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PG&E Letter DCL-03-113

U.S. Nuclear Regulatory Commission
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Docket No. 50-275, OL-DPR-80
Diablo Canyon Unit 1
PG&E Response to NRC Questions on 1R11 Steam Generator Tube Inspections

Dear Commissioners and Staff:

Pacific Gas & Electric (PG&E) submitted Diablo Canyon Letter (DCL) 02-064, dated May 22, 2002 (ML021560548), and letter DCL-02-098, dated August 22, 2002 (ML022420012), summarizing the steam generator (SG) tube inspections performed during the 2002 Unit 1 eleventh refueling outage (1R11).

On February 6, 2003, a NRC staff e-mail requested additional information regarding the 1R11 SG inspections.

Formal reply to the request for additional information is enclosed. Data corrections to DCL-02-98 identified during preparation of this reply are evaluated on pages 2 and 3, and an asterisk identifies the corrected data in revised Tables 1 and 2 on pages 4 and 6, and Tables 3, 4 and 5 on pages 15 and 16 of 32.

If you have further questions please contact John Arhar at (805) 545-4629.

Sincerely

David H. Oatley
Vice President and General Manager -Diablo Canyon

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PG&E Response to NRC Questions on 1R11 Steam Generator Tube Inspections

PG&E has provided the following submittals to the NRC regarding the Diablo Canyon Power Plant (DCPP) Unit 1 eleventh refueling outage (1R11) steam generator (SG) tube inspections:

- PG&E letter DCL-02-064 dated May 22, 2002, Licensee Event Report (LER) 1-2002-002, "Steam Generator Tube Plugging Due to Stress Corrosion Cracking."

- PG&E letter DCL-02-098 dated August 22, 2002, "Special Report 02-02 - Results of Steam Generator Inspections for Diablo Canyon Power Plant Unit 1 Eleventh Refueling Outage," 90-day Report

- PG&E letter DCL-03-054 dated May 19, 2003, "Special Report 03-01: Results of Steam Generator Tube Eddy Current Inspections During Unit 1 Eleventh Refueling Outage," 12 Month Report

On February 6, 2003, the NRC forwarded questions to PG&E based on NRC's review of DCL-02-064 and DCL-02-098. PG&E's responses to these questions are provided in this enclosure.

Questions on W* Alternate Repair Criteria (ARC)

NRC Question No. 1:

> "It was indicated that one indication was identified in steam generator 1-1 as having an axial indication extending into the expansion transition. This indication was plugged, and the leakage from this indication was assessed for the end-of-cycle (EOC) 11 condition monitoring assessment. Please discuss why at least one similar indication was not postulated to develop during Cycle 12 such that it would be included in the EOC 12 operational assessment."

PG&E Response:

As noted in the 1R11 90-day report, a new axial primary water stress corrosion cracking (PWSCC) indication in SG 1-2 R3C38 (not in SG 1-1 as noted in the request for additional information) was detected in the WEXTEX region transition zone, below the top of tube sheet (TTS). The indication extended from 0.32 inch (lower tip) to 0.19 inch (upper tip) below the TTS. The location of the bottom of the WEXTEX transition (BWT) was measured by bobbin as 0.31 inch below the TTS. The tube was plugged because the upper crack tip was above BWT. The indication was not detectable in the Unit 1 tenth refueling outage (1R10) based on a lookup review.

Since this indication is located in the expansion transition region, W* criteria do not apply to this indication. W* applies to indications initiated below the bottom of the expansion transition. It is possible for some W* indications to grow into the lower end of the expansion transition, but the dominant length would be below the BWT. The W* alternate repair criteria (ARC) methodology does not require that potential new indications below the BWT be accounted for in operational assessments on the basis that new W* indications are not likely to be through-wall and contribute to leakage.

The steam line break (SLB) leakage was assessed as part of the W* ARC because a fraction of the indication (0.01 inch) was located below BWT, and a conservative 0.045 gpm leak rate (maximum leak rate in W* leak model) was assigned to this indication for condition monitoring. Since the W* ARC does not apply to this flaw, a separate tube integrity assessment could have been performed, as follows:

Because the flaw was located entirely below the top of tubesheet, the tubesheet provides burst restraint. Structural and SLB leakage integrity are also supported for this indication because of its small voltage (0.22 volts) and shallow depth (67 percent) as measured by Plus Point. EPRI Report 1007904, "Steam Generator In Situ Pressure Test Guidelines," Revision 2, August 2003, demonstrates that axial PWSCC indications in explosive transitions less than 2.5 volts Plus Point have no SLB leakage potential, and degradation less than 0.5 volts Plus Point has no burst potential at 3 times normal operation differential pressure. For operational assessment, it can be assumed this flaw size is the largest undetected flaw in the transition. Applying the PWSCC ARC operational assessment methodology to this flaw results in a projected EOC 12 burst pressure in excess of 6100 psi, and no leakage at SLB conditions. Therefore, no axial PWSCC indications in the transition region are expected that would challenge structural performance criteria at EOC 12, and no leakage is postulated in a faulted SG following a SLB at EOC 12.

To reflect the change of classifying tube SG 1-2 R3C38 as a non-W* tube, Table 1 of this enclosure provides an update to DCL-02-098 Table 1 from Enclosure 1 of the 1R11 90-day report, "1R11 Indications in Hot Leg WEXTEX Tubesheet Region (excluding circumferential indications that were plugged)." No condition monitoring SLB leakage is assigned to R3C38 based on the above assessment.

While reviewing Table 1 from the 1R11 90-day report, a typographical error was noted for the BWT location of tube SG 1-1 R3C2. The correct BWT location is "-0.22", not "0.22", such that the upper crack tip is closer to BWT than previously reported. The revised condition monitoring (CM) and operational assessment (OA) leak rates for R3C2 are 0.01525 gpm and 0.02029 gpm respectively, which are greater than the previously reported CM and OA leak rates of 0.00740 gpm and 0.00816 gpm, respectively. These corrections are also incorporated into Table 1 of this enclosure.

Table 2 of this enclosure provides an update to DCL-02-098 Enclosure 1 of the 1R11 90-day report, "DCPP Unit 1 Steam Line Break Leak Rates for Alternate Repair Criteria." Table 2 incorporates the corrected leak rates for SG 1-1 R3C2 and SG 1-2 R3C38 based on the above discussion. Based on these changes, the limiting CM ARC leak rate is 0.340 gpm in SG 1-1, which is a decrease compared to the previous 90-day report limiting leak rate of 0.368 gpm in SG 1-2. The limiting OA ARC leak rate is 1.127 gpm in SG 1-1, which is an increase compared to the previous 90-day report limiting leak rate of 1.115 gpm in SG 1-1. The corrected leak rates remain well below the current ARC SLB leak rate limit of 10.5 gpm in a faulted SG.

Table 1
1R11 Indications in Hot Leg WEXTEX Tubesheet Region (excluding circumferential indications that were plugged)
(*Corrected Table 1 of Enclosure 1 to 1R11 90-day report)

SG	R	C	Ind	+Pt volt	MD	From	To	L	UCT to TSH	W* Zone	W* L	BWT	EOC11 UCT-BWT	UCT Below W*	UCT Below BWT	EOC 12 UCT	UCT Below TSH at EOC12	W* Tube	Insp Ext	W* Insp Dist	Flex W* L	CM LR	EOC12 UCT-BWT	OA LR	Plug 1R11	Type
11	3	2	SAI	0.35	47	-1.53	-1.34	0.19	-1.12	A	5.32	-0.22*	0.84*	No	Yes	-0.99	Yes	Yes	-12.8	12.93*	5.50	0.01525*	0.71*	0.02029*	No	Repeat
11	15	10	SAI	0.63	40	-9.03	-8.88	0.15	-8.66	A	5.32	-0.24	8.36	Yes	Yes	-8.53	Yes	Yes	-10.57	10.24	5.32	0	8.23	0	No	New
11	15	10	SAI	0.8	46	-8.51	-8.37	0.14	-8.15	A	5.32	-0.24	7.85	Yes	Yes	-8.02	Yes	Yes	-10.57	10.24	5.32	0	7.72	0	No	New
11	20	44	SAI	0.31	34	-7.96	-7.82	0.14	-7.6	B2	7.12	-0.31	7.23	Yes	Yes	-7.47	Yes	Yes	-10.95	10.55	7.12	0	7.10	0.00051	No	Repeat
12	3	38	SAI	0.22	67	-0.32	-0.19	0.13	0.03	B1	7.12	-0.31	-0.4	No	No	0.16	No	No	-9.74	9.34	7.24	0 (Note 2)	NA	NA	Yes	New
12	7	33	SAI	1	71	-2.03	-1	1.03	-0.78	B2	7.12	-0.35	0.37	No	Yes	-0.65	Yes	Yes	-10.32	9.88	8.14	0.03100	0.24	0.03583	No	deplug 1R11
12	20	37	SAI	1.25	82	-1.9	-1.75	0.15	-1.53	B3	7.12	-0.18	1.29	No	Yes	-1.40	Yes	Yes	-12.32	12.05	7.26	0.01410	1.16	0.01581	No	deplug 1R11
13	2	14	SVI	0.59	NA	-8.36	-8.12	0.24	-7.9	A	5.32	-0.2	7.64	Yes	Yes	-7.77	Yes	Yes	-9.28	8.99	5.32	0	7.64	0	No	deplug 1R11
13	31	36	SAI	0.47	20	-2.92	-2.77	0.15	-2.55	A	5.32	-0.25	2.24	No	Yes	-2.42	Yes	Yes	-9.43	9.09	5.46	0.00360	2.11	0.00385	No	Repeat
13	33	37	SAI	0.53	24	-5.5	-5.36	0.14	-5.14	A	5.32	-0.48	4.6	No	Yes	-5.01	Yes	Yes	-9.11	8.54	5.45	0.00054	4.47	0.00059	No	Repeat
13	30	45	SAI	0.31	20	-1.9	-1.81	0.09	-1.59	B4	7.12	-0.27	1.26	No	Yes	-1.46	Yes	Yes	-9.3	8.94	7.20	0.01100	1.13	0.01212	No	Repeat
13	39	46	SAI	0.74	26	-2.43	-2.31	0.12	-2.09	A	5.32	-0.27	1.76	No	Yes	-1.96	Yes	Yes	-9.84	9.48	5.43	0.00500	1.63	0.00556	No	Repeat
14	23	7	SAI	0.45	41	-8.21	-8.06	0.15	-7.84	A	5.32	-0.16	7.62	Yes	Yes	-7.71	Yes	Yes	-10.68	10.43	5.32	0	7.49	0	No	Repeat
14	28	57	SAI	0.27	20	-3.26	-3.11	0.15	-2.89	B4	7.12	-0.34	2.49	No	Yes	-2.76	Yes	Yes	-10.46	10.03	7.26	0.00420	2.36	0.00457	No	Repeat
14	28	57	SAI	0.35	20	-7.28	-7.13	0.15	-6.91	B4	7.12	-0.34	6.51	No	Yes	-6.78	Yes	Yes	-10.46	10.03	7.26	0.00022	6.38	0.00022	No	Repeat
14	39	58	SAI	0.32	20	-6.22	-6.07	0.15	-5.85	A	5.32	-0.11	5.68	Yes	Yes	-5.72	Yes	Yes	-10.23	10.03	5.32	0	5.55	0	No	Repeat

