q3	2024 Q4
Solar	7	26	101	150	182	318	321	331
Battery	654	810	1,302	1,825	2,504	5,199	5,528	5,538
Paired /Hybrid	395	473	638	1,280	1,446	1,847	1,856	2,324
Wind	-	14	14	14	14	14	14	14
Geothermal	21	21	21	21	21	74	74	92
Biomass /Biogas	-	-	-	3	22	22	22	25
Total	1,076	1,344	2,076	3,293	4,188	7,474	7,814	8,324

Source: CPUC staff, data as of August 2023

⁹ Kootstra, Mark (CEC) and Nathan Barcic (CPUC). 2023. Joint Agency Reliability Planning Assessment. California Energy Commission. Publication Number: CEC-200-2023-011.

¹⁰ Erne, David and Chie Hong Yee Yang. September 2023. Draft SB 846 Diablo Canyon Power Plant Extension Cost Comparison. California Energy Commission. Publication Number: CEC-200-2023-013-SD.

Resource Type	2025 Q1	2025 Q2	2025 Q3	2025 Q4	2026 Q1	2026 Q2	2026 Q3	2026 Q4
Solar	441	459	459	459	462	462	462	462
Battery	5,972	6,743	6,743	6,743	6,865	7,221	7,221	7,221
Paired /Hybrid	2,498	2,815	2,929	2,993	3,001	3,061	3,061	3,061
Wind	14	31	31	31	31	60	60	60
Geothermal	93	122	143	144	160	195	195	200
Biomass /Biogas	25	28	28	28	28	28	28	28
Total	9,043	10,198	10,333	10,398	10,546	11,026	11,026	11,030

Even limiting the analysis to resources that “have already been constructed and interconnected” by the end of 2023, as does the Proposed Decision adopted by the CPUC today¹¹, California still has at least 1,075 MW surplus capacity by the end of 2023. (As shown below in Table C, the “Net Gain” exceeds the “Net Shortfall” by 1,075 MW).

Table C - California has at least 931 MW of excess capacity by the end of 2023, based on Joint Agency Fourth Quarterly report.

Category	Capacity (MW)
DCPP	2200
Constructed & Interconnected by 2023	3293
Net Gain if DCPP were retired	1093
Contingency Reserves	2,588
2022 Equivalent Event shortfall	-2,606
Net Shortfall	18
Bottomline by the end of 2023	1,075

However, it is important to note that a number of significant improvements shown above are not credited in the CEC staff’s analysis. Most significantly, the CEC staff report excludes almost all of the

¹¹ PROPOSED DECISION OF ALJ SEYBERT (Mailed 10/26/2023).

10,230 MW of renewables because they supposedly “compete with the Integrated Resource Planning procurement orders.” The 10,230 MW of excluded resources has increased to 11,030 MW in the Joint Agency fourth quarterly report, which are listed in Table B. The CEC staff’s failure to credit these renewable resources does not make sense because they are being built in California for the purpose of building capacity and because they can substantially reduce the likelihood of blackouts in California. This substantial volume of renewable capacity should be counted in agency forecasts, not ignored.

In addition to excluding 10,230 MW of renewables (which has increased to 11,030 MW in the Joint Agency fourth quarterly report), the draft September CEC staff’s analysis only recognizes 3,600 MW potential for Demand Response in CA by 2025. But when the California Governor initiated Emergency Alerts¹² on September 6, 2022, 4,800 MW of demand was reduced.¹³ Therefore, potential demand response should be increased by at least 1,200 MW.

The draft September CEC staff report also assumes it takes 6 years for new resources to interconnect when new and improved interconnection reforms at other grid operators estimate 1-2 years. Based on new requirements from the Federal Energy Regulatory Commission (FERC) and recent experience, new renewable resources should be expected to be online much sooner.

