

BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

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DATE: June __, 2016
WITNESS: John L. Geesman

PREPARED DIRECT TESTIMONY OF
JOHN L. GEESMAN ON BEHALF OF
THE ALLIANCE FOR NUCLEAR RESPONSIBILITY

IN

APPLICATION NO. 15-09-001

PACIFIC GAS & ELECTRIC COMPANY TEST YEAR 2017 GENERAL RATE CASE

1 Q1. Please state your name and business address.

2 A1. My name is John L. Geesman. My business address is 1999 Harrison Street, Suite 2000, Oakland,
3 California.

4
5 Q2. What is the purpose of your appearance today?

6 A2. I am appearing for the purpose of providing testimony to support and describe five ratemaking
7 recommendations being proposed by the Alliance for Nuclear Responsibility for the Commission's
8 consideration in the Pacific Gas & Electric Company ("PG&E) Test Year 2017 General Rate Case.

9
10 Q3. Are your qualifications, as provided in Attachment 1 to this testimony, true and correct?

11 A3. Yes.

12
13 Q4. What is the nature of the five ratemaking recommendations being proposed by the Alliance for Nuclear
14 Responsibility in this proceeding?

15 A4. The five ratemaking recommendations proposed by the Alliance for Nuclear Responsibility would result
16 in the adoption of (a) reasonable ratemaking assumptions and forecasts relevant to determining the Test
17 Year 2017 and Post-Test Years 2018 and 2019 revenue requirements for Diablo Canyon Nuclear Power
18 Plant operations, and (b) alternative performance-based rates through which Diablo Canyon Nuclear Power
19 Plant-related revenue requirement would be recovered from PG&E electric customers. In several respects,
20 I believe PG&E is proposing to increase electric rates on the basis of erroneous, inconsistent or
21 unreasonable assumptions and analyses. I am proposing the Commission reject certain of those
22 assumptions and analyses and modify the Test Year 2017 revenue requirement to reflect more reasonable
23 assumptions and forecasts. I also address whether current ratemaking will fairly allocate the financial risks
24 associated with the operation of Diablo Canyon Nuclear Power Plant between PG&E shareholders and
25 customers. Because I believe current ratemaking allocates a disproportionate level of these financial risks
26 to customers, I am proposing alternative, performance-based ratemaking for the recovery of Diablo Canyon
27 Nuclear Power Plant-related revenue requirement.

28
29 Q5. Are there any interdependencies or interrelationship among these five recommendations?

30 A5. No. Each of the recommendations is presented, and should be evaluated, on its own merits. The
31 Commission can adopt any one of my recommendations, or any combination of them, without adopting all

1 of them. My abiding recommendation is, of course, that the Commission should adopt all of them in order
2 to assure the electric rates adopted in this proceeding are just and reasonable.

3
4 Q6. What are the five ratemaking recommendations the Alliance for Nuclear Responsibility is proposing in
5 this proceeding?

6 A6. The five ratemaking recommendations are as follows:

- 7 ▪ First, the Alliance for Nuclear Responsibility recommends the revenue requirement directly
8 related to Diablo Canyon Nuclear Power Plant operations adopted by the Commission in
9 this phase of the general rate case be removed from base electric rates and recovered
10 through a new rate schedule denominated as “Schedule DC”. Given the specific
11 deficiencies in the PG&E risk analyses and related risk-based budgeting for the Diablo
12 Canyon Nuclear Power Plant, which I describe later in my testimony, I believe the
13 Commission should take steps to hold PG&E’s customers financially harmless from
14 misrepresented, unaddressed or inadequately mitigated safety and reliability risks
15 associated with the continuing operation of the Diablo Canyon Nuclear Power Plant. My
16 proposal provides PG&E fair opportunity to recover the entire Diablo Canyon Nuclear
17 Power Plant-related costs of operation adopted in this rate case, including return of and on
18 capital, but allocates an appropriate measure of financial risk to the company;
- 19 ▪ Second, the Alliance for Nuclear Responsibility recommends the Commission exclude the
20 costs of the proposed project to replace the main generator stator of Diablo Canyon
21 Nuclear Power Plant Unit 2 from PG&E’s revenue requirement. PG&E’s test year revenue
22 requirement for this project is inconsistent with the company’s internal evaluations of the
23 reasonably foreseeable full costs of the project, precluding the Commission from making
24 any findings regarding the reasonableness of the project costs. In addition, the analyses
25 and materials relied upon by PG&E to justify the project are insufficient to establish that the
26 project is cost-effective or prudent. Those analyses and materials are, in large part, based
27 upon the assumption Diablo Canyon Nuclear Power Plant Unit 2 will operate for a period
28 well beyond the current license period authorized by the Nuclear Regulatory Commission.
29 That assumption is inconsistent with other aspects of PG&E’s case-in-chief. As a result, I
30 am recommending the Commission omit the costs of the project from PG&E’s revenue
31 requirement until such time as PG&E receives all licenses, authorities, permits, and/or

1 exemptions necessary to extend the operating life for the Diablo Canyon Nuclear Power
2 Plant Unit 2 for a period consistent with the project justifications relied upon by PG&E in its
3 internal project-approval processes;

- 4 ■ Third, the Alliance for Nuclear Responsibility recommends the Commission reject the
5 unreasonably high annual depreciation expense proposed by PG&E for the remaining and
6 proposed capital investment in the generating assets and equipment, transmission assets
7 and equipment, and general plant constituting Diablo Canyon Nuclear Power Plant-related
8 rate base. In lieu of PG&E's proposed annual depreciation expense for Diablo Canyon
9 Nuclear Power Plant-related assets, the Commission should adopt (a) a lower annual
10 depreciation expense for Diablo Canyon Nuclear Power Plant-related assets consistent
11 with PG&E's own internal analyses and ratemaking policies, and (b) adjust Diablo Canyon
12 Nuclear Power Plant-related revenue requirement in a manner consistent with that lower
13 annual depreciation expense;
- 14 ■ Fourth, the Alliance for Nuclear Responsibility recommends the Commission reject PG&E's
15 proposal to terminate the Diablo Canyon Nuclear Power Plant seismic studies balancing
16 account. PG&E proposes to terminate the balancing account because the costs subject to
17 recovery through this mechanism are relatively small and can be forecasted accurately.
18 But the balancing account provides improved State oversight of PG&E's assessment of the
19 plant's seismic setting, which potentially can cause profound economic and physical
20 effects on public safety, resource-planning and environmental quality. The public interest
21 in careful scrutiny would be better served through the annual reviews provided under the
22 balancing account mechanism than would be true under triennial (or worse, under Staff's
23 proposed quadrennial) general rate case filings;

24 and,

- 25 ■ Fifth, the Alliance for Nuclear Responsibility recommends the Commission omit the costs
26 of the Independent Spent Fuel Storage Installation expansion project from electric rates
27 until such time as PG&E demonstrates it is in full compliance with the recommendations of
28 the California Energy Commission regarding the transfer of spent fuel assemblies to dry
29 cask storage. A plan for such compliance was previously required by this Commission as
30 a condition precedent to cost recovery for the expansion project. PG&E's plan as
31 submitted falls far short of a reasonable attempt to comply with the California Energy

1 Commission's recommendations regarding the acceleration of the transfer of spent fuel
2 assemblies to dry cask storage.

3
4 **A. Alternative Ratemaking for Diablo Canyon Nuclear Power Plant-Related Revenue Requirement**

5 Q7. Let's return to the first recommendation you enumerated. To begin, please restate the
6 recommendation.

7 A7. The Alliance for Nuclear Responsibility is recommending the Commission exclude the revenue
8 requirement directly related to Diablo Canyon Nuclear Power Plant operations from base electric rates. I
9 propose these costs instead be recovered through a new rate schedule, denominated as "Schedule DC".
10 Schedule DC would be used to recover the revenue requirement associated with Diablo Canyon Nuclear
11 Power Plant-related generation, transmission and general plant costs of ownership and operating
12 expenses.

13
14 Q8. What purpose would the adoption of the new rate schedule serve?

15 A8. First, the adoption of the new rate schedule would provide motivation for PG&E to improve the quality
16 of the risk assessments the utility performs for the Diablo Canyon Nuclear Power Plant. This
17 recommendation stems from my conclusion that PG&E has failed, in the context of its nuclear operations,
18 to meet the directions imposed by this Commission regarding the conduct of risk assessments, analyses,
19 and budgeting that reflects diligence in identifying, evaluating and mitigating safety and reliability risks
20 inherent in this aspect of the company's utility operations. In many respects, the PG&E risk analyses
21 related to its nuclear operations are flawed, incomplete or, in PG&E's lexicon, "immature." If the
22 Commission is serious about enforcing an emphasis on public safety and effecting cultural changes in utility
23 management and operations, the Commission's ratemaking orders must impose consequences where a
24 utility performs and submits inadequate or incomplete risk analyses. As is evident from PG&E's case-in-
25 chief, current ratemaking as applied to Diablo Canyon Nuclear Power Plant-related revenue requirement
26 does not provide sufficient financial incentives for a utility to perform comprehensive and effective risk-
27 based analyses or budgeting.

28
29 Q9. Would you elaborate on your characterization of the PG&E risk analyses as being "flawed, incomplete
30 or otherwise deficient" in the context of the company's nuclear operations?

1 A9. Based on my review of the Commission's safety rulemaking docket and orders, the Commission
2 instructed the regulated utilities to conduct comprehensive, self-critical analyses designed to seek and
3 reveal omissions and deficiencies in their organizations, personnel, training, planning, operations, and
4 assets posing undue risks to public safety. I believe the Commission expects the utilities to create new
5 insights into the extent and magnitude of the risks to public safety posed by existing utility practices and
6 facilities and then, as appropriate, implement new activities, projects, practices, and standards marked by
7 innovation, cultural shifts or changes in course which would mitigate undue risks to public safety. In
8 reviewing the PG&E risk analyses related to the Diablo Canyon Nuclear Power Plant presented in this
9 general rate case, I did not see anything approaching the level of significance or emphasis the Commission
10 has placed on public safety or risk analysis. To the contrary, PG&E's case-in-chief strikes me as
11 comporting with "business as usual." That is, PG&E has based the vast majority of its case-in-chief on the
12 wholly unremarkable results of operations derived from Base Year 2014 and, as a result, Test Year 2017
13 brings no discernibly momentous changes to PG&E's organizations, personnel, training, planning,
14 operations, or assets. This is quite evident from the numerous "step function" waterfall charts PG&E
15 provides throughout its showing to describe the build-up of its Test Year 2017 revenue requirement.

16
17 If I were to delete any mention of "risk analyses" and "risk-based budgeting" from PG&E's case-in-chief, I
18 would expect very little, if any, change in the proposed Test Year 2017 revenue requirement or the
19 multitude of activities, projects and programs planned for the three-year rate period. Where I, and I believe
20 the Commission, expected to see innovation, this is an ordinary, run-of-the-mill rate case where mundane
21 programs, such as a renewed emphasis on driver safety and attentiveness, are characterized as important
22 safety-related cultural shifts.

23
24 Q10. Do you have more specific criticisms of the manner in which the PG&E risk analyses and risk-based
25 budgeting processes are reflected in PG&E's proposed Test Year 2017 Diablo Canyon Nuclear Power
26 Plant-related revenue requirement?

27 A10. Yes. My review of the PG&E general rate case materials focused primarily on PG&E's nuclear
28 operations and PG&E's assessments of the risks to public safety posed by the continuing operation of the
29 Diablo Canyon Nuclear Power Plant. As to those operations, I am skeptical PG&E has fully identified the
30 risks to public safety posed by Diablo Canyon Nuclear Power Plant operations and, even as to the risks
31 PG&E has assessed, that PG&E's analyses are robust or reliable. As a result, I believe PG&E has

1 understated the nature of the risks posed by Diablo Canyon Nuclear Power Plant operations to the public
2 safety and/or failed to mitigate those risks adequately. My view is based on several specific deficiencies
3 and omissions I found in the PG&E risk analyses.

4
5 First, although the risk assessments and risk-based budgeting processes performed for the Diablo Canyon
6 Nuclear Power Plant were done by PG&E's nuclear organization and outside PG&E's corporate-wide risk
7 processes, those assessments and the resulting budgets suffer from many of the deficiencies found in the
8 corporate-wide processes. As Messrs. Suri and Davies explain in their testimony, PG&E's risk-assessment
9 and -budgeting processes are relatively early stage and have not yet incorporated steps and resources
10 characteristic of mature, effective risk-based planning processes. For example, PG&E's risk analyses do
11 not address uncertainty risks, a particularly important consideration for nuclear operations, do not provide
12 for independent assurance and validation of process results, and rely exclusively upon information and
13 opinions provided by internal subject matter experts, which exposes PG&E's processes to inherent biases
14 and blind spots.

15
16 Second, the PG&E risk-assessment processes bear a misplaced and undue emphasis on financial risks to
17 PG&E's shareholders rather than safety risks posed to the public. As an example, PG&E's risk analyses
18 place a higher priority on addressing (a) the likelihood this Commission will impose ratemaking
19 disallowances for power purchase costs incurred under contracts previously approved by the Commission,
20 but which the Commission might later second-guess, than would be the case for (b) the occurrence of
21 precursors leading to a catastrophic core-damaging event at the Diablo Canyon Nuclear Power Plant.
22 These results demonstrate fundamental and structural flaws in PG&E's analytical approach which can only
23 cause PG&E's risk assessments to fall well short of the Commission's regulatory objective of protecting
24 public safety.

25
26 Third, PG&E's risk-based budgeting relies heavily on the assumption that compliance with relevant federal
27 and state regulatory requirements would largely mitigate enterprise- and operating-level risks posed by
28 potential Diablo Canyon Nuclear Power Plant failures. This assumption is flawed in several respects:

- 29 ▪ My experience is that federal and state safety regulations and standards represent "works
30 in progress" rather than some "gold standard." Official regulations and standards are
31 subject to continuous revisions and improvement, oftentimes significant. From a practical

1 standpoint, unknown or uncertainty-related risks are not and cannot be addressed, a point
2 on which I believe PG&E and I are in agreement. In particular, the Nuclear Regulatory
3 Commission, the federal agency charged with overseeing the safety of commercial nuclear
4 power plants, is constantly amending its regulations as new events reveal potential
5 hazards left unaddressed by existing rules and regulations. As I present this testimony,
6 the agency is considering the adoption of new and likely stricter regulations addressing
7 safety- and reliability-related vulnerabilities exposed by the seismic and tsunami event and
8 aftermath experienced at the Fukushima Daiichi facility in Sendai, Japan. PG&E implicitly
9 concedes the absence of regulations addressing potential, significant hazards unknown
10 prior to that event and proposes to cover its exposure to the additional costs of complying
11 with any new regulations through a balancing account assuring the full recovery of any and
12 all such costs. PG&E also concedes its omission of uncertainty analyses despite its own
13 internal analyses characterizing beyond-design-basis events as credible and warning that
14 addressing such events is critical to plant safety and reliability. I should point out that,
15 based on my review of the list of domestic commercially operated nuclear plants which
16 have surrendered their reactor operating licenses, only two have done so according to a
17 planned schedule. The others have done so as a result of unforeseen or unplanned
18 events or conditions rendering them unreliable, unsafe or too costly to operate;

- 19 ■ I must also express some skepticism as to the adequacy of federal safety regulations in
20 addressing even well-known and –understood safety risks posed by commercial nuclear
21 power plants. There are several instances of which I am aware where the Nuclear
22 Regulatory Commission has proposed the adoption of regulations addressing known
23 potential risks, only to abandon or relax them in response to industry opposition to the
24 costs of compliance;

25 and,

- 26 ■ Finally, determinations as to whether any particular plant or operator is in “full” compliance
27 with federal and state regulations are to some extent subjective and speculative. The
28 Nuclear Regulatory Commission only audits a tiny fraction of the components of a nuclear
29 power plant during its inspections and extrapolates from the limited samples it observes to
30 determine whether a plant is or is not in compliance with applicable safety regulations and
31 license requirements. This places a great deal of reliance on the plant owners and

1 operators to self-inspect, identify hazards, and correct violations. The Diablo Canyon
2 Nuclear Power Plant operating and safety record is indicative. The Nuclear Regulatory
3 Commission recently approved a license amendment for the Diablo Canyon Nuclear
4 Power Plant indicating PG&E had, in 2015, finally proposed a complete solution to safety
5 issues identified by the plant designer in 1998 which were only partially addressed by
6 actions taken in 2004. This example is particularly alarming, even if isolated and
7 unrepresentative of PG&E's larger compliance with safety regulations, because the 2015
8 response to the compliance gap is directly related to addressing the failure responsible for
9 causing the partial core meltdown at Three Mile Island, the most dangerous event in the
10 history of domestic nuclear power operations, and the core meltdown at the Fukushima
11 Daiichi plants. As another example, PG&E has reported that the Diablo Canyon Nuclear
12 Power Plant design poses the same conditions which led to the failure of safety systems at
13 Exelon's Byron Nuclear Generating Station Unit 2. These conditions are pending
14 corrective rulemaking by the Nuclear Regulatory Commission and have yet to be
15 independently addressed or corrected by PG&E.

