Pacific Gas and Electric Company

Lawrence F. Womack
Vice President
Nuclear Services

Diablo Canyon Power Plant
P.O. Box 56
Avila Beach, CA 93424

805.545.4600
Fax: 805.545.4234

October 31, 2003

PG&E Letter DCL-03-139

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Docket No. 50-323, OL-DPR-82
Diablo Canyon Unit 2
PG&E Response to NRC Questions on 2R11 Steam Generator Tube Inspections

Dear Commissioners and Staff:

Pacific Gas & Electric (PG&E) submitted Diablo Canyon Letter (DCL) DCL-03-076, "Special Report 03-02 - Results of Steam Generator Inspections for Diablo Canyon Power Plant Unit 2 Eleventh Refueling Outage," dated June 23, 2003, providing the 90-day steam generator (SG) report for the Unit 2 eleventh refueling outage (2R11).

On August 12, 2003, an NRC staff e-mail transmitted a request for additional information (RAI) regarding the 2R11 SG tube inspections. Enclosed are PG&E's responses to the August 12, 2003, RAI and a response to NRC Question No. 1 regarding the W* Alternate Repair Criteria associated with the Unit 1 eleventh refueling outage 90-day RAI as noted in PG&E Letter DCL-03-113, "PG&E Response to NRC Questions on 1R11 Steam Generator Tube Inspections," dated September 15, 2003. Minor data and typographical errors in DCL-03-076 were identified during this RAI preparation. Tables 1-2 and 1-3 of the enclosure provide the corrected data. Editorial corrections are discussed in the applicable response to NRC questions.

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

Sincerely

Lawrence F. Womack

ddm/469
Enclosure
cc/enc: Bruce S. Mallett
David L. Proulx
Girija S. Shukla
Diablo Distribution

A047

PG&E Response to NRC Questions on Unit 2 Eleventh Refueling Outage Steam Generator Tube Inspection 90-Day Report

In PG&E Letter DCL-03-076, "Special Report 03-02 - Results of Steam Generator Inspections for Diablo Canyon Power Plant Unit 2 Eleventh Refueling Outage," dated June 23, 2003, PG&E submitted the Unit 2 '90-day report' documenting the steam generator (SG) tube condition monitoring (CM) and operational assessment (OA) following the Unit 2 eleventh refueling outage (2R11) SG tube inspections. On August 12, 2003, PG&E received an NRC request for additional information (RAI) on this report, divided into several sections. This enclosure provides PG&E responses to the NRC questions.

PG&E's response to NRC Question No. 6 (W* ARC) is applicable to both 2R11 and the Unit 1 eleventh refueling outage (1R11) 90-day RAI as noted in the response to NRC Question No. 2 associated with W* ARC in the enclosure to PG&E Letter DCL-03-113, "PG&E Response to NRC Questions on 1R11 Steam Generator Tube Inspections," dated September 15, 2003.

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

NRC Question No. 1 (W* ARC):

> *"In Table 1 of Enclosure 1 to your June 23, 2003, letter, there is a column entitled "EOC(N+1) UCT to BWT". Please clarify how the information in this column was calculated including the values used for the uncertainties."*

PG&E Response:

This column entitled "EOC (N+1) UCT to BWT" describes the projected location of the upper crack tip (UCT) at the end of cycle (EOC) 12 with respect to the bottom of the WEXTEX transition (BWT). This location is then used to calculate the steam line break (SLB) leak rate at EOC 12 for operational assessment using the W* leak rate methodology. A negative number in this column implied that the upper crack tip was above BWT at EOC(n+1).

PG&E reviewed this column and determined that all UCT locations were incorrectly (over-conservatively) calculated to be 0.22 inches closer to the BWT than they should have been. It was determined that this error was introduced during the pre-outage development of a Microsoft ACCESS database to support implementation of W* calculations, and was not identified until review of this NRC question. The value of 0.22 inch is the Plus Point uncertainty in locating the UCT relative to the top of tube sheet (TTS), and was additionally applied in error in this column. The EOC(n+1) UCT locations should have been calculated as the as-measured UCT elevation, plus 0.28 inch Plus Point uncertainty in locating the UCT relative to BWT, plus the upper 95 percent growth rate (0.115 inch per effective full power year (EFPY) times

1.54 EFPY, or 0.18 inch). Note that if the distance at EOC(n+1) becomes negative, the crack is projected to be above BWT and the maximum leak rate is assigned.

W* ARC Table 1 of Enclosure 1 of the 90-day report has been corrected and is provided as Table 1-1 of this enclosure. The corrected table results in lower SLB leak rates for OA.

The enclosed Table 1-3 updates and replaces Table 4 of Enclosure 1 of the 90-day report and provides the Unit 2 Cycle 12 OA record of results for SLB leak rate. Table 1-3 incorporates updated SLB leak rates from W* ARC as discussed above, plus tube support plate (TSP) outside diameter stress corrosion cracking (ODSCC) voltage-based ARC as defined in Table 11-4 of the enclosure to DCL-03-121, "PG&E Response to NRC Questions on 2R11 Steam Generator Tube Inspections," dated September 30, 2003.

Table 1-2 is also provided to correct Table 3 of Enclosure 1 of the 90-day report, which had inadvertently used a W* ARC CM leak rate of 0.045 gpm for SG 2-4 R4C18 (which is not a W* tube due to crack tip location).

Table 1-1
Revised Table 1 from Enclosure 1 to DCL-03-076 - 2R11 Axial PWSCC Indications in Hot Leg WEXTEX Tubesheet Region

SG	Row	Col	PP Volts	Crack No	LCT	UCT	Crack Length	UCT adj	UCT below TTS	W* Zone	W* Length	BWT	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	EOC (N+1) UCT to BWT	OA Leak Rate	Prev W* Tube	Tube Plugged
21	3	59	4.95	1	-1.48	-0.76	0.72	-0.54	Yes	B1	7.12	-0.42	0.06	No	Yes	-0.36	Yes	Yes	-10.66	10.15	7.88	0.043	-0.12	0.045	Repeat	No
21	6	77	0.86	1	-1.4	-1.23	0.17	-1.01	Yes	B4	7.12	-0.40	0.55	No	Yes	-0.83	Yes	Yes	-10.94	10.45	7.33	0.026	0.37	0.031	Repeat	No
21	7	24	0.19	1	-1.98	-1.87	0.11	-1.65	Yes	B3	7.12	-0.37	1.22	No	Yes	-1.47	Yes	Yes	-10.97	10.51	7.27	0.015	1.04	0.017	Repeat	No
21	7	62	3.58	1	-2.34	-1.44	0.90	-1.22	Yes	B2	7.12	-1.06	0.10	No	Yes	-1.04	Yes	Yes	-21.4	20.25	8.06	0.042	-0.08	0.045	Repeat	No
21	8	32	0.39	1	-2.13	-1.98	0.15	-1.76	Yes	B2	7.12	-0.39	1.31	No	Yes	-1.58	Yes	Yes	-10.8	10.32	7.31	0.015	1.13	0.017	Repeat	No
21	9	49	0.49	1	-2.16	-1.96	0.20	-1.74	Yes	B1	7.12	-0.36	1.32	No	Yes	-1.56	Yes	Yes	-10.93	10.48	7.36	0.015	1.14	0.017	Repeat	No
21	10	49	0.25	1	-0.94	-0.80	0.14	-0.58	Yes	B1	7.12	-0.30	0.22	No	Yes	-0.40	Yes	Yes	-10.76	10.37	7.30	0.037	0.04	0.044		No
21	11	37	0.42	1	-7.54	-7.43	0.11	-7.21	Yes	B2	7.12	-0.41	6.74	No	Yes	-7.03	Yes	Yes	-10.63	10.13	7.27	0.001	6.56	0.001	Repeat	No
21	11	37	0.64	2	-6.65	-6.48	0.17	-6.26	Yes	B2	7.12	-0.41	5.79	No	Yes	-6.08	Yes	Yes	-10.63	10.13	7.33	0.001	5.61	0.001	Repeat	No
21	11	37	0.31	3	-2.11	-1.85	0.26	-1.63	Yes	B2	7.12	-0.41	1.16	No	Yes	-1.45	Yes	Yes	-10.63	10.13	7.42	0.017	0.98	0.019	Repeat	No
21	11	39	1.3	1	-1.93	-1.61	0.32	-1.39	Yes	B1	7.12	-0.42	0.91	No	Yes	-1.21	Yes	Yes	-10.92	10.41	7.48	0.020	0.73	0.023	Repeat	No
21	11	40	0.37	1	-0.97	-0.83	0.14	-0.61	Yes	B1	7.12	-0.49	0.06	No	Yes	-0.43	Yes	Yes	-10.94	10.36	7.30	0.043	-0.12	0.045	Repeat	No
21	11	48	1.99	1	-4.84	-4.39	0.45	-4.17	Yes	B1	7.12	-0.42	3.69	No	Yes	-3.99	Yes	Yes	-10.54	10.03	7.61	0.006	3.51	0.006	Repeat	No
21	13	49	0.28	1	-1.68	-1.54	0.14	-1.32	Yes	B1	7.12	-0.66	0.60	No	Yes	-1.14	Yes	Yes	-11.53	10.78	7.30	0.025	0.42	0.030		No
21	23	70	0.95	1	-1.66	-1.27	0.39	-1.05	Yes	A	5.32	-0.22	0.77	No	Yes	-0.87	Yes	Yes	-10.9	10.59	5.75	0.018	0.59	0.025	Repeat	No
21	30	59	2.43	1	-10.13	-9.82	0.31	-9.60	Yes	B4	7.12	-0.15	9.39	Yes	Yes	-9.42	Yes	Yes	-21.4	21.16	7.12	0.000	9.21	0.000		No
21	45	59	0.24	1	-0.55	-0.38	0.17	-0.16	Yes	A	5.32	-0.46	-0.36	No	No	0.02	No	No	-11.11	10.56	5.53	0.045	NA	0.000		Yes
22	28	15	0.51	1	-2.3	-2.16	0.14	-1.94	Yes	A	5.32	-0.45	1.43	No	Yes	-1.76	Yes	Yes	-21.4	20.86	5.50	0.006	NA	0.000	Repeat	Yes
22	28	15	0.5	2	-1.89	-1.69	0.20	-1.47	Yes	A	5.32	-0.45	0.96	No	Yes	-1.29	Yes	Yes	-21.4	20.86	5.56	0.011	NA	0.000	Repeat	Yes
22	28	15	0.83	3	-11.11	-10.82	0.29	-10.6	Yes	A	5.32	-0.45	10.09	Yes	Yes	-10.42	Yes	Yes	-21.4	20.86	5.32	0.000	NA	0.000	Repeat	Yes
22	28	15	5.4	4	-20.88	-19.38	1.50	-19.16	Yes	A	5.32	-0.45	18.65	Yes	Yes	-18.98	Yes	Yes	-21.4	20.86	5.32	0.000	NA	0.000	Repeat	Yes
22	28	15	4.7	5	-21.01	-19.29	1.72	-19.07	Yes	A	5.32	-0.45	18.56	Yes	Yes	-18.89	Yes	Yes	-21.4	20.86	5.32	0.000	NA	0.000	Repeat	Yes
22	5	18	0.66	1	-1.24	-0.99	0.25	-0.77	Yes	B4	7.12	-0.24	0.47	No	Yes	-0.59	Yes	Yes	-10.03	9.70	7.41	0.028	0.29	0.030	Repeat	No
22	31	25	4.05	1	-2.18	-1.59	0.59	-1.37	Yes	A	5.32	-0.55	0.76	No	Yes	-1.19	Yes	Yes	-9.57	8.93	5.95	0.018	0.58	0.025	Repeat	No
22	13	43	0.73	1	-1.42	-1.23	0.19	-1.01	Yes	B1	7.12	-0.45	0.50	No	Yes	-0.83	Yes	Yes	-10.38	9.84	7.35	0.027	0.32	0.033	Repeat	No
22	10	48	0.42	1	-3.04	-2.9	0.14	-2.68	Yes	B1	7.12	-0.09	2.53	No	Yes	-2.50	Yes	Yes	-10.16	9.98	7.30	0.008	2.35	0.010	Repeat	No
22	10	56	0.88	1	-1.07	-0.9	0.17	-0.68	Yes	B1	7.12	-0.58	0.04	No	Yes	-0.50	Yes	Yes	-10.46	9.79	7.33	0.044	-0.14	0.045	Repeat	No
23	28	12	2.37	1	-2.1	-1.51	0.59	-1.29	Yes	A	5.32	-0.54	0.69	No	Yes	-1.11	Yes	Yes	-12.19	11.56	5.95	0.021	NA	0.000	Repeat	Yes