Finally, the draft CEC staff report is hampered by including the inflexible and expensive 24/7 DCPD operation, when California needs flexible resources to provide reliable, low cost electricity sources. The 2022 rolling blackouts provide an illustration of this phenomenon. CAISO has to maintain 26% planning reserve margin at all times, including covering the threat of loss of the largest power generator on the grid. Thus, one of the contributing factors to the 2020 rolling blackouts was the fact that CAISO needed an additional reserve margin of 2200 MW, just in case DCPD unexpectedly went off-line during the two-hour demand peak.¹⁴ In short, the operation of DCPD increased the blackout risk rather than reducing it.

Therefore, it is important to evaluate the data presented by the CEC and the Joint Agency, rather than relying on the CEC’s distorted analysis. The data strongly show that CA has enough energy to keep the lights on without extended operation of DCPD.

¹² <https://www.gov.ca.gov/2022/09/06/as-record-heat-wave-intensifies-governor-newsom-extends-emergency-response-to-increase-energy-supplies-and-reduce-demand/>

¹³ <https://www.canarymedia.com/articles/nuclear/california-faces-big-power-challenges-even-if-diablo-canyon-stays-open>

¹⁴ <https://calmatters.org/commentary/2022/07/the-diablo-canyon-power-plant-wont-stop-power-outages/>

ATTACHMENT 3

Extended Operation of the Diablo Canyon Nuclear Plant: What will it cost and who will pay for it?

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Economic Expert for San Luis Obispo Mothers for Peace¹
December 14, 2023

California is slouching toward an economic mistake of epic proportions. The California Public Utilities Commission (CPUC) has followed the lead of Governor Newsom and the Legislature in reversing its decision to replace the Diablo Canyon nuclear power plant (DCPP) with an assortment of less costly resources far more compatible with a 21st century electric power grid. Running DCPP for an additional 5 years harms customers immediately, and each dollar wasted on keeping DCPP online also makes California's goal of transitioning to a carbon-free, reliable and safe grid more difficult and expensive. See my June 30, 2023 [testimony](#) to the CPUC on behalf of San Luis Obispo Mothers for Peace.

The cost to customers of continuing to operate the Diablo Canyon nuclear power plant past the reactors' operating license expiration dates in 2024 and 2025 are significant, even taking into account a \$1.4 billion taxpayer subsidy from state and federal funds. In its December 14, 2023 decision to permit continued operation of DCPP, the California Public Utilities Commission (CPUC) stated in the agenda for its December 14, 2023 meeting that while “[c]omplete costs are unknown,” they are “expected to exceed \$6 billion (2023-2030).” Other estimates are much higher, especially if operation continues after 2030.²

And the CPUC's cost estimate is only for the first 5 years. But S.B. 846 did not rule out further extensions and PG&E has applied to the U.S. Nuclear Regulatory Commission (NRC) for a 20-year extension. Testimony submitted in the CPUC rulemaking by other parties indicate that the cost of extending DCPP operation could be another \$7-\$9 billion over the 2nd 5-years, and another \$18-\$19 billion over 20-years. **Consumers will be harmed.** The estimated \$6 billion minimum cost of continued operation of DCPP exceeds \$500 for every family of four in the state -- a sobering sum. The CPUC has said that all customer classes will bear a part of this cost burden, although the PUC lacks the information needed to calculate its basic responsibility, *i.e.*, what the bill impacts will be. Some of the costs will of course show up in the price of goods and services rather than in electric bills. PG&E ratepayers will certainly be harmed. The cost burden will also be spread to other (non-PG&E) ratepayers, but exactly how large their share will be is also unclear.

The CPUC says it will exercise its obligation to ensure that rates are just and reasonable. But given the potentially large size of the costs of running DCPP for another 5 years or more, it is irresponsible to make a decision to go ahead without reckoning with those costs. In any event, as discussed elsewhere in this paper, it is clear today that adding significant total costs to ratepayer bills and consumer pocketbooks is unjustified now -- and will raise costs in the future by curbing the growth of cheaper renewables.

¹ For forty years, Mark Cooper, President of Citizen Research and former Research Director of the Consumer Federation of America, has studied and published widely concerning the economics of energy technologies, including nuclear and renewables. He has testified before Congress, federal regulatory agencies, and state regulatory agencies across the U.S. Without exception, the nuclear projects whose excess costs he identified in the last two decades have been canceled, though only after costing customers large sums and delaying more effective responses to climate change.

