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

August 21, 2001

PG&E Letter DCL-01-086

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

Docket No. 50-323, OL-DPR-82
Diablo Canyon Unit 2
Special Report 01-04 – 90-Day Report, Results of Steam Generator Alternate Repair Criteria for Diablo Canyon Power Plant Unit 2 Tenth Refueling Outage

Dear Commissioners and Staff:

In accordance with Technical Specifications 5.6.10.e and 5.6.10.f, this Special Report transmits the 90-day steam generator tube alternate repair criteria report for the Unit 2 tenth refueling outage. Enclosure 1 provides the implementation results of Wstar (W*) repair criteria. Enclosure 2 provides the implementation results of voltage-based repair criteria.

Sincerely,

Lawrence F. Womack

cc: Ellis W. Merschoff
David L. Proulx
Girija S. Shukla
State of California
Diablo Distribution

Enclosures

DDM/469

A001

SPECIAL REPORT 01-04

90-DAY REPORT
W* ALTERNATE REPAIR CRITERIA
DIABLO CANYON POWER PLANT UNIT 2 TENTH REFUELING OUTAGE

NRC Reporting Requirements

Diablo Canyon Power Plant (DCPP) Technical Specification (TS) 5.6.10.e requires that the results of the inspection of Wstar (W*) tubes be reported to the Commission pursuant to 10 CFR 50.4 within 90 days following return to service of the steam generators (SGs). The report shall include:

1. Identification of W* tubes. Per TS 5.5.9.d.1.k, a W* tube is a tube left in service with degradation within or below the W* length.

2. W* inspection distance measured with respect to the bottom of the WEXTEX transition (BWT) or the top of tubesheet, whichever is lower.

3. Elevation and length of axial indications within the flexible W* distance and the angle of inclination of clearly skewed axial cracks (if applicable).

4. The total steam line break leakage for the limiting SG per WCAP-14797.

DCPP TS 5.6.10.f requires that the aggregate calculated steam line break leakage from application of all alternate repair criteria (ARC) be reported to the Commission pursuant to 10 CFR 50.4 within 90 days following return to service of the SGs.

W* Inspections and Results

This report implements the DCPP TS reporting criteria. W* ARC was implemented for the second time in DCPP Unit 2 during the tenth refueling outage (2R10). Following inspections and maintenance, the SGs were returned to service on May 22, 2001, upon entry into Mode 4.

One hundred percent of the SG tubes were inspected by bobbin from tube end to tube end, with the exception of rows 1 and 2 U-bends. One hundred percent of the hot leg top of tube sheet (TTS) region was inspected by Plus Point. Cold leg TTS inspections by Plus Point were not required.

Table 1 provides a comprehensive list of axial primary water stress corrosion cracking (PWSCC) indications detected in the WEXTEX region during 2R10 Plus Point inspections. The following TS-required reporting information is extracted from the table:

1. *Identification of W* tubes*. See "W* Tube" column in Table 1. Fifty-eight tubes (containing 68 indications) are categorized as W* tubes and left in service. Only

three new W* tubes were detected in 2R10, one of which was plugged because the axial PWSCC indication did not meet W* ARC because the upper crack tip was located above BWT, after accounting for nondestructive examination (NDE) uncertainty. One circumferential PWSCC indication (not listed) was also detected and plugged because circumferential indications in the W* region are excluded from W* ARC. All W* tubes that had been left in service in 2R9 were also left in service in 2R10.

2. *W* inspection distance measured with respect to BWT or TTS, whichever is lower.* For the 100 percent Plus Point hot leg TTS exam, the inspection extent relative to the TTS was specified as +2/-8 inches. Assuming no degradation in the W* length, 8 inches below the TTS constitutes the W* inspection distance. This distance bounds W* lengths for Zone A and Zone B (5.2 and 7.0 inches, respectively, relative to BWT), and includes margin for a nominal distance from BWT to TTS plus NDE uncertainty in measuring W* length. If degradation is detected in the W* region, the inspection extent must bound the calculated flexible W* length. The "W* Insp Dist" column in Table 1 lists the W* inspection distances measured with respect to BWT for tubes in which axial PWSCC was detected (in all cases, BWT was lower than the TTS).

3. *Elevation and length of axial indications within the flexible W* distance.* See "From," "To," and "L" columns in Table 1 for elevation and length of axial indications.

4. *Angle of inclination of clearly skewed axial cracks (if applicable).* None of the axial indications were skewed, so the angle of inclination was reported as 0 degrees for all axial indications.

5. *The total steam line break leakage for the limiting steam generator per WCAP-14797.* Steam Line Break (SLB) leakage attributed to each W* indication at end of cycle (EOC) 10 (condition monitoring) and projected EOC 11 (operational assessment) are listed in "CM LR" and "OA LR" columns in Table 1. The limiting W* SLB leak rates for condition monitoring and operational assessment are 0.477 gpm and 0.661 gpm, respectively, in SG 2-3 (see Table 2).

Table 2 reports the following SLB leak rates, pursuant to TS 5.6.10.e.4 and 5.6.10.f:

1. *W* ARC SLB leakage for each SG at EOC 10.* The maximum leak rate is 0.477 gpm in SG 2-3.

2. *W* ARC SLB leakage for each SG at EOC 11.* The maximum leak rate is 0.661 gpm for SG 2-3.

3. *Generic Letter (GL) 95-05 voltage based ARC SLB leakage for each SG at EOC 10 and EOC 11.* The maximum EOC 10 leak rate is 1.041 gpm in SG 2-4. The maximum EOC 11 leak rate is 2.852 gpm in SG 2-4.

4. *The aggregate calculated SLB leakage from application of both ARC at EOC 10.* The maximum leak rate is 1.329 gpm in SG 2-4.

5. *The aggregate calculated SLB leakage from application of both ARC at EOC 11.* The maximum leak rate is 3.309 gpm in SG 2-4.

Growth Rates

Based on 2R10 inspections, 67 additional growth rate data points were added to the industry growth distribution for W* region axial PWSCC indications. There are 138 data points in the industry growth distribution. The updated 95 percent cumulative probability growth rate is 0.19 inch per effective full power year (EFPY), slightly lower than the prior rate of 0.21 inch per EFPY.

Insitu Leak Testing

In an effort to validate the leak rate model in WCAP-14797, Revision 1, four W* indications in three tubes were insitu leak tested in 2R10: SG 2-3 R7C52, SG 2-4 R3C5, and SG 2-4 R2C29 (2 indications). All indications were in tubes that had been deplugged in 2R9. The insitu guidelines for selecting indications for leak testing were established in PG&E Letter DCL-01-052, dated May 4, 2001.

Two indications required testing based on exceeding the insitu selection criteria. The peak Plus Point voltage for R2C29 was 4.51 volts, exceeding the 4.0 volt threshold voltage, and the depth profile indicated the flaw was greater than 80 percent deep for a length exceeding 0.1 inch. The peak Plus Point voltage for R7C52 was 3.37 and did not exceed the 4.0 volt threshold, but was among the 5 largest voltages and the depth profile indicated the flaw was greater than 80 percent deep for a length exceeding 0.1 inch.

The peak Plus Point voltage for R3C5 was 1.51 volts and did not exceed the 4.0 volt threshold nor was it in the top 5 voltages, but was insitu tested for discretionary reasons because the depth profile indicated the flaw was greater than 80 percent deep for a length exceeding much greater than 0.1 inch, and the indication was located near the BWT.

The indications were insitu tested full length to normal operating pressure differential. Because they did not leak, the test was terminated at that pressure. Plus Point inspections were performed again and verified that the indications satisfy the W* repair criteria. The indications were returned to service.

Tube Integrity Performance Monitoring

Performance Criteria to Limit Free Span Cracking. The upper crack tip of W* indications returned to service under W* ARC shall remain below the TTS by at least the NDE uncertainty on locating the crack tip relative to the TTS. The "UCT to TSH"

column in Table 1 provides the elevation of the upper crack tip relative to the top of tubesheet, accounting for NDE uncertainty in locating the crack relative to the top of tubesheet. In all cases, the crack tip is below the top of tubesheet. Therefore, the performance criteria were satisfied for condition monitoring at EOC 10.

Accident-Induced Leakage Performance Criteria. Calculated W* leak rates under postulated SLB conditions, when combined with calculated leak rates from application of GL 95-05 voltage-based ARC, shall not exceed 12.8 gpm (at room temperature) in the faulted SG for condition monitoring and operational assessment. Based on Table 2, the aggregate calculated SLB leakage from application of both ARC at EOC 10 and EOC 11 for the limiting SG is much less than the allowable limit of 12.8 gpm for a faulted SG. Therefore, the performance criteria were satisfied for condition monitoring at EOC 10 and operational assessment at EOC 11.

Table 1
DCPP Unit 2 - 2R10 Axial PWSCC Indications in Hot Leg WEXTEX Region

SG	R	C	IND	PP Volts	From	To	L	UCT to TSH	W* Zone	W* L	BWT	UCT to BWT	UCT Below W*	UCT below BWT	EOC 11 UCT	UCT below TSH at EOC 11	W* Tube	Insp Ext	W* Insp Dist	Flex W* L	CM LR	EOC 11 UCT-BWT	OA LR	LIS 2R9	Deplug 2R9	Plug 2R10
2-1	7	24	SAI	0.26	-1.92	-1.78	0.14	-1.56	B3	7.12	-0.25	1.25	No	Yes	-1.22	Yes	Yes	-9.77	9.43	7.46	0.015	-1.00	0.018	YES	YES	
2-1	8	32	SAI	0.48	-1.75	-1.62	0.13	-1.4	B2	7.12	-0.25	1.09	No	Yes	-1.06	Yes	Yes	-9.94	9.6	7.45	0.017	-0.84	0.021	YES	-	
2-1	15	32	SAI	0.4	-0.46	-0.35	0.11	-0.13	B2	7.12	-0.4	-0.33	No	No	0.21	No	No	-9.73	9.24	7.43	0.045	0.58	0.000	-	-	Yes
2-1	11	37	SAI-1	0.55	-7.34	-7.2	0.14	-6.98	B2	7.12	-0.33	6.59	No	Yes	-6.64	Yes	Yes	-9.56	9.14	7.86	0.000	-6.34	0.000	YES	-	
2-1	11	37	SAI-2	0.74	-6.45	-6.29	0.16	-6.07	B2	7.12	-0.33	5.68	No	Yes	-5.73	Yes	Yes	-9.56	9.14	7.86	0.001	-5.43	0.001	YES	-	
2-1	11	37	SAI-3	0.4	-1.85	-1.61	0.24	-1.39	B2	7.12	-0.33	1	No	Yes	-1.05	Yes	Yes	-9.56	9.14	7.86	0.018	-0.75	0.023	YES	-	
2-1	11	39	SAI	1.55	-1.5	-1.37	0.13	-1.15	B1	7.12	-0.33	0.76	No	Yes	-0.81	Yes	Yes	-9.26	8.84	7.45	0.022	-0.51	0.028	YES	YES	
2-1	11	40	SAI	0.48	-0.94	-0.79	0.15	-0.57	B1	7.12	-0.31	0.2	No	Yes	-0.23	Yes	Yes	-8.85	8.45	7.47	0.038	0.05	0.045	YES	-	
2-1	11	48	SAI	1.68	-5.05	-4.67	0.38	-4.45	B1	7.12	-0.36	4.03	No	Yes	-4.11	Yes	Yes	-10.14	9.69	7.70	0.005	-3.78	0.005	YES	-	
2-1	9	49	SAI	0.32	-2.04	-1.9	0.14	-1.68	B1	7.12	-0.32	1.3	No	Yes	-1.34	Yes	Yes	-10.39	9.98	7.46	0.015	-1.05	0.018	-	-	
2-1	3	59	SAI	4.67	-1.41	-0.81	0.6	-0.59	B1	7.12	-0.36	0.17	No	Yes	-0.25	Yes	Yes	-9.82	9.37	7.92	0.039	0.08	0.045	YES	YES	
2-1	7	62	SAI	4.08	-2.13	-1.53	0.6	-1.31	B2	7.12	-1.06	0.19	No	Yes	-0.97	Yes	Yes	-21.4	20.25	7.92	0.038	0.06	0.045	YES	YES	
2-1	23	70	SAI	1.03	-1.58	-1.23	0.35	-1.01	A	5.32	-0.13	0.82	No	Yes	-0.67	Yes	Yes	-9.1	8.88	5.87	0.016	-0.57	0.026	YES	YES	
2-1	6	77	SAI	1.21	-1.36	-1.17	0.19	-0.95	B4	7.12	-0.4	0.49	No	Yes	-0.61	Yes	Yes	-9.47	8.98	7.51	0.028	-0.24	0.037	YES	YES	
2-2	28	15	SAI-1	2.95	-20.1	-18.6	1.47	-18.38	A	5.32	-0.36	17.96	Yes	Yes	-18.04	Yes	Yes	-21.4	20.95	N/A	0.000	-17.71	0.000	YES	YES	
2-2	28	15	SAI-2	3.95	-20	-18.64	1.36	-18.42	A	5.32	-0.36	18	Yes	Yes	-18.08	Yes	Yes	-21.4	20.95	N/A	0.000	-17.75	0.000	YES	YES	
2-2	28	15	SAI-3	0.67	-10.7	-10.55	0.16	-10.33	A	5.32	-0.36	9.91	Yes	Yes	-9.99	Yes	Yes	-21.4	20.95	N/A	0.000	-9.66	0.000	YES	YES	
2-2	28	15	SAI-4	0.69	-2.49	-2.34	0.15	-2.12	A	5.32	-0.36	1.7	No	Yes	-1.78	Yes	Yes	-9.86	9.41	5.52	0.005	-1.45	0.007	YES	YES	
2-2	28	15	SAI-5	0.69	-2.08	-1.84	0.24	-1.62	A	5.32	-0.36	1.2	No	Yes	-1.28	Yes	Yes	-9.86	9.41	5.52	0.008	-0.95	0.012	YES	YES	
2-2	5	18	SAI	0.56	-1.16	-0.95	0.21	-0.73	B4	7.12	-0.28	0.39	No	Yes	-0.39	Yes	Yes	-10.59	10.22	7.53	0.031	-0.14	0.042	YES	-	
2-2	31	25	SAI	3.82	-2.01	-1.52	0.49	-1.3	A	5.32	-0.5	0.74	No	Yes	-0.96	Yes	Yes	-9.29	8.7	6.01	0.019	-0.49	0.029	YES	YES	
2-2	13	43	SAI	1.21	-1.43	-1.26	0.17	-1.04	B1	7.12	-0.36	0.62	No	Yes	-0.70	Yes	Yes	-9.48	9.03	7.49	0.024	-0.37	0.032	YES	YES	
2-2	10	48	SAI	0.53	-2.97	-2.84	0.13	-2.62	B1	7.12	-0.21	2.35	No	Yes	-2.28	Yes	Yes	-9.08	8.78	7.45	0.009	-2.10	0.009	YES	-	
2-2	10	56	SAI	1.01	-1.04	-0.90	0.14	-0.68	B1	7.12	-0.41	0.21	No	Yes	-0.34	Yes	Yes	-9.02	8.52	7.46	0.037	0.04	0.045	YES	YES	
2-3	28	12	SAI	1.5	-2.24	-1.84	0.4	-1.62	A	5.32	-0.57	0.99	No	Yes	-1.28	Yes	Yes	-9.74	9.08	5.92	0.009	-0.74	0.020	YES	-	
2-3	14	24	SAI	0.5	-1.94	-1.80	0.14	-1.58	B4	7.12	-0.17	1.35	No	Yes	-1.24	Yes	Yes	-8.82	8.56	7.46	0.009	-1.10	0.013	YES	YES	
2-3	16	24	SAI	0.29	-1.45	-1.30	0.15	-1.08	B4	7.12	-0.2	0.82	No	Yes	-0.74	Yes	Yes	-9.24	8.95	7.47	0.019	-0.57	0.026	YES	YES	
2-3	25	37	SAI	2.09	-1.68	-1.20	0.48	-0.98	B4	7.12	-0.38	0.54	No	Yes	-0.64	Yes	Yes	-9.21	8.74	7.80	0.026	-0.29	0.035	YES	YES	
2-3	45	37	SAI	1.55	-1.8	-1.51	0.29	-1.29	A	5.32	-0.24	0.99	No	Yes	-0.95	Yes	Yes	-10.7	10.37	5.81	0.009	-0.74	0.020	YES	YES	
2-3	21	38	SAI	1.13	-1.62	-1.12	0.5	-0.9	B3	7.12	-0.45	0.39	No	Yes	-0.56	Yes	Yes	-9.64	9.1	7.82	0.031	-0.14	0.042	YES	YES	
2-3	12	48	SAI	0.38	-2.22	-2.08	0.14	-1.86	B1	7.12	-0.38	1.42	No	Yes	-1.52	Yes	Yes	-8.65	8.18	7.46	0.014	-1.17	0.017	YES	YES	
2-3	5	51	SAI	0.39	-2.1	-1.97	0.13	-1.75	B1	7.12	-0.29	1.40	No	Yes	-1.41	Yes	Yes	-9.38	9	7.45	0.014	-1.15	0.017	YES	YES	
2-3	7	52	SAI	3.9	-1.32	-0.77	0.55	-0.55	B1	7.12	-0.21	0.28	No	Yes	-0.21	Yes	Yes	-8.88	8.58	7.87	0.000	-0.03	0.045	YES	YES	

SG	R	C	IND	PP Volts	From	To	L	UCT to TSH	W* Zone	W* L	BWT	UCT to BWT	UCT Below W*	UCT below BWT	EOC 11 UCT	UCT below TSH at EOC 11	W* Tube	Insp Ext	W* Insp Dist	Flex W* L	CM LR	EOC 11 UCT-BWT	OA LR	LIS 2R9	Deplug 2R9	Plug 2R10
2-3	5	55	SAI	0.78	-2.14	-1.96	0.18	-1.74	B1	7.12	-0.17	1.51	No	Yes	-1.40	Yes	Yes	-9.41	9.15	7.50	0.013	-1.26	0.016	YES	-	
2-3	32	55	SAI	0.97	-0.98	-0.74	0.24	-0.52	A	5.32	-0.36	0.10	No	Yes	-0.18	Yes	Yes	-9.81	9.36	5.76	0.042	0.15	0.045	YES	YES	
2-3	7	59	SAI	1.44	-1.64	-1.28	0.36	-1.06	B1	7.12	-0.27	0.73	No	Yes	-0.72	Yes	Yes	-8.81	8.45	7.68	0.023	-0.48	0.029	YES	YES	
2-3	9	63	SAI	0.4	-1.19	-1.06	0.13	-0.84	B2	7.12	-0.31	0.47	No	Yes	-0.50	Yes	Yes	-8.69	8.29	7.45	0.027	-0.22	0.038	-	-	
2-3	3	69	SAI	0.55	-1.05	-0.90	0.15	-0.68	B2	7.12	-0.27	0.35	No	Yes	-0.34	Yes	Yes	-9	8.64	7.47	0.032	-0.10	0.043	YES	-	
2-3	19	71	SAI	1.28	-2.1	-1.78	0.32	-1.56	A	5.32	-0.25	1.25	No	Yes	-1.22	Yes	Yes	-9.73	9.39	5.84	0.008	-1.00	0.010	YES	YES	
2-3	17	72	SAI	1.83	-0.96	-0.60	0.36	-0.38	A	5.32	-0.23	0.09	No	Yes	-0.04	Yes	Yes	-9.74	9.42	5.88	0.042	0.16	0.045	YES	YES	
2-3	6	77	SAI	0.35	-1.71	-1.63	0.08	-1.41	B4	7.12	-0.28	1.07	No	Yes	-1.07	Yes	Yes	-9.75	9.38	7.40	0.013	-0.82	0.019	YES	YES	
2-3	21	83	SAI	1.32	-1.11	-0.85	0.26	-0.63	A	5.32	-0.23	0.34	No	Yes	-0.29	Yes	Yes	-9.49	9.17	5.78	0.032	-0.09	0.043	YES	YES	
2-3	2	91	SAI	0.63	-0.84	-0.61	0.23	-0.39	A	5.32	-0.19	0.14	No	Yes	-0.05	Yes	Yes	-8.79	8.51	5.75	0.040	0.11	0.045	YES	YES	
2-3	7	92	SAI	1	-0.88	-0.69	0.19	-0.47	A	5.32	-0.19	0.22	No	Yes	-0.13	Yes	Yes	-8.78	8.5	5.71	0.037	0.03	0.045	YES	YES	
2-3	8	93	SAI	1.38	-0.81	-0.59	0.22	-0.37	A	5.32	-0.11	0.20	No	Yes	-0.03	Yes	Yes	-9.26	9.06	5.74	0.038	0.05	0.045	YES	YES	
2-4	7	4	SAI	0.87	-1.26	-1.09	0.17	-0.87	A	5.32	-0.24	0.57	No	Yes	-0.53	Yes	Yes	-8.69	8.36	5.69	0.025	-0.32	0.034	YES	YES	
2-4	13	4	SAI	0.39	-1.35	-1.23	0.12	-1.01	A	5.32	-0.27	0.68	No	Yes	-0.67	Yes	Yes	-8.39	8.03	5.64	0.021	-0.43	0.030	YES	-	
2-4	3	5	SAI	1.51	-1.53	-0.81	0.72	-0.59	A	5.32	-0.26	0.27	No	Yes	-0.25	Yes	Yes	-8.61	8.26	6.24	0.000	-0.02	0.045	YES	YES	
2-4	2	10	SAI	0.56	-1.38	-1.28	0.1	-1.06	A	5.32	-0.13	0.87	No	Yes	-0.72	Yes	Yes	-8.44	8.22	5.62	0.014	-0.62	0.025	YES	YES	
2-4	15	10	SAI	0.42	-0.9	-0.73	0.17	-0.51	A	5.32	-0.22	0.23	No	Yes	-0.17	Yes	Yes	-8.35	8.04	5.69	0.036	0.02	0.045	YES	YES	
2-4	16	10	SAI	1.98	-2.16	-1.82	0.34	-1.6	A	5.32	-0.11	1.43	No	Yes	-1.26	Yes	Yes	-8.41	8.21	5.86	0.006	-1.18	0.008	YES	YES	
2-4	3	12	SAI-1	0.54	-2.64	-2.52	0.12	-2.3	A	5.32	-0.29	1.95	No	Yes	-1.96	Yes	Yes	-8.12	7.74	5.86	0.004	-1.70	0.005	YES	YES	
2-4	3	12	SAI-2	1.07	-2.32	-2.1	0.22	-1.88	A	5.32	-0.29	1.53	No	Yes	-1.54	Yes	Yes	-8.12	7.74	5.86	0.006	-1.28	0.008	YES	YES	
2-4	24	26	SAI	0.55	-1.85	-1.66	0.19	-1.44	A	5.32	-0.31	1.07	No	Yes	-1.10	Yes	Yes	-9.44	9.04	5.71	0.009	-0.82	0.017	YES	-	
2-4	2	29	SAI-1	4.45	-4.37	-3.42	0.95	-3.2	B2	7.12	-0.26	2.88	No	Yes	-2.86	Yes	Yes	-10.23	9.88	8.53	0.000	-2.63	0.007	YES	YES	
2-4	2	29	SAI-2	0.94	-2	-1.74	0.26	-1.52	B2	7.12	-0.26	1.2	No	Yes	-1.18	Yes	Yes	-10.23	9.88	8.53	0.000	-0.95	0.015	YES	YES	
2-4	6	33	SAI	0.72	-2.51	-2.36	0.15	-2.14	B2	7.12	-0.35	1.73	No	Yes	-1.80	Yes	Yes	-8.3	7.86	7.47	0.011	-1.48	0.013	YES	-	
2-4	4	35	SAI	0.99	-1.69	-1.46	0.23	-1.24	B1	7.12	-0.26	0.92	No	Yes	-0.90	Yes	Yes	-9.52	9.17	7.55	0.020	-0.67	0.024	YES	YES	
2-4	5	36	SAI	0.3	-1.96	-1.8	0.16	-1.58	B1	7.12	-0.11	1.41	No	Yes	-1.24	Yes	Yes	-8.86	8.66	7.48	0.014	-1.16	0.017	YES	-	
2-4	5	37	SAI-1	0.26	-4.18	-4.03	0.15	-3.81	B1	7.12	-0.28	3.47	No	Yes	-3.47	Yes	Yes	-8.71	8.34	7.84	0.006	-3.22	0.007	YES	YES	
2-4	5	37	SAI-2	1.38	-3.98	-3.61	0.37	-3.39	B1	7.12	-0.28	3.05	No	Yes	-3.05	Yes	Yes	-8.71	8.34	7.84	0.007	-2.80	0.008	YES	YES	
2-4	7	38	SAI-1	2.43	-7.04	-6.72	0.32	-6.5	B1	7.12	-0.4	6.04	No	Yes	-6.16	Yes	Yes	-8.67	8.18	8.24	0.000	-5.79	0.001	YES	YES	
2-4	7	38	SAI-2	1.69	-4.62	-4.02	0.6	-3.8	B1	7.12	-0.4	3.34	No	Yes	-3.46	Yes	Yes	-8.67	8.18	8.24	0.006	-3.09	0.007	YES	YES	
2-4	13	40	SAI	1.19	-1.69	-1.45	0.24	-1.23	B2	7.12	-0.27	0.9	No	Yes	-0.89	Yes	Yes	-8.77	8.41	7.56	0.020	-0.65	0.029	YES	YES	
2-4	26	45	SAI	0.91	-3.42	-3.27	0.15	-3.05	B4	7.12	-0.32	2.67	No	Yes	-2.71	Yes	Yes	-8.19	7.78	7.47	0.004	-2.42	0.004	YES	-	
2-4	31	45	SAI	1.38	-1.98	-1.71	0.27	-1.49	A	5.32	-0.35	1.08	No	Yes	-1.15	Yes	Yes	-9.17	8.73	5.79	0.009	-0.83	0.017	YES	YES	
2-4	20	47	SAI	1.29	-1.63	-1.32	0.31	-1.1	B2	7.12	-0.33	0.71	No	Yes	-0.76	Yes	Yes	-8.81	8.39	7.63	0.023	-0.46	0.029	YES	YES	
2-4	5	53	SAI	1.37	-1.97	-1.69	0.28	-1.47	B1	7.12	-0.46	0.95	No	Yes	-1.13	Yes	Yes	-9.51	8.96	7.60	0.019	-0.70	0.023	YES	-	
2-4	25	64	SAI	1.63	-1.3	-1.02	0.28	-0.8	B4	7.12	-0.24	0.5	No	Yes	-0.46	Yes	Yes	-8.77	8.44	7.60	0.027	-0.25	0.037	YES	YES	

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. Some tubes have multiple non-parallel SAI.
PP Volts	Peak voltage from Plus Point coil..
From - To	Elevation (inch) of lower crack tip (from) to upper crack tip (to), relative to the hot leg top of tubesheet (TSH).
L	Length of crack (inch)
UCT to TSH	Elevation (inch) of the upper crack tip (UCT) relative to TSH, including $\Delta NDE_{CT\text{-}TTS}$ (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 based on W* Zone, plus ΔNDE_W (NDE uncertainty in measuring the W* depth).
BWT	Bottom of the WEXTEX transition (inch), measured by bobbin relative to TSH.
UCT to BWT	Distance (inch) from the upper crack tip (UCT) to BWT, minus $\Delta NDE_{CT\text{-}BWT}$ (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 11, based on growing the UCT at 0.21 inch/EFPY. Unit 2 Cycle 11 is projected to be 1.61 EFPY.
UCT below TSH at EOC 11	If the UCT is below TSH at EOC 11, a free span indication is precluded and the tube is a W* candidate.
W* Tube	If the UCT is below BWT and the UCT is below TSH at EOC 11, then the tube is a W* tube. If the UCT is located below the W* length, 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, 0.21 inch/EFPY)
CM LR	Condition monitoring SLB leak rate at EOC 10 conditions, gpm at room temperature, using Figure 6.4-3 of WCAP-14797 Rev 1, based on distance of UCT to BWT. No accident leakage is assigned to indications with UCT below the W* length. No accident leakage is assigned to indications that were insitu leak tested and no leakage was detected.
EOC 11 UCT to BWT	Distance of UCT to BWT (inch) at EOC 11 for operational assessment, based on growing the UCT at the latest updated industry combined 95 percent growth rate (0.19 inch/EFPY).
OA LR	Operational assessment leak rate at EOC 11 conditions, gpm at room temperature, using Figure 6.4-3 of WCAP-14797 Rev 1, based on distance of projected UCT (at EOC 11) to BWT.
LIS 2R9	Indication had been left in service in 2R9.
Deplug 2R9	Tube had been deplugged in 2R9.
Plug 2R10	Tube was plugged in 2R10.