Table 1-1
Revised Table 1 from Enclosure 1 to DCL-03-076 - 2R11 Axial PWSCC Indications in Hot Leg WEXTEX Tubesheet Region

SG	Row	Col	PP Volts	Crack No	LCT	UCT	Crack Length	UCT adj	UCT below TTS	W* Zone	W* Length	BWT	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	EOC (N+1) UCT to BWT	OA Leak Rate	Prev W* Tube	Tube Plugged
23	14	24	0.35	1	-1.91	-1.76	0.15	-1.54	Yes	B4	7.12	-0.16	1.32	No	Yes	-1.36	Yes	Yes	-11.65	11.40	7.31	0.010	1.14	0.012	Repeat	No
23	16	24	0.25	1	-1.38	-1.23	0.15	-1.01	Yes	B4	7.12	-0.16	0.79	No	Yes	-0.83	Yes	Yes	-11.85	11.60	7.31	0.019	0.61	0.024	Repeat	No
23	25	37	1.87	1	-1.29	-0.88	0.41	-0.66	Yes	B4	7.12	-0.31	0.29	No	Yes	-0.48	Yes	Yes	-11.57	11.17	7.57	0.034	0.11	0.041	Repeat	No
23	45	37	1.50	1	-1.56	-1.22	0.34	-1.00	Yes	A	5.32	-0.28	0.66	No	Yes	-0.82	Yes	Yes	-12.04	11.67	5.70	0.022	0.48	0.028	Repeat	No
23	21	38	0.54	1	-1.52	-1.02	0.50	-0.80	Yes	B3	7.12	-0.33	0.41	No	Yes	-0.62	Yes	Yes	-11.57	11.15	7.66	0.030	0.23	0.036	Repeat	No
23	12	48	0.29	1	-1.99	-1.87	0.12	-1.65	Yes	B1	7.12	-0.29	1.30	No	Yes	-1.47	Yes	Yes	-11.58	11.20	7.28	0.015	1.12	0.017	Repeat	No
23	5	51	0.51	1	-2.12	-2.01	0.11	-1.79	Yes	B1	7.12	-0.24	1.49	No	Yes	-1.61	Yes	Yes	-11.64	11.31	7.27	0.013	1.31	0.015	Repeat	No
23	7	52	4.21	1	-1.53	-0.79	0.74	-0.57	Yes	B1	7.12	-0.28	0.23	No	Yes	-0.39	Yes	Yes	-11.99	11.62	7.90	0.036	0.05	0.044	Repeat	No
23	5	55	1.13	1	-2.2	-1.93	0.27	-1.71	Yes	B1	7.12	-0.19	1.46	No	Yes	-1.53	Yes	Yes	-11.89	11.61	7.43	0.014	1.28	0.015	Repeat	No
23	32	55	1.21	1	-1.3	-0.9	0.40	-0.68	Yes	A	5.32	-0.37	0.25	No	Yes	-0.50	Yes	Yes	-11.55	11.09	5.76	0.035	0.07	0.043	Repeat	No
23	7	59	1.50	1	-1.88	-1.44	0.44	-1.22	Yes	B1	7.12	-0.31	0.85	No	Yes	-1.04	Yes	Yes	-11.84	11.44	7.60	0.021	0.67	0.023	Repeat	No
23	9	63	0.40	1	-1.29	-1.13	0.16	-0.91	Yes	B2	7.12	-0.38	0.47	No	Yes	-0.73	Yes	Yes	-11.62	11.15	7.32	0.028	0.29	0.034	Repeat	No
23	3	69	0.94	1	-1.22	-0.88	0.34	-0.66	Yes	B2	7.12	-0.34	0.26	No	Yes	-0.48	Yes	Yes	-11.42	10.99	7.50	0.035	0.08	0.043	Repeat	No
23	19	71	1.08	1	-2.14	-1.8	0.34	-1.58	Yes	A	5.32	-0.38	1.14	No	Yes	-1.40	Yes	Yes	-11.40	10.93	5.70	0.008	0.96	0.010	Repeat	No
23	17	72	1.67	1	-1	-0.53	0.47	-0.31	Yes	A	5.32	-0.29	-0.04	No	No	-0.13	Yes	No	-13.38	13.00	5.83	0.045	NA	0.000	Repeat	Yes
23	6	77	0.26	1	-1.78	-1.66	0.12	-1.44	Yes	B4	7.12	-0.42	0.96	No	Yes	-1.26	Yes	Yes	-11.96	11.45	7.28	0.015	0.78	0.020	Repeat	No
23	21	83	0.94	1	-1.16	-0.85	0.31	-0.63	Yes	A	5.32	-0.31	0.26	No	Yes	-0.45	Yes	Yes	-11.92	11.52	5.67	0.035	0.08	0.043	Repeat	No
23	4	90	0.33	1	-1.11	-0.97	0.14	-0.75	Yes	A	5.32	-0.19	0.50	No	Yes	-0.57	Yes	Yes	-10.12	9.84	5.50	0.027	0.32	0.033		No
23	2	91	0.62	1	-0.95	-0.6	0.35	-0.38	Yes	A	5.32	-0.23	0.09	No	Yes	-0.20	Yes	Yes	-11.92	11.60	5.71	0.042	-0.09	0.045	Repeat	No
23	7	92	0.92	1	-1.15	-0.81	0.34	-0.59	Yes	A	5.32	-0.24	0.29	No	Yes	-0.41	Yes	Yes	-13.61	13.28	5.70	0.034	0.11	0.041	Repeat	No
23	8	93	1.22	1	-0.8	-0.57	0.23	-0.35	Yes	A	5.32	-0.26	0.03	No	Yes	-0.17	Yes	Yes	-12.08	11.73	5.59	0.044	-0.15	0.045	Repeat	No
24	2	10	0.43	1	-1.46	-1.33	0.13	-1.11	Yes	A	5.32	-0.20	0.85	No	Yes	-0.93	Yes	Yes	-11.37	11.08	5.49	0.015	0.67	0.022	Repeat	No
24	2	29	5.25	1	-4.58	-3.61	0.97	-3.39	Yes	B2	7.12	-0.29	3.04	No	Yes	-3.21	Yes	Yes	-10.77	10.39	8.13	0.006 Note 1	NA	0.000	Repeat	Yes
24	2	29	1.22	2	-2.42	-1.78	0.64	-1.56	Yes	B2	7.12	-0.29	1.21	No	Yes	-1.38	Yes	Yes	-10.77	10.39	7.80	0.016 Note 1	NA	0.000	Repeat	Yes
24	3	5	1.77	1	-1.85	-0.85	1.00	-0.63	Yes	A	5.32	-0.29	0.28	No	Yes	-0.45	Yes	Yes	-11.29	10.91	6.36	0.034	0.10	0.042	Repeat	No
24	3	12	0.44	1	-2.81	-2.69	0.12	-2.47	Yes	A	5.32	-0.28	2.13	No	Yes	-2.29	Yes	Yes	-11.28	10.91	5.48	0.004	1.95	0.004	Repeat	No
24	3	12	0.94	2	-2.49	-2.28	0.21	-2.06	Yes	A	5.32	-0.28	1.72	No	Yes	-1.88	Yes	Yes	-11.28	10.91	5.57	0.005	1.54	0.006	Repeat	No

Table 1-1
Revised Table 1 from Enclosure 1 to DCL-03-076 - 2R11 Axial PWSCC Indications in Hot Leg WEXTEX Tubesheet Region