² William A. Monsen, expert for The Utility Reform Network in CPUC Rulemaking Docket: R.23-01-007, [testified](#) to estimated costs of \$10 billion for the first five years. See also [testimony](#) by Alliance for Nuclear Responsibility, and [testimony](#) by Women's Energy Matters.

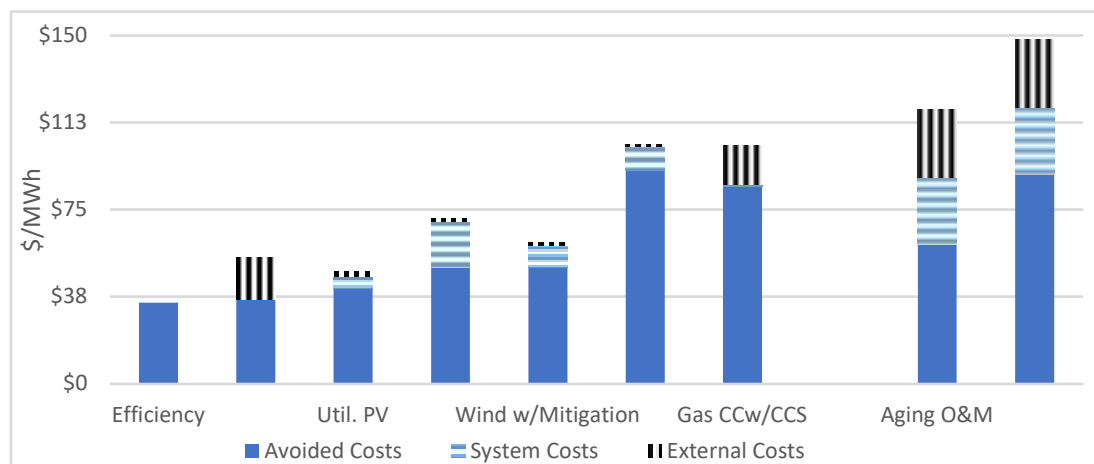
By committing significant funds to DCP as a “must-run” source of electricity, the State will also have to cut back use of less expensive alternatives (renewables with storage, efficiency, and demand response). This will affect the future availability and cost of these alternatives.

PG&E has recognized this for years, and in fact it planned on making a transition to renewables until passage of S.B. 846. In 2018, PG&E formally abandoned a 2009 license renewal application that would have extended DCP’s operation by 20 years, because it recognized that DCP could not compete with the alternatives and was too inflexible in its operation to be compatible with a reliable 21st century power grid. That remains true today. PG&E has never retracted its previously stated view that DCP could not compete with renewables.

Alternatives have played a key role in grid management in the past two years, rendering the effort to restore the operation of DCP not only too costly to justify, but unnecessary. As Mr. Konidena’s report (Attachment 2) demonstrates, these alternatives also make for a more reliable electric system to respond to the weather and fire-related challenges that California faces.

Renewable alternatives are much less costly than the full cost of operating an aging reactor. Figure 1 shows the total “system” cost for many of the resources, with the value of carbon and other pollutants added to the avoided cost and system costs.

FIGURE 1: ESTIMATES OF TOTAL SYSTEM COST OF POWER SOURCES



Conclusion: Continued operation of DCP is a bad economic bargain for California ratepayers in both the short run and the long run. Keeping DCP online will crowd out and slow the development of alternatives (wind, solar, storage, efficiency, demand response). And it will depress the State’s growing renewables market, thus causing collateral economic effects and undermining the State’s goal of converting to an entirely renewable and zero carbon electric energy grid by 2045.