Table 2

DCPP Unit 2 Steam Line Break Leak Rates for Alternate Repair Criteria

EOC 10 Condition Monitoring Leak Rate (gpm at room temperature)	SG 2-1	SG 2-2	SG 2-3	SG 2-4
W* ARC	0.297	0.133	0.477	0.288
Voltage-Based ARC	0.150	0.055	0.124	1.041
Aggregate ARC	0.447	0.188	0.601	1.329

EOC 11 Operational Assessment Leak Rate (gpm at room temperature)	SG 2-1	SG 2-2	SG 2-3	SG 2-4
W* ARC	0.314	0.176	0.661	0.457
Voltage-Based ARC	0.617	0.344	0.353	2.852 (1)
Aggregate ARC	0.931	0.520	1.014	3.309

Note 1: SG 2-4 leak rate of 2.852 gpm was calculated using a normal growth rate distribution. Using a more conservative voltage-dependent growth rate distribution, leak rate of 3.730 gpm was calculated for SG 2-4.

SPECIAL REPORT 01-04

90-DAY REPORT
GENERIC LETTER 95-05 VOLTAGE-BASED REPAIR CRITERIA
DIABLO CANYON POWER PLANT
UNIT 2 TENTH REFUELING OUTAGE

FRAMATOME ANP

CALCULATION SUMMARY SHEET (CSS)

Document Identifier: 86 - 5013685 - 01

Title: DCPP Unit 2 - 2R10 90 Day ARC Calculations

PREPARED BY:		REVIEWED BY:	
		METHOD: ☒ DETAILED CHECK ☐ INDEPENDENT CALCULATION	
NAME	Victor F Newman	NAME	Alan M Brown
SIGNATURE		SIGNATURE	
TITLE	Engineer IV	TITLE	Engineer IV
DATE	8/15/01	DATE	8/15/01
COST CENTER	12742	REF. PAGE(S)	62-63
		TM STATEMENT: REVIEWER INDEPENDENCE	AMB for JMF

PURPOSE AND SUMMARY OF RESULTS:

This report provides the results of the Diablo Canyon Unit 2 May 2001 Outage (2R10) with respect to (1) the eddy current inspection of the steam generator tubes at TSP intersections and (2) the implementation of the Alternate Repair Criteria (ARC) as specified in Generic Letter 95-05 for ODSCC at TSP intersections in Westinghouse-designed steam generators with drilled supports and alloy 600 tubing. This summary also provides the projected EOC-11 probability of burst and leak rate tube integrity calculations as required for ARC implementation.

Note that this is the non-proprietary version of the 90 Day summary report contained in Ref. 24.

THE FOLLOWING COMPUTER CODES HAVE BEEN USED IN THIS DOCUMENT:		THE DOCUMENT CONTAINS ASSUMPTIONS THAT MUST BE VERIFIED PRIOR TO USE ON SAFETY-RELATED WORK
CODE/VERSION/REV	CODE/VERSION/REV	
Burst97 Simulation/1.0/01		☐ YES ☒ NO
Leaker97 Simulation/1.0/00		

RECORD OF REVISIONS

Revision Number	Affected Page(s)	Description of Change(s)
0	All	Original Release
1	35	Removed Section 4.1 in Rev. 0
	59	Added SG 2-4 specific growth distribution
	9	Added reasons for using SG 2-4 growth distribution
	6	Section 2.0; changed 864 to 862, added sentence regarding AONDB indications
	10	Section 3.3; removed text in 2nd paragraph
	6, 7, 8, 11, & 63	Miscellaneous editorial changes

TABLE OF CONTENTS

LIST OF TABLES

Glossary of Acronyms

Term	Definition
AONDB	Axial ODSCC Not Detected by Bobbin
ARC	Alternate Repair Criteria
BOC	Beginning of Cycle
CPDF	Cumulative Probability Distribution Function
CFR	Code of Federal Regulations
CLT	Cold-Leg Thinning
DCPP	Diablo Canyon Power Plant
DIS	Distorted ID Support Signal with possible Indication
DOS	Distorted OD Support Signal with possible Indication
DNF	Degradation Not Found
EFPD	Effective Full Power Day
EFPY	Effective Full Power Year
ECT	Eddy Current Test
EOC	End of Cycle
FS	Free Span
FRA-ANP	Framatome Advanced Nuclear Power
GL	NRC Generic Letter 95-05
GPM	Gallons per Minute
ISI	In-service Inspection
LRL	Lower Repair Limit
MSLB	Main Steam Line Break
NDE	Non Destructive Examination
NDD	No Degradation Detected
NRC	Nuclear Regulatory Commission
ODSCC	Outside Diameter Stress Corrosion Cracking
PG&E	Pacific Gas and Electric Company
POB	Probability of Burst
POD	Probability of Detection
POPCD	Probability of Prior Cycle Detection
POL	Probability of Leak
PWSCC	Primary Water Stress Corrosion Cracking
RPC	Rotating Pancake Coil
RSS	Retest Support Plate Signal
RTS	Return to Service
SG	Steam Generator
SER	Safety Evaluation Report
TS	Technical Specification
TSP	Tube Support Plate
WEXTEX	Westinghouse Explosive Tubesheet Expansion
+Point	Plus Point Coil

1.0 Introduction

The Diablo Canyon Power Plant (DCPP) Unit 2 completed the tenth cycle of operation and subsequent steam generator ISI in May 2001. The unit employs four Westinghouse-designed Model 51 SGs with 7/8-inch OD mill annealed alloy 600 tubing and ¾-inch carbon steel drilled-hole tube support plates.

In accordance with the Generic Letter 95-05, ARC implementation requires a pre-startup assessment (Ref. 1) and a 90-day post-startup tube integrity assessment. The NRC Generic Letter 95-05, Ref. 2, outlines an alternate repair criteria (ARC) for allowing tubes containing ODSCC indications to remain in service if the indications are contained within the TSP structure and the measured Bobbin voltage is $\leq$2.0 volts. A complete list of exclusion criteria is provided in section 1.b of Ref. 2 and in Ref. 3. The NRC has approved implementation of the voltage-based repair criteria at both DCPP units per Ref. 3. The steam generator TSP ISI results and the postulated MSLB leak rate and tube burst probabilities are summarized in this report. FRA-ANP uses Monte Carlo codes, as described in Refs. 4 and 5, to provide the burst and leak rate analysis simulations. These evaluations are based on the methods in Ref. 6, as well as previous 90-day reports (Refs. 7 - 10). The correlation parameters used in the simulation are taken from the EPRI ODSCC ARC Addendum 3 Updated Database (Ref. 13) for burst correlations and Addendum 2 Updated Database (Ref. 20) for leak rate correlations as reviewed in Section 4 of this report.

2.0 Executive Summary

Based on the number of indications and the size of the indications, SG 2-4 is predicted to be the limiting generator for Diablo Canyon Unit 2 at the end of Cycle 11. During Cycle 10, SG 2-4 started experiencing voltage dependent growth, where the larger indications were growing faster as measured by voltage. Of the 115 plus point inspections, 100 were confirmed yielding an overall confirmation rate of about 87%. Based on the plus point confirmation rate, approximately 687 tubes were saved by the implementation of the ARC during 2R10.

The EOC-11 leak rate correlations used were based on the latest NRC approved database for 7/8" tubing (Ref. 13). Both NRC mandated constant 0.6 POD and the voltage dependent distribution POPCD were considered. The results of POPCD are provided in Section 6 of this document. The limiting EOC-11 SLB leak rates (SG 2-4) predicted with constant POD were 2.85 gpm (Normal growth) and 3.73 gpm (voltage dependent growth), where both predictions meet the limit of 12.8 gpm for a full cycle of operation. The tube burst probabilities with constant POD for the limiting generator (SG 2-4) were 1.30×10^{-3} (normal growth) and 3.66×10^{-3} (voltage dependent growth), which is well below the NRC reporting guideline of 1.0×10^{-2}.

A total of 862 indications were found in the EOC-10 inspection, of which 148 were over 1 volt, 22 were over 2 volts, and 3 exceeded the upper repair limit of 4.9 volts. All indications over 2 volts were confirmed by plus point inspection and repaired by plugging. Two additional indications were identified as AONDB (axial ODSCC not detected by bobbin).

The EOC-10 projections were approximately equivalent to the actual as-found conditions of the SGs. SG 2-3 and SG 2-4 experienced voltage dependent growth over the previous cycle;

however, it was not significant enough to invalidate the previous 90-day report projections. Refer to Section 5.5 for further details.

3.0 EOC-10 Inspection Results and Voltage Growth Rates

3.1 EOC-10 Inspection Results

The DCPP 2R10 bobbin coil inspection consisted of a 100% complete full-length bobbin coil examination of tubes in all four steam generators except Rows 1 and 2 U-bends. 720 replaceable feet bobbin probes were used for the straight length examinations including all TSP intersections in the hot and cold legs. Special interest plus point examinations were conducted as follows in support of the voltage-based ARC.

- 100% of DOSs greater than 2 volts (as identified in Ref. 12)
- 100% of DOSs in dented intersections (Ref. 12)
- 100% of DISs
- Dent examinations per Ref. 12.
- Other Special Interest or test programs that may test TSP intersections per Ref. 12.

Based upon the 100% bobbin inspection of all steam generators, a total of 862 DOS indications were identified. The results of the inspections are summarized as follows:

1. Table 3-1 lists the DOS indications that were above the LRL (2.0 volts). Each of the indications was confirmed as ODSCC and was repaired by plugging.

2. 2 circumferential ODSCC indications were detected at support plates containing dents >5 volts in SG 2-2.

3. Table 3-2 lists the indications that were identified as AONDB (axial ODSCC not detected by bobbin). These indications have axial ODSCC but with no indication of a bobbin DOS signal. One of the indications was called DIS and the other was NDD by bobbin. These locations are typically smaller voltage ODSCC, by plus point, and are accompanied by a dent that masks the bobbin voltage. Per Refs. 12 and 13, a methodology has been developed to assign a bobbin voltage based on a correlation to the plus point voltage. Once the calculated voltages are obtained, the locations are subjected to the same exclusion criteria as the DOS population.

4. 5 DOS indications were detected in the cold leg thinning (CLT) region. These indications were inspected with plus point and confirmed as CLT. They were not included in the DOS analysis pool.

5. Overall, 38 DOS indications in 28 tubes were repaired.

A summary of the ECT results for TSP indications is provided in Table 3-3. Table 3-3 summarizes the voltage distributions for the as-found condition of the indications, the repaired indications, the indications returned to service that were either confirmed by plus point or not inspected with plus point, and finally, the indications returned to service. Table 3-3 clearly illustrates that steam generator 2-4 is the limiting generator based on the number of indications and the number of large indications. Over 50% of the indications removed from service exceeded the 2 volt repair criteria; others were plugged due to exclusion criteria. The plus point inspections required for DOS indications were accomplished as a part of the special interest exams. The 2R10 inspection scope also included a scheduled number of dents based on the current inspection results as noted in the degradation assessment (Ref. 12). 115 plus point inspections were performed where DOS indications were called by bobbin, i.e., excluding the AONDB intersections. Of the inspections, 100 were confirmed yielding an overall confirmation rate of about 87%. Based on the plus point confirmation rate, approximately 687 tubes were saved by the implementation of the ARC during 2R10.

Figure 3-1 and Figure 3-2 show the actual bobbin voltage distribution for all tubes that were in service during Cycle 10. Figure 3-3 and Figure 3-4 show the indications removed from service at EOC-10. Notice that the largest number of indications removed from service were in SG 2-4; thus, further supporting the conclusion that SG 2-4 is the limiting generator. Figure 3-5 and Figure 3-6 illustrate all the indications returned to service following the EOC-10 ECT inspection. Note that a large number of >1 volt indications are being returned to service in SG 2-4. Table 3-4 summarizes the largest voltage indications, as well as indications that experienced the largest growth over the previous cycle of operation. Table 3-4 illustrates that all the ≥ 2 volt indications were present during the previous cycle; however, these indications also have the largest growth rates for all SGs. Voltage dependent growth will be explored further in the growth section of this report.

A summary of the ECT voltages and growth by TSP is provided in Table 3-5 and Figure 3-7. As shown, the ODSCC mechanism is most active at the lower TSPs with minimal interaction at the 6th TSP and no interaction at the 7th TSP. The largest maximum growth also occurs at the 1st and 2nd TSPs. This distribution indicates a temperature dependence of ODSCC at Diablo Canyon Unit 2.

3.2 Voltage Growth Rates

For projection of leak rates and tube burst probabilities at the end of Cycle 11 operations, voltage growth rates were developed from the EOC-10 inspection data. For indications not reported during the EOC-9 inspection (i.e. new at EOC-10), the indications were sized using the EOC-9 ECT signals based on a lookup review. Table 3-5 provides the maximum and average voltage growth distribution by TSP. Table 3-6 shows the voltage growth distributions for each SG and the composite for all four SGs. The cumulative probability distribution function is also provided here. For the tube integrity calculations, the negative growth values were included as zero growth rates as required by Generic Letter 95-05. Reviewing the average and maximum voltage growth for all indications for each SG does not indicate any significant differences; however, reviewing the growth distribution for each SG in Figure 3-8 and Figure 3-9 indicates that SG 2-4 has significantly more indications. Also, using Figure 3-9, the growth distribution appears to be shifted further to the right for SG 2-4 and the tail of the distribution almost reaches 3 volts/EFPY.

To determine if these differences were due to voltage dependent growth, the growth rate was plotted against the BOC voltage for all SGs. This data for SG 2-1 and SG 2-2 is shown in Figure 3-10. This data for SG 2-3 and SG 2-4 is shown in Figure 3-11. Notice that the growth rate does significantly change for indications with a BOC voltage greater than one volt in SG 2-4. It is difficult to determine conclusively if SG 2-3 is experiencing the same type of voltage dependent growth rate given the small number of data points greater than one volt. Figure 3-12 shows the cumulative probability distribution functions for SG 2-4. Figure 3-13 illustrates the CPDF for all SGs. Table 3-7 and Table 3-8 summarize the voltage dependent growth distribution for all SGs as well as the CPDFs. For the voltage dependent growth, two different growth distributions were determined (one distribution for indications <= 1.00 volt and another distribution for indications > 1.00 volt). The 1 volt criterion was selected based on the guidance in Reference 20. Reference 20 states that the largest growth bin should be limited to about 50 indications. Using the > 1 volt criterion gives 42 indications in the growth distribution for SG 2-4 and 53 indications in the composite growth distribution. A composite growth distribution was used for SG 2-3 because SG 2-3 has less then 200 indications.

For the EOC-11 leak rate and probability of burst projections, the composite normal growth rate was used for SG 2-1, SG 2-2, and SG 2-3. A SG 2-4 specific normal growth distribution was used for SG 2-4 because the SG 2-4 growth distribution was limiting and SG 2-4 had more than 200 data points. In addition, a composite voltage dependent growth rate was used for SG 2-3 and SG 2-4 specific voltage dependent growth rate was used for SG 2-4.

To confirm that indications in the tubes deplugged at EOC-9 are growing similarly, the growth rates for EOC-9 deplugged tubes and EOC-9 in-service tubes were calculated separately and compared. The results for each SG are presented in Figure 3-14, Figure 3-15, Figure 3-16, and Figure 3-17. Figure 3-18 shows the CDPF for all deplugged tubes and all in-service tubes. There are no significant differences between deplugged tubes and in-service tubes.

Since DCPP-2 has more than the required minimum of 200 indications in its Cycle 10 active tube growth rate distribution, plant-specific growth rate can be used in lieu of the conservative industry bounding growth rate distribution. The cumulative probability distribution function (CPDF) for the five DCPP cycles in which voltage-based ARC was implemented are shown in Figure 3-19. This figure also shows the industry bounding growth distribution. Per the Generic Letter, the most limiting growth distribution from the two previous cycles should be used. Figure 3-19 shows that the U2-C10 growth distributions bounds the U2-C9 distribution. Therefore, the Cycle 10 growth distribution was used for the leakage and burst analysis.

3.3 Probe Wear Criteria

The first NRC requirement regarding probe wear is to minimize the potential for tubes to be inspected with a probe that had failed the probe wear check. This was accomplished by implementing ETSS #1 (Ref. 14) which required the probe have its feet replaced when failing the probe wear check, or in the case of non-changeable feet probes, the probe discarded.

If the DOS voltage is at the retest threshold (1.5 volts or higher) and the Cal is designated as "ARC Out" on the cal board, the indication code is changed from a DOS to a RSS (retest support plate signal). No new indications were detected in the tubes when inspected with the new probe.

The 2R10 eddy current inspection resulted in 25 bobbin indications in excess of 1.5 volts that were inspected with a worn probe. Those indications are shown in Table 3-9. The RSS and DOS voltage variation was tabulated for each worn probe inspection. The retest voltage values compare reasonably with the worn probe voltages. No retest voltage increased by more than 15% compared to the worn probe voltage. Figure 3-20 shows a comparison of the worn probe and good probe voltages. The data in this figure also includes data from previous Diablo Canyon inspections (1R9, 1R10, and 2R9). This figure shows that the voltages do not change significantly between the worn probes and the good probes. Therefore, continued use of the 1.5 volt retest threshold is justified.

All RSS bobbin indications were inspected in accordance with the Ref. 14 analysis guidelines. Review of the probe wear log sheets and the eddy current test results indicate that no tubes were inspected with a probe known to have failed the probe wear check. These reviews in conjunction with the results in Table 3-9 address the NRC requirements listed in Ref. 18.

The next requirement involves monitoring tubes that contain new DOS indications that were inspected with probes that failed the wear check in the previous outage. This evaluation is intended to look for new large indications or a non-proportionately large percentage of new indications in tubes that failed the check in the previous outage. Large is defined as $\geq$ 0.5 volt DOS. The 2R10 >= 0.5 volts DOS indications in tubes that failed the probe wear check in 2R9 are shown in Table 3-10.

Overall there were 862 DOS indications detected in the 2R10 inspection of the active tube population. 362 or 42% of the DOS indications were new indications. This percentage is considerably lower than the 2R9 results where about 62% of the DOS indications were new. The 2R10 results are more indicative of expected percentages as the population of repeat DOSs increase with consecutive outages implementing the ARC criteria.

In order to assess the new indications against the probe wear requirements, Table 3-11 and Table 3-12 are presented. Of the 362 total new indications, 169 were in tubes inspected with a worn probe in 2R9 and 193 were in tubes inspected with a good probe in 2R9. The number of new indications $\geq$ 0.5 volts was determined to be 147. Out of these, 62 were in tubes that were inspected with a worn probe in 2R9 and all were detectable in historical lookup review. When these numbers are compared to the total number of inspections in 2R9, the results shown in Table 3-12 are obtained. This table shows the approximate percentage of tubes with new indications. The results are categorized based on whether the previous inspection was performed with a worn probe or a good probe. This table shows that about 2.9% of the 2R9 worn probe inspections yielded new indications in 2R10. This is slightly higher than the 2.3 % rate for the tubes inspected with good probes in 2R9. For the new indications $\geq$ 0.5 volts, the rates were about the same (1.1% for the worn probes and 1.0% for the good probes).

Nearly all of the new DOS indications were detected during the historical review of the 2R9 data. Since most of the newly reported DOS indications were detected during the review of the 2R9 data, probe wear is not considered to be significantly affecting the quality of the data and,

therefore, the ODSCC detection capability. In addition, the fact that the rates of new indications ≥ 0.5 volts is about the same for the worn probe and the good probe populations suggests that detection of these larger indications is not affected. The slightly higher frequency of new indications in tubes inspected with worn probes is limited to indications < 0.5 volts which are insignificant relative to the tube integrity calculations.

New indications are more a result of probability of detection rather than the fact that the tube was inspected with a worn probe in 2R9. These percentages are not considered to indicate that a disproportionate number of new DOSs are present in tubes that were inspected with a worn probe in the previous outage. In summary, the NRC analysis requirements regarding probe wear monitoring were met during the 2R10 bobbin coil inspection and a more stringent wear tolerance is not required.

3.4 *Upper Voltage Repair Limit*

Per Generic Letter 95-05, the upper repair limit must be calculated prior to each outage, and the more conservative of the plant-specific average growth rate per EFPY or 30 percent per EFPY should be used as the anticipated growth rate input for this calculation. The upper voltage repair limit was calculated prior to the 2R10 inspection and was determined to be 4.9 volts (Ref. 15) based on the following formula. This calculation used a 35.6 percent per EFPY growth based on the 2R9 90-day report (Ref. 8).

$$V_{URL} = \frac{V_{SL}}{1 + \frac{\%V_{NDE}}{100} + \frac{\%V_{CG}}{100}}$$

where: V_{URL} = upper voltage repair limit,
V_{NDE} = NDE voltage measurement uncertainty = 20%,
V_{CG} = voltage growth anticipated between inspections = 35.6%,
V_{SL} = voltage structural limit from the burst pressure – Bobbin voltage correlation, where the limit of 8.3 volts was used based on Ref. 11.

Although the upper repair limit will not be calculated again until shortly before the next inspection, the average growth rates from Cycle 10 are documented in this report to verify the limiting growth rate to be used for the 2R11 outage. The 30% per EFPY NRC minimum limit is not bounding for DCPP Unit 2 Cycle 11 as Table 3-13 shows that the average percent growth for Cycle 10 is 33.4% per EFPY.

3.5 *NDE Uncertainty Distributions*

NDE uncertainties must be taken into account when projecting the end-of-cycle voltages for the next operating cycle. The NDE uncertainties used in the calculations of the EOC-11 voltages are described in Ref. 6. The acquisition uncertainty was sampled from a normal distribution with a mean of zero, a standard deviation of 7%, and a cutoff limit of 15% based on the use of the probe wear standard. The analyst uncertainty was sampled from a normal distribution with a mean of zero, a standard deviation of 10.3%, and no cutoff limit. These uncertainty distributions are shown in Table 3-14 and Figure 3-21.

Table 3-1: 2R10 DOS Indications > 2.0 volts

SG	Row	Col	Ind	Elev	Inch	Volts	Deg	Cal
21	5	17	DOS	2H	-0.02	3.35	61	HL-39
	11	27	DOS	1H	0.06	2.54	68	CL-14
23	5	5	DOS	3H	0.00	2.2	70	HL-30
	6	54	DOS	1H	0.02	2.16	77	CL-37
	24	26	DOS	2H	0.09	4.31	69	CL-16
	27	59	DOS	1H	0.06	3.81	65	HL-4
24	16	57	DOS	2H	-0.06	2.20	89	HL-2
	31	45	DOS	1H	0.02	2.23	96	CL-17
	27	69	DOS	2H	0.15	2.71	58	CL-37
	29	35	DOS	1H	0.00	2.74	86	CL-40
	24	84	DOS	1H	-0.06	2.89	66	HL-6
	38	60	DOS	2H	0.11	3.08	65	CL-37
	8	65	DOS	1H	0.13	3.13	63	CL-37
	38	47	DOS	2H	0.13	3.32	72	CL-17
	36	48	DOS	2H	0.22	3.44	70	CL-10
	7	62	DOS	1H	0.00	3.81	69	CL-40
	4	45	DOS	1H	0.04	4.06	58	HL-12
	13	63	DOS	1H	-0.04	4.14	63	CL-37
	5	48	DOS	1H	-0.11	4.40	74	HL-13
	42	48	DOS	2H	0.18	5.06	70	CL-11
	8	63	DOS	1H	0.10	5.22	66	CL-40
	3	51	DOS	1H	0.04	5.42	56	HL-13

Table 3-2: 2R10 AONDB Indications

SG	Row	Col	Elevation	Dent Voltage	+Pt Voltage	Assigned DOS Voltage
22	12	71	1H	4.04	0.23	0.533
24	30	36	3H	4.19	0.23	0.533

Table 3-3: Summary of Inspection and Repair for Tubes

	SG 1				SG 2				SG 3			
			DOSs Returned to Service				DOSs Returned to Service				DOSs Returned to Service	
Voltage Bin	As-found EOC-10	Repaired Tubes	Conf. OD-SCC or Not Insp. w/+Pt	Total (1)	As-found EOC-10	Repaired Tubes	Conf. OD-SCC or Not Insp. w/+Pt	Total (1)	As-found EOC-10	Repaired Tubes	Conf. OD-SCC or Not Insp. w/+Pt	Total (1)
0.1												
0.2	3		3	3	3		3	3	3		3	3
0.3	25		25	25	11		9	11	19		17	19
0.4	23		23	23	25	1	22	24	12		12	12
0.5	32		30	32	19		19	19	14		13	14
0.6	23		21	23	16		15	16	10		9	10
0.7	22		22	22	11		10	11	12		12	12
0.8	7		6	7	3		3	3	5		5	5
0.9	9		8	9	9		9	9	6		6	6
1	4	1	3	3	6		6	6	1		1	1
1.1	2		2	2	1		1	1	5		5	5
1.2	3		3	3					2		2	2
1.3	3		3	3	2		2	2	2		2	2
1.4	4		4	4								
1.5	2		2	2					1		1	1
1.6												
1.7												
1.8												
1.9	2		2	2	1		1	1				
2	1		1	1	1		1	1				
2.1												
2.2									2	2		
2.3												
2.4												
2.5												
>2.5	2	2							2	2		
TOTAL	167	3	158	164	108	1	101	107	96	4	88	92
>1 V	19	2	17	17	5		5	5	14	4	10	10
>2 V	2	2							4	4		

	SG 4				Composite of All SGs			
			DOSs Returned to Service				DOSs Returned to Service	
Voltage Bin	As-found EOC-10	Repaired Tubes	Conf. OD-SCC or Not Insp. w/+Pt	Total (1)	As-found EOC-10	Repaired Tubes	Conf. OD-SCC or Not Insp. w/+Pt	Total (1)
0.1								
0.2	6		6	6	15		15	15
0.3	32		32	32	87		83	87
0.4	58	3	55	55	118	4	112	114
0.5	68	2	65	66	133	2	127	131
0.6	73	2	70	71	122	2	115	120
0.7	55	1	52	54	100	1	96	99
0.8	40		40	40	55		54	55
0.9	29		29	29	53		52	53
1	22		22	22	33	1	32	32
1.1	27	3	24	24	35	3	32	32
1.2	8	1	7	7	13	1	12	12
1.3	11		11	11	18		18	18
1.4	15	1	14	14	19	1	18	18
1.5	7	1	6	6	10	1	9	9
1.6	6		6	6	6		6	6
1.7	7		7	7	7		7	7
1.8	5		5	5	5		5	5
1.9	3		3	3	6		6	6
2	5		5	5	7		7	7
2.1								
2.2	1	1			3	3		
2.3	1	1			1	1		
2.4								
2.5								
>2.5	14	14			18	18		
TOTAL	493	30	459	463	864	38	806	826
>1 V	110	22	88	88	148	28	120	120
>2 V	16	16			22	22		

(1) Total Includes all DOSs returned to service (confirmed, not inspected and not confirmed with Plus Point)

Table 3-4: Summary of Largest Voltage Growth Rates per EFPY

SG_ID	Row	Col	Elev	Volts	99 Voltage	Growth	RPC	New?	2001 Cal	1999 Cal
24	3	51	1H	5.42	1.26	2.8889	SAI	Repeat	HL-13	HL-61
24	42	48	2H	5.06	1.39	2.5486	SAI	Repeat	CL-11	CL-22
24	8	63	1H	5.22	1.58	2.5278	SAI	Repeat	CL-40	CL-41
23	24	26	2H	4.31	1.48	1.9653	SAI	Repeat	CL-16	CL-20
24	7	62	1H	3.81	1.1	1.8819	SAI	Repeat	CL-40	CL-29
24	4	45	1H	4.06	1.35	1.8819	SAI	Repeat	HL-12	HL-70
24	5	48	1H	4.4	1.89	1.7431	SAI	Repeat	HL-13	HL-61
21	5	17	2H	3.35	0.88	1.7153	SAI	Repeat	HL-39	HL-55
24	13	63	1H	4.14	1.76	1.6528	SAI	Repeat	CL-37	CL-41
24	8	65	1H	3.13	0.91	1.5417	SAI	Repeat	CL-37	CL-29
24	38	47	2H	3.32	1.34	1.375	SAI	Repeat	CL-17	CL-21
23	27	59	1H	3.81	1.94	1.2986	SAI	Repeat	HL-4	CL-40
24	36	48	2H	3.44	1.64	1.25	SAI	Repeat	CL-10	CL-22
21	11	27	1H	2.54	0.82	1.1944	SAI	Repeat	CL-14	CL-13
24	27	69	2H	2.71	1.04	1.1597	SAI	Repeat	CL-37	CL-28
24	24	84	1H	2.89	1.31	1.0972	SAI	Repeat	HL-6	CL-35
24	44	45	2H	2	0.49	1.0486	SAI	Repeat	CL-37	CL-21
21	37	45	2H	1.96	0.5	1.0139		Repeat	CL-40	CL-22
24	29	35	1H	2.74	1.28	1.0139	SAI	Repeat	CL-40	CL-20
21	31	51	1H	1.84	0.48	0.9444		Repeat	CL-40	CL-23
23	5	5	3H	2.2	0.84	0.9444	SAI	Repeat	HL-30	HL-62
24	18	76	2H	1.73	0.39	0.9306		New	HL-6	CC-32
24	38	60	2H	3.08	1.93	0.7986	SAI	Repeat	CL-37	CL-28
24	40	58	3H	1.96	0.89	0.7431		Repeat	HL-9	CL-23
24	35	45	1H	1.35	0.36	0.6875		Repeat	CL-17	CL-22
24	4	68	2H	1.97	1.01	0.6667		Repeat	HL-43	HL-56
24	16	57	2H	2.2	1.25	0.6597	SAI	Repeat	HL-2	CL-26
21	27	33	1H	1.36	0.43	0.6458		Repeat	CL-17	CL-15
24	16	55	2H	1.26	0.33	0.6458		Repeat	HL-2	CL-26
24	11	77	2H	1.82	0.89	0.6458		Repeat	HL-5	CL-31
24	12	38	1H	1.9	0.97	0.6458		Repeat	CL-10	CL-58
21	15	92	1H	1.29	0.37	0.6389		Repeat	HL-5	CL-37
24	38	43	2H	1.64	0.72	0.6389		Repeat	CL-37	CL-19
21	7	33	1H	1.88	0.99	0.6181		Repeat	CL-7	CL-12
23	6	54	1H	2.16	1.27	0.6181	SAI	Repeat	CL-37	CL-41
24	38	32	1H	1.66	0.77	0.6181		Repeat	CL-37	CL-17
24	2	47	1H	1.51	0.63	0.6111		Repeat	HL-13	HL-61
22	38	40	1H	1.94	1.08	0.5972		Repeat	CL-5	CL-21
22	22	67	2H	1.84	1.01	0.5764		Repeat	HL-4	CL-46
24	3	50	2H	1.68	0.85	0.5764		Repeat	HL-14	HL-61
24	7	54	2H	1.03	0.21	0.5694		New	HL-1	CC-42
24	1	52	1H	1.44	0.62	0.5694		Repeat	HL-14	HL-61
21	37	24	1H	1.44	0.66	0.5417		Repeat	CL-16	CL-7
24	7	62	2H	1.37	0.59	0.5417		Repeat	CL-40	CL-29
24	19	84	2H	2	1.22	0.5417	SAI	Repeat	HL-5	CL-33
23	9	23	1H	1.04	0.28	0.5278		Repeat	CL-15	CL-9
24	40	59	2H	1.22	0.46	0.5278		Repeat	HL-9	CL-23
24	31	45	1H	2.23	1.47	0.5278	SAI	Repeat	CL-17	CL-2
24	2	59	2H	1.54	0.79	0.5208		Repeat	HL-15	HL-56
21	2	28	1H	1.37	0.64	0.5069		Repeat	HL-13	HL-55
24	6	39	1H	1.24	0.52	0.5		Repeat	CL-11	CL-58
24	5	50	1H	1.92	1.2	0.5		Repeat	HL-13	HL-61