Notes:

1. SG 1-1 R3C2 BWT location is corrected to "-0.22" inch, and was incorrectly listed as "0.22" inch in the 90-day report. An asterisk lists all associated changed values.

2. The W* leakage model is not applied to SG 1-2 R3C38 because the majority of the indication is located above BWT. The revised condition monitoring leak rate for this indication is 0 gpm based on a separate analysis.

Column – Table 1	Legend and Notes for Table 1
SG	Steam generator
R	Row
C	Column
Ind	Plus point indication. SAI is single axial indication. SVI is single volumetric indication.
+P Volt	Peak voltage from Plus Point coil.
MD	Maximum depth, percent through-wall, using TSP axial PWSCC depth sizing technique.
From	Elevation (inch) of lower crack tip, relative to the top of tubesheet hot leg (TSH).
To	Elevation (inch) of upper crack tip, relative to the top of tubesheet hot leg (TSH).
L	Length of crack (inch)
UCT to TSH	Elevation (inch) of the upper crack tip (UCT) to TSH, including ΔNDE_{CT-TTS} (Plus Point NDE uncertainty on locating the crack tip relative to the TTS). None of the indications extended above the top of tubesheet.
W* Zone	W* tubesheet zone based on crack location.
W* L	W* length is 7.12 inch for Zone B and 5.32 inch for Zone A, and includes ΔNDE_W (NDE uncertainty in measuring the W* depth).
BWT	Bottom of the WEXTEX transition (inch), measured by bobbin relative to TSH.
EOC 11 UCT to BWT	Distance (inch) from the upper crack tip (UCT) to BWT at EOC 11, minus ΔNDE_{CT-BWT} (Plus Point NDE uncertainty on locating the crack tip relative to the BWT).
UCT below W*?	If the UCT is located below the W* length, then the tube is a W* tube. Any type of degradation below the W* length is acceptable.
UCT below BWT?	If the UCT is located below BWT, then the tube is a W* candidate.
EOC 11 UCT	UCT location (inch) relative to TSH at the end of the next operating cycle, EOC 12, based on growing the UCT at 0.081 inch/EFPY. Unit 1 Cycle 12 is projected to be 1.61 EFPY.
UCT below TSH at EOC 11?	If the UCT is below TSH at EOC 12, a free span indication is precluded and the tube is a W* candidate.
W* Tube?	If the EOC 11 UCT is below BWT and the UCT is projected to be below TSH at EOC 12, then the tube is a W* tube.
Insp Ext	Inspection extent of Plus Point relative to TSH (inch).
W* Insp Dist	W* inspection distance (inch). This is the +Point inspection extent relative to BWT. The W* inspection distance below BWT is equal to the Plus Point inspection extent below TSH, plus measured distance from BWT to TSH, plus bobbin NDE uncertainty in locating BWT relative to TSH. The W* inspection distance must be greater than or equal to the flexible W* length.
Flex W* L	Flexible W* length relative to BWT (inch), equal to W* Length + $\sum Cl_i$ (total axial crack length) + $N_{CL}*\Delta NDE_{CL}$ (number of indications times Plus Point NDE uncertainty with measuring length of axial cracks) + $N_{CL}*\Delta CG$ (number of indications times crack growth allowance from prior cycle tube integrity assessment, 0.081 inch/EFPY)
CM LR	Condition monitoring SLB leak rate at EOC 11 conditions, gpm at room temperature, based on distance of UCT (at EOC 11) to BWT using Figure 6.4-3 of WCAP-14797 Rev 1. No accident leakage is assigned to deplugged indications and an indication with UCT below W* length.
EOC 12 UCT to BWT	Distance (inch) from the upper crack tip (UCT) to BWT at EOC 12, minus ΔNDE_{CT-BWT} (Plus Point NDE uncertainty on locating the crack tip relative to the BWT), based on growing the UCT at 0.081 inch/EFPY (95% growth rate).
OA LR	Operational assessment leak rate at EOC 12 conditions based on EOC 12 UCT to BWT, gpm at room temperature, using Figure 6.4-3 of WCAP-14797 Rev 1. No accident leakage is assigned to an indication with UCT below W* length.
Plug 1R11?	Tube was plugged in 1R11.
Type	Identifies the flaw as new, repeat, or deplugged in 1R11.

Table 2

DCPP Unit 1 Steam Line Break Leak Rates for Alternate Repair Criteria
(*Corrected Table 2 of Enclosure 1 to 1R11 90-day report)

EOC 11 Condition Monitoring Leak Rate (gpm at room temperature)	SG 1-1	SG 1-2	SG 1-3	SG 1-4
W* ARC	0.01525*	0.04510*	0.02014	0.00442
Voltage-Based ARC	0.325	0.278	0.153	0.059
PWSCC ARC	0	0	0	0
Aggregate ARC	0.340*	0.323*	0.173	0.063

EOC 12 Operational Assessment Leak Rate (gpm at room temperature)	SG 1-1	SG 1-2	SG 1-3	SG 1-4
W* ARC	0.02080*	0.05163	0.02213	0.00480
Voltage-Based ARC	1.106 (Note 1)	0.861	0.436	0.233
PWSCC ARC	0	0	0	0
Aggregate ARC	1.127*	0.913	0.458	0.238

Note 1: SG 1-1 leak rate of 1.106 gpm was calculated using a normal growth rate distribution. Using a more conservative voltage-dependent growth rate distribution, a leak rate of 1.143 gpm is calculated for SG 1-1.

Note 2: Asterisks reflect corrected values based on revised W* ARC leak rates for SG 1-1 R3C2 and SG 1-2 R3C38

Questions on W* Alternate Repair Criteria (ARC) (continued)

NRC Question No. 2:

> "For the W* ARC, the steam line break differential pressure was assumed to be 2560 psi; however, for other ARCs the differential pressure was assumed to be 2405 psi. For most flaws, assuming a differential pressure of 2560 psi would be considered conservative because of the higher driving force; however, for flaws in the tubesheet region, this higher driving force may be offset by the increased contact pressure between the tube and tubesheet resulting from the higher pressure. Please provide 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). This may require assessing a number of different size flaws at various elevations within the tubesheet."

PG&E Response:

This question is identical to "W* ARC" NRC question 6 on the 2R11 90-day report. PG&E will respond to this question as part of the 2R11 responses.

NRC Question No. 3:

> "Please discuss how the leakage was assessed for circumferential flaws that were plugged or for flaws that may remain in service below the region inspected with a probe qualified for detecting these flaws. In addition, please discuss how potential leakage from axial flaws below the region inspected was addressed in your assessment."

PG&E Response:

The topic of leakage from indications below the W* region is addressed in Section 6.4.4 of WCAP-14797, Revision 1. The SLB leak rate from cracks at the W* depth is decreased by factors between 10 and 100 compared to cracks about 2 inches below BWT as shown in Figure 6.4-3 of the WCAP. The number of cracks decreases significantly with distance below the BWT by more than about 2 inches as shown in Figure 7.1.3-1b. These two factors combine to reduce leakage from indications below the W* distance to a small fraction of the W* leak rate. Section 6.4.4 includes an example calculation for 75 flaws with 5 of the 75 located between 1.97 inches and 3.5 inches below the BWT and the remainder between the BWT and 1.9 inches below. The results of the analysis, as given in Figure 6.4-4, show that the 5 indications below 1.9 inches contribute significantly less than 5 percent to the total leak rate. It is concluded that due to the increasing crevice restriction to leakage and the decreasing fraction of indications with distance below BWT, leakage from indications below the W* distance that may remain in service can be expected to be negligible compared to the leakage predicted for indications within the W* distance. The increasing crevice restriction with distance applies to both axial and circumferential indications such that the total leakage from both axial and circumferential indications can be expected to be a small fraction of the total predicted leakage.