ATTACHMENT 4

PG&E SIGNIFICANTLY UNDERESTIMATES SEISMIC RISK TO DCP

Prepared by Dr. Peter Bird, Professor of Geophysics and Geology, Emeritus
at the University of California at Los Angeles (UCLA)¹
on behalf of San Luis Obispo Mothers for Peace
December 14, 2023

California residents should be greatly concerned about the significantly underestimated risk of an earthquake-caused accident at the Diablo Canyon nuclear power plant (DCPP) during extended operation. Seismic studies by Pacific Gas and Electric Company (PG&E) fail to consider recent data and analyses by well-respected experts showing that seismic risk to DCP is considerably greater than estimated by PG&E in three respects.

- First, PG&E found an artificially low hazard based on outdated methods for assessing the slip-rate of known faults.
- Second, PG&E based its evaluation of seismicity from unexpected, undetected and/or subterranean ruptures between known faults on a set of data that was too limited. Focusing only on a few decades of microseismicity, PG&E ignored globally-calibrated relationships between long-term tectonic strain-rate and (typically higher) long-term-mean-seismicity (including seismic crisis).
- Finally, PG&E failed to recognize or investigate the significant potential for thrust faults dipping under the DCP reactors. PG&E's analysis focuses instead on strike-slip faults like the Hosgri Fault. The omission is significant for DCP safety because thrust faults behave differently than strike-slip faults. Instead of moving on a primarily horizontal plane, thrust faults push one block over another, thickening the crust and causing uplift. It is already known, from widely-accepted published equations, that maximum ground accelerations above a thrust fault will be higher than next to a strike-slip fault (for the same earthquake magnitude). And a thrust fault can be located directly below the reactor, even though on the surface it does not break the ground within the fence. The closer the fault is to the reactor, the more shaking there will be and therefore the more hazardous it is. The existence of the Irish Hills is strong evidence of thrust faults. The Shoreline Fault – a complicated braided network of faults close to DCP – probably includes thrust faults.

¹ For over 46 years, Dr. Bird has been a Professor of Geophysics and Geology at UCLA. His broad expertise in the fields of geology and geophysics includes a focus on plate motion and plate deformation. Over the past 44 years, he has authored or contributed to a number of academic papers on computer modeling methods and applications, including studies of the ongoing (neotectonic) deformation in California. In 2012, Dr. Bird participated in a Senior Seismic Hazards Analysis Committee (SSHAC) workshop sponsored by PG&E and Lettis Consultants International consultants regarding seismic hazard at the Diablo Canyon power plant site. He presented results on both strike-slip and compressional deformation rates affecting the site, which were derived from his latest computer models of neotectonics (prepared for the Southern California Earthquake Center's project Unified California Earthquake Rupture Forecast version 3, and also for the US Geological Survey's 2013 Update to the National Seismic Hazard Model).

On behalf of San Luis Obispo Mothers for Peace (SLOMFP), I submitted my expert analysis of PG&E's seismic studies to the U.S. Nuclear Regulatory Commission (NRC) and the California Public Utilities Commission (CPUC).² These agencies are responsible for ensuring the safety and cost-effectiveness of DCP's continued operation. But as of this writing, neither agency has considered the information I have submitted, and indeed each proposes to allow or support the continued operation of DCP based on inadequate information:

- The NRC proposes to rely on PG&E's inadequate and outdated analyses in support of a sweeping conclusion that all aging reactors will be reasonably protected from earthquakes during an extended term of operation.³ While I commented on the NRC's proposal, the agency has given no indication that it will consider my comments. And PG&E's recent license renewal application to the NRC explicitly refuses to consider the new information and analyses I presented to the NRC.⁴
- On December 14, 2023, the CPUC approved an administrative law judge decision that DCP may continue operating past its operating license expiration dates, without considering earthquake risks.⁵

As I have testified, PG&E should be required to re-do its seismic studies to correct their biases against consideration of up-to-date data and methods. Use of these updated data and methods could substantially alter PG&E's conclusions and potentially lead to requirements for expensive reinforcement to the reactors. Failing to do so would be irresponsible and pose an unacceptable level of risk to human health and the environment.