16
17 In light of these circumstances, I believe PG&E's risk assessments should have gone well beyond
18 investigating whether PG&E believes the Diablo Canyon Nuclear Power Plant is in compliance with federal
19 and state safety regulations and that PG&E's failure to do more warrants Commission attention. The point
20 is obvious and compelling to me given California's own recent experience with the San Onofre Nuclear
21 Generating Station, where plant design, construction, operation, and maintenance appear to have been
22 performed in full compliance with all federal and state regulations and permit requirements, but where the
23 plant nevertheless suffered a catastrophic failure resulting in premature retirement, at great expense and
24 loss to consumers.

25
26 Fourth, as I noted earlier, PG&E's nuclear risk analyses omit consideration of uncertainty risks. This is
27 particularly important in the area of nuclear operations. Industry experts count "Black Swan" events or
28 unique, unforeseeable combinations of cascading failures, resulting from human error, minor equipment-
29 related failures or some combination of the two, as among their greatest fears. But most importantly, the
30 location of the Diablo Canyon Nuclear Power Plant on multiple known and hypothesized seismic faults
31 should heighten PG&E's concerns regarding the risks posed to the plant by the occurrence of a

1 catastrophic seismic event of unanticipated magnitude. Yet, to the contrary, PG&E has a history of
2 disputing and dismissing the risks posed by Diablo Canyon Nuclear Power Plant operations from potentially
3 severe earthquakes, and in this case is proposing to take steps to reduce this Commission's oversight of
4 highly controversial seismic studies that would, if nothing else, improve the understanding of the seismic
5 characteristics of the area in the plant's vicinity. These factors lead me to believe PG&E's assessment of
6 the potential risks to and from its nuclear operations fail to consider an appropriately robust universe of
7 risks to public safety posed by the operation of the Diablo Canyon Nuclear Power Plant.

8
9 Fifth, PG&E's risk assessments omitted a critically important element of effective risk analysis, namely,
10 incorporating a reexamination of prior decisions and legacy investments to determine whether the risks
11 stemming from those decisions and investments should be mitigated by changing what is done altogether.
12 This omission violates PG&E's own internal operating standard describing its risk-assessment processes.
13 Those processes require the evaluation of four levels of "risk response strategies" in assessing risks and
14 determining appropriate risk mitigations. One of the four strategies, "Avoid," is defined as "exiting the
15 activities that give rise to the risk." In the area of nuclear operations, I found absolutely no evidence PG&E
16 considered the retirement of the Diablo Canyon Nuclear Power Plant units, either coincidentally with the
17 expiration of the current licenses and permits held by PG&E or prior to that time, as a risk-mitigation
18 strategy. To the contrary, in evaluating risk-mitigating activities, projects and programs for the Diablo
19 Canyon Nuclear Power Plant, PG&E generally evaluated different forms of the activity, project or program
20 under consideration and selected one, in some cases dismissing all of the other alternatives as incomplete,
21 infeasible or ineffective. The evaluation of response strategies, particularly for nuclear operations, requires
22 much more than the summary execution of hapless straw men and, for an asset posing such great risks to
23 public safety and whose costs of ownership and operations are so high, the "Avoid" strategy should at the
24 very least have been on the list of responses considered.

25
26 Given that nuclear operations pose significant enterprise-level and operating-level risks to PG&E, I believe
27 PG&E should have considered the "Avoid" strategy for at least some of the proposed risk mitigations
28 planned for the Diablo Canyon Nuclear Power Plant or, better yet, by considering the "Avoid" strategy in the
29 broader context of the aggregated risks of Diablo Canyon Nuclear Power Plant operations. As things
30 stand, PG&E's risk assessments were narrow and self-limiting, and completely failed to consider even
31 known financial and operational risks such as the likelihood the State Water Resources Control Board will

1 impose restrictions or mitigations on the Diablo Canyon Nuclear Power Plant regarding the use of marine
2 waters for power plant cooling or that the Nuclear Regulatory Commission may adopt significant new
3 requirements stemming from that agency's investigation of the Fukushima Daiichi failures. Had PG&E
4 done analyses of this kind, I would agree PG&E had attempted to address the Commission's interest in risk
5 assessment and risk mitigation to the best of PG&E's ability. But the complete omission of any
6 consideration of the "Avoid" strategy, even though required under the specific terms of PG&E's internal risk
7 assessment standards and even though consistent with the general consideration of "risk tolerance" as Mr.
8 Davies describes the concept in his testimony, leads me to conclude PG&E's risk assessments are
9 incomplete, deficient and ultimately useless for ratemaking purposes in the Diablo Canyon Nuclear Power
10 Plant context. PG&E is clearly relying on the Commission and current ratemaking to make the company
11 whole for all of its costs of nuclear operations, including those it cannot or will not attempt to forecast even
12 where such costs are reasonably foreseeable.

13
14 Sixth, the results of the PG&E risk analysis are, as you would expect, dependent on the assumptions
15 inputted to the PG&E risk-assessment model. For the Diablo Canyon Nuclear Power Plant risk
16 assessments, PG&E went beyond what was generally done for other aspects of PG&E's utility operations
17 and used a probabilistic, rather than deterministic, assessment that an event posing an enterprise-level or
18 operating-level risk would occur. In addition, PG&E relied upon outside, rather than internal, data as inputs
19 for the probabilities that such an event might occur. Notwithstanding these relative improvements to the
20 PG&E risk analytics, the chosen data had the effect of discounting the levels of safety and reliability risks
21 posed by the Diablo Canyon Nuclear Power Plant to unreasonably low levels. As an example, PG&E's
22 analysis indicates there is a 1-in-100,000-year likelihood the Diablo Canyon Nuclear Power Plant facilities
23 would be subjected to a seismic event of a magnitude beyond the plant's design basis. This assumption
24 stands in stark contrast to risk assessments performed by the nuclear operations group – those
25 assessments conclude that beyond-design-basis events should be considered "credible" and addressed
26 through appropriate mitigation measures. Similarly, the Nuclear Regulatory Commission is reviewing the
27 seismic data incorporated into the plant's design basis for sufficiency and actively considering both revising
28 the design-basis seismic-safety requirements and imposing beyond-design-basis seismic-safety
29 requirements for the Diablo Canyon Nuclear Power Plant specifically and all commercial nuclear power
30 plants generally. A comprehensive, rational risk analysis would consider these factors and at the very least
31 address them.

1
2 Finally, PG&E exacerbates the problems posed by its incomplete evaluation of risk response strategies by
3 adopting a new operating strategy posing *additional* risks and uncertainties in the operation of the Diablo
4 Canyon Nuclear Power Plant. As PG&E indicates in its case-in-chief, the Diablo Canyon Nuclear Power
5 Plant will in the future operate as a flexible-capacity resource and curtail output when called upon to do so
6 by the PG&E Short-Term Energy Supply Department, subject to approval by the Diablo Canyon Nuclear
7 Power Plant shift manager. Under this mode of operation, the Diablo Canyon Nuclear Power Plant will
8 offer real-time ramping attributes coordinated between PG&E's short-term energy-trading desk, plant
9 operators and transmission-system operators at the California Independent System Operator ("CAISO").
10 No other pressurized water reactor in the United States operates in a load-following mode and operation in
11 this mode has not been fully analyzed for potential safety or performance issues. PG&E has admitted the
12 need to impose constraints governing the total amount of output the Diablo Canyon Nuclear Power Plant
13 can reduce during a fuel cycle and the notice the Diablo Canyon Nuclear Power Plant needs prior to
14 reducing output – these constraints were based upon federal regulations, guidance from Westinghouse
15 Electric designer recommendations and guidance, and PG&E's interpretation of existing statements issued
16 by the Institute of Nuclear Power Operations ("INPO"). In addition, PG&E recognizes additional constraints
17 implied by the chemistry and science of nuclear power production governing the time it will take for the
18 Diablo Canyon Nuclear Power Plant to reduce output, the optimal duration of any curtailment, the time it will
19 take for the Diablo Canyon Nuclear Power Plant to return to full power output, and how often and when it
20 will be feasible for the Diablo Canyon Nuclear Power Plant to curtail power output. In light of all of the
21 foregoing constraints, PG&E and the CAISO have agreed to special and specific operating protocols
22 limiting the degree to which the Diablo Canyon Nuclear Power Plant may be dispatched to provide load-
23 following services.

24
25 Even with the PG&E-CAISO operating protocols in place, the Commission should recognize that both the
26 Nuclear Regulatory Commission and INPO have established performance metrics strongly encouraging
27 continuous operation of nuclear power plants at full output – these metrics are specifically designed to
28 minimize the potential for initiating events that might challenge plant safety. PG&E simply dismisses the
29 implications of disregarding these metrics and operating outside of the guidelines by placing certain
30 limitations on how it will curtail Diablo Canyon Nuclear Power Plant output. Despite such limitations, PG&E
31 must still adopt additional operating safeguards and standards increasing operator attention to fuel handling

1 and water chemistry in case unanticipated challenges to plant operations arise from operating the plant in a
2 load-following mode.

3
4 Furthermore, PG&E's engineering analyses indicate the planned Diablo Canyon Nuclear Power Plant
5 modal change must be closely monitored for its effect on future core design and the waste of unburned
6 fuel; this unburned fuel must later be removed to the spent fuel pool and, eventually, placed in dry cask
7 storage. Additionally, PG&E's engineering analyses indicate a number of potentially hazardous conditions
8 must be considered, monitored and addressed. These conditions are numerous and varied. They are
9 inventoried and described in the internal PG&E assessment I am providing as an attachment to my direct
10 testimony. A number of new operating systems and standards will be required to monitor and address
11 these potential hazards. Given the potential hazards, including the creation of additional radioactive waste
12 and exposure to hazards plant personnel may face, there are a number of necessary precautions PG&E
13 must implement to address them, all in the hope that no unforeseen safety or operating hazards will arise. I
14 question whether the resource or financial benefits PG&E expects from the change in operating mode can
15 possibly be worth it. I found no indication in PG&E's safety assessments that any cost-benefit analysis,
16 weighing safety risks against the value provided by this fundamental change in operating mode, was
17 performed.

18
19 In sum, I found no evidence PG&E's internal risk-assessment practices were observed in the process
20 leading to PG&E's decision to transition the operation of the Diablo Canyon Nuclear Power Plant into load-
21 following mode. The failure of PG&E's senior management to consider the potential risks the change in the
22 mode of Diablo Canyon Nuclear Power Plant operations might pose to public safety or plant reliability, in
23 the absence of any grid-based need to take on these risks, flies in the face of the Commission's clear
24 objective to reduce or eliminate risks to public safety posed by utility operations and assets. This omission
25 reinforces my concerns that PG&E's risk-assessment and –mitigation processes are flawed and that those
26 processes do not drive the most important decisions senior management is making regarding minimizing
27 the risks to public safety posed by PG&E's nuclear operations.

28
29 Q11. How should the Commission address the deficiencies and omissions you found in the PG&E risk
30 analyses and risk-based budgeting processes for PG&E's nuclear operations?

1 A11. PG&E's failure to perform adequate and sufficient risk analyses in the context of PG&E's nuclear
2 operations exposes PG&E's electric customers to extreme financial risks from the consequences of any
3 and all safety or performance failures suffered at the Diablo Canyon Nuclear Power Plant. Given the
4 deficiencies in PG&E's risk analyses, I believe the Commission should take steps to mitigate the financial
5 exposures faced by PG&E's customers. To this end, I propose the Commission adopt ratemaking
6 protocols that would hold PG&E's customers financially harmless from unaddressed or inadequately
7 mitigated safety and reliability risks associated with the plant's operations. I propose the Commission do
8 this by adopting a new rate schedule, denominated as "Schedule DC", through which PG&E would
9 exclusively recover the Diablo Canyon Nuclear Power Plant-related revenue requirement adopted by the
10 Commission in this rate case.

11
12 Q12. Please describe how new Schedule DC would operate.

13 A12. I propose the Commission adopt a new balancing-account mechanism bearing a new rate schedule,
14 "Schedule DC." The rate adopted for this schedule as a part of Phase 1 of this general rate case would be
15 set so as to recover the "Diablo Canyon Nuclear Power Plant **baseline** revenue requirement" associated
16 with the operation of the plant, which would include (a) capital-related costs, such as depreciation and
17 return on generation- and transmission-related rate base, and general, common and intangible plant, and
18 (b) operating expenses, such as operating and maintenance costs, and income and ad valorem taxes.

19
20 Based on my review of the PG&E testimony, workpapers and data provided to Alliance for Nuclear
21 Responsibility through discovery, I estimate the total Diablo Canyon Nuclear Power Plant baseline revenue
22 requirement to be recovered through Schedule DC should be \$1,028,392,000 for Test Year 2017. This
23 amount is derived directly from PG&E's case-in-chief, and any changes to PG&E's proposed Diablo
24 Canyon Nuclear Power Plant-related revenue requirement should be reflected in the 2017 baseline
25 revenue requirement actually adopted for Schedule DC. As examples of the changes I have in mind, the
26 Alliance for Nuclear Responsibility is recommending the Commission extend the depreciation schedule
27 (and reduce annual depreciation expense) for PG&E's remaining and proposed capital investment in the
28 Diablo Canyon Nuclear Power Plant; the Alliance for Nuclear Responsibility is also recommending the
29 Commission reject the rate base additions for the proposed replacement of the Unit 2 main generator stator
30 and the expansion of the Independent Spent Fuel Storage Installation. If the Commission adopts these
31 adjustments, the total Diablo Canyon Nuclear Power Plant baseline revenue requirement eligible for

1 recovery through the new rate schedule should be reduced accordingly. I estimate these adjustments
2 would reduce the 2017 Diablo Canyon Nuclear Power Plant baseline revenue requirement to
3 \$809,270,000.

4
5 The actual billing determinants and rates for Schedule DC, effective January 1, 2017, should be adopted in
6 the upcoming rate design phase of this proceeding. I anticipate the total Diablo Canyon Nuclear Power
7 Plant baseline revenue requirement would be allocated to customer classes in the same manner as would
8 be the case for costs related to other utility-owned generation and, further, that the setting of billing
9 determinants chargeable under Schedule DC would also follow the example of other utility-owned
10 generation. The Diablo Canyon Nuclear Power Plant baseline revenue requirement would, however, be
11 recovered separately through the new schedule and revenues received from customers would be recorded
12 to an associated balancing account mechanism.

13
14 At the end of 2017, **actual revenues** recorded in the Schedule DC balancing account would be compared
15 to the “2017 **adjusted** Diablo Canyon Nuclear Power Plant revenue requirement.” The 2017 adjusted
16 Diablo Canyon Nuclear Power Plant revenue requirement would be the product of (a) actual net energy
17 production, expressed in megawatt-hours, achieved by the two generating units, multiplied by (b) “the
18 authorized per-unit production charge,” expressed in dollars-per-megawatt-hours, adopted by the
19 Commission in this phase of the general rate case. The authorized per-unit production charge would be
20 based on the adopted 2017 Diablo Canyon Nuclear Power Plant baseline revenue requirement, divided by
21 the energy forecasted to be produced by the plant, or “the Production Target.”

