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Ref: 10 CFR 50.55a(g)
GL 95-05

CPSES-200402142
Log # TXX-04172

September 27, 2004

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

SUBJECT: COMANCHE PEAK STEAM ELECTRIC STATION (CPSES)
UNIT 1, DOCKET NO. 50-445
SUBMITTAL OF CORRECTED UNIT 1 TENTH REFUELING OUTAGE (1RF10) GL 95-05 REPORT

REF: TXU Power letter, logged TXX-04141, from Mike Blevins to the NRC; dated July 29, 2004.

Gentlemen:

Pursuant to the guidance of Attachment 1 to the Generic Letter (GL) 95-05 "Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking," TXU Generation Company LP (TXU Power) submits the revised 90-day report for 1RF10. The original report, previously submitted in the above referenced letter, incorrectly listed 272 total indications versus the correct number of 273 indications. Because inclusion of the omitted indication does not affect leak rates, tube burst probability, or growth rates, the report continues to provide justification for continued application of the voltage-based repair criteria for outside diameter stress corrosion crack (ODSCC) indications at support plate intersections.

This communication contains no new licensing basis commitments regarding CPSES Unit 1. If you have any questions about this communication, please contact Mr. Robert Kidwell at (254) 897-5310.

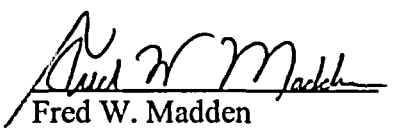
A001

Sincerely,

TXU Generation Company LP

By: TXU Generation Management Company LLC,
Its General Partner

Mike Blevins

By: 
Fred W. Madden
Director, Regulatory Affairs

RJK
Enclosure

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W. D. Johnson, Region IV (w/o Encl)
M. C. Thadani, NRR (w/o Encl)
Resident Inspectors, CPSES (w/o Encl)

ENCLOSURE TO TXX-04172

COMANCHE PEAK STEAM ELECTRIC STATION
UNIT - 1

CYCLE 10 VOLTAGE-BASED REPAIR CRITERIA
90-DAY REPORT

Revision 1

August 2004

SG-SGDA-04-29, Revision 1

COMANCHE PEAK UNIT - 1

CYCLE 11 VOLTAGE-BASED REPAIR CRITERIA 90-DAY REPORT

Revision 1
August 2004

Westinghouse Electric Company LLC
Nuclear Services Business Unit
P.O. Box 158
Madison, Pennsylvania 15663-0158

SG-SGDA-04-29, Revision 1

COMANCHE PEAK UNIT - 1

CYCLE 11 VOLTAGE-BASED REPAIR CRITERIA 90-DAY REPORT

Revision 1
August 2004

Record of Revisions

Rev	Date	Revision Description
0	July 2004	Original Issue
1	August 2004	One indication from steam generator 2 (SG2R26C80) was left out from original calculations in Revision 0. This revision was updated to reflect 273 total indications as opposed to 272. As a result of this change, Tables 3-1, 3-2, 3-4, 3-5, 6-1 and 6-2 and Figure 3-1, 3-2, and 6-1 were updated. Leak rates, tube burst probability, and growth rates were not affected by these changes. Therefore, analysis and conclusions from previous revision are correct and unchanged.

Table of Contents

Comanche Peak Unit - 1

Cycle 11 Voltage-Based Repair Criteria Report

1.0 Introduction

This report provides a summary of the results for the 1RF10 steam generator (SG) bobbin and rotating pancake coil (RPC) probe inspections at tube support plate (TSP) intersections for Comanche Peak Unit-1, together with leak rate and tube burst probability analysis results for a postulated steam line break (SLB) accident. The results support continued implementation of the voltage-based repair criteria as outlined in the NRC Generic Letter 95-05 (Reference 8-1). A 1.0-volt repair criterion for outside diameter stress corrosion cracking (ODSCC) indications at the TSP intersections was implemented for the first time for Comanche Peak Unit-1 during the EOC-7 outage (Reference 8-2). Information required by the Generic Letter to support a 1-volt repair criterion is provided in this report.

As in the last inspection, a relatively small number of ODSCC indications were detected during the EOC-10 inspection (a total of 273 indications from all 4 SGs combined), and a majority of those indications (186) were found in SG-4. Analyses for leak rates and burst probabilities at SLB conditions based on the actual bobbin voltage distributions (condition monitoring analysis) were carried out for SG 4 and compared with the projections performed after the last outage. Steam generators 1, 2, and 3 were not analyzed separately since so few indications were found in each of these generators. Leak rates and burst probabilities at the end of the ongoing cycle (Cycle 11) were also estimated for SG 4 as well as for all 4 SGs combined. Westinghouse generic methodology based on Monte Carlo simulations presented in Reference 8-3 was used, which is the methodology utilized in all leak and burst analyses performed to date by the industry in support of Generic Letter 95-05.