Enclosure 3 of the 90-day report includes condition monitoring assessment of 8 circumferential indications detected and plugged in 1R11 that are located in the WEXTEX hot leg tubesheet region. Three circumferential PWSCC indications and five circumferential outside diameter stress corrosion cracking (ODSCC) indications were detected by Plus Point. One indication was located below the W* region and, therefore, does not contribute to burst or leakage in accordance with W* ARC. Seven of the indications were located in the WEXTEX transition region (above BWT), and are not applicable to W* ARC. The largest measured maximum voltages were 0.28 volts for ODSCC and 0.82 volts for PWSCC (excluding the indication below the W* region). EPRI Report 1007904, Revision 2, demonstrates that circumferential indications in explosive transitions less than 1.31 volts Plus Point for ODSCC, and 1.25 volts Plus Point for PWSCC, have no SLB leakage potential. The indication voltages are much less than the EPRI threshold values and, as such, no SLB leakage should be postulated for these indications.

Questions on Primary Water Stress Corrosion Cracking (PWSCC) ARC

NRC Question No. 1:

> "An evaluation was provided regarding the ability of the operational assessment methodology to predict flaw distributions as a function of flaw size. This evaluation focused on the predicted burst pressure of the specimens. Whereas the burst pressure gives insights on the severity of the degradation, it does not directly verify whether the methodology for predicting the length and depth of the degradation provides conservative results (i.e., the predicted burst pressure may be accurate but for the wrong reasons). In addition, given that the computer code for predicting the burst pressure only provides an actual estimate of the burst pressure when it is less than some cutoff value (e.g., 6100 psi), it would not provide information that would indicate whether under predictions of the burst pressure were being made (unless most burst pressures were less than this cutoff value). That is, suppose the predicted burst pressure for EOC 12 was 9000 psi, the computer code would only indicate that it was greater than 6100 psi. If in this case, the actual burst pressure was determined at the EOC 12 to be 6500 psi, the methodology would have under predicted the burst pressure by 2500 psi. Whereas this specific example does not pose a safety issue, it may provide an early indication that the methodology is not providing conservative results. Please discuss your plans to address these issues in future assessments."

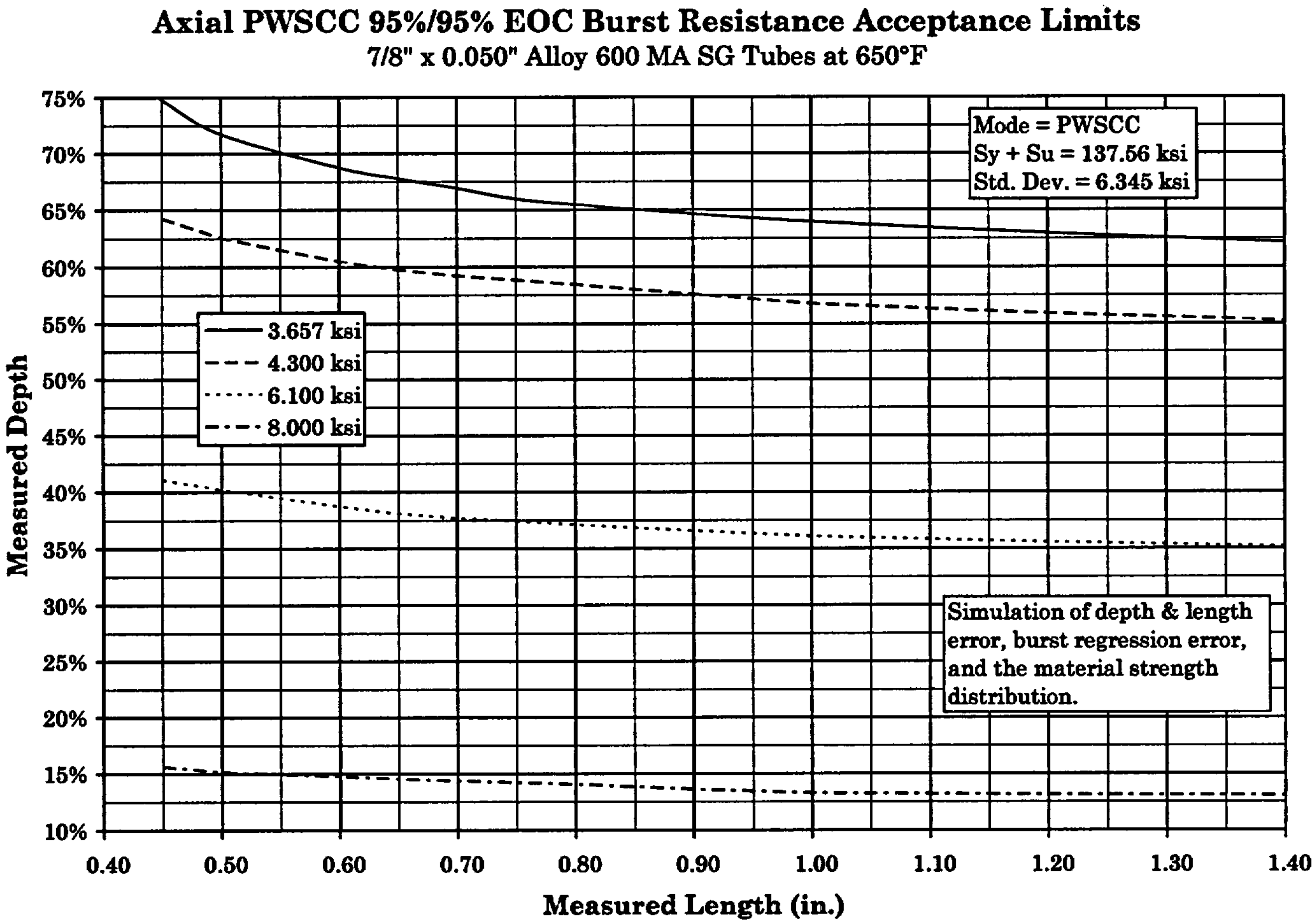
PG&E Response:

As previously discussed with the NRC in PG&E letter DCL-02-045, "Response to Final NRC Request for Additional Information Regarding Supplement 3 to License Amendment Request 00-06, 'Alternate Repair Criteria for Axial PWSCC at Dented Intersections in Steam Generator Tubing,'" dated April 18, 2002, the distribution of burst pressures above 6100 psi is not considered to be important for tube integrity assessments. In addition, differences between projected and as found burst pressures where both burst pressures are greater than 6100 psi are not recommended for assessments of the adequacy of the methodology. The flaw sizes at the beginning of the cycle being projected are very small where nondestructive examination (NDE) uncertainties are large and differences between projections and as found burst pressures can be significant with no implications on the adequacy for tube integrity analyses. Figure 1 plots average depth versus length requirements (at the 95/95 confidence levels used for burst analyses) to satisfy burst pressures of 8000, 6100, 4300 (near $3\Delta P_{NO}$) and 3657 ($1.4\Delta P_{SLB}$) psi. To satisfy burst pressures of 6100 psi and 8000 psi, the average depths must be less than about 35 percent to 42 percent and 16 percent, respectively, or less than a length of 0.45 inch for which even a throughwall indication satisfies burst margin requirements. If the indication is projected to have an average depth less than 40 percent such that the projected burst pressure is greater than 6100 psi, and the as found indication has an average depth less than 40 percent to satisfy a burst pressure greater than 6100 psi, the methodology is considered to be very adequate even if the burst pressures might differ by 1000 psi above 6100 psi. Since the axial PWSCC sizing methods require the maximum depth to be at least 20 percent, predictions of burst pressures less than 8000 psi are essentially forced by the sizing methods. Consequently, there is no need to assess differences in burst pressures above 6100 psi and there is no need to revise the computer code to edit the high burst pressures.

Assessing the adequacy of the operational assessment methods based on burst pressure comparisons is considered to be more relevant and significant than separate comparisons of lengths and depths. Typically, when lengths are underestimated, the flaw has shallow tails that are not detected and the sizing would be expected to reflect a larger average depth over the detected length than would be obtained for the total length. If a length and/or depth was different between the projections and as found, the significance of the difference would have to be assessed by comparing the burst pressures. The sizing methods are considered to predict conservative results only if the burst pressure is conservatively predicted.

In summary, the current comparisons of projections and as found based on burst pressures less than 6100 psi and on SLB leak rates are considered to be the most appropriate and meaningful methods for evaluating the methodology. It is planned to continue these comparisons for future assessments.

Figure 1


Axial PWSCC 95%/95% EOC Burst Resistance Acceptance Limits
7/8" x 0.050" Alloy 600 MA SG Tubes at 650°F
Mode = PWSCC
Sy + Su = 137.56 ksi
Std. Dev. = 6.345 ksi
3.657 ksi
4.300 ksi
6.100 ksi
8.000 ksi
Simulation of depth & length error, burst regression error, and the material strength distribution.
Measured Depth
75%
70%
65%
60%
55%
50%
45%
40%
35%
30%
25%
20%
15%
10%
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
1.20
1.30
1.40
Measured Length (in.)

Questions on Primary Water Stress Corrosion Cracking (PWSCC) ARC (continued)

NRC Question No. 2:

> "Please clarify page 2-8 of the August 22, 2002, report regarding the number of axial PWSCC indications detected (131 or 138)."

PG&E Response:

The correct number is 131, whereas 138 is a typographical error.

Questions on Condition Monitoring Report

NRC Question No. 1:

> "150 tubes were deplugged and inspected in steam generator 1-2. Of these 53 tubes were re-plugged because they did not meet the acceptance criteria. In addition to these deplugged tubes, tubes were also deplugged in at least one previous outage. Please discuss whether there were any unusual findings in any of these deplugged tubes (e.g., swelling, severance, extensive degradation, water). In addition, please discuss the restriction observed in one of these tubes in 2002. Also address whether any of these tubes were stabilized based on the findings from the inspection."