22
23 Under PG&E’s proposed revenue requirement for the Diablo Canyon Nuclear Power Plant, I developed an
24 illustrative 2017 authorized per-unit production charge of \$56.38 per megawatt-hour. This per-unit
25 production charge was determined by taking the Diablo Canyon Nuclear Power Plant baseline revenue
26 requirement using figures taken from PG&E’s case-in-chief (discussed previously), divided by a forecast of
27 energy production I derived from PG&E’s testimony. I determined the forecast of energy production by
28 multiplying the combined unit capacity for the plant by 8760 hours for each year, less the hours in each
29 year for planned outage days, with a minor adjustment for historical run-rate variances. The following table
30 shows the derivation of the illustrative year-by-year per-unit production charges using the foregoing
31 methodology:

1

	2017	2018	2019
A: Revenue Requirement	\$1,028,392,000	\$1,024,764,000	\$1,019,339,000
B: Production Forecast (Target) (Gwh)	18,174	19,230	17,389
C: Unit cost (A ÷ B) (\$/mwh)	\$56.38	\$53.29	\$58.62

2

3 As I indicated earlier, the 2017 **adjusted** Diablo Canyon Nuclear Power Plant revenue requirement would
4 be compared to the **actual revenues** recorded under the new rate schedule. If 2017 actual revenues
5 recorded exceed the 2017 adjusted Diablo Canyon Nuclear Power Plant revenue requirement, customers
6 would be entitled to a revenue credit for the excess; the amount of the excess would flow through to
7 customers using a rate credit specified as a separate line item in the 2018 rates adopted for the schedule.
8 If the 2017 actual revenues recorded under the new schedule were below the 2017 adjusted revenue
9 requirement for that schedule, customers would be responsible for a revenue debit; the debit would be
10 passed on to customers through a rate surcharge specified as a separate line item in the 2018 rates
11 adopted for the schedule. These revenue true-ups would be performed through advice letter filings. The
12 same process would be repeated for Post-Test Years 2018 and 2019 using the per-unit production charges
13 adopted by the Commission in this proceeding for each of those years.

14

15 Importantly, if the units operate as forecasted by PG&E, PG&E will fully recover the Commission-adopted
16 Diablo Canyon Nuclear Power Plant baseline revenue requirement for each of the three years covered by
17 this rate case. Thus, I intend, if PG&E has correctly identified, analyzed and mitigated the full range of
18 safety and reliability risks posed by Diablo Canyon Nuclear Power Plant operations and both of the plant's
19 units perform as forecasted by PG&E, PG&E will recover its entire Diablo Canyon Nuclear Power Plant-
20 related revenue requirement. But if I am correct and PG&E has failed to perform a proper risk analysis,
21 whether by relying on faulty or erroneous assumptions, omitting a risk that should have been identified and
22 addressed, or by failing to appreciate the full magnitude and consequences of a risk, or by failing to
23 properly mitigate the potential threats posed by a risk, then I would expect the Diablo Canyon Nuclear
24 Power Plant net power output to fall below the annual Production Targets and PG&E would owe a credit to
25 its customers. This would mitigate, in some part, the financial consequences PG&E electric customers
26 might otherwise bear for PG&E's failure to expose, understand and/or address the risks associated with the
27 operation of this aging facility. If the Commission is serious about forcing regulated utilities to do risk-based
28 operational analyses and budgeting, adopting a ratemaking protocol where the utilities, and not customers,

1 bear the financial consequences of poor risk analyses or inadequate risk-based budgeting is a means for
2 enforcing the Commission's intent. Clearly, current ratemaking fails to provide any incentives for the
3 utilities to comply with the Commission's safety orders in this regard.

4
5 Q13. You described the figures provided in your testimony as "illustrative." Can you explain what you
6 mean by the term "illustrative?"

7 A13. As I noted, the figures I used in determining the total Diablo Canyon Nuclear Power Plant baseline
8 revenue requirement were taken from PG&E's case-in-chief, augmented by information I received from
9 PG&E through discovery. The Commission may adopt costs and estimates differing from PG&E's case-in-
10 chief, and the Commission-adopted costs and estimates should be substituted for the figures shown in Line
11 A.

12
13 The figures shown in Line A of the table I have provided include Diablo Canyon Nuclear Power Plant-
14 related operating expenses, return on weighted average rate base, annual depreciation expense, charges
15 from other departments, income taxes, property taxes, and an allowance for franchise fees and
16 uncollectible bills. For certain of these costs, I used proxy methods to calculate and represent them, for
17 example, tax expenses, in part because they would be determined through the use of the PG&E results-of-
18 operation model. The final 2017 Diablo Canyon Nuclear Power Plant baseline revenue requirement should
19 be developed using the PG&E model, reflecting the Commission-adopted costs and estimates
20 (independent variables to be inputted to the PG&E results-of-operation model) for Diablo Canyon Nuclear
21 Power Plant operating expenses, weighted average rate base and annual depreciation expense, and the
22 model results (dependent variables to be produced by the PG&E results-of-operation model) should be
23 substituted for my proxy calculations. Importantly, I should also point out I omitted cybersecurity costs from
24 my calculation of the Diablo Canyon Nuclear Power Plant baseline revenue requirement – my
25 recommendations regarding the per-unit production charge are not intended to place the recovery of
26 cybersecurity costs at risk to PG&E. Finally, the per-unit production charge would also be subject to
27 change to reflect any adjustments the Commission might adopt to my annual production assumptions.

28
29 I would emphasize my recommendation is that the Commission should adopt a specific 2017 baseline
30 Diablo Canyon Nuclear Power Plant revenue requirement in this proceeding and set the initial Schedule DC
31 rate accordingly. I believe the figures shown in Line A are fair representations of that revenue requirement

1 and, therefore, as the Commission evaluates my recommendation regarding the adoption of a Schedule
2 DC balancing account mechanism, I believe the figures are illustrative of the effects my recommendation
3 would have on PG&E and PG&E electric customers.
4

5 Q14. You earlier indicated your proposal is not unprecedented. Please explain what you mean by this.

6 A14. The Commission has, from time to time, authorized rates based upon utility performance, that is,
7 rewarding superior performance and penalizing poor performance, rather than setting rates strictly upon the
8 basis of cost estimates and forecasts. In fact, PG&E benefited from production- and performance-based
9 ratemaking in the case of the Diablo Canyon Nuclear Power Plant. When the Diablo Canyon Nuclear
10 Power Plant was first placed into commercial operation, PG&E's costs, both capital-related and operating
11 expense, were recovered through a production-based incentive rate. For each unit of production, PG&E
12 was paid a per-unit rate in a manner similar to the proposal I am making. I believe my proposal is
13 consistent with performance-based ratemaking and production-based rates.
14

15 Q15. In describing your proposal, you only discuss calendar years 2017, 2018 and 2019. Would your
16 proposal also apply to the ensuing years?

17 A15. At this point in time, the Alliance for Nuclear Responsibility is not making any recommendations for
18 the years following the period covered by this general rate case. If PG&E performs risk assessments and
19 analyses which the Commission finds to be reasonable and consistent with the Commission's directions in
20 its next-filed general rate case (*i.e.*, for Test Year 2020), Diablo Canyon Nuclear Power Plant-related
21 revenue requirement could be returned to base electric rates for recovery and Schedule DC would be
22 retired. If PG&E does not perform such risk assessments and analyses, my proposal could be applied to
23 the next rate case period as well as the current one. Importantly, it could prove to be the case that PG&E,
24 in doing future risk analyses, considers an "Avoid" risk-response scenario to address safety and reliability
25 risks posed by the Diablo Canyon Nuclear Power Plant and, in light of its financial exposure to those risks,
26 would revisit its decision to extend the operating life for the Diablo Canyon Nuclear Power Plant units.

27 Under that case, my proposal could, but might not, be appropriate for the years following 2019. But for the
28 moment, I am only proposing to make Diablo Canyon Nuclear Power Plant-related revenue requirement
29 subject to performance-based rate schedules for the period January 1, 2017, through December 31, 2019.
30

31 Q16. Does this conclude your testimony on the first Alliance for Nuclear Responsibility recommendation?

1 A16. Yes, it does.

2

3 **B. The Diablo Canyon Nuclear Power Plant Unit 2 Main Generator Stator Replacement Project**

4 Q17. Let's turn to the second recommendation you enumerated. To begin, please restate the
5 recommendation.

6 A17. The Alliance for Nuclear Responsibility is recommending the Commission withhold approval of the
7 proposed project to replace the Diablo Canyon Nuclear Power Plant Unit 2 main generator stator and,
8 further, exclude the costs of the project from PG&E's proposed revenue requirement. This would reduce
9 the 2019 Diablo Canyon Nuclear Power Plant capital additions by \$76.5 million.

10

11 Q18. Why is the Alliance for Nuclear Responsibility recommending the Commission withhold approval of
12 the project and omit the costs of the project from PG&E's revenue requirement?

13 A18. The analyses and materials relied upon by PG&E to justify the project are insufficient to establish that
14 the proposed costs are reasonable or that the project will be cost-effective taking into consideration all of
15 the likely costs of the project.

16

17 Q19. Why do you believe PG&E has failed to demonstrate the proposed costs of the project are
18 reasonable?

19 A19. I believe PG&E has failed to demonstrate the proposed project costs are reasonable for several
20 reasons. To begin, the project costs included in PG&E's case-in-chief significantly understate the likely
21 final costs of the project, exposing PG&E electric customers to even higher costs than proposed by PG&E.
22 In its testimony and proposed test year revenue requirement, PG&E indicates the total capital costs of the
23 project are \$76.5 million. This figure, however, omits any allowance for contingency, which PG&E
24 estimates could increase project costs to \$151 million. This omission represents a material deviation from
25 standard industry practices and PG&E's own internal engineering practices; those practices, as well as
26 PG&E's project-specific engineering analyses, indicate allowances for contingency in projects of the
27 difficulty and complexity inherent in the stator replacement project should be assumed to be relatively high.
28 In this regard, I note that PG&E's senior management explicitly approved early-stage project costs of \$46.1
29 million, including contingency of thirty-six percent (36%), or \$16.6 million. These early-stage activities
30 represent planning, preparation of bid packages and vendor selection – if even early-stage project activities
31 carry cost uncertainty, no doubt construction and completion of the project will pose equal, if not greater,

1 cost risks. PG&E's internal engineering practices assume allowances for contingency factors represent
2 costs that are highly likely to be incurred in completing the project, and PG&E has provided no explanation
3 for why it chose to exclude contingency-related costs from its showing in this rate case.

4
5 By excluding PG&E's internal estimates for contingency factors from the costs of the stator replacement
6 project presented to the Commission, PG&E is knowingly understating the reasonably foreseeable, and
7 significantly higher, final costs of the project most likely to be recorded to rate base upon the completion of
8 the project. Until PG&E makes a full showing of the reasonable costs of the Unit 2 main generator stator
9 project and justifies the project using a reasonable *and complete* cost estimate comporting with its own
10 internal engineering practices and project-specific analyses, the Commission should withhold its approval
11 of the project and exclude its costs from the revenue requirement adopted in this rate case.

12
13 Q20. How does PG&E's omission of allowances for contingency factors affect the evaluation of the
14 reasonableness of the costs and justification for the project?

15 A20. Without speculating as to the reasons for PG&E's omission of allowances for contingency factors
16 from its case-in-chief, I can say that this omission complicates the evaluation of the reasonableness of the
17 costs and justifications for the project. PG&E's internal economic analyses of the project determined the
18 project would pose negative cash flows and related rate consequences even using the lower, contingency-
19 free estimate of project costs. Those negative cash flows will increase as actual project costs increase. I
20 would expect PG&E to seek to offset any negative cash flows through rate increases. If PG&E fails to
21 provide reasonable estimates of project costs, the Commission cannot make an informed determination as
22 to the reasonableness of the potential rate increases posed by its approval of the project.

23
24 Q21. With or without considering the omission of allowances for contingency, do the forecasted benefits of
25 the proposed project justify its approval by the Commission?

26 A21. No, not in this instance. Apart from providing an incomplete cost picture for the proposed project,
27 PG&E made no attempt to perform a cost-benefit analysis of any kind for this project. This omission
28 renders PG&E's project justifications and, in particular, the selection of the project alternative now being
29 presented to the Commission, deficient bases upon which to approve the project. My review of PG&E's
30 project justifications indicate PG&E's senior management approved the higher-cost project alternative, and
31 rejected alternatives considered, for the sole reason that the selected project would allow Diablo Canyon

1 Nuclear Power Plant Unit 2 to operate for another thirty years. While PG&E has asserted in its case-in-
2 chief that license extension for the Diablo Canyon Nuclear Power Plant units is not within the scope of this
3 general rate case, this project and the reflection of its costs in rates was justified internally on the
4 assumption that Unit 2 would operate for another thirty years – the Commission should not approve the
5 proposed project in light of this inconsistency in PG&E’s showing.
6

7 Q22. Would approval of the proposed Unit 2 main generator stator project result in the adoption of just and
8 reasonable rates?

9 A22. No, to the contrary, it would place unreasonable rate burdens on PG&E electric customers. PG&E’s
10 testimony asserts that issues related to Diablo Canyon Nuclear Power Plant-related license and permit
11 extensions are beyond the scope of this rate case, but PG&E brings high-cost, life-extending projects to the
12 Commission for approval in direct contravention of those assertions. As an aside, I would point out PG&E
13 multiplies the rate impacts of replacing this long-lived equipment by stuffing the depreciation of project
14 capital costs into an extremely short seven years rather than across the full thirty years of life the project is
15 intended to breathe into Diablo Canyon Nuclear Power Plant Unit 2. A fundamental core tenet of the
16 Commission’s role here is to determine the just and reasonableness of the rates proposed by PG&E for the
17 rate case period. It is axiomatic that the forecasted costs underlying the Commission’s rate determinations
18 must reflect the actual useful life of any facility whose costs are included in those forecasts. The
19 Commission’s determination of whether the costs of the proposed Diablo Canyon Nuclear Power Plant Unit
20 2 main generator stator project are just and reasonable can only be made with a clear knowledge of the
21 intended and expected operating life of that unit. The approval of the costs of the proposed stator
22 replacement by the Commission under the cloud of the inconsistent assumptions presented by PG&E
23 would violate fundamental principles of ratemaking.
24

25 Q23. Should the Commission be concerned that delaying its approval of the proposed Unit 2 main
26 generator replacement project until such time as PG&E provides a better demonstration of the project’s
27 prudence and the reasonableness of project costs could result in a “run to failure” posing safety risks to the
28 public or plant personnel?

29 A23. No. Unlike most of PG&E’s other proposed capital projects for the Diablo Canyon Nuclear Power
30 Plant, the Unit 2 main generator stator replacement project has been characterized by PG&E as a
31 “reliability” project, and not a “safety” project. The project does not bear other “flags” associated with

1 “safety” projects, that is, PG&E does not consider the project to be a “mandatory” or “compliance” project
2 necessary to meet regulatory or permit requirements addressing public or employee safety. As I said in my
3 earlier testimony, the selection of the specific project alternative presented to the Commission in this
4 general rate case seems to be driven largely by PG&E’s interest in operating Unit 2 beyond the end of the
5 unit’s current license period in 2025 rather than by any safety concerns.

6
7 Q24. Should the Commission be concerned that delaying its approval of the proposed Unit 2 main
8 generator replacement project until such time as PG&E provides a better demonstration of the project’s
9 prudence and the reasonableness of project costs could result in a “run to failure” posing risks of a
10 catastrophic failure of the Unit 2 main generator?

