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PG&E Letter DCL-05-017

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Docket No. 50-275, OL-DPR-80
Diablo Canyon Power Plant Unit 1
Reply to Request for Additional Information Regarding: Special Report 04-02 - Results of Steam Generator Inspections for Diablo Canyon Power Plant Unit 1 Twelfth Refueling Outage

Dear Commissioners and Staff:

On September 7, 2004, PG&E Letter DCL-04-112, "Special Report 04-02 - Results of Steam Generator Inspections for Diablo Canyon Power Plant Unit 1 Twelfth Refueling Outage," submitted the results of steam generator inspections performed during the Unit 1 twelfth refueling outage (1R12). The purpose of the letter was to provide technical information in accordance with Technical Specifications 5.6.10.e, 5.6.10.f, and 5.6.10.h, and commitment to industry guidance contained in NEI 97-06, Revision 1, and Generic Letter 95-05, "Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking (ODSCC)."

On October 20, 2004, the NRC requested additional information regarding Special Report 04-02 (TAC MC4433). PG&E's response to the NRC's questions regarding the 1R12 inspection is enclosed. If you have any questions or require additional information, please contact John Arhar at (805) 545-4629.

Sincerely,

Donna Jacobs

ddm1/469
Enclosure

cc: Bruce S. Mallett
David L. Proulx
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cc/enc: Girija S. Shukla

A047

Reply to Request for Additional Information Regarding: Special Report 04-02 - Results of Steam Generator (SG) Inspections for Diablo Canyon Power Plant (DCPP) Unit 1 Twelfth Refueling Outage (1R12)

PG&E Letter DCL-04-112 dated September 7, 2004, submitted the DCPP 1R12 SG tube condition monitoring and operational assessment (CMOA) report. On October 19, 2004, PG&E received a NRC request for additional information (RAI). The NRC questions and PG&E responses are provided in this enclosure.

W-Star (W*) Alternate Repair Criteria (ARC)

NRC W Request 1:*

- *It was indicated that accident induced leakage was not postulated for the indications detected in the plug expansion zone since the indications are located within the original shop hard roll, such that leakage is precluded during all plant conditions. Qualitatively discuss how far below the end of the shop hard roll these indications were. Given that these tubes were subjected to a tungsten inert gas (TIG) relaxation process, discuss the extent to which this process would have relaxed the tube-to-tubesheet joint such that leakage may occur.*

PG&E W* Response 1:

Table 1 provides the location, relative to the bottom of the hot leg tube end, of the upper and lower extent of each set of indications detected in the plug expansion zone in 1R12. This data supplements Table 4 of Enclosure 1 of DCL-04-112 dated September 7, 2004 (90-day report for W* alternate repair criteria (ARC)). There are 136 tubes listed in Table 1, and 7 of these tubes were plugged in 1R12. As a clarification to DCL-04-112, a total of 129 tubes are classified as W* tubes. The shop hard roll ends about 2.75 inches above the tube end, although there may be a few occurrences with an extra hard roll step that extends the hard roll distance. All indications were located within 2.75 inches of the tube end, with the exception of one tube: R17C9 at 3.15 inches. The data for this tube was re-reviewed and the indication was verified to be below the hard roll transition.

The Framatome ANP Qualification Program for the TIG relaxation process included the removal of both rolled and ribbed plugs. The results of the testing indicated that the tube inside diameter (ID) wall was not affected by the tigging or the jacking removal of the plug. The process does not permit sufficient heat to the tube ID to allow relaxation of the tube-to-tubesheet joint. No indications of tube diameter change have been detected on the nondestructive examination (NDE) inspections of these tubes at DCPP. Even if some relaxation of the rolled joint did occur in the DCPP tubes, primary-secondary leakage through the plug expansion zone (PEZ) indications would be very unlikely since the remaining 18 to 19 inches of WEXTEX expansion is still intact.

NRC W Request 2:*

- *A differential pressure of 2560 pounds per square inch (psi) is used for predicting the leakage for indications in the tubesheet region; however, a differential pressure of 2405 psi is used for other degradation mechanisms. For flaws in the free span, a higher differential pressure results in a higher leak rate and is conservative. For flaws in the tubesheet, a higher differential pressure results in a higher contact pressure (i.e., a "tighter" tube-to-tubesheet joint). This higher contact pressure may reduce or eliminate any increase in leakage as a result of the higher differential pressure. Please discuss whether the existing leakage model (DENTFLO) and the existing database support a conclusion that a higher differential pressure (2560 psi versus 2405 psi) will result in increased leakage for flaws in the tubesheet region.*

PG&E W* Response 2:

This appears to be similar to a question from the NRC dated August 12, 2003, which requested "an analysis of whether assuming a differential pressure of 2560 psi provides a conservative estimate of the leakage for flaws within the tubesheet region (when compared to the leakage estimates assuming a differential pressure of 2405 psi)." Pages 9 and 10 of the enclosure to PG&E Letter DCL-03-139 dated October 31, 2003, provided a response to the RAI, and that response is also applicable to the current RAI. The response is summarized below:

It is not believed that higher differential pressures cause tube tightening within the tubesheet to the extent that leak rates are suppressed. The data presented in Table 6.2-2 of WCAP-14797, Revision 1, clearly show that there is no trend for the leak rate to decrease as a function of the increase in internal pressure in the tube in tests ranging from 1620 to 2650 psi. These results would indicate that increasing pressure differential across the crack face is more influential on leakage than the associated increase in contact pressure between the tube and tubesheet.

NRC W Request 3:*

- *The end-of-cycle 12 accident induced leakage was underpredicted based on the 1R11 inspection results. The underpredictions were insignificant. Nonetheless, the results indicate that flaws may grow greater than anticipated with the existing methodology and that new flaws may initiate with time (which is not accounted for in the existing methodology). Please discuss your plans to assess the need to alter the methodology to account for these observations so as to ensure that tube structural integrity is maintained and accident induced leakage limits are not exceeded.*

PG&E W* Response 3:

There is no need to alter the methodology to account for new flaws or for flaws that may have growth rates that are greater than anticipated to ensure that tube structural integrity is maintained and accident induced leakage limits are not exceeded.

Regarding maintenance of structural integrity, the existing W* ARC method contains the following performance criterion: The upper crack tip (UCT) of W* indications returned to service under W* ARC in the prior inspection shall remain below the top of tubesheet (TTS) at the end of cycle (EOC) 12 by at least the NDE uncertainty on locating the crack tip relative to the TTS. As discussed in the 90-day report, the EOC 12 crack tip for indications returned to service in the prior inspection is below the top of tubesheet. Therefore, this performance criterion was satisfied for condition monitoring at EOC 12.

Regarding contributions of new flaws to accident induced leakage; this question is similar to an NRC question dated August 12, 2003, which requested a description of possible methodology changes to include new indications in projections. PG&E letter DCL-03-139 dated October 31, 2003, provided PG&E's response to the RAI, and that response is also applicable to the current RAI.

PG&E believes that the W* ARC methodology for operational assessments does not need to include projections of new or undetected indications based on considerations of the low likelihood that new indications would leak, and the conservatisms included in the leak rate methodology including deterministic analysis methods for leakage.

New or undetected indications are not expected to have a throughwall length sufficient to result in leakage after one cycle of operation. A throughwall indication is expected to have a Plus Point voltage exceeding 2.5-volts. As explained in the 1R12 90-day report, the one new indication in the W* length located in SG 1-3 R10C20 is only 0.44 volts and not expected to leak at steam line break (SLB) conditions. The in-situ screening data of Table 2 of Enclosure 1 of the 90-day report show that none of the 1R12 W* indications have voltages exceeding the 2.5-volt threshold. Of these 16 indications, 12 have Plus Point volts less than 1.0 volt, 2 have voltages between 1.0 and 2.0 volts, and only 2 have voltages between 2.0 and 2.5 volts. These data support the W* methods assumption that new indications would have negligible contributions to SLB leakage.

As indicated in DCL-03-139, based on the considerations that new indications are not expected to be throughwall for leakage and that the W* ARC analysis methods are very conservative, there is no need to modify the methods to include new indications in the projections. It can be expected that new indications will sometimes lead to the calculated condition monitoring (CM) leak rates exceeding the projections. However, given the very conservative CM analysis that assumes all indications, including new and prior indications, are throughwall (even though no leakage would be expected for the low voltage 1R12 indications) the CM analysis is conservative and the conservatisms in the OA analysis are adequate to conservatively bound the true leak rate.

The 90-day report indicated that the slight SG 1-1 leak rate underprediction is attributed to a repeat indication in R3C2 (only 0.61 volt Plus Point, not expected to leak at SLB conditions), which had a growth rate that was larger than anticipated in the prior cycle operational assessment (OA) (0.118 inch per effective full power year (EFPY) as found versus 0.081 inch/EFPY used in prior cycle OA). The sizing profile of R3C2 was rereviewed and was determined that the upper and lower crack tips were conservatively over estimated, such that the CM leak rate was over estimated for this indication. The revised CM leak rate is 0.021 gpm, which matches the prior cycle projected OA leak rate. Therefore, the SG 1-1 leak rate was not underpredicted. The corrected growth rate of the indication is 0.025 inch/EFPY.

Table 2 provides a corrected 1R12 W* table, which supersedes Table 1 of the 90-day report. Also included is a column titled "OA Leak Rate" that provides the prior cycle OA projected leak rates for comparison. The 95% growth rate of 0.119 inch/EFPY for Unit 1 EOC 13 projections is still used for conservatism, although a slightly lower 95% growth rate could have been used due to the R3C2 growth rate correction.

<u>*NRC W* Request 4:*</u>

- *Please clarify the statement on page 1-5 of Enclosure 1 to your September 7, 2004 letter, that the updated growth rate is 0.119-inch per effective full power year, "identical to the pre-1R12 growth rate (includes data through 2R11)." In particular, address whether the pre-1R12 growth rate was 0.081-inch per effective full power year (as indicated elsewhere in the report) or 0.119-inch per effective full power year.*

<u>PG&E W* Response 4:</u>

The following table provides the 95% cumulative growth rates since 2R10. Based on this data, the 95% growth rate used in the Unit 1 Cycle 12 predictions was 0.081-inch/EFPY. The 95% growth rate used in the Unit 1 Cycle 13 predictions was 0.119-inch/EFPY, which is the same rate as the pre-1R12 growth rate.