Table 3-5: Voltage and Growth Distribution by TSP

Growth units are volts/EFPY

Tube Support Plate	Steam Generator 2-1				
	No. of Indications	Maximum Voltage	Average Voltage	Maximum Growth	Average Growth
1H	112	2.54	0.63	1.19	0.15
2H	33	3.35	0.60	1.72	0.15
3H	8	0.95	0.63	0.25	0.13
4H	3	0.51	0.38	0.11	0.03
5H	8	0.74	0.60	0.14	0.03
6H	1	0.32	0.32	0.16	0.16
7H	0				
CL	2	0.60	0.56	0.10	-0.01
All Inds	167	3.35	0.61	1.72	0.14

Tube Support Plate	Steam Generator 2-2				
	No. of Indications	Maximum Voltage	Average Voltage	Maximum Growth	Average Growth
1H	41	1.94	0.57	0.60	0.08
2H	47	1.84	0.58	0.58	0.10
3H	10	0.93	0.47	0.37	0.11
4H	3	0.69	0.49	0.03	-0.01
5H	1	0.63	0.63	-0.09	-0.09
6H	1	0.33	0.33	0.05	0.05
7H	0				
CL	5	0.69	0.39	0.04	0.01
All Inds	108	1.94	0.55	0.60	0.08

Tube Support Plate	Steam Generator 2-3				
	No. of Indications	Maximum Voltage	Average Voltage	Maximum Growth	Average Growth
1H	54	3.81	0.66	1.30	0.10
2H	26	4.31	0.71	1.97	0.17
3H	7	2.20	0.82	0.94	0.22
4H	2	0.46	0.38	0.15	0.07
5H	2	0.62	0.51	-0.05	-0.08
6H	2	0.22	0.22	0.00	-0.05
7H	0				
CL	3	0.53	0.35	0.22	0.06
All Inds	96	4.31	0.66	1.97	0.12

Tube Support Plate	Steam Generator 2-4				
	No. of Indications	Maximum Voltage	Average Voltage	Maximum Growth	Average Growth
1H	182	5.42	0.85	2.89	0.23
2H	245	5.06	0.83	2.55	0.20
3H	51	1.96	0.68	0.74	0.12
4H	11	0.94	0.49	0.15	0.03
5H	1	0.49	0.49	-0.03	-0.03
6H	0				
7H	0				
CL	3	0.64	0.37	0.20	0.08
All Inds	493	5.42	0.81	2.89	0.20

Tube Support Plate	Composite of All Four SGs				
	No. of Indications	Maximum Voltage	Average Voltage	Maximum Growth	Average Growth
1H	389	5.42	0.73	2.89	0.17
2H	351	5.06	0.76	2.55	0.18
3H	76	2.20	0.66	0.94	0.13
4H	19	0.94	0.46	0.15	0.03
5H	12	0.74	0.58	0.14	0.00
6H	4	0.33	0.27	0.16	0.03
7H	0				
CL	13	0.69	0.40	0.22	0.04
All Inds	864	5.42	0.72	2.89	0.16

Tube Support Plate	Steam Generator 2-4			
	Max Growth BOC <=1	Avg Growth BOC <=1	Max Growth BOC > 1	Avg Growth BOC > 1
1H	1.54	0.15	2.89	1.18
2H	1.05	0.17	2.55	0.49
3H	0.74	0.13	-0.05	-0.06
4H	0.15	0.03		
5H	-0.03	-0.03		
6H				
7H				
CL	0.20	0.08		
All Inds	1.54	0.15	2.89	0.70

Table 3-6: Summary of Voltage Growth per EFPY

Delta Volts	SG 1		SG 2		SG 3		SG 4		TOTAL	
	No. of Obs.	CPDF	No. of Obs.	CPDF	No. of Obs.	CPDF	No. of Obs.	CPDF	No. of Obs.	CPDF
-0.7	0	0.000	1	0.009	0	0.000	0	0.000	1	0.001
-0.6	0	0.000	0	0.009	0	0.000	0	0.000	0	0.001
-0.5	0	0.000	0	0.009	0	0.000	0	0.000	0	0.001
-0.4	0	0.000	0	0.009	0	0.000	0	0.000	0	0.001
-0.3	0	0.000	0	0.009	0	0.000	0	0.000	0	0.001
-0.2	1	0.006	0	0.009	0	0.000	0	0.000	1	0.002
-0.1	4	0.030	4	0.047	4	0.042	5	0.010	17	0.022
0	18	0.138	20	0.234	27	0.323	41	0.094	106	0.146
0.1	67	0.539	49	0.692	28	0.615	152	0.406	296	0.491
0.2	41	0.784	18	0.860	19	0.813	144	0.701	222	0.749
0.3	19	0.898	7	0.925	7	0.885	65	0.834	98	0.864
0.4	4	0.922	3	0.953	4	0.927	28	0.891	39	0.909
0.5	4	0.946	3	0.981	2	0.948	19	0.930	28	0.942
0.6	2	0.958	2	1.000	1	0.958	8	0.947	13	0.957
0.7	3	0.976	0	1.000	1	0.969	9	0.965	13	0.972
0.8	0	0.976	0	1.000	0	0.969	2	0.969	2	0.974
0.9	0	0.976	0	1.000	0	0.969	0	0.969	0	0.974
1	1	0.982	0	1.000	1	0.979	1	0.971	3	0.978
1.1	1	0.988	0	1.000	0	0.979	3	0.977	4	0.983
1.2	1	0.994	0	1.000	0	0.979	1	0.980	2	0.985
1.3	0	0.994	0	1.000	1	0.990	1	0.982	2	0.987
1.4	0	0.994	0	1.000	0	0.990	1	0.984	1	0.988
1.5	0	0.994	0	1.000	0	0.990	0	0.984	0	0.988
1.6	0	0.994	0	1.000	0	0.990	1	0.986	1	0.990
1.7	0	0.994	0	1.000	0	0.990	1	0.988	1	0.991
1.8	1	1.000	0	1.000	0	0.990	1	0.990	2	0.993
1.9	0	1.000	0	1.000	0	0.990	2	0.994	2	0.995
2	0	1.000	0	1.000	1	1.000	0	0.994	1	0.997
2.1	0	1.000	0	1.000	0	1.000	0	0.994	0	0.997
2.2	0	1.000	0	1.000	0	1.000	0	0.994	0	0.997
2.3	0	1.000	0	1.000	0	1.000	0	0.994	0	0.997
2.4	0	1.000	0	1.000	0	1.000	0	0.994	0	0.997
2.5	0	1.000	0	1.000	0	1.000	0	0.994	0	0.997
2.6	0	1.000	0	1.000	0	1.000	2	0.998	2	0.999
2.7	0	1.000	0	1.000	0	1.000	0	0.998	0	0.999
2.8	0	1.000	0	1.000	0	1.000	0	0.998	0	0.999
2.9	0	1.000	0	1.000	0	1.000	1	1.000	1	1.000
Total	167	NA	107	NA	96	NA	488	NA	858	NA

Table 3-7: Voltage Dependent Growth

BOC-10 Voltage ≤ 1 Volt

Delta Volts	SG 1		SG 2		SG 3		SG 4		TOTAL	
	No. of Obs.	CPDF	No. of Obs.	CPDF	No. of Obs.	CPDF	No. of Obs.	CPDF	No. of Obs.	CPDF
-0.7	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
-0.6	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
-0.5	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
-0.4	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
-0.3	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
-0.2	1	0.006	0	0.000	0	0.000	0	0.000	1	0.001
-0.1	4	0.030	3	0.029	3	0.033	5	0.011	15	0.020
0	18	0.139	20	0.223	27	0.330	37	0.094	102	0.147
0.1	65	0.533	49	0.699	28	0.637	149	0.428	291	0.508
0.2	41	0.782	18	0.874	19	0.846	137	0.735	215	0.775
0.3	19	0.897	7	0.942	6	0.912	62	0.874	94	0.892
0.4	4	0.921	3	0.971	4	0.956	24	0.928	35	0.935
0.5	4	0.945	3	1.000	2	0.978	15	0.962	24	0.965
0.6	2	0.958	0	1.000	1	0.989	6	0.975	9	0.976
0.7	3	0.976	0	1.000	0	0.989	7	0.991	10	0.989
0.8	0	0.976	0	1.000	0	0.989	1	0.993	1	0.990
0.9	0	0.976	0	1.000	0	0.989	0	0.993	0	0.990
1	1	0.982	0	1.000	1	1.000	1	0.996	3	0.994
1.1	1	0.988	0	1.000	0	1.000	1	0.998	2	0.996
1.2	1	0.994	0	1.000	0	1.000	0	0.998	1	0.998
1.3	0	0.994	0	1.000	0	1.000	0	0.998	0	0.998
1.4	0	0.994	0	1.000	0	1.000	0	0.998	0	0.998
1.5	0	0.994	0	1.000	0	1.000	0	0.998	0	0.998
1.6	0	0.994	0	1.000	0	1.000	1	1.000	1	0.999
1.7	0	0.994	0	1.000	0	1.000	0	1.000	0	0.999
1.8	1	1.000	0	1.000	0	1.000	0	1.000	1	1.000
1.9	0	1.000	0	1.000	0	1.000	0	1.000	0	1.000
2	0	1.000	0	1.000	0	1.000	0	1.000	0	1.000
2.1	0	1.000	0	1.000	0	1.000	0	1.000	0	1.000
2.2	0	1.000	0	1.000	0	1.000	0	1.000	0	1.000
2.3	0	1.000	0	1.000	0	1.000	0	1.000	0	1.000
2.4	0	1.000	0	1.000	0	1.000	0	1.000	0	1.000
2.5	0	1.000	0	1.000	0	1.000	0	1.000	0	1.000
2.6	0	1.000	0	1.000	0	1.000	0	1.000	0	1.000
2.7	0	1.000	0	1.000	0	1.000	0	1.000	0	1.000
2.8	0	1.000	0	1.000	0	1.000	0	1.000	0	1.000
2.9	0	1.000	0	1.000	0	1.000	0	1.000	0	1.000
Total	165	NA	103	NA	91	NA	446	NA	805	NA

Table 3-8: Voltage Dependent Growth

BOC-10 Voltage > 1 Volt

Delta Volts	SG 1		SG 2		SG 3		SG 4		TOTAL	
	No. of Obs.	CPDF	No. of Obs.	CPDF	No. of Obs.	CPDF	No. of Obs.	CPDF	No. of Obs.	CPDF
-0.7	0	0.000	1	0.250	0	0.000	0	0.000	1	0.019
-0.6	0	0.000	0	0.250	0	0.000	0	0.000	0	0.019
-0.5	0	0.000	0	0.250	0	0.000	0	0.000	0	0.019
-0.4	0	0.000	0	0.250	0	0.000	0	0.000	0	0.019
-0.3	0	0.000	0	0.250	0	0.000	0	0.000	0	0.019
-0.2	0	0.000	0	0.250	0	0.000	0	0.000	0	0.019
-0.1	0	0.000	1	0.500	1	0.200	0	0.000	2	0.057
0	0	0.000	0	0.500	0	0.200	4	0.095	4	0.132
0.1	2	1.000	0	0.500	0	0.200	3	0.167	5	0.226
0.2	0	1.000	0	0.500	0	0.200	7	0.333	7	0.358
0.3	0	1.000	0	0.500	1	0.400	3	0.405	4	0.434
0.4	0	1.000	0	0.500	0	0.400	4	0.500	4	0.509
0.5	0	1.000	0	0.500	0	0.400	4	0.595	4	0.585
0.6	0	1.000	2	1.000	0	0.400	2	0.643	4	0.660
0.7	0	1.000	0	1.000	1	0.600	2	0.690	3	0.717
0.8	0	1.000	0	1.000	0	0.600	1	0.714	1	0.736
0.9	0	1.000	0	1.000	0	0.600	0	0.714	0	0.736
1	0	1.000	0	1.000	0	0.600	0	0.714	0	0.736
1.1	0	1.000	0	1.000	0	0.600	2	0.762	2	0.774
1.2	0	1.000	0	1.000	0	0.600	1	0.786	1	0.792
1.3	0	1.000	0	1.000	1	0.800	1	0.810	2	0.830
1.4	0	1.000	0	1.000	0	0.800	1	0.833	1	0.849
1.5	0	1.000	0	1.000	0	0.800	0	0.833	0	0.849
1.6	0	1.000	0	1.000	0	0.800	0	0.833	0	0.849
1.7	0	1.000	0	1.000	0	0.800	1	0.857	1	0.868
1.8	0	1.000	0	1.000	0	0.800	1	0.881	1	0.887
1.9	0	1.000	0	1.000	0	0.800	2	0.929	2	0.925
2	0	1.000	0	1.000	1	1.000	0	0.929	1	0.943
2.1	0	1.000	0	1.000	0	1.000	0	0.929	0	0.943
2.2	0	1.000	0	1.000	0	1.000	0	0.929	0	0.943
2.3	0	1.000	0	1.000	0	1.000	0	0.929	0	0.943
2.4	0	1.000	0	1.000	0	1.000	0	0.929	0	0.943
2.5	0	1.000	0	1.000	0	1.000	0	0.929	0	0.943
2.6	0	1.000	0	1.000	0	1.000	2	0.976	2	0.981
2.7	0	1.000	0	1.000	0	1.000	0	0.976	0	0.981
2.8	0	1.000	0	1.000	0	1.000	0	0.976	0	0.981
2.9	0	1.000	0	1.000	0	1.000	1	1.000	1	1.000
Total	2	NA	4	NA	5	NA	42	NA	53	NA

Table 3-9: Re-tested DOSs ≥ 1.5 Volts that Failed the Probe Wear Check

SG	Row	Col	Ind	Elev	Volts	Probe	Cal No.	ARC Out 2R10	% Diff
21	3	54	RSS	1H	1.61	720PR	12	Yes	
	3	54	DOS	1H	1.27	720PR	39		-26.8
	5	17	RSS	2H	3.24	720PR	13	Yes	
	5	17	DOS	2H	3.35	720PR	39		3.3
	31	51	RSS	1H	1.58	720PR	8	Yes	
	31	51	RSS	1H	1.82	720PR	32	Yes	
	31	51	DOS	1H	1.84	720PR	40		14.1
	37	45	RSS	2H	1.75	720PR	21	Yes	
	37	45	RSS	2H	1.89	720PR	32	Yes	
	37	45	DOS	2H	1.96	720PR	40		10.7
23	5	5	RSS	3H	2.26	720PR	13	Yes	
	5	5	DOS	3H	2.2	720PR	30		-2.7
	6	54	RSS	1H	2.13	720PR	13	Yes	
	6	54	DOS	1H	2.16	720PR	37		1.4
24	3	69	RSS	1H	1.73	720PR	11	Yes	
	3	69	DOS	1H	1.64	720PR	43		-5.5
	4	68	RSS	2H	2.08	720PR	11	Yes	
	4	68	DOS	2H	1.97	720PR	43		-5.6
	7	62	RSS	1H	3.94	720PR	3	Yes	
	7	62	DOS	1H	3.81	720PR	40		-3.4
	8	63	RSS	1H	4.95	720PR	4	Yes	
	8	63	DOS	1H	5.22	720PR	40		5.2
	8	65	RSS	1H	2.77	720PR	4	Yes	
	8	65	DOS	1H	3.13	720PR	37		11.5
	13	63	RSS	1H	4.12	720PR	3	Yes	
	13	63	DOS	1H	4.14	720PR	37		0.5
	13	66	RSS	2H	1.69	720PR	3	Yes	
	13	66	DOS	2H	1.71	720PR	37		1.2
	23	42	RSS	2H	1.59	720PR	6	Yes	
	23	42	DOS	2H	1.54	720PR	37		-3.2
	24	38	RSS	1H	1.74	720PR	6	Yes	
	24	38	DOS	1H	1.67	720PR	40		-4.2
	24	73	RSS	2H	1.74	720PR	4	Yes	
	24	73	DOS	2H	1.77	720PR	37		1.8
	27	69	RSS	2H	2.4	720PR	7	Yes	
	27	69	DOS	2H	2.71	720PR	37		11.4
	28	29	RSS	2H	1.5	720PR	15	Yes	
	28	29	DOS	2H	1.48	720PR	40		-1.4
	29	35	RSS	1H	2.82	720PR	15	Yes	
	29	35	DOS	1H	2.74	720PR	40		-2.9
	38	32	RSS	1H	1.59	720PR	14	Yes	
	38	32	DOS	1H	1.66	720PR	37		4.2
	38	43	RSS	2H	1.61	720PR	16	Yes	
	38	43	DOS	2H	1.64	720PR	37		1.8
	38	60	RSS	2H	2.95	720PR	7	Yes	
	38	60	DOS	2H	3.08	720PR	37		4.2
	44	45	RSS	2H	1.8	720PR	16	Yes	
	44	45	DOS	2H	2	720PR	37		10.0

Table 3-10: New 2R10 DOSs >=0.5 Volts In Tubes Inspected With A Worn Probe In 2R9

SG	Row	Col	Ind	Elev	Volts	Probe	Cal	ARC Out 99?
21	10	8	DOS	1H	0.74	720PR	CL-10	Out
	16	85	DOS	1H	0.5	720PR	HL-5	Out
	18	39	DOS	1H	0.51	720PR	CL-6	Out
	19	18	DOS	2H	0.64	720PR	CL-11	Out
	40	51	DOS	1H	0.69	720PR	HL-7	Out
	43	54	DOS	1H	0.66	720PR	HL-7	Out
22	7	82	DOS	1H	1.1	720PR	HL-3	Out
	7	73	DOS	2H	0.92	720PR	HL-3	Out
	15	73	DOS	1H	0.83	720PR	HL-3	Out
	17	81	DOS	2H	0.83	720PR	HL-3	Out
	6	43	DOS	1H	0.82	720PR	CL-22	Out
	19	78	DOS	2H	0.69	720PR	HL-3	Out
	5	88	DOS	3C	0.69	720PR	CL-28	Out
	3	77	DOS	5H	0.63	720PR	HL-10	Out
	9	9	DOS	1H	0.53	720PR	CL-11	Out
	26	49	DOS	1H	0.51	720PR	CL-1	Out
	18	21	DOS	1H	0.5	720PR	CL-11	Out
23	4	32	DOS	2H	0.69	720PR	HL-15	Out
	17	30	DOS	2H	0.55	720PR	CL-15	Out
	17	34	DOS	2H	0.62	720PR	CL-15	Out
	24	16	DOS	1H	0.55	720PR	CL-16	Out
	27	81	DOS	2H	0.64	720PR	HL-1	Out
	39	45	DOS	1H	1.19	720PR	CL-3	Out
	44	42	DOS	3H	0.71	720PR	CL-4	Out
24	3	55	DOS	2H	0.79	720PR	HL-16	Out
	4	46	DOS	1H	0.56	720PR	HL-46	Out
	4	50	DOS	1H	1.05	720PR	HL-13	Out
	4	60	DOS	1H	0.5	720PR	HL-16	Out
	6	54	DOS	1H	0.63	720PR	HL-2	Out
	6	56	DOS	1H	0.71	720PR	HL-2	Out
	7	54	DOS	2H	1.03	720PR	HL-1	Out
	7	58	DOS	1H	0.53	720PR	HL-1	Out
	7	70	DOS	2H	0.64	720PR	HL-3	Out
	8	69	DOS	1H	0.6	720PR	HL-3	Out
	8	69	DOS	2H	0.63	720PR	HL-3	Out
	9	57	DOS	2H	1.3	720PR	HL-1	Out
	9	67	DOS	2H	0.56	720PR	HL-3	Out
	11	66	DOS	1H	0.61	720PR	HL-3	Out
	11	68	DOS	3H	0.52	720PR	HL-3	Out
	12	60	DOS	2H	0.61	720PR	HL-2	Out
	12	83	DOS	3H	0.5	720PR	HL-5	Out
	13	49	DOS	1H	0.51	720PR	CL-9	Out

SG	Row	Col	Ind	Elev	Volts	Probe	Cal	ARC Out 99?
24	14	38	DOS	3H	0.64	720PR	CL-10	Out
	16	37	DOS	1H	0.58	720PR	CL-6	Out
	16	61	DOS	2H	0.74	720PR	HL-4	Out
	16	62	DOS	2H	0.5	720PR	HL-4	Out
	16	68	DOS	3H	0.85	720PR	HL-4	Out
	17	25	DOS	1H	0.81	720PR	CL-5	Out
	17	68	DOS	2H	0.79	720PR	HL-3	Out
	18	68	DOS	2H	0.72	720PR	HL-4	Out
	18	71	DOS	2H	0.57	720PR	HL-4	Out
	18	76	DOS	2H	1.73	720PR	HL-6	Out
	20	64	DOS	1H	0.81	720PR	HL-4	Out
	22	47	DOS	2H	0.73	720PR	CL-11	Out
	23	64	DOS	2H	0.62	720PR	HL-3	Out
	24	64	DOS	4H	0.53	720PR	HL-4	Out
	26	25	DOS	1H	0.8	720PR	CL-13	Out
	28	22	DOS	2H	0.64	720PR	CL-13	Out
	28	54	DOS	1H	1.1	720PR	HL-9	Out
	29	47	DOS	2H	0.81	720PR	CL-17	Out
	35	28	DOS	1H	0.65	720PR	CL-12	Out
	35	55	DOS	2H	0.57	720PR	HL-10	Out

Table 3-11: Summary of New DOS Indications Sorted by Category

	2R10 DOSs (Total)	New 2R10 Not Detected in 2R9	New 2R10 Ind. In Tubes Insp. w/ Worn Probe in 2R9	New 2R10 Ind. In Tubes Insp. w/ Good Probe in 2R9	New 2R10 Ind. ≥0.5 Volts	New 2R10 Ind. ≥0.5 Volts in Tubes Insp. w/ Worn Probe in 2R9
2-1	167	71	18	53	29	6
2-2	107	52	35	17	17	11
2-3	96	46	23	23	19	7
2-4	492	193	93	100	82	38
Tot.	**862**	**362**	**169**	**193**	**147**	**62**

Table 3-12: Percentage of Tubes With New Indications

	Worn Probe In 2R9	Good Probe In 2R9
Number of Inspections In 2R9	5775	8290
New Indications	169	193
Percentage w/ New Indications	2.9%	2.3%
New Indications ≥0.5V	62	85
Percentage w/ New Indications ≥0.5V	1.1%	1.0%

Table 3-13: Average Growth Rates for Cycle 10

SG	No of Inds In Growth Dist.	Average BOC-10 Voltage	Average Voltage Growth	Average Growth per EFPY	Average Percent Growth for Cycle 10	Average Percent Growth per EFPY
SG 2-1	167	0.42	0.20	0.14	47.8%	33.2%
SG 2-2	107	0.43	0.12	0.08	27.4%	19.0%
SG 2-3	96	0.48	0.18	0.12	36.7%	25.5%
SG 2-4	488	0.53	0.28	0.20	54.0%	37.5%
Total	858	0.49	0.24	0.16	48.1%	33.4%

Table 3-14: NDE Uncertainty Distributions

Analyst Uncertainty

Percent Variation	Cumulative Probability
-40.0%	0.00005
-38.0%	0.00011
-36.0%	0.00024
-34.0%	0.00048
-32.0%	0.00095
-30.0%	0.00179
-28.0%	0.00328
-26.0%	0.00580
-24.0%	0.00990
-22.0%	0.01634
-20.0%	0.02608
-18.0%	0.04027
-16.0%	0.06016
-14.0%	0.08704
-12.0%	0.12200
-10.0%	0.16581
-8.0%	0.21867
-6.0%	0.28011
-4.0%	0.34888
-2.0%	0.42302
0.0%	0.50000
2.0%	0.57698
4.0%	0.65112
6.0%	0.71989
8.0%	0.78133
10.0%	0.83419
12.0%	0.87800
14.0%	0.91296
16.0%	0.93984
18.0%	0.95973
20.0%	0.97392
22.0%	0.98366
24.0%	0.99010
26.0%	0.99420
28.0%	0.99672
30.0%	0.99821
32.0%	0.99905
34.0%	0.99952
36.0%	0.99976
38.0%	0.99989
40.0%	0.99995
Std Deviation = 10.3% Mean = 0.0% No Cutoff	

Acquisition Uncertainty

Percent Variation	Cumulative Probability
<-15.0%	0.00000
-15.0%	0.01606
-14.0%	0.02275
-13.0%	0.03165
-12.0%	0.04324
-11.0%	0.05804
-10.0%	0.07656
-9.0%	0.09927
-8.0%	0.12655
-7.0%	0.15866
-6.0%	0.19568
-5.0%	0.23753
-4.0%	0.28385
-3.0%	0.33412
-2.0%	0.38755
-1.0%	0.44320
0.0%	0.50000
1.0%	0.55680
2.0%	0.61245
3.0%	0.66588
4.0%	0.71615
5.0%	0.76247
6.0%	0.80432
7.0%	0.84134
8.0%	0.87345
9.0%	0.90073
10.0%	0.92344
11.0%	0.94196
12.0%	0.95676
13.0%	0.96835
14.0%	0.97725
15.0%	0.98394
>15.0%	1.00000
Std Deviation = 7.0% Mean = 0.0% Cutoff = +/- 15.0%	