11 A24. No. There is some indication the equipment faults and reliability issues the project is intended to
12 address have existed for quite some time, starting as early as before the time Unit 2 was first placed into
13 commercial operation. PG&E has employed various operating strategies to address the fault condition in
14 the Unit 2 main generator stator since that time and, while those strategies are now being characterized as
15 “cumbersome” and “time-consuming,” they have proved quite effective in keeping the stator condition
16 “stable” and the unit fully operational. Additionally, in considering reliability issues, the Commission should
17 keep in mind that PG&E senior management, in approving the project, only gave approval for preparatory,
18 early-stage project activities, pending any reconsideration by PG&E of whether to continue pursuing license
19 extensions for the unit. Senior management’s approval of the project did not authorize incurring costs or
20 conducting project activities related to fabrication of the project components or project execution, and there
21 is a “bridging strategy” PG&E would implement if PG&E abandons the pursuit of license and permit
22 extensions for Diablo Canyon Nuclear Power Plant Unit 2. Logically, if this bridging strategy could be
23 implemented until the unit’s retirement at the end of its current license period in 2025, the same strategy
24 would be equally effective at avoiding a catastrophic failure of the unit until such time as PG&E can provide
25 a proper demonstration of the project’s merits in the next general rate case or in a special application. If,
26 however, the Commission is concerned that delaying regulatory approval of the project could risk a
27 catastrophic failure of the unit, the Commission could approve the project, but should only do so subject to
28 the imposition of conditions consistent with my other ratemaking recommendations in order to protect
29 PG&E electric customers from any undue financial burdens they might otherwise bear.

30

1 Q25. If the Commission approves the Diablo Canyon Nuclear Power Plant Unit 2 main generator stator
2 replacement project in this general rate case, what conditions should be attached to that approval?

3 A25. First, the Commission should cap the project's costs at \$76.5 million. As I testified earlier, I do not
4 believe this cost is realistic, but since PG&E represents this cost as the reasonably likely cost of the project,
5 PG&E should be forced to stand behind its representations and its cost estimates as submitted in its case-
6 in-chief.

7
8 Second, the Commission should limit the project's annual depreciation expense recovered through rates to
9 a level consistent with an assumption that the remaining life of the Unit 2 main generator stator would be
10 coterminous with the unit's retirement in 2045, the end date of the license extension PG&E is currently
11 seeking from the Nuclear Regulatory Commission. PG&E senior management approved the project
12 because it would extend the operating life of the unit for another thirty years, and rates should reflect
13 PG&E's internal characterization and view of the project.

14
15 Third, and most importantly, PG&E should only be authorized to proceed with the project if the Commission
16 adopts the performance-based ratemaking mechanism I propose for all Diablo Canyon Nuclear Power
17 Plant-related costs of service. If the Unit 2 main generator stator project overruns its project schedule, or
18 fails to resolve the reliability issues it is designed to address, then PG&E, and not PG&E electric customers,
19 should bear the financial consequences of any performance failures experienced during the project or the
20 operation of the unit.

21

22 Q26. Does this conclude your testimony on the second Alliance for Nuclear Responsibility
23 recommendation?

24 A26. Yes, it does.

25

26 **C. Diablo Canyon Nuclear Power Plant-Related Annual Depreciation Expense**

27 Q27. Let's turn to the third recommendation you enumerated. To begin, please restate the
28 recommendation.

29 A27. The Alliance for Nuclear Responsibility is recommending the Commission reject the unreasonably
30 high annual depreciation expense proposed by PG&E for its remaining and proposed capital investment in

1 the generating assets and equipment, transmission assets and equipment, and general plant of the Diablo
2 Canyon Nuclear Power Plant.

3

4 Q28. Please explain your reasons for characterizing PG&E's proposed annual depreciation expense for
5 the Diablo Canyon Nuclear Power Plant assets and equipment as "unreasonably high."

6 A28. For the purposes of determining its annual depreciation expense for its forecasted net investment in
7 Diablo Canyon Nuclear Power Plant, PG&E assumed Diablo Canyon Nuclear Power Plant Unit 1 would be
8 retired in 2024 and Diablo Canyon Nuclear Power Plant Unit 2 would be retired in 2025. These
9 assumptions are consistent with the expiry of the current operating licenses issued by the Nuclear
10 Regulatory Commission. By assuming the Diablo Canyon Nuclear Power Plant units would be retired in
11 2024 and 2025, PG&E proposes to use relatively short remaining service lives, generally eight to nine
12 years, for the purpose of determining the annual depreciation expense for the vast majority of the assets
13 and equipment comprising depreciable Diablo Canyon Nuclear Power Plant investment. There are any
14 number of facts and factors indicating the assumed retirement dates do not reflect the likely remaining
15 service lives of the Diablo Canyon Nuclear Power Plant assets and that the appropriate remaining service
16 lives for those assets should be assumed to be some twenty years longer than proposed by PG&E. By
17 using unreasonably short remaining service lives, PG&E is significantly and unreasonably increasing the
18 Diablo Canyon Nuclear Power Plant-related annual depreciation expense it proposes to include in its
19 annual revenue requirement. The Commission should make appropriate adjustments to that expense for
20 each of the years 2017, 2018 and 2019.

21

22 Q29. What factors do you believe indicate the assumed retirement dates for the Diablo Canyon Nuclear
23 Power Plant units proposed by PG&E should not be used to determine the annual depreciation expense for
24 the Diablo Canyon Nuclear Power Plant assets?

25 A29. First of all, the determination of annual depreciation expense is in some respects a matter of
26 judgment. At a planning meeting related to this rate case, PG&E's regulatory leadership advised PG&E's
27 senior management that depreciation expense, a large component of PG&E's costs of service, had in the
28 past and could in this general rate case be used as a "lever." This "levering" concept was explained by
29 PG&E as meaning that the level of depreciation expense requested in the general rate case could be
30 adjusted, through the application of judgment and discretion, up or down to serve purposes other than
31 capital recovery, including maintaining rates at publicly acceptable levels. With this in mind, I scrutinized

1 the very large discrepancy between, on the one hand, PG&E's proposed Diablo Canyon Nuclear Power
2 Plant-related annual depreciation expense used to forecast test year costs of operation and, on the other
3 hand, the deductions taken for Diablo Canyon Nuclear Power Plant-related depreciation expense used to
4 forecast tax expense on the other hand. This discrepancy is in large part the result of using shorter
5 remaining service lives in estimating annual depreciation expense for the Diablo Canyon Nuclear Power
6 Plant assets than is allowed under federal and state regulations for tax purposes.

7

8 Q30. Why should any discrepancy between depreciation deductions taken for tax purposes and
9 depreciation expense reflected in rates be of any concern to you or the Commission?

10 A30. As I indicated, the discrepancy in the context of Diablo Canyon Nuclear Power Plant-related
11 depreciation is significant and required any number of adjustments to the overall results of operation
12 presented by PG&E in this general rate case, most notably in the adjustment to deferred tax expense.
13 More to the point, the discrepancy is yet another example of the rate impacts flowing from the inconsistency
14 between PG&E's assertion that the license extensions PG&E is seeking for the Diablo Canyon Nuclear
15 Power Plant units are beyond the scope of this proceeding and the assumptions PG&E is using to set its
16 test year revenue requirement.

17

18 At this juncture, I should point out PG&E may request rulings from federal and state tax authorities pursuant
19 to which PG&E could calculate its income taxes using bases other than those specified by the tax codes
20 and related tax regulations. Thus, PG&E could request a ruling allowing it to take deductions for
21 depreciation expense based upon 2024 and 2025 retirement dates for the Diablo Canyon Nuclear Power
22 Plant units rather than on the remaining service lives for the plant's constituents as specified in the more
23 generic tax regulations. But PG&E has not filed any such request. This omission indicates that, while
24 PG&E is willing to represent to this Commission that the Diablo Canyon Nuclear Power Plant units will be
25 retired within the next few years in order to set its electric rates (higher, I might add), PG&E is not willing to
26 make those same representations to federal and state tax authorities in order to reduce its federal and state
27 income taxes.

28

29 PG&E's reluctance to approach federal and state tax authorities for this tax break is entirely
30 understandable. In the event the Diablo Canyon Nuclear Power Plant units are not in fact retired in 2024
31 and 2025, the depreciation expenses taken in the tax years covered by any favorable tax rulings allowing

1 PG&E to increase its deductions for Diablo Canyon Nuclear Power Plant-related depreciation expense
2 would be subject to audit, review and revision, which could in turn lead to the recapture of inappropriately
3 avoided taxes and even the imposition of penalties. PG&E's ability to recover the costs of any back taxes
4 imposed by either federal or state authorities would likely be barred by California's ban against retroactive
5 ratemaking, giving PG&E a financial incentive not to play "depreciation roulette" with tax authorities.
6 Equally likely, PG&E has not sought tax relief for the same reason I believe the Commission should reject
7 PG&E's proposed annual depreciation expense for the Diablo Canyon Nuclear Power Plant assets: the
8 facts do not support the use of the 2024 and 2025 retirement dates as the bases for determining the
9 remaining service lives and resulting annual depreciation expense for the Diablo Canyon Nuclear Power
10 Plant assets.

11

12 Q31. What facts do not support the use of the 2024 and 2025 retirement dates as the bases for
13 determining the remaining service lives and resulting annual depreciation expense for the Diablo Canyon
14 Nuclear Power Plant assets?

15 A31. There are several. Contrary to its position in this rate case, PG&E is actively pursuing twenty-year
16 extensions for both units of the Diablo Canyon Nuclear Power Plant before the Nuclear Regulatory
17 Commission. Similarly, PG&E is actively pursuing related extensions for other permits and authorities
18 necessary to allow the operation of the Diablo Canyon Nuclear Power Plant units beyond 2024 and 2025.
19 These regulatory activities are intentional, unequivocal, coordinated, extensive, and well-funded. For just
20 the activities before the Nuclear Regulatory Commission, PG&E had spent \$47,974,254, including an
21 Allowance for Funds Used During Construction, through the end of 2015. PG&E forecasts another
22 \$15,396,415 will be spent in 2016 and \$4,580,445 will be spent in 2017, including Allowances for Funds
23 Used During Construction, to continue its efforts to allow the Diablo Canyon Nuclear Power Plant to
24 operate until 2044 and 2045. Either PG&E is wasting the time, attention and resources of the agencies
25 which are reviewing PG&E's applications and submittals, or PG&E is misrepresenting its intention to retire
26 the Diablo Canyon Nuclear Power Plant units in this rate case.

27

28 In addition, the Commission requires the regulated electric utilities to submit periodic long-term
29 procurement plans demonstrating they own, control, have procured, and/or will procure reliable resources
30 sufficient to meet their peak loads forecasted for the next ten years. PG&E has not indicated in any of its
31 filings with this Commission that the Diablo Canyon Nuclear Power Plant units will be retired in 2024 and

1 2025 and are subject to replacement. The strong inferences from this omission are that PG&E does not
2 intend to retire the Diablo Canyon Nuclear Power Plant units in 2024 and 2025, and that PG&E intends to
3 rely on the Diablo Canyon Nuclear Power Plant as a resource beyond the periods subject to review under
4 the Commission's resource-planning regulations. Similarly strong inferences can be taken from PG&E's
5 showings in the Integrated Energy Policy Report proceedings of the California Energy Commission. In the
6 data provided to that agency, PG&E has never indicated any intention of replacing the Diablo Canyon
7 Nuclear Power Plant with other resources. More recently, PG&E has requested the modeling of a "Diablo-
8 in" scenario as part of this Commission's long-term procurement proceeding. The Commission should take
9 these plain facts and reasonable inferences into account in setting Diablo Canyon Nuclear Power Plant-
10 related annual depreciation expense in this proceeding.

11

12 Q32. As you have noted, PG&E has provided testimony indicating its pursuit of authorities extending the
13 operating life of the Diablo Canyon Nuclear Power Plant is beyond the scope of this general rate case and
14 it is not seeking to recover the costs you mention. Why should the Commission take these facts into
15 consideration in light of PG&E's testimony?

16 A32. PG&E's activities before other agencies are relevant to adjudging the validity of its assumptions used
17 to calculate Diablo Canyon Nuclear Power Plant-related annual depreciation expense. The magnitude of
18 the expenses being incurred by PG&E clearly demonstrates the seriousness of PG&E's intention to extend
19 the operating period for the Diablo Canyon Nuclear Power Plant units and provides an explicit measure of
20 the incongruity between its position before other agencies and its position before this Commission in this
21 general rate case.

22

23 I disagree with PG&E's testimony as to the relevance of its efforts to convince other agencies to authorize
24 the Diablo Canyon Nuclear Power Plant to remain in operation for an additional twenty years. Those efforts
25 are relevant in determining whether the assumption the Diablo Canyon Nuclear Power Plant units will retire
26 in 2024 and 2025, upon which PG&E's annual depreciation expense for the Diablo Canyon Nuclear Power
27 Plant assets rests, is a reasonable one. The level of effort and magnitude of the costs PG&E is devoting to
28 these activities are at considerable odds with that assumption. The Commission should consider these
29 factors in evaluating the validity and truth of the assumption and, in turn, the reasonableness of the cost
30 forecasts which are dependent on that assumption, including annual depreciation expense.

31

1 Frankly, I am dismayed by PG&E's assertion that this Commission should ignore the level of PG&E's
2 expenditures in support of extending the operating period of the Diablo Canyon Nuclear Power Plant simply
3 because those expenditures are not included in PG&E's proposed test year revenue requirement. PG&E
4 has disclosed to the Alliance for Nuclear Responsibility its intent to recover from its electric customers the
5 full extent of its costs incurred in extending the Diablo Canyon Nuclear Power Plant operating licenses.
6 PG&E is currently recording those costs to a subaccount of Construction Work-in-Progress, accruing an
7 Allowance for Funds Used During Construction on the amounts recorded, and planning to recoup its costs
8 through some future rate application, whether as an addition to the Diablo Canyon Nuclear Power Plant
9 rate base or as recoverable expenses associated with abandoned plant. Unless PG&E is spending these
10 funds in the good faith pursuit of extending the operating life of the Diablo Canyon Nuclear Power Plant,
11 those costs are being unreasonably and imprudently incurred and their recovery through regulated rates
12 would be barred as a matter of California law. PG&E can certainly try to keep these costs and the
13 underlying activities from the oversight and review of this Commission through a regulatory sleight-of-hand,
14 but I believe PG&E's position on these matters contravenes PG&E's prior position that these costs
15 constitute ordinary operating expenses subject to rate recovery during the year incurred. In addition,
16 PG&E's position disregards the provisions of the Public Utilities Code which can be reasonably interpreted
17 to require this Commission's prior approval for capital projects whose costs are expected to exceed \$50
18 million. The very least the Commission should do in light of these facts and issues is to adopt an annual
19 depreciation expense consistent with the inferences that (a) PG&E means what it says before other
20 agencies and intends to operate the Diablo Canyon Nuclear Power Plant through 2045, (b) PG&E would
21 prefer not to contradict its position before these other agencies by applying for otherwise reasonable and
22 available tax relief, and (c) PG&E is, for the time being, recording the costs of its license-extension activities
23 to nonrevenue accounts under a good faith belief that extending the operating life of the Diablo Canyon
24 Nuclear Power Plant units is reasonable and prudent. Under these inferences, PG&E's proposed Diablo
25 Canyon Nuclear Power Plant-related annual depreciation expense should be rejected and reduced using
26 assumptions more consistent with the facts at hand.

27

28 Q33. Are there other facts or factors which lead you to believe PG&E's use of the 2024 and 2025
29 retirement dates in determining Diablo Canyon Nuclear Power Plant-related annual depreciation expense is
30 unreasonable?