Outage	Number of growth points cycle	Number of growth points cumulative	Cumulative 95% growth rate (inch/EFPY at 604°F)
2R10	66	97	0.081
1R11	11	108	0.071
2R11	74	182	0.119
1R12	15	197	0.119

Primary Water Stress Corrosion Cracking (PWSCC) ARC

NRC PWSCC Request 1:

- *Three axial primary water stress corrosion cracks were detected at cold-leg tube support 7C. These indications were found as a result of the rotating probe examinations performed in the U-bend region of rows 3 to 10 (i.e., for detection of stress corrosion cracking in the bend area). Please discuss the magnitude of any dents/dings that may have been at these locations. Please discuss whether the indications were identified during the routine analysis of the bobbin coil data. Given that these indications were found on the cold-leg (and not at the next highest temperature tube support and presumably not detected with the bobbin coil), please discuss the need to increase the sampling of dents (e.g., to perform a sampling of dents at all tube support plate elevations).*

PG&E PWSCC Response 1:

The 3 SG 1-2 axial PWSCC indications at 7C are located in R3C46 (2.87 volt dent), R6C55 (3.05 volt dent), and R7C31 (4.14 volt dent). These dent signals have been called every outage since the sixth refueling outage (1R6). The axial PWSCC indications were not found by routine analysis of the bobbin coil data. They were found as a result of the Plus Point examinations performed in the U-bend region of rows 3 to 10.

PG&E has assessed the potential need to increase sampling of dents at all tube support plate (TSP) elevations. The reason that PWSCC was detected at 7C in 1R12, and not at an earlier inspection, was that these 7C dents had never been inspected with a rotating coil in any prior inspection.

Table 3 provides the 1R12 greater than 2-volt dent distributions with corresponding number of 1R12 Plus Point dent inspections. Axial PWSCC has currently progressed to 4H, 7C, and 6H in SGs 1-1, 1-2, and 1-4, respectively. These elevations are referred to as the critical areas. It is very unlikely that there are undetected axial PWSCC indications at elevations above these TSPs, or below for the cold leg, based on the large sample of Plus Point inspections of dents at these elevations and the very small number of dents at 6C and below. (Note that axial PWSCC has not been detected in SG 1-3 based on Plus Point sampling of >2-volt dents at each hot leg TSP elevation every outage.) Nonetheless, given that new indications were found on the cold leg and not at the next highest temperature TSP elevation, PG&E will augment the 1R13 Plus Point dent inspection plan by inspecting 100% of >2-volt hot and cold leg dents that have never been previously inspected with Plus Point, regardless of the TSP elevation. The purpose of this inspection is to validate the Unit 1 SG critical areas. This augmented Plus Point inspection plan was also conducted in 2R12 to validate the Unit 2 SG critical areas.

NRC PWSCC Request 2:

- *A circumferential indication was detected at a dent whose magnitude was 0.51 volts. This dent resulted in the expansion of your rotating probe examination at the tube support plate in which this indication was detected and the next highest tube support plate (in the affected steam generator). The indication detected was considered small. Please discuss why this specific location was inspected with a rotating probe (since it did not appear to meet the dent inspection criteria). Given that cracks may be observed at dented locations and may not follow a pattern of being observed at the hottest location (see previous question), discuss the need to significantly expand the scope of the rotating probe inspections in future inspections to ensure that circumferential cracks are being promptly detected. In other words, discuss how you assessed the integrity of dented tubes that were not inspected with rotating probes, given the 1R12 inspection results and the limited information that would be available on the largest crack size that could be present at these dented locations.*

PG&E PWSCC Response 2:

Plus Point inspection of SG 1-1 R29C46 1H was performed as a prudent measure because of a 1.44 volt DOS at this location. PG&E was performing Plus Point inspection of 100% of >1.4 volts DOS indications in SGs 1-1 and 1-2 (lower than the recommended 1.7-volt DOS cutoff) because of PG&E's effort to determine if large Plus Point outside diameter stress corrosion cracking (ODSCC) indications could be present in this population, which could result in outlier growths in the subsequent cycle. Based on resolution of the Plus Point data for R29C46 1H, there were 3 axial ODSCC indications with amplitudes of 0.26, 0.28, and 0.29 volt, and one circumferential ODSCC indication with an amplitude of 0.80 volt (0.63 volt by sizing analyst). A small dent (0.51 volt) was subsequently detected that would account for the presence of the circumferential indication. Based on this discovery, PG&E followed the requirements of the Technical Specification (TS) 5.5.9 and performed SG 1-1 Plus Point inspections of 100% >0.21 volt dents at 1H and 20% >0.21 volt dents at 2H. No additional circumferential indications were detected. PG&E believes that the circumferential degradation at R29C46 1H is considered an outlier relative to the DCPP experience, and that there is an extremely low potential for undetected circumferential indications in less than 2-volt dents at TSP elevations higher than 1H, based on the following discussion.

In Unit 1 refueling outages 8, 9, and 10 (1R8, 1R9, 1R10) and Unit 2 refueling outages 7, 8, and 9 (2R7, 2R8, and 2R9), prior to outages in which the bobbin coil was used to credit detection of axial PWSCC in less than or equal to 2-volt dents, a large number of less than 2-volt dents were Plus Point inspected. The population of less than 2-volt dents was based on a manual analysis of bobbin data, including resolution of the data. (Note: The less than 2-volt dent manual analysis of bobbin data was last conducted in 1R9 and 2R9.) Over 15000 Unit 1 and 5000 Unit 2 Plus Point inspections of less than 2-volt dents were conducted in those 6 outages, and no circumferential indications were detected in this population. With respect to Unit 1, the 1R8 Plus Point inspection of less than 2-volt dents included 100% of dents from 1H through 4H for each SG. In 1R9 and 1R10, the 100% Plus Point inspection of less than 2-volt dents was limited to the highest TSP in which PWSCC had been detected in that SG.

The primary reason that the R29C46 1H circumferential indication was not detected until 1R12 was that the small 0.51 volt dent at this location was not called in the less than 2-volt dent analyses at 1R8 and 1R9. As such, this TSP was never scheduled for a Plus Point inspection. The dent signal was identified after a detailed review of the 1R12 Plus Point circumferential indication. A rereview of the 1R8 to 1R12 bobbin data indicates that a small dent signal is present in the data for all outages except 1R9. The 1R9 signal was not consistent with the other outage signals. The presence of mix residual signals on the order of a volt at TSP intersections also complicates identification of small 0.5-volt dents in routine eddy current analyses. The DOS signal was called in 1R10, 1R11, and 1R12 and did not experience abnormal growth. Analysts are trained to review all bobbin TSP signals for signs of denting, which would prompt a Plus Point inspection.

PG&E will continue to meet the TS requirements to Plus Point inspect 100% of greater than 0.21-volt dents at 1H in SG 1-1, plus 20% at 2H. PG&E does not believe that significant expansion of the Plus Point scope in future inspections beyond this TS requirement is warranted.

With respect to the NRC request for a discussion of "how you assessed the integrity of dented tubes that were not inspected with rotating probes, given the 1R12 inspection results and the limited information that would be available on the largest crack size that could be present at these dented locations," Section 7.0 of Enclosure 3 to DCL-04-112 provides the operational assessment for circumferential ODSCC at dented TSPs. The OA focuses on R29C46 1H, as this was the largest circumferential ODSCC TSP indication detected in 1R12 in terms of maximum voltage, maximum depth, and average depth. Although the largest TSP circumferential indication, the indication was small with a Plus Point voltage of 0.63 volt, maximum depth of 59% and average depth of 43%. Even though this indication occurred at an intersection with three axial ODSCC indications, the circumferential indication was separated from the axial indications by 0.31 inch and had no mixed mode effects based either on separation distance or crack depths assuming interaction. Circumferential indications at dented TSPs occur at local areas of deformation with significant axial stresses and are expected to be small in size as confirmed by the detected indications. Given the low likelihood of circumferential cracks at <2-volt dents as discussed above and the small size of circumferential cracks at dented TSP intersections, structural and leakage integrity can be expected for circumferential indications at small dents with high confidence that additional inspections are not warranted.

NRC PWSCC Request 3:

- *An assessment of the bobbin overcall rate was performed. For three of the four steam generators, the overcall rate was consistent with past performance tests; however, for the other steam generator, the overcall rate was lower than these tests indicated. Please discuss the reason for the lower than expected overcall rate in this steam generator. For example, discuss whether there are unique conditions in this steam generator or in the eddy current testing analysis that would routinely cause this condition.*

PG&E PWSCC Response 3:

The SG 1-1 overcall rate of 72% was lower than the 96% to 100% overcall rate in the other 3 SGs because SG 1-1 contained 5 of the 6 new axial PWSCC indications called by bobbin at less than 2-volt dents. There are no unique conditions in SG 1-1 or in the eddy current testing analysis that would routinely cause this condition. SG 1-2 has the highest number of axial PWSCC indications, followed by SG 1-1. The number of less than 2-volt hot leg dented TSPs in SGs 1-1 and 1-2 is about 1100 and 1700, respectively, based on 1R9 manual bobbin analysis. These are approximately the same populations, so it would be expected in the future that the number of bobbin identified indications in less than 2-volt dents would be about the same in these SGs. In the prior inspection in 1R11 for SGs 1-1 and 1-2, there were 2 and 3 new PWSCC indications and high overcall rates of 97% and 98%, respectively, which supports no unique conditions in SG 1-1.

NRC PWSCC Request 4:

- *The burst pressures for several flaws were under predicted. One of the largest under predictions was for the indication in tube R34C49. The cause of this under prediction was assessed and determined to be a statistical consequence of assessing the burst pressure at a probability of 95% (given that the actual growth rate for this indication would only have been expected to occur 3% of the time). This flaw historically had a large growth rate (i.e., its growth rate was in the upper 95% tail of the growth distribution in the prior cycle). It appears from the information provided that similar situations could arise in future outages. In some cases the effects may be insignificant and at other times they may be significant. Please discuss whether there is a trend for high growth rate indications to continue to grow at high growth rates and whether the tube integrity* *assessment methodology should be modified to account for this. In addition, please discuss whether there is a trend for "large" flaws to grow at a higher rate than other flaws and whether the tube integrity assessment methodology should be modified to account for this.*

PG&E PWSCC Response 4:

PG&E notes that the NRC observation that axial PWSCC in R34C49 had a historically large growth rate is not correct. There is no data to suggest that the tube historically had a high growth rate. There was no growth rate data for this indication prior to 1R12. The tube was plugged in 1R6 and was deplugged in 1R11.

