

Replies to Comments from Mr. Bruce Severance dated 15 April 2024

prepared by Mark Kirk for the DCISC · 22 May 2024

Overview

Following issuance of evaluations performed for the DCISC of public concerns regarding Diablo Canyon Unit 1 [Part 1 Report] and of PG&E's embrittlement forecasts for that plant [Part 2 Report], the DCISC invited members of the public to comment on those reports. This document provides my replies to comments provided by Mr. Bruce Severance to the DCISC in his document titled, "Is DCCP Unit 1 Reactor a 'Good Bet' for the People of California?" dated 15 April 2024. I have marked Mr. Severance's document:

_Severance Comments - 2024-04-15 - Marked for Reply.pdf

to highlight the specific comments to which I have replied in the remainder of this document. In many cases the comments are repetitive, although not exactly so. I have tried my best to cross-reference replies to minimize repetition. Also, I have, to the greatest extent possible, provided pointers to information in the Part 1 and Part 2 reports where this information helps to address the comments made by Mr. Severance. In a few cases figures and tables have been copied from the Part 2 report and incorporated into this document for clarity. Some of my replies may be repetitious, but I thought this approach better than allowing potentially significant public concerns to remain unanswered.

While none of the details of Mr. Severance's inter-connected concerns should be overlooked, his most frequently expressed concerns fall broadly into three categories:

- (A) Concerns regarding correct application of NRC procedures for embrittlement forecasting and assessment. This includes the following sub-topics:
 - a. The NRC's credibility criteria by which surveillance data is used to forecast future embrittlement,
 - b. The use of similar data from so-called "sister plants" to help inform future predictions of embrittlement for Diablo Canyon Unit 1,
 - c. The amount of data on which the Diablo Canyon Unit 1 forecast is based, and
 - d. The reasons why future embrittlement forecasts for Diablo Canyon Unit 1 have changed over time.
- (B) Concerns regarding deferrals of plans to test surveillance Capsule B and evaluate the impact of data obtained from that capsule on future embrittlement forecasts.

- (C) Concerns that the supplemental upper shelf energy (USE) analysis that appeared in Section 4.2 of the [Part 2 report] indicated that USE the limiting weld in the Diablo Canyon Unit 1 RPV could fall below the NRC's 68J USE screening criteria by 2029 or 2030.

In summary response:

- (A) Chapter 2 of the [Part 1 report] attempted to explain and clarify the NRC's procedures for embrittlement forecasting and assessment, addressing all of the topics listed under Category (A). Unfortunately, Mr. Severance's Category (A) concerns all arise due to a continued misunderstanding of the NRC's procedures. I have attempted to further clarify and explain the NRC's procedures and how PG&E's data collection, analyses, and embrittlement forecasts are compliant with these procedures, in the following pages.
- (B) Section 2.3 of the [Part 2 report] summarized the NRC's requirements for surveillance monitoring with a focus on the specific requirements for Diablo Canyon Unit 1. Mr. Severance's Category (B) comments claim to reveal a 2006 amendment to the operating license of Diablo Canyon Unit 1 that would have required testing of a fourth surveillance capsule (Capsule B) during the original 40-year license term. I have reviewed the 2006 document and determined that while the document does in fact discuss a license amendment and surveillance capsule testing, the amendment does not require testing of a fourth surveillance capsule (Capsule B) during the original 40-year license term. As summarized in Section 2.3 of the [Part 2 report], and as affirmed by the NRC in many documents, Diablo Canyon Unit 1 is a three-capsule plant for the original 40-year license term.
- (C) Mr. Severance's Category (C) comments are correct in noting that a supplemental (non-NRC required) analysis of USE that appeared in Section 4.2 of the [Part 2 report] determined that the USE of the limiting weld in the Diablo Canyon Unit 1 RPV could fall below the NRC's 68J USE screening criteria by 2029 or 2030. However, as also stated elsewhere in that report, because the analysis was neither required nor endorsed by the NRC the outcome of the analysis has no impact on the licensing basis of the Diablo Canyon Unit 1 nuclear power plant. Also, an equivalent margins analysis following Regulatory Guide 1.161 could be performed to address any USE concerns. Equivalent margins analyses performed on other reactors have, without exception, demonstrated that continued operation at USE values considerably below 68J is acceptable. The uniformity of this result across all plants and embrittlement conditions speaks to the conservatism of the 68J screening criteria.

In summary, none of the concerns expressed by Mr. Severance change any of the conclusions with respect to Diablo Canyon Unit 1 as expressed in the [Part 1 report] and [Part 2 report]. I still conclude that embrittlement predictions made by PG&E for Unit 1 are accurate and compliant with NRC procedures, including the characterization of credibility of the Charpy impact toughness transition temperature shift (ΔT_{41J}) data throughout Unit 1's operation. Based on data currently available, Unit 1 is not forecast to exceed the

NRC’s PTS screening criteria or the NRC’s 68J screening criteria on Charpy USE until sometime after 60-years of operation. Also, the several deferrals of Capsule B testing, which was originally planned for 2009, were all acceptable because Diablo Canyon was required to test only three capsules during its original 40-year license, a requirement fulfilled in 2003.

The following pages provide my detailed replies to the various comments arising in Mr. Severance’s document provided to the DCISC on 15 April 2024.

Page 1, Item A

Comment “The pre-2004 test data and PG&E’s own 2006 calculations indicate this embrittlement will be reaching the Federal Code of Regulation “screening limits” [on pressurized thermal shock as expressed in 10 CFR 50.61]¹ by 2025 (also confirmed by NRC in 2006)”

Reply The statement that, based on data available before 2004, Diablo Canyon Unit 1 was forecast to exceed the PTS screening criteria in 2025 is incorrect. This information does not agree with that submitted by PG&E as part of its 2009 license renewal application [Diablo2009 LRA], which was based on the pre-2004 surveillance capsule data from Diablo Canyon Unit 1 cited in this comment. [Diablo2009 LRA] provided the following information.

Maximum ID Fluence at 32 EFPY (40 operating years)	$1.26 \times 10^{19} \text{ n/cm}^2$	Table 4.2-1
Maximum ID Fluence at 54 EFPY (60 operating years)	$2.06 \times 10^{19} \text{ n/cm}^2$	Table 4.2-1
RT _{PTS} value for weld wire heat 27204, Lower shell longitudinal weld 3-442C, at 54 EFPY	280.4 °F (138 °C)	Table 4.2-4

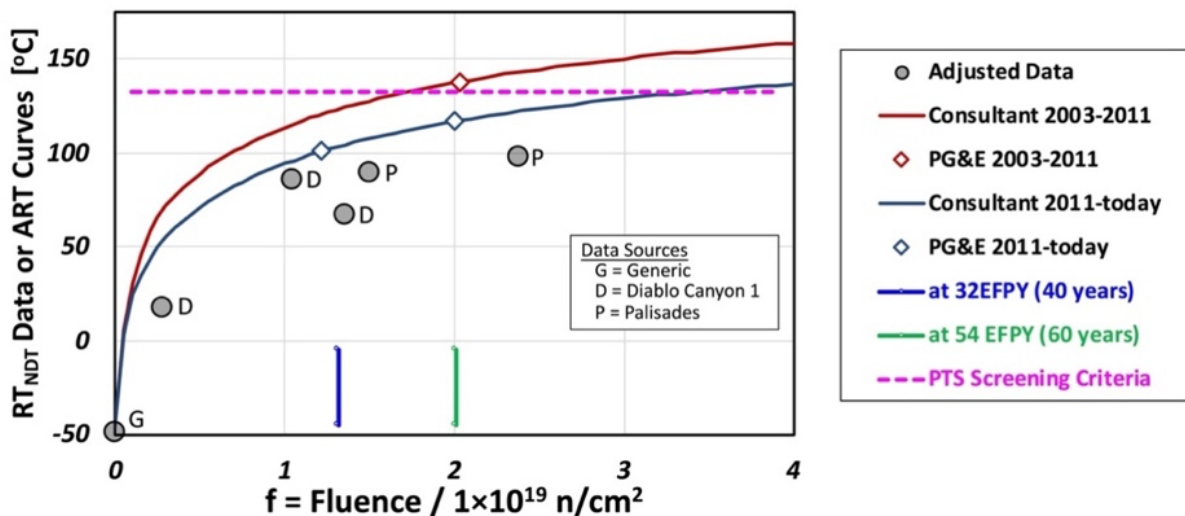
Figure 4 of the Part 2 report, which is copied below for convenience, validated this RT_{PTS} estimate to within 1 °C. The dark red curve on Figure 4 shows this estimate of RT_{PTS} to be below the PTS screening criteria (270 ° F or 132.2 °C) at the 32 EFPY fluence but above the screening criteria at the 54 EFPY fluence. The information from Figure 4 was used to determine that, using only information available before 2009, the PTS screening criteria was then forecast to be exceeded at a fluence of $1.8 \times 10^{19} \text{ n/cm}^2$, which would occur at approximately 46 EFPY. However, in 2025 refueling outage Diablo Canyon Unit 1 is currently forecast to reach 35.2 EFPY. Thus, the statement

¹ In this document sections labeled “Comment” are a direct quotation from the 15 April 2024 document provide by Mr. Severance. Text appearing in square brackets has sometimes been added for clarity. Text within the square brackets is not a direct quotation.

in the comment that, based on data available before 2004, Diablo Canyon Unit 1 was forecast to exceed the PTS screening criteria in 2025 is incorrect.

It should also be pointed out that the 2006 RT_{PTS} estimates cited by this comment are no longer current. Since 2011 additional information on the limiting weld (weld wire heat 27204) has been available in the form of two ΔT_{41J} measurements made by the Diablo Canyon's "sister plant" Palisades [WCAP-17315]. When incorporated into the PTS analysis, as required by the NRC, those data demonstrate that Diablo Canyon Unit 1 will not exceed the 10 CFR 50.61 screening criteria until long after 60 years of operation (see blue curve on the Part 2 report, Figure 4, which is copied below). The Part 2 report validated the [WCAP-17315] evaluation Diablo Canyon Unit 1 surveillance data as augmented by the sister plant data from Palisades (also see the figure).

Finally, it should be noted that while [WCAP-17315] was completed by Westinghouse and delivered to PG&E in 2011, PG&E did not place this information on the NRC docket until 2023 when they submitted an updated license renewal application [DCL-23-038]. I cannot speak to the reason, but it may be noted that the added plant lifetime demonstrated by the [WCAP-17315] calculations was not needed by PG&E until the decision in 2022 to again pursue license renewal.



Part 2 Report, Figure 4. Comparison of consultant's ART estimates (curves) with those of PG&E (diamonds) for the timeframe 2003-2011 [Diablo LRA 2009] and 2011-today [WCAP-17315]. The NRC's required process for adjusting data is described in the Part 1 report, Section 2.4.2.2.

Page 2, Item B

Comment “The critical question is whether NRC procedures were in fact followed in the process of reanalyzing the DCP-1 pre-2004 stress test data, and whether the Kirk Report accurately represents the current state of Unit 1 embrittlement and confirms the Westinghouse assessment based on accurate interpretation of NRC procedure. I cannot claim to have all the answers, but there are serious questions about how data from two severely embrittled plants can be combined and integrated mathematically to yield far more favorable projections than either subset of data would suggest.”

Reply Comments concerning the embrittlement of another plant, Palisades in this case, are not relevant to assessment of the embrittlement condition at Diablo Canyon Unit 1. The Diablo Canyon analysis has used, as is required by NRC, data from weld wire heat 27204 that was irradiated in a capsule installed at Palisades. While Diablo Canyon Unit 1 uses these data, the forecast degree of embrittlement at Palisades, which is controlled by data on a different weld wire heat (W5214), is of no consequence to Diablo Canyon Unit 1 [WCAP-17628].

Information presented in Chapter 3 of the Part 2 report provides extensive validation that, with one exception, PG&E’s calculations have correctly followed NRC procedures for all data states that have existed since the plant began operation. The exception (see Section 3.2.2 of the Part 2 report) was a minor error in the USE analysis reported in [WCAP-15958] and that error produced a 1 Joule under-estimate of USE. This error, which was in a conservative direction and was corrected in 2015, had no effect on the assessment as both values are above the NRC’s USE screening criteria of 50 ft-lb (68J).

This comment speculates about possible conclusions that may result if the Diablo Canyon Unit 1 surveillance data were analyzed separately from the Palisades sister plant data. However, analysis of data subsets is not permitted by the NRC’s procedures in [10CFR50.61]. As explained in Section 2.4.2.2 of the Part 1 report, if sister plant data is available it must be analyzed together with the surveillance data of the plant in question to forecast the future embrittlement state. This forecast is then compared to the PTS screening criteria set forth in [10CFR50.61]. Chapter 3 of the Part 2 report validates that such analyses have been correctly performed by PG&E.

Page 3, Item C

Comment “While PG&E was allowed to review and edit Dr. Kirk’s analysis, public advocates such as myself, were not afforded this privilege.”

Reply The comment that PG&E edited the analysis is false. PG&E was specifically asked to review the Part 1 and Part 2 reports only to confirm that the data used was factually correct.

The comment that public advocates were not afforded the privilege of review is also false. The DCISC made the Part 1 and Part 2 reports available to the public on 31 January (21 days prior to the DCISC’s public meeting held on 21 February 2024), and at the same time notified all parties on the DCISC’s distribution list that the reports were available. The DCISC also extended the time for the public to review and comments on the reports to April 15. The DCISC also made accommodations for Mr. Severance and Dr. Macdonald to provide sufficient time to comment.