1 A33. Yes, there are two aspects of PG&E's case-in-chief which are inconsistent with the use of 2024 and
2 2025 retirement dates in determining Diablo Canyon Nuclear Power Plant-related annual depreciation
3 expense. First, various licenses issued by the Federal Energy Regulatory Commission for the operation of
4 certain PG&E hydroelectric generating stations are pending license extensions and renewals. PG&E
5 indicates the issuance of those licenses are "uncertain" and subject to the imposition of various, yet-to-be-
6 determined conditions and mitigations. Notwithstanding these uncertainties, PG&E has assumed, for the
7 purposes of depreciating its net remaining and planned capital investment in the hydroelectric facilities
8 subject to license expirations, it will receive all of the requested license extensions for periods of up to
9 thirty-five years. The use of inconsistent assumptions in the calculation of annual depreciation expense
10 between hydroelectric facilities subject to license expiration and the Diablo Canyon Nuclear Power Plant is
11 unreasonable and results in an unreasonably high Diablo Canyon Nuclear Power Plant-related revenue
12 requirement. Second, as I said earlier in my testimony, in evaluating the planned main generator stator
13 replacement project for Diablo Canyon Nuclear Power Plant Unit 2, PG&E's senior management explicitly
14 considered that the project would allow the unit to operate well beyond 2025, and approved the project on
15 that basis, dismissing lower-cost operational alternatives more consistent with an assumption that the
16 Diablo Canyon Nuclear Power Plant Unit 2 would be retired in 2025. This reveals an incongruity between
17 PG&E's internal assessment of risk-mitigation projects and the assumption used in determining the annual
18 depreciation expense for the Diablo Canyon Nuclear Power Plant assets. That incongruity is in full
19 evidence in the case of the Unit 2 stator replacement project: the project was approved because it extends
20 the service life of Unit 2 through 2045, but PG&E proposes to depreciate all of the capital costs of the
21 project during the period 2019 to 2025. There are additional programs and projects, although of lesser
22 costs, demonstrating this same incongruity.

23

24 Q34. Under an assumption that the Diablo Canyon Nuclear Power Plant units will be retired in 2044 and
25 2045, what would the Diablo Canyon Nuclear Power Plant-related annual depreciation expense be?

26 A34. Ideally, PG&E should calculate the remaining service lives of the constituent components of the
27 Diablo Canyon Nuclear Power Plant assets under assumptions consistent with the retirement of the Diablo
28 Canyon Nuclear Power Plant units in 2044 and 2045. It should be kept in mind that not all of these
29 components can be expected to remain in service through those years and that there would be interim
30 retirements and replacements along the way. PG&E has not done such an analysis and the Alliance for
31 Nuclear Responsibility does not have the ability to perform such a study given the thousands of evaluations

1 that must be performed in developing an accurate composite remaining service life for depreciable Diablo
2 Canyon Nuclear Power Plant investment. The Commission should require PG&E to do such a study for the
3 next PG&E general rate case, unless of course PG&E abandons its license extension activities and advises
4 the Commission of its intent to retire the Diablo Canyon Nuclear Power Plant units in 2024 and 2025. In
5 the absence of a full depreciation study, I am proposing the adoption of a proxy method in the interim for
6 the purposes of setting Test Year 2017 revenue requirement in this general rate case.

7
8 Under my proxy method, the Commission would simply apply a ratio representing the difference between a
9 2024-2025 retirement assumption and a 2044-2045 retirement assumption, *i.e.*, 8.5-to-28.5, in the
10 calculation of Diablo Canyon Nuclear Power Plant-related annual depreciation expense. “8.5” represents
11 the number of years over which PG&E proposes to depreciate Diablo Canyon Nuclear Power Plant rate
12 base, and “28.5” represents the number of years during which the Diablo Canyon Nuclear Power Plant
13 would operate under a license extension. Under this method, Diablo Canyon Nuclear Power Plant annual
14 depreciation expense would be \$90.72 million, \$95.99 million and \$102.88 million for Years 2017, 2018,
15 and 2019, respectively. I should note these figures are based on PG&E’s proposed Diablo Canyon Nuclear
16 Power Plant rate base, from which the Alliance for Nuclear Responsibility would deduct the forecasted
17 annual depreciation expense arising from capital expenditures related to the Independent Spent Fuel
18 Storage Installation and the Unit 2 main generator stator project. Those deductions would comport with
19 other recommendations being made by the Alliance for Nuclear Responsibility in this proceeding.

20
21 Q35. Why should the Commission rely on your proxy in lieu of PG&E’s depreciation study?

22 A35. The PG&E depreciation study is methodologically sound but, in the context of determining annual
23 depreciation expense for the Diablo Canyon Nuclear Power Plant assets, the results are fatally flawed. For
24 that portion of forecasted annual depreciation expense, PG&E’s depreciation study relies upon an
25 unreasonable assumption, namely, the retirement of the Diablo Canyon Nuclear Power Plant units in 2024
26 and 2025. As I testified earlier, that assumption is disregarded by PG&E for all other purposes known to
27 me. My proxy relies on more reasonable assumptions regarding the most likely retirement dates for the
28 Diablo Canyon Nuclear Power Plant units and, under PG&E’s proposition that adjustments to depreciation
29 based on judgment and discretion may be used as a “lever” in the setting of reasonable rates, my proxy
30 would result in the setting of rates more reasonable than would be the case using PG&E proposed annual
31 depreciation expense and therefore may reasonably be relied upon by the Commission in this proceeding.

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Q36. What effects would the adoption of annual depreciation expense using the proxy you are proposing have on Test Year 2017 revenue requirement?

A36. The principal effect would be a reduction in Diablo Canyon Nuclear Power Plant-related annual depreciation expense. The reduction would be a little over \$200 million per year. There are, however, other, sometimes offsetting, changes in other costs that should be reflected in the test year revenue requirement. For example, decreasing test year depreciation expense would increase Diablo Canyon Nuclear Power Plant-related test year net weighted average rate base. In turn, this would result in higher revenue requirement reflecting returns on higher levels of net invested capital. In addition, state and federal income tax expense would increase compared to PG&E's forecast for taxes since deductions taken for depreciation expense would be lower and income would be correspondingly higher. This would also result in lower levels of accumulated deferred taxes. Next, forecasted ad valorem taxes, to the extent based on net book value of the Diablo Canyon Nuclear Power Plant, would be higher for the same reason. There may be other effects of which I am unaware.

Q37. How would the aggregated net effects of your recommendations on Diablo Canyon Nuclear Power Plant-related annual depreciation expense be reflected in the final Test Year 2017 revenue requirement?

A37. As I understand things, PG&E will prepare and present revised and alternative Results of Operations later in this proceeding, including a final revision prepared in coordination with the Commission's Energy Division Staff based upon the Commission's decision in this phase of the rate case. The revised Results of Operations would be produced using a PG&E model designed to reflect the interrelationships and interdependencies of the model inputs among one another. I am not an expert on this model or its operation, but am relying on PG&E's expertise and the oversight of the Energy Division Staff as to the model's validity and the accuracy of the model's results. It would be during the process of revising the Results of Operations by PG&E and the Energy Division that the full net effects of substituting my proposed Diablo Canyon Nuclear Power Plant-related annual depreciation expense would be determined. I am deferring to PG&E and the Commission's Energy Division Staff to perform these calculations, subject to public review by the parties.

Q38. Will PG&E suffer any financial prejudice from the adoption of your recommendation?

1 A38. No. I am not recommending any capital costs or depreciation-related expense be “disallowed” in the
2 context of recommending a lower annual depreciation expense than proposed by PG&E. My
3 recommendation only lengthens the period across which PG&E’s remaining, depreciable investment in the
4 Diablo Canyon Nuclear Power Plant assets would be returned to the company. PG&E would be
5 compensated through rate of return on rate base for the entire period of the deferral. I should add that, in
6 the event PG&E decides to retire the Diablo Canyon Nuclear Power Plant units in 2024 and 2025
7 coincident with the expiry of the current Nuclear Regulatory Commission operating licenses, there would be
8 a greater amount of Diablo Canyon Nuclear Power Plant-related capital investment on PG&E’s books than
9 would be the case under PG&E’s proposed annual depreciation expense. There are, however, ratemaking
10 protocols allowing for the full recovery of that remainder through rates set upon the retirement of the units,
11 so, in the absence of good reason to do otherwise (and I am unaware of any at this time), I do not foresee
12 any financial prejudice to PG&E attributable to the adoption of my recommendation regarding annual
13 depreciation expense.

14
15 Q39. Would PG&E electric customers suffer any disadvantage from the adoption of your recommendation?

16 A39. There would be offsetting intertemporal advantages and disadvantages to PG&E electric customers
17 arising from the adoption of my recommendation. Over the next eight or nine years (2017 to 2024/2025),
18 PG&E electric customers would see significantly lower rates due to the lower annual depreciation expense
19 included in rates, but for the ensuing twenty years (2025 through 2044/2045), PG&E electric customers
20 would see slightly higher rates due to the deferral of capital recovery that would occur under my
21 recommendation. I would note that the magnitude of the rate changes seen by any vintage of electric
22 customers would be considerably different, assuming the Diablo Canyon Nuclear Power Plant operates
23 until the Year 2045: early vintage customers would see a rate decrease approximately three times the
24 increase experienced by later vintage customers. Over the long-term, PG&E’s electric customers would be
25 economically indifferent to my proposal. Equally important, PG&E’s proposed Diablo Canyon Nuclear
26 Power Plant-related annual depreciation expense poses similar intertemporal advantages and
27 disadvantages to PG&E electric customers and some of the disadvantages are not offset by countervailing
28 advantages.

29
30 Q40. Please explain the intertemporal advantages and disadvantages to PG&E electric customers under
31 PG&E’s proposed Diablo Canyon Nuclear Power Plant-related annual depreciation expense.

1 A40. As with my proposal, there are offsetting intertemporal advantages and disadvantages to PG&E
2 electric customers arising from the adoption of PG&E's proposed Diablo Canyon Nuclear Power Plant-
3 related annual depreciation expense. Over the next eight or nine years (2017 to 2024/2025), PG&E electric
4 customers would see significantly higher rates due to the higher annual depreciation expense included in
5 rates but, assuming the Diablo Canyon Nuclear Power Plant units remain in operation through 2044 and
6 2045, PG&E electric customers would see relatively lower rates during the period 2025 to 2045 due to the
7 accelerated return of capital that would occur under PG&E's proposal. Once again, the magnitude of the
8 changes in rates seen by any vintage of electric customers would be considerably different. Assuming the
9 Diablo Canyon Nuclear Power Plant operates until the Year 2045, early vintage customers would see a rate
10 increase roughly three times the decrease experienced by later vintage customers. Over the long-term,
11 PG&E's electric customers would be economically indifferent, just as in the case with my proposed annual
12 depreciation expense.

13
14 Beyond this simple rate indifference, however, PG&E is already distributing intertemporal rate advantages
15 and disadvantages between current and future customers for Diablo Canyon Nuclear Power Plant-related
16 costs. As I have previously testified, PG&E is recording its costs related to extending the operating life of
17 the Diablo Canyon Nuclear Power Plant to a nonrevenue subaccount of Construction Work-in-Progress,
18 including an Allowance for Funds Used During Construction. This transmutes an ordinary operating
19 expense, *i.e.*, administrative and general expenses recoverable in the year incurred, which should be paid
20 by current electric customers, into capital expenditures that will be recovered through rates from future
21 customers, whether as a rate base addition if the Diablo Canyon Nuclear Power Plant operates beyond
22 2024/2025 or as the costs of abandoned plant if PG&E does not receive authority to operate the Diablo
23 Canyon Nuclear Power Plant beyond its current license and permit authorities. From PG&E's chosen
24 accounting treatment for these costs, I am assuming PG&E does not consider intertemporal rate
25 advantages and disadvantages to be compelling and the Commission should take this into consideration as
26 it weighs intertemporal equity issues arising from my recommendation regarding annual depreciation
27 expense.

28
29 Notwithstanding that PG&E electric customers would be economically indifferent to my or PG&E's
30 depreciation proposal over the long term, the Commission should consider that PG&E's proposed Diablo
31 Canyon Nuclear Power Plant-related annual depreciation expense bears important resource-planning and

1 potential cost disadvantages to PG&E electric customers. By fully depreciating PG&E's investment in the
2 Diablo Canyon Nuclear Power Plant within the next nine years, the Diablo Canyon Nuclear Power Plant will
3 receive a considerable but undue economic advantage in any comparison to potentially viable and cost-
4 effective alternative resources which could otherwise replace the Diablo Canyon Nuclear Power Plant in the
5 post-2024/2025 period. Virtually all of the major components and systems comprising the Diablo Canyon
6 Nuclear Power Plant are capable of providing service well beyond 2025 according to the reliability analyses
7 submitted by PG&E to the Nuclear Regulatory Commission. Yet these components will bear no capital-
8 related revenue requirement in any cost-based comparison simply as a function of the truncated remaining
9 service lives adopted in and for PG&E's depreciation study. This could bias resource-planning processes
10 in favor of continuing Diablo Canyon Nuclear Power Plant operations, which in turn could result in
11 continuing public exposure, and PG&E's electric customers' financial exposure, to both enterprise- and
12 operating-level risks related to Diablo Canyon Nuclear Power Plant operations. This should be of grave
13 concern to the Commission given, as I have previously testified, PG&E is understating these exposures by
14 a significant margin. Over the short term, it is important to rectify the problems I have identified with the
15 PG&E risk analyses by adopting risk- and performance-based ratemaking for the recovery of Diablo
16 Canyon Nuclear Power Plant-related costs. Until and unless the Commission does so, the Commission
17 should not rely upon PG&E to evaluate risk exposures accurately and comprehensively. For the long term,
18 a poor resource decision would lay the foundation for an endless series of potentially significant Diablo
19 Canyon Nuclear Power Plant-related rate increases not considered in this general rate case but which
20 PG&E acknowledges are foreseeable. These rate increases would be imposed through future general rate
21 cases, other existing balancing accounts (e.g., the Nuclear Regulatory Commission Regulatory Balancing
22 Account), other special applications (e.g., the expected filings covering license-extension activities and the
23 costs of compliance with upcoming regulations restricting the Diablo Canyon Nuclear Power Plant's use of
24 marine waters for cooling purposes), and/or other ratemaking mechanisms invoked to hold utilities
25 harmless from the consequences of any enterprise- and operating-level risks.

26

27 Q41. Does this conclude your testimony on the third Alliance for Nuclear Responsibility recommendation?

28 A41. Yes, it does.

29

30

1 **D. Maintaining the Diablo Canyon Nuclear Power Plant Seismic Studies Balancing Account**

2 Q42. Let's turn to the fourth recommendation you enumerated. To begin, please restate the
3 recommendation.

4 A42. The Alliance for Nuclear Responsibility is recommending the Commission reject PG&E's proposal to
5 terminate the Diablo Canyon Nuclear Power Plant seismic studies balancing account. The Commission
6 should continue to require PG&E to maintain the balancing account until such time as the Commission has
7 reviewed the seismic analyses whose costs are recovered through the balancing account. The balancing
8 account should be maintained until the Commission determines (a) the assessments are complete and (b)
9 any required mitigation measures are prudent and reasonable. The balancing account serves several
10 functions including enabling the Commission's economic and financial oversight authorities.

11
12 Q43. What benefits does the balancing account currently afford to the Commission and ratepayers?

13 A43. The balancing account serves the purposes of regulatory oversight, regulatory transparency and
14 utility accountability. It is important to have a balancing account devoted to the study of seismic hazards
15 and related safety issues so that the Commission can clearly and consistently monitor the analytic activities
16 aimed at revealing and addressing those issues. Without the balancing account, it will be more difficult for
17 the Commission to monitor whether the funds used for seismic studies and safety activities are being
18 prudently incurred in the years between general rate cases. Pre- and post-expenditure audits of seismic
19 review costs allow the Commission to determine whether the purposes of the costs are being well-served
20 and whether the results of the studies affect other regulatory proceedings. PG&E contends the studies
21 relevant to the balancing account have been completed and, as a result, the balancing account is no longer
22 needed and should be closed. To the contrary, there is strong evidence suggesting the Nuclear Regulatory
23 Commission will require further seismic upgrades for the Diablo Canyon Nuclear Power Plant as a result of
24 the Fukushima Daiichi failures. In addition, the Legislature unanimously enacted urgency legislation in
25 2015 to extend and codify the role of the Commission's Independent Peer Review Plan to provide oversight
26 to PG&E's Long-Term Seismic Program. That panel is reviewing PG&E's integration of the studies
27 required by 2006 Assembly Bill 1632 (Blakeslee) into the report ordered by the Nuclear Regulatory
28 Commission of PG&E's Senior Seismic Hazard Analysis Committee. Considerable follow-up work remains,
29 and likely will for some time.