PG&E reviewed the DCPP Units 1 and 2 PWSCC ARC growth rate database (602 data points), and determined that 31 indications had average depth growth rates that exceeded the 95% value. Only 7 of these indications have subsequent outage growth rate data, and only 1 indication had an average depth growth rate that was slightly greater than the mean value. Therefore, there is no trend for high growth rate indications to continue to grow at high growth rates, and the tube integrity assessment methodology does not require modifications.

In 1R11, there were no tubes with CM burst pressures less than 6100 psi that were returned to service. Therefore, no trending of cycle 12 growth rates versus flaw size can be performed. In 1R12, there were several tubes with CM burst pressures less than 6100 psi, such that trending of 1R12 CM burst pressure and associated cycle 12 average depth growth rates was performed. Figure 1 provides a plot of 1R12 CM burst pressure versus cycle 12 average depth (AD) growth rate, based on the data from Table 6 of Enclosure 3 of the 1R12 90-day report. This figure shows that there is no correlation of flaw size (i.e., burst pressure) to AD growth rate. The lowest burst pressure and largest growth rate in Figure 1 corresponds to R34C49 discussed above. Therefore, there is no need to modify the tube integrity assessment methodology.

NRC PWSCC Request 5:

- *On page 2-11, a comparison of projected and actual steam generator tube burst probability is discussed. It is not clear whether this comparison is also affected by the same statistical situation as discussed in the previous question. For example, it would appear that a "successful" comparison could be made even if a flaw would have a burst pressure less than the acceptance criterion (1.4 times the differential pressure observed during a steam line break). In addition, it is not clear why this comparison indicates that new indications do not need to be accounted for in the analysis (the comparison may provide acceptable results simply because a very conservative growth rate or non-destructive examination uncertainty distribution was used). Please discuss.*

PG&E PWSCC Response 5:

As discussed on page 2-11 of the 90-day report, to confirm that the R34C49 underprediction has no affect on the total SG probability of burst, a benchmark was conducted by calculating the total SG 1-2 probability of burst (POB) using Monte Carlo analysis for both the projected EOC 12 (prior cycle OA) and for the as found EOC 12 conditions (CM). The results show that POB projections were conservative when applying either a POD of 1.0 or 0.6. The conservative benchmarking using a POD of 1.0 (8.5E-05 projected versus 1.3E-05 as found) validates the ARC methods assumption that new indications do not need to be accounted for in the ARC analysis. The negligible contribution of new indications is very clear for this analysis given that the total CM burst probability is only 1.3E-05.

If an indication had a CM burst pressure less than the acceptance limit, a CM POB analysis is required using a POD of 1.0. NRC reporting is required if the resulting POB is greater than 10^{-2}. In addition, an OA POB analysis is required using either a POD of 1.0 (if repeat indication) or 0.6 (if new indication, indicating a significant condition). The resulting POB must be less than 10^{-2}, or additional indications are required to be plugged. Corrective actions are required to be implemented to reduce the potential for recurrence of this issue, and may include the need to define improved methods for including new indications in future OAs. Therefore, the ARC method has built in triggers for assessing the need to account for new indications.

The NDE uncertainty distribution is the same for both the CM and OA, so NDE uncertainty is not a factor in this comparison. The growth rate distribution used in the prior cycle OA was conservative with respect to the actual growth rate distribution. For example, Table 3 of the 90-day report notes that the 95% length, maximum depth, and average depth growth rates used in the OA were 0.081 inch, 14.57%, and 12.35%, respectively, while the actual cycle 12 95% length, maximum depth, and average depth growth rates were 0.060 inch, 9.69%, and 9.14%, respectively. Overall, new indications should not be considered significant when they have burst margins meaningfully above the burst margin requirements and do not cause burst probability projections to be underestimated.

NRC PWSCC Request 6:

- *In Row 31 Column 78 in Steam Generator 2, there is an indication with a maximum (unadjusted) depth of 45% through-wall, which appears to be entirely outside the tube support plate. The tube was plugged for a permeability variation. Please clarify why this tube was not required to be plugged since the through-wall depth exceeded the plugging limit.*

Specifically address whether the "depth of record" is the adjusted or unadjusted depth.

PG&E PWSCC Response 6:

The axial PWSCC indication in SG 1-2 R31C78 5H is located entirely outside the TSP, but has an adjusted maximum depth of 36%, less than the 40% repair criteria applied to axial PWSCC indications extending outside the TSP. Therefore, this indication was not required to be repaired. The depth of record is the adjusted depth. The unadjusted NDE data is for information only.

Outside Diameter Stress Corrosion Cracking (ODSCC) ARC

NRC ODSCC Response 1:

- *A number of references are cited through Enclosure 4 to your September 7, 2004 letter. Some of these references are not available to the staff and some may not reflect the methodology approved by the staff and/or may not reflect commitments made during the review process (e.g., since staff approval was gained after the document was published). Please confirm that the implementation of this repair criteria was consistent with the NRC approval and your commitments. If any aspects of your implementation of this repair criteria were not consistent with the staff's approval or your commitments, please provide the technical basis.*

PG&E ODSCC Response 1:

Implementation of voltage-based repair criteria in 1R12 followed the GL 95-05 methodology, including use of 0.6 probability of detection (POD). Probability of prior cycle detection (POPCD) methods were not needed to ensure full Unit 1 Cycle 13 operation applying a 2-volt repair limit in 1R12. However, Section 8 of the 1R12 ODSCC ARC report also implemented POPCD and extreme growth methods at the discretion of PG&E (i.e., information only, not ARC analysis of record) to increase the NRC's understanding of the impact of these methods and to provide support of NRC approval of License Amendment Request (LAR) 04-01 for a permanent POPCD. NRC approval of LAR 04-01 was subsequently received in NRC letter to PG&E dated October 28, 2004.

Implementation of the POPCD and growth rate methods were consistent with commitments made in PG&E Letter DCL-04-028 dated March 18, 2004 (LAR 04-01), as clarified and supplemented by PG&E's responses to NRC questions in PG&E Letter DCL-04-104 dated August 18, 2004.

Implementation of the extreme growth method was consistent with the enclosure to NEI letter to NRC dated July 9, 2004, as clarified by PG&E's responses to NRC questions on extreme growth methods in PG&E Letter DCL-04-105 dated

August 20, 2004, and PG&E Letter DCL-04-117 dated September 17, 2004. DCL-04-117 acknowledged that NRC approval of the extreme growth method is pending, such that use of the method would not be credited in the 1R12 90-day report. As such, an additional POPCD analysis case has been evaluated, as described in response to NRC question 7 below, which does not include the extreme growth method.

The 90-day ODSCC ARC report was issued on September 2, 2004, and thus did not address PG&E's commitment in DCL-04-117 dated September 17, 2004, to assess bobbin voltages assigned to AONDB indications to verify that the assigned voltages are conservative. This assessment is provided in response to NRC question 4 below.

NRC ODSCC Response 2:

- *As a result of recent interactions on the probability of prior cycle detection (POPCD), several modifications were made to the analysis procedures for ODSCC at the tube support plates. For example, various options were inserted depending on whether the staff approved the extreme growth methodology. Please confirm that the analysis provided in your report for ODSCC at tube support plates is consistent with your most recent submittals. If not, please provide an updated analysis for the 1R12 condition monitoring and your cycle 13 operational assessment.*

PG&E ODSCC Response 2:

As discussed in response to question 1, the ODSCC ARC 90-day report reflects methods that are consistent with PG&E's submittals, with two exceptions. See PG&E's responses to question 4 (for assessment of bobbin voltages assigned to AONDB indications) and question 7 (for POPCD case with no extreme growth method).

NRC ODSCC Request 3:

- *Two tube support plate intersections could not be inspected with a 0.720-inch diameter bobbin probe so they were inspected with a 0.700-inch diameter probe. Please discuss the cause of the restrictions in these tubes. Please discuss the size of the largest probe that ever passed through these tubes. If the restrictions are service-induced, please discuss the number of tubes that could potentially be affected and the expected severity of the restrictions.*

PG&E ODSCC Response 3:

The 1R12 report indicates that SG 1-4 R7C89 7H and R9C86 7C could not be inspected with a 0.720-inch diameter bobbin probe due to restrictions. They were inspected with a 0.700-inch diameter bobbin probe and Plus Point probes, with no degradation detected.

For SG 1-4 R7C89 7H, the cause of the restriction is a large dent at 7H. The dent was service induced and was originally reported in the Unit 1 first refueling outage (1R1) as 78.0 volts based on 0.720-inch bobbin probe data analysis. In the Unit 1 second refueling outage (1R2) and all subsequent outages, the 0.720-inch bobbin probe would not pass entirely through 7H, and the 7H dent amplitude was reported ranging from 174 to 254 volts from the 0.700-inch bobbin probe data. The 1R12 dent amplitude is 192.9 volts based on 0.700-inch bobbin probe data. There are no other inservice TSP intersections that cannot pass a 0.720-inch bobbin probe due to a dent restriction at the TSP.