Page 3, Item D

Comment “Dr. Kirk’s own independent analysis suggests Unit 1 will be approaching the maximum screening limits for embrittlement by 2029 (USE projection).”

Reply The analysis referred to was reported in Chapter 4 of the Part 2 report. As stated in the report while the techniques used evolve from currently accepted practices and in some cases are currently in codification review by ASME, none are currently endorsed or required by the NRC. Thus, the information presented in this chapter has no impact on the licensing basis of the Diablo Canyon Unit 1 nuclear power plant.

Please see the reply to Page 10, Item 10 below for a fully detailed reply to this comment.

Page 3, Item E

Comment “In my comment to the DCISC in February 2024, I pointed to a 2006 NRC document (Letter granting 37-month extension approval to Nov. 2024 in which PG&E has asserted and NRC confirmed that Unit 1 would be within 3% of maximum screening limits for embrittlement by Nov. 2024.”

Reply The 2006 calculations of RT_{PTS} based on surveillance data have since been superseded by more recent calculations that are based on additional data provided by the sister plant Palisades [WCAP-17315, DCL-23-038]. These

newer calculations form the current licensing basis for Diablo Canyon Unit 1, which demonstrate that the PTS screening limit will not be reached until well after 60 years of service.

Please see the reply on Page 9 Item 1 below for a fully detailed reply to this comment.

Page 3, Item F

Comment “Neither the Kirk nor Westinghouse Reports makes mention of the 2006 PG&E PTS Evaluation that accompanied the application for a 37-month license extension. The 2006 NRC document granting the extension clearly states that the 37-month extension granted by this document amends the surveillance program requiring a fourth capsule be tested by roughly 2009.”

Reply Despite the assertion of the commenter, the referenced letter [NRC 2006] does not amend the Diablo Canyon Unit 1 license to require an additional capsule test (Capsule B) be conducted by 2009. Capsule B testing was not a requirement during the initial 40-year license period.

Please see the reply to Page 9, Item 5 below for a fully detailed reply to this comment.

Page 4, Item G

Comment “PG&E and the NRC based their 2006 PTS analysis and embrittlement projections based upon the premise that the pre-2004 test data met the credibility requirements as stated in RG1.99 and the NRC’s independent assessment produced calculated results that were within less than 1% deviation from PG&E’s assessment. The extreme correlation between PG&E’s and the NRC’s independent results should be noted. Yet the 2006 NRC-PG&E projection that Unit 1 will reach embrittlement screening limits is not even mentioned in either the 2011 PTS Evaluation or by Dr. Kirk. This PTS analysis that only pre-dates the 2011 Westinghouse PTS Evaluation by five years, and it is not even mentioned as a reference as is customary in such reports to the NRC. The omission is notable and perhaps contrary to NRC procedures. Wichman’s 1998 clarification of GL92-01 (NRC PTS calculation procedures) clearly states:”

“..., licensees shall consider plant-specific information that could affect the level of embrittlement. This information includes but is not limited to the reactor vessel operating temperature and any related surveillance program5 results.”

Footnote 5 noted above states:

“Surveillance program results means any data that demonstrates the embrittlement trends for the limiting beltline material, including but not limited to data from test reactors or from surveillance programs at other plants with or without surveillance program integrated per 10 CFR Part 50, Appendix H.”.

Reply The 2006 analysis referred to in this comment appears in [DCL-06-045]. While I did not review this document while preparing the Part 1 and Part 2 reports, it merely repeats the PTS analysis of the time, providing no new information. The 2006 analysis could only be based on the data available at the time (that is: data from Diablo Canyon Unit 1 Capsules S, Y, and V). These same data were assessed as not-credible in both the Capsule V report in 2003 [WCAP-15958] and in the 2009 license renewal application [Diablo LRA 2009], both documents that I did review. These calculations were validated in Section 3.1 of the Part 2 report.

[DCL-06-045] gives a RT_{PTS} value for the limiting weld of 258.7 °F (125.9 °C) at a fluence of 1.43×10^{19} n/cm². This value compares with my calculations that appear as the dark red curve in the figure that on page 4 of this document. At a fluence of 1.43×10^{19} n/cm². The dark red curve has a RT_{PTS} value of 258.9 °F (126.1 °C), confirming the PG&E result from [DCL-06-045]. The close agreement noted here is as expected given that the calculation is algebraic and that both PG&E and I used the same input data.

Page 4-5, Item H

Comment “There are aspects of the Kirk Report which appear to me to be misleading. Kirk states: **“Currently available surveillance data pertinent to Diablo Canyon Unit 1 RPV have already quantified embrittlement at exposure levels that the [DCPP-1] RPV will not reach until after 60 years...indicating that the deferral of the withdrawal and testing of Capsule B has not compromised safety.”** The Palisades data to which Dr. Kirk refers to here did not give Entergy license to operate for 60 years and only gave them an extension to operate under the standard 50.61 regulations until 2017, or for about 5-6 years beyond their original 40-year license. In 2014, it was clear that Palisades could not comply under 50.61 rules beyond 2017 and that they applied for an extension to 2031 on the basis of 50.61a rules (which Dr. Kirk wrote for the NRC). Their embrittlement data failed to meet the test to comply in any other manner.”

Reply Comments related to licensing of the Palisades plant (Entergy was the operator of Palisades) are not pertinent to Diablo Canyon Unit 1. It is true the Diablo Canyon Unit 1 shares a “sister plant” status with Palisades because

they both used weld wire heat 27204 in the fabrication of their RPV. However, the weld wire heat 27204 in Palisades is a circumferential weld while it is an axial weld in Diablo Canyon Unit 1. Also, the weld wire heat 27204 data was not the limiting weld in the Palisades evaluation using the alternate PTS rule and as such did not influence its licensable life. In Palisades axial welds made from weld wire heat W5214 were limiting [WCAP-17628].

The **quotation above (highlight added)** taken from the Executive Summary of the Part 1 report was not a comment related to plant licensing. The quotation summarizes available evidence pertinent to Diablo Canyon Unit 1, which includes both the plant's own surveillance data as well as the Palisades sister plant data. These data provide information on embrittlement to a fluence that exceeds the projected 54 EFPY (60 year) fluence for Diablo Canyon Unit 1 (see the figure on page 4 of this document).

Page 5, Item I

Comment “The fact that Dr. Kirk makes representations that the Palisades “sister plant” data has assured their safe operation for the 60-year operation period is inaccurate. That plant can only qualify under the alternative rules and Dr. Kirk was the primary reviewer of the Palisades 50.61a license application in 2014. He is well aware that Palisades is severely embrittled and that the Palisades operating conditions are entirely different from DCCP-1, and that it was operating under the alternative rules from 2017 until it closed in 2022. If the reference is to the 2011 Westinghouse PTS Evaluation for DCCP-1, that report was never submitted to the NRC until December of 2023 and the analysis is still under review by the NRC. Neither interpretation is a justification for delaying withdrawal and testing of Capsule B.”

Reply As stated in my reply to Page 4-5, Item H above, the operating and embrittlement status as well as the licensing of the Palisades nuclear plant in Michigan have no bearing on Diablo Canyon Unit 1. The only nexus between Palisades and Diablo Canyon Unit 1 is that data on weld wire heat 27204 was available from the Palisades surveillance program. However, as stated in my reply to Page 4-5, Item H, this weld wire heat was not limiting in Palisades and, as such, played no role in that plant's decision to comply with the NRC's PTS requirements via use of the alternative rule [10CFR50.61a].

As stated in Section 2.3.1 of the Part 2 report, the multiple deferrals of Capsule B withdrawal and testing have been appropriately requested by PG&E and granted by the NRC because Diablo Canyon Unit 1 was required to test only three capsules as part of its original 40-year license, a requirement

fulfilled by 2003. Testing of a fourth capsule (Capsule B) was not required for any purpose during the 40-year initial license period.

The PTS analysis of [WCAP-17315] has no bearing on the capsule withdrawal schedule, so it is unclear why this report is mentioned in the context of the planned Capsule B withdrawal. My reply to the Page 1 Item A above discusses a possible reason for PG&E's delay in placing [WCAP-17315] on the NRC's docket after they received the report from Westinghouse in 2011.

Page 5, Item J

Comment "While Dr. Kirk's report seems to repeatedly reassure that "conservatisms" are incorporated into the Westinghouse PTS Evaluation, it appears the opposite is the case."

Reply Statements I made in the reports concerning the conservatism of the RPV assessment process go beyond analysis procedures for surveillance data. For example, in RPV safety analyses flaws are consistently over-size, loads are consistently over-estimated, and fracture toughness is consistently under-estimated.

Please see my reply to Page 10, Item 8 below for a fully detailed reply to this comment.

Page 5, Item K

Comment "It is simply remarkable and somewhat implausible that by combining the test data from these two severely embrittled "sister plants", a new mathematical projection is achieved that shows both plants having substantially lower embrittlement (as much as a 64% shift in the data as compared with prior reports)."

Reply The analyses performed by PG&E do not address "both" plants (meaning Diablo Canyon Unit 1 and Palisades); PG&E analyses address only Diablo Canyon Unit 1. The 2011 analysis [WCAP-17315] updates previous analyses to consider data from two capsules tested as part of the Palisades surveillance program on weld wire heat 27204. Section 3.1 of the Part 2 report validates that PG&E's analysis of its surveillance data, including its treatment of sister plant data, has been correctly performed. Use of sister plant data from 2011 onwards is not a "new mathematical projection;" rather it uses the NRC's established procedure (same mathematics) with consideration of new data from the sister plant that was unavailable before 2011.

Use of the adjective “severely” does not clearly communicate that both plants nevertheless meet (or met in the case of Palisades) the NRC’s PTS screening criteria. Diablo Canyon Unit 1 and Palisades both experience neutron irradiation embrittlement. Because their welds have a relatively high copper content the magnitude of this embrittlement is higher than in other plants, but the NRC’s criteria have always been met by both plants.

Page 5, Item L

Comment “Where the prior hard test data and the 2006 PTS analysis revealed that the DCCP-1 reactor materials demonstrate a propensity toward brittle fracture characteristics in lab tests, the new math lowers the value of ‘chemistry factors’ (CF) that account for the embrittled material properties.”

Reply Differences between 2006 and later PTS analyses is not the use of “new math” but, rather the result of the availability of additional data on weld wire heat 27204. Taking account of these new data using the NRC’s required analysis procedures provides an improved estimate of the current and future embrittlement behavior of weld wire heat 27204. The updated estimate showed that these new data reduced the embrittlement estimate slightly (reduced the chemistry factor); however, this reduction in chemistry factor was not a foregone conclusion. Whenever additional data is incorporated, the resulting estimate could either reduce or increase the chemistry factor.

Before 2006 the only data available for the Diablo Canyon Unit 1 weld wire heat 27204 came from the plant’s own surveillance program. At that time PG&E estimated the chemistry factor and margin term following the NRC’s guidance, which is described in Section 2.4.2 of the Part 1 report. Since 2011, these data were supplemented by the sister plant data from Palisades. Again, the chemistry factor and margin term was estimated following the NRC’s guidance, which is described in Section 2.4.2 of the Part 1 report. In both cases the equations used, the data treatment, and the procedure follows the NRC’s guidance exercised on different data sets. In section 3.1 of the Part 2 report, I have validated that PG&E has made these calculations correctly. Table 6 of the Part 2 report, which is repeated below for convenience, shows that following these procedures both the chemistry factor and the margin term are reduced when the sister plant data is considered.

Part 2 Report, Table 6. Evolution of estimates of chemistry factor (CF) and margin for the limiting weld in Diablo Canyon Unit 1 with time.

Year	Event	Number of ΔT_{41J} Data	Chemistry Factor (CF) in eq. (3-1) [°C]	Margin in eq. (3-1) [°C]	Are ΔT_{41J} Data Credible?
1985	Unit 1 Start	0	126.0	36.5	No
1987	Capsule S tested	1	126.0	36.5	No
1993	Capsule Y tested	2	123.2	24.5	Yes
2003	Capsule V tested	3	126.0	36.5	No
2011	Sister plant data from Palisades added to analysis	5	118.8	24.5	Yes

Page 6, Item M

Comment "... .21% copper and .98% nickel. Those values should not change over time and the regulations incorporate tables to determine "chemistry factors" (CF) based on material property analysis (RG1.99, pg1.99-4). In some references the "table CF" which are extrapolated from the RG1.99-4 table are shown to be 222F, and in other references shown to be 226.8F."

Reply It is correct to note that CF depends only on chemistry and product form. For example, the weld in the vessel and the surveillance weld can have slightly different chemistries which will result in slightly different chemistry factors. For example, footnote (c) in Table 5.1-1 which appears in [WCAP-17315] gives the following:

- CF = 226.8 °F for the 27203 weld in the Diablo Canyon Unit 1 vessel
- CF = 222.3 °F for the 27203 weld used in the Diablo Canyon Unit 1 surveillance program.

Without further information I am unsure which references are referenced by the comment; however, the small differences illustrated here may be the basis for this comment.

Page 6, Item N

Comment "Additionally, the 1995 Update to 10 CFR50.61 spells out clear criteria for qualifying "sister plants". Dr. Kirk has stated repeatedly in his report that "NRC requires" that sister plant data be integrated. That is a misstatement. NRC encourages reference to sister plant data, but to use that data to reduce chemistry factors and margin in a sum of squares procedure, the licensee must first demonstrate that the two "sister plants" have similar

designs and operating conditions as defined by the 1995 Update to 10CFR50.61. (See footnote 8 and Appendix C) No such sister plant analysis has been performed to date, and the 2011 Westinghouse PTS Evaluation makes no reference to this NRC requirement. Dr. Kirk dismisses the importance of this NRC requirement and asserts that one can safely assume operational similarities between sister plants. He makes the argument that operational differences are accounted for through application of temperature adjustments. However, it remains an NRC procedure that is clearly required and has not been followed by the 2011 Westinghouse PTS Report. Dr. Kirk's suggestion that the sum of squares procedure for integrating data from other plants is "required", fails to address this important qualification criteria."