PG&E Response:

In 1R9, 1R10, and 1R11, tubes have been deplugged for the purpose of returning to service under new PWSCC and ODSCC repair criteria. There have been no unusual findings in these tubes, such as tube swelling, severance, or extensive degradation. There is typically a small amount of water behind the plug. In some cases, boron deposits on the tube inside diameter (ID) were found, thus restricting the diameter of the tube in these areas and not permitting eddy current probes to pass. In all but one case, the restrictions were removed to permit passage of the probes. The exception was 1R11 deplugged tube SG 1-2 R11C80, where two restrictions (21 inches above tube support plate (TSP) 1H and 11 inches below TSP 5H) prevented probes from completing a full length inspection. As such, the tube was replugged.

None of the deplugged tubes required stabilization.

NRC Question No. 2:

> "Please clarify the hot-leg tube support plate categories in Table 4. For example, for the entry that indicates "PWSCC Mix Mode, Ax/Circ", does this imply that there was an axial PWSCC indication and a circumferential

PWSCC indication? Similarly, for the entry that indicates "PWSCC/ODSCC, Axial" does this imply that these locations had an axial PWSCC indication and an axial ODSCC indication?"

PG&E Response:

"PWSCC Mix Mode, Ax/Circ" means an axial PWSCC indication and a circumferential indication at the same intersection (the circumferential indication may be either ODSCC or PWSCC). In 1R11, active tube SG 1-2 R11C81 at 2H had an axial PWSCC indication and a circumferential PWSCC indication. The 1R11 deplugged tube SG 1-2 R11C86 at 1H had an axial PWSCC indication and a circumferential ODSCC indication.

Likewise, "ODSCC Mix Mode, Ax/Circ" means an axial ODSCC indication and a circumferential indication at the same intersection (the circumferential indication may be either ODSCC or PWSCC). In 1R11, active tube SG 1-2 R35C69 at 2H had an axial ODSCC indication and a circumferential ODSCC indication. The 1R11 deplugged tube SG 1-2 R21C42 at 1H had an axial PWSCC indication, an axial ODSCC indication, and a circumferential ODSCC indication. R21C42 was listed as a deplugged ODSCC mix mode indication in the 90-day report tables and, on further review, it would be better classified as a deplugged PWSCC mix mode indication because the original defect was axial PWSCC. This change of classification is included in Tables 3, 4, and 5 in this enclosure.

"PWSCC/ODSCC, Axial" means an axial PWSCC indication and an axial ODSCC indication at the same intersection.

When tubes are plugged with multiple types of degradation, judgment is used to classify the degradation in the post outage summary tables.

NRC Question No. 3:

"Please clarify the number of circumferential indications detected during the outage. Tables 3 and 5 of Enclosure 3 are consistent in the number of tubes plugged due to circumferential indications. These tables indicate that a total of 9 tubes were plugged due to circumferential indications (these indications may be associated with axial flaws). Of these 9 tubes, 2 were tubes that were deplugged during the outage and subsequently replugged. Of the 9 tubes, one was attributed to circumferential PWSCC and four were attributed to circumferential ODSCC; however, Section 7.0 indicates that 2 circumferential PWSCC indications were detected and 5 circumferential ODSCC indications were detected (two of which were in the same tube). In addition, only 6 tubes with circumferential indications are listed in Table 7. Please clarify."

PG&E Response:

With respect to the number of circumferential TSP indications detected in 1R11, PG&E reviewed Tables 3, 4, 5, and 7 of the 90-day report and found a typographical error that was common to Tables 3, 4, and 5.

There were 8 tubes with circumferential TSP indications detected in 1R11, 2 nonactive tubes (deplugged and replugged) and 6 active tubes. Table 3 of the 90-day report was incorrect in that it listed 3 (instead of 2) nonactive tubes with circumferential TSP indications, and listed 0 (instead on 1) nonactive tubes with volumetric TSP indications. The Table 3 errors were carried over to Tables 4 and 5 of the 90-day report. These tables have been corrected and are included in this enclosure as Tables 3, 4, and 5.

Condition monitoring is performed for degradation in active tubes; therefore, Section 7.0 and Table 7 of the 90-day report accurately identified the 6 active tubes (with 7 indications). The 2 deplugged tubes with circumferential indications are not subject to condition monitoring and are not discussed in Section 7.0.

Table 3 - DCPP Unit 1 Tubes Plugged by Mechanism and SG in 1R11 Active and Deplugged Tubes (*Corrected Table 3 of 1R11 90-day report)

LOCATION	MECHANISM	ORIENT	1-1	1-2	1-2 unplug	1-3	1-4	Total
WEXTEX Region	PWSCC	Axial		1				1
	PWSCC	Circ	2					2
	ODSCC	Circ	4			1		5
Hot Leg TSP	PWSCC	Axial			5			5
	PWSCC	Circ		1				1
	ODSCC	Axial	8	16		7	6	37
	ODSCC	Circ		2	0*		1	3
	PWSCC Mix Mode	Axial PWSCC/Circ		1	2*			3
	ODSCC Mix Mode	Axial ODSCC/Circ		1	0*			1
	PWSCC/ODSCC	Axial	7	7	44			58
	Volumetric	OD		1	1*		2	4
Cold Leg TSP	Cold Leg Thinning			3			1	4
U-Bends	AVB Wear		1	3		2		6
Rows 1 and 2 U-bend	Preventive Data Quality		7	2				9
Restriction					1			1
Tubes Plugged			29	38	53	10	10	140
Tubes Unplugged					150			150
Net Plugged			29	38	-97	10	10	-10

Table 4 - DCPP Unit 1 Historical Tube Plugged by Mechanism and SG (*Corrected Table 4 of 1R11 90-day Report)

LOCATION	MECHANISM	ORIENT	1-1	1-2	1-3	1-4	Total
WEXTEX Region	PWSCC	Axial	2	3	0	2	7
	PWSCC	Circ	4	4	0	1	9
	ODSCC	Circ	7	0	9	0	16
	Volumetric		3	0	5	4	12
Hot Leg TSP	PWSCC	Axial	38	34	0	15	87
	PWSCC	Circ	1	8	0	0	9
	ODSCC	Axial	21	32	9	10	72
	ODSCC	Circ	0	6*	0	2	8
	PWSCC Mix Mode	Ax/Circ	0	4*	0	0	4
	ODSCC Mix Mode	Ax/Circ	0	1*	0	0	1
	PWSCC/ODSCC	Axial	10	65	0	0	75
	PWSCC/ODSCC	Circ	0	1	0	0	1
	Volumetric		1	2*	1	3	7
	Preventive Data Quality	PVN	0	1	0	0	1
Cold Leg TSP	Cold Leg Thinning		17	27	1	8	53
	Volumetric		2	1	1	1	5
Rows 1 and 2 U-bend	PWSCC	Axial	6	17	2	1	26
	PWSCC	Circ	7	5	0	1	13
	Preventive Data Quality		8	10	4	9	31
U-bend	AVB Wear		5	13	14	16	48
Factory Plug			0	1	0	0	1
Restriction			0	3	0	0	3
Free span	SVI or SAI scratch		1	0	2	2	5
Fatigue (88-02)	Preventive		5	0	1	0	6
Implant Tubes			16	0	0	0	16
Tubes Plugged			154	238	49	75	516
% Plugged			4.5	7.0	1.4	2.2	3.8

Table 5 - DCPP Unit 1 Tubes Plugged by Mechanism and Outage (*Corrected Table 5 of 1R11 90-day Report)

LOCATION	MECHANISM	ORIENT	Pre	1R1	1R2	1R3	1R4	1R5	1R6	1R7	1R8	1R9	1R10	1R11	UnPlug	Total
Cumulative EFPYs				1.25	2.27	3.45	4.49	5.86	7.14	8.46	9.75	11.4	12.87	14.28		
Cycle EFPY				1.25	1.02	1.18	1.04	1.37	1.28	1.32	1.29	1.62	1.49	1.41		
WEXTEX Tubesheet	PWSCC	Axial							2	2	1	1	2	1	2	7
	PWSCC	Circ								1	4		2	2		9
	ODSCC	Circ										2	9	5		16
	Volumetric	SVI								1	5	5	1	0		12
Hot Leg TSP	PWSCC	Axial							31	72	124	20	13	5	178	87
	PWSCC	Circ								4	1	2	1	1		9
	PWSCC Mix Mode	Ax/Circ										1		3*		4
	ODSCC Mix Mode	Ax/Circ												1*		1
	PWSCC/ODSCC	Axial									1	3	13	58		75
	PWSCC/ODSCC	Circ											1	0		1
	ODSCC	Axial							7	8	44	10	18	37	52	72
	ODSCC	Circ											5	3*		8
	Volumetric	SVI									2	1		4*		7
Cold Leg TSP	Thinning								10	14	2	11	12	4		53
	SVI										1	4				5
Row 1 and 2 U-bend	PWSCC	Axial				4		13	4		5					5
	PWSCC	Circ						4		1	4		4			13
U-bend	AVB Wear					2	1	12	8	12	3	1	3	6		48
U-bend or straight leg	Probe restriction					1			1					1		3
Free Span	SVI or scratch								1			4				5
Factory Plug	Preservice		1													1
Possible UB indication					1										1	0
Preventive Plugging	Fatigue (88-02)					5					1					6
Preventive Plugging	UB Data Quality												23	9	1	31
Preventive Plugging	TSP Data Quality	PVN											1			1
Implant Tubes									4	2	1	9				16
Tubes Plugged			1	0	1	12	1	29	68	117	199	74	108	140		
Tubes Unplugged						1						40	43	150		
Cum Tubes Plugged			1	1	2	13	14	43	111	228	427	461	526	516		
Cum Tubes Plugged (%)			0.01	0.01	0.01	0.10	0.10	0.32	0.82	1.68	3.15	3.4	3.9	3.8		