² See my May 2023 declaration in support of SLOMFP's [comments](#) to the U.S. Nuclear Regulatory Commission (NRC) on the NRC's Draft Generic Environmental Impact Statement for Reactor License Renewal and my July 2023 [testimony](#) in Rulemaking R.23-01-007 by the California Public Utilities Commission (CPUC).

³ Draft Generic Environmental Impact Statement for Reactor License Renewal (2023) (NRC Accession Nos. ML23010A078, ML23010A086).

⁴ Environmental Report at G-27 (Nov. 7, 2023) (NRC Accession No. ML23311A154).

⁵ Decision by ALJ Seybert (Oct. 26, 2023).

ATTACHMENT 5

EMBRITTEMENT OF REACTOR PRESSURE VESSEL AT DIABLO CANYON UNIT 1 POSES AN UNACCEPTABLE SAFETY RISK DURING CURRENT AND EXTENDED OPERATION

Prepared by Dr. Digby Macdonald, Professor in Residence, Departments of Nuclear Engineering and Materials Science and Engineering, University of California at Berkeley¹
on behalf of San Luis Obispo Mothers for Peace
December 14, 2023

In the summer of 2023, on behalf of San Luis Obispo Mothers for Peace (SLOMFP), I conducted a comprehensive investigation of the condition of the Unit 1 reactor pressure vessel (RPV) at the Diablo Canyon Nuclear Plant (DCPP) operated by Pacific Gas and Electric Co. (PG&E). Based on my investigation, I have concluded that the current operation and proposed extended operation of DCPP Unit 1 pose an unreasonable risk to public health and safety due to serious indications of an unacceptable degree of embrittlement, coupled with a lack of information to establish otherwise. In my expert opinion, the reactor should be closed unless and until PG&E obtains and analyzes additional data demonstrating that Unit 1 is safe to operate. My analysis is set forth in detail in a [declaration](#) submitted by SLOMFP to the U.S. Nuclear Regulatory Commission (NRC) on September 14, 2023, in support of a hearing request and request for emergency action to address the safety risks posed by operation of DCPP Unit 1.

RVP safety at DCPP Unit 1 is too important to be left to chance. The unknown and potentially significant degree of embrittlement in the Unit 1 RPV is an extremely serious safety and environmental issue because of the key safety role played by the RPV. The RPV keeps water on the highly radioactive reactor core at all times. If an embrittled RPV fails during a loss of coolant accident (LOCA), there is no backup to prevent the core from overheating and possibly melting down. The melting of the core, should it occur, could release a large quantity of radioactivity into the reactor's containment. Should the containment building also fail, this would probably result in the release of significant levels of radiation outside the plant, potentially causing deaths, illness, environmental damage, and economic injuries. The Chernobyl accident is illustrative of the scale of potential health and environmental effects and costs, although that reactor did not have containment of the type in Western reactors.

The condition of the DCPP Unit 1 RPV poses the particular concern that the composition of the welds in the pressure vessel was found to be defective at the time it was installed by having excessive copper and nickel. Not surprisingly, in 2006, the NRC identified the Unit 1 pressure vessel among the nation's most embrittled, with only 14 of 72 PTS reference temperatures as high as or higher than DCPP Unit 1. And today, half of those 14 reactors are closed. Previous

¹ Dr. Macdonald is one of the world's leading corrosion scientists. Since completing his Ph.D in 1969, he has held multiple positions relating to nuclear engineering and materials science, including Distinguished Professor of Materials Science and Engineering Director for the Center for Electrochemical Science and Technology at Penn State University (2003 to 2012) and his current position at UC Berkeley. He has published over 1,000 scientific papers and 4 books, and he holds 11 patents. In 2003, Dr. Macdonald received the highest award in the field of corrosion science and engineering – the U.R. Evans Award from the Institute of Corrosion in the United Kingdom. In 2011, he was nominated for the Nobel Prize in Chemistry. Dr. Macdonald holds a B.Sc. (1965) and M.Sc. (1966) in Chemistry, University of Auckland (New Zealand) and Ph.D. in Chemistry (1969), University of Calgary (Canada).

actions by the NRC have demonstrated the seriousness of RPV embrittlement as a safety concern. In 1991, concerns about a lack of information concerning the condition of the Yankee Rowe RPV led the NRC to order that after a refueling outage, the reactor should remain shut down until the licensee had determined the extent of embrittlement. Similarly, in this case, PG&E's failure to monitor the condition of the DCP Unit 1 pressure vessel for the past 20 years, combined with indications of an unacceptable rate of embrittlement during the last round of testing in 2003, call for a similarly rigorous regulatory response.