For SG 1-4 R9C86, the 1R12 report conservatively reported that the 7C intersection could not be inspected with a 0.720-inch diameter bobbin probe due to restrictions. Based on a rereview of the 0.720-inch bobbin data after receiving this question, PG&E determined that the 0.720-inch bobbin probe did indeed pass through the dent at the 7C TSP intersection, and no degradation was detected at 7C. The tube restriction is several inches above 7C, near the tangent point. The restriction was reported in the first inservice inspection (ISI) of the tube in the Unit 1 fifth refueling outage (1R5). The exact cause of the restriction is not known, but is likely related to tube ovality in the transition into the U-bend region. There is a small population of other tubes (outside of rows 1 and 2) in which a 0.720-inch probe cannot pass entirely through the U-bend, and a 0.700-inch bobbin probe is routinely used to inspect this region. For example, in 1R12, 151 U-bends (all SGs) were inspected with a 0.700-inch bobbin probe due to similar restrictions in the U-bend region. The majority of these tubes (95) are located in rows 9 and less, and these U-bends were also Plus Point inspected as part of the 100% of rows 1 to 10 inspection. No PWSCC or ODSCC was detected. To address potential U-bend axial PWSCC or other indications due to high ovality tubes, 20% of rows 12 to 18 were Plus Point inspected, and no axial PWSCC or ODSCC was detected.

NRC ODSCC Request 4:

- *There were approximately 20 axial outside diameter stress corrosion cracking indications that were not detectable by bobbin coil (AONDBs) during 1R11, but were subsequently detected by a bobbin coil during 1R12. The growth rates for most of these indications were not included in the growth rate distribution since the tube support intersections at which these indications were found were dented and any 1R11 bobbin voltages that could be obtained (with hindsight) were not considered to be reliable. Please discuss whether the growth rates for these AONDB indications (and the three AONDBs included in the cycle 12 growth distribution) using the inferred bobbin voltage from 1R11 are consistent with the growth rate for the remaining population of indications. Specifically address whether* *the inclusion of these points would have resulted in a more conservative growth rate distribution.*

PG&E ODSCC Response 4:

Table 4 provides a summary of the 20 1R11 AONDB indications that were subsequently detected by bobbin in 1R12, including cycle 12 growth rates. As discussed in the 90-day report, growth rates using the inferred bobbin voltage from 1R11 from the 3 >2-volt bobbin indications (1.60, 1.13, and 0.94-volts/EFPY) were included in the cycle 12 growth rates. The average cycle 12 growth rate for all bobbin indications is 0.13 volt/EFPY, much smaller than these 3 growth rates, so inclusion of these 3 growth rates in the OA is appropriate and adds conservatism to the growth distribution relative to the average growth.

The growth rates for the remaining 17 AONDB indications that were subsequently detected by bobbin in 1R12 were not included in the growth rate distribution. The average growth rate of these 17 indications is 0.07 volts/EFPY, smaller than the 0.13 volt/EFPY average growth rate for all bobbin indications. Inclusion of all of these growth rates would not result in more conservative projections, and the largest growth of 0.41 volts/EFPY in this group is negligible compared to the larger growth rates in the overall growth distribution.

A review of the indications that were AONDB in 1R11 and remained AONDB in 1R12 was also performed. There were 39 TSP intersections that fell into this category in 1R12. The average growth rate is -0.017 volt/EFPY for these indications, using inferred voltages in both inspections, with the largest growth at 0.125 volt/EFPY. Inclusion of these growth rates would not result in more conservative projections.

PG&E Letter DCL-04-117 committed to assess bobbin voltages assigned to AONDB to verify that the assigned voltages are conservative. For prior cycle AONDB indications that become detectable by bobbin, PG&E committed to assess prior cycle assigned voltages, current cycle actual bobbin voltages, and growth rates. Table 4 provides data to verify the adequacy of the inferred voltages assigned to AONDB indications. The actual bobbin coil DOS voltage in 1R12 was reduced by the average cycle 12 voltage change for DOS indications (0.21 volts for full operating cycle), to arrive at a "1R11 postulated AONDB voltage." This voltage was then compared to the 1R11 assigned (inferred) voltage. Excluding the three indications that were included in the cycle 12 growth assessment, the assigned AONDB voltages are noted to be generally overestimated based on most of the values in the Table 4 column "Voltage Difference from 1R11 Inferred to 1R11 Postulated" being positive. The average overestimate of the 1R11 inferred voltage (compared to the postulated voltage) was 0.10 volt.

NRC ODSCC Request 5:

- *In Section 3.2 of Enclosure 4 to your September 7, 2004 letter, you discuss three AONDBs from 1R11 whose cycle 12 growth rates were included in the growth distribution since the bobbin voltage in 1R12 was greater than 2-volts. For these indications, you indicate that the 1R12 inferred voltages (from the rotating probe) were less than the actual measured bobbin voltage. You postulated that the small dents at these intersections may be artificially increasing the bobbin voltage. Please discuss whether these results indicate that the correlation of rotating probe voltage to bobbin voltage has significant uncertainty, which should be accounted for when assigning voltages to AONDBs. Please discuss whether any AONDBs have ever been destructively examined to confirm that the burst and leakage behavior is consistent with expectations (i.e., based on expectations determined from the inferred bobbin voltage).*

PG&E ODSCC Response 5:

The correlation between bobbin and Plus point voltages at DCPP was recently updated to re-evaluate the inspection data up through 2R11 and includes 981 data points. The updated correlation meets the requirements specified in the EPRI Database Addendum for p-value (5%) and R^2 for statistical significance and is applied at the upper 95th confidence on the mean regression line when used for assigning bobbin coil voltages to indications that can only be detected by Plus point. Confidence on the mean bobbin/rotating pancake coil (RPC) correlation is applied as an uncertainty on bobbin voltages and included in the ARC analyses. As stated in the 90-day report, the reason for the differences in the assigned versus the actual voltages is attributed to the affect of the dents at these intersections. The small 1R12 peak RPC voltages (0.49 and 0.72 volt) for the two indications with significantly low inferred volts support the structural integrity of these indications and an expectation that the bobbin volts should be smaller than measured if no dent was present. Since the ARC bobbin volts are measured as peak-to-peak volts and include the vector addition of the dent voltage, bobbin volts at dents are expected to be conservative compared to nondented indications. No TSP intersections with AONDB have been removed from DCPP SGs and destructively examined. The ARC pulled tube database does not include identified dented tubes to permit an assessment of the influence of dents on bobbin voltages or tube integrity.

Therefore, no additional uncertainty needs to be added to the correlation of rotating probe voltage to bobbin voltage.

NRC ODSCC Request 6:

- *In Section 6 of Enclosure 4 to your September 7, 2004 letter, the benchmarking of the projections to the actual results for end-of-cycle 12*

(EOC-12) is provided. In the future, it would be beneficial if these tables annotated the distributions (e.g., growth, POPCD, extreme growth) used in the projections. For example, the growth distribution was obtained from Table x-y from Reference z. Such information is provided in Table 7-1 for the EOC-13 projections.

PG&E ODSCC Response 6:

The following table, patterned after Table 7-1 of the 90-day report, provides the inputs used to compare the EOC-12 projections to the as-found results.

Input Description	Section or Table Reference	Comments
BOC Voltage Distribution	Enclosure 1 to DCL 04-019; Section 3.2 and Table 3-1	
Repaired Voltage Distribution	Enclosure 1 to DCL-04-019; Section 3.2 and Table 3-1	
NDE Uncertainties	Enclosure 6 to DCL-04-112; Section 3.5 Table 3-17	
POD (0.6)	NRC GL 95-05	
POPCD	Enclosure 6 to DCL-04-112; Table 8-5	Previous POPCD correlation was used
Growth (SG 1-1)	Enclosure 1 to DCL 04-019; Table 3-2	
Growth (SGs 1-2, 1-3, and 1-4)	Enclosure 4 to DCL-02-098, Tables 3-7 and 3-8	
Cycle Length	Enclosure 6 to DCL-04-112; Section 3.2	1.61 EFPY (actual Cycle 12 cycle length was used)
Tube Integrity Correlations	Enclosure 6 to DCL-04-112; Tables 5-1 through 5-3	
Material Properties	Enclosure 6 to DCL-04-112; Section 7.1	

NRC ODSCC Request 7:

- *In Section 8 of Enclosure 4 to your September 7, 2004 letter, you discuss the EOC-13 projections using POPCD. Please discuss your plans for updating your EOC-13 projections to be consistent with your POPCD amendment request (e.g., possibly without extreme growth).*

PG&E ODSCC Response 7:

Table 8-11 of the 1R12 90-day ODSCC ARC report provides projected EOC-13 leak rate and POB using POPCD and the extreme growth model. Another EOC-13 projection has been performed using POPCD without the extreme growth model. These results are provided below. As expected, all results decreased or remained the same as a result of the removal of the extreme growth from the analysis.

Steam Generator	Projected Number of Indications at EOC-13	Probability of Burst		SLB Leak Rate
		Best Estimate	95% UCL (1 or More Failures)	(gpm)
SG 1-1	1430	2.16×10^{-3}	2.27×10^{-3}	2.14
SG 1-2	797	5.50×10^{-4}	6.08×10^{-4}	0.82
SG 1-3	386	4.30×10^{-4}	4.81×10^{-4}	0.54
SG 1-4	331	2.12×10^{-4}	2.49×10^{-4}	0.27
Reporting Threshold			1.0×10^{-2}	10.5

NRC ODSCC Request 8:

- *From Table 8-3 of Enclosure 4 to your September 7, 2004 letter, it appears that 12 indications were detected by bobbin at EOCn (with no rotating probe examination performed) and were subsequently not detected with bobbin at EOCn+1. Please discuss the cause and severity of these potential disappearing flaws. Please discuss what actions, if any, are taken during the outage to address this category of potential flaws (e.g., is the bobbin data from the current and previous outage reviewed to ascertain whether rotating probe examinations should be performed or to determine if the "flaw" was simply missed). Please discuss how this category of flaws is addressed in your condition monitoring and operational assessment.*

PG&E ODSCC Response 8:

As discussed in permanent POPCD LAR 04-01 in PG&E Letter DCL-04-028, bobbin indications reported at the end of cycle 'n' (EOCn) but not found by the bobbin inspection at EOCn+1 are considered false bobbin calls and are not included in the POPCD method analyses. Indications reported in one inspection but not reported in the subsequent inspection are classified as indications not reportable (INR) and require resolution analysis to confirm that an indication is not present at EOCn+1. PG&E's NDE procedure also requires that the lead analyst review and concur with the INR call. For these 12 signals, the data analysts determined that they were not indicative of typical ODSCC signals. This supplemental review of INR indications is considered adequate with no additional actions required. The EOCn amplitude of these indications was less than 1 volt and, therefore, the impact is irrelevant to the tube integrity calculations.