SG	Row	Col	PP Volts	Crack No	LCT	UCT	Crack Length	UCT adj	UCT below TTS	W* Zone	W* Length	BWT	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	EOC (N+1) UCT to BWT	OA Leak Rate	Prev W* Tube	Tube Plugged
24	3	17	0.39	1	-3.59	-3.38	0.21	-3.16	Yes	B4	7.12	-0.60	2.50	No	Yes	-2.98	Yes	Yes	-10.91	10.22	7.37	0.004	2.32	0.005		No
24	4	18	0.47	1	-0.27	-0.09	0.18	0.13	No	B4	7.12	-0.41	-0.60	No	No	0.31	No	No	-11.46	10.96	7.34	NA Note 2	NA	NA		Yes
24	4	35	1.07	1	-1.58	-1.37	0.21	-1.15	Yes	B1	7.12	-0.25	0.84	No	Yes	-0.97	Yes	Yes	-11.14	10.8	7.37	0.021	0.66	0.024	Repeat	No
24	5	31	0.61	1	-1.03	-0.83	0.20	-0.61	Yes	B2	7.12	-0.33	0.22	No	Yes	-0.43	Yes	Yes	-8.88	8.46	7.36	0.037	0.04	0.044		No
24	5	36	0.4	1	-1.91	-1.76	0.15	-1.54	Yes	B1	7.12	-0.14	1.34	No	Yes	-1.36	Yes	Yes	-11.24	11.01	7.31	0.015	1.16	0.017	Repeat	No
24	5	37	1.54	2	-4.07	-3.63	0.44	-3.41	Yes	B1	7.12	-0.28	3.07	No	Yes	-3.23	Yes	Yes	-11.21	10.84	7.60	0.007	2.89	0.008	Repeat	No
24	5	37	0.27	1	-4.25	-4.10	0.15	-3.88	Yes	B1	7.12	-0.28	3.54	No	Yes	-3.70	Yes	Yes	-11.21	10.84	7.31	0.006	3.36	0.006	Repeat	No
24	5	53	1.78	1	-1.96	-1.54	0.42	-1.32	Yes	B1	7.12	-0.26	1.00	No	Yes	-1.14	Yes	Yes	-10.62	10.27	7.58	0.018	0.82	0.021	Repeat	No
24	6	33	0.87	1	-2.84	-2.61	0.23	-2.39	Yes	B2	7.12	-0.16	2.17	No	Yes	-2.21	Yes	Yes	-10.83	10.58	7.39	0.008	1.99	0.009	Repeat	No
24	7	4	0.62	1	-1.25	-1.06	0.19	-0.84	Yes	A	5.32	-0.21	0.57	No	Yes	-0.66	Yes	Yes	-11.5	11.2	5.55	0.025	0.39	0.031	Repeat	No
24	7	38	1.98	1	-6.70	-6.31	0.39	-6.09	Yes	B1	7.12	-0.25	5.78	No	Yes	-5.91	Yes	Yes	-11.13	10.79	7.55	0.001	5.60	0.001	Repeat	No
24	7	38	1.71	2	-4.33	-3.71	0.62	-3.49	Yes	B1	7.12	-0.25	3.18	No	Yes	-3.31	Yes	Yes	-11.13	10.79	7.78	0.007	3.00	0.007	Repeat	No
24	7	53	0.3	1	-2.71	-2.53	0.18	-2.31	Yes	B1	7.12	-0.34	1.91	No	Yes	-2.13	Yes	Yes	-10.94	10.51	7.34	0.010	1.73	0.012		No
24	13	4	0.42	1	-1.32	-1.20	0.12	-0.98	Yes	A	5.32	-0.23	0.69	No	Yes	-0.80	Yes	Yes	-11.50	11.18	5.48	0.021	0.51	0.027	Repeat	No
24	13	40	1.65	1	-1.90	-1.51	0.39	-1.29	Yes	B2	7.12	-0.21	1.02	No	Yes	-1.11	Yes	Yes	-11.43	11.13	7.55	0.018	0.84	0.021	Repeat	No
24	15	10	0.34	1	-1.04	-0.83	0.21	-0.61	Yes	A	5.32	-0.21	0.34	No	Yes	-0.43	Yes	Yes	-11.44	11.14	5.57	0.032	0.16	0.039	Repeat	No
24	16	10	2.23	1	-2.36	-1.86	0.50	-1.64	Yes	A	5.32	-0.29	1.29	No	Yes	-1.46	Yes	Yes	-11.43	11.05	5.86	0.007	1.11	0.008	Repeat	No
24	20	47	1.79	1	-1.69	-1.25	0.44	-1.03	Yes	B2	7.12	-0.25	0.72	No	Yes	-0.85	Yes	Yes	-11.14	10.80	7.60	0.023	0.54	0.026	Repeat	No
24	24	26	1.17	1	-2.01	-1.69	0.32	-1.47	Yes	A	5.32	-0.32	1.09	No	Yes	-1.29	Yes	Yes	-11.58	11.17	5.68	0.009	0.91	0.012	Repeat	No
24	25	64	1.64	1	-1.52	-1.20	0.32	-0.98	Yes	B4	7.12	-0.35	0.57	No	Yes	-0.80	Yes	Yes	-9.34	8.90	7.48	0.025	0.39	0.031	Repeat	No
24	26	45	1.12	1	-3.83	-3.50	0.33	-3.28	Yes	B4	7.12	-0.23	2.99	No	Yes	-3.10	Yes	Yes	-11.10	10.78	7.49	0.003	2.81	0.003	Repeat	No

Note 1: SG 24 R2C29 was in-situ tested to SLB conditions, and no leakage was detected. The leak rates listed for these indications are for information only and are based on W* ARC leak rate model. The total SG leak rate assumes no leakage from R2C29 indications.
Note 2: SG 24 R4C18 is located in the WEXTEX transition and is not applicable to W* ARC.

Table 1-2
Revised Table 3 from Enclosure 1 to DCL-03-076 (changes noted by *)
DCPP Unit 2 Condition Monitoring Steam Line Break Leak Rates for Alternate Repair Criteria

EOC 11 Condition Monitoring Leak Rate (gpm at room temperature)	SG 2-1	SG 2-2	SG 2-3	SG 2-4
W* ARC (Note 3)	0.367	0.144	0.585	0.356*
Voltage-Based ARC (Note 1)	0.682	0.362	0.211	3.21
PWSCC ARC	0	0	0	0
Non-ARC degradation (Note 2)	0	0	0	0.003
Aggregate ARC	1.049	0.506	0.796	3.569*

Note 1: Voltage-based ARC leak rates are defined in Table 7-2 of Enclosure 4 of DCL-03-076.
Note 2: Non-ARC degradation leak rate of 0.003 gpm based on in-situ leak test result for SG 2-4 R5C62 circumferential primary water stress corrosion cracking (PWSCC) in U-bend region (Enclosure 3 of DCL-03-076).
Note 3: SG 2-4 W* ARC CM leak rate reduced due to removal of calculated leakage for R4C18 which is not a W* tube.

Table 1-3
Revised Table 4 from Enclosure 1 to DCL-03-076 (changes noted by *)
DCPP Unit 2 Operational Assessment Steam Line Break Leak Rates for Alternate Repair Criteria

EOC 12 Operational Assessment Leak Rate (gpm at room temperature)	SG 2-1	SG 2-2	SG 2-3	SG 2-4
W* ARC (Note 1)	0.365*	0.145*	0.612*	0.425*
Voltage-Based ARC (Note 2)	0.71*	0.60	0.48	2.86*
PWSCC ARC	0	0	0	0
Non-ARC degradation	0	0	0	0
Aggregate ARC	1.075*	0.745*	1.092*	3.285*

Note 1: W* ARC OA leak rates reflect reduced values based on corrected UCT to BWT distance at $EOC_{(n+1)}$.
Note 2: Voltage-Based ARC leak rates are taken from Table 11-4 of enclosure to DCL-03-121.

NRC Question No. 2 (W* ARC):

"Please clarify why tube R28C15 in SG 2-2 was repaired. This tube had multiple axial indications near the hot-leg tube end; however, it appeared to have an adequate undegraded tube length (i.e., flexible W length)."*

PG&E Response:

SG 2-2 R28C15 has an adequate undegraded W* length and could have been left in service under W* ARC. However, PG&E decided to preventively plug this tube because, as discussed in the 90-day report pages 1-6 and 1-7, two of the axial PWSCC indications in the tube (near the tube end) exceeded 4 volts and had maximum depth greater than 80 percent over 0.1 inch. The statement in the 90-day report page 1-7 that "R18C25 was subsequently plugged," is a typographical error and should have stated "R28C15 was subsequently plugged."

NRC Question No. 3 (W* ARC):

"Discuss how flaw growth is accounted for in determining the extent of inspection into the tubesheet. That is, flaws are left in service provided the W inspection distance is greater than or equal to the W* flexible length. The W* flexible length in Table 1 appears to be the sum of the crack length, the W* length, and a 0.04-inch uncertainty allowance. Assuming that the W* inspection distance is equal to the W* flexible length, it would appear that any flaw growth during the course of the next cycle may potentially result in a potentially non-conservative inspection distance (assuming the inspection distance matched the flexible W* length, the flaw grew, and there was a 360-degree circumferential flaw at the W* inspection distance). In other words, shouldn't the flexible W* length include an adjustment for flaw growth. Discuss whether this adjustment should be made for both flawed and unflawed tubes."*

PG&E Response:

The flexible W* distance includes an allowance for growth as described in Section 8.3.1 of WCAP-14797, Revision 1, and as noted in the legend on page 1-5 of Enclosure 1 of the 90-day report. The flexible W* distance includes: W* length, nondestructive examination (NDE) uncertainty on W* length, measured crack length, NDE uncertainty on crack length and crack growth allowance. These factors are included in the calculations of Table 1 of Enclosure 1 of the 90-day report as described below.

As given in the W* 90-day report, the axial PWSCC growth rate is 0.115 inch/EFPY or 0.18 inch for the planned cycle length of 1.54 EFPY. The W* lengths and NDE uncertainties are given in the WCAP. The following shows the

contributions for SG 2-1, R3C59 (first entry in Table 1 of Enclosure 1 of the 90-day report):

- W* length = 7.0"
- W* length NDE uncertainty = 0.12"
- Measured crack length = 0.72"
- Crack length NDE uncertainty for assumed throughwall crack = -0.14"
- Crack growth allowance = 0.18"

The sum of the above components is 7.88 inches as given for the flexible W* length requirement in Table 1. The length uncertainty has a negative contribution at 95 percent confidence due to the mean overestimate of deep PWSCC crack lengths by +Point as developed from NDE measurements reported in the WCAP.

The above describes the requirements for flawed tubes and includes crack growth allowances. No adjustment for crack growth is required in the flexible W* criterion for unflawed tubes. In addition to a crack growth allowance, it would be necessary to speculate on the throughwall crack length for the unflawed tube in order to project a flexible W* length for unflawed tubes. An adjustment for unflawed tubes is not considered to be necessary, as new indications are not anticipated to have sufficient throughwall depth to significantly decrease the contact pressure between the tube and tubesheet hole. The assumption for flawed tubes that the flawed length with allowances for NDE uncertainty and growth does not contribute to the contact pressure is a very conservative assumption. Since the associated length is also added to the bottom of the W* length where contact pressures are higher than at the crack location, the conservatism is further increased with the crack length distance above the W* length.