Questions on Primary Water Stress Corrosion Cracking (PWSCC) ARC (continued)

NRC Question No. 4:

> "Regarding the tube with the circumferential ODSCC and axial ODSCC indication at the same tube support indication, provide the bobbin voltage for this indication from 1R10 and 1R11. In addition, discuss whether the axial indication was a single crack or a network of closely spaced cracks. Discuss the database used to support the conclusion that the burst and leakage integrity of the axial ODSCC indication was not affected by the presence of the circumferential flaw. In particular address whether the database consisted of ODSCC flaws and whether networks of axial cracks were included in the database. Given the potential for circumferential flaws to develop in less than 5 volt dents and to interact with axial ODSCC flaws, discuss the need to alter the voltage based methodology for addressing ODSCC at TSP intersections. The staff notes that in this instance, the burst pressure of the axial indication may not have been affected by the circumferential indication; however, there may be a population of tubes that are allowed to remain in service under the voltage-based ARC which if a circumferential indication were to develop at these locations, the burst pressure may be adversely affected."

PG&E Response:

SG 1-2 R35C69 had a circumferential ODSCC and axial ODSCC indication at the same dented TSP intersection (2.5 volt dent) in 1R11. This degradation is termed as ODSCC mixed mode. A return to null was not discernable between the axial and circumferential indication, so the indications were defined as interacting for the condition monitoring assessment, using the mixed mode indication guidance in WCAP-15573, Revision 1.

The bobbin voltage of the axial ODSCC indication was reported as 0.79 volts and 0.99 volts in 1R10 and 1R11, respectively. Plus Point inspection was performed in both 1R10 and 1R11, confirming a single axial ODSCC indication each inspection, as opposed to multiple axial indications.

Following 1R11, an operational assessment (OA) was issued (internal to PG&E) for circumferential ODSCC and axial ODSCC indications at the same dented TSP intersection. The assessment concluded that there is a low likelihood of interacting ODSCC mixed mode indications developing that could affect leakage or burst margins of the axial ODSCC indication. The assessment in provided below.

The OA for ODSCC mixed mode indications applies similar criteria to the OA for PWSCC mixed mode indications defined in WCAP-15573, Revision 1, as follows:

- If an interacting mixed mode indication is found to have led to a reduction in the axial indication burst pressure by more than 10 percent and to less than 4000 psi, or to have caused an indication to not satisfy burst margin requirements, corrective actions will be taken to adjust burst margin requirements for the operational assessment. As discussed in the 90-day report, the circumferential component of the 1R11 ODSCC mixed mode indication was 49.5 percent average depth, less than the 75 percent average depth threshold for mixed mode burst affects. Therefore, no OA corrective actions are required for structural integrity.

- If an interacting mixed mode indication is found, and the axial indication CM predicts SLB leakage at 95/50, and the circumferential indication has greater than 50 percent average depth, including uncertainty, then the SLB leak rate for an operational assessment should be increased for each SG by a leakage multiplier. Because the circumferential component of the 1R11 ODSCC mixed mode indication was 49.5 percent average depth, less than the 50 percent average depth threshold for mixed mode leakage affects, no OA corrective actions are required for leakage integrity. In addition, no leakage should be predicted from the axial ODSCC indication because the small Plus Point voltage (0.44 volts) is indicative of a shallow flaw.

In Unit 1 Cycle 12, there is a low likelihood of interacting ODSCC mixed mode indications developing that could affect leakage or burst margins of the axial ODSCC flaw, based on the following assessment. Circumferential cracking in Unit 1 Cycle 12 is assumed to occur only in greater than 2 volt dents, based on the observation that 2.4 volts is the smallest dent in which a circumferential indication has been detected by Plus Point at DCPP Units 1 and 2. In 1R11, 25 axial ODSCC indications located at greater than 2 volt dents were left in service under voltage-based ARC. All of these were inspected by Plus Point to verify that no axial PWSCC or circumferential indications were detectable. The largest bobbin voltage of this population is 1.46 volts. (Note: The 1.46 volts bobbin flaw has a small Plus Point amplitude of 0.25 volts. The largest Plus Point amplitude of the 25 flaws is 0.57 volts, with associated bobbin amplitude of 1.11 volts.)

Assuming the largest projected EOC 12 circumferential indication (60 percent average depth) interacts with an axial ODSCC indication that was left in service under voltage-based ARC, the axial ODSCC indication burst margin would not be affected because the 60 percent circumferential OD is less than the 75 percent average depth threshold for mixed mode burst affects.

In summary, the occurrence of either a PWSCC or ODSCC circumferential crack at a TSP intersection requires the presence of a dent. PG&E requires Plus Point inspection of bobbin indications at dented intersections. Consequently, the occurrence of axial ODSCC indication with a circumferential indication at the same intersection would be detected and the tube would be repaired. The growth of a circumferential indication between inspections from below detection levels to the depths required to reduce the structural integrity of an axial indication left in service has a negligible likelihood of occurrence as shown in

Section 4.13 of WCAP-15573, Revision 1, and further monitored as a part of condition monitoring assessments. The inspection practices and methodology being applied are adequate to address the potential for mixed mode indications, and there is no need to alter the voltage based methodology for ODSCC at TSP intersections.

NRC Question No. 5:

> "Discuss whether the size estimates for the single volumetric indications accounted for NDE uncertainty. Briefly discuss the method used to size these indications. In addition, address how the uncertainty with respect to the type of degradation actually being observed was addressed (e.g., were size estimates associated with wear, intergranular attack, and pitting made and the most conservative estimate assumed for the depth of the flaw)."

PG&E Response:

As discussed in the 90-day report, six volumetric indications (in five tubes) were detected by Plus Point in 1R11: one that was left in service below the W* length, and five that were plugged at hot leg TSP 1H intersections. Two of the five TSP indications were located in tube SG 1-2 R2C68 that was deplugged in 1R11 and therefore was not subject to condition monitoring.

The indications were sized by Plus Point for length and width (using from-to measurements) and for depth using phase angle. The Plus Point sizing estimates are in Table 6 of the 90-day report, and the estimated maximum depths were less than 40 percent throughwall. There is no EPRI qualified Plus Point sizing technique for volumetric indications at hot leg TSP intersections. As such, there is no NDE uncertainty included in the estimates. Plus Point length estimates are considered to be conservative.

The volumetric indications may be attributed to closely spaced axial ODSCC. For example, in 1R10, a single axial ODSCC indication was confirmed by Plus Point in R28C50, and was left in service under ODSCC ARC. In 1R11, the Plus Point signal was similar, but two indications were called (volumetric outside diameter indication and single axial ODSCC indication), causing the tube to be plugged.

Not knowing with certainty that the TSP indications are volumetric or ODSCC, the flaws can be evaluated as either volumetric or ODSCC by comparing the flaw voltages with the voltage screening thresholds contained in EPRI Report 1007904, Revision 2.

- The largest Plus Point voltage is 0.52 volts. Treating the indication as ODSCC, this voltage is less than the 0.85 Plus Point voltage threshold for leakage based on a maximum depth to Plus Point voltage correlation for axial ODSCC. The 90-day report also indicated that, if the indications were assumed to be axial cracks, the burst pressures would be very high due to the short lengths.

- The largest bobbin voltage is 1.85 volts in SG 1-2 R28C50, which has two Plus Point indications (one volumetric and one axial ODSCC). Conservatively treating the indication as pitting, this voltage is less than the 2.03 bobbin voltage threshold for leakage. The 90-day report also indicated that the estimated volumetric flaw measurements were much less than the cold leg thinning structural limit length and depth combination.

In conclusion, because of the significant structural and leakage margins associated with these indications, NDE uncertainty does not need to be considered in the NDE measurements.

Questions on outside diameter stress corrosion cracking (ODSCC) ARC

NRC Question No. 1:

> "It was indicated that 7 DOS indications were identified in the cold-leg thinning region and that they were not confirmed as cold leg thinning or ODSCC. Please clarify whether there was an indication based on the rotating probe examination (i.e., there was no cold leg thinning or ODSCC indication, but was there some other type of indication). If there was an indication confirmed by rotating probe examination, discuss the nature of the indication and whether or not the tube was plugged."

PG&E Response:

The 7 distorted ODSCC signal (DOS) indications that were identified in the cold leg thinning region were subsequently inspected by Plus Point and had no degradation detected by Plus Point. If volumetric degradation had been identified by Plus Point (confirming the presence of cold leg thinning), then the DOS call would have been changed to a percent throughwall call and sized as cold leg thinning. All cold leg DOS indications that were left in service were conservatively included in the ARC Monte Carlo simulations for condition monitoring and operational assessment.

NRC Question No. 2:

> "For axial ODSCC indications detected by rotating probe but not detected by bobbin (AONDB), a methodology is used to assess what an appropriate bobbin voltage should be for these indications. This voltage is then used to assess the structural and leakage integrity of these indications. Discuss what assessments are performed to confirm the adequacy of this approach. For example, are the growth rates of AONDB indications monitored from outage to outage to ensure they are consistent with non-AONDB indications? Once the indications are detected by bobbin, are the bobbin voltages smaller (indicating a conservative

methodology) or larger than what was originally observed (indicating that some growth within expected limits may have occurred). In addition to the above, given that some of these AONDB indications may be associated with dents, discuss whether the dent may affect the voltage readings and whether any tests were performed to ascertain the affect of denting on the bobbin voltage of an indication."