30
31 Q44. Is it your opinion that balancing accounts lead to more effective regulatory oversight?

1 A44. Yes. As a former Commissioner of the California Energy Commission and from my involvement in
2 numerous regulatory proceedings, I believe balancing accounts provide far more effective regulatory
3 oversight as compared to general rate cases. As PG&E itself argued in its last general rate case as well as
4 this one, costs recovered through balancing accounts and the activities and projects underlying those costs
5 can be easily reviewed and monitored by interested parties and the Commission. Earthquake
6 preparedness and impacts on public safety, as is the case for utility-caused wildfires and the costs of
7 mitigating their causes, should be separated from general rate cases to allow regulators, customers,
8 interested parties, and the general public a distinct venue in which to track expenditures and review utility
9 activities.

10

11 PG&E's assertion that the costs recovered through the seismic studies balancing account are relatively
12 small simply ignores the important purposes being served by the activities being funded, a far more
13 important reason for the Commission's creation of the balancing account in the first place. That assertion is
14 oddly misplaced as well, since PG&E well knows general rate cases march to the strict beat of the
15 Commission's regulatory lag plan schedule, which strongly discourages parties from spending days and,
16 perhaps weeks, on relatively small amounts of money.

17

18 Q45. In what manner does the seismic studies balancing account contribute to the Commission's ability to
19 protect the public safety?

20 A45. By singling out the expenditures related to the seismic studies and identifying any necessary and
21 required seismic upgrades which might result from new findings, the Commission is able to coordinate
22 PG&E's characterization of the seismic hazards present at the Diablo Canyon Nuclear Power Plant site
23 with the Commission's review of the costs of mitigating the potential consequences posed by those
24 hazards. The Tohoku earthquake and resulting impact to the Fukushima Daiichi nuclear facility were
25 catastrophic, the full impacts of which are yet to be fully understood and inventoried. The Diablo Canyon
26 Nuclear Power Plant's proximity to known seismic faults increases the likelihood the Nuclear Regulatory
27 Commission or other regulatory agencies will impose additional design and safety requirements as more
28 becomes known about the risks posed to nuclear operations from seismic events. In addition, some of the
29 studies which PG&E considers completed were only completed very recently and the California Energy
30 Commission, the California agency most interested in reviewing those studies, has yet to indicate whether it
31 considers those studies to be complete or whether additional issues need to be addressed. The

1 Commission should proceed cautiously in considering the regulatory tools and forums it may need in the
2 future to evaluate how PG&E assesses and will address any new seismic hazards and findings revealed by
3 the latest studies. PG&E has been known to be out of compliance with seismic-related safety procedures
4 and the Commission should not assume PG&E will fully appreciate its responsibilities with respect to
5 seismic safety in the future. The seismic studies balancing account provides a well-suited regulatory
6 mechanism by which the Commission can oversee PG&E's activities in these important areas.

7

8 Q46. How are the seismic studies and any safety-related projects related to the Commission's economic
9 jurisdiction over the Diablo Canyon Nuclear Power Plant?

10 A46. As PG&E, the Nuclear Regulatory Commission and other agencies, including this Commission,
11 evaluate the requested license extensions for the Diablo Canyon Nuclear Power Plant, close review of the
12 recent seismic studies may suggest amendments to the plant's design, components and/or procedures, all
13 of which will pose potential costs of compliance. Review of these matters in the immediately available
14 annual proceeding where the costs and results of the seismic studies are considered should provide an
15 early warning as to the economic efficacy of the requested license extensions, a natural precursor to
16 PG&E's next application under the Nuclear Regulatory Commission Regulatory Balancing Account where
17 any new design requirements and additional compliance requirements will be proposed.

18

19 Q47. Does this conclude your testimony on the fourth recommendation of the Alliance for Nuclear
20 Responsibility?

21 A47. Yes, it does.

22

23 **E. Excluding the Costs of the Independent Spent Fuel Storage Installation from Rate Base and**
24 **Rates**

25 Q48. Let's turn to the fifth recommendation you enumerated. To begin, please restate the
26 recommendation.

27 A48. The Alliance for Nuclear Responsibility is recommending the Commission omit the capital costs of the
28 Independent Spent Fuel Storage Installation ("ISFSI") expansion project from electric rates until such time
29 as PG&E demonstrates it is in full compliance with the recommendations of the California Energy
30 Commission regarding the transfer of spent fuel assemblies to dry cask storage. This would reduce Test
31 Year 2017 Diablo Canyon Nuclear Power Plant capital investment by \$36.754 million.

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Q49. Why is the Alliance for Nuclear Responsibility recommending the exclusion of the costs of the ISFSI expansion project from rate base and rates?

A49. In PG&E's last general rate case, the Commission directed PG&E to file "a satisfactory plan to comply with California Energy Commission recommendations regarding the transfer of spent fuel to dry cask storage in its Assembly Bill 1632 Report" in this general rate case. The Commission approved the project and PG&E's forecasted capital estimate of \$26.1 million, which should be compared to PG&E's forty percent (40%) higher recorded costs of \$36.754 million, to construct five additional five pads at the ISFSI, *subject to* PG&E's compliance with this directive. The Energy Commission's 2013 Integrated Energy Policy Report provides guidance as to the manner in which PG&E could comply with this direction, namely, "PG&E should, as soon as practicable and while maintaining compliance with Nuclear Regulatory Commission spent fuel cask and pool storage requirements, transfer spent fuel from the pools into dry casks and report to the Energy Commission on its progress until the pools have been returned to open racking arrangements." PG&E has not complied with the Energy Commission's recommendations or the Commission's ratemaking directive. In the 2015 Integrated Energy Policy Report, the Energy Commission confirmed PG&E's failure to meet the recommendations adopted in the 2013 Integrated Energy Policy Report.

Q50. Have you reviewed PG&E's plan for transferring spent fuel from wet storage to dry cask storage filed in this general rate case?

A50. Yes, I have.

Q51. Is the spent fuel storage plan filed by PG&E in this general rate case sufficient to meet this Commission's ratemaking directions from the last PG&E general rate case?

A51. No, it is not. As this Commission has said, PG&E was required to file a plan "*satisfactory*" to the *Energy Commission*. As the Energy Commission has said in its most recent Integrated Energy Policy Report, PG&E's plan does not meet the agency's recommendations regarding spent fuel storage. PG&E excuses its noncompliance by claiming its fuel-transfer plan is impacted by a number of factors, and that moving spent fuel assemblies from wet pools to dry storage is very complex and takes years to plan and perform. PG&E claims that it has adopted a "reasonable and prudent fuel transfer schedule," and further claims to be constrained by Nuclear Regulatory Commission heat-loading restrictions to keeping a

1 minimum of 772 fuel assemblies in each of its spent-fuel storage pools. PG&E has not explained why it
2 has not studied and appears to reject the “low-density” pool definition used by the Nuclear Regulatory
3 Commission, which contemplates that as few as 312 fuel assemblies may be placed in each spent-fuel
4 storage pool. The Energy Commission recently made clear that PG&E’s position is not compelling. In
5 doing so, the Energy Commission noted a Nuclear Regulatory Commission Staff study, upon which
6 PG&E’s resistance to the Energy Commission’s recommendation relied, was based on a seismic
7 assessment of nuclear plant sites in the eastern and central United States, not nuclear power plants in the
8 seismically active western United States. The Energy Commission noted the admission of the chairman of
9 the Nuclear Regulatory Commission that agency staff had not adequately explored these regional issues
10 affecting fuel-storage issues.

11
12 Based on its review of PG&E’s fuel storage plan, the Energy Commission has recommended that PG&E
13 should not be allowed “to recover from ratepayers the additional costs associated with its failure to expedite
14 the movement of spent fuel from the pool to dry casks. In addition, PG&E should file annual reports with
15 the CPUC and the Energy Commission on its efforts to comply with California regulators’ directives in this
16 area, and its estimate of the costs implications. These reports should contain the amount of spent fuel and
17 the associated radiation in the spent fuel pool and an estimate of the incremental amount above the level
18 desired by the Energy Commission and the CPUC.” I support the Energy Commission’s recommendation
19 in these regards.

20
21 Q51. Does this conclude your testimony on the fifth Alliance for Nuclear Responsibility recommendation?

22 A51. Yes, it does.

23

24 Q52. Does this also conclude your prepared direct testimony in this proceeding?

25 A52. Yes, it does.

26

EXHIBIT A4NR-2: ATTACHMENT 1
QUALIFICATIONS OF JOHN L. GEESMAN

1 John L. Geesman is an attorney with the Oakland law firm, Dickson Geesman LLP, and a member
2 in good standing of the California State Bar Association.

3 Mr. Geesman served as a member of the California Energy Commission from 2002 to 2008, and
4 was the agency's Executive Director from 1979 to 1983. Between his two tours at the Energy Commission,
5 Mr. Geesman spent nineteen years as an investment banker focused on the U.S. bond markets and served
6 as a financial advisor to municipal electric utilities throughout the West.

7 Mr. Geesman has a long history of providing leadership on issues related to resource planning,
8 environmental policy, financial management, and risk practices. This is demonstrated by his service in
9 numerous executive capacities, including stints as:

- 10 • Co-Chair of the American Council on Renewable Energy;
- 11 • Chairman of the California Power Exchange;
- 12 • President of the Board of Directors of The Utility Reform Network (nee Toward Utility Rate
13 Normalization);
- 14 • Member of the Governing Board of the California Independent System Operator; and,
- 15 • Chairman of the California Managed Risk Medical Insurance Board.

16
17 Mr. Geesman has previously testified as an expert witness before the California Public Utilities
18 Commission.

19 Mr. Geesman is a graduate of Yale College and the University of California Berkeley School of
20 Law.

21

ATTACHMENT 2
PG&E RESPONSE TO DATA REQUEST A4NR 7.1

DCPP NON-EMERGENCY CURTAILMENT SCHEDULING GUIDELINES BASIS DOCUMENT
(with redactions by PG&E)

1

Memorandum

Date: September 29, 2014

To: SENIOR VICE PRESIDENT - ENERGY PROCUREMENT
VICE PRESIDENT - ENERGY SUPPLY MANAGEMENT
VICE PRESIDENT - TRANSMISSION OPERATIONS

From: SITE VICE PRESIDENT – DIABLO CANYON POWER PLANT

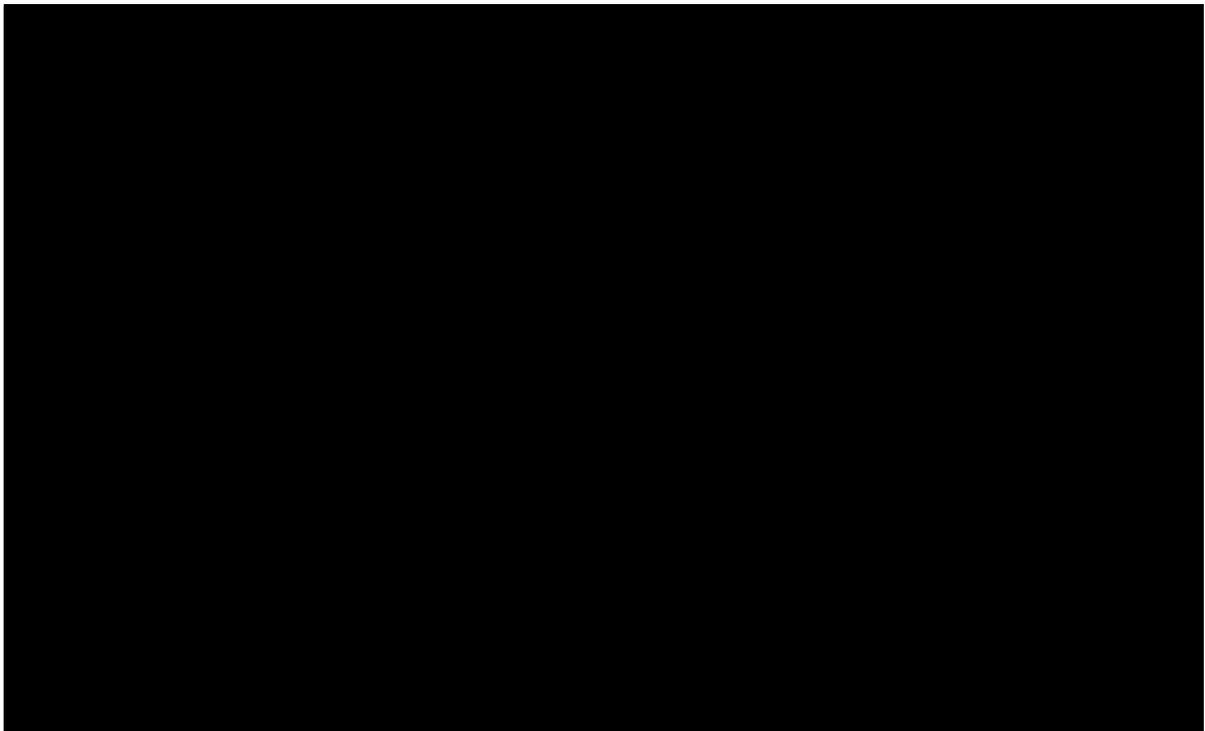
Subject: Diablo Canyon Power Plant Scheduling Guidelines



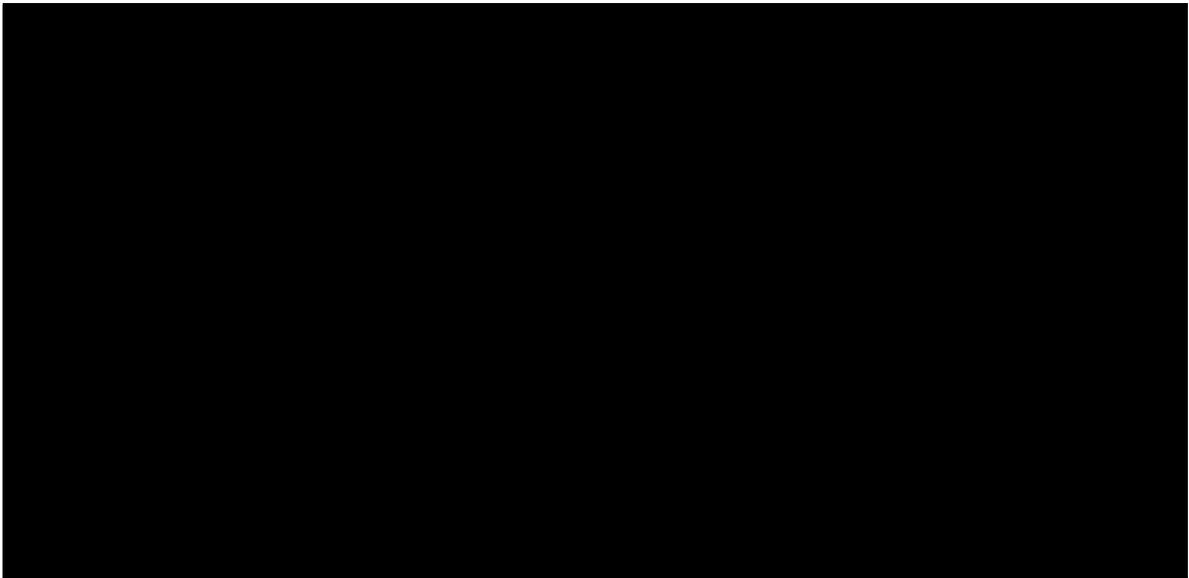
***Pacific Gas and
Electric Company***

FONG WAN
ROY M. KUGA
GREGG LEMLER

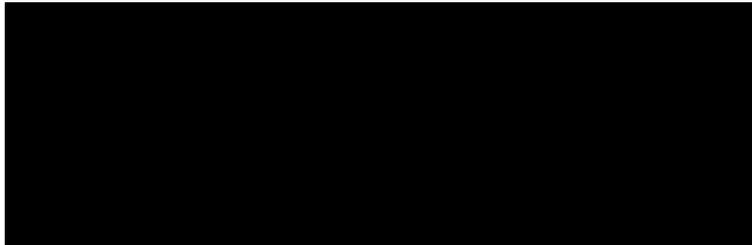
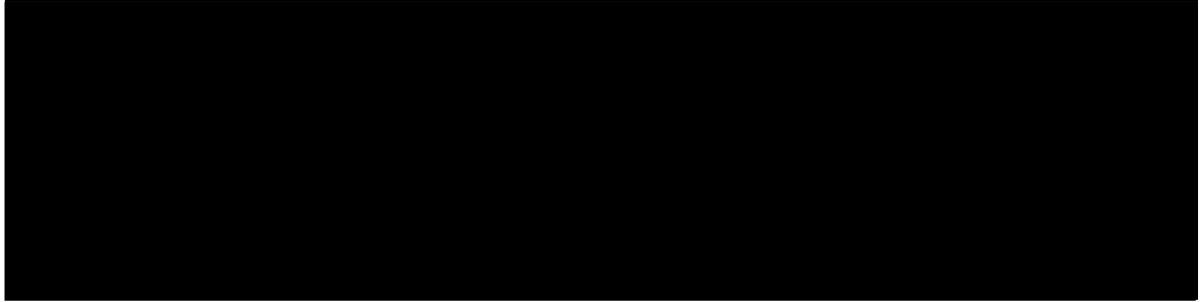
This supersedes Diablo Canyon Power Plant (DCPP) memorandum dated March 1, 2013, regarding the DCPP backdown capability. DCPP will notify the Senior Vice President, Energy Procurement, the Vice President, Energy Supply Management, and the Vice President, Transmission Operations of any changes in DCPP operating conditions affecting DCPP backdown capability. If any changes unexpectedly occur during non-business hours, the DCPP Shift Manager (SM) will notify the Grid Control Center (GCC) via tie-line and Energy Trading (ET) at Company number 8.223.5789.