NRC Question No. 4 (W* ARC):

> *"Regarding the circumferential indication near the top of the tubesheet in tube R20C45 of SG 2-1, please discuss the location of the indication with respect to the expansion transition. From Table 8 in Enclosure 3 to your June 23, 2003, letter, the indication is located above the top of the tubesheet and is not associated with a dent. If the indication is not in the expansion transition and is located in the non-expanded portion of the tube, discuss the driving force for this flaw and provide a technical justification for limiting the rotating probe examinations in the region above the top of the tubesheet to +2-inches."*

PG&E Response:

Based on the bobbin data, the WEXTEX expansion transition for tube SG 2-1 R20C45 starts at top of tubesheet hot leg minus 0.29 inch (TSH – 0.29 inch) and ends at TSH + 0.22 inch. As noted in Table 8 of Enclosure 3 of the 90-day

report, the circumferential indication is located at TSH + 0.07 inch, based on the Plus Point data. The indication is slightly above the top of the tubesheet and however, still within the expansion transition region. The indication is not located in the non-expanded portion of the tube. In addition, based on PG&E's re-review of the Plus Point data for this tube, the outside diameter (OD) circumferential indication does not appear crack-like. The Plus Point signal was very small (0.15 volts) and on a very shallow OD plane (139 degrees phase angle), and appears to be an anomalous signal. The indication was an extremely conservative call and could have been called no detectable degradation (NDD).

The current inspection extent of TSH + 2.0 inches to TSH - 8.5 inches is still appropriate since no circumferential indications have been detected in the non-expanded portion of the tube.

NRC Question No. 5 (W* ARC):

> *"Since the in-situ leak test for tube R2C29 in SG 2-4 did not result in any leakage, it was assumed that there was no leakage for the condition monitoring assessment. Discuss how the effects of tubesheet bow were accounted for in this assessment. Also, refer to question 6 regarding the effects of pressure on the results of the in-situ pressure test."*

PG&E Response:

The effects of tubesheet bow cannot be directly accounted for in the results of in-situ testing of tube indications in the tubesheet. However, it is noted that almost all tests that were used to validate the model for crevice leakage leaked under all test conditions. The two specimens that did not exhibit leakage at an engagement length of 2.6 inches BWT did not leak at any elevated temperature conditions. While tubesheet bow might influence the magnitude of the leak rate, it would not be expected to change a non-leaking indication to a leaking indication in a WEXTEX expansion.

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 the increase in leakage with increasing pressure differential across the crack face is more influential on leakage than the associated increase in contact pressure between the tube and tubesheet. Moreover, a specimen-by-specimen comparison of the individual data demonstrates a marked reduction of leak rate with an increase in temperature from 70 to 600 degrees Fahrenheit.

NRC Question No. 6 (W* ARC):

> *"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 flaw sizes at various elevations within the tubesheet."*

PG&E Response:

It is not believed that higher differential pressures cause tube tightening within the tubesheet to the extent that leak rates are suppressed. See PG&E's response to NRC Question No. 5 (W* ARC) above on this topic for a discussion of the trend of the test data presented in the Westinghouse supporting document.

NRC Question No. 7 (W* ARC):

> *"Please discuss how the leakage was assessed for circumferential flaws that were plugged in the tubesheet region."*

PG&E Response:

In 2R11, one circumferential indication (SG 2-1 R20C45) was detected in the WEXTEX expansion transition region (not a W* indication) and plugged. PG&E's response to NRC Question No. 4 (W* ARC) provides a discussion of this indication, and notes that the indication was a conservative call and could have been NDD. The SLB leakage evaluation of this indication for CM and OA is discussed in Section 10 of Enclosure 3 of the 90-day report, and concludes that no SLB leakage should be postulated.

NRC Question No. 8 (W* ARC):

> *"Regarding the growth rate distribution, it appears that the growth rate for all PWSCC indications detected in the tubesheet region were combined (i.e., regardless of whether the indication was entirely below the bottom of the expansion transition or in the expansion transition). Discuss whether the growth rate of the PWSCC indications associated with the expansion transition is similar to the growth rate of PWSCC indications that are clearly below the transition. That is, are the growth rates from the two*

populations of indications the same? If not, discuss the effects on your analysis."

PG&E Response:

As discussed in the 90-day report, there are 182 Plus Point data points for DCPP Units 1 and 2 in the W* growth rate distribution. W* ARC applies to axial PWSCC indications for which the majority (judged to be 75 percent) of the indication length is below BWT. Of the 182 data points, only 8 are associated with indications that do not meet this criterion, that is, less than 75 percent of the indication length is below BWT. The average and maximum growth rate of these 8 indications is 0.013 and 0.041 inch/EFPY, respectively, indicating slow growth, and are bounded by the growth rate of the other 174 indications in the distribution, for which the average and maximum growth rate is 0.013 and 0.231 inch/EFPY, respectively. Since the average growth rates are essentially the same and the population of the transition cracks is small (8 of 182 indications), the growth rates of the two populations can be considered to be the same. The influence of the 8 indications on the EOC-12 projections is negligible. For future analyses beyond Cycle 12, growth rates will be based on the guideline that 75 percent of the indication length is below the BWT to consider the indications as W* applicable.

NRC Question No. 9 (W* ARC):

"Regarding the methodology for projecting the amount of leakage during postulated accidents, it was indicated that the under prediction in leak rate for steam generator 2-1 was attributed to new axial indications within the W length that were not accounted for. Please discuss your plans for modifying the methodology to include these in your projections. In addition, discuss the methodology to be used in assessing the number and size of these new indications."*

PG&E Response:

The W* ARC methodology for operational assessments does not 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. The three new indications in the W* length in SG 2-1 had voltages ranging from 0.24 to 0.28 volt as noted in Table 1-1 of this enclosure (same voltage data as contained in Table 1 of Enclosure 1 of the 90-day report). These voltages are substantially too low to contribute to leakage. In Table 1-1, there are 8 new W*

indications in the W* length summed over all four SGs. The largest voltage of the 8 indications is 0.61 volt, well below the 2.5 volt leakage threshold. Except for deplugged tubes for which the voltages may increase in the plugged tube condition, the in-situ screening data of Table 2 of Enclosure 1 of the 90-day report show that none of 28 indications continuously in service have voltages exceeding the 2.5 volt threshold. Of these 28 indications, 21 have Plus Point volts <1.0, 5 have voltages between 1.0 and 2.0 and only 2 have voltages between 2.0 and <2.5 volts. These data strongly support the W* methods assumption that new indications would have negligible contributions to SLB leakage.

The SLB leakage analysis methods were very conservatively developed to permit relatively simplistic deterministic analyses. The conservatism in the SLB leakage analyses includes the following:

- All indications are assumed to be throughwall.
- No tube to tubesheet contact pressure is assumed over the first 0.7" below the BWT for all indications although only a fraction of the indications show a tapered expansion over part of this length.
- All growth and NDE length uncertainties at 95 percent probability are assumed to be in the direction of the BWT (i.e., shorten the distance below the BWT), which increases the leak rate compared to growth in both directions.
- The SLB leak rate assigned to a tubesheet position zone is the most limiting leak rate for any tube in the zone such as to bound leakage for all other tubes in the zone.
- Contact pressures used to develop the SLB leak rates exclude the WEXTEX contact pressure.

The assumption that all indications are throughwall is a significant conservatism as noted from the voltage analysis given above. Section 6.5 of WCAP-14797, Revision 1, describes a Monte Carlo analysis that addressed principally the conservatisms of the third and fourth bullets noted above but retained the conservatisms of the first two and last bullets. For the sample set of 75 WEXTEX indications in the analysis, the Monte Carlo results were 20 percent lower than the deterministic analysis, which further notes the conservatism in the SLB analysis methods.

Based on the above considerations that new indications are not expected to be throughwall for leakage and that the 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 CM leak rates exceeding the projections. However, given the very conservative CM analysis that assumes all indications including new and prior indications are throughwall, the CM analysis is overly conservative and the conservatisms in the OA analysis are adequate to conservatively bound the true leak rate. A more

realistic estimate of the CM leakage would be to assign a voltage threshold (e.g., 2.5 volts) to the leakage analysis such that only indications above this threshold would be included in the leakage analysis. With this methodology, it would be more appropriate to assess SLB leakage analysis methods if the OA predictions exceed the CM leak rates calculated with a voltage threshold.

NRC Question No. 10 (W* ARC):

> *"The growth rate increased from a pre-2R11 growth rate of 0.069 inches per effective full power year (EFPY) to a growth rate of 0.115 inches per EFPY for 2R11. Discuss the need to account for an increasing growth rate in your projections of end-of-cycle conditions."*

PG&E Response:

The 95 percent growth rate for axial PWSCC in the WEXTEX region increased from 0.069 inch/EFPY (pre-2R11) to 0.115 inch/EFPY (post-2R11). The 95 percent growth rates from Unit 2 Cycle 10 and Unit 2 Cycle 11 were reviewed and a small increase from 0.087 to 0.122 inch/EFPY was calculated. However, there were no changes in Unit 2 plant operation that would account for increased PWSCC growth rates.

PG&E's commitment is to use the most recent 200 data points in the growth distribution, and the current distribution has 182 data points. 200 data points is considered a statistically valid data set.

Performance criteria have been developed to ensure that the upper crack tip of axial PWSCC indications left in service remain below the TTS by at least the 95 percent confidence NDE uncertainty in locating the crack tip relative to the TTS. In the four W* ARC inspections at DCPP Units 1 and 2 subsequent to the first W* ARC implementation in 1R9/2R9, this performance criteria has been satisfied.

The growth rate used in the Unit 2 Cycle 11 OA was 0.21 inch/EFPY, which was much greater than the Unit 2 Cycle 11 95 percent growth rate of 0.122 inch/EFPY and resulted in conservative projections of the upper crack tip locations. The growth rate distribution was revised after Unit 2 Cycle 11 to delete all pancake data and non-DCPP growth data, in accordance with PG&E Letter No. DCL-01-095, "Extension of Steam Generator Tube W* Alternate Repair Criteria for Indications in the Westinghouse Explosive Tube Expansion (WEXTEX) Region" to the NRC dated September 13, 2001. As discussed in DCL-01-095, the 95 percent growth rate of the new distribution is 0.08 inch/EFPY, using all DCPP Units 1 and 2 Plus Point growth data through 2R10.

Benchmarking was performed to determine if applying the 0.08 inch/EFPY 95 percent growth rate would have resulted in a conservative estimate of the as-found UCT location at 2R11. Without applying 0.22 inch NDE uncertainty to the

UCT locations, 57 of the 67 repeat indications detected at 2R11 have a projected EOC-11 UCT location higher than the as-found 2R11 UCT location. When applying the 0.22 inch NDE uncertainty to the projected UCT location, 66 of the 67 indications have a projected EOC-11 UCT location higher than the as-found (unadjusted) 2R11 UCT location. This demonstrates that the prior cycle 95 percent growth rate would have provided a conservative estimate of the UCT location, when combined with NDE uncertainty, 98 percent of the time. Therefore, growth rate methods do not require refinement for Unit 2 Cycle 12, considering the conservatisms in the leak rate analyses listed in the response to Question No. 9 (W* ARC) above.