PG&E Response:

AONDB indications are detected during dented TSP Plus Point inspections. By definition, no OD bobbin coil signal is present or discernable within the data. As such, these indications are very small in amplitude and are considered to be a conservative call relative to the bobbin coil ARC, where indications less than 1 volt are insignificant to burst and leakage calculations. The EPRI ODSCC database update (Addendum 5) recognizes the existence of these indications in operating SGs and provides the recommendation that a plant specific correlation be developed to assign a bobbin coil voltage to these indications based on the rotating coil inspection results of the TSP intersection. DCPP has developed this correlation using plant specific data.

Continued monitoring of the intersections has been performed during SG inspections using the bobbin coil. Growth rates of AONDB indications are not included in the voltage growth rate assessment used in the Monte Carlo simulations, because a bobbin signal is not present in either inspection. Typically, these indications exhibit insignificant voltage change from inspection to inspection in both Plus Point and bobbin data. Considering the ARC inspections at DCPP Units 1 and 2, only a very small population of AONDB indications actually became detectable by bobbin in a following inspection, again indicating insignificant change between inspections.

PG&E has trended the Unit 1 AONDB indications detected in 1R10 and 1R11 in the continuously active tube population. There were 50 TSP intersections with AONDB indications in 1R10 (ten were subsequently plugged in 1R10), and 87 TSP intersections with AONDB indications in 1R11 (18 were subsequently plugged in 1R11). Of the 40 AONDB indications left inservice in 1R10, the following calls were made in 1R11: 21 AONDB, 9 DOS, 9 not Plus Point inspected (and no bobbin call), and 1 no detectable degradation (NDD) by Plus Point (and no bobbin call).

PG&E concludes that the assigned bobbin voltage for AONDB indications is a good estimate of the flaw voltage and conservative for tube integrity assessment calculations, based on the following trends:

For the 21 back-to-back AONDB calls in 1R10 and 1R11, the assigned bobbin voltages are fairly close, with an average and maximum change of 0.03 volts and 0.14 volts/effective full power years (EFPY). The maximum AONDB growth rate is bounded by the average growth rate of repeat DOS indications. The average growth rate of the 424 repeat DOS indications is 0.14 volts/EFPY.

For the 9 AONDB indications in 1R10 that were subsequently detected by bobbin as DOS in 1R11, in 4 cases the 1R11 bobbin voltage was lower than the 1R10 assigned bobbin voltage, reflecting a conservative methodology. In the other 5 cases, the maximum increase in the 1R11 bobbin voltage compared to the 1R10 assigned bobbin voltage was 0.19 volts/EFPY. This growth rate is within expected limits of repeat ODSCC indications (average growth rate of the 424 repeat DOS indications is 0.14 volts/EFPY).

All but one of the Unit 1 AONDB indications are located at dented TSP intersections. No tests have been performed to ascertain the affect of denting on the bobbin voltage of an indication, but any affect of the dent on the bobbin signal, once it is discernable, would tend to increase the bobbin voltage and change the bobbin phase angle as well. The flaw signal may appear ID or very shallow OD depending on the interaction of the dent and the flaw signal. The growth rate based on these bobbin voltage readings would then be very conservative. On the other hand, the Plus Point voltage is not affected by the dent. Therefore, the growth rate based on the Plus Point voltage readings would be more reliable for AONDB indications at dented TSP intersections.

<u>NRC Question No. 3:</u>

> "It was indicated that one TSP was inspected with a 0.700-inch probe and there was no indication at this location. Although not applicable in this situation, data supporting the use of alternate probe sizes (i.e., other than a 0.720-inch probe) should be submitted for NRC approval. That is, if alternate probe sizes are to be relied upon in the future, the data supporting their use should be submitted for NRC approval consistent with the guidance in Generic Letter 95-05."

<u>PG&E Response:</u>

SG 1-4 R7C89 TSP 7H was not inspected with a 0.720 inch bobbin probe because of a large dent (approximately 200 volts at dent) restriction at the 7H TSP intersection. Therefore, a 0.700 bobbin probe was used to inspect the intersection, no bobbin signal was detected, and the tube was left in service. PG&E recognizes that alternate probe sizes cannot be used for ARC application without NRC approval and, as such, plant procedures require a Plus Point inspection in cases where a 0.720 bobbin probe cannot be used. However, this required step was missed in 1R11, and a Plus Point inspection was not performed. PG&E issued an action request and the inspection vendor issued a nonconformance report to identify the cause and corrective action. As part of the corrective action evaluation, PG&E concluded that the tube could remain in service in Unit 1 Cycle 12 because Plus Point inspection of the 7H TSP intersection was performed in the prior inspection (1R10), with no degradation detected. Since 20 percent Plus Point sampling of greater than 5 volt dents was performed at 7H, in accordance with PG&E commitments to the NRC, this

intersection was not scheduled for Plus Point inspection in 1R11 as part of the dent inspection program.

NRC Question No. 4:

> "What is the basis for the 1 volt limit for support plate residual (SPR) indications? Discuss whether the voltage readings for indications located at SPR intersections are consistent with the voltage readings that would be obtained from the same indication if there was no support plate residual influence.

PG&E Response:

The 1 volt repair limit for axial ODSCC located at large SPR is obtained from GL 95-05, which states: "*All intersections with large mix residuals should be inspected with rotating pancake coil (RPC). For purposes of this guidance, large mix residuals are those that could cause a 1.0 volt bobbin signal to be missed or misread. Any indications found at such intersections with RPC should cause the tube to be repaired.*" The 1 volt limit does not apply to the mix residual signal as discussed below.

To implement the GL 95-05 inspection criteria for SPR, PG&E determined that a 2.3 volts SPR at DCPP had the potential to mask a 1 volt bobbin indication. The 2.3 volts threshold was derived from a correlation of DCPP bobbin voltage to SPR voltage to determine the "threshold" SPR voltage (at 95 percent confidence) that could potentially mask a 1 volt bobbin ODSCC signal. Thus, PG&E requires Plus Point inspection of all hot leg TSP intersections that have a greater than 2.3 volts SPR signal and, at a minimum, the 5 largest hot leg SPR in each SG. At each inspection, computer data screening (CDS) is performed to identify greater than 2 volts, or lower, SPRs such that a minimum of five large SPRs are called in each SG. Production analysts are also trained to identify and report large SPRs. In 1R11, four greater than or equal to 2.3 volts SPRs were called, all of which were inspected with Plus Point and no degradation was detected.

To implement the GL 95-05 repair criteria for SPR, the following plugging criteria is followed based on Addendum 5 of the EPRI ODSCC ARC database:

- Intersections containing Plus Point confirmed axial ODSCC at a mix residual are plugged if the bobbin voltage is greater than 1 volt based on a review of the 200 Khz data. Note: To date (through 2R11), only one indication (DCPP Unit 2 2R11 SG2-2 R29C54) has met this criterion and has been plugged.

- Intersections containing Plus Point confirmed AONDB at a mix residual are plugged if the inferred bobbin voltage is greater than 1 volt. The inferred bobbin voltage is assigned based on a correlation of Plus Point voltage to bobbin voltage as previously described. Note: To date, no DCPP Units 1 and 2 indications have met this criterion.

PG&E provided the following discussion to the NRC at a public meeting on April 15, 2003, in response to NRC questions on mix residual signals, and is provided again for completeness.

With regard to the presence of mix residuals and the influence of the mix residuals on sizing the indications, it must be emphasized that all TSP intersections have mix residuals after the first one or two cycles of operation. After about two cycles, the mix residuals generally do not change with operating time. The dominant voltage for the mix residual signals is not affected by the mixing used to analyze the bobbin data so the mix residual signal amplitude does not vary with operating time or NDE analyst. Frequently, a significant part of the mix residual signal is present in bobbin data obtained without a TSP for pulled tubes examined in the laboratory. Some of the model boiler specimens show mix residuals although generally smaller than field data due to the shorter time at temperature. The bobbin response apparently includes an effect of the time at temperature at a TSP on the magnetic properties of the tube. Metallography was performed on a pulled tube to attempt to identify the cause for the signal, but was not successful in identifying any physical change to the tube or grain structure.

Many of the pulled tubes in the ARC database (and the prior cycle probability of detection or POPCD database) have mix residual signals larger than typically found in currently operating SGs. Figure 2 shows the 1.87 flaw voltage and the 3.23 mix residual voltage for pulled tube R27C54 from plant A-1 in the ARC database. This is only one example of the pulled tube data. Whatever influence the mix residuals may have on voltage sizing for TSP indications is built into the ARC database by the pulled tubes. The mix residuals may be more easily understood as TSP noise. The noise may distort the flaw signal particularly when the two-phase responses are similar.

The mix residual voltage is not being used in current assessments of the influence of noise on detection or sizing. For signal to noise evaluations, the noise is being evaluated as the peak voltage response over one third sections of the TSP to reflect the larger noise near the edges of the TSP. Figure 3 shows the lower and upper TSP noise amplitudes for R27C54-1H. Noise at the middle section cannot be evaluated due to the presence of the flaw. Figure 4 shows the R27C54-2H mix residual voltage and noise levels at the center, upper and lower one-third sections of the TSP. The 3.24 mix residual is the same as found at 1H. The noise level affecting detection and sizing at the center of the TSP, where most of the TSP ODSCC indications are found, is 0.70 volts while the edge noise amplitudes are 1.70 and 1.52 volts. These noise differences between the center and edge affect detectability of short, low voltage indications located at the edges of the TSP. The short indications at the TSP edges must grow to the center of the TSP to become structurally significant and the lower noise levels at the TSP center provide for detection of even low voltage indications. For simplicity in the graphics, the noise levels in these figures are peak-to-peak amplitudes although the vertical amplitudes are more appropriate for assessing signal to noise for flaw detection.