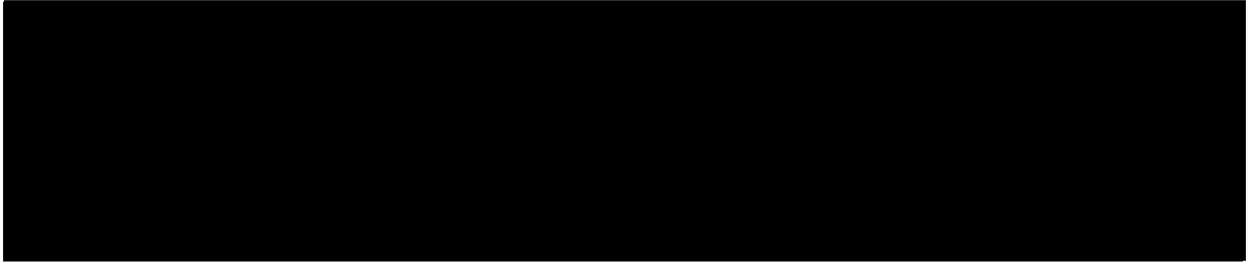
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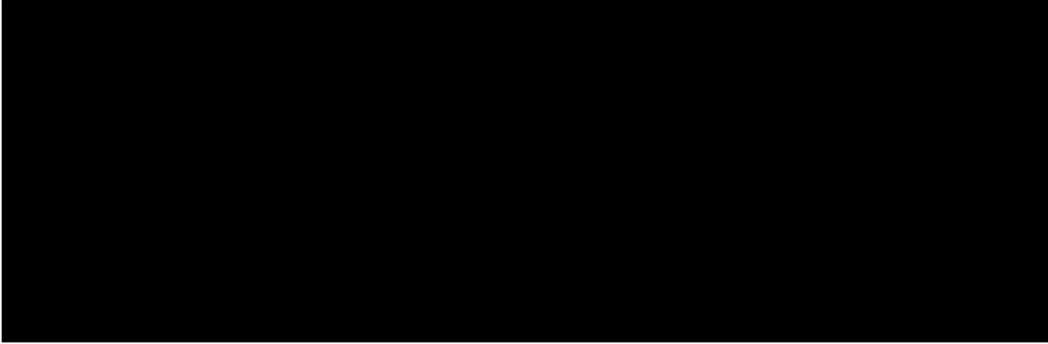
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DCPP NON-EMERGENCY CURTAILMENT SCHEDULING GUIDELINES BASIS DOCUMENT

Several parameters govern the ability of Diablo Canyon Power Plant, a Westinghouse pressurized water reactor (PWR), to reduce power in non-emergency conditions, including: (1) regulations and guidance of the Nuclear Regulatory Commission (NRC); (2) vendor (Westinghouse) recommendations and guidance regarding use of its equipment; (3) recommendations and guidance of the Institute of Nuclear Power Operations (INPO); (4) the chemistry/science of nuclear operations; and (5) operational safety-based limitations and considerations. Each of these parameters supports the plant's safe, efficient and cost-effective operation.

NRC regulations and guidance and INPO and Westinghouse recommendations and guidance govern the total amount of output DCPP can reduce per fuel cycle and how much notice DCPP needs prior to reducing output. The chemistry/science of nuclear operations governs how long it takes to reduce output, the optimal duration of curtailment, how long it takes to come back up to full power, and how often and when it is feasible to curtail power output. Operational and safety-based limitations and considerations govern decisions to be made at the time DCPP receives a request from Short Term Energy Supply (STES) to curtail DCPP.

PG&E has evaluated whether other, similarly-designed nuclear power plants operating in the United States operate in load-following mode. PG&E learned that there are no other PWR plants in the United States that operate in this manner. Columbia Generating Station (CGS), a boiling water reactor (BWR) is the only nuclear plant in the United States that regularly follows load. In doing so, CGS follows similar parameters and imposes similar requirements on non-emergency power curtailment as those PG&E implements through the Diablo Canyon Power Plant Scheduling Guidelines supported by this document. Benchmarking information is summarized at the end of this basis document.

[REDACTED]

[REDACTED]

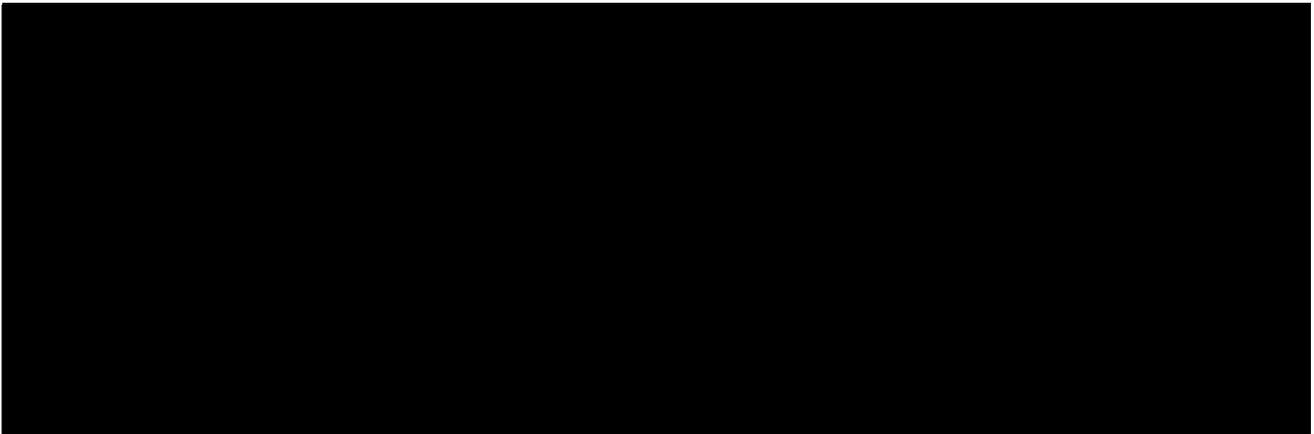
[REDACTED]

[REDACTED]

[REDACTED]

A nuclear power plant may only operate in analyzed conditions. In June of 2006, Westinghouse notified licensees of their Nuclear Steam Supply Systems (NSSS) (InfoGram IG 06-03) that the Loss of Coolant Accident (LOCA) blowdown loads analyses have always been performed only at full power initial conditions. This decision by Westinghouse to perform these analyses only at full power was based on the following:

- The industry practice of performing LOCA blowdown loads analyses only for full power initial conditions is based on the assumption that plants would operate at full power most of the time.
- The probability of a large break LOCA at zero power is reasonably expected to be lower than that at full power for the Westinghouse plant fleets as a result of less challenging plant conditions at zero power and the shorter amount of time spent at zero power compared to full power.
- Definitive regulatory guidance regarding initial conditions for LOCA blowdown loads analyses does not appear to exist.
- The Nuclear Regulatory Commission (NRC) has not explicitly required performing LOCA blowdown loads analyses at reduced power levels.
- In Generic Letter GL-84-21, "Long Term Low Power Operation in Pressurized Water Reactors" (October 16, 1984), the NRC expressed concern about the effects of extended reduced power operation on core physics parameters. Although the Generic Letter does not specifically address LOCA blowdown loads analyses, it indicates NRC concern about extended operation outside analyzed conditions.
- Performing LOCA blowdown loads analyses at full power initial conditions is consistent with the assumptions required by 10 CFR 50.46 for analyzing the LOCA that produces the highest peak cladding temperatures and oxidation percentages.



The NRC and INPO have established performance metrics that strongly encourage operation at full power. These metrics support nuclear safety by minimizing the potential for initiating events that might challenge nuclear safety. The NRC's regulatory oversight process for inspection, assessment and enforcement of commercial nuclear power reactors utilizes performance indicators, including Unplanned Power Changes per 7,000 Critical Hours. This indicator monitors unplanned power changes that could challenge safety functions of the plant.

[REDACTED]

This indicator supports NRC Safety Cornerstone #1,

Initiating Events.

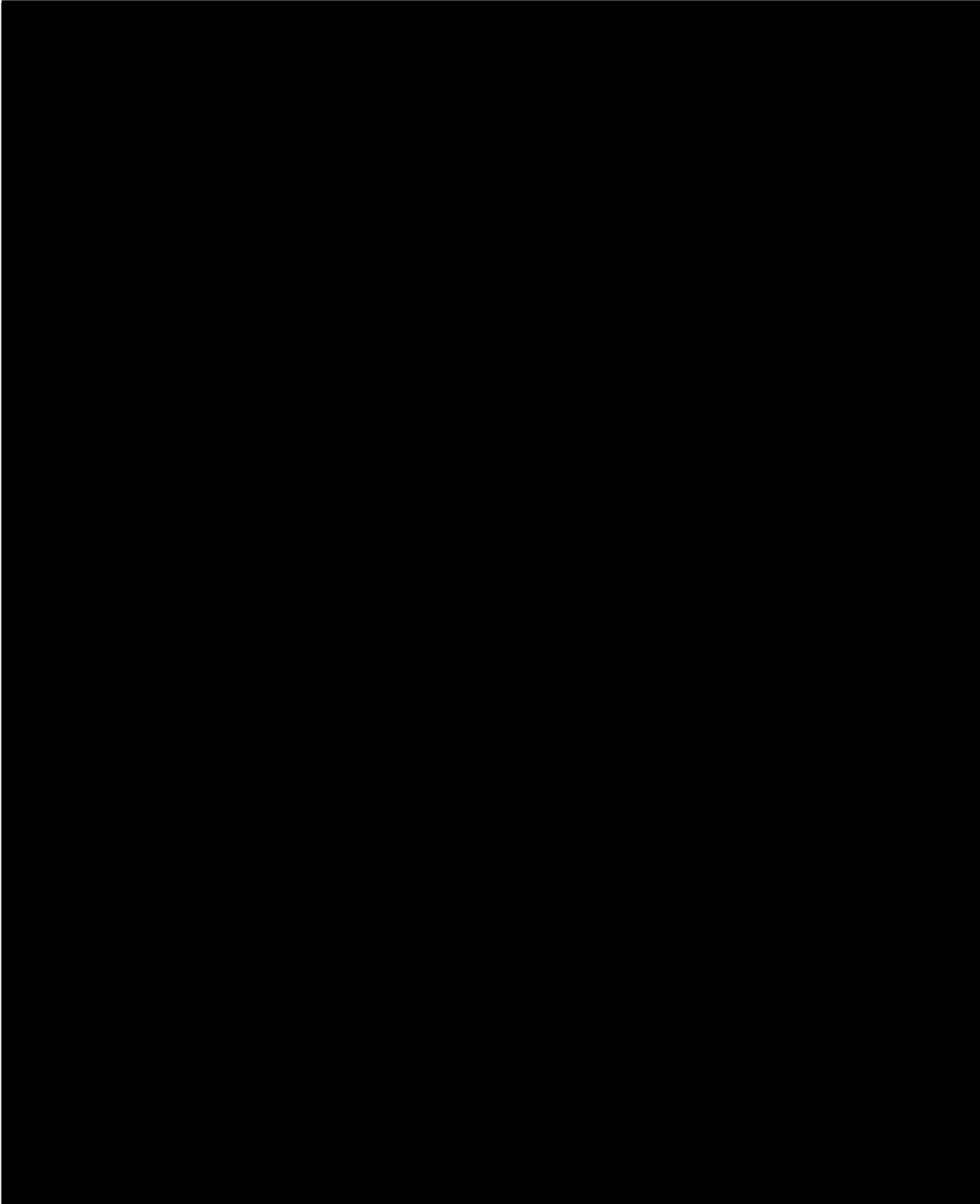
INPO evaluates, monitors, and sets agreed upon standards for all U.S. nuclear power plants. INPO's evaluation of plants includes metrics on performance. INPO performance metrics include:

Forced Loss Events - The number of forced power reduction events > 20% not scheduled or planned > 10 days prior to the event. PG&E has received feedback from INPO that if a power reduction was ordered by the system operator, it will not be accounted for as a forced loss event.

Unit Capacity Factor - The ratio of available energy generation over a given period to the reference energy generation over that period.

Unplanned power changes per 7000 Critical Hours (IE05) - The objective of this cornerstone is to limit the frequency of those events that upset plant stability and challenge critical safety functions.

Number of unplanned power changes - The number of unplanned power changes that are initiated less than 72 hours following the discovery of an off-normal condition and that result in or require a change in power level.



An additional factor [REDACTED] is the efficient management of nuclear fuel. The number of effective full power days the unit is expected to complete during the upcoming operating cycle is an important factor in reactor core design. The statistic of concern here is the energy removed from the core during the cycle. If the reactor does not produce a predetermined amount of energy (i.e., does not achieve a specific burn-up), the design of the subsequent core is affected. If the energy difference is small, the task is to reanalyze the proposed design and demonstrate that the new core design would still be acceptable. A large energy difference can potentially require a physical core redesign and substantially delay restart of the unit. It could require restarting with a fresh design, a complete new analysis, and (in the worst case) require a different initial enrichment and replacing the fabricated assemblies with other new assemblies. Also, if the core is designed to operate at full power for the cycle but operates at reduced power for a significant duration, the unburned nuclear fuel energy will be wasted. This loss is unavoidable due to the fixed refueling outage dates, which are laid out years in advance. Operation contrary to the core design results in unused energy being placed in the spent fuel pool and eventually dry cask storage.