Reply

The NRC criteria to which this comment refers (Appendix C in the 15 April 2024 Severance document) does not apply to qualification of sister plant data for use in a PTS analysis. Rather the quoted section of the 1995 rulemaking document [FR60No243] refers to Section III(C) of Appendix H to 10 CFR Part 50, which describes the NRC's requirement for an integrated surveillance program [10CFR50 App-H]. An integrated surveillance program is both a legal and a technical arrangement between plants whereby surveillance data from one plant is used to inform embrittlement predictions at other plants. The NRC places certain requirements on integrated surveillance programs in Section III(C) of [10CFR50-AppH], but these requirements do not apply to the use of sister plant data. Diablo Canyon Unit 1 does not participate in an integrated surveillance program under [10CFR50-AppH] so the NRC's requirements for an integrated surveillance program do not apply to Diablo Canyon.

As described by Section 2.4.4.1 of the Part 1 report, language in the NRC's PTS rule, [10CFR50.61] establishes what has come to be referred to the requirement for consideration of "sister plant" data. The applicable language from [10CFR50.61] is as follows (**emphasis** added):

(v)(2) To verify that RT_{NDT} for each vessel beltline material is a bounding value for the specific reactor vessel, **licensees shall consider** plant-specific information that could affect the level of embrittlement. This information includes but is not limited to the reactor vessel operating temperature and any related surveillance program^{FOOTNOTE 5} results.

FOOTNOTE 5 Surveillance program results means any data that demonstrates the embrittlement trends for the limiting beltline material, including but not limited to data from test reactors **or from surveillance**

programs at other plants with or without surveillance program integrated per 10 CFR part 50, appendix H.

As stated in Section 2.4.4.1 of the Part 1 report, **these words** make clear that the NRC requires the analysis of surveillance data performed in support of any particular plant to consider data obtained from the surveillance programs of other plants. However, these words do not describe a process for determining which data from other plants should be considered and which should not. Information on this process can be inferred from the example cases presented by the NRC in 1998 [Wichman 1998]. [Wichman 1998] provides an example (Case 4) that considers “surveillance data from plant and other sources” where plants containing the same weld wire heat are the “other sources” of data. A 1993 EPRI report introduced the term “sister plants” to describe different plants having welds made from the same heat of material [EPRI 1993].

Since 1998 the industry has consistently interpreted “sister plant data” as coming from the same weld wire heat but being irradiated in different plants. The only adjustment for plant operating conditions that is performed is to take account of operating temperature effects on embrittlement magnitude as outlined in [Wichman 1998]. The NRC has consistently agreed with this interpretation. More detailed assessments of the plant-to-plant similarity, as is required for plants that participate in an integrated surveillance program (see Appendix C of the April 2024 Severance document), have never been required for sister plant analysis by the NRC.

Section 3.2.4.2 of the Part 1 report reviews the effect that of environmental and operational factors other than plant operating temperature on ΔT_{41J} for plants operating in the USA. (The effect of temperature on ΔT_{41J} is explicitly accounted for following NRC guidance when sister plant data are used.) This review concludes that these effects are either conservatively treated by the current procedure or are small relative to Charpy measurement uncertainty. As such, when sister plant data is taken from a US operating reactor no considerations other than similarity of the weld wire heat and differential operating temperature between the plants in question need be considered.

Page 6, Item O

Comment	“The operational conditions between the two plants (PNP and DCPD) are significantly different, and not at all similar as Dr. Kirk’s report suggests would be safe to assume. Earlier capsule testing at Palisades indicated rapid embrittlement of the RPV welds and there was concern that the plant would have to close as early as 1999. For this reason, and from 1999
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onwards, Palisades implemented an “Ultra Low Leakage Core Strategy” to reduce the flux (radiation exposure) at the critical welds. This involved a change in the fuel configuration, reduction of generation capacity to 90% (to reduce radiation damage), and the addition of stainless steel shielding to protect the most vulnerable welds. Although DCPD operated at 97.9% of its current capacity (3338MWt) until the 10th fuel cycle (about 1992), it has operated at its current 100% capacity (3411MWt) since then. Most significantly, DCPD1 has not employed stainless steel shielding at its limiting welds as PNP has, and there is no accounting of this in the Westinghouse PTS Evaluation.”

Reply Operational conditions are accounted for by the dosimetry calculations that are used to estimate the fluence at each location. The operational factors mentioned in this comment largely affect the differences in fluence experienced by the vessel wall and at the capsules themselves, which are addressed by the dosimetry calculations. Different calculations are performed to estimate the fluence at the capsule location and in the vessel wall, each accounting for factors particular to that situation such as reactor power level, fuel assembly loading patterns, and shielding.

Page 7, Item P

Comment “The Kirk Report suggests that all of these variables are captured by the operating temperature adjustments that made when sister plant is integrated, and while that may be true of the capacity reduction, it would not likely be true of shielding or fuel configuration changes that move fuel away from critical welds. Some of these operational changes may be accounted in the dosimetry (radiation sensors), but that is not safe to assume. The fact that a detailed discussion of such variables and regulatory requirements is completely overlooked by the Westinghouse PTS Evaluation and the Kirk Report is a significant analytical omission.”

Reply As stated in reply to Page 6, Item N above the regulatory requirement cited in that comment pertained to integrated surveillance programs not to sister plant data. All other factors are either accounted for in the fluence estimation, are addressed conservatively, or are of small magnitude relative to Charpy measurement uncertainty. Please see also the reply to Page 6, Item O above.

Page 7, Item Q

Comment “It is important to note that Dr. Kirk dismisses the concerns expressed by Dr. Macdonald and myself about the manner in which PG&E has tried to judge

its pre-2004 data “not credible” and in several sections of Part 1 of his report, attributes this to an “apparent misunderstanding of NRC’s definition of credibility in the context of embrittlement analysis.””

Reply It still appears that there is an apparent misunderstanding of data credibility on the part of Mr. Severance and Dr. Macdonald. Please see reply to Page 9, Item 6 below which discusses credibility criteria in more detail. Section 4.2.2.2 of the Part 1 report describes these criteria and how they are applied. The comment made as Page 9, Item 6 below only makes sense if credibility is assessed on individual datum, rather than on the data set as a whole; however, the NRC’s requirements do not allow analysis of the data in this fashion.

The 2004 analysis has been updated in 2011 [WCAP-17315]; the 2011 analysis defines the current state of embrittlement until such time as additional data becomes available. Section 3.1 of the Part 2 report confirmed the correctness of these calculations by PG&E.

Page 7, Item R

Comment “At the same time that PG&E is claiming that their pre-2004 data is not credible (as per RG1.99 definitions), Palisades is assuming that the data is credible. However, the 2011 DCPPT PTS Evaluation by Westinghouse appears to be an effort to replace the 2006 PTS Evaluation, and the data is judged “not-credible” at the beginning of their sum of squares procedure.”

Reply Evaluations performed on the Palisades plant have no bearing on Diablo Canyon Unit 1. Also, datum that was once determined to be part of a non-credible set can later change to be part of a credible set when more data is collected because the NRC’s credibility evaluation, evaluates the data set as a whole, not each datum individually.

When the three Diablo Canyon Unit 1 surveillance data points for weld wire heat 27204 are combined with the two surveillance data points from Palisades for that same weld wire heat, the data set is found to be credible as assessed in the [WCAP-17315] analysis of Diablo Canyon Unit 1 performed in 2011. Section 3.1.1 of the Part 2 report validates that this determination is correct.

The [WCAP-17315] evaluation does indeed replace (or supersede) the earlier 2003 analysis on based only the three Diablo Canyon Unit 1 surveillance data for weld wire heat 27204 [WCAP-15958]. That analysis, which

determined the data set to be not creditable, was validated by Section 3.1.1 of the Part 2 report.

Page 7, Item S

Comment “This appears to be a violation of the rules as set out in RG1.99 Position 2.1 which allow the use of the sum of squares procedure only if your data is deemed credible. The precise language in RG1.99 suggests that if two or more sets of surveillance data are deemed credible, then Position 2.1 can be used to determine chemistry factors based on a best fit of the data. In the 1998 update to GL92-01, Case 5 as presented by Wichman clearly states that 5 out of 6 data sets (87%) must be deemed “credible” to use the sum of squares procedure. If only 2 of 5 data sets are deemed credible (2 Palisades capsules were judged credible), the sum of squares procedure cannot be used to lower the margin and CF values as performed in the 2011 Westinghouse PTS Evaluation. (See RG1.99, Position 2.1). This appears to be inconsistent with NRC procedures.”

Reply As stated in several previous replies, credibility is assessed with respect to a data set as a whole, not with respect to individual datum. A datum that was once determined to be part of a not-credible set can later change to be part of a credible set when more data is collected. Section 3.1.1 of the Part 2 report validates that PG&Es assessment of credibility has been correctly performed, consistent with NRC procedures.

Page 7, Item T

Comment “One must ask, how can PG&E waffle about the credibility of the same 3 sets of data over time?”

Reply The assertion that PG&E is waffling appears to arise due to the commenter’s misunderstanding of the NRC’s credibility procedure, which is explained in Section 2.4.2.2 of the Part 1 report. That section describes how credibility is assessed with respect to a data set as a whole, not with respect to individual datum. A datum that was once determined to be part of a not-credible set can later change to be part of a credible set when more data is collected. Section 3.1.1 of the Part 2 report validates that PG&Es assessment of credibility has been correctly performed, consistent with NRC procedures. Table 6 of the Part 2 report, which is copied for convenience on page 11 above of this document, shows how credibility of the weld wire heat 27204 data sets has changed over time.

Page 8, Item U

Comment “What is different about DCP-1 is that it is only one of two plants in the world still in operation that contain the flawed weld material (heat#27204) which was recognized by Westinghouse to be substandard immediately after delivery of the Unit 1 RPV. The metallurgical specifications were revised before Unit 2 was delivered. Because of the early recognition that the 27204 weld material was **flawed**, very few reactors in the world contain this material. There have only been five “capsule tests” in the entire world that we know of using this material as evidenced by NRC’s extensive review.”

Reply Having only one sister plant should not be seen as indicative of a plant having too little data. Roughly one-third of all operating PWRs have no sister plants data at all, yet these plants remain compliant with NRC requirements for surveillance monitoring [10CFR50-App G]. Please see the reply to Page 9, Item 2 below for additional details.

The use of the word “**flawed**” by the commenter to describe weld wire heat 27204 is misleading. Weld wire heat 27204 has a higher copper content that was typical of RPV-grade steels and weld wires used at the time of Diablo Canyon Unit 1’s fabrication. While the use higher copper steels has been discontinued, many plants with even higher copper content than Diablo Canyon Unit 1 remain in safe service today.

Page 8, Item V

Comment “By 1992, raw samples of the 27204 weld material proved impossible to obtain and that is why Capsule B (still in the Unit 1 RPV) only contains broken fragments of previously tested samples of the 27204 weld material. This is important historical context, because there is insufficient test data industry-wide to analyze with accuracy how embrittled the DCP-1 welds actually are.”

Reply As mentioned in the reply to Page 8, Item U above and to Page 9, Item 2 below Diablo Canyon Unit 1 is not, by industry or regulatory standards, deficient in the amount of data it has available. The “fragments” that were inserted in Capsule B are broken halves of Charpy specimens. There are well developed and accepted ASTM standards by which such samples can be re-constituted to make them acceptable for testing. See for example [ASTM-E1253].

Page 8, Item W

Comment “A linear extrapolation of the reported 2006 PTS results appear to suggest that the jump in the embrittlement data contained in the 2011 Westinghouse Evaluation represents a 64% shift in the embrittlement projections. How is that plausible?”

Reply The 2011 change in data occurred because the sister plant data were incorporated into the analysis as required by the NRC regulations. The change between the PTS predictions circa-2006 and those of 2011 are illustrated by Figure 4 of the Part 2 report, which is copied on page 4 of this document above for convenience. On this figure the red curve provides RT_{PTS} estimates circa-2006 while the blue curve provides the 2011 RT_{PTS} estimate. The change from the red curve to the blue curve occurred because the sister plant data were incorporated into the analysis in 2011. The incorporation of this data was appropriate as discussed in the reply to Page 2, Item B above.

I am not sure to what the commenter’s 64% value refers, especially since temperature differences are not typically expressed as a percentage due to the arbitrariness of zero on temperature scales.

Page 9, Item 1

Comment “According to PG&E’s own 2006 projections and corroborated by the NRC, Unit 1 will be within 3% of maximum embrittlement ‘screening limits’ as defined by the Federal Code of Regulations by November 2024. This projection of embrittlement was based on “hard data”, (Charpy stress tests) performed on material samples and indicated some samples demonstrated “fast fracture”, characteristic of embrittlement. The “reference temperature” or RT_{PTS} value was projected to be 258.7°F by Nov. 2024. Note that the 10CFR50.61 screening limit is <270°F. By independent calculation, the NRC calculated this value to be 258.8°F, a remarkable confirmation of both their mathematical accuracy and their faith in the pre-2004 data.”