NRC ODSCC Request 9:

- *The bobbin coil examination of the pulled tube (R20C54) exhibited a dent signal at the second tube support plate. During the destructive examination of this tube, no dent was observed; however, patches of* *intergranular attack (IGA) were detected. One of these patches extended axially approximately 0.8-inches (portions of which were above the top of the tube support), extended circumferentially approximately 90-degrees, and had a maximum depth of approximately 46% through-wall. Please discuss the cause of the eddy current dent signal in this tube.*

Cracks (circumferential and axial) have been found in the Diablo Canyon steam generators at locations with dent/ding signals. Given the tube pull results (i.e., a non-dented tube may exhibit a dent signal), it would appear that some of the tubes in which these cracks were found may have actually had dents which were very small in physical size. It would also appear likely that the dent signals from a small dent could be low (indicating minimal physical deformation) or high (based on the tube pull results). As a result, it appears that the dent voltage may not be a good indicator of the severity of a dent (i.e., it may not be representative of the amount of tube deformation and the stresses in the tube). As a result, please discuss the potential implications of the tube pull results on your rotating probe inspection of "dented" locations which are based primarily on the dent voltage (larger dents receiving more scrutiny). Do the tube pull results call into question the use of dent voltage for determining which locations should be inspected with a rotating probe (e.g., is it possible that some of the cracks observed at dents with large voltages actually had very small dents, and at other locations these small dents may have low voltages). Regarding the missed patches of intergranular attack, please discuss what corrective actions, if any, have been taken in response to these findings.

PG&E ODSCC Response 9:

Table 2 of the destructive examination (DE) report indicates that the pre tube pull dent signal was 3.27 volts (in-generator), and the post tube pull dent signal was 1.11 volts and 1.29 volts as measured on the platform and in the laboratory, respectively. Page 16 of the DE report states that "the dent voltage decreased following tube pull, which may reflect removal of the influence of the tube support plate on the dent signal." PG&E has rereviewed the in-generator dent signal, and believes that the 3.27 volts dent signal is a conservative voltage, as it includes the mixed residual. A more realistic in-generator dent voltage is about 1.35 volts.

It is not believed that the IGA found after burst testing is associated with the dent signal. The eddy current dent signal was caused by a dent that was too small or gradual to be readily seen in the visual or the destructive examinations. Table 1 of DE report states that "no visible signs of denting" were observed during the receipt inspection. However, the visual examination of the tube support plate region did reveal an area of compressed black deposit, or scale, located in the lower half of the intersection between 190° and 270°. The scale can be seen in the photographs of the 2H TSP as presented in Figures 20 through 23 of the DE report. It is possible that very minor wall denting was associated with this dense deposit; however, no confirmatory methods were utilized to determine the geometry or severity of the dent identified by the bobbin coil inspection.

The DCPP Units 1 and 2 Plus Point inspection program of dented TSPs is based on the dent voltage threshold of 2-volts. The bobbin coil is qualified to detect axial PWSCC in less than or equal to 2-volt dents. Dents greater than 2-volts are Plus Point inspected in a consistent manner. That is, on a SG basis, 100% of >2-volt dents are inspected up to the highest TSP where PWSCC or "circ" indications have been detected in the prior 2 outages. This Plus Point inspection program is conservatively augmented for dents greater than or equal to 5-volts (due to GL 95-05 requirements). For Unit 2, 100% of ≥5-volt dents (both hot leg and cold leg) are inspected. For Unit 1, at least 20% of ≥5-volt dents are inspected at each hot leg TSP.

With respect to the NRC observation "that the dent voltage may not be a good indicator of the severity of a dent (i.e., it may not be representative of the amount of tube deformation and the stresses in the tube)," PG&E believes that the dent voltage is a relatively accurate indicator of the severity of a dent relative to the occurrence of PWSCC. The bobbin voltage is a function of the local deformation, the circumferential extent of the deformation and the tube ovality caused by the dent. It is not a unique function of the local deformation and the cause of the dent signal may not be easily found in a destructive examination without costly additional measurement methods to locate the cause for the dent signal. In addition, the tube pull axial loads can have some influence on the pulled tube geometry that can further mask identification of the cause for a small dent signal. Historical data have shown a good relationship between dent voltage and the occurrence of PWSCC, and dent voltage is considered an adequate indicator for prioritizing inspection locations and defining inspection extent.

The tube pull results do not call into question the use of dent voltage for determining which locations should be Plus Point inspected. The dent inspection program outlined above provides adequate interrogation of the dented TSPs at DCPP. However, as an added measure of confidence and as previously discussed in response to question 1 under PWSCC ARC, the Units 1 and 2 dent inspection results were reviewed, and it was determined that 18 Unit 2 >2-volt dents and 133 Unit 1 >2-volt dents have never been Plus Point inspected. In 2R12 the 18 dents previously not Plus Point inspected were Plus Point inspected for the first time with no PWSCC or circumferential indications identified. A similar program will be conducted in 1R13 to verify that PWSCC or circumferential indications do not exist in un-inspected >2-volt dents. Most of the Unit 1 uninspected dents are at 7H or 7C.

Per the EPRI ODSCC Database Addendum tube pull results, small regions of IGA are not uncommon in the TSP intersections removed from Westinghouse

SGs. In some cases, more patch-like degradation of the tube is the predominant degradation mode, compared to other plants where single deep axial indications are typical. The missed patches of intergranular attack do not require any corrective actions, as the patches were shallow and had negligible affect on the burst pressure of the tube (10,428 psi burst pressure per Table 7 of the 1R12 destructive examination report).

NRC ODSCC Request 10:

- *In Section 2.11 of Enclosure 5 to your September 7, 2004 letter, it was noted that several relatively deep cracks were located on both sides of the primary crack. These cracks were not reported as being detected during the field or laboratory examinations. Please discuss whether the burst pressure of the primary crack (as determined from the flaw profile) was affected by these "adjacent" cracks. In addition, please discuss the implications of these findings relative to your PWSCC and ODSCC ARC (i.e., could the burst pressure of a detected flaw be affected by "adjacent" undetected flaws). If so, discuss what corrective actions, if any, have been taken in response to these findings.*

PG&E ODSCC Response 10:

This question is similar to a previous question received from the NRC on August 12, 2003, regarding the 2R11 destructive examination results. As previously discussed in PG&E Letter DCL-03-139 in response to the question, closely spaced axial cracks (ODSCC) are not an unusual occurrence in SG tubes (e.g., EPRI report 1006783) and any effects on burst pressure are inherently included in the industry database. Test data for axial flaws shows that multiple parallel axial flaws encompassed by a longer, deeper axial flaw have no influence on the burst pressure. The long, deep flaw determines the burst pressure. This was the case for 2R11 pulled tube R35C57, and is also the case for 1R12 pulled tube R20C54. The opening of the secondary axial crack was small and had no interaction with the main burst surface.

For 1R12 pulled tube R20C54, scanning electron microscope (SEM) fractography was not carried out for the cracks adjacent to the primary crack. Transverse metallography indicated that the depth of these cracks varied from 47% to 65% through wall, per Table 19 of the 1R12 DE report. These cracks were not visible after leak rate testing, while the primary crack was easily visible under magnification.

The predicted nominal burst pressure using the R20C54 destructive exam profile is about 5.65 ksi using the PWSCC ARC Westinghouse burst correlation with measured material properties for an OD indication, compared to the measured burst pressure of 5.819 ksi. Since the measured burst pressure is higher than the predicted, the measured burst pressure was not reduced or affected by the second crack. In addition, as discussed in the Attachment to Enclosure 2 of the 1R12 90-day report (ligament tearing report), application of the PWSCC ARC ligament tearing model using the destructive exam profile for analysis of the leak rate measurements leads to an over prediction of the measured leak rate by more than a factor of about 8 (measured 0.00074 gpm vs calculated 0.006 gpm) for the average leak rate from Monte Carlo analyses. These burst and leak analysis results support the adequacy of the PWSCC burst pressure and leak rate models.

Other Inspection Findings (not directly associated with an ARC)

NRC Other Request 1:

- *On page 3-7 of Enclosure 3 to your September 7, 2004 letter, several degradation mechanisms are listed. Similar mechanisms are listed in Table 2 of Enclosure 3. In comparing the table to the text of the report, please clarify whether any tube support intersections had both an axial PWSCC indication and a circumferential ODSCC indication (or should the text on page 3-7 have indicated that PWSCC mix mode involves axial PWSCC and circumferential PWSCC). Please clarify why axial PWSCC and circumferential ODSCC is not considered a potential mixed mode degradation mechanism and why it is not included in the Tables at the end of the enclosure. In addition, please clarify why axial ODSCC and circumferential PWSCC is not considered a potential mixed mode degradation mechanism and why it is not included in Tables at the end of the enclosure.*

PG&E Other Response 1:

When referring to mix mode indications, the term "ODSCC" and "PWSCC" always refers to the axial component.

PWSCC mix mode indication is a term used for axial PWSCC and any type of circumferential indication (either ODSCC or PWSCC) at the same dented TSP. In Section 9 on page 3-19 of Enclosure 3 of the report, PG&E noted that one PWSCC mix mode indication was detected in 1R12, SG 1-2 R36C53 3H, and had circumferential ODSCC as the circumferential component.

ODSCC mix mode indication is a term used for axial ODSCC and any type of circumferential indication (either ODSCC or PWSCC) at the same dented TSP. In Section 10 on page 3-20 of Enclosure 3 of the report, PG&E noted that two ODSCC mix mode indications were detected in 1R12, SG 1-1 R29C46 1H and SG 1-2 R17C45 1H, and both of them had circumferential ODSCC as the circumferential component.

In summary, one TSP intersection had both an axial PWSCC indication and a circumferential ODSCC indication (defined as PWSCC mixed mode), and two TSP intersections had both an axial ODSCC indication and a circumferential ODSCC indication (ODSCC mix mode). Table 2 of Enclosure 3 of the 90-day report accurately lists these 3 tubes in their appropriate categories, and the text on page 3-7 is correct.