Figure 3-1

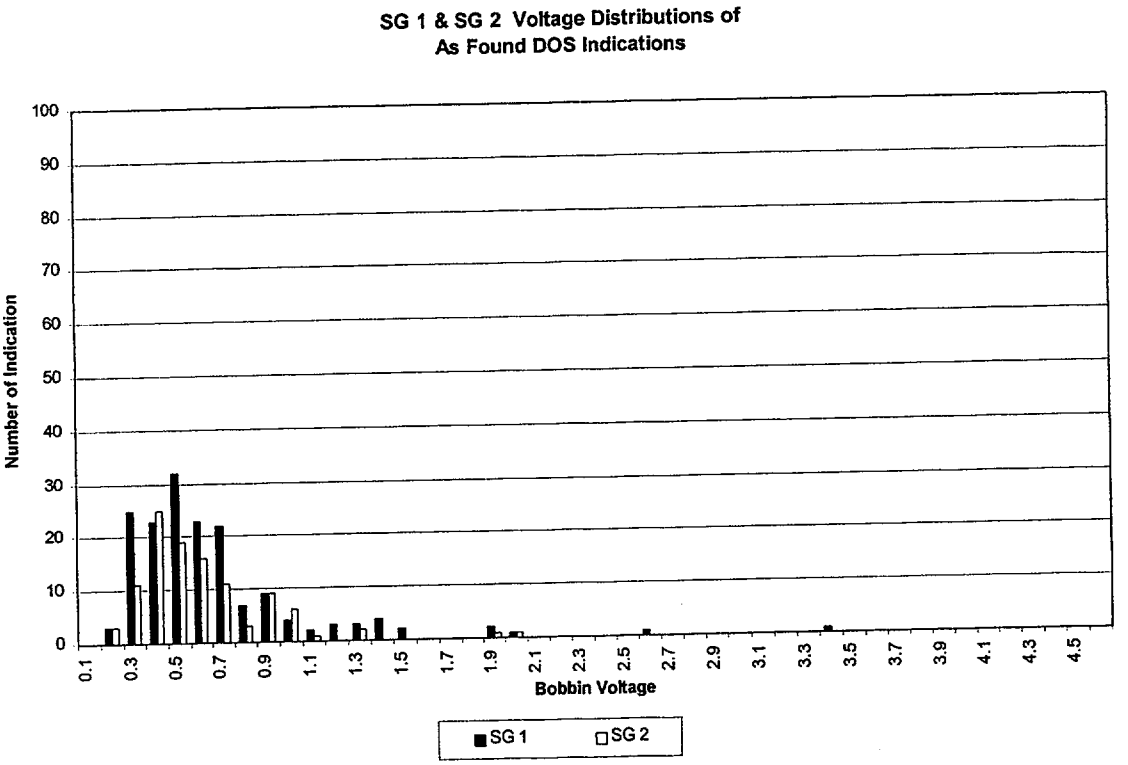


Figure 3-2

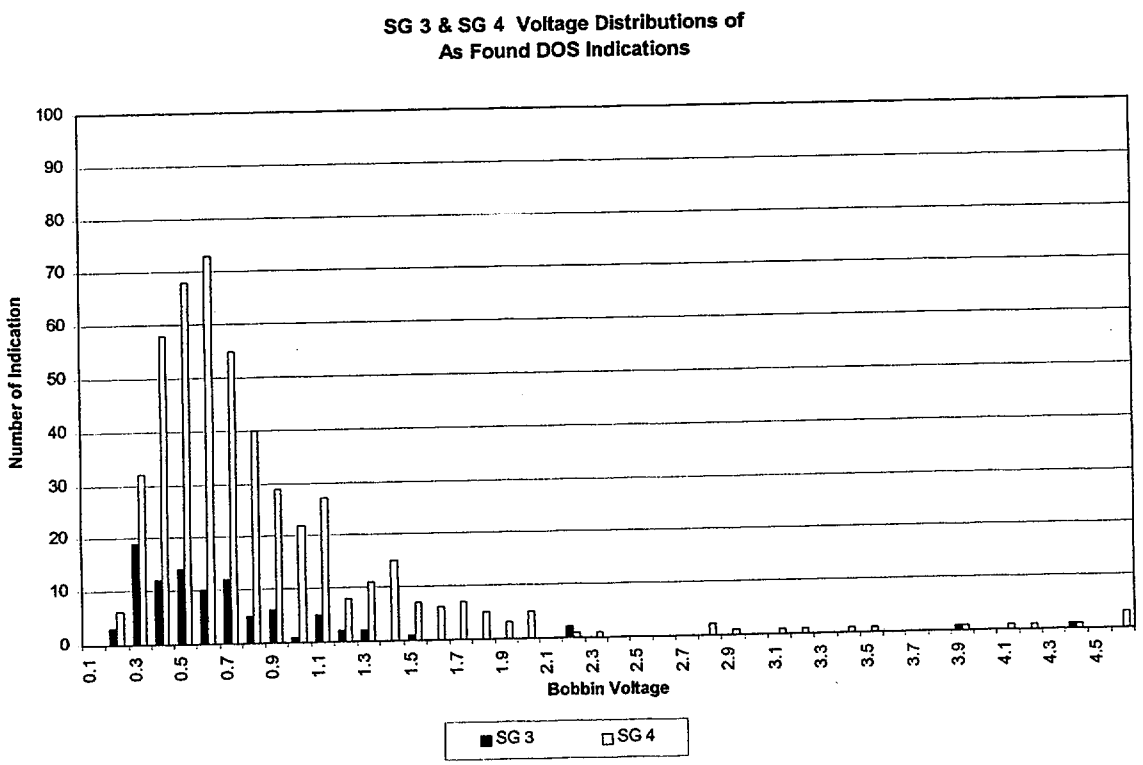


Figure 3-3

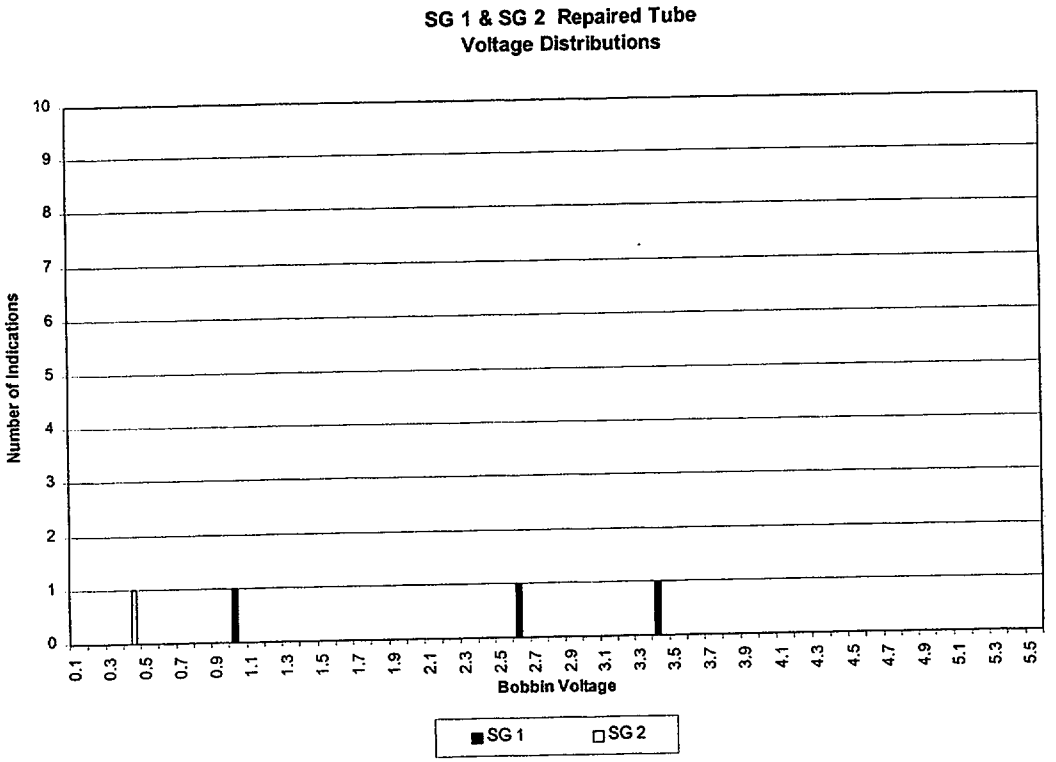


Figure 3-4

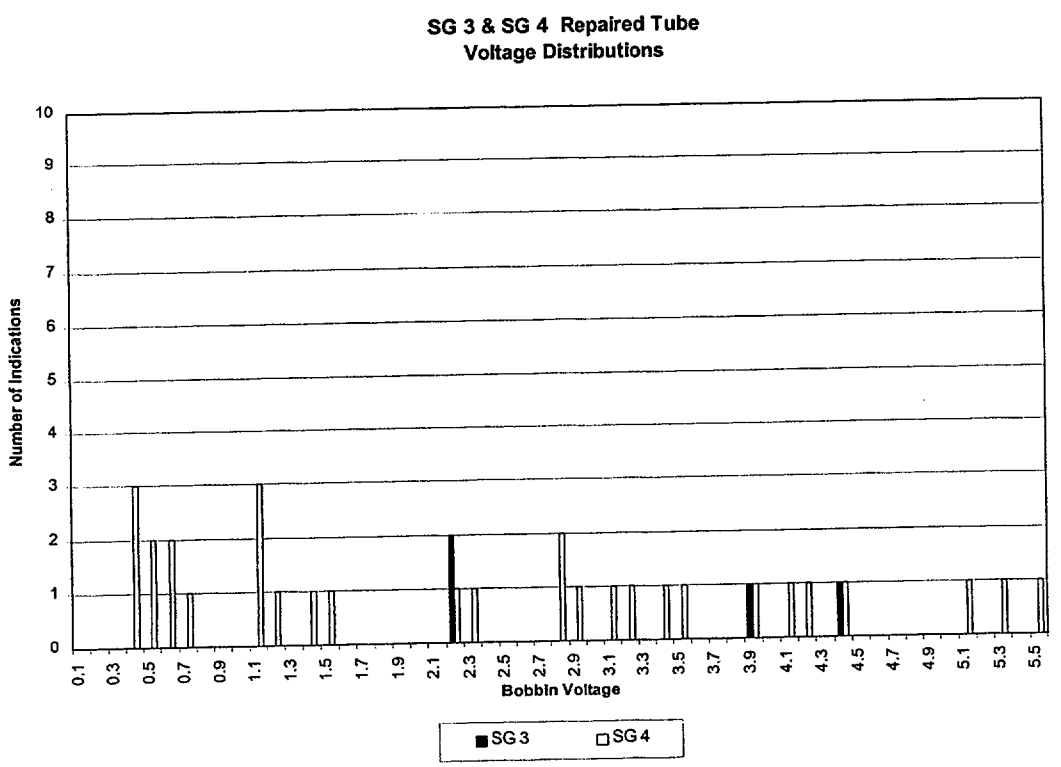


Figure 3-5

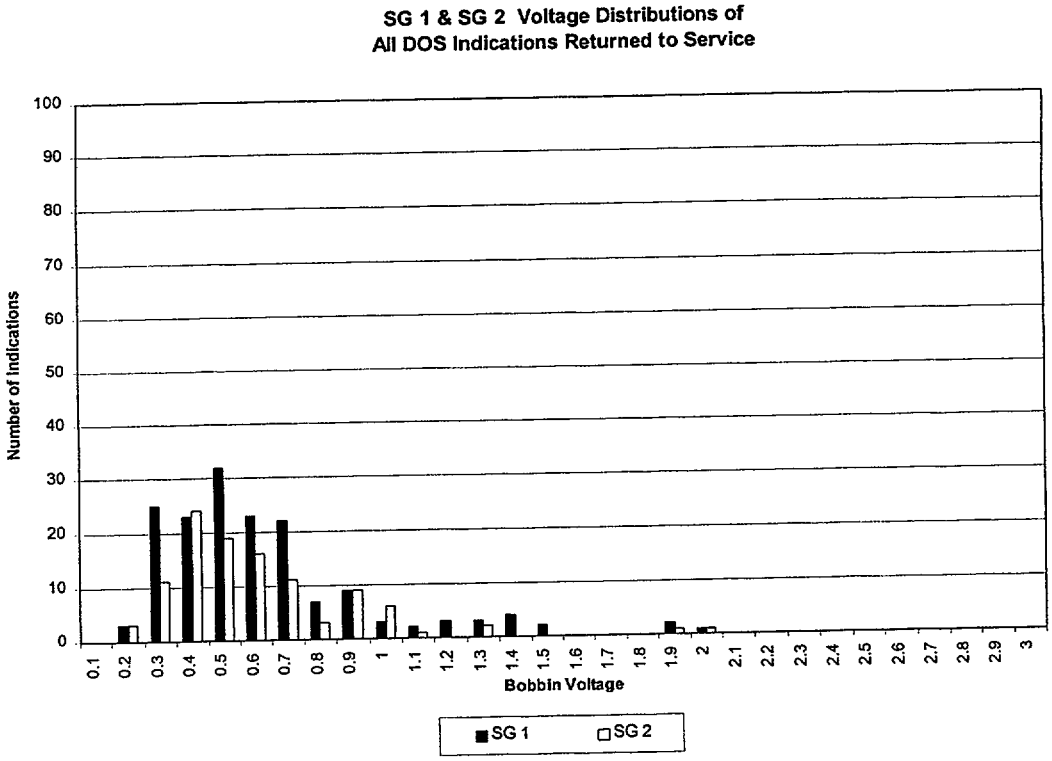


Figure 3-6

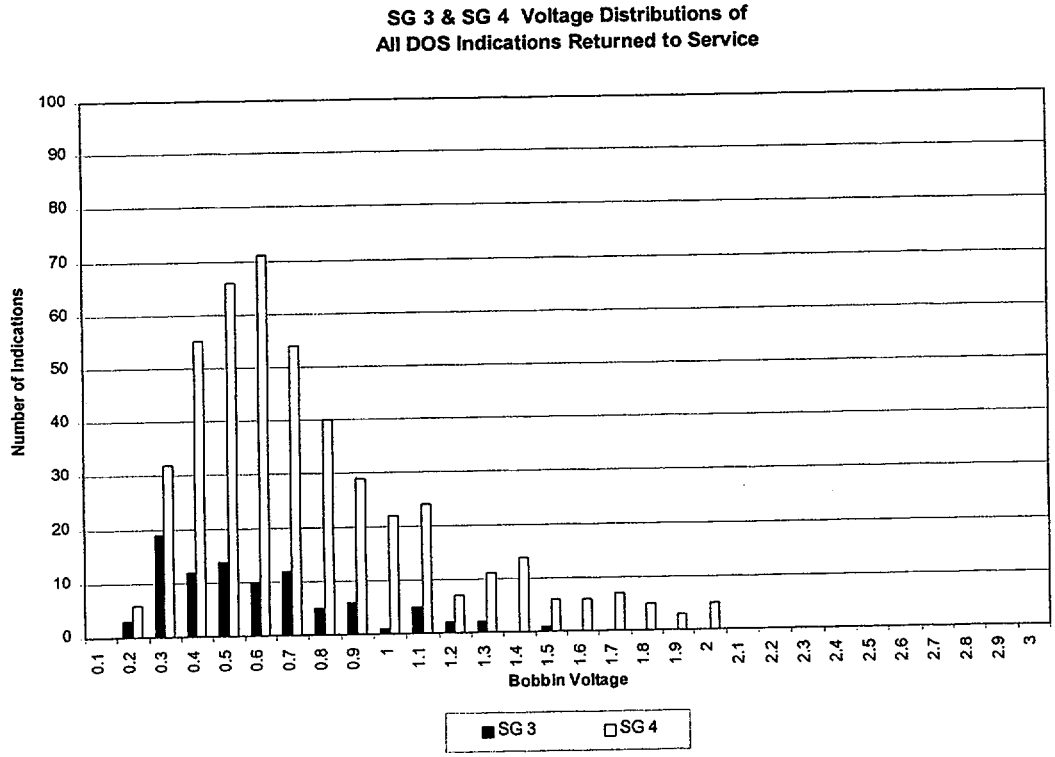
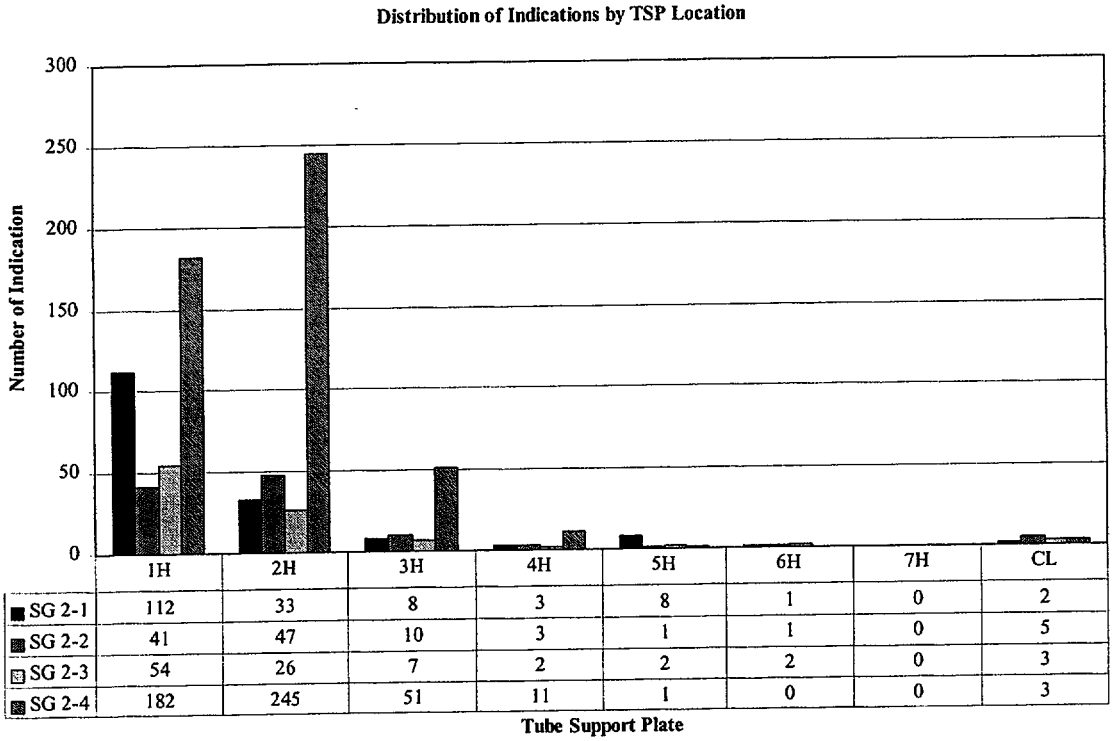


Figure 3-7



	1H	2H	3H	4H	5H	6H	7H	CL
SG 2-1	112	33	8	3	8	1	0	2
SG 2-2	41	47	10	3	1	1	0	5
SG 2-3	54	26	7	2	2	2	0	3
SG 2-4	182	245	51	11	1	0	0	3

Figure 3-8

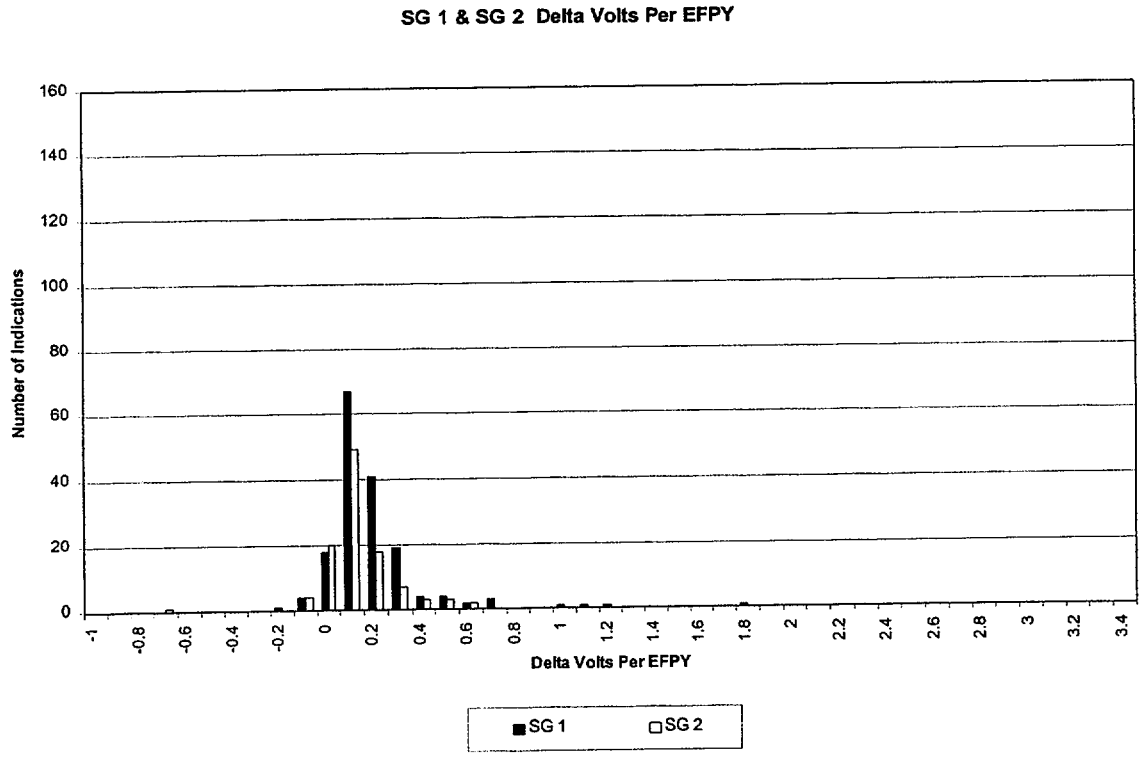


Figure 3-9

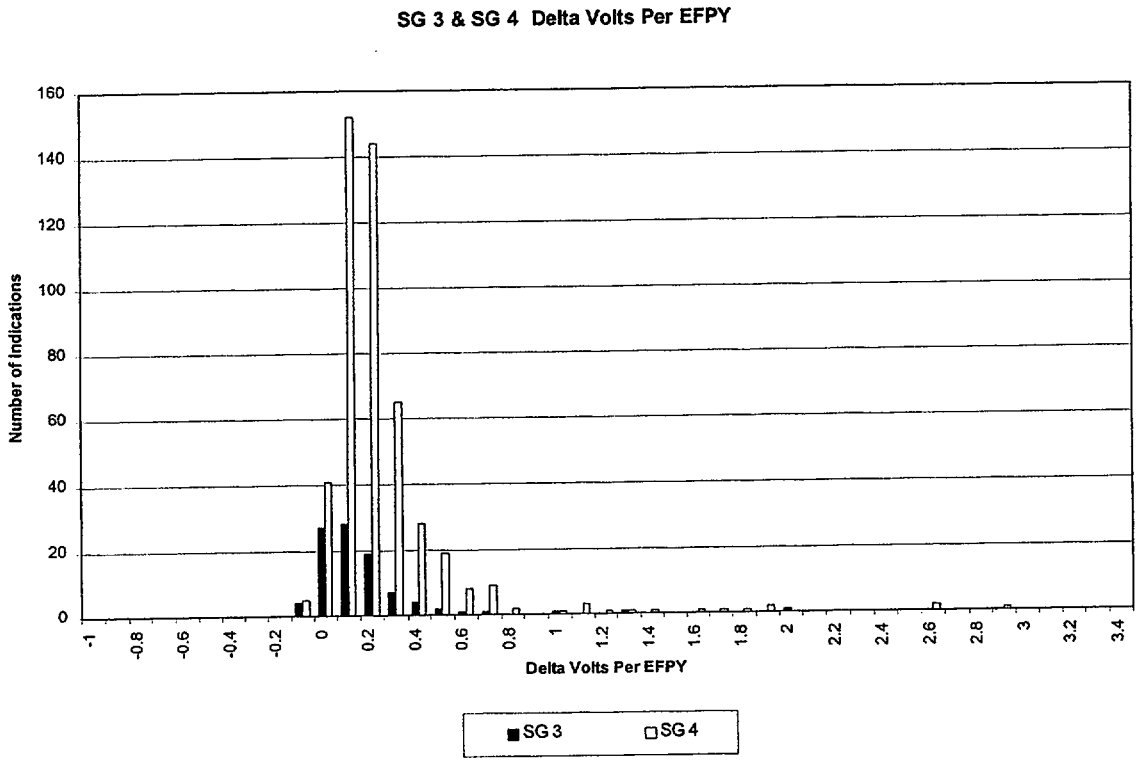

SG 3 & SG 4 Delta Volts Per EFPY
Number of Indications
160
140
120
100
80
60
40
20
0
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
Delta Volts Per EFPY
SG 3
SG 4