B. OPERATIONAL/CHEMISTRY BASIS

The power output of a nuclear reactor is adjusted by controlling how many neutrons are able to create more fissions. Control rods made of a neutron poison are used to absorb neutrons. Absorbing more neutrons in a control rod means that there are fewer neutrons available to cause fission, so pushing the control rod deeper into the reactor will reduce its power output, and extracting the control rod will increase it. At the first level of control in all nuclear reactors, a process of delayed neutron emission by a number of neutron-rich fission isotopes is an important physical process. These delayed neutrons account for about 0.65% of the total neutrons produced in fission, with the remainder (termed "prompt neutrons") released immediately upon fission. The fission products which produce delayed neutrons have half-lives for their decay by neutron

emission that range from milliseconds to as long as several minutes. Keeping the reactor in the zone of chain-reactivity where delayed neutrons are *necessary* to achieve a critical mass state, allows time for mechanical devices or human operators to have time to control a chain reaction in "real time"; otherwise the time between achievement of criticality and nuclear meltdown as a result of an exponential power surge from the normal nuclear chain reaction, would be too short to allow for intervention.

In some reactors, the coolant also acts as a neutron moderator. A moderator increases the power of the reactor by causing the fast neutrons that are released from fission to lose energy and become thermal neutrons. Thermal neutrons are more likely than fast neutrons to cause fission. If the coolant is a moderator, then temperature changes can affect the density of the coolant/moderator and therefore change power output. A higher temperature coolant would be less dense, and therefore a less effective moderator.

In other reactors the coolant acts as a poison by absorbing neutrons in the same way that the control rods do. In these reactors power output can be increased by heating the coolant, which makes it a less dense poison. Nuclear reactors generally have automatic and manual systems to scram the reactor in an emergency shutdown. These systems insert large amounts of poison (often boron in the form of boric acid) into the reactor to shut the fission reaction down if unsafe conditions are detected or anticipated.

Most types of reactors are sensitive to a process variously known as xenon poisoning, or the iodine pit. Xenon-135 produced in the fission process acts as a "neutron poison" that absorbs neutrons and therefore tends to shut the reactor down. Xenon-135 accumulation can be controlled by keeping power levels high enough to destroy it as fast as it is produced. Fission also produces iodine-135, which in turn decays (with a half-life of under seven hours) to new xenon-135. When the reactor is shut down, iodine-135 continues to decay to xenon-135, making restarting the reactor more difficult for a day or two. This temporary state is the "iodine pit." If

the reactor has sufficient extra reactivity capacity, it can be restarted. As the extra xenon-135 is transmuted to xenon-136 which is not a neutron poison, within a few hours the reactor experiences a "xenon burnoff (power) transient". Control rods must be further inserted to replace the neutron absorption of the lost xenon-135.



Late in core life, boric acid, the neutron poison used to control the reactor, has become diluted. The boric acid changes required during power changes can challenge the ability of the installed equipment to dilute the boric acid concentration. A typical power reduction will require adding boron to start the ramp downward. As xenon concentrations start to increase in the down power, the boric acid concentration can be held reasonably constant. Once power starts to stabilize at the lower power level, a dilution will be required to stop the power change and to compensate for the increase in xenon concentration. As the xenon concentration peaks and starts to drop, the dilution will stop and boration will be required to compensate for the decreasing xenon concentration. This process is reversed for increases in power.

The amount of water required to reduce boric acid concentrations in the reactor coolant system is a function of the initial boric acid concentration. When the boric acid concentration is high (beginning and middle of fuel cycle), boric acid concentration changes are straightforward and readily achievable. At the low boric acid concentrations typical of late cycle, large amounts of water are required to reduce boric acid concentration. A power ramp can require dilutions in excess of 10,000 gallons of water. This requires that any power changes associated with reducing boron concentrations (associated with increasing xenon concentrations) be conducted at

a rate that the chemical processing capability of the plant can sustain. As an example, a recent contingency ramp to reduce Unit 1 power late in core life predicted that the reduction would have required approximately 14,000 gallons of water to reduce and stabilize reactor power at 80%. A return to full power would likely have required an additional similar quantity of water.

Radioactive waste water must be processed and discharged into the ocean. Large radioactive waste volumes due to end-of-life power changes could overwhelm plant water treatment capacity if performed on multiple consecutive days. The plant also needs to consider other routine and periodic sources that contribute to the liquid radioactive waste holdup tanks. Increasing the volume of liquid radioactive waste will decrease the available capacity for gaseous radioactive waste. Also, increasing the throughput to the system will decrease the holdup (decay) time, and therefore increase the curies of activity disposed of or discharged. If failed fuel is present, thermal cycling of the fuel can increase the damage, thus aggravating the leak.

Following a refueling outage, the nuclear fuel core must be conditioned in accordance with vendor recommendations. A substantial portion of the core has been replaced with new, unconditioned fuel, and the remainder of the core (the fuel on its second or third burn) has been moved to locations with different power distributions. Thus, the fuel in the core needs to be conditioned for operation in the new core, new set points established and other operating parameters for normal power operation established.

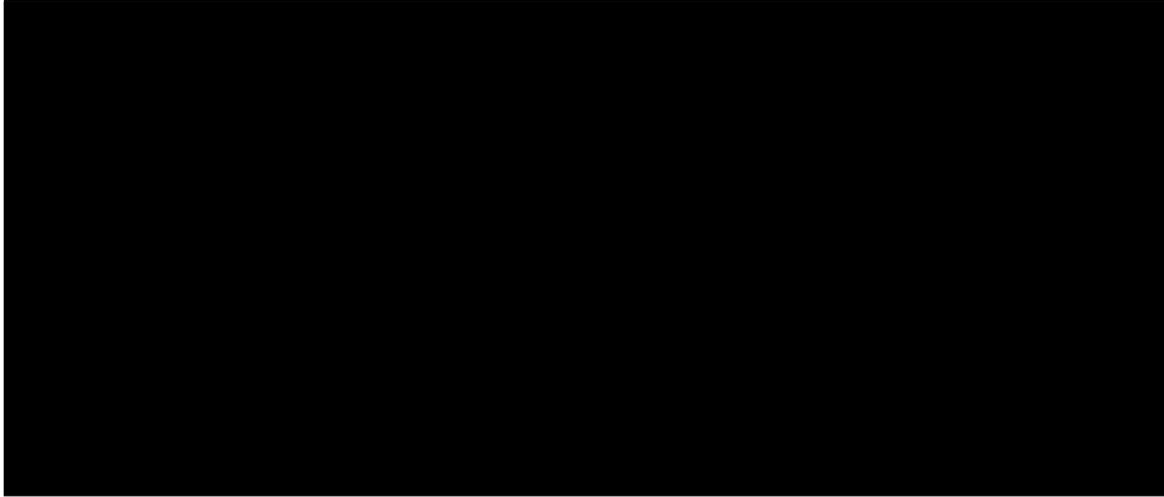
This limit prevents damage to the fuel due to

physical stresses from thermal growth and associated conditioning of the fuel. [REDACTED]

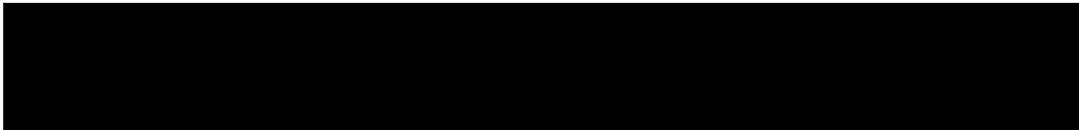
3. Backdown Duration Varies with the Amount of Power Reduction

Xenon is a fission product poison produced during and immediately following operation of a critical core. The amount of xenon in the core is controlled while the reactor is critical and at a stable power level. When the reactor power decreases, xenon concentration will change and adjust to a new equilibrium value (rises and then drops to a new lower value). [REDACTED]

[REDACTED] During ramp up, the opposite effect (xenon concentration drops and then builds up) occurs. To compensate for the effects of xenon concentration changes, operators are required to change the boron concentration in the reactor coolant system in conjunction with moving control rods. Large power changes result in potentially large xenon oscillation, which can translate into large and undesirable power distribution oscillations. The effects of these xenon oscillations should be evaluated in advance to assess the impacts of the power change on power distribution and to plan for the required reactivity manipulations to ensure that the reactor continues to operate within analyzed limits.



As described in section 3, when reactor power is changed, core physics and parameters change and can potentially result in an unstable power oscillation.



Chemistry-related work associated with non-emergency power reductions is the same, regardless of the number of MW reduced. Current core design limits control rod movement for reactivity control. As such, curtailing load in non-emergency conditions will require frequent Reactor Coolant System (RCS) boration and dilution. These adjustments will impact chemistry parameters, including boric acid required for reactivity control, and chemistry control parameters, including lithium hydroxide and dissolved hydrogen, in addition to other important diagnostic parameters. Changes in power and flow through the core will increase corrosion product transport and activation, leading to increased coolant activity and potentially to increased

plant radiation fields and personnel exposure. Increased Chemical and Volume Control System (CVCS) cleanup flow for the purpose of reducing RCS corrosion products will contribute to increased filter changes and activity loading on CVCS demineralizer resin. Nitrogen blanked boric acid storage tanks (BAST) and primary water storage tanks (PWST) will increase nitrogen feed to the RCS and increase RCS non-condensable gases, leading to a decrease in the hydrogen concentration and requiring increased Pressurizer venting and Volume Control Tank (VCT) degassing, all of which increases gaseous radwaste. Each boration and dilution event will divert flow to the Liquid Hold Up Tanks (LHUT) and decrease the LHUTs' freeboard, decreasing gaseous radwaste storage capacity. The increased liquid volume routed to the LHUTs also will increase resin and filter consumption (to treat the liquid before discharge), which in turn potentially increases radioactive effluents to the environment due to decreased decay time from challenging the systems' installed capacity.

Changes to the secondary system will impact feedwater iron concentrations and Condensate Polisher (CP) operation and regeneration. Chemical feed will need to be more frequently adjusted to maintain secondary chemistry within specification. Furthermore, changes in secondary flow and temperatures have the potential to impact flow-accelerated corrosion (FAC) in locations not previously observed when operating continuously at 100% power.

Each of the following tasks must be performed to effectively and safely manage and control DCPP operation at less than full power.

(a) Primary Systems

- Boration of the Reactor Cooling System (RCS) by adding boric acid for reactivity control; dilution of boron from the RCS by adding primary water for reactivity control.
 - Sample/analyze RCS for boron with each boration and dilution
 - Increased boric acid usage
 - Sample/analyze the BASTs with increased boric acid usage

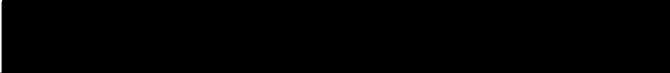
- Increased primary water usage
- Increased lithium hydroxide feed to the RCS (for pH control) with borations and dilution
 - Sample/analyze the RCS for lithium hydroxide with each boration and dilution
 - Increased lithium hydroxide usage
- Increased monitoring of RCS dissolved hydrogen due to borations and dilution
 - Increased hydrogen gas usage
- Increased activated corrosion product generation in the RCS with changes in flow and chemistry
 - Potential for increased plant radiation fields and personnel radiation exposure
- Increased CVCS flow from 75 gpm to 120 gpm
 - Increased CVCS filter dose rates
 - Increased CVCS filter replacements
 - Increased personnel radiation exposure
 - Increased CVCS pumps run time; two pumps required to achieve 120 gpm
- Increased depleted zinc acetate feed to the RCS with borations and dilutions
 - Increased depleted zinc usage
- Increased argon-40 gas feed to the RCS with borations and dilutions
 - Decreased accuracy for detecting primary-to-secondary leakage, if present
- Increased volume of liquid generated due to borations and dilutions
 - Increased CVCS letdown demineralizer resin and CVCS evaporative feed resin usage
 - Decreased decay time for liquid and gaseous radwaste
 - Decreased gaseous radwaste system capacity
 - Challenge the capacity of liquid radwaste system discharge
 - Potential increase in radioactive effluents to the environment
- Increased Pressurizer venting and VCT degassing
 - Increased non-condensable gases in the system with borations and dilutions

- Increased gaseous radwaste volume generated from venting and degassing

(b) Secondary Systems

- Adjust the number of CP vessels in service based on power (e.g., 6-7 vessels at 100% power; 5-6 vessels at 82% power; 4-5 vessels at 50% power)
 - Revise CP regeneration frequency
 - Increased iron transport may impact CP regenerations
 - Increased resin regenerations (chemical usage) or resin replacement is possible
 - Adjust hydrazine and ethanolamine chemical feed rate based on power
 - Adjust air injection for oxygen control and increased monitoring

Given all of the tasks involved and impacts of performing these tasks (all of which are subject to human performance), it is not reasonable from the perspective of safe and efficient operations to undertake the effort required to reduce power by a nominal amount. 

When reactor power is changed more than 15% in an hour, DCPP's license requires additional chemistry sampling for radioiodine be taken and evaluated. When fuel defects are present, additional sampling may be required. 

C. U.S. BENCHMARK INFORMATION

1. United States Nuclear Power Plants

PG&E contacted INPO to identify U.S. nuclear plants that could be benchmarked concerning reduced power operations. INPO advised that Columbia Generating Station (GS) in

Washington is the only nuclear plant in the U.S. conducting any type of load following. PG&E contacted the Columbia GS operations manager during the week of December 10, 2012 and learned the following:

- Columbia GS load follows in the spring and summer due to hydro abundance.
- Columbia GS is a Boiling Water Reactor (BWR) with a net output of approximately 1180 MW.
- When dispatched to load follow, the unit curtails between 10 and 15% of rated output (up to approximately 180 MW).
- The change in power stays below the NRC Unplanned Power Change and the INPO Forced Loss Event 20% triggers.
- When changing power, no ramp plan is provided. This is due to the relatively “small” change in power.
- Curtailment durations average about three days. Nominal notice prior to initiating the power change is 24 - 48 hours.
- Core design does not plan for these curtailments. The resulting unburned fuel is moved to the Spent Fuel Pool and eventually to dry cask storage. This impacts capacity factor less than 10% per cycle.
- Columbia GS is dispatched and owned by the same entity, Bonneville Power Administration.
- Because there is no reactor temperature change with these small power reductions, no LOCA load issue similar to that experienced by Pressurized Water Reactors (PWR) arises. Refer to Westinghouse InfoGram 06-3.
- The Columbia GS operations manager was not aware of any other nuclear unit in the U.S. that follows load.
- BWR designs inherently allow reactor power changes more easily than PWR designs. Columbia GS is a BWR, while DCPP is a PWR.

2. AREVA- French Nuclear Power Plants

AREVA categorizes its nuclear power plants as either 'A mode' reactors, which are similar in design to DCPP, and gray mode reactors, which are designed more specifically to follow load. Once installed, this design feature cannot be altered due to Reactor Pressure Vessel head design and upper reactor vessel internal components.

According to AREVA personnel, the control modes depend upon the design of the rod cluster control assemblies (RCCAs). If the RCCAs are fabricated with a strong ("black") neutron absorber such as silver-indium-cadmium (AIC) (*DCPP RCCAs are AIC*) or boron carbide (B4C), then operating the reactor with the RCCAs inserted into the core for long periods may cause adverse burn-up effects on the adjacent fuel rods ("shadowing"). If the control rods are later withdrawn, the shadowed fuel will undergo an unacceptably large increase in power peaking factors, or local linear heat generation rates. Therefore, plants that operate with RCCAs that use AIC or B4C absorber have to follow load using the A Mode methods in which the control rods are not allowed to be inserted for long periods. Since the control rods cannot be inserted very far into the core for long periods, load follow maneuvers have to rely more heavily on changes in the reactor coolant boron concentration to control the transient xenon reactivity. Although it is possible to conduct load follow operations using A Mode methods, feed and bleed volumes would have to be managed. The plant design is more suited for long periods of base load operation than for frequent or extensive load following.

However, if some of the RCCAs are fabricated with a weaker neutron absorber material such as Inconel ("gray" rods), then the core can operate with the control rods inserted for longer periods because the shadowing effect is reduced. Then the plant can be operated using the G Mode ("gray" mode) methods. To operate in G Mode, the control rods may have to be re-patched so that they are configured and controlled in groups or banks that are different from the typical patching that would be used for A Mode operation. The advantage of operating with the

gray RCCAs is that the control rods can be used more extensively to control *both* the thermal power and xenon reactivity changes, with a significant reduction in feed and bleed volumes.