Importance of compliance with NRC monitoring requirements. Given the important role of the RPV, compliance with NRC requirements for monitoring the condition of the plant-specific pressure vessel is essential. These regulatory requirements are three-fold and complementary. First, through "Charpy" testing of samples taken from the reactor vessel, the licensee must demonstrate that the "reference" temperature for pressurized thermal shock (RT_{PTS}) is below a threshold of 270°F for axially oriented welds and 300°F for circumferential welds.² Second, also through Charpy testing, the licensee must demonstrate that the RPV is strong enough to withstand the transient stresses induced by thermal shock of the rapidly changing temperature caused by the addition of cooling water, *i.e.*, that the "upper shelf energy" (USE) will remain above 50 ft-lb. Finally, every ten years, the licensee must conduct ultrasound testing (UT) inspections of the most vulnerable part of the RPV, the welds around the beltline, to examine for flaws and cracks. NRC guidance appropriately provides that the schedules for these inspections may be relaxed only upon a verifiable demonstration that safety will not be jeopardized.

Each of these three types of tests makes a distinct and significant contribution to determining the vulnerability of a pressure vessel to cracking. While the reference temperature and USE calculations are both derived from the same Charpy tests, the method of analysis for each is different; and of course, the UT inspections involve completely different methods of acquiring and analyzing data. Equally important, each type of test or inspection has a different level of reliability.³ Thus the three types of data must be considered in unison because they convey important, complementary information on the safety of the RPV.

Trend of unacceptable embrittlement identified in 2003. In 2002, in the course of its Unit 1 RPV monitoring program, PG&E withdrew and tested "coupons" or weld samples from the Unit 1 pressure vessel and conducted Charpy tests for PTS reference temperature and USE. In 2003, PG&E reported that it had calculated a limiting RT_{PTS} value of 250°F for the limiting weld 3-442C. Thus, PG&E predicted that in 2021 (the expected retirement date for Unit 1 at that time), the reference temperature for Unit 1 would be slightly more than 10° below the screening limit of 270 °F. Taking into consideration a reasonable margin of error of about ± 10 °F (as estimated by inspection of the Charpy curves), PG&E's test showed that Unit 1 would be approaching the limit at the end of its operating life.

² RT_{PTS} is the temperature at which fracture morphology of the pressure vessel changes from ductile to brittle as its temperature drops from the addition of cooling water during a loss of coolant accident (LOCA).

³ My calculations show that Charpy tests are not particularly sensitive to the extent of embrittlement. Therefore, their results should not be substituted for UT inspections, nor should they be used to justify an extension of the schedule for UT inspections.

Despite embrittlement indications, PG&E discredited troubling data and stalled further inspections. Nevertheless, PG&E discounted the data as “not credible.” *Id.* But PG&E may have found that the data *were* credible if it had applied standard scientific and NRC guidance for its evaluation. PG&E’s failure to apply this well-established and reasonable guidance is both inexplicable and gravely concerning, given that the RT_{PTS} data indicated a serious degree of embrittlement. The NRC Staff’s approval of PG&E’s disregard of the data is also puzzling, given that PG&E had ignored the agency’s own guidance.

Instead of crediting the data it had gathered from Unit 1, PG&E substituted generic data and data from other reactors. But PG&E’s reliance on substitute data from other reactors is unreasonable, especially for a period that stretched across decades. Regardless of their initial similarities, all nuclear reactors soon become unique because of the particular operating conditions and histories. At the very least, PG&E should have applied a larger error band to any reference temperature calculations that were based on generic data or data from so-called “sister” reactors.