Reply The 2006 calculations of RT_{PTS} based on surveillance data have since been superseded by more recent calculations that are based on additional data provided by the sister plant Palisades [WCAP-17315, DCL-23-038]. These newer calculations form the current licensing basis for Diablo Canyon Unit 1. As such this comment is not relevant to the current and future estimates of RPV embrittlement and safety. Nevertheless, the following comments are provided for information:

- (A) Sections 3.1.1 and 3.1.2 of the Part 2 report to DCISC confirm the appropriateness and accuracy of the RT_{PTS} calculations performed by both PG&E and the NRC, including the calculations referenced here.

- (B) As noted in these sections, when in the past the set of surveillance data used to estimate RT_{PTS} has been determined to be “not credible” (which was the situation in 2006) the Diablo Canyon Unit 1 RPV was forecasted to exceed the NRC’s 10CFR50.61 RT_{PTS} screening limit (270 °F or 132 °C) after 40 but before 60 years of operation.
- (C) More recent calculations (which represent the current licensing basis) demonstrate that the Diablo Canyon Unit 1 RPV is not forecast to exceed the NRC’s RT_{PTS} screening limit until well after 60 years of operation (see Figures 2 and 3 in the Part 2 report).
- (D) Due to the diminished rate of embrittlement at higher fluences for the Diablo Canyon Unit 1 weld (see, for example Figures 2 and 3 in the Part 2 report) the proximity of the Diablo Canyon RT_{PTS} value to the screening criteria (that is, within 11 °F or 6 °C) does not correspond to a similar proximity in time.
- (E) This proximity to the screening criteria should not be a cause for concern because the effects of material uncertainty and data scatter have been incorporated into the screening criteria by the NRC.
- (F) The similarity of the RT_{PTS} values cited in this comment is expected. Different engineers performing an algebraic calculation using the same input data should produce very similar results.

Page 9, Item 2

Comment “There is considerable evidence that both the PNP and DCPP Unit 1 reactor pressure vessels are severely embrittled, and yet these are the only data sets available as inputs into the DCPP PTS Evaluation. For this reason, further investment in Unit 1 should be postponed awaiting further data. PG&E has failed to report on their 2006 PTS Evaluation confirmed by the NRC as it is not even mentioned in either the Kirk or Westinghouse Reports.”

Reply The 2006 calculations of RT_{PTS} based on surveillance data have since been superseded by more recent calculations that are based on additional data provided by the sister plant Palisades [WCAP-17315, DCL-23-038]. These newer calculations are available to inform predictions of embrittlement at Diablo Canyon Unit 1. As such this comment is not relevant to the current and future estimates of RPV embrittlement and safety. Nevertheless, the following comments are provided for information:

- (A) Future estimates of embrittlement change only when new input data becomes available. New input data become available with each capsule tested and when sister plant data becomes available. In Section 3.1.1 of the Part 2 report, I therefore performed calculations associated with the expanded data set made available after each surveillance capsule report [WCAP-8465, WCAP-11567, WCAP-13750,

WCAP-15958] was published and with the availability of the sister plant data from Palisades [WCAP-17315]. My estimates of future embrittlement in Section 3.1.1 of the Part 2 report for each evolution in available data ties to these reports. In licensee communication with the NRC these estimates are frequently repeated with no change in data or in predicted outcomes. For example, the 2006 PTS calculations referred to in this comment simply repeat the evaluation of data from three capsules (S, Y, and V) that could be calculated following publication of the Capsule V report in 2003. Thus, the 2006 PTS calculations are effectively addressed in the Part 2 report by the evaluation of data from three capsules (see Figure 2 in the Part 2 report).

- (B) In the USA, PWRs have between zero and three sister plants that provide data for PTS evaluation. Roughly two-thirds of PWRs have sister plant data while roughly one-quarter have one sister plant, which is the situation for Diablo Canyon Unit 1. While consideration of available sister plant data is required by the NRC when doing a PTS (10CFR50.61) evaluation, a plant should not be considered deficient of data if it has only one sister, like Diablo Canyon Unit 1. As few as three plant-specific measurements fully satisfy the NRC's requirements [10CFR50-AppH], and by considering sister plant data Diablo Canyon Unit 1 has five relevant measurements.
- (C) Whatever the state of embrittlement of the Palisades Nuclear Power plant may be, it is irrelevant to assessing the condition of Diablo Canyon Unit 1. The only nexus to Palisades for Diablo Canyon is the use of appropriate sister plant data, which PG&E has done. Both my reports and the NRC's evaluations confirm the appropriateness of PG&E's use of the sister plant data from Palisades.

Page 9, Item 3

Comment	“Immediately after delivery of the Unit 1 RPV in the late 1960’s, Westinghouse admitted to PG&E that Unit 1 contained weld material with metallurgical deficiencies in the form of impurities of copper and nickel that would predispose the RPV to premature failure. Dr. Kirk rather absurdly argues that these “flaws” were not “flaws” or “errors” because the metallurgical issues were not understood at the time. However, window dressing aside, the historical significance of the known substandard metallurgy is the point. The mathematical predictions in the 1986-2003 capsule reports also took into account the known impurities in the RPV weld material, and the physical stress test indicated there was a predisposition for brittleness.”
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Reply The semantics of word choice notwithstanding, the simple fact is that when the Unit 1 vessel was fabricated, the weld metal used was higher in copper and nickel than would be recommended today based on the state of knowledge that exists today. Today's state of knowledge differs greatly from state of knowledge when the Unit 1 vessel was specified and fabricated.

It is correct to state that the Diablo Canyon Unit 1 RPV has greater susceptibility to the effects of neutron irradiation due to relatively high copper content in the limiting weld than do modern RPV alloys. This copper content is higher than many, but certainly not all, operating RPVs. Nevertheless, this increased susceptibility to embrittlement is quantified by the surveillance data that has been collected for the Diablo Canyon Unit 1 RPV and is accounted for by the NRC's prediction formula [RG1.99R2]. Additionally, the criteria that ensure the safe operation of the RPV (for example, the NRC's PTS screening criteria) have been satisfied by the Diablo Canyon Unit 1 RPV for an operational period beyond 60 years. Finally, as noted in the Part 1 report (see Section 3.6.2) *"At least 25 units having a copper content equal to or exceeding that of the Diablo Canyon Unit 1 weld remain in operation today."*

Page 9, Item 4

Comment "This historical context has been omitted from the Kirk Report. Given that the Kirk report was reviewed unilaterally by PG&E for historical accuracy, and no opposing parties were engaged in such discussion, and because there are significant historical inaccuracies in the Kirk Report which are contradicted by the NRC record, it is difficult to express confidence in the 'independence' of this reporting."

Reply PG&E was not asked to review the Part 1 and Part 2 reports for "historical accuracy," but rather to confirm that the data used was correct. This was done to ensure that my calculations on the embrittlement projections that appear in the Part 1 and Part 2 reports were based on accurate input data. See also the reply to Page 3, Item C above.

Page 9, Item 5

Comment "Kirk's citation of a 2008 letter from the NRC indicates that NRC had by then forgotten the 2006 conditions of license extension approval that the embrittlement stress test program ("surveillance program") was amended by the July 17, 2006 letter of approval which required an additional capsule test (Capsule B) be conducted by 2009. Because PG&E has waffled on the issue of credibility of their data, there are a great deal of questions about the

actual state of the Unit 1 reactor. PG&E continues to oppose immediate retesting of previously tested samples under test methods that are known to be credible. Since Capsule B may not be tested until 2028, why is the DCISC not moving to retest samples that are already in hand?”

Reply

Despite the assertion of the commenter, the referenced letter [NRC 2006] does not amend the Diablo Canyon Unit 1 license to require an additional capsule test (Capsule B) be conducted by 2009. The letter from the NRC to PG&E notes (see pdf page 5, item 2) that “*the license is amended by changes to the Facility Operating License No. DPR-82 as indicated in the attachment to this license amendment.*” An image of the referenced attachment appears below. A review of modifications to pages 3, 7, and 9 of the facility operating license reveal that these change only expiration date of the license and make no mention of any other license modification, particularly concerning Capsule B.

ATTACHMENT TO LICENSE AMENDMENT NO. 188	
TO FACILITY OPERATING LICENSE NO. DPR-80	
AND AMENDMENT NO. 190 TO FACILITY OPERATING LICENSE NO. DPR-82	
DOCKET NOS. 50-275 AND 50-323	
Replace the following pages of the Facility Operating Licenses with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.	
Facility Operating License No. DPR-80:	
<u>REMOVE</u>	<u>INSERT</u>
- 3 -	- 3 -
- 9 -	- 9 -
Facility Operating License No. DPR-82:	
<u>REMOVE</u>	<u>INSERT</u>
- 3 -	- 3 -
- 7 -	- 7 -

The NRC staff’s safety evaluation, which appears on pdf pages 8-16 of [NRC 2006], does address the capsule withdrawal schedule. On pdf page 12 the NRC states (in part) the following (***emphasis added***):

“Under this supplemental program, four capsules, Capsule S, Y, V, and B, were designated for removal from the DCP-1 RV. Capsules S, Y, and V have been removed and tested in accordance with the licensee’s program. The request to recover the testing time for DCP-1 amends the projected withdrawal for Capsule B to approximately 20.7 EFPY, when the capsule is projected to achieve a neutron fluence of 2.9×10^{19} n/cm² (E > 1.0 MeV). Therefore, the

capsule will achieve a neutron fluence approximately equal to twice the projected limiting inside RV fluence for DCP-1 at the EOL (i.e., approximately $2 \times 1.43 \times 10^{19}$ n/cm² [$E > 1.0$ MeV]). This complies with the criterion in ASTM E185-82 for withdrawal of the final capsule of a four capsule withdrawal program. This is acceptable because 10 CFR Part 50, Appendix H, permits the licensee's to meet the RVMSP withdrawal criteria of more recent versions of ASTM E185, inclusive of E185-82. Therefore, the NRC staff concludes that the adjustments to the withdrawal time and projected neutron fluence for Capsule B will still be in compliance with 10 CFR Part 50, Appendix H."

These statements, and indeed all statements in the NRC Staff's safety evaluation, do not constitute conditions on the Diablo Canyon Unit 1 license. Were a condition placed on the license it would be extremely clear and appear in the amended operating license rather than being relegated to the safety evaluation.

Additionally, as noted in the Section 2.3 of the Part 2 report, this capsule withdrawal schedule was subsequently superseded by various PG&E requests and NRC approvals. Section 2.3.1 of the Part 2 report noted that in every instance, both before and after [NRC 2006] was written in 2006, the NRC referred to the Diablo Canyon Unit 1 surveillance capsule program for the first 40 years of operation as being a *three-capsule program*; only [NRC 2006] makes a different statement. If the commenter feels that this topic poses a safety risk, the appropriate form of redress would be a 2.206 petition filed with the NRC. However it should be noted that the NRC recently denied a 2.206 petition filed by the Mothers for Peace in 2023 with respect to Diablo Canyon Unit 1 (see <https://www.nrc.gov/docs/ML2405/ML24058A103.pdf> dated 8 March 2024). The topic of Capsule B testing was addressed extensively in the NRC's response to the petition. In their response the NRC makes the following statements:

- 1 *"The final capsule required for the current operating license period (i.e., Capsule V) received an estimated neutron exposure greater than the RPV is expected to receive at the end of the current 40-year operating license period. Thus, the licensee obtained surveillance data representative of the RPV beyond the end of the current operating license period."*
- 2 *"As indicated in the approval of the supplemental surveillance program on September 4, 1992 (ML16341G687), Capsule B was intended to be removed and tested when the accumulated fluence is equivalent to the vessel inside surface at 48 Effective Full Power Years (i.e., operation of the plant well beyond the original 40-year design). Thus, as part of the licensee's current licensing basis for Diablo Canyon, Unit 1, the*

withdrawal, and testing of Capsule B is not required to demonstrate compliance with Appendix H during its current operating 40-year license period.”

- 3 *“The licensee is not required under Appendix H to withdraw their “license renewal capsule” to support their current operating license, as all required capsules for Diablo Canyon, Unit 1 have already been withdrawn and tested, as discussed in NRC’s letter dated July 20, 2023. However, if a renewed license is issued for Diablo Canyon, this “license renewal capsule” would become required under Appendix H to support the renewed operating license.”*

These statements are all consistent with the findings of the Part 2 report to the DCISC. In particular, the NRC’s comment 3 (above) indicates that Capsule B testing was not needed during the initial license period and that the NRC has no concerns regarding a need to expedite testing of Capsule B, as suggested by this comment. As described in Section 2.3.2 of the Part 2 report, Capsule B should be tested before 2028 to be consistent with NRC guidance [NUREG-1801].

Page 9, Item 6

Comment “By 2011, PG&E reassessed all of their pre-2004 to be “not-credible” and in a manner that appear to be inconsistent with NRC procedures as defined in Reg. Guide 1.99. First, PG&E claimed one data point in the capsule Y set was out of standard deviation range and then eliminated the entire set. This directly violated GL92-01 which states: “A priori exclusion of some data based on ‘inconsistency’ with expected norms should not be used before analysis for statistical outliers is conducted.” Then PG&E claimed that the two remaining “credible” sets did not meet the minimum number of sets required to regard them as “credible”. This seems to violate Reg. Guide 1.99, criterion 3 which clearly states that you need only two sets of credible data for each “limiting material” (most embrittled) to regard them as “credible”. PG&E had the minimum two sets for each material, but the NRC did not question this incorrect interpretation of data set credibility criterion.”