Figure 3-10

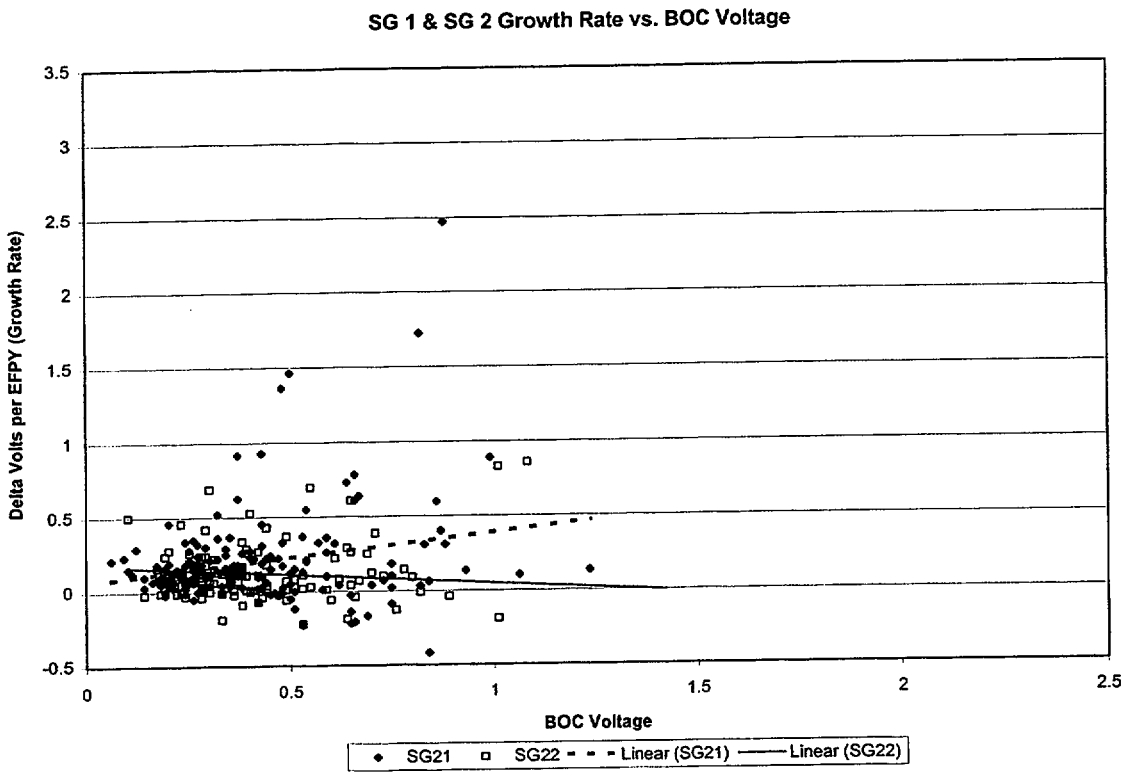


Figure 3-11

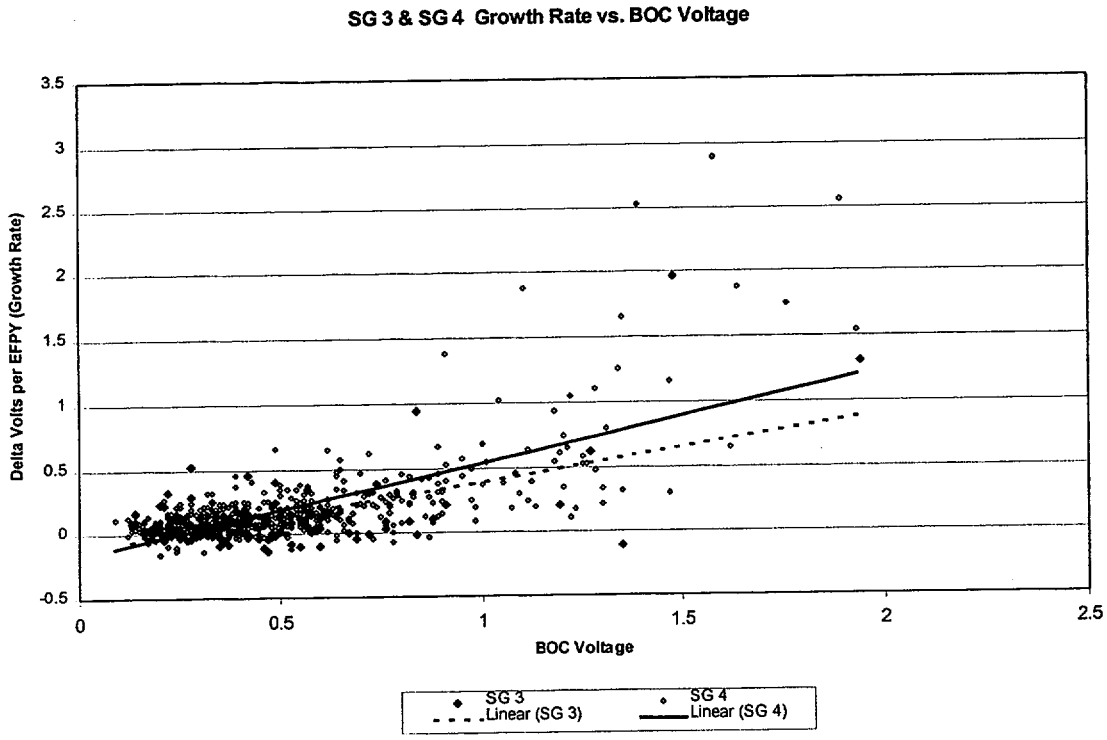


Figure 3-12

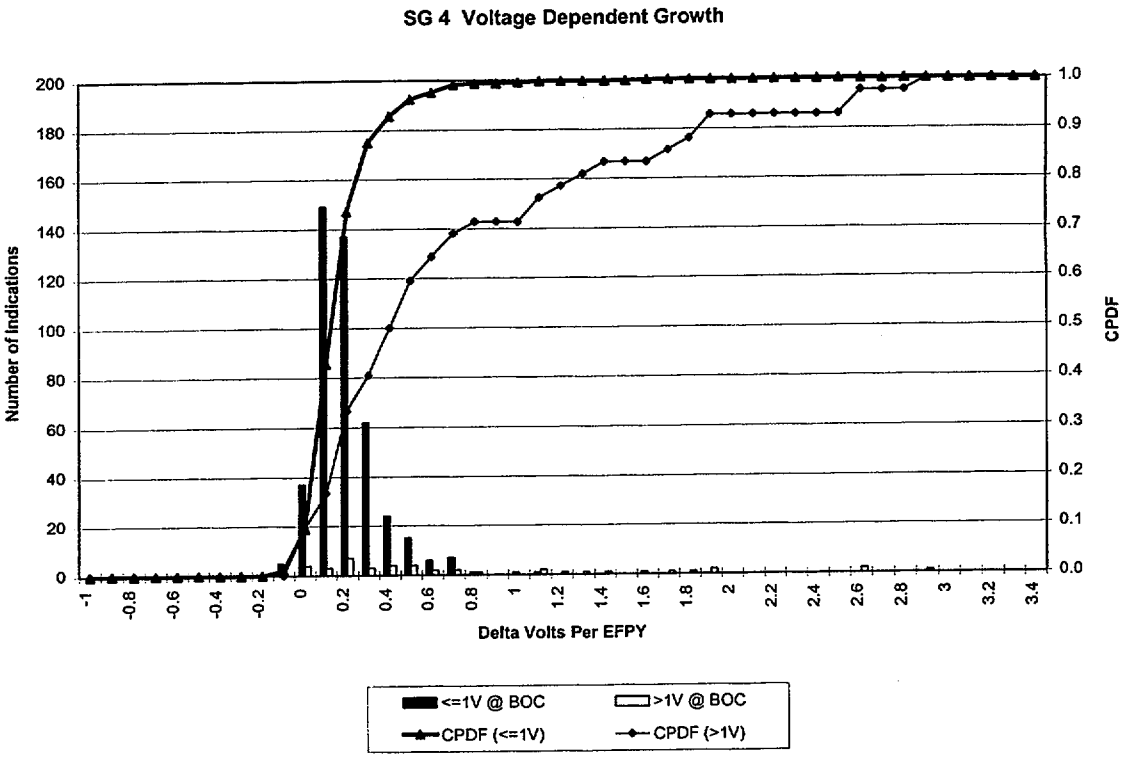


Figure 3-13

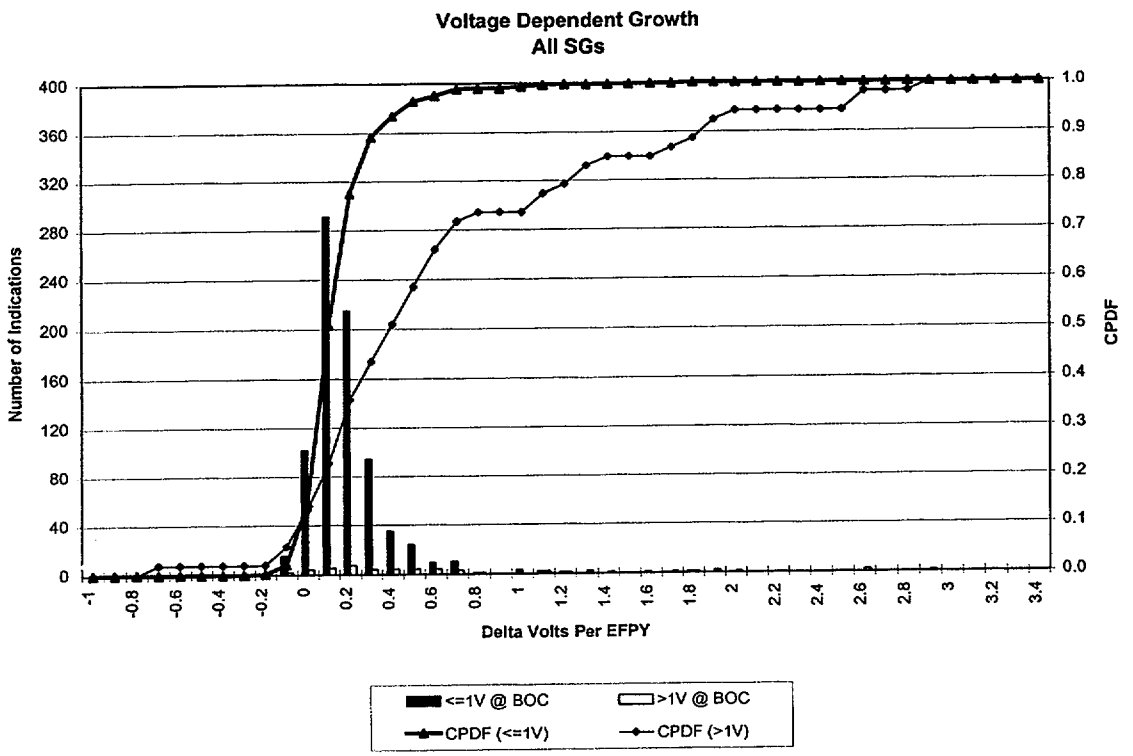


Figure 3-14

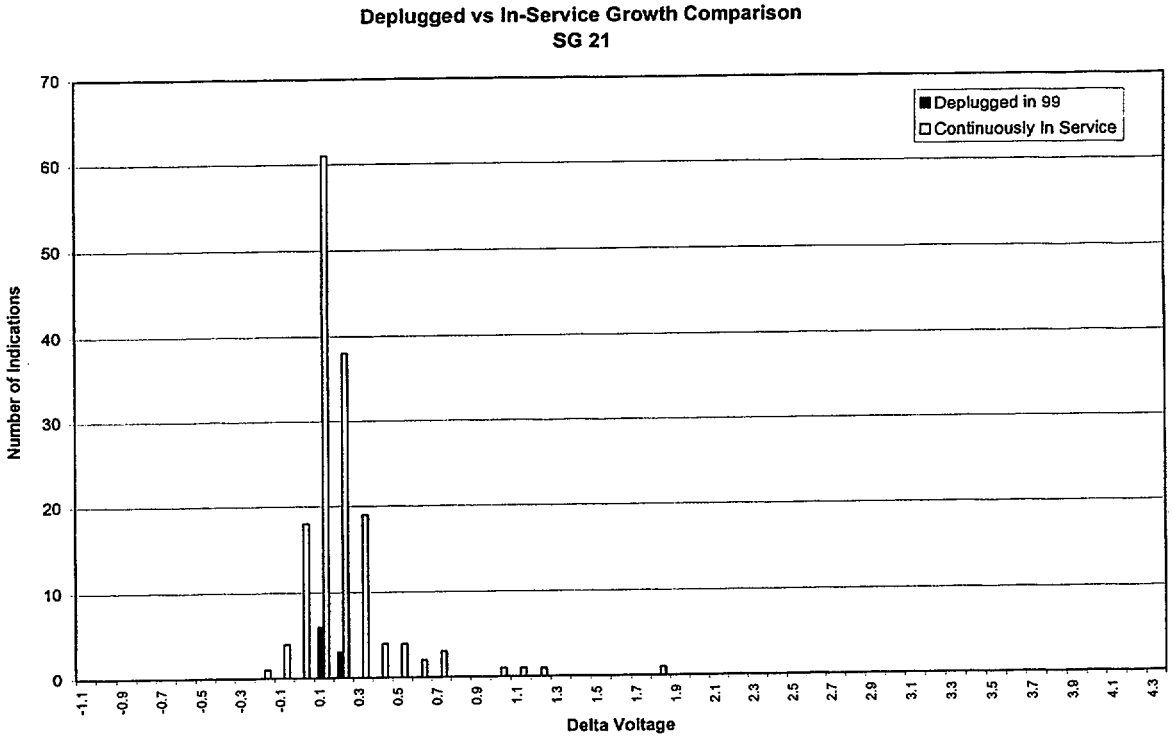


Figure 3-15

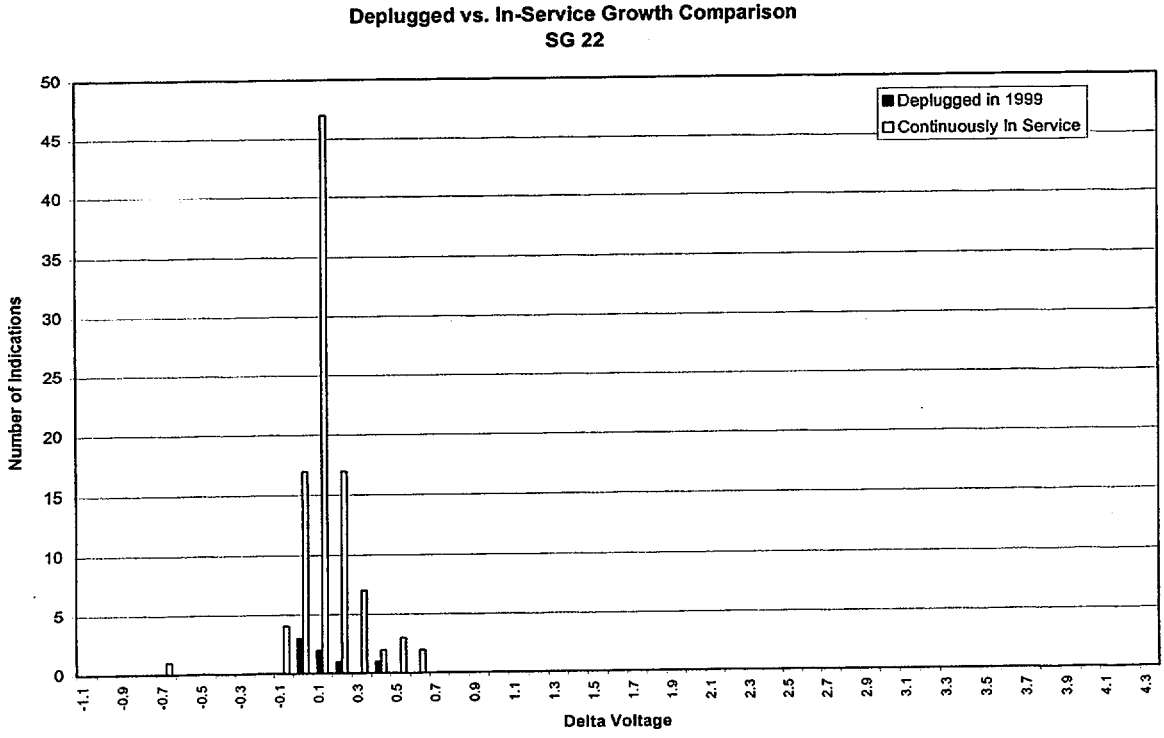


Figure 3-16

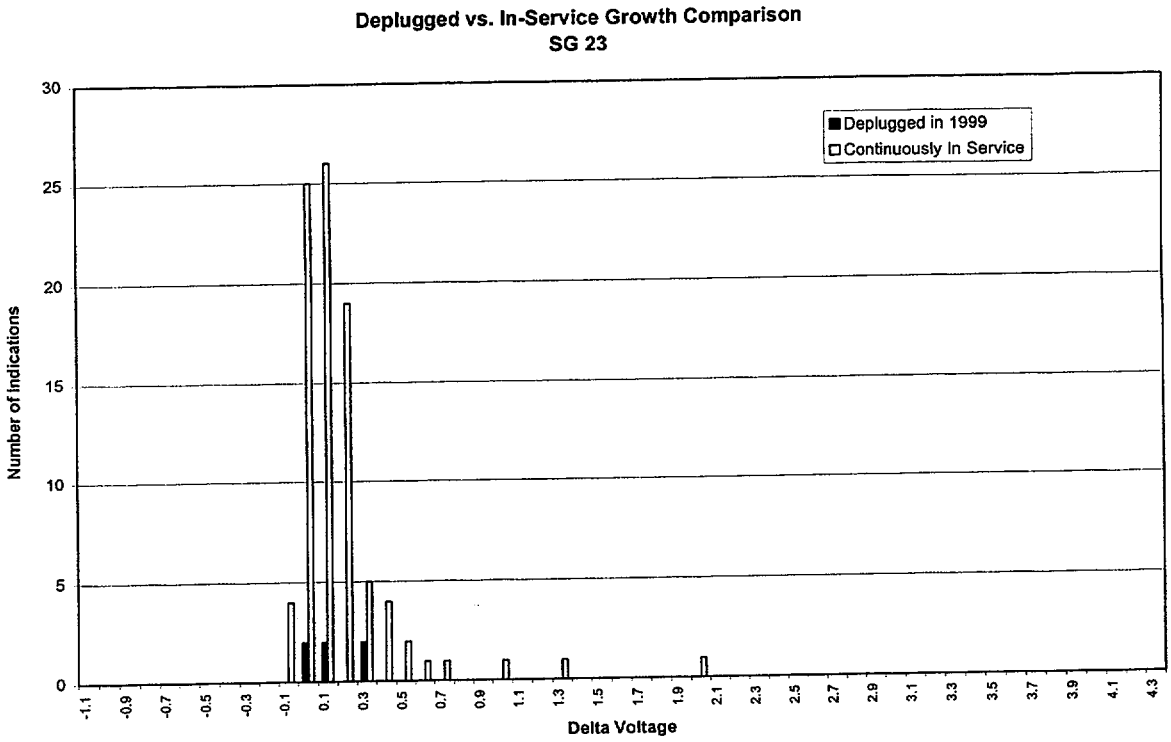


Figure 3-17

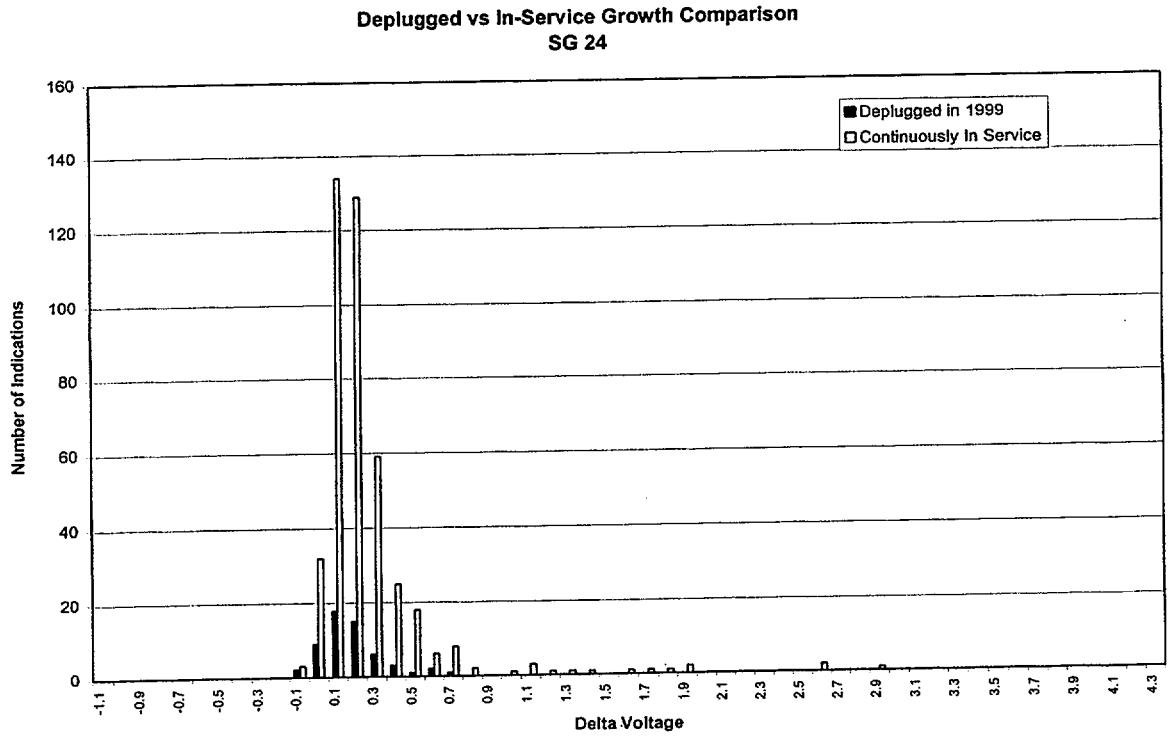


Figure 3-18

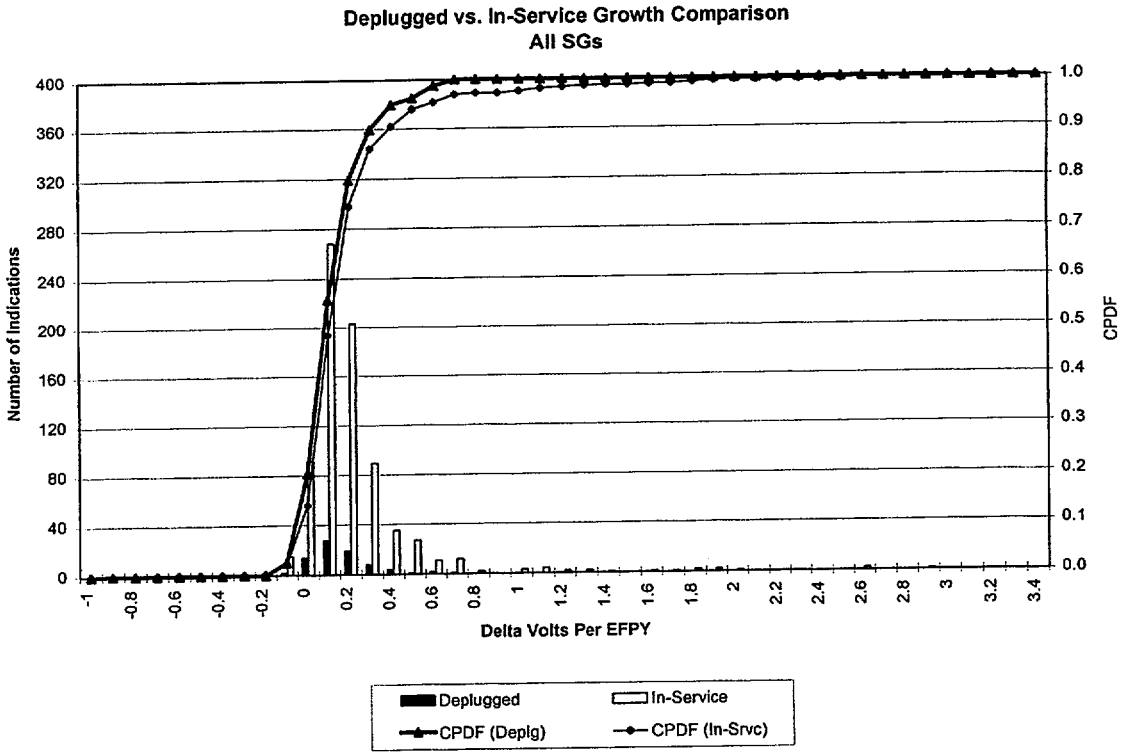


Figure 3-19

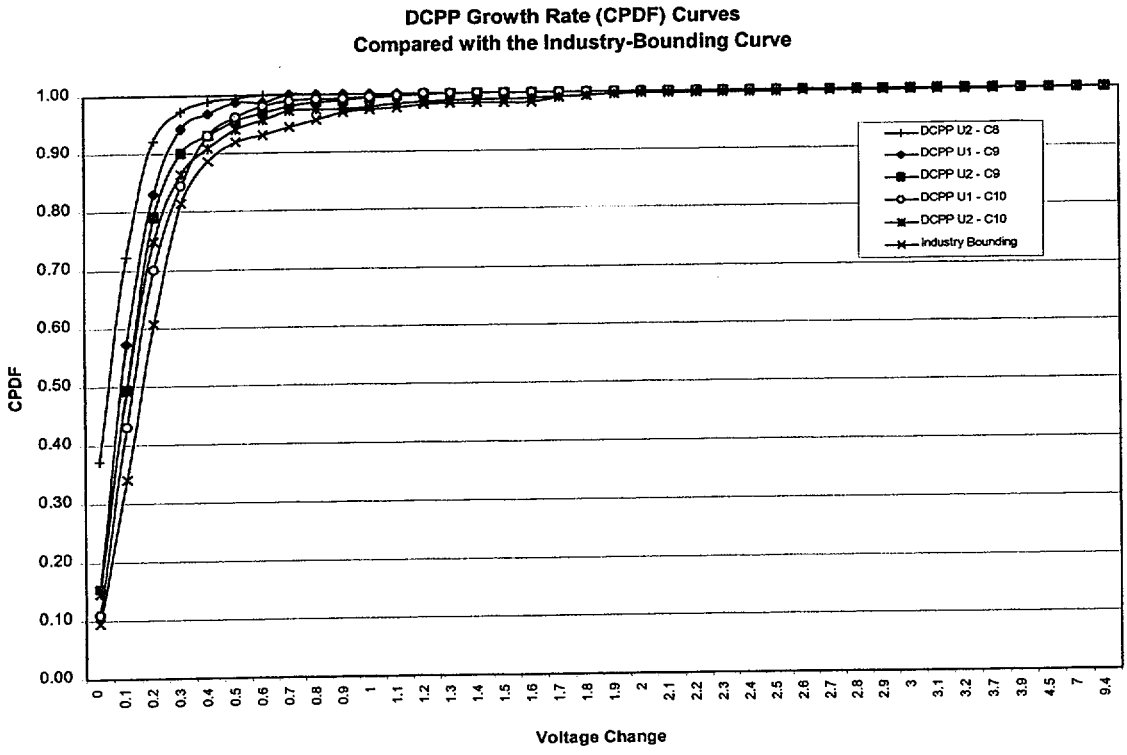


Figure 3-20

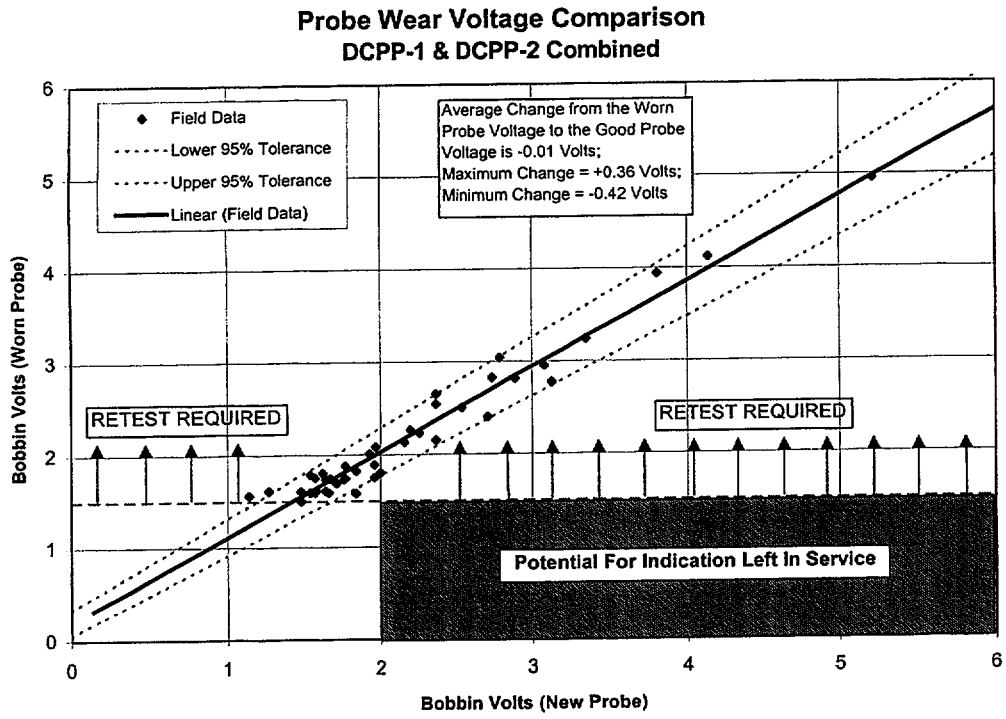
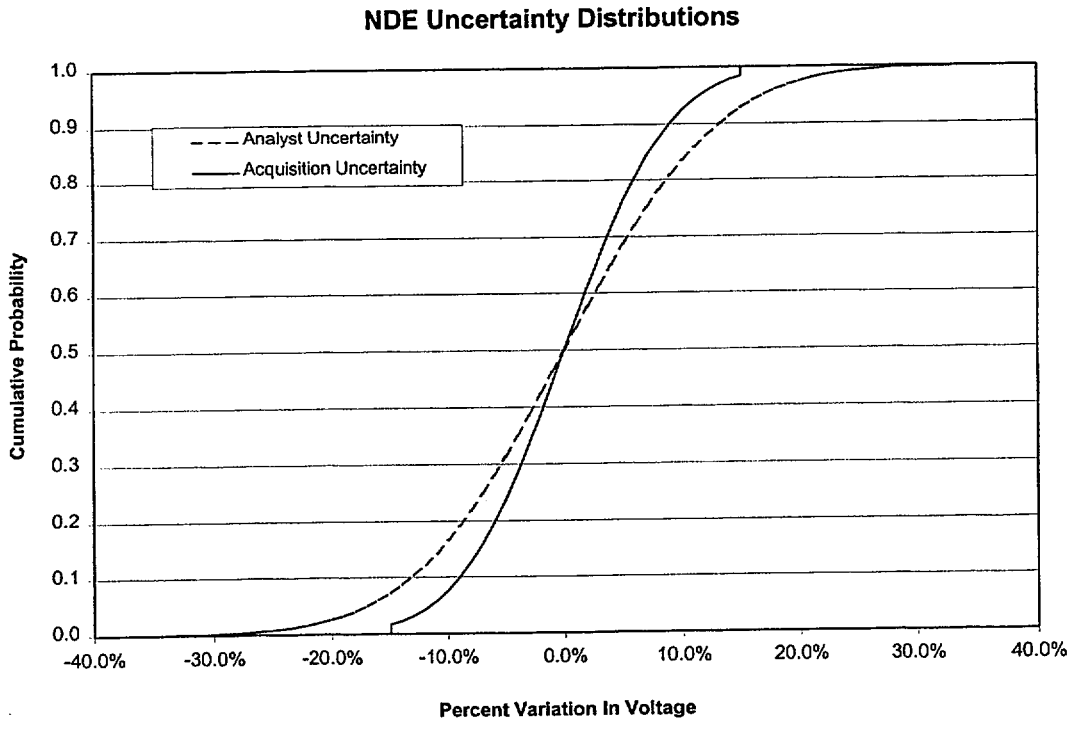


Figure 3-21



4.0 Database Applied for Leak and Burst Correlations

The leak and burst correlations utilized in the analyses presented in this report are based on the Addendum 3 1999 Updated Database (Ref. 13) and Addendum 2 Updated Database (Ref. 20) for the voltage-based repair criteria for 7/8 inch tubing. The leak rate correlations used were developed for a MSLB delta P of 2560 psi. The correlations have been developed specifically for the evaluation of ODSCC indications at TSP locations in Model 51 steam generators and relate Bobbin voltage amplitudes, free span burst pressure, probability of leakage and associated leak rates to assess end of next cycle structural integrity.

4.1 Conditional Probability of Burst

For the burst pressure versus voltage correlation, the database contained in Ref. 13 meets all GL 95-05 requirements and was used in these calculations. Material properties were also considered as part of the calculations and were obtained from Ref. 6. The FTI Monte Carlo computer code was utilized to predict the POB at the end of cycle 11 based upon the input parameters shown in Table 4-1 (from Ref. 13, Table 6-6). This simulation follows the statistical methods presented in Ref. 6.

Table 4-1: Tube Burst Pressure vs. Bobbin Amplitude Correlation

$$P_B = \alpha_0 + \alpha_1 \log(Volts)$$

Parameter	Database	Adjusted Input[1]
α_0	7.57661	8.261536
α_1	-2.39816	-2.61495
r^2	82.3%	82.3%
σ_{Error}	0.82389	0.89837
N (data pairs)	91	91
p Value for α_2	1.60×10^{-35}	1.60×10^{-35}
Reference σ_f	68.78	75

Note:
(1) The slope and intercept coefficients and the standard error value from Ref. 13 were adjusted for a reference flow stress of 75.0 ksi by multiplying those input terms by 1.0904.

4.2 Conditional Leak Rate

Ref. 20 presents the results of the regression analysis for the voltage-dependent leak rate correlation using the updated leak rate database for 7/8" tubes mentioned above. It is shown that the one-sided p-value for the slope parameter in the voltage dependent leak rate correlation is 3.5%, which is below the 5% threshold for an acceptable correlation specified in Generic Letter 95-05.

The methodology used in the calculation of these parameters is consistent with the NRC criteria in Ref. 2. The POL and leak rate correlation parameters used in this analysis are shown in Tables 4-2 and 4-3. The inputs are taken directly from Ref. 13 Table 6-7 and Ref. 20 Table 6-7, respectively.

Table 4-2: 7/8" Tube Probability of Leak Correlation (2560 psi)

$$Pr(Leak) = \{1 + e^{-[\beta 1 + \beta 2 \log(V)]}\}^{-1}$$

Parameter	Database
β_1	-4.31236
β_2	4.21125
$V_{11}^{(1)}$	0.67152
V_{12}	-0.59145
V_{22}	0.59172
$DoF^{(2)}$	137
Deviance	78.81
Pearson SD	75.0%

Notes:

(1) Parameters V_{ij} are elements of the covariance matrix of the coefficients, β_i, of the regression equation.