NRC Other Request 2:

- *Please clarify how the cold leg thinning equation on page 3-26 of Enclosure 3 to your September 7, 2004 letter is applied, since simple substitution of a 37% through-wall depth into the equation does not result in a depth of 57% through-wall.*

PG&E Other Response 1:

The resulting cold leg thinning flaw of 57% throughwall depth represents a value at 95% probability and 50% confidence level (i.e., 95/50) that the actual depth would be less than 57%. The standard deviation times 1.64 is added to the depth calculated from the mean regression equation (48%) to arrive at the 95/50 depth of 57%.

PG&E conservatively chose to evaluate cold leg thinning at 95/50. The EPRI SG Integrity Assessment Guidelines, Revision 1, require CMOA evaluations at 90/50. In this case, 1.28 times the standard deviation would be added to 48% to arrive at 90/50 depth of 55%.

In Section 10 of Enclosure 3 of the 90-day report, anti-vibration bar (AVB) wear is evaluated at 90/50. CMOA evaluations of AVB wear at 95/50 also provide acceptable margins.

NRC Other Request 3:

- *Please clarify why the last several entries in Table 7 of Enclosure 3 to your September 7, 2004 letter has no information for the axial ODSCC indications.*

PG&E Other Response 3:

The last several entries in Table 7 that have no listed information for the axial ODSCC indications are noted as axial PWSCC crack number 2. The associated axial ODSCC data for these indications is provided under the axial PWSCC crack number 1 entries in the table.

Table 1
1R12 PWSCC Indications in the Plug Expansion Zone (PEZ)
(Supplements Table 4 of W* ARC 90-day Report)

SG	Row	Col	Plug Removed	Type plug Removed	Removal Method	Tube end indication	# Ind	Max Volts	Crack Lower Extent relative to TEH, inch	Crack Upper Extent relative to TEH, inch
11	4	61	1R9	Roll	TIG	MAI	12	3.89	0.83	2.37
11	5	59	1R9	Roll	TIG	MAI	9	2.96	0.92	2.45
11	5	64	1R9	Roll	TIG	MAI	17	3.23	0.81	2.35
11	11	58	1R9	Roll	TIG	MAI	16	4.47	0.64	1.8
11	14	13	1R10	Rib	TIG	MAI	8	0.83	0.98	2.2
11	15	76	1R10	Roll	TIG	SAI	1	2.53	0.59	0.84
11	16	68	1R9	Roll	TIG	MAI	20	4.28	0.6	1.69
11	16	70	1R10	Rib	TIG	MAI	8	2.87	1.04	2.01
11	17	76	1R9	Roll	TIG	MAI	13	4.78	0.77	1.58
11	20	28	1R10	Rib	TIG	MAI	11	0.76	0.98	1.94
11	20	29	1R10	Roll	TIG	MAI	14	2.11	0.58	1.96
11	20	65	1R10	Rib	TIG	MAI	6	1.15	1.18	1.59
11	25	40	1R9	Roll	TIG	SAI	1	0.58	0.85	0.91
11	25	57	1R10	Roll	TIG	MAI	9	3.87	0.57	1.19
11	28	41	1R9	Roll	TIG	SAI	1	1.82	0.63	0.96
11	29	37	1R10	Rib	TIG	MAI	9	1.96	1.01	1.67
11	30	67	1R10	Rib	TIG	MAI	16	1.82	0.88	1.88
11	37	32	1R10	Rib	TIG	MAI	2	0.99	1.24	1.34
12	1	44	1R11	Roll	TIG	MAI	4	2.96	1.08	1.53
						MAI	5	2.62	1.83	2.51
12	2	28	1R11	Roll	TIG	SAI	13	4.12	0.61	1.77
12	2	79	1R10	Roll	TIG	MAI	7	3.03	0.68	1.94
12	2	90	1R11	Roll	TIG	MAI	9	1.71	0.74	1.13
						MAI	5	1.32	1.62	1.9
12	4	54	1R11	Roll	TIG	MAI	9	2.98	0.56	1.69
12	4	84	1R10	Roll	TIG	MAI	7	4.05	0.7	1.2
						MAI	3	2.41	1.44	2
12	5	39	1R11	Roll	TIG	MAI	10	3.75	0.56	1.92
12	5	49	1R11	Roll	TIG	MAI	7	2.86	0.66	1.78
12	5	65	1R10	Roll	TIG	MAI	4	3.19	0.55	1.72
12	5	66	1R10	Roll	TIG	MAI	7	3.33	0.61	0.99
						SAI	1	2.38	1.41	1.52
12	5	78	1R11	Roll	TIG	MAI	9	1.9	0.76	1.87
12	5	93	1R10	Roll	TIG	MAI	11	2.91	0.69	1.77
12	7	17	1R9	Roll	TIG	MAI	9	3.68	0.47	1.9
12	7	33	1R11	Rib	TIG	MAI	10	1.99	0.88	2
12	7	53	1R11	Roll	TIG	MAI	10	2.52	0.62	1.77
12	7	68	1R10	Roll	TIG	MAI	13	3.11	0.58	1.79
12	8	66	1R10	Roll	TIG	MAI	10	3.88	0.59	1.81
12	9	27	1R11	Roll	TIG	MAI	8	2.63	0.62	1.9

SG	Row	Col	Plug Removed	Type plug Removed	Removal Method	Tube end indication	# Ind	Max Volts	Crack Lower Extent relative to TEH, inch	Crack Upper Extent relative to TEH, inch
12	9	30	1R11	Rib	TIG	MAI	12	2.06	1.74	1.9
12	9	38	1R11	Rib	TIG	MAI	12	1.77	1.01	1.79
12	9	45	1R11	Rib	TIG	MAI	7	2	0.89	1.69
12	9	53	1R11	Roll	TIG	MAI	9	2.97	0.59	1.83
12	9	82	1R11	Roll	TIG	MAI	3	3.02	0.64	1.69
12	10	49	1R11	Roll	TIG	MAI	9	2.68	0.74	2.47
12	10	62	1R11	Roll	TIG	MAI	11	4.52	0.64	1.81
12	10	67	1R10	Roll	TIG	MAI	7	5.36	0.59	1.78
12	10	85	1R10	Roll	TIG	MAI	6	2.41	0.64	0.93
						MAI	2	2.33	1.72	1.86
12	11	20	1R11	Rib	TIG	MAI	8	1.9	0.87	1.84
12	11	71	1R11	Roll	TIG	MAI	4	2.23	0.61	1.68
12	12	77	1R11	Rib	TIG	MAI	2	1.77	0.99	1.81
12	13	34	1R11	Roll	TIG	MAI	8	3.5	0.57	2.02
12	13	44	1R11	Rib	TIG	MAI	6	1.82	0.87	1.79
12	13	60	1R11	Roll	TIG	MAI	12	3.43	0.57	2.17
12	13	83	1R11	Roll	TIG	MAI	5	1.11	0.81	0.99
						MAI	3	0.97	1.61	1.71
12	14	68	1R10	Roll	TIG	MAI	14	3.15	0.58	1.51
12	14	70	1R10	Roll	TIG	MAI	8	2.43	0.6	1.06
12	14	74	1R11	Roll	TIG	MAI	10	1.98	0.64	1.83
12	16	82	1R11	Roll	TIG	MAI	8	2.57	0.8	1.86
12	16	85	1R11	Roll	TIG	MAI	6	2.13	0.72	1.85
12	16	87	1R11	Rib	TIG	SAI	1	0.65	1.24	1.75
12	16	88	1R11	Rib	TIG	MAI	3	0.84	1.04	1.67
12	17	9	1R11	Roll	TIG	MAI	7	2.28	1.09	3.15
12	17	59	1R11	Roll	TIG	MAI	8	2.76	0.68	1.74
12	17	66	1R11	Roll	TIG	MAI	13	3.09	0.67	1.73
12	17	67	1R11	Roll	TIG	MAI	13	2.92	0.68	1.79
12	17	88	1R11	Rib	TIG	MAI	6	1.78	1.07	2.07
12	18	64	1R11	Roll	TIG	MAI	13	2.73	0.59	1.65
12	19	34	1R11	Roll	TIG	MAI	10	3.62	0.61	2.06
12	20	37	1R11	Rib	TIG	MAI	8	2.17	0.93	1.9
12	20	40	1R11	Rib	TIG	MAI	5	1.05	1.38	1.7
12	20	43	1R9	Roll	TIG	MAI	14	6.14	0.54	1.85
12	20	77	1R11	Roll	TIG	MAI	7	2.83	0.63	1.81
12	21	38	1R11	Rib	TIG	MAI	5	1.18	1.49	1.91
12	21	46	1R11	Roll	TIG	MAI	12	3.59	0.6	1.96
12	21	57	1R11	Roll	TIG	MAI	12	3.1	0.69	1.76
12	21	60	1R10	Roll	TIG	MAI	11	4.29	0.55	1.77
12	21	62	1R9	Roll	TIG	MAI	12	4.84	0.58	1.74
12	21	65	1R11	Rib	TIG	MAI	6	1.33	0.99	1.74
12	22	22	1R9	Roll	TIG	MAI	7	3.77	0.5	1.9
12	22	42	1R11	Roll	TIG	MAI	15	10.2	0	2.03