No excuse for the delay. The results of the 2003 Charpy tests should have motivated PG&E to speed up its schedules for obtaining more data in order to get a better sense of the Unit 1 RPV’s condition. At the very least, PG&E should have adhered to its approved schedule for the next capsule extraction and Charpy test in approximately 2009. And PG&E should have ensured that the most recent (2005) UT inspection -- which identified “one indication . . . in the beltline region” (PG&E (2014)) -- would be followed on schedule with another beltline inspection in 2015.

Yet, PG&E repeatedly sought and obtained extensions of time for all three of the inspections, until 2025. The 20-year delay between the last Charpy (2003) and UT (2005) inspections is unacceptable for three significant reasons. First, PG&E had indications of embrittlement from the 2002 Charpy tests. The 2005 UT inspection results also raised a red flag that the UT testing may have been faulty because the results were found to be “almost identical” to tests taken ten years earlier. It is reasonable to expect many more indications of voids and cracks and that they would increase over time.

Second, monitoring should be conducted approximately every ten years because the condition of the pressure vessel may change significantly over a single decade.

Finally, PG&E relied for too long on generic data and data from so-called “sister” reactors. In any complex industrial system, the judgment that the system is safe to operate must be based on plant-specific data in the same way that a health professional judges the viability of a person to operate successfully in life. That decision cannot be made upon the basis of the health of a sibling, even if that sibling was an identical twin. So it is for a nuclear reactor. It is for that reason that the NRC mandates a plant-specific surveillance program.

Immediate action is necessary to protect public health. Under these circumstances, it is my expert opinion that the NRC currently lacks an adequate basis to conclude that DCP Unit 1 can be operated safely. In order to protect the public from the unacceptable risk of a core meltdown accident caused by pressure vessel cracking and fracture during a LOCA, the NRC should:

- a) order the immediate closure of the reactor, and it must remain closed pending completion of the next scheduled Charpy tests,
- b) ensure that any coupons or capsules that have been withdrawn but were not tested are subject to Charpy tests,
- c) account for the data provided by the wedge opening loading (WOL) specimens and the remaining tensile specimens that were scheduled to be contained in the capsules, and
- d) ensure that any remedial steps taken by PG&E to address the condition of the Unit 1 reactor pressure vessel are subjected to rigorous review by the NRC Staff, the Advisory Committee on Reactor Safeguards (ACRS), and the general public.

Finally, the newly developed method of nano-indentation should be used to evaluate specimens that already have been removed from the Unit 1 RPV. Not only will nano-indentation provide more immediate results, but it promises to be capable of far more extensive results from a single specimen than the conventional Charpy Impact Test methods prescribed by NRC regulations. The more extensive data will permit rigorous statistical analysis, something that is not possible with Charpy. Importantly, this method has already been applied by Professor Peter Hosemann of the Department of Nuclear Engineering, University of California, Berkeley and found to be sensitive to the change in physical properties of pressurized water reactor RPV steels brought about by radiation embrittlement. Accordingly, the technique offers to provide additional information on the state of embrittlement of the DCP Unit 1 RPV that could confirm or deny the validity of the Charpy data that were declared “non-credible” by PG&E, as well as provide additional information about the condition of the Unit 1 RPV.

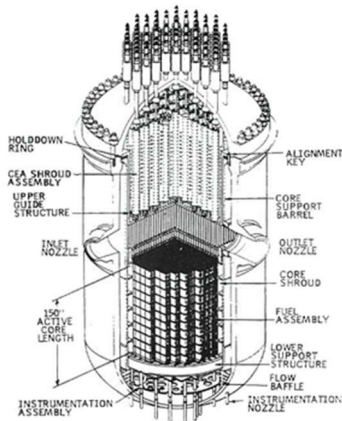


Figure 1: Cutaway view of the internals of a PWR RPV. The beltline of concern is mid-way of the active core length where the neutron flux and fluence are highest and hence the risk of radiation embrittlement is greatest.