NRC Question No. 11 (W* ARC):

> *"In-situ pressure testing was performed, in part, to assess the adequacy of the leak rate model. Discuss whether any operating experience provides additional insights into the adequacy of the leakage model. For example, discuss whether operational leakage from defects in the tubesheet region (from either domestic or foreign reactors) provide any insights into the adequacy of the leakage model."*

PG&E Response:

Primary-to-secondary leakage from tubesheet indications led to an unscheduled SG tube inspection outage at Paluel 2 in October of 2002. The leaking indications were attributed by the utility to axial cracks in tubes located in misdrilled tubesheet holes. The indications were not hydraulically in-situ tested. The conclusion that the indications were leaking was based on helium leak testing. There are no other operating experiences known to Westinghouse or PG&E where operating leakage was attributed to throughwall tube indications within the tubesheet of full depth expanded tubes. On the contrary, there is no doubt that throughwall tube indications exist within the tubesheet in a Westinghouse plant with hydraulically expanded tube-to-tubesheet joints. There was no detectable operational leakage from those tubes and no leakage was identified from in-situ testing of the tubes. The insight on the WEXTEX leakage model provided by these data is that the model assumption that all indications are throughwall and leak is extremely conservative.

Primary Water Stress Corrosion Cracking (PWSCC) ARC

NRC Question No. 1 (PWSCC ARC):

> *"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 to be 6500 psi at the end of the cycle, the methodology would have under predicted the burst pressure by 2500 psi. Whereas this specific example does not pose an immediate 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:

This question is a repeat of NRC Question No. 1 on PWSCC ARC from the 1R11 90-day report RAI questions. PG&E's Letter DCL-03-113, "PG&E Response to NRC Questions on 1R11 Steam Generator Tube Inspections," dated September 15, 2003, provided the response.

NRC Question No. 2 (PWSCC ARC):

"In Table 5 of Enclosure 2 to your June 23, 2003 letter, several indications are reported that were either above or below the tube support plate. Presumably, these tubes are dented at the tube support plate. Please discuss whether these indications extend into the tube support plate region (i.e., are the indications in the dented region). If the indications are not associated with the dent, please discuss the driving force for these indications. Also, if the indications appear to initiate at the edge of the dent, please discuss whether the dent is limiting the ability of the analysts to identify the entire length of the flaw."

PG&E Response:

All of the axial PWSCC indications in Table 5 of Enclosure 2 to the 90-day report are located at dented TSP intersections. For the axial PWSCC indications in Table 5, the 0.75 inch long TSP region is defined as plus 0.375 inch to minus 0.375 inch, relative to the centerline of the TSP. There are 10 axial PWSCC indications that extend outside the TSP, of which 5 are located entirely outside the TSP region, and 5 extend from within the TSP region. The peaks of the dent signals in all 10 tubes are located at the center of the TSP. Localized maximum dent size is commonly located near the TSP center, but the dent results in tube

ovalization that leads to the stresses causing some cracks located away from the center of the TSP. The Plus Point signals are not influenced by the dents. The 10 PWSCC indications are located well away from the dents and the dent is not limiting the ability of the analysts to identify the entire length of the flaw.

The database used to develop the PWSCC NDE sizing uncertainties includes indications starting away from the TSP center and extending outside the TSP or located entirely outside the TSP. These data, as well as the more common indications extending through the center of the support, have permitted adequate length sizing and any associated effects of dents are included in the sizing uncertainties.

NRC Question No. 3 (PWSCC ARC):

> *"Regarding the assessment of the ligament tearing model in assessing the leak rate for PWSCC, please clarify whether the as-measured destructive examination profile was adjusted in any manner (e.g., for examination uncertainty). If the as-measured profile was adjusted, please provide the technical basis."*

PG&E Response:

The as-measured destructive examination profile was not adjusted for the ligament tearing calculations.

Outside Diameter Stress Corrosion Cracking (ODSCC) ARC

NRC Question No. 1 (ODSCC ARC):

> *"On page 11 of 117 of Enclosure 4 to your June 23, 2003 letter, a discussion of cold leg thinning is provided. With respect to this discussion:*
>
> *a. It was indicated that bobbin indications detected on the cold leg are confirmed as volumetric indications through +PointTM examinations upon initial identification of the bobbin indication. Discuss how closely spaced cracks, which may also appear as volumetric indications, are distinguished from cold leg thinning. Discuss whether additional +PointTM examinations are performed at these locations during subsequent outages to confirm that no cracks are developing at these locations. If +PointTM examinations are not performed at these locations every outage, discuss how the initiation of cracks at intersections with previously identified cold leg thinning volumetric indications is monitored.*
>
> *b. It was indicated that no cold leg ODSCC indications have been detected at Diablo Canyon Unit 2; however, in Table 3-5 of Enclosure 4 several cold leg indications are reported. Please clarify what these cold*

leg indications are. If these indications are not ODSCC, please discuss why are they included in this Table? If these indications are attributed to cold leg thinning, please clarify whether they are assessed with the ODSCC indications in the voltage-based alternate repair criteria calculations."

PG&E Response:

At DCPP Units 1 and 2, analysts are instructed to initially call all cold leg TSP indications as a distorted outside diameter signal (DOS). If the DOS is in the cold leg thinning (CLT) region (lower TSP elevations and in the periphery) and has never been inspected with a rotating coil, the intersection is inspected by Plus Point. If the indication confirms as volumetric in nature, which is indicative of CLT, a resolution analyst will change the DOS to a percent throughwall indication, such that the indication is not treated under ODSCC ARC rules. If the DOS is not confirmed by Plus Point, or if the DOS is located outside the CLT region and not Plus Point inspected, the DOS is assumed to be ODSCC and included in the Monte Carlo ARC calculations.

(a) Cold leg thinning can be distinguished from closely spaced cracks based on bobbin and Plus Point signals. The shape, phase angle and amplitude of the bobbin signal associated with cold leg thinning indicate that they are a volumetric wastage type of signal and not a volumetric crack like signal as seen in OTSG units. Also, the terrain plot, phase angle and amplitude of the Plus Point data are indicative of cold leg thinning and not closely spaced cracks. If it were closely spaced cracks, the bobbin and Plus Point signals would be jagged and irregular. Also, both bobbin and Plus Point data from the in-generator indications are consistent with the bobbin and Plus Point data from the cold leg thinning samples that have been prepared for the development of cold leg thinning sizing techniques in Westinghouse report SG-SGDA-02-41. This report is discussed in PG&E response to NRC Question 4 from "Other Inspection Findings (not associated with an ARC)".

Additional Plus Point examinations are not performed nor required at these locations during subsequent outages based on the experience that there has been no confirmed ODSCC at cold leg TSPs at DCPP Units 1 and 2 from >100 and >275 cold leg Plus Point inspections in 1R11 and 2R11, respectively. The number of cold leg TSP inspections in 2R11 does not include approximately 13,000 7C TSP intersections that were Plus Point inspected as part of the 100 percent U-bend inspection program in 2R11.

(b) No cold leg ODSCC indications have been confirmed by Plus Point at Diablo Canyon Units 1 and 2. Table 3-5 of Enclosure 4 of the 90-day report identifies 55 cold leg DOS, of which 19 were inspected with Plus Point and no degradation of any kind was detected. The remaining 36 were not inspected with Plus Point. Eight of these DOS are located in the CLT region (lower TSP and periphery of

the bundle), and were not confirmed as CLT based on NDD response from Plus Point, but are conservatively included in the general DOS population for ODSCC ARC calculations. Plus Point volumetric indications in the CLT region are not included in the ODSCC ARC population because they are attributed to CLT.

NRC Question No. 2 (ODSCC ARC):

"Table 3-4 of Enclosure 4 to your June 23, 2003 letter, lists the largest voltage growth rates observed during cycle 11. All of these indications were single axial indications. Please discuss whether this is a common industry occurrence or whether there is some unique factors (e.g., all are from previously plugged tubes) at Diablo Canyon Unit 2 which result in all of the largest growth rates coming from single axial indications."

PG&E Response:

As clarified in PG&E's response to NRC Question No. 10, submitted via PG&E Letter DCL-03-121, dated September 30, 2003, the indications in Table 3-4 of Enclosure 4 to the 90-day report were not all single axial indications. Additionally, none of these tubes were deplugged and returned to service at previous outages.

NRC Question No. 3 (ODSCC ARC):

"On page 60 of 117 of Enclosure 4 to your June 23, 2003 letter, you indicate, in part, that the R44C45 destructive examination has a second microcrack of 0.056 inch length "that was throughwall on the ID of the tube." Please clarify the portion of the statement in parentheses. Since a throughwall crack must always penetrate to the ID of the tube, was this statement implying that the crack initiated from the inside diameter of the tube or simply that the through-wall length of 0.056-inch was measured from the ID of the tube."

PG&E Response:

There was no intention to imply that this crack segment initiated from the ID of the tube. The stated length of 0.056 inches was the axial extent as measured on the ID of the tube.

NRC Question No. 4 (ODSCC ARC):

"On page 73 of 117 of Enclosure 4 to your June 23, 2003 letter, you indicate, in part, that a Diablo Canyon "bobbin-to-Plus-point correlation" was used to determine the bobbin voltage for several indications. Please discuss why a plant-specific correlation was used rather than a generic one. If there are differences in the correlations (i.e., from plant-specific to

generic), please discuss the nature of these differences. If the differences are due to flaw morphology, please include in your response an assessment of the implications to using generic databases for assessing leakage and burst."

PG&E Response:

In accordance with Section 10.1.3 of Addendum 5 of EPRI report NP-7480-L (ODSCC Database Update), PG&E has developed a plant-specific correlation to assign bobbin voltages to indications that are NDD by bobbin, but rotating coil inspection identifies an axially oriented OD signal. No generic correlation has been developed. The EPRI report NP-7480-L provides an example correlation of a data set using only 0.080" pancake coil data.

NRC Question No. 5 (ODSCC ARC):

"On page 4 of 16 in Attachment 1 to Enclosure 4 of your June 23, 2003 letter, you indicate, in part, that the implication of the change in the p-value (for the leak rate correlation) is that a "decreased number of Monte Carlo simulations will be performed considering that there is no correlation of the log leak rate to the log bobbin amplitude." Please clarify this statement. For example, please address the relationship between the p-value and the number of simulations. Why does a decrease in the p-value to a value less than 5% imply there is no correlation of the log leak rate to the log bobbin amplitude?"