Reply I assume that this comment refers to the PTS and upper shelf energy evaluations performed by Westinghouse in 2011 for PG&E [WCAP-17315]. The credibility criteria as expressed by the NRC have been correctly considered by PG&E and Westinghouse in the 2011 report [WCAP-17315] and in subsequent documents that repeat this analysis result. These evaluations considered the two sister plant data from Palisades along with data from the three Diablo Canyon Capsules (S, Y, and V) tested in 1987, 1993, and 2003, respectively. This analysis is still the analysis of record

[DCL-23-038]. Here I will address only the evaluation of weld wire heat 27204, which is the limiting weld for Diablo Canyon Unit 1.

- (A) Appendix A of [WCAP-17315] provides the Westinghouse credibility evaluation.
- (B) On pages A-1 to A-6 Westinghouse assesses the credibility of only the Diablo Canyon surveillance data from Capsules S, Y, and V. On page A-6 they conclude that “*Criterion 3 is also **not** met for the surveillance weld material when **only** Diablo Canyon Unit 1 data is considered.*” The presence of this analysis, which is not required, may have given rise to this comment.
- (C) As described in Section 2.4.2.2 of the Part 1 report, credibility is assessed on the available data set as a whole, not on individual datum or on data subsets. If, as has been the case for Diablo Canyon Unit 1 since 2011, there are five measurements of ΔT_{41J} all five measurements will either be deemed credible or not credible following the NRC’s procedures. This comment seems to be based on the faulty premise that in a set of five data points some data points may be credible while others are not. This outcome is not possible when correctly using the NRC procedures. Additionally, for PTS assessments consideration of sister plant data is required (again see the Part 1 report Section 2.4.2.2).
- (D) As required and as just described in item (C), On pages A-7 to A-10 Westinghouse assesses the credibility of the Diablo Canyon surveillance data from Capsules S, Y, and V as supplemented by the two sister plant data from Palisades. On page A-10 they conclude that “*Table A.1-8 indicates that all five surveillance data points fall within the $\pm 1\sigma$ of 28°F scatter band for surveillance weld materials; therefore, the weld material (Heat # 27204) is deemed “credible” per the third criterion when all available data is considered. In conclusion, the combined surveillance data from Diablo Canyon Unit 1 and Palisades for weld Heat # 27204 may be applied to the Diablo Canyon Unit 1 reactor vessel weld.*”
- (E) As required by 10CFR50.61, Table 6.1-1 of [WCAP-17315] uses the evaluation of the Diablo Canyon Unit 1 surveillance data along with the sister plant data to form the basis for their PTS evaluation.

In summary, the credibility criteria as expressed by the NRC have been correctly considered by PG&E and Westinghouse in the 2011 report [WCAP-17315] and in subsequent documents that repeat this analysis result.

Page 10, Item 7

Comment	“The DCISC has not weighed in on the fact that PG&E set aside the 2006 PTS Evaluation (maximum embrittlement by 2025) by means that do not appear to comply with NRC regulations. There should at least be a motion to
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include reference to the earlier PTS projections in the Westinghouse PTS Evaluation as is customary. The DCISC hired Dr. Kirk to make recommendations to them and he now claims that the 2011 Westinghouse PTS Evaluation is consistent with NRC procedure when it appears that there were many critical omissions. It is fairly clear that several NRC procedures were not followed, and that Dr. Kirk has overlooked details required by NRC procedures.”

- Reply The 2006 calculations of RT_{PTS} based on surveillance data have since been superseded by more recent calculations that are based on additional data provided by the sister plant Palisades [WCAP-17315, DCL-23-038]. These newer calculations form the current licensing basis for Diablo Canyon Unit 1. As such this comment about the 2006 PTS evaluation is not relevant to the current and future estimates of RPV embrittlement and safety. Nevertheless, the following comments are provided for information:
- (A) Section 3.1.1 of the Part 2 report provided my independent evaluation of each data set that has existed since Diablo Canyon Unit 1 was placed into service. This analysis validated results provided by PG&E (see Section 3.1.2 of the Part 2 report) since 2003. This latter section provides confirmation that PG&E’s 2006 PTS evaluation is correct.
 - (B) As stated in my response to Page 9, Item 6 above, PG&E has correctly followed the NRC’s procedures for credibility evaluation and has reached conclusions that agree with my own.

Page 10, Item 8

Comment “While the Kirk Report assures “conservatisms” in at least a dozen places, a review of Tables 5.1-1, 5.1-2 and 6.1-1 and 6.1-2 in the Westinghouse report quickly reveals that the Westinghouse PTS Evaluation uses the least conservative surveillance-based chemistry factors. The Westinghouse PTS Evaluation appears to employ a sum of squares procedure that is only allowed under RG1.99, Position 2 when all data sets are credible. Wichman 1998 modifies this requirement to allow sum of squares procedure when 5 of 6 data sets are credible (83%). The numerous references to “conservatisms” by which Dr. Kirk assures a margin of safety to the public when non-credible sets are used are false assurances. In the final analysis, the Westinghouse PTS Evaluation employs the LEAST CONSERVATIVE chemistry factors based upon a sum of squares procedure with questionable results. All conservatisms have been eliminated by reducing both the chemistry factors and the margin (M) resulting in a significant reduction of the projected level of embrittlement for both DCP and Palisades. Both RPVs previously appeared to be among the most embrittled RPVs in the US.”

Reply I assume that the “Westinghouse Report” referred to by this comment is the 2011 report on PTS and USE evaluations [WCAP-17315]. Use of a chemistry factor for weld wire heat 27204 of 214.1 °F is appropriate and allowed by the NRC because this chemistry factors was estimated from a credible set of surveillance data, which has been the case since 2011.

Statements I made in the reports concerning the conservatism of the RPV assessment process go beyond analysis procedures for surveillance data. For example:

- Analysis of pressure temperature limits for normal operation
 - Assumes the presence of a very large flaw (¼ wall thickness) that has never been found in a reactor vessel.
 - Assumes loading magnitude that exceeds that which occurs under normal operation.
 - Assumes a lower-bound representation of the fracture toughness of the material in addition to the margin terms imposed by the NRC.
- Analysis of severe events like PTS
 - Assume the presence of a very large flaws in greater density than detected in a reactor vessel inspection.
 - Assumes a binned representation of severe loadings that are intended to bound (exceed) the transients that may occur during postulated accident scenarios.

Page 10, Item 9

Comment “In 2013, in response to questions at a public meeting regarding the Palisades RPV embrittlement, the NRC responded in writing admitting that Palisades and DCCP-1 were among the five most embrittled reactors in the US at that time. Due to retirements of older plants that used the 27204 weld material, these two plants are the only remaining in the US to use the #27204 weld material are now among the four most embrittled plants in the US. (See NRC proceeding written response to public concern about Palisades embrittlement, Appendix A).”

Reply The fact that certain plants are among the five most embrittled reactors in the USA is irrelevant to the plant’s continued operating safety. PG&E’s analysis, as affirmed by the NRC and by the Part 2 report, remains in compliance with the NRC’s embrittlement screening criteria and, thereby, remains safe to operate.

Additionally, the following information is provided for clarification:

- (A) The referenced list of five plants comes from an answer to Question 4 that occurred during a NRC Webinar on PTS [NRC 2013]. In that document, the NRC's response to a question from the meeting includes the list of the five plants and begins with the statement, "*The NRC currently estimates that the following plants will exceed the PTS screening criteria of 10 CFR 50.61 during their 20-year period of operation beyond their original 40-year licenses.*"
- (B) Additional statements in the NRC's response clearly stated that there were methods available to those plants to update calculations and change that estimate to support future extended operations.
- (C) None of the NRC's responses infer that any of the listed plants, including Diablo Canyon Unit 1, are currently unsafe for operation or are expected to become unsafe in the future provided that the NRC's regulations continue to be satisfied.

Page 10, Item 10

Comment "Dr. Kirk performed his own calculation of "upper shelf energy" (USE), a second embrittlement metric, and found Unit 1 would reach maximum embrittlement screening limits by 2029 and only if it is operated with a reduced capacity factor of 85% to 95%. This is in direct contradiction to Dr. Kirk's support of the 2011 Westinghouse PTS Evaluation conclusions. However, to his credit, Dr. Kirk does suggest additional embrittlement testing to confirm the status of the Unit 1 RPV and suggests that the mini-CT test methodology is perhaps more accurate than the 100-year old Charpy methodology. Dr. Macdonald agrees with this suggestion. However, Dr. Kirk affirms the 2011 Westinghouse conclusion that embrittlement is within regulatory limits until 2044, and he dismisses his own USE calculations without a clear explanation of the contradiction."

Reply The analysis referred to was reported in Chapter 4 of the Part 2 report. As stated at the beginning of that chapter "*It should be emphasized that while the techniques used in this chapter evolved from currently accepted practices and in some cases are currently in codification review by ASME, none are currently endorsed or required by the NRC. Thus, the information presented in this chapter has no impact on the licensing basis of the Diablo Canyon Unit 1 nuclear power plant.*"

It is also stated in Section 4.2 of the Part 2 report, which concerns the supplemental USE analysis, that an equivalent margins analysis following Regulatory Guide 1.161 could be performed to address any USE concerns. The report further stated that "*Equivalent margins analyses performed on other reactors have, without exception, demonstrated that continued*

operation at USE values considerably below 68J is acceptable.” The uniformity of this result across all plants and embrittlement conditions speaks to the conservatism of the 68J screening criteria.

Additional material property data could be collected to support an equivalent margins analysis by performing J-R curve tests following ASTM Standard E1820. Such tests, if performed, would need to use a larger specimen than the mini-CT to appropriately measure the J-R curve of the Diablo Canyon material. It is possible that collection of additional material property data may not be necessary because the needed information can often be estimated by correlative methods allowed by the NRC in Regulatory Guide 1.161. In any event, all previous experience indicates that an equivalent margins analysis performed on Diablo Canyon Unit 1 would most likely demonstrate its continued operating safety even for USE values below 68J.

The supplemental analysis of upper shelf energy appearing in Section 4.2 of the Part 2 report did assume an 85-95% capacity factor to arrive at the estimate that the USE of the Diablo Canyon Unit 1 limiting weld could fall below the NRC’s 68J screening criteria by 2029-2030. It should be mentioned that an 85-95% capacity factor is not “reduced” but rather is typical of current operating experience. It is impossible, and therefore unrealistic to assume, that a nuclear plant can run at 100% capacity.

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Appendix

Comments Made by Mr. Bruce Severance on
15 April 2024 follow

Comment to the Diablo Canyon Independent Safety Committee

Is DCP Unit 1 Reactor a 'Good Bet' for the People of California?

By Bruce Severance, Regulatory Compliance Engineer
April 15, 2024

The DCISC's Determination on the Kirk Report Will Signal a Green or Red Light to the State

When it comes to the safety and reliability of a nuclear reactor, why would anyone ever gamble if there is a clear path to obtaining the data necessary to minimize both financial and safety risks?

As a climate mitigation policy analyst, co-founder of the Central Coast Economic Recovery Initiative and the Green Infrastructure Research Collaborative, I have always supported the most cost-effective infrastructure development alternatives for building a bridge to a carbon-free economy. For a number of reasons I support continued operation of Unit 2 at the Diablo Canyon Power Plant (DCPP), but I cannot support continued operation or further investment in Unit 1 based on calculated risks of lost investment. It is clear to me from the NRC docket record, having thoroughly reviewed roughly 4000 pages of it, that Unit 1 is not a "good bet" for the citizens of our state. It is the citizens of SLO County that would pay most dearly should any "pressurized thermal shock" event result directly from misunderstood or miscalculated radiation embrittlement assessments. On this note, there are many points of the Kirk and Westinghouse reports that raise serious questions regarding the credibility of the analysis and whether NRC procedures were in fact closely followed. This paper is an effort to point to the specific instances in which the DCISC's expert may not have clearly stated the facts, and why the DCISC should reconsider its proposed endorsement of the analysis.

However, the larger picture of how the DCISC's endorsement of the Kirk Report will need to be evaluated by state agencies in the broader context of whether further investment in continued operation of Unit 1 is in fact a sound financial decision. It is clear from PG&E's own 2017 submission to the CPUC, that DCP has represented 22% of its in-house generation capacity while consuming over 40% of its in-house generation budget (2017 CPUC report), so it is already the least cost-effective generation in its fleet. This translates into a cost roughly 2.3 times higher than the average of the rest of their in-house generation. Although the DCISC is focused on safety, safety issues have a direct bearing on projected operation and repair costs, and there are a number of cost-risk considerations that are likely to cause the relative operational costs (over generation alternatives) to increase significantly in the coming years. These include: 1) the known metallurgical flaws in the Unit 1 reactor pressure vessel (RPV) which predispose it to more rapid embrittlement, 2) the pre-2004 test data and PG&E's own 2006 calculations indicate this embrittlement will be reaching the Federal Code of Regulation "screening limits" by 2025(also confirmed by NRC in 2006); 3) the probability or risk of escalating repair costs as high-dollar components begin to fail; 4) the postponed maintenance over the past six years that were reasonably deferred to minimize further investment loss in a plant that had been slated for closure in 2018, but which have also kept average repair costs and operational costs artificially low.

A

Considering all of these variables, the relative cost of continued operation of Unit 1 is likely to swell from 2.3 to 4 times that of more cost-effective generation alternatives. Does this make sense? Is Unit 1 in fact needed to meet the projected grid supply shortfall expected to peak between 2025 and 2030? The CEC will need to make those determinations based on the DCISC's assessment of Unit 1 embrittlement. So the question is not simply one of safe operation for 5 years or 20 years, but also a matter of the impacts of safety assessments on the state's financial risk assessment. The CPUC will also need to approve of the additional cost burdens on ratepayers.