Noise analyses at cold leg TSP intersections have been performed for about 200 intersections spanning DCPP Units 1 and 2. The average peak-to-peak noise amplitudes at the TSP center were about 0.38 volts with an upper 95 percent confidence value of 0.70 volts. At the TSP edges, the average was about 0.51 volts with an upper percentile value of 0.88 volts. It is clear that the noise levels at DCPP TSP intersections are lower than that found for the R27C54 indication and many other indications in the ARC database. The vertical amplitude values at 95 percent confidence that may influence detection are about 0.25 volts at the TSP edges and about 0.2 volts at the TSP center.

Vertical amplitude noise levels that could influence detection were also evaluated for DCPP dented hot leg TSP intersections (PWSCC ARC, WCAP-15573). At the TSP center, the mean vertical amplitudes are 0.12 volts, with a 95 percent confidence value of 0.24 volts. At the TSP edge, the corresponding values are 0.38 and 0.62 volts.

Based upon the above noise and mix residual discussion, it is not feasible or necessary to attempt to define bobbin voltages that are not affected by the TSP noise or mix residuals. All indications have negligibly small to a range of noise influence on voltage sizing, and the ARC database includes many indications with larger noise levels than DCPP and other active SGs.

Figure 2. Flaw and Mix Residual (400/100 Mix) for Plant A-1 Pulled Tube R27C54-1H

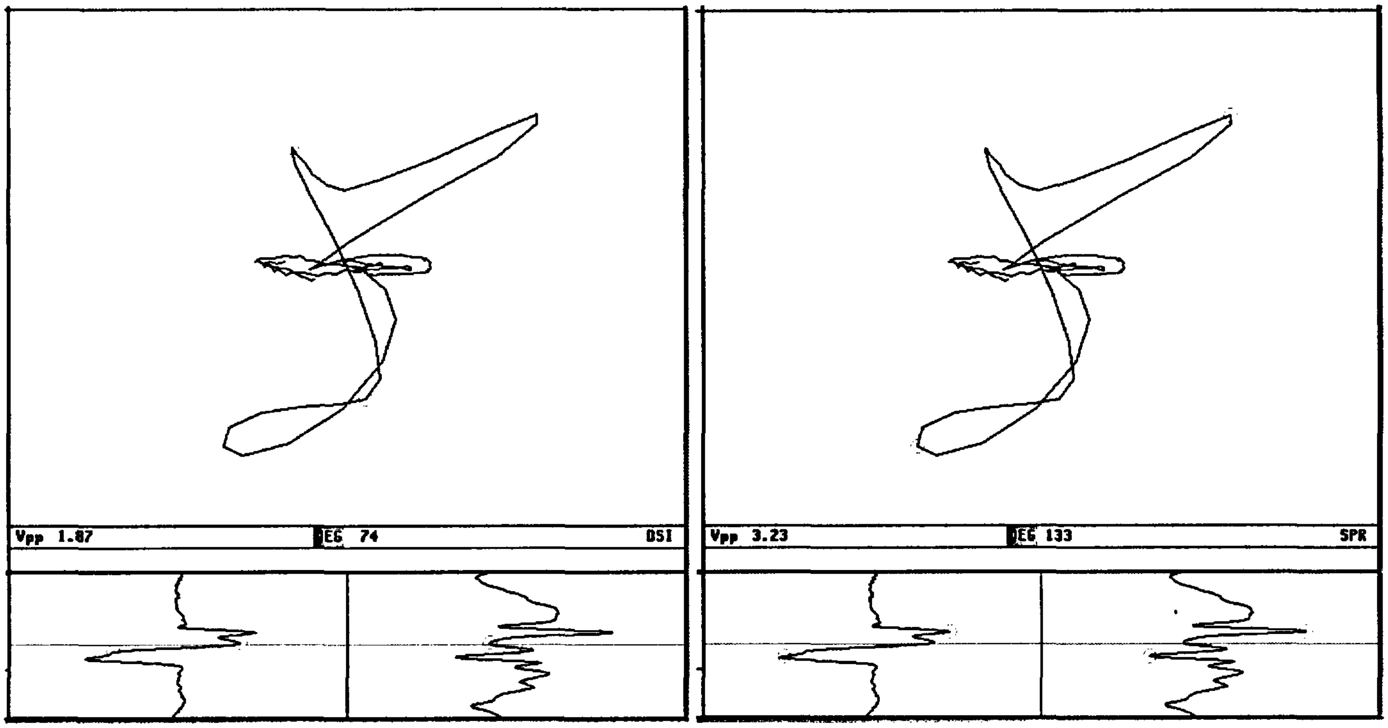


Figure 3. Upper and Lower TSP Noise Signals for Plant A-1 R27C54-1H (Center 1/3 of TSP Cannot be Evaluated Due to Flaw Signal)

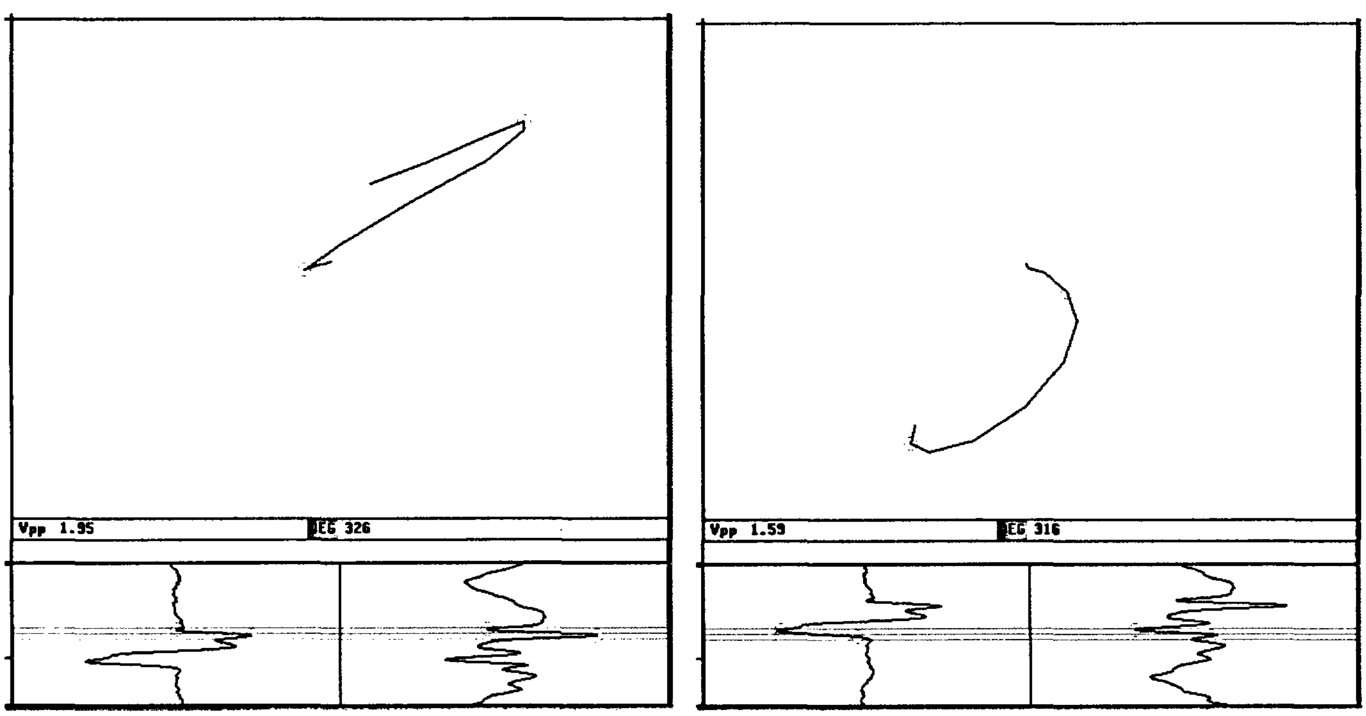
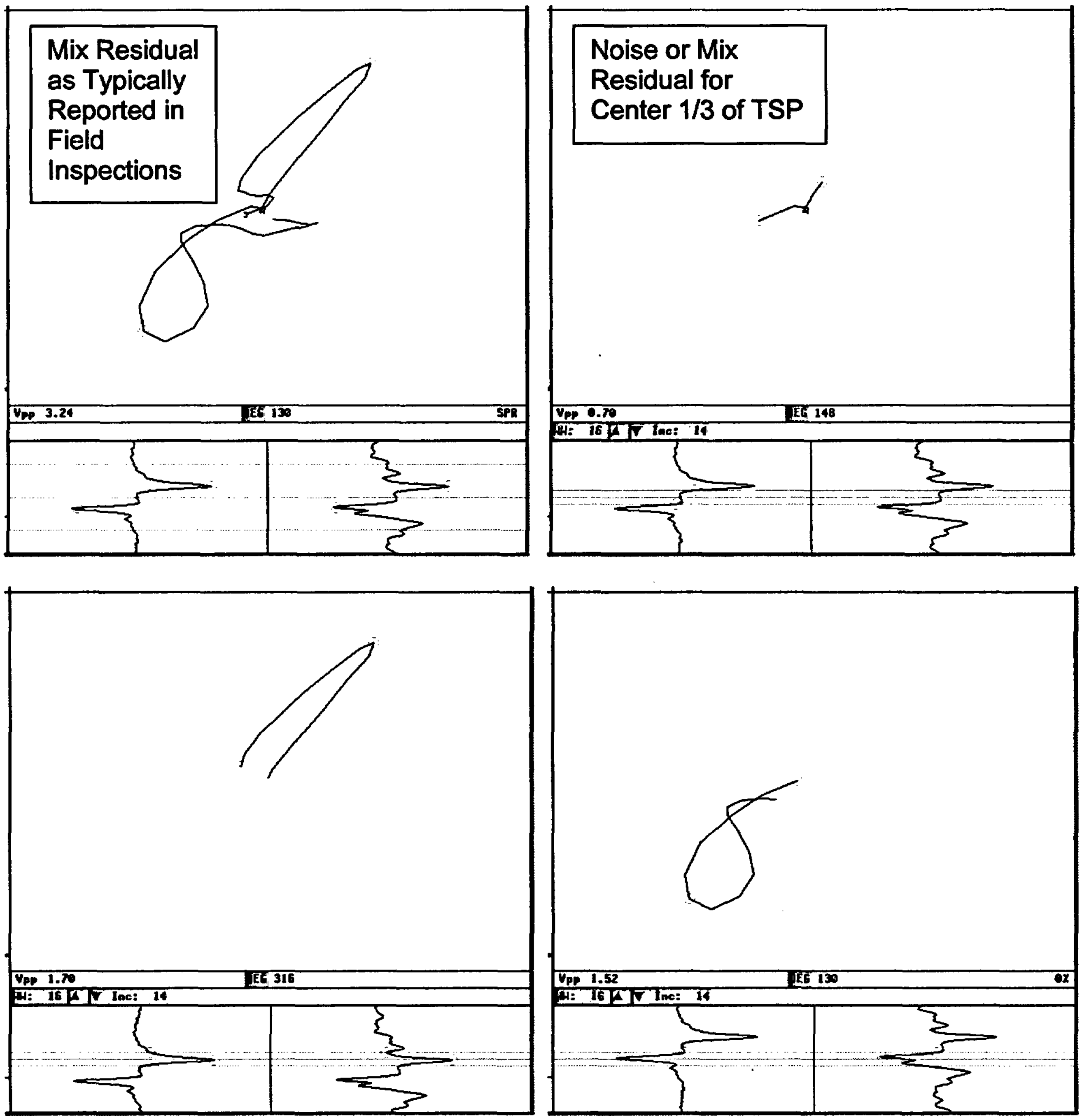