(2) Degrees of freedom.

Table 4-3: Leak Rate Database for 7/8" Tube ARC Applications

$$Q = 10^{\left(b3 + b4 \times \log(volts) \right)}$$

Parameter	Database
Intercept, b_3	-0.526882
Slope, b_4	0.987179
Index of Deter, r^2	11.7%
Residuals, σ_{Error} (b_5)	0.808109
Data Pairs, N	29
Mean of Log(V)	1.15437
SS of Log(V)	2.39739
p Value for b_4	3.5%

5.0 Bobbin Voltage Distributions

This section describes the prediction of the EOC voltage distribution used for evaluating tube leakage and burst probabilities at the end of the operating period.

5.1 Probability of Detection

The number of bobbin indications used to predict the tube leak rate and burst probability is obtained by adjusting the number of reported indications to account for the detection capability of the bobbin coil. This is accomplished by using a POD factor. The calculation of the bobbin voltage distribution is a net total number of indications returned to service, defined as:

$$N_{BOC11} = \frac{N_{EOC10}}{POD} - N_{repaired} + N_{deplugged}$$

where:

N_{BOC11}	=	Number of bobbin indications being returned to service for the next operating cycle
N_{EOC10}	=	Number of bobbin indications reported in the current inspection
POD	=	Probability of Detection
$N_{repaired}$	=	Number of bobbin indications repaired after the last cycle
$N_{deplugged}$	=	Number of previously plugged indications which are deplugged after the last cycle and are returned to service

Note that no tubes were deplugged and subsequently returned to service this outage. Therefore, $N_{deplugged}$ is equal to zero.

The NRC generic letter (Ref. 2) requires the application of a constant POD equal to 0.6 to define the BOC distribution for the EOC voltage projections. The operating cycle length is required for proper voltage projection calculations: Cycle 10 (actual) = 1.44 EFPY and Cycle 11 (estimated)=1.61 EFPY (Ref. 23).

5.2 Probability of Prior Cycle Detection

For voltage-based repair criteria applications, the important indications are those that could significantly contribute to EOC leakage or burst probability. These significant indications can be expected to be detected by bobbin and confirmed by the plus point inspection. Thus, the population of interest for POD assessments is the EOC RPC confirmed indications that were or were not detected at the prior inspection. The probability of prior cycle detection (POPCD) is defined as follows:

$$POPCD_{EOC\text{-}9} = \frac{\text{EOC-10 RPC confirmed and detected at EOC-9} + \text{EOC-9 RPC confirmed and repaired at EOC-9}}{\text{(NUMERATOR)} + \text{New EOC-10 RPC confirmed indications}}$$

The POPCD evaluation for the 1999 EOC-9 inspection data is summarized in Table 5-1 and Figure 5-1. The predicted POPCD values based on both RPC confirmed indications only and RPC confirmed and not inspected indications approach 0.9 at about 1.0 volts and reach unity at approximately 2.0 volts. Although the Diablo Canyon POPCD distribution has a limited number of data points, it illustrates that using the EPRI generic POPCD distribution is conservative. The EPRI POPCD distribution is in Reference 22. The EPRI generic POPCD was used in calculating the BOC-11 voltage distribution. This POPCD evaluation supports a voltage dependent POD.

5.3 Calculation of BOC-11 Voltage Distributions

First, the initial condition of the steam generator at BOC-11 is determined from ECT inspection data. The BOC-11 distribution is calculated by dividing the as-found condition of the SG by the probability of detection (POD), and subtracting the number of repaired tubes. For this analysis, the BOC-11 distributions for each SG were calculated using two POD functions: 0.6 and probability of prior cycle detection (POPCD) from EPRI (Ref. 22). Table 5-2, Table 5-3, Table 5-4, and Table 5-5 summarize the as-found distribution, repaired tubes, and the two calculated BOC-11 distributions for SG 2-1, SG 2-2, SG 2-3, and SG 2-4 respectively. The distributions using POPCD are for information only.

5.4 Predicted EOC-11 Voltage Distributions

Once the BOC-11 voltage distribution has been determined, the EOC-11 voltage distributions are obtained by applying a Monte Carlo sampling process to the BOC-11 voltages. This process randomly assigns uncertainty values and a growth value to each of the BOC-11 indications. The EOC-11 voltage distributions are used to calculate a leak rate and probability of tube burst. Table 5-6 summarizes the BOC and growth voltage distributions used for the leak rate and burst simulations.

Table 5-7 and Table 5-8 summarize the EOC-11 voltage distributions for 0.6 POD and POPCD, respectively; using composite normal growth distributions for SG 2-1, SG 2-2, and SG 2-3, SG 2-4 specific normal growth distribution for SG 2-4, composite voltage dependent growth distributions for SG 2-3, and SG 2-4 specific voltage dependent growth distributions for SG 2-4. Figure 5-6, Figure 5-7, Figure 5-8, Figure 5-9, Figure 5-10, and Figure 5-11 illustrate the calculated BOC-11 and EOC-11 voltage distributions for 0.6 POD and POPCD for SG 2-1, SG 2-2, SG 2-3, and SG 2-4, respectively. As expected, SG 2-4 has the largest number of indications at EOC-11 and also has the largest voltage indications.

5.5 *Comparison of Predicted and Actual EOC-10 Voltage Distributions, Leak Rate and Probability of Burst*

The actual EOC-10 bobbin voltage distributions and the predictions from the previous 90-day report (Ref. 8) are compared in Table 5-9 and Table 5-10 and Figure 5-12 through Figure 5-15. The total number of indications found at EOC-10 and projected is very similar; however, as seen in the figures the projected voltage distributions on average display a population with larger voltages. Note in Figure 5-14 and Figure 5-15 that the as-found population of larger voltages differs from the projected population. The most likely contributor is the voltage dependent growth that was not used in the Cycle 10 projections.

The leak rate and probability of burst projected and actual EOC-10 were also compared in Table 5-10. The projected leak rates were greater than the actual EOC-10 leak rates for all SGs. However, the projected probability of burst for SG 2-3 and SG 2-4 was slightly lower than actual EOC-10. Again, the most likely contributor to the underprediction is the voltage dependent growth.

Table 5-1: Diablo Canyon Unit 2 POPCD Evaluation

Composite of All Steam Generator Data

Voltage Bin	New Indications		Bobbin Call In Both Inspections		First Inspection	POPCD			
	RPC Confirmed	RPC Confirmed Plus Not Inspected	RPC Confirmed	RPC Confirmed Plus Not Inspected	RPC Confirmed and Plugged	RPC Confirmed		RPC Confirmed Plus Not Inspected	
						Frac	Count	Frac	Count
>0 - 0.2	4	61	1	19	0	0.200	1/5	0.238	19/80
0.2 - 0.4	22	171	5	147	6	0.333	11/33	0.472	153/324
0.4 - 0.6	20	82	4	156	7	0.355	11/31	0.665	163/245
0.6 - 0.8	9	28	1	77	2	0.250	3/12	0.738	79/107
0.8 - 1.0	2	7	5	43	0	0.714	5/7	0.860	43/50
1.0 - 1.2	0	2	4	20	0	1.000	4/4	0.909	20/22
1.2 - 1.6	1	1	14	24	0	0.933	14/15	0.960	24/25
1.6 - 2.0	0	0	6	6	0	1.000	6/6	1.000	6/6
2.0 - 2.5	0	0	0	0	4	1.000	4/4	1.000	4/4
2.5 - 3.2	0	0	0	0	2	1.000	2/2	1.000	2/2
3.2 - 3.5	0	0	0	0	0				
TOTAL	58	352	40	492	21				
Total >1v	1	3	24	50	6				

Table 5-2: SG 2-1 As-Found and BOC-11 Voltage Distribution

							DOSs Returned to Service	
Voltage Bin	As-found EOC-10	POD (0.6)	Repaired Tubes	Calculated BOC-11	POPCD EPRI	Calc. POPCD BOC-11	Conf. OD-SCC or Not Insp. w/+Pt	Total (1)
0.1								
0.2	3	5		5	9.09	9.09	3	3
0.3	25	41.67		41.67	54.35	54.35	25	25
0.4	23	38.33		38.33	41.82	41.82	23	23
0.5	32	53.33		53.33	50.79	50.79	30	32
0.6	23	38.33		38.33	32.86	32.86	21	23
0.7	22	36.67		36.67	28.95	28.95	22	22
0.8	7	11.67		11.67	8.86	8.86	6	7
0.9	9	15		15	10.84	10.84	8	9
1	4	6.67	1	5.67	4.76	3.76	3	3
1.1	2	3.33		3.33	2.33	2.33	2	2
1.2	3	5		5	3.41	3.41	3	3
1.3	3	5		5	3.37	3.37	3	3
1.4	4	6.67		6.67	4.44	4.44	4	4
1.5	2	3.33		3.33	2.21	2.21	2	2
1.6								
1.7								
1.8								
1.9	2	3.33		3.33	2.16	2.16	2	2
2	1	1.67		1.67	1.08	1.08	1	1
2.1								
2.2								
2.3								
2.4								
2.5								
2.6	1	1.67	1	0.67	1.04	0.04		
2.7								
2.8								
2.9								
3								
3.1								
3.2								
3.3								
3.4	1	1.67	1	0.67	1			
3.5								
3.6								
3.7								
3.8								
3.9								
4								
4.1								
4.2								
4.3								
4.4								
4.5								
>4.5								
Total	167	278.34	3	275.34	263.36	260.36	158	164

Note: Total includes all DOSs returned to service, i.e., confirmed, not inspected, and not confirmed with plus point.

Table 5-3: SG 2-2 As-Found and BOC-11 Voltage Distribution

Voltage Bin	As-found EOC-10	POD (0.6)	Repaired Tubes	Calculated BOC-11	POPCD EPRI	Calc. POPCD BOC-11	DOSs Returned to Service: Conf. OD-SCC or Not Insp. w/+Pt	DOSs Returned to Service: Total (1)
0.1								
0.2	3	5		5	9.09	9.09	3	3
0.3	11	18.33		18.33	23.91	23.91	9	11
0.4	25	41.67	1	40.67	45.45	44.45	22	24
0.5	19	31.67		31.67	30.16	30.16	19	19
0.6	16	26.67		26.67	22.86	22.86	16	16
0.7	11	18.33		18.33	14.47	14.47	10	11
0.8	3	5		5	3.8	3.8	3	3
0.9	9	15		15	10.84	10.84	9	9
1	6	10		10	7.14	7.14	6	6
1.1	1	1.67		1.67	1.16	1.16	1	1
1.2								
1.3	2	3.33		3.33	2.25	2.25	2	2
1.4								
1.5								
1.6								
1.7								
1.8								
1.9	1	1.67		1.67	1.08	1.08	1	1
2	1	1.67		1.67	1.08	1.08	1	1
2.1								
2.2								
2.3								
2.4								
2.5								
2.6								
2.7								
2.8								
2.9								
3								
3.1								
3.2								
3.3								
3.4								
3.5								
3.6								
3.7								
3.8								
3.9								
4								
4.1								
4.2								
4.3								
4.4								
4.5								
>4.5								
Total	108	180.01	1	179.01	173.29	172.29	102	107

Note: Total includes all DOSs returned to service, i.e., confirmed, not inspected, and not confirmed with plus point.

Table 5-4: SG 2-3 As-Found and BOC-11 Voltage Distribution

							DOSs Returned to Service	
Voltage Bin	As-found EOC-10	POD (0.6)	Repaired Tubes	Calculated BOC-11	POPCD EPRI	Calc. POPCD BOC-11	Conf. OD-SCC or Not Insp. w/+Pt	Total (1)
0.1								
0.2	3	5		5	9.09	9.09	3	3
0.3	19	31.67		31.67	41.3	41.3	17	19
0.4	12	20		20	21.82	21.82	12	12
0.5	14	23.33		23.33	22.22	22.22	13	14
0.6	10	16.67		16.67	14.29	14.29	9	10
0.7	12	20		20	15.79	15.79	12	12
0.8	5	8.33		8.33	6.33	6.33	5	5
0.9	6	10		10	7.23	7.23	6	6
1	1	1.67		1.67	1.19	1.19	1	1
1.1	5	8.33		8.33	5.81	5.81	5	5
1.2	2	3.33		3.33	2.27	2.27	2	2
1.3	2	3.33		3.33	2.25	2.25	2	2
1.4								
1.5	1	1.67		1.67	1.1	1.1	1	1
1.6								
1.7								
1.8								
1.9								
2								
2.1								
2.2	2	3.33	2	1.33	2.13	0.13		
2.3								
2.4								
2.5								
2.6								
2.7								
2.8								
2.9								
3								
3.1								
3.2								
3.3								
3.4								
3.5								
3.6								
3.7								
3.8								
3.9	1	1.67	1	0.67	1			
4								
4.1								
4.2								
4.3								
4.4	1	1.67	1	0.67	1			
4.5								
>4.5								
Total	96	160	4	156	154.82	150.82	88	92

Note: Total includes all DOSs returned to service, i.e., confirmed, not inspected, and not confirmed with plus point.

Table 5-5: SG 2-4 As-Found and BOC-11 Voltage Distribution

							DOSs Returned to Service	
Voltage Bin	As-found EOC-10	POD (0.6)	Repaired Tubes	Calculated BOC-11	POPCD EPRI	Calc. POPCD BOC-11	Conf. OD-SCC or Not Insp. w/+Pt	Total (1)
0.1								
0.2	6	10		10	18.18	18.18	6	6
0.3	32	53.33		53.33	69.57	69.57	32	32
0.4	58	96.67	3	93.67	105.45	102.45	55	56
0.5	68	113.33	2	111.33	107.94	105.94	66	66
0.6	73	121.67	2	119.67	104.29	102.29	72	72
0.7	55	91.67	1	90.67	72.37	71.37	52	54
0.8	40	66.67		66.67	50.63	50.63	40	40
0.9	29	48.33		48.33	34.94	34.94	29	29
1	22	36.67		36.67	26.19	26.19	22	22
1.1	27	45	3	42	31.4	28.4	24	24
1.2	8	13.33	1	12.33	9.09	8.09	7	7
1.3	11	18.33		18.33	12.36	12.36	11	11
1.4	15	25	1	24	16.67	15.67	14	14
1.5	7	11.67	1	10.67	7.73	6.73	6	6
1.6	6	10		10	6.59	6.59	6	6
1.7	7	11.67		11.67	7.65	7.65	7	7
1.8	5	8.33		8.33	5.43	5.43	5	5
1.9	3	5		5	3.24	3.24	3	3
2	5	8.33		8.33	5.38	5.38	5	5
2.1								
2.2	1	1.67	1	0.67	1.06	0.06		
2.3	1	1.67	1	0.67	1.06	0.06		
2.4								
2.5								
2.6								
2.7								
2.8	2	3.33	2	1.33	2.06	0.06		
2.9	1	1.67	1	0.67	1.03	0.03		
3								
3.1	1	1.67	1	0.67	1.02	0.02		
3.2	1	1.67	1	0.67	1.01	0.01		
3.3								
3.4	1	1.67	1	0.67	1			
3.5	1	1.67	1	0.67	1			
3.6								
3.7								
3.8								
3.9	1	1.67	1	0.67	1			
4								
4.1	1	1.67	1	0.67	1			
4.2	1	1.67	1	0.67	1			
4.3								
4.4	1	1.67	1	0.67	1			
4.5								
>4.5	3	5.00	3	2.00	3			
Total	493	821.67	30	791.67	711.34	681.34	463	463

Note: Total includes all DOSs returned to service, i.e., confirmed, not inspected, and not confirmed with plus point.

Table 5-6: Summary of Monte Carlo Simulations

	BOC Distribution	Growth Distribution
SG 2-1	1. POD=0.6 2. EPRI POPCD	1. Composite Normal 2. Composite Normal
SG 2-2	1. POD=0.6 2. EPRI POPCD	1. Composite Normal 2. Composite Normal
SG 2-3	1. POD=0.6 2. EPRI POPCD	1. Composite Normal and Composite Voltage Dependent 2. Composite Normal and Composite Voltage Dependent
SG 2-4	1. POD=0.6 2. EPRI POPCD	1. SG 2-4 specific Normal and SG 2-4 specific Voltage Dependent 2. SG 2-4 specific Normal and SG 2-4 specific Voltage Dependent

Table 5-7: EOC-11 Distributions with POD=0.6

Voltage Bin	Normal Growth				Voltage Dependent Growth	
	SG 1	SG 2	SG 3	SG 4	SG 3	SG 4
0.1	0.0352	0.0354	0.0354	0.0457	0.0357	0.0456
0.2	1.2099	0.8802	1.0684	1.2932	1.0756	1.2907
0.3	6.1569	3.6294	4.6632	6.4033	4.7156	6.4837
0.4	12.8524	8.7859	8.6452	17.1565	8.9218	17.7687
0.5	21.8614	15.2161	13.3753	34.7063	13.8690	36.3996
0.6	29.8158	20.3075	16.6767	55.1153	17.2524	57.9234
0.7	31.9175	22.2377	16.5530	70.7933	17.1217	74.4505
0.8	32.1118	20.7648	16.6333	78.3955	17.1878	82.3408
0.9	27.4110	18.0508	14.3550	77.3316	14.7576	80.9237
1	22.3252	14.8777	12.2824	70.0281	12.4777	72.5434
1.1	17.4740	12.0825	10.2794	60.8283	9.9990	60.9333
1.2	13.2797	9.6418	8.2462	51.3919	7.3536	48.1280
1.3	10.5036	7.3031	6.7550	42.9507	5.3877	36.8051
1.4	8.6239	5.4361	5.5149	35.9803	4.0283	28.0423
1.5	7.1044	3.9986	4.2796	30.1206	2.9636	21.5345
1.6	5.8009	2.8344	3.1997	25.2450	2.2132	17.1662
1.7	4.5467	1.9954	2.2870	21.1022	1.6959	14.3744
1.8	3.4774	1.4257	1.6223	17.4680	1.3836	12.4371
1.9	2.7089	1.1110	1.1967	14.3570	1.2392	10.9745
2	2.1801	1.0061	0.8964	11.8201	1.1071	9.7602
2.1	1.8829	0.9500	0.7478	9.8394	1.0291	8.7490
2.2	1.6207	0.8806	0.6323	8.1503	0.9119	7.7882
2.3	1.3871	0.7635	0.5585	6.6435	0.7638	6.7847
2.4	1.1794	0.6466	0.5109	5.3306	0.5900	5.7293
2.5	0.9516	0.5408	0.4277	4.2226	0.4280	4.6751
2.6	0.7622	0.4312	0.3566	3.3429	0.2987	3.7575
2.7	0.5830	0.3331	0.2789	2.6462	0.2445	3.1808
2.8	0.4608	0.2464	0.2303	2.1251	0.2689	2.9859
2.9	0.3870	0.1972	0.1997	1.7781	0.3113	2.9548
3	0.3429	0.1723	0.1719	1.5674	0.3234	2.9094
3.1	0.3273	0.1646	0.1588	1.4689	0.3556	2.8572
3.2	0.3606	0.1717	0.1819	1.4391	0.3872	2.7793
3.3	0.3708	0.1900	0.1819	1.4599	0.3505	2.6305
3.4	0.3931	0.2009	0.1930	1.5032	0.2849	2.3736
3.5	0.3855	0.2015	0.1891	1.4780	0.2094	2.0571
3.6	0.3442	0.1778	0.1728	1.3622	0.1536	1.7786
3.7	0.2856	0.1396	0.1566	1.1875	0.1389	1.6586
3.8	0.2231	0.1033	0.1417	0.9868	0.1578	1.6767
3.9	0.1659	0.0762	0.1305	0.8251	0.1925	1.7806
4	0.1233	0.0535	0.1220	0.7027	0.2433	2.0080
4.1	0.0945	0.0379	0.1162	0.6091	0.2962	2.2427
4.2	0.0743	0.0244	0.1112	0.5322	0.3190	2.2336
4.3	0.0609	0.0168	0.1076	0.4782	0.2985	2.0387
4.4	0.0753	0.0266	0.1225	0.4982	0.2444	1.7820
4.5	0.1298	0.0598	0.1564	0.6331	0.1854	1.5267
>4.5	0.9711	0.5828	1.0783	8.3692	2.2288	20.4440
Total	275.3397	179.0093	155.9999	791.7124	156.0017	791.7081

Table 5-8: EOC-11 Voltage Distributions with EPRI POPCD

Voltage Bin	Normal Growth				Voltage Dependent Growth	
	SG 1	SG 2	SG 3	SG 4	SG 3	SG 4
0.1	0.0636	0.0641	0.0638	0.0831	0.0645	0.0831
0.2	1.8978	1.4694	1.7147	2.0982	1.7254	2.0970
0.3	8.2422	4.9310	6.3750	8.7528	6.4662	8.9059
0.4	15.9730	10.8386	11.1539	21.3694	11.5431	22.2408
0.5	25.3877	17.5192	16.2378	40.1023	16.8613	42.1537
0.6	32.1042	21.7385	18.6933	58.7166	19.3443	61.7554
0.7	31.8976	22.4957	17.0767	70.0929	17.6639	73.7000
0.8	30.4577	19.8131	16.1118	72.9790	16.6165	76.5950
0.9	24.6253	16.3742	12.9730	68.1815	13.2948	71.1759
1	19.3304	12.9012	10.6429	59.1383	10.7743	61.0830
1.1	14.7968	10.1313	8.6838	49.6466	8.4369	49.6692
1.2	10.8988	7.9144	6.6991	40.6508	6.0215	38.2383
1.3	8.4629	5.9118	5.3969	33.1095	4.3642	28.7058
1.4	6.8509	4.3926	4.3690	27.1853	3.2617	21.5855
1.5	5.4919	3.2226	3.3135	22.3359	2.3457	16.3436
1.6	4.3595	2.2473	2.4188	18.3265	1.6948	12.7374
1.7	3.3099	1.5357	1.6817	14.9648	1.2558	10.3597
1.8	2.4904	1.0741	1.1833	12.1203	1.0122	8.7302
1.9	1.9570	0.8357	0.8962	9.8382	0.9291	7.5792
2	1.5936	0.7791	0.6748	8.1008	0.8153	6.6869
2.1	1.4193	0.7473	0.5690	6.7926	0.7481	5.9638
2.2	1.2203	0.6937	0.4492	5.6543	0.6423	5.2584
2.3	1.0436	0.6015	0.3735	4.6004	0.5177	4.5307
2.4	0.8925	0.5078	0.3337	3.6815	0.3779	3.7737
2.5	0.7028	0.4265	0.2591	2.9042	0.2571	3.0360
2.6	0.5439	0.3351	0.2056	2.2675	0.1650	2.4041
2.7	0.3925	0.2538	0.1499	1.7406	0.1290	2.0121
2.8	0.2986	0.1882	0.1300	1.3587	0.1560	1.9077
2.9	0.2527	0.1572	0.1268	1.1225	0.1953	1.9184
3	0.2271	0.1470	0.1188	0.9822	0.1958	1.8824
3.1	0.2280	0.1522	0.1243	0.9218	0.2255	1.8137
3.2	0.2769	0.1665	0.1618	0.9170	0.2584	1.7288
3.3	0.2868	0.1912	0.1623	0.9640	0.2249	1.6016
3.4	0.3097	0.1992	0.1706	1.0115	0.1781	1.4136
3.5	0.2936	0.1917	0.1540	0.9510	0.1238	1.1921
3.6	0.2436	0.1600	0.1213	0.8186	0.0836	0.9996
3.7	0.1838	0.1184	0.0911	0.6471	0.0711	0.9146
3.8	0.1288	0.0821	0.0676	0.4819	0.0804	0.9307
3.9	0.0864	0.0569	0.0494	0.3552	0.0998	1.0045
4	0.0570	0.0391	0.0350	0.2687	0.1295	1.1603
4.1	0.0399	0.0268	0.0252	0.2071	0.1613	1.3182
4.2	0.0294	0.0172	0.0184	0.1592	0.1755	1.3137
4.3	0.0267	0.0134	0.0164	0.1361	0.1588	1.1798
4.4	0.0599	0.0338	0.0438	0.2141	0.1206	1.0102
4.5	0.1301	0.0692	0.0886	0.3870	0.0798	0.8416
>4.5	0.7932	0.5253	0.4138	4.0043	0.7711	9.8041
Total	260.3584	172.2904	150.8197	681.3418	150.8182	681.3399

Table 5-9: EOC-10 As-Found vs Projected Voltage Distribution

Voltage Bin	Normal Growth and POD=0.6							
	SG 1 EOC -10		SG 2 EOC -10		SG 3 EOC -10		SG 4 EOC -10	
	As-Found	Projected	As-Found	Projected	As-Found	Projected	As-Found	Projected
0.1	0	0.0982	0	0.1833	0	0.0217	0	0.0132
0.2	3	2.1719	3	1.4086	3	0.6022	6	0.4889
0.3	25	7.0241	11	4.3593	19	2.6298	32	3.5376
0.4	23	13.4823	25	8.4282	12	5.6214	58	13.5007
0.5	32	20.4804	19	12.2942	14	8.6468	68	29.0110
0.6	23	24.4314	16	13.7909	10	11.3975	73	46.8621
0.7	22	23.3101	11	13.2365	12	11.4365	55	57.6301
0.8	7	19.7832	3	10.7765	5	10.2318	40	58.4478
0.9	9	15.4008	9	8.3288	6	8.3197	29	52.0781
1	4	11.7380	6	6.0900	1	6.4910	22	43.1866
1.1	2	8.8361	1	4.3547	5	4.9147	27	34.6052
1.2	3	6.6465	0	3.1830	2	3.7593	8	27.8162
1.3	3	4.8502	2	2.5475	2	2.9041	11	22.9405
1.4	4	3.4954	0	2.0649	0	2.2507	15	19.2555
1.5	2	2.6063	0	1.5630	1	1.8384	7	16.2955
1.6	0	1.9818	0	1.1540	0	1.5419	6	13.5148
1.7	0	1.4932	0	0.8472	0	1.2549	7	10.7735
1.8	0	1.1110	0	0.6129	0	1.0138	5	8.3243
1.9	2	0.8427	1	0.4531	0	0.8281	3	6.3648
2	1	0.6761	1	0.3657	0	0.7174	5	5.1009
2.1	0	0.5677	0	0.3211	0	0.6407	0	4.3177
2.2	0	0.4722	0	0.2529	2	0.5869	1	3.7937
2.3	0	0.3473	0	0.1883	0	0.5061	1	3.2387
2.4	0	0.2324	0	0.1306	0	0.4181	0	2.6083
2.5	0	0.1436	0	0.0996	0	0.3290	0	2.0050
2.6	1	0.1214	0	0.0896	0	0.2602	0	1.5144
2.7	0	0.1558	0	0.1174	0	0.2319	0	1.2459
2.8	0	0.1919	0	0.1658	0	0.2076	2	1.1571
2.9	0	0.2196	0	0.1771	0	0.1891	1	1.1154
3	0	0.2230	0	0.1848	0	0.1805	0	1.0858
3.1	0	0.1956	0	0.1864	0	0.1518	1	1.0073
3.2	0	0.1550	0	0.1437	0	0.1203	1	0.8530
3.3	0	0.1092	0	0.1062	0	0.0931	0	0.6682
3.4	1	0.0722	0	0.0865	0	0.0641	1	0.4844
3.5	0	0.0456	0	0.0636	0	0.0440	1	0.3458
3.6	0	0.0299	0	0.0460	0	0.0315	0	0.2570
3.7	0	0.0183	0	0.0354	0	0.0230	0	0.1953
3.8	0	0.0096	0	0.0274	0	0.0164	0	0.1489
3.9	0	0.0048	0	0.0205	1	0.0124	1	0.1134
4	0	0.0023	0	0.0146	0	0.0094	0	0.0855
4.1	0	0.0011	0	0.0103	0	0.0072	1	0.0622
4.2	0	0.0005	0	0.0073	0	0.0056	1	0.0445
4.3	0	0.0002	0	0.0056	0	0.0045	0	0.0328
4.4	0	0.0001	0	0.0044	1	0.0035	1	0.0254
4.5	0	0.0000	0	0.0032	0	0.0032	0	0.0202
>4.5	0	0.2207	0	0.1400	0	0.1280	3	0.8346
Total	167	174.0001	108	98.6707	96	90.6893	493	497.0077

Table 5-10: EOC-10 Projected vs Actual POB & Leak Rate

	EOC-10 Projected		EOC-10 Actual	
Steam Generator	**Probability of Burst**	**SLB Leak Rate**	**Probability of Burst**	**SLB Leak Rate**
2-1	6.66×10^{-5}	0.2349	2.19×10^{-5}	0.1497
2-2	4.41×10^{-5}	0.1267	6.30×10^{-6}	0.0546
2-3	5.55×10^{-5}	0.1500	9.31×10^{-5}	0.1240
2-4	3.24×10^{-4}	1.2448	5.82×10^{-4}	1.0409