SG	Row	Col	Plug Removed	Type plug Removed	Removal Method	Tube end indication	# Ind	Max Volts	Crack Lower Extent relative to TEH, inch	Crack Upper Extent relative to TEH, inch
12	22	54	1R11	Rib	TIG	MAI	2	1.4	1.58	1.65
12	23	17	1R11	Rib	TIG	MAI	11	1.2	0.9	2.01
12	25	25	1R9	Roll	TIG	MAI	9	3.5	0.57	1.94
12	25	50	1R11	Rib	TIG	SAI	1	1.49	0.98	1.48
12	25	57	1R9	Roll	TIG	MAI	8	5.17	0.7	1.65
12	25	87	1R11	Roll	TIG	MAI	6	1.43	0.54	0.78
						SAI	1	0.55	1.58	1.69
12	26	22	1R11	Roll	TIG	MAI	9	2.89	0.57	1.72
12	26	73	1R11	Rib	TIG	MAI	4	1.12	1.03	1.7
12	27	29	1R9	Roll	TIG	MAI	12	4.05	0.5	1.78
12	27	63	1R11	Rib	TIG	MAI	2	1.45	1.03	1.82
12	27	64	1R10	Roll	TIG	MAI	16	2.39	0.65	1.6
12	27	65	1R11	Rib	TIG	MAI	4	1.11	0.91	1.71
						SCI	1	0.48	1.55	
12	27	69	1R11	Roll	TIG	MAI	8	3.45	0.59	1.6
12	28	24	1R9	Roll	TIG	MAI	10	5.84	0.56	1.81
12	28	47	1R11	Roll	TIG	MAI	10	1.53	0.78	2.06
12	29	24	1R11	Roll	TIG	MAI	8	3.08	0.61	1.81
12	29	38	1R11	Rib	TIG	MAI	2	1.19	1.01	1.68
12	29	66	1R11	Rib	TIG	MAI	9	1.79	1.33	1.86
12	30	30	1R11	Rib	TIG	MAI	3	0.93	1	1.66
12	30	35	1R9	Roll	TIG	MAI	4	5.87	0.54	1.76
12	30	56	1R11	Rib	TIG	MAI	4	1.32	0.92	1.8
						SCI	1	0.66	1.64	
12	30	62	1R10	Roll	TIG	MAI	8	1.6	0.63	1
12	31	37	1R10	Roll	TIG	MAI	8	2.95	0.56	0.99
						MAI	7	2.79	1.18	1.41
12	31	47	1R11	Rib	TIG	MAI	6	0.91	1.23	1.81
12	31	66	1R11	Roll	TIG	MAI	9	3.81	0.65	1.91
12	31	68	1R11	Roll	TIG	MAI	13	2.56	0.67	1.78
12	32	30	1R11	Roll	TIG	MAI	7	1.94	0.59	0.99
						MAI	6	1.81	1.41	1.75
12	32	37	1R10	Roll	TIG	MAI	9	2.28	0.53	1.74
12	32	44	1R11	Roll	TIG	MAI	7	3.66	0.61	1.87
12	32	47	1R11	Roll	TIG	MAI	10	1.58	0.65	1.85
12	33	57	1R11	Roll	TIG	MAI	9	3.84	0.59	1.81
12	33	72	1R11	Roll	TIG	MAI	8	2.9	0.58	1.8
12	34	36	1R10	Roll	TIG	MAI	10	2.74	0.53	1.77
12	34	47	1R11	Roll	TIG	MAI	9	1.69	0.55	1.65
12	34	49	1R11	Rib	TIG	MAI	8	1.15	0.95	1.76
12	34	53	1R11	Rib	TIG	MAI	6	1.02	1	1.49
12	34	57	1R11	Rib	TIG	MAI	2	1.36	0.99	1.86
12	34	59	1R11	Roll	TIG	MAI	2	1.08	1.41	1.52
12	34	65	1R10	Roll	TIG	MAI	2	1.03	0.6	0.69

SG	Row	Col	Plug Removed	Type plug Removed	Removal Method	Tube end indication	# Ind	Max Volts	Crack Lower Extent relative to TEH, inch	Crack Upper Extent relative to TEH, inch
						SAI	1	1.02	0.88	0.97
12	35	49	1R11	Rib	TIG	MAI	7	1.62	0.96	1.96
12	35	56	1R10	Roll	TIG	MAI	6	1.92	0.56	0.86
12	36	53	1R11	Roll	TIG	MAI	9	3.71	0.57	1.82
12	37	53	1R11	Rib	TIG	SCI	1	0.41	1.09	
						MAI	4	1.54	1.2	1.95
12	37	69	1R11	Roll	TIG	MAI	2	1.25	0.54	0.85
						MAI	4	1.44	1.34	1.64
12	37	70	1R11	Rib	TIG	MAI	3	1.82	1.6	1.8
12	37	73	1R10	Roll	TIG	MAI	7	1.59	0.75	1.21
						MAI	2	1.33	1.49	1.83
12	37	74	1R11	Roll	TIG	MAI	4	1.87	0.59	1.69
12	43	49	1R11	Roll	TIG	MAI	10	2.85	0.57	1.75
13	9	56	1R9	Roll	TIG	MAI	10	3.64	0.37	1.57
13	9	61	1R9	Roll	TIG	MAI	3	2	0.83	1.58
13	9	66	1R9	Roll	TIG	MAI	9	3.56	0.6	1.83
13	9	70	1R9	Roll	TIG	MAI	10	3.01	0.46	1.81
14	4	6	1R9	Roll	TIG	MAI	2	1.16	0.7	1.63
14	16	66	1R9	Roll	TIG	MAI	11	3.77	0.62	1.98
14	20	63	1R9	Roll	TIG	MAI	7	2.45	0.66	1.51
14	35	36	1R9	Roll	TIG	MAI	8	1.92	0.61	1.85
14	39	48	1R9	Roll	TIG	MAI	10	3.89	0.63	1.98
14	39	58	1R9	Roll	TIG	MAI	7	4.25	0.67	2.05

Table 2
1R12 Indications in Hot Leg WEXTEX Tubesheet Region (Excluding Circumferential Indications and PWSCC at Tube End)
(Supersedes Table 1 of W* ARC 90-day Report)

SG	Row	Col	Ind	Volts	MD	Crack No	Cal	LCT	UCT	Crack Length	UCT adj	UCT below TTS?	W* Zone	W* Length	BWT	Dist UCT to BWT	UCT Below W* ?	UCT Below BWT?	EOC (N+1) UCT to TTS	EOC (N+1) UCT Below TTS?	W* Tube?	Inspect Extent	W* Inspect Dist	Flex W* Length	CM Leak Rate	Dist EOC (N+1) UCT to BWT	OA Leak Rate	Prev W*Tube?	Tube Plugged?
11	3	2	SAI	0.61	49	1	21	-1.29	-1.06	0.23	-0.84	Yes	A	5.32	-0.09	0.69	No	Yes	-0.68	Yes	Yes	-8.93	8.75	5.57	0.021	0.53	0.027	Yes	
	15	10	SAI	0.72	43	1	21	-8.60	-8.37	0.23	-8.15	Yes	A	5.32	-0.26	7.83	Yes	Yes	-7.99	Yes	Yes	-9.45	9.10	5.32	0.000	7.67	0.000	Yes	
	15	10	SAI	1.02	61	2	21	-7.98	-7.57	0.41	-7.35	Yes	A	5.32	-0.26	7.03	Yes	Yes	-7.19	Yes	Yes	-9.45	9.10		0.000	6.87	0.000	Yes	
	20	44	SAI	0.58	36	1	54	-8.27	-8.19	0.08	-7.97	Yes	B2	7.12	-1.85	6.06	No	Yes	-7.81	Yes	Yes	-9.68	7.74	7.22	0.001	5.90	0.001	Yes	
	Total Leak Rate																								**0.022**		**0.028**		
12	1	87	SAI	2.26	63	1	59	-9.67	-9.34	0.33	-9.12	Yes	A	5.32	-0.28	8.78	Yes	Yes	-8.96	Yes	Yes	-11.35	10.98	5.32	0.000	8.62	0.000		
	7	33	SAI	1.23	96	1	31	-2.04	-1.67	0.37	-1.45	Yes	B2	7.12	-0.35	1.04	No	Yes	-1.29	Yes	Yes	-9.20	8.76	7.51	0.018	0.88	0.020	Yes	
	20	37	SAI	2.09	96	1	31	-1.53	-1.36	0.17	-1.14	Yes	B3	7.12	-0.13	0.95	No	Yes	-0.98	Yes	Yes	-10.32	10.10	7.31	0.019	0.79	0.021	Yes	
	Total Leak Rate																								**0.037**		**0.042**		
13	2	14	SVI	0.44	NA	1	31	-8.40	-8.16	0.24	-7.94	Yes	A	5.32	-0.20	7.68	Yes	Yes	-7.78	Yes	Yes	-9.57	9.28	5.32	NA	NA	NA	Yes	
	10	20	SAI	0.44	20	1	61	-2.17	-2.02	0.15	-1.8	Yes	B4	7.12	-0.11	1.63	No	Yes	-1.64	Yes	Yes	-11.34	11.14	7.29	0.007	1.47	0.008		
	30	45	SAI	0.32	20	1	30	-1.97	-1.84	0.13	-1.62	Yes	B4	7.12	-0.19	1.37	No	Yes	-1.46	Yes	Yes	-9.64	9.36	7.27	0.009	1.21	0.011	Yes	
	31	36	SAI	0.44	20	1	30	-2.63	-2.48	0.15	-2.26	Yes	A	5.32	-0.21	1.99	No	Yes	-2.10	Yes	Yes	-9.75	9.45	5.49	0.004	1.83	0.005	Yes	
	33	37	SAI	0.46	20	1	30	-5.62	-5.47	0.15	-5.25	Yes	A	5.32	-0.40	4.79	No	Yes	-5.09	Yes	Yes	-9.84	9.35	5.49	0.000	4.63	0.001	Yes	
	39	46	SAI	0.63	20	1	30	-2.54	-2.29	0.25	-2.07	Yes	A	5.32	-0.25	1.76	No	Yes	-1.91	Yes	Yes	-10.4	10.06	5.59	0.005	1.60	0.006	Yes	
	Total Leak Rate																								**0.026**		**0.030**		
14	23	7	SAI	0.41	24	1	30	-8.17	-7.99	0.18	-7.77	Yes	A	5.32	-0.19	7.52	Yes	Yes	-7.61	Yes	Yes	-10.85	10.57	5.32	0.000	7.36	0.000	Yes	
	28	57	SAI	0.26	20	1	30	-2.91	-2.77	0.14	-2.55	Yes	B4	7.12	-0.33	2.16	No	Yes	-2.39	Yes	Yes	-9.74	9.32	7.42	0.005	2.00	0.006	Yes	
	28	57	SAI	0.39	20	2	30	-7.11	-6.99	0.12	-6.77	Yes	B4	7.12	-0.33	6.38	No	Yes	-6.61	Yes	Yes	-9.74	9.32		0.000	6.22	0.000	Yes	
	39	58	SAI	0.35	20	1	76	-6.43	-6.35	0.08	-6.13	Yes	A	5.32	-0.04	6.03	Yes	Yes	-5.97	Yes	Yes	-21.4	21.27	5.32	0.000	5.87	0.000	Yes	
	Total Leak Rate																								**0.005**		**0.006**		

Note: SG 1-1 R3C2 data has been corrected, resulting in corrected CM and OA leak rates for R3C2 and SG 1-1.