Figure 4. Mix Residual and Center, Upper and Lower 1/3 TSP Noise Signals (400/100 kHz Mix) for Plant A-1 R27C54 at 2H



NRC Question No. 5:

"Please clarify how many dents/dings greater than 5 volts exist and how many indications were detected at these locations (page 8 of 68)."

PG&E Response:

Table 6 provides a summary of the greater than or equal to 5 volts dented TSP intersections that are currently in service in DCPP Unit 1. The 1R11 inspection criteria required Plus Point inspection of 100 percent of the greater than or equal to 5 volts hot leg dents, except where an asterisk is listed, in which case a 20 percent sample (minimum sample size of 50) were required to be Plus Point inspected. Thirteen AONDB indications were detected at greater than 5 volt dents, as listed in Table 3-2 of the 90-day report, thus requiring 13 tubes to be plugged. No bobbin DOS indications were detected at these locations.

Table 6
Greater than or Equal to 5 Volt Dented TSP Intersections in DCPP Unit 1
Hot Leg and Cold Leg

TSP	SG 1-1	SG 1-2	SG 1-3	SG 1-4	TOTAL
1H	1	90	17	356	464
2H	20	62	5	52	139
3H	5	59	9	62	135
4H	2	75	4	88	169
5H	4	18	36	38	96
6H	1	1	16	240	258
7H	163*	29	102*	354*	648
7C	82	5	20	100	207
6C	0	0	0	0	0
5C	0	0	0	0	0
4C	0	0	0	1	1
3C	0	0	0	0	0
2C	0	0	0	0	0
1C	0	0	0	0	0
Total	278	339	209	1291	2117

NRC Question No. 6:

"An assessment of the growth of deplugged tubes was provided. This assessment looked at the distribution of growth rates for the indications in these tubes for the cycle immediately following the deplugging of the tube. Discuss your plans for assessing the growth rates of these indications for the remaining service life of these tubes. In addition to evaluating the distribution of growth rates, discuss whether projections of end-of-cycle

> voltage readings using the deplugged tube growth rates bounded the actual results and also bounded the projections using the standard growth distribution. Discuss any assessments performed comparing the average voltage growth for these indications. Discuss whether the deplugged tubes had a greater propensity for developing other types of flaws at the tube support plate intersections in subsequent cycles (e.g., circumferential flaws, PWSCC flaws)."

PG&E Response:

PG&E has deplugged tubes in several outages for return to service under ARC. Once deplugged tubes are returned to service they are included in the growth population of all tubes. The reason for handling them separately the first cycle of operation after deplugging is that some plants (not DCPP) have experienced higher growth in these indications the first cycle after deplugging. The DCPP history of deplugged growth show that ODSCC in deplugged tubes do not grow differently than the rest of the ODSCC population once returned to service. As discussed in section 3.2 of the 90-day report, 14 DOS indications were detected in 1R11 in tubes that were deplugged in 1R10 and returned to service in Cycle 11. The growth rate of these deplugged ODSCC indications during Cycle 11 was bounded by the growth rate of active ODSCC indications. No further growth rate assessment of these indications is planned for the remaining service life of these tubes. The average voltage growth of indications in deplugged tubes is very small in the first cycle after they are returned to service: 0.03 volts/EFPY for 14 indications in Cycle 11, and 0.07 volts/EFPY for 52 indications in Cycle 10.

For axial ODSCC indications at TSP intersections that have been returned to service under the ODSCC ARC, different degradation has not developed at the same TSP intersection, such as PWSCC or circumferential cracking. Therefore, deplugged TSP intersections do not have a propensity to develop other types of degradation.

NRC Question No. 7:

> "A comparison of the predicted to actual EOC 11 conditions indicated that the projections for leakage and burst were conservative; however, the number of flaws and the severity of some of the flaws was underestimated. Discuss whether this trend has occurred in the past. Discuss what plans, if any, you have to change the methodology for predicting the EOC distributions if these trends continue."

PG&E Response:

As discussed in Section 5.5 of the 90-day report, the projected number of flaws was underestimated in each SG when using a POD of 0.6. The highest under predictions generally occurred in voltage bins less than 0.7 volts, which is a result of assuming a 0.6 POD for these smaller voltage indications. For Unit 2, the reason for under predictions using a POD of 0.6 is documented in the 2R11 90-day report. Using a POD of 0.6 to estimate the number of indications not detected in the low voltage range will not provide accurate projections. The use of a more realistic, voltage dependent POD (POPCD), that is less than 0.6 in the low voltage ranges, provides for more accurate predictions at EOC conditions.

The severity of some of the flaws at EOC-11 was under predicted due to the onset of voltage dependent growth (VDG) occurring in some of the higher voltage flaws that were returned to service following 1R10. The 1R11 90-day report accounted for VDG in SG 1-1, which exhibited the most pronounced VDG during Cycle 11. The VDG phenomenon is likely to continue at DCPP Unit 1 based on the behavior of the flaws at DCPP Unit 2. The 2R11 90-day report provides updated methods for developing VDG distributions and, when combined with POPCD, should provide more accurate EOC projections. PG&E plans to benchmark these methods prior to and during the next Unit 1 inspection in 1R12, scheduled for March 2004.

NRC Question No. 8:

> "Regarding the use of a voltage dependent growth rate, discuss what assessments are performed to ensure that the methodology used provides conservative results."

PG&E Response:

As discussed in the response to question 7, PG&E plans to benchmark the VDG methods prior to and during the next Unit 1 inspection, scheduled for March 2004.

NRC Administrative Question

> "Technical Specification 5.6.10 addresses various reporting requirements for steam generators. It appears that your May 22, 2002 letter was intended to address the requirements of TS 5.6.10.a and 5.6.10.c. In addition, this letter documents your actions to satisfy TS 5.6.10.d. Furthermore, it appears that your August 22, 2002 letter was intended to address the requirements of TS 5.6.10.e, 5.6.10.f, and 5.6.10.h. With respect to TS reporting requirement 5.6.10.b, was it your intent to submit a separate report addressing the information described in this requirement? Also, your May 22, 2002, letter indicates 77 tubes were plugged in 1R11 (page 4 of 6) whereas your August 22, 2002, letter indicates 87 tubes were plugged (page 3-4). Please clarify this apparent discrepancy."

PG&E Response:

With respect to TS reporting requirement 5.6.10.b, PG&E's intent was to submit a 12-month separate report addressing the information described in this requirement. The 12-month report was submitted to the NRC in PG&E Letter DCL-03-054 dated May 19, 2003.

PG&E's May 22, 2002, letter notes that 77 defective active tubes were plugged in 1R11. PG&E's August 22, 2002, letter indicates that 87 active tubes were plugged. These numbers are accurate. The reason for the difference is that 10 tubes were preventively plugged in 1R11 and, as such, were not counted as defective. Nine tubes were preventively plugged due to U-bend noise concerns, and one tube was preventively plugged due to less than 40 percent anti-vibration bar (AVB) wear.