PG&E Response:

The statement regarding the decreased number of simulations considering no correlation between the log leak rate and the log bobbin amplitude follows from a prior statement noting that the p-value for the correlation decreased. The p-value can be thought of as the probability of obtaining a slope of less than or equal to zero when in fact there is correlation between the variables and a positive slope exists. Alternatively, the p-value can also be thought of as approximately equal to the probability of observing a correlation when one does not exist. According to guidance of the Generic Letter, the trigger used to assume that a correlation does not exist is a p-value that exceeds 5 percent, i.e., the probability that no correlation exists exceeds 5 percent. So, if the data show a p-value of 7 percent, it was conservatively assumed that a correlation does not exist for all simulations.

The current methodology involves simulations of the slope of the regression equation. The fraction of times that the slope will be simulated to be less than or equal to zero is approximately equal to the p-value. If a zero or negative slope is simulated it is assumed that no correlation exists and a simulation of the statistics of the leak rate data without a correlation is performed. This latter step results in

using the standard deviation associated without a correlation, which is larger than the standard deviation that results from the regression analysis. Since the number of simulations performed considering that a correlation does not exist is approximately equal to the p-value, if the p-value decreases, so does the number of simulations performed considering no correlation to exist. Note that the fraction of simulations performed considering a correlation to exist is simply 1-p, thus the number of simulations using the correlation increases with decreasing p-value, the total number of simulations being constant.

NRC Question No. 6 (ODSCC ARC):

> *"For the two tubes removed from the steam generator for destructive examination during 2R11, please discuss whether any other examinations were performed on other portions of those tubes other than those discussed in Enclosure 5 of your June 23, 2003 letter. For example, were any other portions of the tube destructively examined (e.g., the expansion transition, the portion of the tube within the tubesheet)? If so, discuss the results and compare it to the non-destructive examination results."*

PG&E Response:

No other areas of interest were identified during the in-service inspection of these areas of the tubes, and as such no destructive examination or lab testing was performed on any of these areas. A freespan area of each tube was used in the determination of the material properties of the tubes via a room temperature tensile test.

NRC Question No. 7 (ODSCC ARC):

> *"Please discuss any insights on why the dent at the 2H location in tube R35C57 was not detected prior to the tube pull (e.g., was the dent induced during the tube pull)."*

PG&E Response:

Since the dent did not exist in the pre-pull NDE data and was present in the platform NDE data, it was concluded that the denting of the TSP intersection occurred during tube removal. This occurrence is not uncommon in tube removal from SGs that are heavily dented and/or have packed TSP crevices. The visual inspection of this tube identified a large number of axial scrape marks and an almost complete absence of scale on the OD, compared to the other pulled tube, R44C45.

An important fact was that the tubesheet was drilled entirely out in this location, so any load seen during the removal was due to the 1st and 2nd TSP corrosion products. The pull loads that were recorded during the test did not exceed the

predetermined allowable limits. The total breakaway force including the two TSP intersections was approximately 1380 lbs_f. A single pull load as high as about 4400 lbs_f was observed during the removal process, and an average load of about 3600-3800 lbs_f was observed while the area of interest (TSP 2H) was passing through the TSP 1H. Finally, gripping the tube on the ID or OD within 3 inches of the area of the defect is not permitted during the removal process. Based on these facts and the visual inspection of the tube OD, it is concluded that the area was either dented during breakaway from TSP 2H or from passing through TSP 1H during the removal process.

NRC Question No. 8 (ODSCC ARC):

> *"During the burst test of the 2H location in tube R44C45, the test was interrupted at 3403 pounds per square inch (psi) because the brass shim had slipped out of place resulting in leakage from the plastic bladder at the defect location. The pressurization rate during this portion of the test was stipulated to be between 20 and 500 psi/second. After reshimming the sample, the burst test was continued with a pressurization rate of nearly 2000 psi/second. The final burst pressure was recorded as 4226 psi. Given the potential for the testing parameters (e.g., pressurization rate/foil) to affect the burst pressure of severely degraded locations, please discuss what steps you have, or will be, taking to confirm that the burst pressure was not adversely affected (i.e., inflated) as a result of the testing procedure. For example, please discuss whether the burst pressure reported is consistent with the burst pressure predicted based on empirical models such as the Argonne National Laboratory (ANL)/EPRI model and/or the Westinghouse model."*

PG&E Response:

For the 2R11 destructive examination, PG&E followed the guidelines of EPRI report 1006783, December 2002, "Steam Generator Tubing Burst Testing and Leak Rate Testing Guidelines," which supersedes the guidelines in Appendix G in EPRI report TR-016743-V4R1, December 1997. In fact, the testing was supervised by the same engineer responsible for much of the test data in the original ODSCC ARC database. In EPRI report TR-016743-V4R1, pressurization rates were specified to be between 200 and 2000 psi/second. The majority of data in the ARC database and from which the empirical models were developed were obtained at the higher pressurization rates. In EPRI report 1006783, pressurization rates were specified to be between 50 and 500 psi/second (these lower rates originated because some burst pressure test equipment was unable to record data quickly enough at higher pressurization rates), and allows pressurization rates up to 2000 psi/sec for specialized requirements. Since this rate does not challenge the data taking ability of the burst pressure system used by Framatome ANP and because the crack had opened somewhat when the bladder leaked, the decision was made to pressurize at the higher rate to avoid

possible problems created by the wider crack opening. The final pressurization rate on the burst test of the 2H section of tube R44C45 was fully consistent with the testing rates used for the ODSCC ARC database. An in depth review of destructive examination results for both R44C45 and R35C57 and all available axial flaw burst equations showed that the reported burst results are consistent with the very large database of axially flawed steam generator tubes. Therefore, based upon this discussion and on previous experience with burst testing, the burst pressure recorded for tube R44C45 is considered to be consistent with the industry ODSCC ARC database.

NRC Question No. 9 (ODSCC ARC):

> *"Two closely spaced cracks were observed in tube R35C57 at the second tube support plate. The two cracks were not distinguished by eddy current because they were closely spaced (approximately 0.07-inch). Please discuss the implications of this second crack on the comparison of the non-destructive examination results to the destructive examination results plotted in Figure 4-6 of Enclosure 4 to your June 23, 2003 letter. A plot of the destructive examination results of both flaws would be useful. Please discuss whether the presence of the second flaw had any affect on the burst pressure or leak rate of the "main flaw". Discuss whether the results of this evaluation support the assumptions in the primary water stress corrosion cracking (PWSCC) alternate repair criteria (ARC)."*

PG&E Response:

Closely spaced axial cracks (ODSCC) are not an unusual occurrence in steam generator tubes (see, for example, EPRI report 1006783) and any effects on burst pressure are inherently included in the industry database. In the case of tube R35C57, SEM fractography was not carried out for the second crack. A metallographic cross section through the center of the main crack suggested that the crack may have penetrated throughwall; however, the axial extent of any throughwall penetration was not determined.

It should be noted that the second crack was not visible after leak rate testing, while the primary crack was visible under magnification. Therefore, it is unlikely that the second crack, even if throughwall, had a measurable influence on the leak rate.

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 is the case for tube R35C57. The opening of the secondary axial crack was small and had no interaction with the main burst surface.

The predicted nominal burst pressure using the R35C57 destructive exam profile is about 5.50 ksi, using the PWSCC ARC burst correlation as adjusted for an OD indication, compared to the measured burst pressure of 5.96 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, 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 25 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.

NRC Question No. 10 (ODSCC ARC):

> *"Copper, lead, and sulfur were found on the pulled tubes. Please discuss whether the concentrations observed are consistent with other tubes removed in support of the ODSCC database."*

PG&E Response:

Only a limited amount (about 8 grams) of free span deposit was collected from tube R44C45 for analysis. There was almost no scale left on the OD surface of R35C57, or within the 2H TSP regions of either tube to allow for analysis. As a result, comparison with industry data could be misleading.

The small amount of deposited material that was collected was subjected to Inductively Coupled Plasma (ICP) spectroscopy to determine elemental composition. Copper, lead, and sulfur levels were 1.120 weight percent (wt percent), 0.010 wt percent, and <0.002 wt percent respectively. Since the only source of copper in the Diablo Canyon feedwater train is the condenser tubesheet material (90/10 Cu/Ni), copper levels in the tube scale should be on the high end of all-ferrous feedwater cycles. EPRI report TR-106048, "Characterization of PWR Steam Generator Deposits", February 1996, reports copper levels in tube scale from all-ferrous feed trains ranging from a minimum of 0.09 wt percent to a maximum of 1.09 wt percent. The Diablo Canyon Unit 2 copper level of 1.12 wt percent is thus seen to be as expected.

In EPRI report TR-106048, sulfur levels are reported that vary from a low of 0.0067 wt percent to a high of 1.15 wt percent, as elemental sulfur. Likewise, the average lead concentrations were reported as 0.008 wt percent for plants with all-ferrous feed trains, to 0.015 wt percent for plants with copper in the feed train. For Diablo Canyon Unit 2, the sulfur deposit level was reported as <0.002 wt percent, or less than reported in the industry for tube scale. The lead concentration in the Diablo Canyon Unit 2 scale was 0.010 wt percent, or within the range reported in the industry.

Upon review, there is no information, chemical or otherwise, that indicates the Diablo Canyon Unit 2 pulled tubes are not within the expectations of the ODSCC ARC database.

NRC Question No. 11 (ODSCC ARC):

"It was indicated that a portion of tube R35C57 was bowed in an "S" shape. Please discuss how this bowing occurred. If the bowing occurred during operation, please discuss the implications of this bowing on the structural and leakage integrity of the tubes."

PG&E Response:

It is suspected that the tube bow in a portion (the longest section removed) of tube R35C57 was caused during tube removal. As discussed in PG&E response to NRC question 7 above, the OD scale on tube R35C57 had been scraped off during tube removal and axial scrape marks were prevalent on the OD.

NRC Question No. 12 (ODSCC ARC):

"Please clarify your process for dispositioning tubes with large mix residuals (as defined in Generic Letter 95-05). If all locations with large mix residuals are not inspected with a rotating probe and/or flaws associated with intersections that have large mix residuals are left in service, please provide your technical basis for the process used (in your response, please consider the questions in Enclosure 3 of ADAMS Accession Number ML031550196.). Include in this response, the criteria you use for determining a large mixed residual."

PG&E Response:

In PG&E letter DCL-03-113 in the response to NRC question 4 (related to 1R11 ODSCC ARC), PG&E explained the process for dispositioning tubes with large mix residuals at DCPP Units 1 and 2, provided the basis for defining a large mix residual as greater than or equal to 2.3 volts by bobbin, indicated that all hot leg TSP intersections with large mix residuals are inspected with Plus Point, and provided the plugging criteria based on Addendum 5 of the EPRI ODSCC ARC database (EPRI report NP-7480-L). There have been no flaws detected by bobbin or Plus Point at TSP intersections with greater than or equal to 2.3 volts mix residuals.