Table 3 – 1R12 >2-volt Dent Distributions and 1R12 Plus Point Dent Inspections

>2 and <5-volts Dented Intersections (measured +/- 0.7" from TSP)								
	S/G11		S/G12		S/G13		S/G14	
	# TSP	# RPC	# TSP	# RPC	# TSP	# RPC	# TSP	# RPC
1H	14	14	166	166	79	54	341	341
2H	58	58	144	144	38	3	145	145
3H	13	13	98	98	51	2	202	202
4H	6	6	121	121	28	0	130	130
5H	5	5	66	66	64	2	84	84
6H	1	0	20	20	36	0	222	222
7H	126	61	101	101	159	87	206	101
7C	149	83	24	24	106	77	116	98
6C	1	0	1	1	0	0	11	0
5C	0	0	2	0	1	0	0	0
4C	0	0	2	0	1	0	1	0
3C	0	0	4	0	0	0	0	0
2C	2	0	0	0	1	0	0	0
1C	2	0	2	0	7	0	2	0
Total	377	240	751	741	571	225	1460	1323

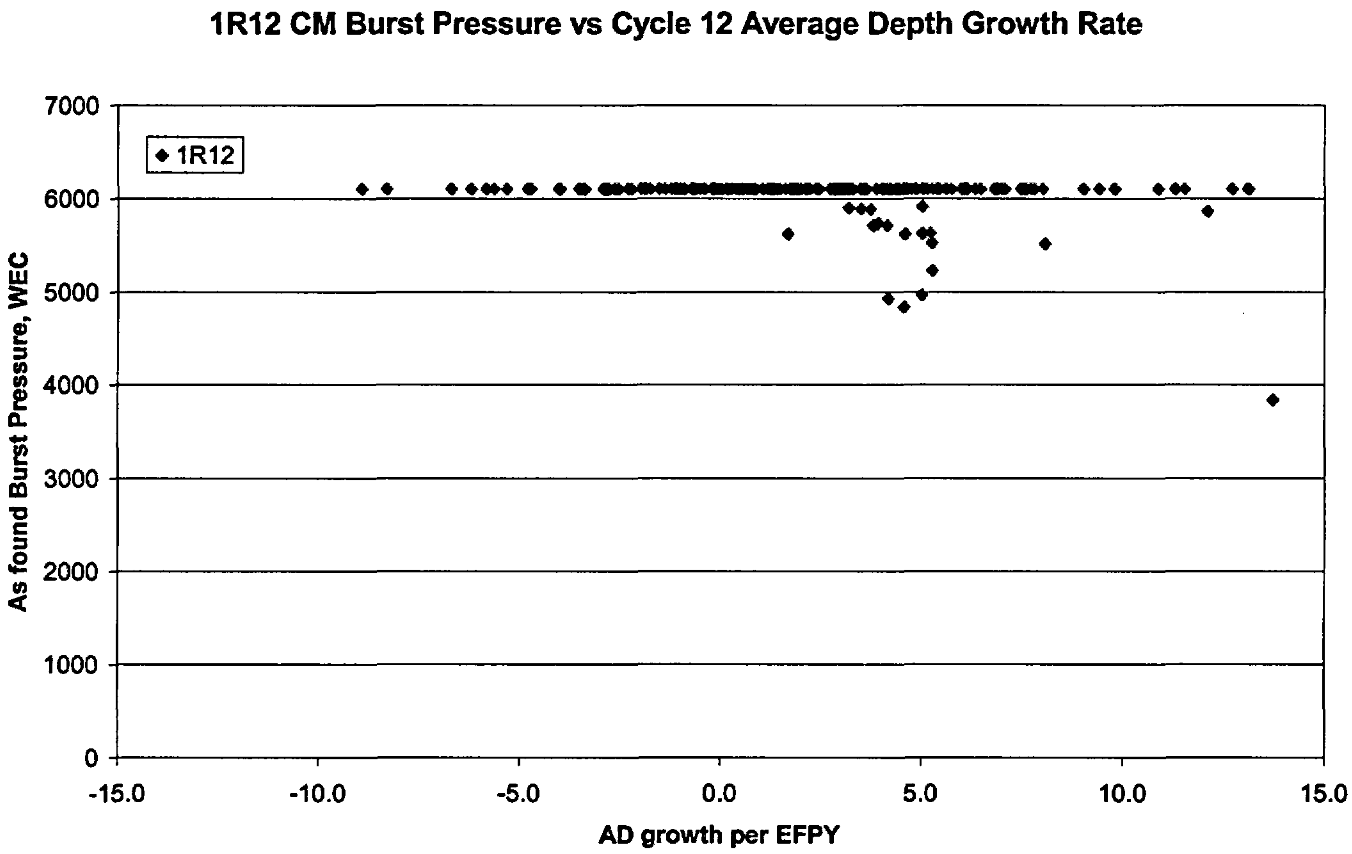
>=5-volts Dented Intersections (measured +/- 0.7" from TSP)								
	S/G11		S/G12		S/G13		S/G14	
	# TSP	# RPC	# TSP	# RPC	# TSP	# RPC	# TSP	# RPC
1H	1	1	89	89	15	15	355	355
2H	18	18	63	63	4	4	48	48
3H	5	5	61	61	10	10	63	63
4H	2	2	74	74	5	5	96	96
5H	4	4	19	19	35	35	36	36
6H	1	1	1	1	16	16	248	248
7H	157	118	27	27	101	62	348	257
7C	79	40	5	5	19	15	99	79
6C	0	0	0	0	0	0	0	0
5C	0	0	0	0	0	0	0	0
4C	0	0	0	0	0	0	1	0
3C	0	0	0	0	0	0	0	0
2C	0	0	0	0	0	0	0	0
1C	0	0	0	0	0	0	0	0
Total	267	189	339	339	205	162	1294	1182

Table 4 - 1R11 AONDB Indications Detected by Bobbin in 1R12

SG	Row	Col	TSP	1R12 Bobbin		1R12 Plus Point			1R11 Plus Point			Cycle 12 Growth Rate per EFPY		Cycle 12 Voltage Change	1R11 Postulated AONDB Voltage	Voltage Difference from 1R11 Inferred to 1R11 Postulated
				Ind	Volts	Ind	PP Volts	Inferred Volts	Ind	PP Volts	Inferred Volts	Inferred to DOS (ARC)	Inferred to Inferred			
11	8	69	1H	DOS	3.4	MAI	0.14/0.23/0.35/2.29	2.84	MAI	0.10/0.15/0.25	0.82	1.60*	1.25	0.21	3.19	-2.37
11	14	62	2H	DOS	0.28	SAI	0.13	0.43	SAI	0.14	0.44	-0.10	-0.01	0.21	0.07	0.37
11	16	79	2H	DOS	0.6	SAI	0.2	0.50	SAI	0.15	0.45	0.09	0.03	0.21	0.39	0.06
11	19	61	1H	DOS	0.85	MAI	0.23/0.36	0.85	MAI	0.14/0.24	0.70	0.09	0.09	0.21	0.64	0.06
11	23	58	3H	DOS	0.49	SAI	0.15	0.45	SAI	0.1	0.40	0.05	0.03	0.21	0.28	0.12
11	24	51	1H	DOS	0.24	SAI	0.32	0.62	SAI	0.21	0.51	-0.17	0.07	0.21	0.03	0.48
11	41	68	2H	DOS	0.42	MAI	0.12/0.20	0.66	MAI	0.11/0.18	0.64	-0.13	0.01	0.21	0.21	0.43
11	42	50	4H	DOS	0.69	SAI	0.13	0.43	SAI	0.12	0.42	0.16	0.01	0.21	0.48	-0.06
12	13	83	3H	DOS	1.02	MAI	0.12/0.18	0.64	MAI	0.13/0.13	0.61	0.25	0.02	0.21	0.81	-0.20
12	13	83	5H	DOS	0.77	MAI	0.15/0.21	0.69	MAI	0.23/0.28	0.79	-0.01	-0.07	0.21	0.56	0.23
12	14	76	1H	DOS	0.58	MAI	0.16/0.42	0.86	SAI	0.34	0.64	-0.04	0.13	0.21	0.37	0.27
12	19	85	2H	DOS	2.59	MAI	0.18/0.49	0.93	MAI	0.15/0.32	0.77	1.13*	0.10	0.21	2.38	-1.61
12	20	72	1H	DOS	1.08	SAI	0.16	0.46	SAI	0.12	0.42	0.41	0.02	0.21	0.87	-0.45
12	21	32	1H	DOS	0.6	SAI	0.23	0.53	SAI	0.22	0.52	0.05	0.01	0.21	0.39	0.13
12	22	62	2H	DOS	0.61	SAI	0.38	0.69	SAI	0.32	0.62	-0.01	0.04	0.21	0.40	0.22
12	22	83	1H	DOS	0.61	SAI	0.16	0.46	SAI	0.12	0.42	0.12	0.02	0.21	0.40	0.02
14	3	44	1H	DOS	0.95	MAI	0.15/0.23/0.45	1.03	SAI	0.16	0.46	0.30	0.35	0.21	0.74	-0.28
14	13	6	2H	DOS	0.5	MAI	0.18/0.20/0.36	0.97	SAI	0.36	0.67	-0.10	0.19	0.21	0.29	0.38
14	14	34	1H	DOS	2.13	SAI	0.72	1.03	SAI	0.31	0.62	0.94*	0.26	0.21	1.92	-1.30
14	25	60	1H	DOS	1.05	SAI	0.61	0.92	SAI	0.28	0.58	0.29	0.21	0.21	0.84	-0.26

* Growth rates were used in Cycle 12 growth distribution.

Figure 1


1R12 CM Burst Pressure vs Cycle 12 Average Depth Growth Rate
1R12
As found Burst Pressure, WEC
7000
6000
5000
4000
3000
2000
1000
0
-15.0
-10.0
-5.0
0.0
5.0
10.0
15.0
AD growth per EFPY