Although it has been clearly stated that cost of operation is not the purview of the DCISC, it is the mandate of SB846 to closely evaluate and consider such relative costs to determine that continued operation of DCP is both safe, and that safe operation is cost-effective. For these reasons, accurate reporting about the current and projected safety related repairs that may be required should be carefully evaluated by the DCISC, particularly Unit 1 embrittlement as premature failure of the Unit 1 RPV would result in a loss of all other investments in its continued operation. This is because RPV replacement would add in the range of \$500M to \$700 million, and all other repairs would become "sunk costs" should it be deemed necessary. Considering the SB846 requirement to evaluate cost trade-offs, the DCISC should broaden its consideration to include whether continued operation of the Unit 1 RPV is in fact a "good bet" for the citizens of California. If for example, there is less uncertainty about the degree of RPV embrittlement suffered by Unit 1 versus the greater certainty regarding the condition of Unit 2, such uncertainty and relative risks should be discussed in the DCISC's reporting to state agencies.

It is my perception that the state's decision to move forward with funding the continued operation at DCP Unit 1 relies heavily on the decision of the Diablo Canyon Independent Safety Committee (DCISC) to endorse their expert's report "An Evaluation of the Status of Diablo Canyon Unit 1...".*¹ This report by Dr. Mark Kirk reviews the 2011 Westinghouse PTS Evaluation*² which investigates the embrittlement of

the Unit 1 reactor. The critical question is whether NRC procedures were in fact followed in the process of reanalyzing the DCP-1 pre-2004 stress test data, and whether the Kirk Report accurately represents the current state of Unit 1 embrittlement and confirms the Westinghouse assessment based on accurate interpretation of NRC procedure. I cannot claim to have all the answers, but there are serious questions about how data from two severely embrittled plants can be combined and integrated mathematically to yield far more favorable projections than either subset of data would suggest. It is clear that this is accomplished by nudging chemistry factors (CF variable) downward; the same variable intended to account for the confirmed metallurgical issues with critical welds in both the Palisades and Diablo Canyon Unit 1 reactors. Relatively small changes in CF result in fairly radical changes in the projected embrittlement of both of these power plants.

B

A Contradictory Request

In mid-March, the General Counsel for the DCISC requested that I submit comments to the DCISC regarding Dr. Kirk's analysis of the 2011 Westinghouse Pressurized Thermal Shock (PTS) Evaluation.*^{1&2} However, I was given the constraint that my comments must be submitted without further reference to "historical NRC or PG&E documents". The 2011 Westinghouse PTS Evaluation is itself a "historical document" and it makes many references to other "historical NRC documents". The Kirk Report makes reference to numerous "historical documents" some of which appear to me to be out of context. All of

the regulations can also be considered “historical NRC documents”. The contradiction implicit in this request was immediately apparent to me. Most public policy debate pivots on interpretation of regulations and other references. As a citizen of San Luis Obispo who has read extensively on the topic of Diablo Canyon Unit 1 embrittlement motivated only by civic duty, I do feel that I should have a right to cite regulations and “historical documents” where the historical record may have been presented out of context. Misinformation may not be intentional misleading, but it should nevertheless be corrected.

While PG&E was allowed to review and edit Dr. Kirk’s analysis, public advocates such as myself, were not afforded this privilege. It is therefore unreasonable to constrain discussion only to the Kirk and Westinghouse reports when these clearly rely on interpretation of prior references. Had I complied with the DCISC constraint, I would not be able to comment on the veracity of the reports in question at all.

C

The Relevant Historical Context

During the February 21st meeting, I pointed to a 2013 document from the NRC which stated that Palisades Nuclear Plant (PNP) and DCP-1 were among the four most-embrittled reactors in the nation.*³ (See also Appendix A.) Dr. Kirk was listed as an NRC official overseeing that response to public inquiry. I was a bit surprised that when I raised this as cause for concern, I received an almost heated response with Dr. Budnitz calling this an unfair comparison, and tantamount to calling shortest guy on the Warriors basketball team “short” when he is still much taller than the rest of the population. Such analogies reflect the DCISC’s predisposition to approve continued operation based on the Kirk Report.

And I must ask if the misstatements of fact contained in the report are of significance at all. Dr. Kirk’s own independent analysis suggests Unit 1 will be approaching the maximum screening limits for embrittlement by 2029 (USE projection). Why is no one on the DCISC raising concern with the implicit contradiction between this 2029 projection and Dr. Kirk’s validation of the Westinghouse PTS Evaluation which states Unit 1 will not reach screening limits until 2044?

D

In my comment to the DCISC in February 2024, I pointed to a 2006 NRC document (Letter granting 37-month extension approval to Nov. 2024*⁴ in which PG&E has asserted and NRC confirmed that Unit 1 would be within 3% of maximum screening limits for embrittlement by Nov. 2024. When I mentioned this document to Dr. Kirk, he indicated that it was of no significance and that it had no bearing on the subsequent Westinghouse conclusions. (See excerpt in Appendix B below.)

E

Neither the Kirk nor Westinghouse Reports makes mention of the 2006 PG&E PTS Evaluation that accompanied the application for a 37-month license extension. The 2006 NRC document granting the extension clearly states that the 37-month extension granted by this document amends the surveillance program requiring a forth capsule be tested by roughly 2009: “The request [for the 37-month extension] ...amends the projected withdrawal for Capsule B to approximately 20.7 EFPY”. (approx. the time of 2009 refueling outage) “This complies with the criteria in ASTM E185-82 for withdrawal of the final capsule of a four capsule program.” On page 21 of Part 2 of the Kirk Report, Dr. Kirk cites a 2008 NRC letter which incorrectly stated that PG&E had met the requirement for all three capsule tests required by the DCP-1 test program. The author of the 2008 NRC letter clearly made an error and was unaware that the surveillance program had been previously amended: “The withdrawal and testing of Capsule V fulfilled the third and final recommendation of ASTM E185-70 for the current Diablo Canyon Unit 1

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operating license”. The Kirk Report reaffirms this error. The error should be noted. To date, Capsule B has never been tested and the 2006 condition of extension approval which allowed them to operate beyond 2021 has still not been fulfilled, although the NRC has granted numerous postponements.

Why is such historical inaccuracy not important to the DCISC? I have brought up this 2006 NRC document before, and no member of the DCISC committee has directly commented on it. The official response I have received is instruction from your general counsel that I am to make no further reference to other “historical documents”. The relevant point is that the NRC clearly thought additional capsule testing was needed on Unit 1 because they had confirmed for themselves the degree of severe embrittlement. This would suggest that additional surveillance testing should be done sooner than later, and not wait until 2028 as Dr. Kirk seems to suggest.

PG&E and the NRC based their 2006 PTS analysis and embrittlement projections based upon the premise that the pre-2004 test data met the credibility requirements as stated in RG1.99 and the NRC’s independent assessment produced calculated results that were within less than 1% deviation from PG&E’s assessment. The extreme correlation between PG&E’s and the NRC’s independent results should be noted. Yet the 2006 NRC-PG&E projection that Unit 1 will reach embrittlement screening limits is not even mentioned in either the 2011 PTS Evaluation or by Dr. Kirk. This PTS analysis that only pre-dates the 2011 Westinghouse PTS Evaluation by five years, and it is not even mentioned as a reference as is customary in such reports to the NRC. The omission is notable and perhaps contrary to NRC procedures. Wichman’s 1998 clarification of GL92-01 (NRC PTS calculation procedures) clearly states:

“..., licensees shall consider plant-specific information that could affect the level of embrittlement. This information includes but is not limited to the reactor vessel operating temperature and any related surveillance program⁵ results.”

Footnote 5 noted above states:

*“Surveillance program results means any data that demonstrates the embrittlement trends for the limiting beltline material, including but not limited to data from test reactors or from surveillance programs at other plants with or without surveillance program integrated per 10 CFR Part 50, Appendix H.”*⁵*

The fact that both the 2011 PTS Evaluation and the Kirk Report fail to mention the 2006 PG&E - NRC-corroborated PTS findings is contrary to NRC procedure and the GL92-01 regulatory guide as clearly defined above. Endorsing the Kirk Report in its current form and without correction or attention to such detail validates these misstatements of historical fact and the omission of prior analysis of embrittlement trends.

Misleading Reassurances Regarding Capsule B Test Delays

There are aspects of the Kirk Report which appear to me to be misleading. Kirk states: “Currently available surveillance data pertinent to Diablo Canyon Unit 1 RPV have already quantified embrittlement at exposure levels that the [DCPP-1] RPV will not reach until after 60 years...indicating that the deferral of the withdrawal and testing of Capsule B has not compromised safety”.*⁶ The Palisades data to which

G

H

continued on next page

Dr. Kirk refers to here did not give Entergy license to operate for 60 years and only gave them an extension to operate under the standard 50.61 regulations until 2017, or for about 5-6 years beyond their original 40-year license. In 2014, it was clear that Palisades could not comply under 50.61 rules beyond 2017 and that they applied for an extension to 2031 on the basis of 50.61a rules (which Dr. Kirk wrote for the NRC). Their embrittlement data failed to meet the test to comply in any other manner.

Under the alternative rules (10CFR50.61a), a severely embrittled RPV is allowed to operate with a much more stringent safety regimen even if the projected RT_{PTS} of the most limiting materials doesn't comply with regulatory screening limits. Additional safety measures under this rule include ultrasonic testing (UT), mapping and monitoring of the flaws and cracks that naturally developed in the RPV steels, and many other safety measures. The fact that Dr. Kirk makes representations that the Palisades "sister plant" data has assured their safe operation for the 60-year operation period is inaccurate. That plant can only qualify under the alternative rules and Dr. Kirk was the primary reviewer of the Palisades 50.61a license application in 2014. He is well aware that Palisades is severely embrittled and that the Palisades operating conditions are entirely different from DCP-1, and that it was operating under the alternative rules from 2017 until it closed in 2022. If the reference is to the 2011 Westinghouse PTS Evaluation for DCP-1, that report was never submitted to the NRC until December of 2023 and the analysis is still under review by the NRC. Neither interpretation is a justification for delaying withdrawal and testing of Capsule B.

The Summary of Key Omissions and Misstatements in the Kirk and Westinghouse Reports

While Dr. Kirk's report seems to repeatedly reassure that "conservatism" are incorporated into the Westinghouse PTS Evaluation, it appears the opposite is the case. Taken separately, the Palisades data (Two capsule sets) and the DCP-1 data (three capsule sets) both indicate severe embrittlement of the critical weld material (Heat#27204). In the case of DCP-1, lower axial weld #3-442C appears to be the "most limiting" (most embrittled) with the 2006 PTS Evaluation (cited above), suggesting a reference temperature of pressurized thermal shock (RT_{PTS}) equal to 258.8°F by Nov. 2024 (within 3% of 50.61 screening limits). The Palisades data indicates even more severe embrittlement with the Palisades 2010 PTS Evaluation*⁷ suggesting their circumferential weld #9-112 (using #27204) approaching 280°F by March of 2011. It is simply remarkable and somewhat implausible that by combining the test data from these two severely embrittled "sister plants", a new mathematical projection is achieved that shows both plants having substantially lower embrittlement (as much as a 64% shift in the data as compared with prior reports). Palisades used the "sum of squares" method outlined in Reg. Guide 1.99 in 2010 and represented that the DCP-1 data was "credible", a term of art which references consistency between predictions and measured results as well as standard deviations in the graphed plots of the data. PG&E used the same method months later with a similar effect of radically lowering the embrittlement forecast for the DCP-1 reactor.

Where the prior hard test data and the 2006 PTS analysis revealed that the DCP-1 reactor materials demonstrate a propensity toward brittle fracture characteristics in lab tests, the new math lowers the value of 'chemistry factors' (CF) that account for the embrittled material properties. The precise composition of the welds had previously been tested (around 1992 at DCP-1) and the percentage by weight of nickel and copper impurities that are the direct cause of the reactors' predisposition to

premature embrittlement were reported to be .21% copper and .98% nickel.*⁸ Those values should not change over time and the regulations incorporate tables to determine “chemistry factors” (CF) based on material property analysis (RG1.99, pg1.99-4). In some references the “table CF” which are extrapolated from the RG1.99-4 table are shown to be 222F, and in other references shown to be 226.8F. Kirk has suggested that “table CF” based on RG1.99 and chemical testing values should not change. So why is it appearing as a different value within the same Westinghouse document? In effect, changing the chemistry factors (CF) allow the data to appear to fall into a tighter standard deviation which in turn can also allow the margin (M, like a margin of error) to also be reduced. Minor changes in the variables can add decades to the projected life of a plant.

M

As noted in Wichman (1998), very small changes in CF result in comparatively large changes in the resulting RT_{PTS} calculations and operational life of the plant.

The Use of “Sister Plant” Data Must Meet 10 CFR50.61 Criteria

Additionally, the 1995 Update to 10 CFR50.61 spells out clear criteria for qualifying “sister plants”.*⁹ Dr. Kirk has stated repeatedly in his report that “NRC requires” that sister plant data be integrated. That is a misstatement. NRC encourages reference to sister plant data, but to use that data to reduce chemistry factors and margin in a sum of squares procedure, the licensee must first demonstrate that the two “sister plants” have similar designs and operating conditions as defined by the 1995 Update to 10CFR50.61. (See footnote 8 and Appendix C) No such sister plant analysis has been performed to date, and the 2011 Westinghouse PTS Evaluation makes no reference to this NRC requirement. Dr. Kirk dismisses the importance of this NRC requirement, and asserts that one can safely assume operational similarities between sister plants. He makes the argument that operational differences are accounted for through application of temperature adjustments. However, it remains an NRC procedure that is clearly required and has not been followed by the 2011 Westinghouse PTS Report. Dr. Kirk’s suggestion that the sum of squares procedure for integrating data from other plants is “required”, fails to address this important qualification criteria.