NRC Question No. 13 (ODSCC ARC):

"In-situ pressure tests were performed on a number of axial ODSCC indications at the tube support plates (Table 7 of Enclosure 3). Many of these indications leaked. Please discuss whether the results from these

tests are consistent with the leak rate results from the pulled tube database. Given the presence of the crevice, it would be expected that these indications would leak at a lower rate than that predicted by the correlation (after the appropriate adjustments for testing conditions are made). If the results of the in-situ pressure tests indicate higher leakage than that predicted by the correlations, please discuss the significance of these results."

PG&E Response:

Table 13-1 provides the in-situ leak test results as measured at room temperature and as adjusted to standard SLB conditions using the ARC leak rate adjustment procedure. The table also includes the ARC SLB leak rates at 2405 psi calculated from the regression correlation (median leak rate) for the Addendum 5 data plus the DCPP Unit 2 2R11 pulled tubes. The last column of Table 13-1 provides the ratio of the ARC correlation leak rate to in-situ test results adjusted to hot conditions. The ratios range from factors of 2.7 to 19 consistent with the expectations that these indications would leak at a lower rate than that predicted by the correlation, given the presence of the crevice. These large ratios show the effects of TSP crevice deposits. At SG operating temperatures for which the tube to deposit gap would be essentially eliminated by thermal expansion of the tube, the ratios would be substantially higher since it is expected that TSP indications would not have significantly contributed to the Unit 2 Cycle 11 operational leakage.

During preparation of Table 13-1, some minor errors in the in-situ test data were identified in Table 7 from Enclosure 3 of the 2R11 90-Day Report. There errors have been corrected and a revised table is attached as Table 13-2.

Table 13-1. 2R11 Comparison of Measured In-Situ Leak Rates Adjusted to Hot Conditions with ARC Predictions

							In-Situ Test Results (Measured at Room Temperature)				ARC Leak Corr.(1) Median	ARC to In-Situ Ratio
SG	Row	Col	No. +Point Ind.	Max. +Point Volts	Bobbin Volts	TSP	Room Temp. 1750 psi dP (gpm)	Room Temp. 2250 psi dP (gpm)	Room Temp. 2750 psi dP (gpm)	Adjusted(2) Hot 2405 psi dP (gpm)	Hot 2405 psi dP (gpm)	ARC Hot to Adj. Hot 2405 psi dP
21	27	33	1	1.64	2.83	1H	0		0.0010	0.00023	0.0045	19.3
21	30	41	1	4.44	5.1	1H	0	Notes 3, 4	0.0232	0.0035	0.0103	3.0
21	34	31	1	2.76	2.73	1H	0	Note 4	0.0053	0.00080	0.0070	8.7
24	3	29	1	0.4	0.22	2H	0		0	0	0.0014	
24	6	39	5	1.96	3.35	1H	0		0.0028	0.00046	0.0052	11.4
24	7	48	4	3.63	4.55	2H	0.0012	0.0040	0.0063	0.0024	0.0087	3.7
24	12	38	1	3.37	6.2	1H	0	0.0021	0.0037	0.0013	0.0082	6.3
24	15	80	4	2.83	4.93	2H	0.0011	0.0041	0.0078	0.0026	0.0071	2.7
24	18	76	2	4.55	6.64	2H	0	Note 4	0.01394	0.00209	0.0126	6.0
24	28	54	1	3.02	3.58	1H	0.0011	0.0024	0.0061	0.00166	0.0075	4.5
24	29	48	2	3.5	5.04	2H	0.0016	0.0031	0.0035	0.00167	0.0085	5.1
24	31	39	1	2.49	4.82	1H	0		0.0037	0.00056	0.0064	11.5
24	44	45	2	12.12	21.5	2H	0.0040		NA		0.0238	
24	44	48	2	2.08	2.3	2H	0	Note 4	0.0062	0.00093	0.0055	5.9

Notes:
1. ARC Leak Rate Correlation Median Values for Addendum 5 Data Plus DCPP 2R11 Pulled Tubes
2. Adjusted to hot operating conditions using ARC Methods of EPRI Report NP-7480, Vol. 1, Rev. 2 App. B
3. Actual in-situ test dPs were 1800 psi and 2800 psi for this test
4. Pressure adjustments from zero leakage may be overestimated for significant SLB leak rates when intermediate dP test is not available. Maximum adjustment factor of 0.15 applied for these indications

Table 13-2 - Revised Table 7 from Enclosure 3 of 2R11 90-Day Report
2R11 In-Situ Pressure Test Summary

SG	Row	Col	Degradation by Eddy Current Inspection	Number of Plus Point indications	Maximum Plus Point voltage	Bobbin voltage	Degradation Location	Leakage/Moisture Observed during Secondary Side Pressure test?	NO dP (gpm)	SLB dP (gpm)	3NO dP (gpm)
21	27	33	axial ODSCC	1	1.64	2.83	1H	Yes	0	0.001	NA
21	30	41	axial ODSCC	1	4.44	5.1	1H	Yes	0	0.0232	NA
21	34	31	axial ODSCC	1	2.76	2.73	1H	Yes	0	0.0053	NA
24	3	29	axial ODSCC	1	0.4	0.22	2H	Yes	0	0	0
24	6	39	axial ODSCC	5	1.96	3.35	1H	Yes	0	0.0028	NA
24	7	48	axial ODSCC	4	3.63	4.55	2H	Yes	0.0012	0.0063	NA
24	12	38	axial ODSCC	1	3.37	6.2	1H	Yes	0	0.0037	NA
24	15	80	axial ODSCC	4	2.83	4.93	2H	Yes	0.0011	0.0078	NA
24	18	76	axial ODSCC	2	4.55	6.64	2H	Yes	0	0.0139	NA
24	28	54	axial ODSCC	1	3.02	3.58	1H	Yes	0.0011	0.0061	NA
24	29	48	axial ODSCC	2	3.5	5.04	2H	Yes	0.0016	0.0035	NA
24	31	39	axial ODSCC	1	2.49	4.82	1H	Yes	0	0.0037	NA
24	44	45	axial ODSCC	2	12.12	21.5	2H	Yes	0.004	NA	NA
24	44	48	axial ODSCC	2	2.08	2.3	2H	Yes	0	0.0062	NA
24	6	4	no degradation detected	0	NDD	NDD		Yes	0	0	0
24	42	55	no degradation detected	0	NDD	NDD		Yes	0	0	0
24	2	29	axial PWSCC (W*)	2	5.21	3.32	4 inch below HL TTS	Yes	0	0	NA
21	1	24	Axial PWSCC	1	1.15		U-bend		0	0	0
21	1	43	Circumferential PWSCC	1	0.47		U-bend		0	0	0
21	5	54	Circumferential PWSCC	7	0.73		U-bend		0	0	0
22	4	51	Circumferential PWSCC	21	0.57		U-bend		0	0	0
22	10	19	Circumferential PWSCC	2	0.37		U-bend		0	0	0
23	3	86	Circumferential PWSCC	2	0.56		U-bend		0	0	0
23	3	93	Circumferential PWSCC	1	0.5		U-bend		0	0	0
23	4	52	Circumferential PWSCC	1	1.15		U-bend		0	0	0
24	1	93	Axial PWSCC	1	1.23		U-bend		0	0	0
24	5	60	Circumferential PWSCC	3	1.1		U-bend		0	0	0
24	5	62	Circumferential PWSCC	35	3.04	NDD	U-bend	Yes	0	0.004	0.0456
24	5	68	Circumferential PWSCC	5	0.69		U-bend		0	0	0
24	6	23	Circumferential PWSCC	5	0.64		U-bend		0	0	0
24	6	53	Circumferential PWSCC	1	0.85		U-bend		0	0	0
24	7	52	Circumferential PWSCC	9	0.35		U-bend		0	0	0
21	1	9	sludge lance damage SVI	2	0.41	1	22 inch above HL and CL TTS		0	0	0
21	1	28	sludge lance damage SVI	2	1.22	4.75	22 inch above HL and CL TTS		0	0	0
23	1	86	sludge lance damage SVI	2	0.66	1.54	22 inch above HL and CL TTS		0	0	0
24	1	67	sludge lance damage SVI	2	1.65	4.49	22 inch above HL and CL TTS		0	0	0
24	1	86	sludge lance damage SVI	2	1.52	3.4	22 inch above HL and CL TTS		0	0	0

Notes:

- NA means the tube was not pressurized to the specified differential pressure.
- R44C45 was not tested higher than normal operating pressure (NOP) because the tube was pulled for further destructive exam.
- The leak rates correspond to the test pressures and are in gpm at room temperature condition.
- NOP, SLB, and 3NOP differential pressures for tube integrity analysis are 1473 psi, 2405 psi, and 4419 psi. The actual in-situ test pressures are increased to account for thermal and gage corrections.

The following revisions and clarifications were made compared to Table 7 from Enclosure 3 of 2R11 90-Day Report:

- Actual NO dP in-situ test pressures were 1750 psi, except 1800 psi for SG 2-1 R30C41
- Actual SLB dP in-situ test pressures were 2750 psi, except 2800 psi for SG 2-1 R30C41
- Actual 3NO dP in-situ test pressures were 4950 psi, except 5000 psi for SG 2-1 R1C43, SG 2-3 R4C52, SG 2-4 R1C86, SG 2-4 R5C62; and 5010 psi for SG 2-4 R3C29
- SLB leak rate for SG 24 R15C80 is 0.0078 gpm (0.0041 gpm was the leak rate at an intermediate pressure).
- SLB leak rate for SG 24 R18C76 is 0.0139 gpm (not 0.0134 gpm)
- SG 24 R1C93 had an axial PWSCC indication (not a circumferential PWSCC indication).
- All voltages (except SG 24 R3C39) reflect pre-in-situ testing. SG 24 R18C76 pre-in-situ Plus Point voltage is 4.55 volts (5.65 volts was the post-in-situ test voltage). SG 24 R3C29 had no Plus Point inspection prior to in-situ and was 0.4 volts after in-situ.
- Sludge lance damage SVI Plus Point voltages obtained from Sizing Analysis results.