Figure 5-1

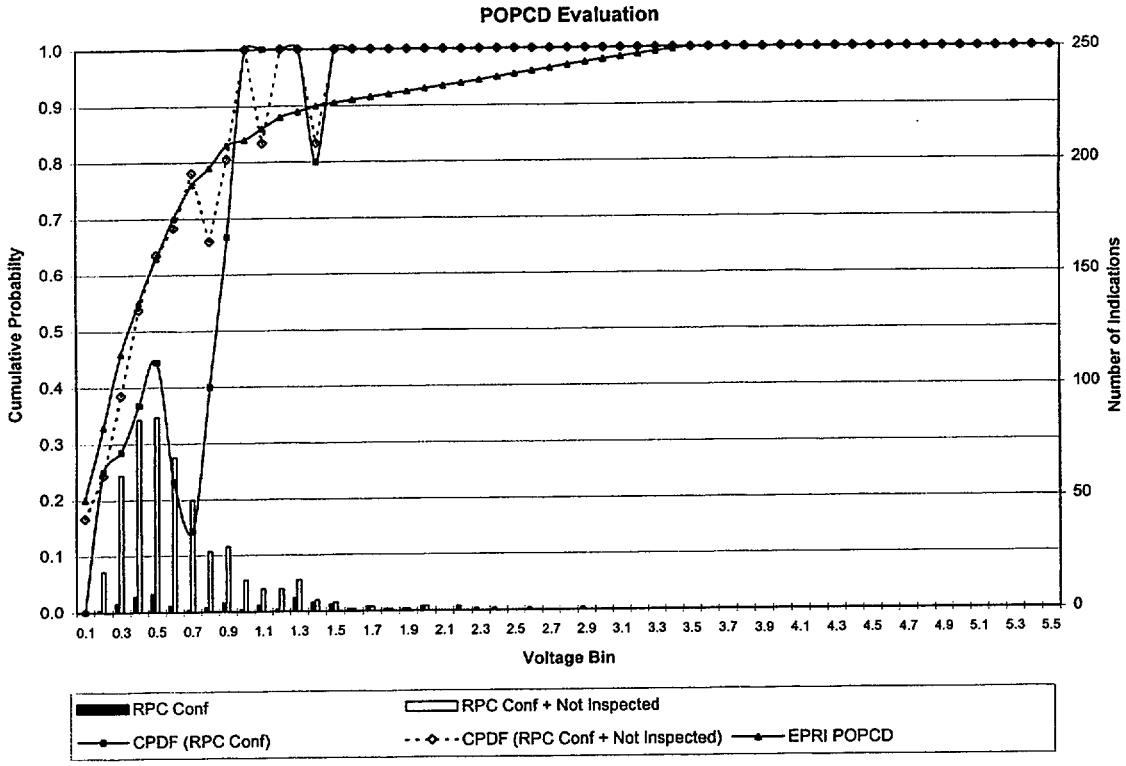


Figure 5-2

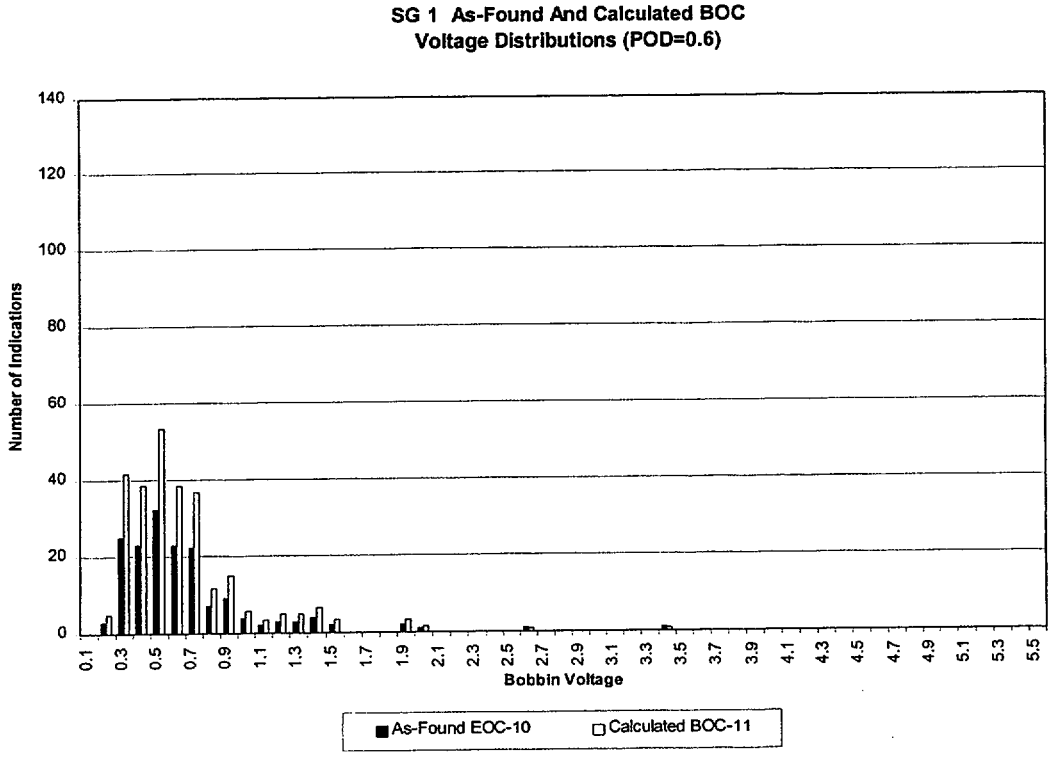


Figure 5-3

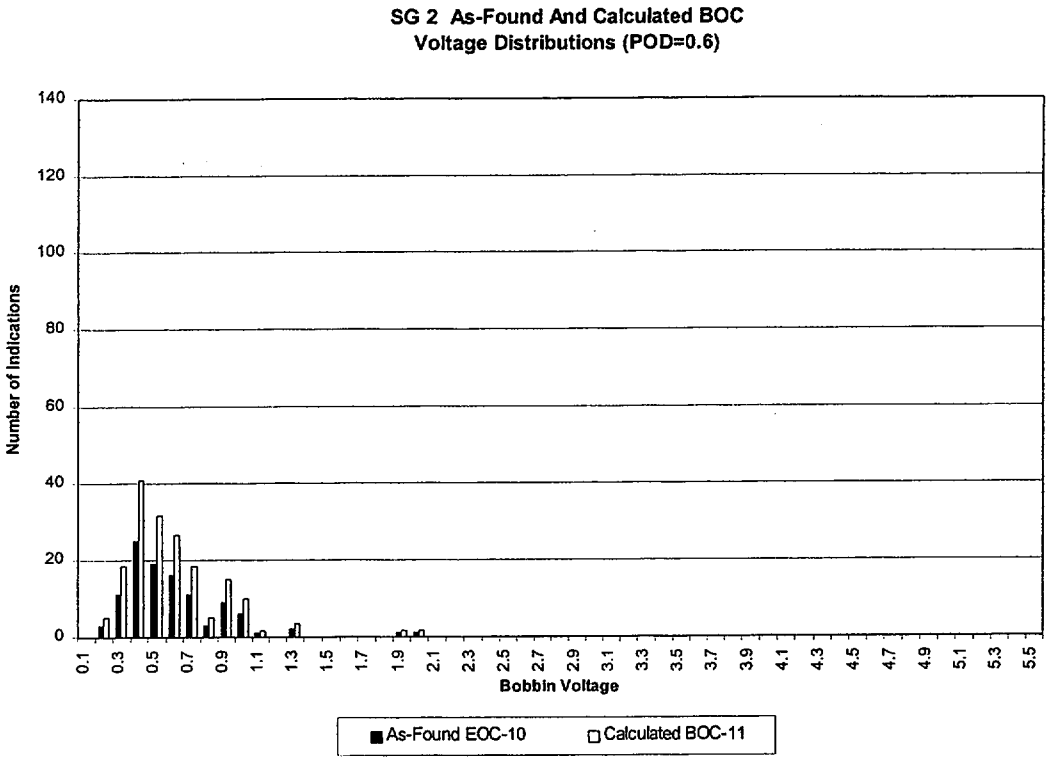


Figure 5-4

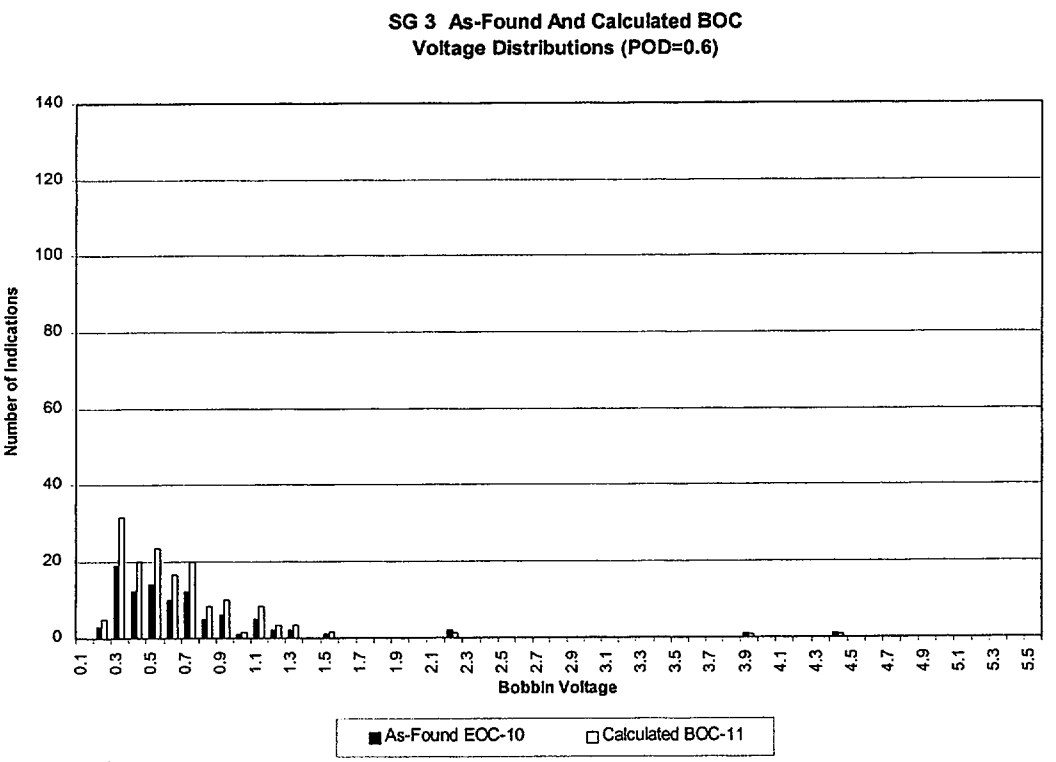


Figure 5-5

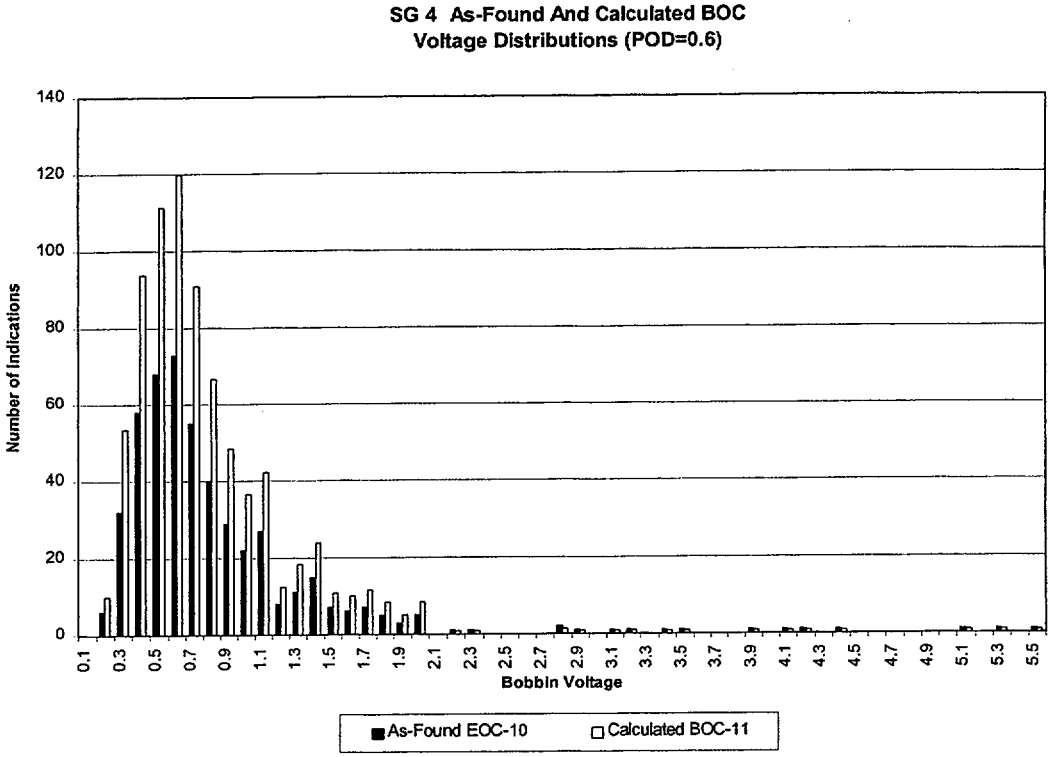


Figure 5-6

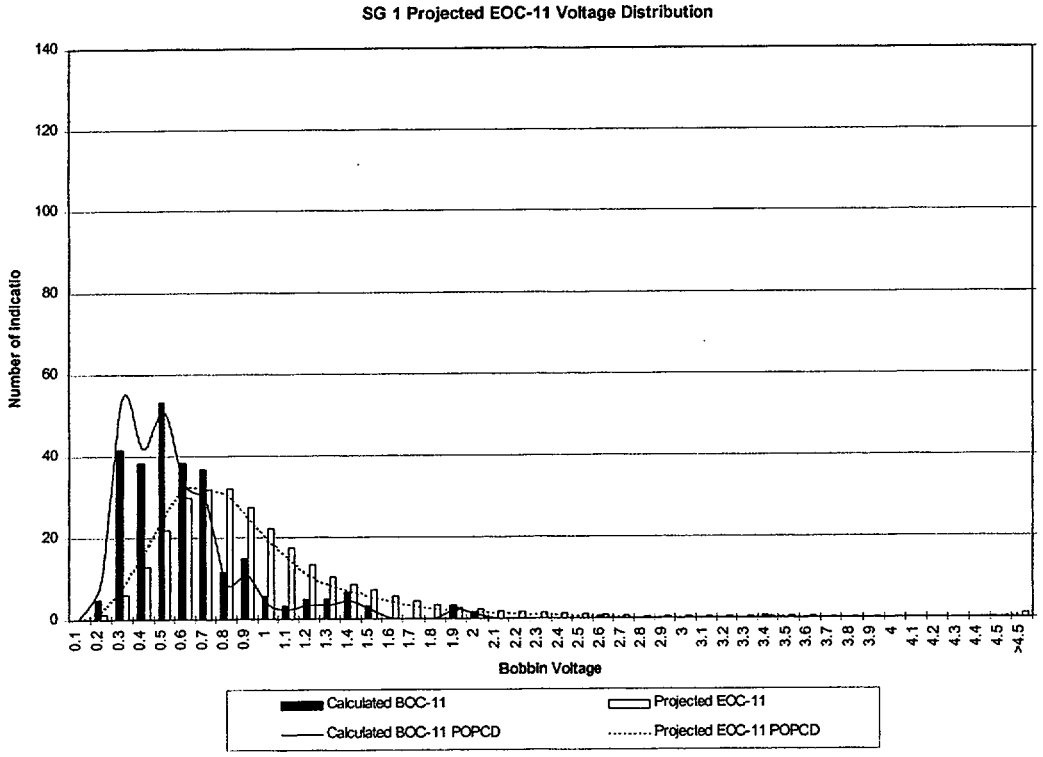


Figure 5-7

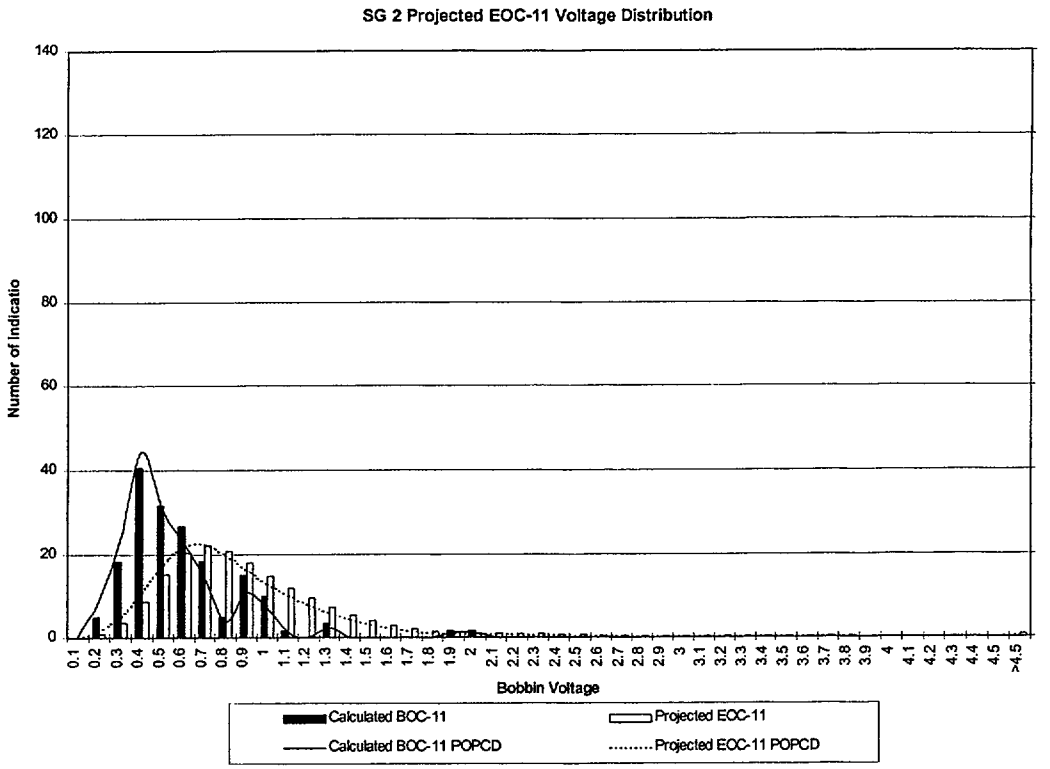


Figure 5-8

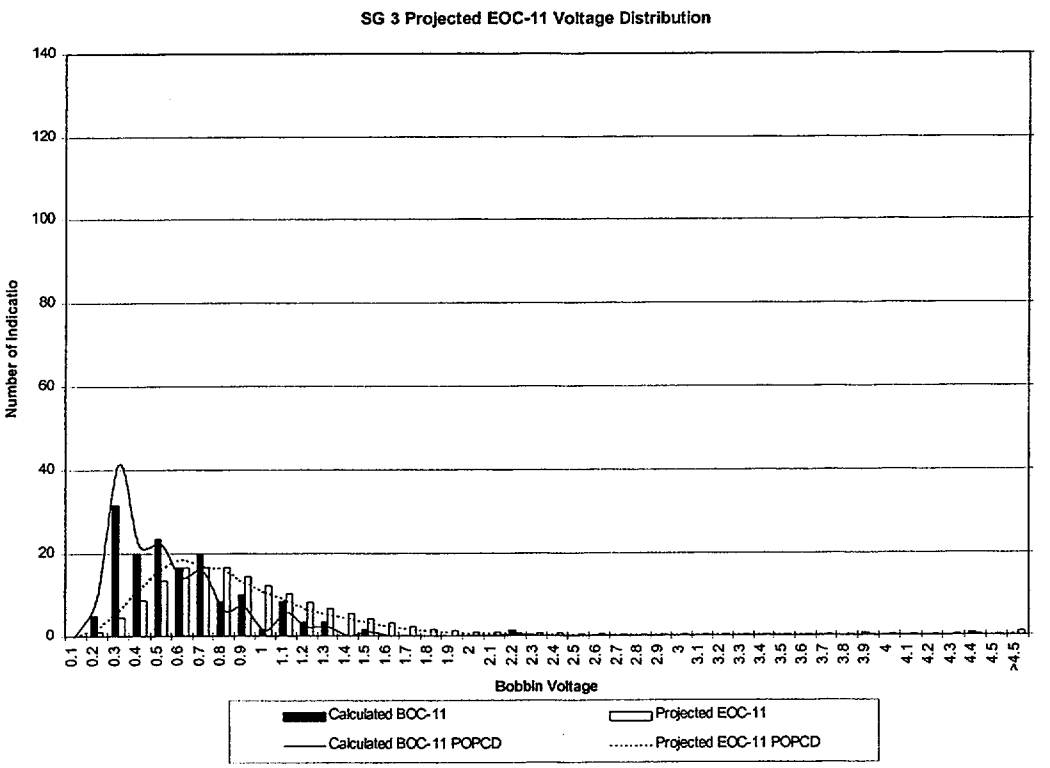


Figure 5-9

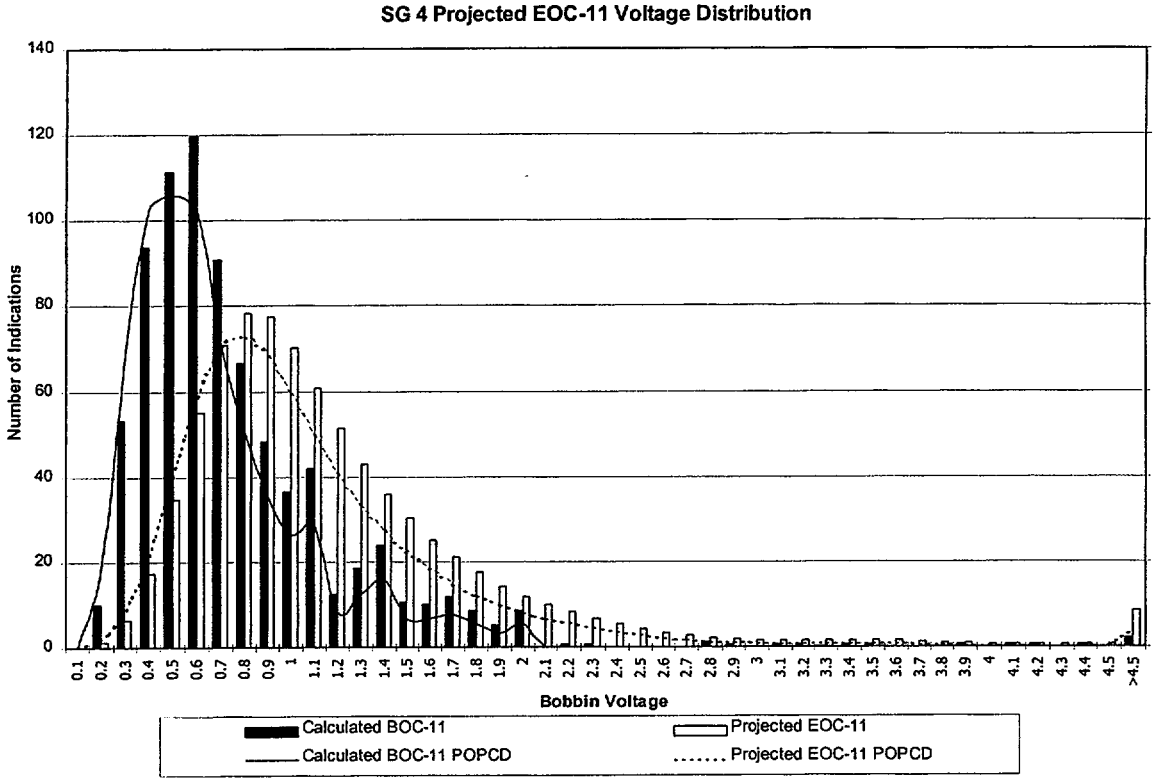


Figure 5-10

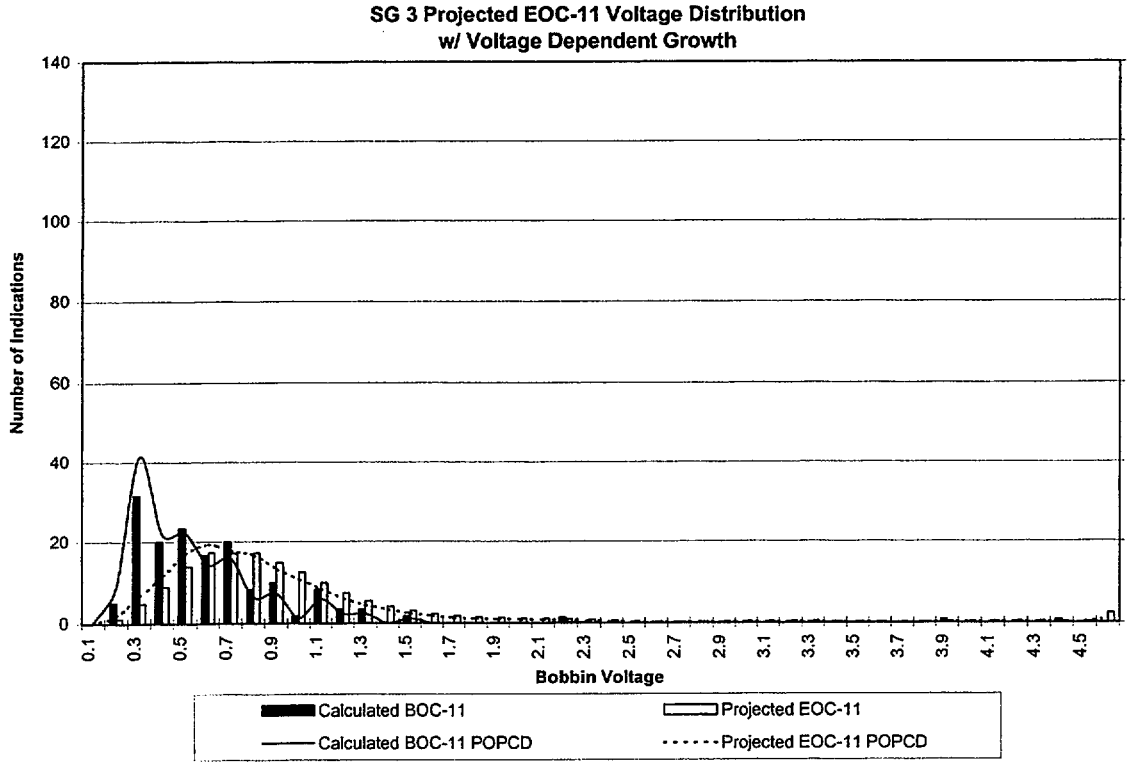


Figure 5-11

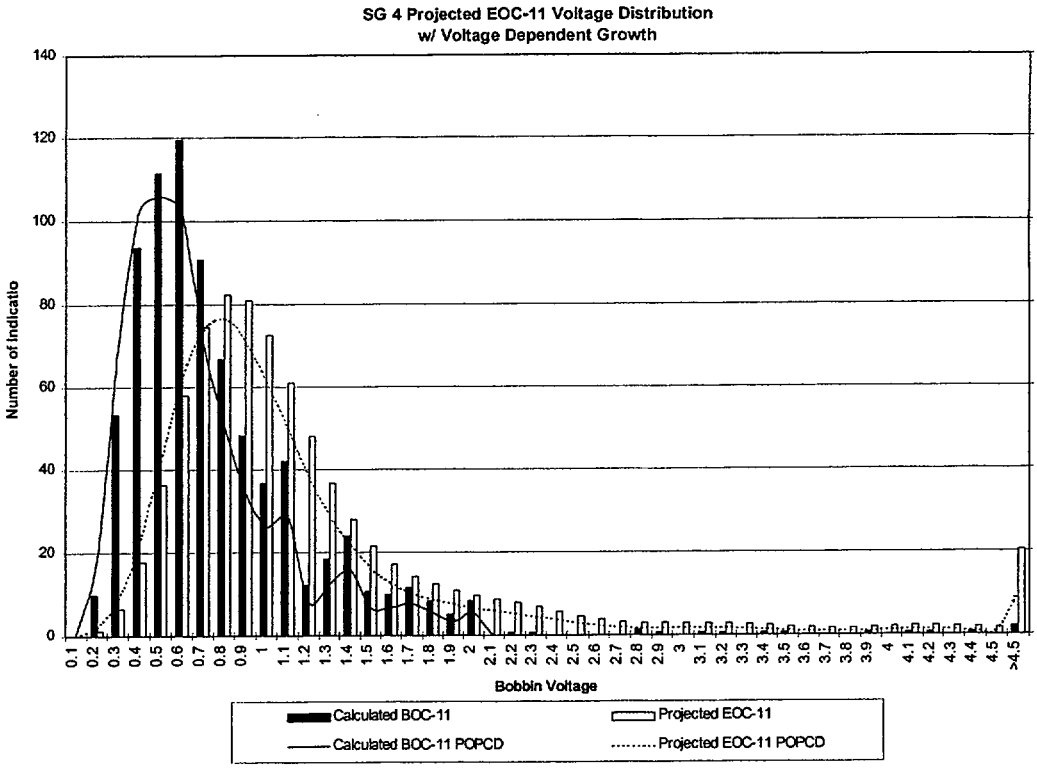


Figure 5-12

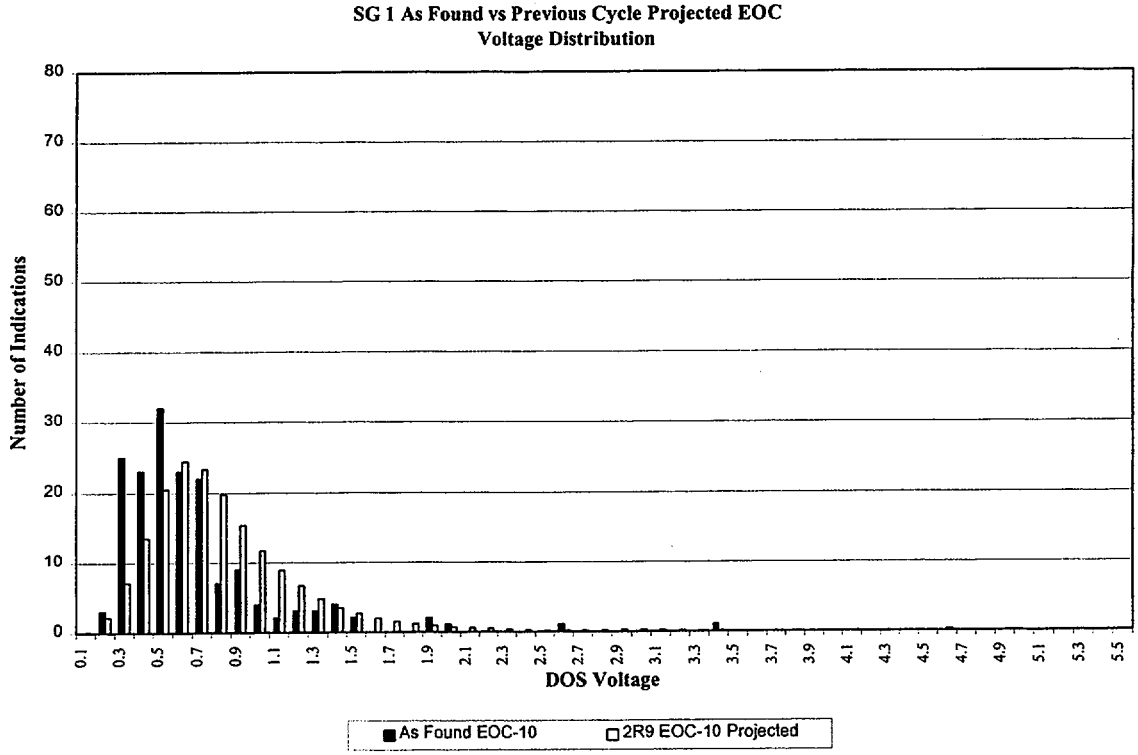


Figure 5-13

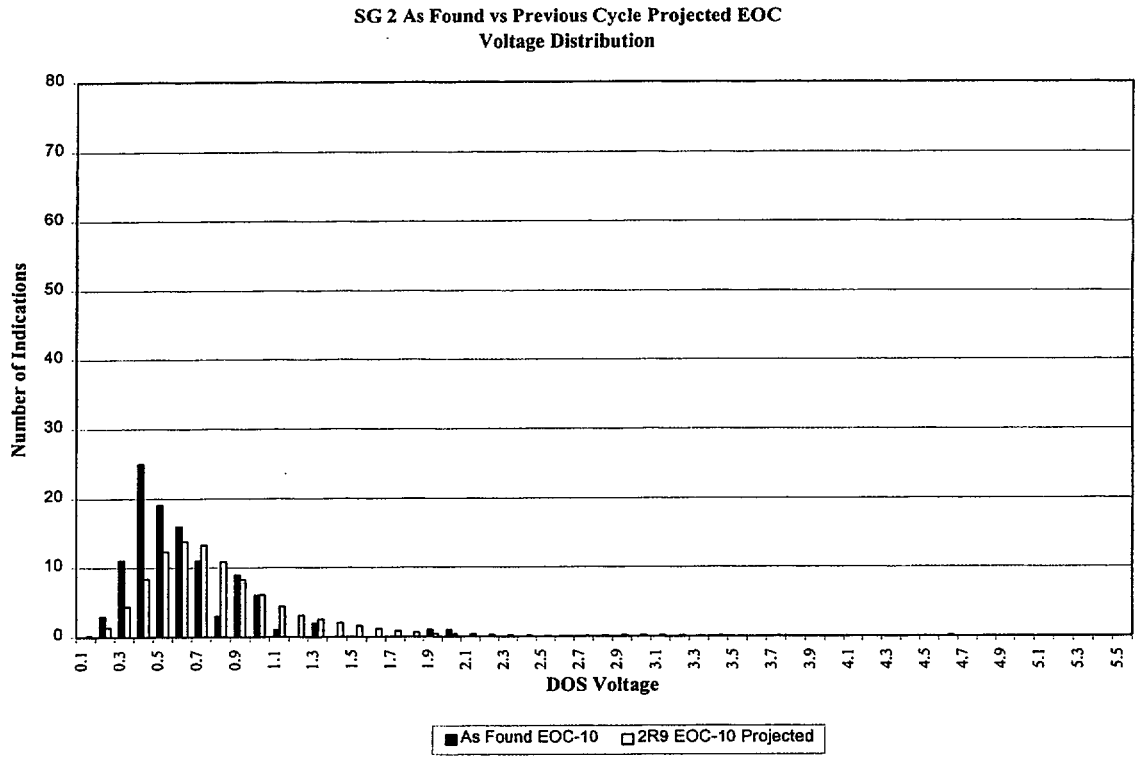


Figure 5-14

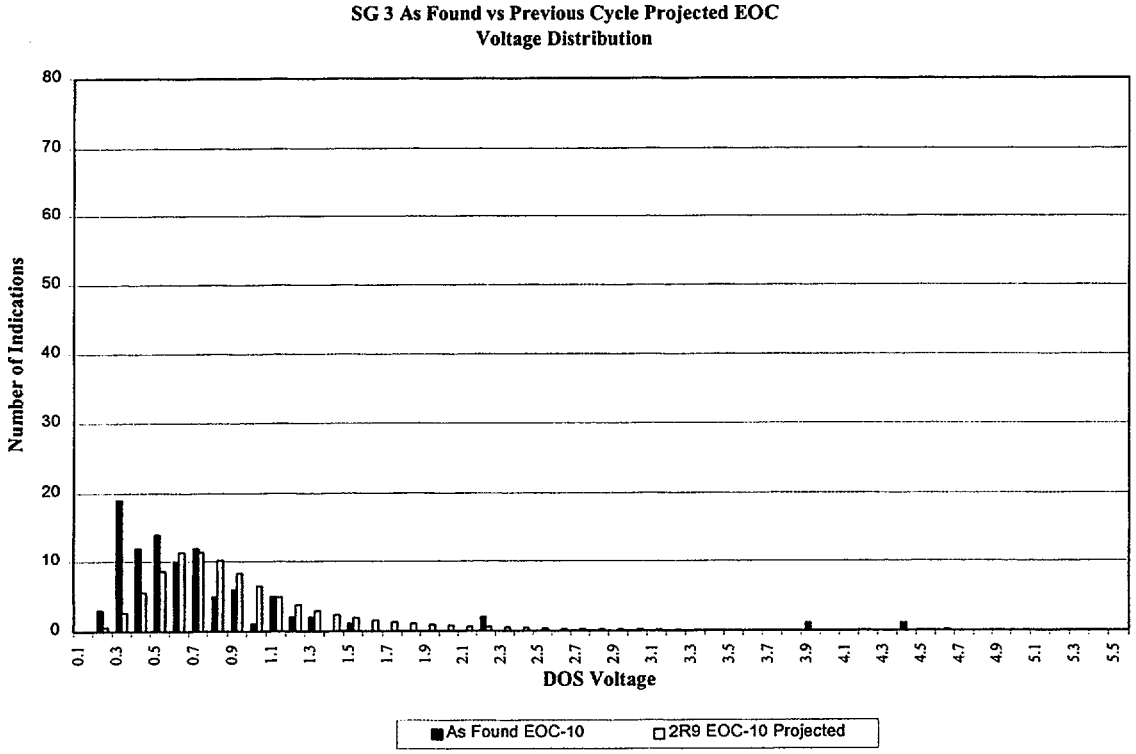
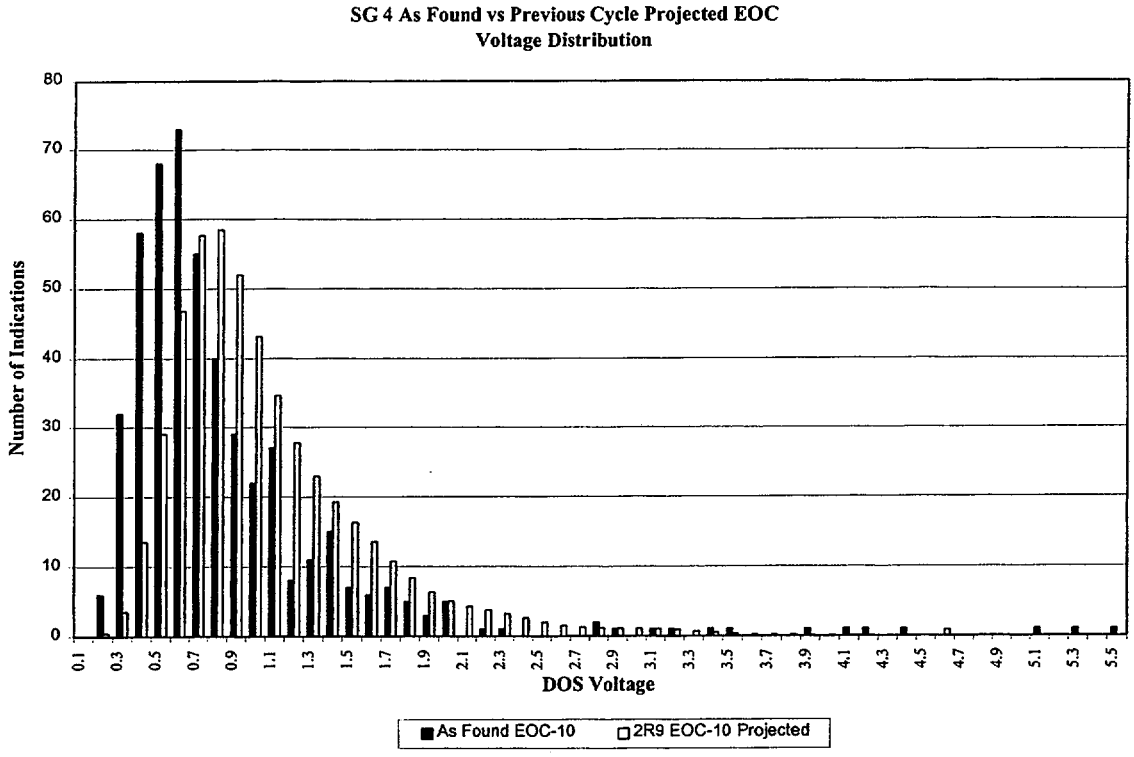


Figure 5-15


SG 4 As Found vs Previous Cycle Projected EOC
Voltage Distribution
Number of Indications
80
70
60
50
40
30
20
10
0
0.1
0.3
0.5
0.7
0.9
1.1
1.3
1.5
1.7
1.9
2.1
2.3
2.5
2.7
2.9
3.1
3.3
3.5
3.7
3.9
4.1
4.3
4.5
4.7
4.9
5.1
5.3
5.5
DOS Voltage
As Found EOC-10
2R9 EOC-10 Projected

6.0 Tube Leak Rate and Tube Burst Probabilities

This section presents the results of analyses carried out to predict leak rates and tube burst probabilities for postulated SLB conditions for the projected EOC-11 voltage distributions. Since SG 2-4 has the largest total number of indications and the largest number of indications over 1 volt, SG 2-4 is expected to yield the limiting SLB leak rates and burst probabilities for Cycle 11.

6.1 Leak Rate and Tube Burst Probability for EOC-11

Calculations to predict SLB leak rate and tube burst probability for each steam generator in DCPP Unit-2 at the EOC-11 conditions were carried out using the NRC-required constant POD value of 0.6. A composite normal growth rate distribution was used for SG 2-1, SG 2-2, and SG 2-3. A SG 2-4 specific growth distribution was used for SG 2-4. The leak and burst results for each steam generator using a 0.6 POD are given in Table 6-1. This table also provides the voltage dependent growth results for SG 2-3 and SG 2-4. For information only, the leak and burst results for each steam generator using POPCD are given in Table 6-2 for the same set of growth distributions used in Table 6-1.

For SG 2-3 and SG 2-4 the results from the two voltage dependent growth analyses (<1 volt, >1 volt) had to be combined. Conservatively, the leak rate and burst results for each analysis was simply summed together.

6.2 Summary and Conclusions

The requirements for burst probabilities are met at EOC-11 with no steam generator exceeding the $1x10^{-2}$ criteria. For the leak rate, the plant-specific value of 12.8 gpm (at room temperature) for the faulted steam generator was not exceeded for any steam generator.

Table 6-1: Leak Rate and Burst Probability Using 0.6 POD

DCPP Unit 2 May 2001 Outage (2R10)
Summary of Calculations of Tube Leak Rate and Burst Probability at EOC-11
for 1 million Simulations Using 0.6 POD

Steam Generator	POD Applied	Number of Indications at EOC-11 (1)	Probability of Burst		SLB Leak Rate (3,5)	Voltage Dependent Growth
			Best Estimate(2)	95% UCL (4) (1 or More Failures)	(gpm)	
2-1	0.6	275.34	1.51×10^{-4}	1.73×10^{-4}	0.6170	No
2-2	0.6	179.01	8.60×10^{-5}	1.03×10^{-4}	0.3439	No
2-3	0.6	156.00	1.43×10^{-4}	1.64×10^{-4}	0.3528	No
2-3	0.6	156.00	3.92×10^{-4}	4.32×10^{-4}	0.4297 (6)	Yes
2-4	0.6	791.71	1.24×10^{-3}	1.30×10^{-3}	2.852	No
2-4	0.6	791.71	3.55×10^{-3}	3.66×10^{-3}	3.730 (6)	Yes
Acceptance Criteria				1.0×10^{-2}	12.8(7)	

Notes:

1) Adjusted for POD.
2) Best Estimate is the number of trials with a failure divided by the number of trials.
3) Equivalent volumetric rate at room temperature.
4) The 95% Upper Confidence Limit (UCL) is based on the number of trials with one or more failures.
5) The calculated total leak rate reflects the upper 95% quantile value at an upper 95% confidence bound.
6) Voltage dependent growth used. SG 2-3 composite; SG 2-4 generator specific.
7) This limit has not been adjusted for leakage contributions from other ARCs that have been implemented during U2R10.

Table 6-2: Leak Rate and Burst Probability Using POPCD

DCPP Unit 2 May 2001 Outage (2R10)
Summary of Calculations of Tube Leak Rate and Burst Probability at EOC-11
for 1 million Simulations Using POPCD

Steam Generator	POD Applied	Number of Indications at EOC-11 (1)	Probability of Burst		SLB Leak Rate (3,5)	Voltage Dependent Growth
			Best Estimate(2)	95% UCL (4) (1 or More Failures)	(gpm)	
2-1	POPCD	260.36	1.09×10^{-4}	1.28×10^{-4}	0.4942	No
2-2	POPCD	172.29	7.70×10^{-5}	9.31×10^{-5}	0.2924	No
2-3	POPCD	150.82	5.90×10^{-5}	7.33×10^{-5}	0.2459	No
2-3	POPCD	150.82	1.31×10^{-4}	1.58×10^{-4}	0.2542 (6)	Yes
2-4	POPCD	681.34	5.71×10^{-4}	6.12×10^{-4}	1.934	No
2-4	POPCD	681.34	1.57×10^{-3}	1.64×10^{-3}	2.3716 (6)	Yes
Acceptance Criteria				1.0×10^{-2}	12.8(7)	

Notes:

1) Adjusted for POD.
2) Best Estimate is the number of trials with a failure divided by the number of trials.
3) Equivalent volumetric rate at room temperature.
4) The 95% Upper Confidence Limit (UCL) is based on the number of trials with one or more failures.
5) The calculated total leak rate reflects the upper 95% quantile value at an upper 95% confidence bound.
6) Voltage dependent growth used. SG 2-3 composite; SG 2-4 generator specific.
7) This limit has not been adjusted for leakage contributions from other ARCs that have been implemented during U2R10.

7.0 References

1. FRA-ANP Document 86-5012862-00, "DCPP 2R10 Bobbin Coil Voltage ARC, Return-to-Power Report," May 2001.

2. NRC Generic Letter 95-05, "Voltage-Based Repair Criteria for the Repair of Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking," USNRC Office of Nuclear Reactor Regulation, August 3, 1995.

3. NRC SER for Diablo Canyon Units 1 and 2 for Voltage-Based Repair Criteria, letter to PG&E dated March 12, 1998.

4. FTI Document 51-5001160-01, "Steam Generator POB Simulation Code - POB97vb.F90", March 2000.

5. FTI Document 51-5001151-00, "Steam Generator Leak Rate Simulation Code LKR97vb.F90", March 1998.

6. WCAP 14277, Revision 1, SLB Leak Rate and Tube Burst Probability Analysis Methods for ODSCC at TSP Intersections, December, 1996.

7. FTI Document 86-5001354-00, "DCPP Unit 2 2R8 90 Day Report," June 1998.

8. FTI Document 86-5006208-01, "Diablo Canyon Unit 2 - 2R9 Voltage-Based Repair Criteria 90 Day Report Unit 2 2R9 90 Day Calculations," January 2000.

9. FTI Document 86-5003756-00, "DCPP Unit 1 1R9 90 Day Report," June 1999.

10. FTI Document 86-5010437-00, "Diablo Canyon 1R10 90 Day Report," March 2001.

11. EPRI TR-113861, "Steam Generator Tubing ODSCC at Tube Support Plates for Alternate Repair Limits Database Update 1999," Electric Power Research Institute, Interim Report, November 1999.

12. Pacific Gas and Electric, Diablo Canyon Unit 2 Refueling Outage 2R10, "Steam Generator Tubing Degradation Assessment", Revision 0, May 3, 2001.

13. EPRI Report NP 7480-L, Addendum 3, 1999 Database Update, "Steam Generator Tube Outside Diameter Stress Corrosion Cracking at Tube Support Plates Database for Alternate Repairs Limits", Electric Power Research Institute, 9/22/99.

14. PG&E NDE Procedure N-ET-7, Rev. 3, "Eddy Current Examination of DCPP Units 1 & 2 Steam Generator Tubing", May 2001.

15. Pacific Gas and Electric Company, Diablo Canyon Power Plant, Surveillance Test Procedure, STP M-SGTI, Revision 4, "Steam Generator Tube Inspection."