N

The operational conditions between the two plants (PNP and DCP) are significantly different, and not at all similar as Dr. Kirk’s report suggests would be safe to assume. Earlier capsule testing at Palisades indicated rapid embrittlement of the RPV welds and there was concern that the plant would have to close as early as 1999. For this reason, and from 1999 onwards, Palisades implemented an “Ultra Low Leakage Core Strategy” to reduce the flux (radiation exposure) at the critical welds. This involved a change in the fuel configuration, reduction of generation capacity to 90% (to reduce radiation damage), and the addition of stainless steel shielding to protect the most vulnerable welds. Although DCP operated at 97.9% of its current capacity (3338MWt) until the 10th fuel cycle (about 1992), it has operated at its current 100% capacity (3411MWt) since then. Most significantly, DCP1 has not employed stainless steel shielding at its limiting welds as PNP has, and there is no accounting of this in the Westinghouse PTS Evaluation.

O

Even if the NRC doesn't flag such an oversight, it is still a violation of their regulatory requirement. Therefore, the sum of squares integration of DCP1 and PNP data sets would not be allowed under the requirements of 10 CFR50.61. The Kirk Report suggests that all of these variables are captured by the operating temperature adjustments that made when sister plant is integrated, and while that may be true of the capacity reduction, it would not likely be true of shielding or fuel configuration changes that move fuel away from critical welds. Some of these operational changes may be accounted in the dosimetry (radiation sensors), but that is not safe to assume. The fact that a detailed discussion of such variables and regulatory requirements is completely overlooked by the Westinghouse PTS Evaluation and the Kirk Report is a significant analytical omission.

P

Inconsistent Application of NRC Procedures Based on Changing 'Credibility' of Data

It is important to note that Dr. Kirk dismisses the concerns expressed by Dr. Macdonald and myself about the manner in which PG&E has tried to judge its pre-2004 data "not credible" and in several sections of Part 1 of his report, attributes this to an "apparent misunderstanding of NRC's definition of credibility in the context of embrittlement analysis". The problem is that PG&E waffles on its characterization of the pre-2004 data, using it to apply for a 37-month extension in 2006 as if it is credible and projecting Unit 1 to reach maximum embrittlement screening limits by about 2025 on the basis of this data. This analysis was closely corroborated by the NRC (less than .5% difference in the results). PG&E then refer to the same data in the 2009 License Renewal Application (2009 LRA) to suggest Unit 1 will far exceed the 270F screening limits by 2044.

Q

By the end of 2010, PG&E appears to be in communication with Palisades about their use of the sum of squares method to demonstrate compliance through April of 2017. At the same time that PG&E is claiming that their pre-2004 data is not credible (as per RG1.99 definitions), Palisades is assuming that the data is credible. However, the 2011 DCP PTS Evaluation by Westinghouse appears to be an effort to replace the 2006 PTS Evaluation, and the data is judged "not-credible" at the beginning of their sum of squares procedure.

R

This appears to be a violation of the rules as set out in RG1.99 Position 2.1 which allow the use of the sum of squares procedure only if your data is deemed credible. The precise language in RG1.99 suggests that if two or more sets of surveillance data are deemed credible, then Position 2.1 can be used to determine chemistry factors based on a best fit of the data. In the 1998 update to GL92-01, Case 5 as presented by Wichman clearly states that 5 out of 6 data sets (87%) must be deemed "credible" to use the sum of squares procedure. If only 2 of 5 data sets are deemed credible (2 Palisades capsules were judged credible), the sum of squares procedure cannot be used to lower the margin and CF values as performed in the 2011 Westinghouse PTS Evaluation. (See RG1.99, Position 2.1). This appears to be inconsistent with NRC procedures.

S

One must ask, how can PG&E waffle about the credibility of the same 3 sets of data over time? The inconsistencies clearly raise questions regarding whether PG&E has actually followed NRC procedure as Kirk has asserted. PG&E has waffled in their position on credibility since 2001 depending upon what

T

their goals were at the time. Such inconsistencies, though buried in historical documents, have direct bearing as to whether the 2011 Westinghouse PTS Evaluation follows correct procedures.

The Applicability of Embrittlement Trend Curves is Overstated

A great deal of merit is given in the Kirk Report to the NRC's multi-decade effort to gather data from all nuclear plants and correlate the results of their materials testing programs (surveillance programs) to improve the accuracy of the results and this in fact has been done with great success in most cases. Kirk is correct to note the value of correlating data regarding the embrittlement of the same weld and plate materials used across a range of plants, and one can see that would lead to greater certainty in the calculations, because as the amount of data available increases, the uncertainty and range of standard deviations generally decreases. The more data, the more clear patterns emerge from it.

What is different about DCP-1 is that it is only one of two plants in the world still in operation that contain the flawed weld material (heat#27204) which was recognized by Westinghouse to be substandard immediately after delivery of the Unit 1 RPV. The metallurgical specifications were revised before Unit 2 was delivered. Because of the early recognition that the 27204 weld material was flawed, very few reactors in the world contain this material. There have only been five "capsule tests" in the entire world that we know of using this material as evidenced by NRC's extensive review.

U

Because of that fact, there is little opportunity to review a broader base of data gathered industry wide and review the embrittlement trend curves (ETCs) as Dr. Kirk suggests. This is a false assurance. Test data beyond the five capsules included in the Westinghouse PTS Evaluation do not exist. What we have are three capsule tests at DCP-1 (multiple samples in each test capsule), and two capsule tests from the

Palisades Nuclear Plant in Michigan. By 1992, raw samples of the 27204 weld material proved impossible to obtain and that is why Capsule B (still in the Unit 1 RPV) only contains broken fragments of previously tested samples of the 27204 weld material. This is important historical context, because there is insufficient test data industry-wide to analyze with accuracy how embrittled the DCP-1 welds actually are, and the data that we do have from Palisades (circumferential weld #9-112) indicate that the

V

reference temperature of pressurized thermal shock (RT_{PTS}) was reaching regulatory limits by 2011 or at effectively 40 years of operation. Through minor changes to chemistry factors, this was extended to 2017. The 2006 DCP-1 PTS Report to the NRC suggested it was also highly embrittled by 40 years of operation, reaching to within 3% of the maximum regulatory screening limits by Nov. 2024 (258.7F). NRC's calculations and assessment of PG&E's pre-2004 test data confirmed their conclusions to within less than .05% variation in the calculated results. Given this context of prior embrittlement analyses, it appears to be highly implausible, that the sum of squares procedure used in the Westinghouse can be

correct. A linear extrapolation of the reported 2006 PTS results appear to suggest that the jump in the embrittlement data contained in the 2011 Westinghouse Evaluation represents a 64% shift in the embrittlement projections. How is that plausible? Since no other nuclear plants employ this rare,

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substandard material, there is no broader base of industry experience that would suggest embrittlement trend curves based on "generic" data from other plants exists or reduces these uncertainties.

A Short List of Inaccuracies and Concerns Regarding the Kirk and Westinghouse Reports

In the following several pages, I will summarize in bullet form the most relevant facts pertaining to the Kirk Report and the accuracy of its conclusions. I believe that all of these considerations taken together weigh heavily against “endorsement” of the Kirk Report:

- Page 9, Item 1** 1) **According to PG&E’s own 2006 projections and corroborated by the NRC, Unit 1 will be within 3% of maximum embrittlement ‘screening limits’ as defined by the Federal Code of Regulations by November 2024.** This projection of embrittlement was based on “hard data”, (Charpy stress tests) performed on material samples and indicated some samples demonstrated “fast fracture”, characteristic of embrittlement. The “reference temperature” or RT_{PTS} value was projected to be 258.7°F by Nov. 2024. Note that the 10CFR50.61 screening limit is <270F. By independent calculation, the NRC calculated this value to be 258.8°F, a remarkable confirmation of both their mathematical accuracy and their faith in the pre-2004 data.
- Page 9, Item 2** 2) **There is considerable evidence that both the PNP and DCP Unit 1 reactor pressure vessels are severely embrittled, and yet these are the only data sets available as inputs into the DCP PTS Evaluation. For this reason, further investment in Unit 1 should be postponed awaiting further data.** PG&E has failed to report on their 2006 PTS Evaluation confirmed by the NRC as it is not even mentioned in either the Kirk or Westinghouse Reports.
- Page 9, Item 3** 3) **Immediately after delivery of the Unit 1 RPV in the late 1960’s, Westinghouse admitted to PG&E that Unit 1 contained weld material with metallurgical deficiencies in the form of impurities of copper and nickel that would predispose the RPV to premature failure.** Dr. Kirk rather absurdly argues that these “flaws” were not “flaws” or “errors” because the metallurgical issues were not understood at the time. However, window dressing aside, the historical significance of the known substandard metallurgy is the point. The mathematical predictions in the 1986-2003 capsule reports also took into account the known impurities in the RPV weld material, and the physical stress test indicated there was a predisposition for brittleness.
- Page 9, Item 4** 4) **This historical context has been omitted from the Kirk Report.** Given that the Kirk report was reviewed unilaterally by PG&E for historical accuracy, and no opposing parties were engaged in such discussion, and because there are significant historical inaccuracies in the Kirk Report which are contradicted by the NRC record, it is difficult to express confidence in the ‘independence’ of this reporting.
- Page 9, Item 5** 5) **Kirk’s citation of a 2008 letter from the NRC indicates that NRC had by then forgotten the 2006 conditions of license extension approval that the embrittlement stress test program (“surveillance program”) was amended by the July 17, 2006 letter of approval which required an additional capsule test (Capsule B) be conducted by 2009.** Because PG&E has waffled on the issue of credibility of their data, there are a great deal of questions about the actual state of the Unit 1 reactor. PG&E continues to oppose immediate retesting of previously tested samples under test methods that are known to be credible. Since Capsule B may not be tested until 2028, why is the DCISC not moving to retest samples that are already in hand?
- Page 9, Item 6** 6) **By 2011, PG&E reassessed all of their pre-2004 to be “not-credible” and in a manner that appear to be inconsistent with NRC procedures as defined in Reg. Guide 1.99.** First, PG&E claimed one data point in the capsule Y set was out of standard deviation range and then

eliminated the entire set. This directly violated GL92-01 which states: “A priori exclusion of some data based on ‘inconsistency’ with expected norms should not be used before analysis for statistical outliers is conducted.” Then PG&E claimed that the two remaining “credible” sets did not meet the minimum number of sets required to regard them as “credible”. This seems to violate Reg. Guide 1.99, criterion 3 which clearly states that you need only two sets of credible data for each “limiting material” (most embrittled) to regard them as “credible”. PG&E had the minimum two sets for each material, but the NRC did not question this incorrect interpretation of data set credibility criterion.

Page 10, Item 7 7) **The DCISC has not weighed in on the fact that PG&E set aside the 2006 PTS Evaluation (maximum embrittlement by 2025) by means that do not appear to comply with NRC regulations.** There should at least be a motion to include reference to the earlier PTS projections in the Westinghouse PTS Evaluation as is customary. The DCISC hired Dr. Kirk to make recommendations to them and he now claims that the 2011 Westinghouse PTS Evaluation is consistent with NRC procedure when it appears that there were many critical omissions. It is fairly clear that several NRC procedures were not followed and that Dr. Kirk has overlooked details required by NRC procedures.

Page 10, Item 8 8) **While the Kirk Report assures “conservatisms” in at least a dozen places, a review of Tables 5.1-1, 5.1-2 and 6.1-1 and 6.1-2 in the Westinghouse report quickly reveals that the Westinghouse PTS Evaluation uses the least conservative surveillance-based chemistry factors. The Westinghouse PTS Evaluation appears to employ a sum of squares procedure that is only allowed under RG1.99, Position 2 when all data sets are credible.** Wichman 1998 modifies this requirement to allow sum of squares procedure when 5 of 6 data sets are credible (83%). The numerous references to “conservatisms” by which Dr. Kirk assures a margin of safety to the public when non-credible sets are used are false assurances. In the final analysis, the Westinghouse PTS Evaluation employs the LEAST CONSERVATIVE chemistry factors based upon a sum of squares procedure with questionable results. All conservatisms have been eliminated by reducing both the chemistry factors and the margin (M) resulting in the a significant reduction of the projected level of embrittlement for both DCP and Palisades. Both RPVs previously appeared to be among the most embrittled RPVs in the US.

Page 10, Item 9 9) **In 2013, in response to questions at a public meeting regarding the Palisades RPV embrittlement, the NRC responded in writing admitting that Palisades and DCP-1 were among the five most embrittled reactors in the US at that time.** Due to retirements of older plants that used the 27204 weld material, these two plants are the only remaining in the US to use the #27204 weld material are now among the four most embrittled plants in the US. (See NRC proceeding written response to public concern about Palisades embrittlement, Appendix A)

Page 10, Item 10 10) **Dr. Kirk performed his own calculation of “upper shelf energy” (USE), a second embrittlement metric, and found Unit 1 would reach maximum embrittlement screening limits by 2029 and only if it is operated with a reduced capacity factor of 85% to 95%.*¹⁰** This is in direct contradiction to Dr. Kirk’s support of the 2011 Westinghouse PTS Evaluation conclusions. However, to his credit, Dr. Kirk does suggest additional embrittlement testing to confirm the status of the Unit 1 RPV and suggests that the mini-CT test methodology is perhaps more accurate than the 100-year old Charpy methodology. Dr. Macdonald agrees with this suggestion.