Other Inspection Findings (not associated with an ARC)

NRC Question No. 1 (non-ARC):

> *"It was determined that one Alloy 600 plug leaked during the secondary side pressure test as a result of a crack. It was postulated that the primary to secondary pressure resulted in unseating the plug (in this case secondary pressure was greater than the primary pressure). Please discuss any assessments of whether the plug had adequate integrity. For example, did it have adequate structural integrity with the appropriate margin during both normal operation and postulated accidents? For example, would the plug have stayed intact during a loss of coolant accident? Please discuss the technical basis for not replacing the remaining I-600 plugs."*

PG&E Response:

The technical basis for not replacing the remaining Alloy 600 mechanical plugs is that they have been repaired using one of multiple repair technologies approved by the NRC staff in 1989 and 1990. WCAP-12244, Addendum 4, delineates the schedule for replacing Alloy 600 mechanical plugs and notes that the Westinghouse Plug-In-Plug (PIP) and the FANP Plug-A-Plug (PAP) were acceptable permanent repairs for mechanical plugs. The Westinghouse PIP design incorporates a flexible flange at the bottom of the plug that permits back-pressure to be relieved in the event of pressurization of a plugged tube that has a PIP installed. The pressure to cause slight flexing of the flange is on the order of 200 psi. The plug would not have expelled during a LOCA.

NRC Question No. 2 (non-ARC):

> *"Tubes with circumferential indications at the top of the tubesheet or at the first tube support plate were stabilized (Table 8 in Enclosure 3). Please discuss the technical basis for not stabilizing the two tubes with circumferential indications at the fourth hot-leg tube support plate."*

PG&E Response:

The technical basis for not stabilizing two tubes with circumferential indications at the fourth hot-leg tube support plate is based on Framatome ANP's Tube Stabilization Criteria for a Series 51 SG, which states that "circumferential indications between 1 inch above the 1^{st} TSP up to 3 inches below the top TSP do not require stabilization".

Framatome ANP has performed flow induced vibration (FIV) analysis for the Series 51 SG, which showed that the upper part of a severed tube in this area of the bundle (row, column and elevation) remains stable, has acceptable

responses, and therefore does not require stabilization. Therefore, if one of these cracks in the subject tubes developed into a full sever; the upper portion of the tube will remain stable. Additionally, both of these tubes are located in the bundle where cross flows are lower than in the periphery. The indications are at the 4th TSP (in the middle of the hot leg straight section of the tube) where cross flow velocities are low and the ρv^2 (dynamic pressure) term in the stability equations is negligible. Since the location of the cracks is removed from areas of high cross flows and the cracks are confined within the tube support plates, it is concluded that the lower portion of the tube will also remain stable in the case of a complete sever at the crack site. Therefore, it is concluded that the two circumferential indications listed above did not require stabilization.

NRC Question No. 3 (non-ARC):

> *"In the operational assessment for potential leakage from PWSCC indications in rows 1 and 2, it was assumed that the detection threshold was similar to that at dented intersections. Reviewing Tables 13 and 14 of Enclosure 3, it appears that the detection threshold in the U-bend region may be significantly higher. Please discuss."*

PG&E Response:

In Table 13 and Table 14 of Enclosure 3 of the 90-day report, the maximum Plus Point depths reported for the three U-bend PWSCC indications (two axial and one circumferential) in both the 2R11 data and the 2R10 lookup data were much higher than the 35 percent detection threshold assumed in the OA. Therefore, PG&E agrees that, if these reported depths are accurate, then a higher detection threshold would be more appropriate. However, as described below, PG&E does not believe these indications are service-induced degradation.

PG&E re-reviewed these indications back to 2R7 (April 1996) when the Row 1 tubes were inspected for the first time with Plus Point. All three indications were traceable to the 1996 data. The review shows that all three indications are located at the hot leg tangent point, the Plus Point response is not crack-like, and the 1996 Plus Point response was similar in amplitude, phase angle and terrain plot to the 2003 Plus Point response. Therefore, PG&E believes that these indications are not PWSCC, but are geometry "bump" signals caused by the tube bending process. Because these three indications were very conservatively called in 2R11 as PWSCC indications, they were subsequently in-situ pressure tested to support condition monitoring. However, operational assessment is not applicable to these indications because they have been determined not to be service induced degradation.

About 56 Rows 1 and 2 tubes in DCPP Unit 2 have been plugged for U-bend indications at tangent points, with the vast majority detected in 2R7 based on the first time use of Plus Point. Only one indication at a tangent point has been

detected since 2R8 (not counting the three 2R11 tubes discussed above because they are not considered to be PWSCC), thus providing support that repeated Plus Point inspections of low row U-bends supports a low detection threshold for tangent-related PWSCC.

NRC Question No. 4 (non-ARC):

> *"It was indicated that phase-based sizing of several cold leg thinning indications yielded large percent through-wall results when the bobbin voltage amplitude was small. In addition it was indicated that phase based depth sizing of cold leg thinning indications is not reliable below about 1.9 volts because of low signal to noise ratios. Please provide a summary of the technical basis used to size cold leg thinning indications (both above and below 1.9 volts). Please address whether the results of the EPRI qualification are consistent with the Westinghouse analysis. If a cold leg thinning indication measures 1.9 volts and the signal-to-noise ratio is small, please address the noise levels in the tubes at Diablo Canyon. Please discuss whether any cold leg thinning indications have ever been removed for destructive examination."*

PG&E Response:

Westinghouse report SG-SGDA-02-41 referenced in the OA describes a development program for bobbin coil sizing and structural integrity analyses of cold leg thinning indications. Two tubes were pulled from Model 51 SGs for cold leg thinning indications in the early 1980s, one from Prairie Island-2 and one from Salem-1. The pulled tube examination results were used to characterize cold leg thinning indications that were then simulated with machined specimens. These specimens were then used to develop NDE sizing techniques. Test data show that phase sizing for indications <40 percent depth, which corresponds to about 1.9 volts, is subject to significant errors dependent upon the location of the indication in the TSP. The field variations in phase sizing below 1.9 volts were simulated with the laboratory specimens. The depths of these shallow indications can be substantially overestimated particularly when located near the higher noise regions away from the center of the TSP. To overcome this deficiency in phase sizing below about 1.9 volts, the report develops amplitude sizing for these indications and the data support phase sizing about 1.9 volts.

Since the sizing techniques of the Westinghouse report have not yet been implemented in site specific performance demonstrations, the amplitude sizing techniques of EPRI examination technique specification sheet (ETSS) 96001.1 were applied at the 2R11 inspection. This ETSS is based on thinning including indications other than cold leg thinning and does not address the TSP location issues for sizing cold leg thinning, and the sizing results do not reflect this issue. To more reliably assess the structural integrity of the 2R11 cold leg thinning indications, the 1.9 volt threshold of the Westinghouse report was applied to

appropriately exclude indications less than 1.9 volts (expected <40 percent deep) from structural integrity concerns.

Based on a sample of about 25 cold leg thinning locations per SG for the eight DCPP SGs, the average peak to peak noise amplitudes are 0.51 volt near the TSP edge and about 0.38 volt near the TSP center, and the largest amplitudes were 1.46 and 1.05 volt, respectively. Vertical max amplitudes that influence detection had maximum values of 0.43 volt near the edge and 0.32 volt near the center. Signal to noise is not an issue for detection of cold leg thinning indications since detection is very high well below 40 percent depth. The larger peak-to-peak noise amplitudes are an influence on phase sizing below about 1.9 volts peak to peak.

NRC Question No. 5 (non-ARC):

> *"Regarding the tube support plate ligament crack indications (LICs), it was indicated that the signal for several of them was increasing with service time. Please describe what is causing the signals to change and the safety significance of these findings."*

PG&E Response:

It has been previously documented in PG&E's response to GL 97-06 (PG&E Letter DCL-98-046, "90-Day Response to Generic Letter 97-06, "Degradation of Steam Generator Internals," dated March 27, 1998) that the safety function of the TSP is not impaired unless there is a loss of a piece of the plate. Single TSP ligament indications (LICs) do not constitute a missing piece of the plate and, therefore, LIC indications do not have safety significance. Likewise, there is no safety significance of an indication in a tube adjacent to a LIC indication. However, for added conservatism and as previously committed to the NRC, axial indications located at TSP intersections that also have a LIC indication are excluded from ARC.

As noted in DCL-98-046, the majority of TSP ligament indications are traceable to preservice inspection (PSI) bobbin data. There have been cases, such as 2R11, where new TSP ligament indications are detected that are not traceable to PSI data, or that reflect a change over time. TSP denting that occurred in the early operating cycles, the main driving force for potential TSP cracking, has been arrested as previously documented with the NRC. Even with denting being arrested, it cannot be ruled out that TSP ligament signals may change and grow stronger over subsequent operating cycles. PG&E's commitment to detect and monitor TSP ligament indications takes this into account. PG&E has committed to perform Plus Point inspections of 20 percent of the baseline TSP ligament indication population, and to expand the inspection to 100 percent if there is evidence of active service-induced degradation. In 2R11, PG&E increased the Plus Point inspections to include 100 percent of the baseline TSP ligament

indications to ensure all prior indications are monitored. Based on continued monitoring of ligament indications, none of the repeat LIC indications had signals that progressed to a missing piece (gap).

There are only two DCPP Unit 2 TSP indications with a ligament gap. As noted in Enclosure 3 of the 90-day report, the largest measured gap was 86 degrees. This measurement reflects some uncertainty, as the gap could be measured from a minimum of 77 degrees to a maximum of 95 degrees, such that the average is about 86 degrees. This gap size is well below the 146-degree threshold gap for preventive tube repair.

NRC Question No. 6 (non-ARC):

> *"Please clarify what the cold leg anomalies referenced in Table 1 of Enclosure 3 refer to."*

PG&E Response:

Tubesheet anomalies refer to a tube that has a partial tube expansion (PTE), no tube expansion (NTE), or an over-expansion (referred to as a bulge, or BLG). These anomalies occurred during the WEXTEX tube expansion process. In DCPP Unit 2, there are 33 tubesheet anomalies (23 in the hot leg and 10 in the cold leg), of which 28 are PTE and 5 are NTE (there are no BLG in DCPP Unit 2). There are 30 tubesheet anomalies in service in DCPP Unit 2.

NRC Question No. 7 (non-ARC):

> *"It was indicated that the majority of the circumferential indications in the U-bend region were concentrated in a few basic areas of the steam generator tube bundle (Attachment 1 to Enclosure 3). In reviewing Figure 2 of Attachment 1 to Enclosure 3, the staff could not ascertain any pattern with respect to these indications. Please clarify the intent of the statement."*

PG&E Response:

Framatome observed that 8 of the 12 tubes with "high row" PWSCC circumferential indications are located in an area between columns 51 through 68, and that at least one tube in each SG is located in columns 51 to 54, near the center of the bundle. There has been no root cause connection between cracking and tube column, so the intent of Framatome's statement was only an observation.