16. FRA-ANP Document 51-5012861-00, "Probe Wear Monitoring for DCPP 2R10", May 2001.

17. FTI Document 51-5003036-00, "50.59 Input for Using Changeable Feet Probes at DCPP, February 1999.

18. NRC Letter to NEI, dated February 9, 1996, "Probe Wear Criteria."

19. WCAP-15289, "Nuclear Design and Core Physics Characteristics of Diablo Canyon Power Plant Unit 2 Cycle 10", September 1999.

20. EPRI Report NP 7480-L, Addendum 2 1998 Database Update, "Steam Generator Tubing Outside Diameter Stress Corrosion Cracking at Tube Support Plates Database for Alternate Repair Limits," Electric Power Research Institute, April 1998.

21. FTI Document 51-5005962-00, "Bobbin Voltage Correlation for AONDB Indications at DCPP", October 1999.

22. NEI letter to NRC dated February 11, 2000, "Steam Generator Degradation Specific Management Database, POPCD Corrections in Addendum 3."

23. E-mail, John Arhar to Jeff Fleck, " U2 Cycle Lengths," May 7, 2001.

24. FRA-ANP Document 32-5013592-00, "DCPP Unit 2 – 2R10 90 Day ARC Calculations", August 2001.

OUTGOING CORRESPONDENCE SCREEN

(Remove prior to NRC submittal)

Document: PG&E Letter DCL-01-086

Subject: Special Report 01-04 – 90-Day Report, Results of Steam Generator Alternate Repair Criteria for Diablo Canyon Power Plant Unit 2 Tenth Refueling Outage

File Location S:\RS\RA\GRP_WORK\ASME\STEAMGEN\DCL01086.doc

FSAR Update Review
Utilizing the guidance in XI3.ID2, does the FSAR Update need to be revised? Yes ☐ No ☒ • If "Yes", submit an FSAR Update Change Request in accordance with XI3.ID2 (or if this is an LAR, process in accordance with WG-9)

COMMITMENT #1 No new commitments are contained in this document.

Statement of Commitment: **None.**

Clarification: None.

Tracking Document:	*AR or NCR* None	*AE or ACT*
Assigned To:	*NAME*	*ORGANIZATION CODE*
Commitment Type:	*FIRM OR TARGET*	*DUE DATE:*
Outage Commitment?	*YES OR NO* No	*IF YES. WHICH? (E.G.. 2R9. 1R10. ETC.)*
PCD Commitment?	*YES OR NO* No	*IF YES. LIST THE IMPLEMENTING DOCUMENTS (IF KNOWN)*
Duplicate of New NCR Commitment in PCD?	*YES OR NO* No	*IF YES. LIST PCD NUMBER (e.e.. T35905. etc.)*
Old PCD Commitment being changed?	*YES OR NO* No	*1. IF YES, LIST PCD NUMBER, AND* *2. CLARIFY TO CLERICAL HOW COMMITMENT TO BE REVISED*

SUBMITTAL PROCESSING CHECKLIST

Regulatory Services Engineer

SUBJECT: Unit 2 10th Refueling 90 day SG Report

PG&E LETTER: DCL-01-086 FIRM / TARGET DATE: 8/21/01

LOCATION: S:\RS\RA\Grp-Work\~~ASME~~\SteamGen\~~2R10-90day R..doc~~ dcl01086.doc

DOCUMENT VERIFICATION INITIALS/DATE

- REFERENCES/BASES IDENTIFIED FOR FACTUAL INFORMATION DDM / 8/15
- COMMITMENT(S) PROPERLY IDENTIFIED (XI1.ID1) DDM / 8/15
- MANAGER'S CONCURRENCE FOR RELEASE PR / 8/17
- RECORD OF REVIEW CHECKLIST (XI1.ID1) COMPLETE AND SIGNED DDM / 8/7
- CLERICAL QUALITY/FORMAT REVIEW Draft # 1 SCR / 8/17/01
  Draft #___ ___/___
  Draft #___ ___/___
  FINAL CLERICAL REVIEW (Letterhead) SCR / 8/17/01
- PEER REVIEW OF FINAL LETTER/ENCLOSURE(S) DDM / 8/17/01
- PROVIDE TO SIGNATORY: DDM 8/17/01
  - Final letter/enclosures, record of review, commitment memo
  - For ***ALL*** submittals, was 2 days met? Yes ☒ No ☐
- COPY OF SUBMITTAL W/RECORD OF REVIEW AND COMMITMENT DATA TO RMS (FIREPROOF) CABINET DDM / 8/21/01
- INTERNAL -- provide this checklist, original of signed submittal, commitment data, and record of review to clerks DDM / 8/22/01
- NCRs , ARs, AND LERtemplate.ppt UPDATED FOR SUBMITTAL COMPLETION DDM / 8/22/01

TRACKING CLOSEOUT WITHIN 15 DAYS OF SUBMITTAL

- VERIFY COMMITMENT ENTRY ON NCR ACTs , AEs DDM / 8/22/01

2nd enclosure still to come from W (200+ pages)

NUCLEAR POWER GENERATION
XI1.ID1
ATTACHMENT 8.1

TITLE: Regulatory Submittal - Record of Review Checklist

SUBMITTAL TITLE Special Report 2R10 -SG 90 day Report.
REQUIRED SUBMITTAL DATE: 8/21/01 [ ] N/A SCHEDULED SUBMITTAL DATE: _____

PRIMARY REVIEWERS	NAME	COMMENTS YES	COMMENTS NO	RESOLVED YES	RESOLVED NO
LEAD TECHNICAL REVIEWER	John Archer	[ ]	[✓]	[ ]	[ ]
LEAD TECHNICAL DIRECTOR/MGR	Bob Exner	[ ]	[✓]	[ ]	[ ]
SUBMITTAL LEAD MANAGEMENT	~~F.R. Hinds~~ S.D. Vosburg	[ ]	[✓]	[ ]	[ ]
INDEPENDENT TECH REVIEWER	Bob Exner	[ ]	[✓]	[ ]	[ ]
CROSS-DISCIPLINE REVIEWER(S)	ISI	[ ]	[✓]	[ ]	[ ]
[ ] OPERATIONS SERVICES		[ ]	[ ]	[ ]	[ ]
[ ] MAINTENANCE SERVICES		[ ]	[ ]	[ ]	[ ]
[ ] ENGINEERING SERVICES	DAVE Miklush	[ ]	[ ]	[ ]	[ ]
[ ] SITE SERVICES		[ ]	[ ]	[ ]	[ ]
[ ] NQAL		[ ]	[ ]	[ ]	[ ]
[ ] ~~LAW~~	Roger Russell Pa	[✓]	[ ]	[ ]	[ ]
[ ] TES		[ ]	[ ]	[ ]	[ ]
[ ] CHEMISTRY & ENVIRONMENTAL		[ ]	[ ]	[ ]	[ ]
OPERATIONS		[ ]	[ ]	[ ]	[ ]
[ ] PSRC		[ ]	[ ]	[ ]	[ ]
[ ] NSOC		[ ]	[ ]	[ ]	[ ]
[ ] OTHER	Pat Nugent - NA	[ ]	[ ]	[ ]	[ ]

SECONDARY REVIEWERS	NAME	COMMENTS YES	COMMENTS NO	RESOLVED YES	RESOLVED NO
DCPP		[ ]	[ ]	[ ]	[ ]
ES		[ ]	[ ]	[ ]	[ ]
NQAL		[ ]	[ ]	[ ]	[ ]
LAW		[ ]	[ ]	[ ]	[ ]
_____		[ ]	[ ]	[ ]	[ ]
_____		[ ]	[ ]	[ ]	[ ]
_____		[ ]	[ ]	[ ]	[ ]

CONCURRENCE HAS BEEN RECEIVED FROM PRIMARY REVIEWERS AND TECHNICAL COMMENTS HAVE BEEN RESOLVED

SUBMITTAL LEAD ENGINEER: Donald D. Malone DATE: 8/17/01

PEER REVIEW CHECKLIST
RS ENGINEER SUBMITTAL
(To be performed on final draft only.)

ITEM	DESCRIPTION	RS ENGR INITIALS
COVER LETTER	Correct signatory letterhead	JM
	Full names used for signatory & cc list; right people listed	JM
	Title correct	JM
	DCL number verified against DCL log	JM
	DCL number appears on all pages	JM
	All pages numbered except first page	JM
	Date correct and appears on all pages (month, day, and year)	JM
	Address and docket number(s) correct	JM
	Text reviewed for obvious errors	JM
	TS and/or 10 CFR references correct	JM
	If affidavit required or NOV response, verify Law Department has reviewed	—
ALL SUBMITTALS	Text reviewed for obvious errors	JM
	Revision bars included (if applicable)	—
	TS and/or 10 CFR references correct	JM
	References to other documents correct (e.g., DCLs, FSAR, etc.)	JM
	Submittal addresses the specific regulation requirements	JM
	Enclosures labeled	JM
COMMITMENT TRACKING MEMO (CTM)	DCL number and title correct	
	Commitment(s) quoted verbatim (& Clarifications made if needed)	JM
	Tracking Document - AR/AE or NCR Action number	—
	Assigned To - Name & Organization Code	—
	Commitment Type - Firm or Target & Due Date	—
	Outage Commitment - Y or N indicator & Applicable Outage	—
	PCD Commitment - Y or N indicator & Implementing Documents	—
	Duplicate of NCR Commitment in NCR - Y or N indicator & PCD number	—
	An individual from all departments assigned commitments was a Cross-Discipline Reviewer (Ref. XI1.ID1, Step 5.2.3.a.4.a)	—
		—
LER FORMS	LER number correct; consistent with cover letter	—
	LER number & docket number(s) on first & remaining pages	—
	Title consistent with cover letter & CTM	—
	Dates correct on first page header (month, day, & year)	—
	Dates & times consistent with 10 CFR 50 ENS reports made	—
	Dates & times consistent with other source documents	—
	Dates & times consistent between abstract, narrative, & Section E	—
	Page numbers correct & all pages accounted for	—
	Abstract word count <1400 characters (including spaces)	—
	IEEE 803 codes entered and correct	—
PROCEDURE SUBMITTALS	Procedure revision numbers current using EDMS (e.g., EPIP)	—
ROR CHECKLIST	Record of Review Checklist completed and signed	JM
FINAL DRAFT	All discrepancies resolved with Lead Submittal Engineer	JM

I have reviewed this submittal for the items initialed above. This submittal is ready for the signatory.

James Marshall
Performed by

8/17/01
Date