However, Dr. Kirk affirms the 2011 Westinghouse conclusion that embrittlement is within regulatory limits until 2044, and he dismisses his own USE calculations without a clear explanation of the contradiction.

Despite these many concerns, the DCISC has already moved to “endorse” the Kirk Report and only narrowly elected to defer the vote on endorsement until the June meeting. Strong arguments were made both for and against waiting for Dr. Macdonald to submit his analysis despite his fight with Covid at the time. It is my earnest hope that this distinguished committee will not disregard the opposing view and consider that there may have been merit to the 2006 PG&E and NRC PTS Evaluation which clearly indicated severe embrittlement by 2025.

When there is so little data, and PG&E has called the credibility of their own data into question, why not at least discuss the possibility of more immediate micro-CT testing to verify the status of Unit 1 embrittlement? Why rush to endorse a report with so many apparent contradictions and inaccuracies?

The only reason this is being rushed to an approval is that many state agencies and the legislature are looking to the DCISC to make a clear determination as to whether Unit 1 is worthy of additional investment. The problem is that the Westinghouse PTS Report written in 2011 doesn’t actually answer this question, because it cannot. It is written in esoteric engineering language that translates into a “green light” without the needed assessment of real potential risks, both in regards to safety and financial. If even two of the above ten summarized concerns proves to be true, the DCISC should not vote to endorse the Kirk Report. Doing so will send a false signal to the state regarding the worthiness of the DCCP Unit 1 reactor. Where the Westinghouse PTS Evaluation fails to provide the much promised “conservatism”, it will be up to the DCISC to provide a more conservative and calculated assessment of the Kirk Report. It is my hope that you will closely examine these details as a great deal rests on your determinations.

PG&E’s methods of revising embrittlement projections should be more deeply analyzed by anyone interested in whether the State’s \$300M gamble on DCCP is in fact a “safe bet”. Alternative test methodologies exist that would produce new data sets based on retesting of archived material samples and they should be employed immediately to minimize risk to the state. If the State is gambling \$1.4B on repairs and continued operation of DCCP, why are we not testing these immediately accessible test samples in order to make a more informed financial decision for the State and its citizens? How much would it cost, \$500k, \$1M? I have raised this in prior comments, letters and during public meetings over the last year, and the DCISC has yet to discuss the possibility.

In closing, it is important to qualify my statements, that as a member of the DCDEP, I do not speak on behalf of that body and my conclusions are my own. I have worked for director and VP level staff as a Regulatory Compliance Engineer for a large company for many years, but my efforts to research DCCP embrittlement are completely voluntary, and have never been paid by anti-nuclear organizations or affiliated with them. I am supportive of running Unit 2 for ten years rather than both reactors for five, as this would be a far better investment than gambling state funds on Unit 1.

Bruce Severance, Regulatory Compliance Engineer, Energy Policy Analyst, submitted April 15, 2024, 5pm

Footnotes:

- *1 An Evaluation of the Status of Diablo Canyon Unit 1 with Respect to Reactor Pressure Vessel Condition , Monitoring and Prediction, Part 1 and 2, Dr. Mark Kirk, Consultant for the DCISC, Phoenix Engineering Associates, Inc., Unity, New Hampshire, January 26, 2024
- *2 Diablo Canyon Units 1 and 2 Pressurized Thermal Shock and Upper Shelf Energy Evaluations, Westinghouse Electric Company LLC, WCAP-17315-NP, July 2011
- *3 NRC written response to public concerns about severe embrittlement at Palisades, published by NRC, 2013 (See Appendix A)
- *4 Letter from NRC to PG&E approving 37-month license extension for DCP-1, July 17, 2006, NRC Docket #ML061660220, pg, 4 (see Appendix B for excerpt below)
- *5 Generic Letter (GL)92-01 and RPV Integrity Assessment, Kieth R. Wichman, NRC Workshop on RPV Integrity Issues, elaborates on GL92-01 (1992), Feb. 12, 1998, pdf p.19
- *6 An Evaluation of the Status of Diablo Canyon Unit 1 with Respect to Reactor Pressure Vessel Condition , Monitoring and Prediction, Part 1, p.4, Dr. Mark Kirk, Consultant for the DCISC, Phoenix Engineering Associates, Inc., Unity, New Hampshire, January 26, 2024
- *7 Revised Pressurized Thermal Shock Evaluation for the Palisades Reactor Pressure Vessel, Attachment to cover letter from Entergy Nuclear Operations, NRC# ML110060692, Structural Integrity Associates, Inc. Report #1000915.401, Nov. 2010
- *8 Analysis of Capsule V from the Pacific Gas and Electric Diablo Canyon Unit 1 Reactor Vessel Radiation Surveillance Program, Westinghouse Corp., WCAP-15958, Jan. 2003, Table 4-3, pg. 4-4
- *9 the 1995 Update to 10 CFR 50 (Code of Federal Regulations, Federal Register, Vol. 60, #243, December 19, 1995, p. 65476 (See Appendix C, below, for excerpts)
- *10 An Evaluation of the Status of Diablo Canyon Unit 1 with Respect to Reactor Pressure Vessel Condition , Monitoring and Prediction, Part 2, p.40, Dr. Mark Kirk, Consultant for the DCISC, Phoenix Engineering Associates, Inc., Unity, New Hampshire, January 26, 2024 (See also Appendix D, below)

Appendices A-D document history of Unit 1 embrittlement issues on following pages

Appendix A: A 2013 NRC written response to public question regarding the reactor integrity of Palisades which mentions DCPP-1 and Palisades as among the four most embrittled reactors in the US. Note that Dr. Kirk was presiding as an official of the NRC at these public listening sessions and the responses:



**UNITED STATES
NUCLEAR REGULATORY COMMISSION**
REGION III
2443 WARRENVILLE ROAD, SUITE 210
LISLE, IL 60532-4352

April 18, 2013

LICENSEE: Entergy Nuclear Operations, Inc.
FACILITY: Palisades Nuclear Plant
SUBJECT: SUMMARY OF THE MARCH 19, 2013, PUBLIC MEETING WEBINAR
REGARDING PALISADES NUCLEAR PLANT

PUBLIC MEETING PRINCIPAL ATTENDEES

March 19, 2013

NRC Attendees

C. Pederson, Deputy Regional Administrator, RIII
J. Giessner, Chief, Division of Reactor Projects, Branch 4
M. Kirk, Senior Materials Engineer, Office of Nuclear Regulatory Research
M. Holmberg, Senior Reactor Inspector, RIII

4. Which are the other most embrittled plants in the U.S.? How many PWRs will reach their screening criteria in the next 10 years?

The NRC currently estimates that the following plants will exceed the PTS screening criteria of 10 CFR 50.61 during their 20-year period of operation beyond their original 40 year licenses. Updated fluence calculations, capacity factors changes, power uprate, new surveillance data, and improved material property information (i.e., the use of direct rather than correlative measurements of the vessel material's resistance to fracture) can change these estimates. For example, Point Beach has made a recent licensing submittal that seeks to use improved material property information to re-evaluate the level of embrittlement in the vessel. If approved, it is estimated that Point Beach would not exceed the screening criteria of 10 CFR 50.61 during their 20-year license extension period.

1. Point Beach 2 (2017)
2. Palisades (2017)
3. Diablo Canyon 1 (2033)
4. Indian Point 3 (2025)
5. Beaver Valley 1 (2033)

Appendix B: *Excerpt from NRC July 17, 2006 Letter approving 37-month extension and showing Unit 1 will reach maximum embrittlement (RT_{PTS} screening limits) by PG&E's own calculation and validating the credibility of the pre-2004 embrittlement stress test data (1986, 1992, 2003 capsule tests):*

The NRC staff performed independent calculations of the RT_{PTS} values for the RV beltline materials at DCP-1/2 through the revised expiration dates for the DCP-1/2 operating licenses. The NRC staff used the methods of analysis in 10 CFR 50.61 as the basis for its independent RT_{PTS} calculations. The NRC staff applied the updated clad-to-base metal neutron fluences that were provided in PG&E Serial Letter No. DCL-06-045.

The NRC staff determined that for DCP-1, Lower Shell Axial Weld No. 3-442C (Heat No. 27204) is the limiting beltline material for PTS. The NRC staff calculated a RT_{PTS} value of 258.8 EF for this weld at 35.2 EFPY. This value is in agreement with the RT_{PTS} value calculated by the licensee for this weld (i.e., 258.7 EF) at 35.2 EFPY. Both of these values meet (i.e., are lower than) the PTS screening criterion of 270 EF in 10 CFR 50.61 for RV axial weld materials at the end of the operating license (EOL) and are acceptable.

The NRC staff determined that for DCP-2, Intermediate Shell Plate No. B5454-2 (Heat No. C5168-2) is the limiting beltline material for PTS. The NRC staff calculated a RT_{PTS} value of 214.8 EF for this weld at 35.8 EFPY. This value is in agreement with the RT_{PTS} value Un-irradiated RT-NDT value of limiting weld is -56F, so total range of embrittlement is 326F (-56 added to 270F. RT-PTS screening limit) at 258.8F Unit 1 has used up 315F of their 326F 'runway', or 97% of their allowed embrittlement without triggering repairs or other significant measures. This projected RT-PTS value was confirmed precisely by NRC based on pre-2004 stress test data. An extrapolation based on rate of embrittlement suggests they have until mid-2026 at the latest.

From page 4 of NRC's July 17, 2006 letter of approval of PG&E's request for a 37-month operational extension for DCP Unit 1 (NRC docket number ML061660220)

EXHIBIT C ON FOLLOWING PAGE

Appendix C: *The following is an excerpt of some of the criteria required by the NRC in order to qualify a “sister plant” as operationally similar enough to compare and integrate surveillance data.*

Criteria required in order to be permitted
to share data between RPVs (1995 Update
to 10CFR 50.61 p.65476 (Amends Append. H)

III. Surveillance Program Criteria

C. Requirements for an Integrated Surveillance Program.

1. In an integrated surveillance program, the representative materials chosen for surveillance for a reactor are irradiated in one or more other reactors that have similar design and operating features. Integrated surveillance programs must be approved by the Director, Office of Nuclear Reactor Regulation, on a case-by-case basis. Criteria for approval include the following:

a. The reactor in which the materials will be irradiated and the reactor for which the materials are being irradiated must have sufficiently similar design and operating features to permit accurate comparisons of the predicted amount of radiation damage.

b. Each reactor must have an adequate dosimetry program.

c. There must be adequate arrangement for data sharing between plants.

d. There must be a contingency plan to assure that the surveillance program for each reactor will not be jeopardized by operation at reduced power level or by an extended outage of another reactor from which data are expected.

e. There must be substantial advantages to be gained, such as reduced power outages or reduced personnel exposure to radiation, as a direct result of not requiring surveillance capsules in all reactors in the set.

2. No reduction in the requirements for number of materials to be irradiated, specimen types, or number of specimens per reactor is permitted.

3. After (the effective date of this section), no reduction in the amount of testing is permitted unless previously authorized by the Director, Office of Nuclear Reactor Regulation.

Note: “Integrated surveillance programs must be approved by the Director, office of Nuclear Reactor Regulation on a case by case basis....”

“Must have sufficiently similar design...”

“There must be a contingency plan to assure that the surveillance program for each reactor will not be jeopardized by operation at reduced power level or by an extended outage of another reactor from which data are expected.”

Palisades was operated at reduced power (95% capacity) since 1999.

APPENDIX D ON FOLLOWING PAGE

Appendix D: Dr. Kirk states on Page 40 of Part 2 of his Report that further embrittlement testing should be performed and that his own evaluation of “upper shelf energy” another embrittlement metric indicates Unit 1 approaching 50.61 screening limits as early as 2029. Despite this independent conclusion, Dr. Kirk asserts the Westinghouse Report follows NRC procedures and validates Unit 1’s safe operation until 2044:

Kirk: USE reaching max by 2029-30. Need for more testing. Kirk Report, Part 2p.40

Limiting weld at DCPD to fall below 1/4T USE of 50fb by 38.5EFY of 2029 at 85-95% power. Proof of bad, risky investment

Since the [RG1.99R2] procedure requires that its trend curve be adjusted to bound all available data, the [RG1.99R2] representation of this similar data set becomes the red curve shown in Figure 10. Figure 11 shows the resultant prediction, based on the red curve, of irradiated USE and how it decreases with increasing fluence. The blue and green vertical lines show the 1/4T fluence values for the Unit 1 RPV at the end of 40 and 60 years of operation (32 and 54 EFY, respectively). This analysis suggests that the Unit 1 RPV could fall below the [10CFR50-AppG] 68 J screening criteria sometime during its license renewal period. More specifically, the limiting weld in the Unit 1 RPV is forecast to fall below the 68J screening criteria at a fluence of 0.87×10^{19} n/cm², which should occur at the 1/4T after 38.5 EFY of operation. Assuming a future capacity factor between 85-95%, 38.5 EFY will be reached in the year 2029 or 2030.

Were it determined to be appropriate to consider all similar data as part of a USE analysis then an equivalent margins analysis performed following the guidance of Regulatory Guide 1.161 would be needed to demonstrate adequate safety margins for Diablo Canyon Unit 1 [RG1.161] after 2029-2030. The NRC would require such an analysis to be submitted three years before the plant is forecast to fall below the 68 J screening criteria [10CFR50-AppG]. Equivalent margins analyses performed on other reactors have, without exception, demonstrated that continued operation at USE values considerably below 68J is acceptable, see [WCAP-17651] and [ANP-3646] as examples.