Eddy current and repair data for EOC-10 TSP indications are provided in Section 3. The leak and burst database applied and the Monte Carlo analysis methodology used to estimate leak rate and tube burst probability are briefly described in Sections 4 and 5. The projected EOC-11 voltage distributions are presented in Section 6. Leak rates and burst probabilities for the actual EOC-10 voltage distributions and projected EOC-11 voltage distributions are reported in Section 7 and compared with allowable limits.

2.0 Summary and Conclusions

A total of 273 indications were found in the EOC-10 inspection, the majority of which (186) were found in SG-4. All indications detected were on the hot leg side. The largest indication detected among the 4 SGs had 1.09 volts amplitude and was found in SG-4. It was inspected with an RPC probe and confirmed to have a single axial ODSCC indication; the tube containing that indication was plugged. No circumferential ODSCC was reported at tube support plates. Also, no ODSCC indications extending outside the TSP edges were found. Bobbin mixed residual signals with voltages large enough to potentially mask a 1.0-volt bobbin indication (residual signal voltage 1.5 volts or greater) were detected at 1 TSP intersection in SG-1, 18 TSP intersections in SG-2, 3 TSP intersections in SG-3, and 7 TSP intersections in SG-4. All of these intersections were inspected with an RPC probe, and no ODSCC was detected.

For Row 1, 2, and 3 tubes repaired using tubesheet TIG welded sleeves at 1RF09, a 0.540" wide groove bobbin probe was used for the TSP inspection on the hot leg. Reference 8-8 describes the on-site qualification of this probe. Approximately 60 DSI signals were tested using both the 0.610" bobbin probe and 0.540" wide groove bobbin probes. Using the 0.610" results as truth, the 0.540" wide groove POD exceeded the EPRI requirements of 0.80 at 90% confidence. Comparison of amplitude response for the two probes indicates the 0.540" wide groove produces a larger amplitude response. As the voltage sizing performance of the 0.540" wide groove was not approved for use by the NRC, TXU practice required repair by plugging of detection of any DSI from the 0.540" wide groove probe. No DSI signals were reported by the 0.540" wide groove probe.

SLB leak rate and tube burst probability analyses were performed using the actual EOC-10 bobbin voltage distributions (condition monitoring analysis) and compared with the results of the corresponding projections performed after the last (EOC-9) outage. The SLB leak rates and tube burst probabilities projected for the EOC-10 conditions (based on ECO-9 data) were small relative to their acceptance limits, and those based on the as-measured EOC-10 voltages are even smaller. The limiting SLB leak rate (4.9×10^{-4} gpm) and tube burst probability (1.2×10^{-5}) values obtained using the actual measured EOC-10 voltages are 3 to 5 orders of magnitude below the corresponding acceptance limits (27.79 gpm at room temperature and 10^{-2}, respectively).

The projected leak rates and tube burst probabilities at the EOC conditions for the current cycle (Cycle 11) are also well within their acceptable limits. Limiting EOC-11 SLB leak rate and burst probability are predicted for SG-4 as it had more than 2/3rds of all indications found in the 4 SGs during the EOC-10 inspection. Since the Comanche Peak Unit-1 growth data for the last 2 cycles contain more than the minimum number of data points required per GL 95-05 (200 points), the limiting

growth distribution for the last two cycles was applied for Cycle 11 projections. The limiting EOC-11 leak rate thus projected (4.98×10^{-4} gpm, in SG-4) is 5 orders of magnitude below the allowable leakage limit of 27.79 gpm (room temperature). The corresponding tube burst probability, 1.2×10^{-5}, is nearly 3 orders of magnitude below the NRC reporting guideline of 10^{-2}. Thus, the GL 95-05 requirements for continued plant operation for the projected duration of Cycle 11 are met.

3.0 EOC-10 Inspection Results and Voltage Growth Rates

3.1 EOC-10 Inspection Results

According to the guidance provided by the NRC Generic Letter 95-05, the EOC 10 inspection of the Comanche Peak Unit-1 SGs consisted of a 100% eddy current (EC) bobbin probe full length examination (the Plus Point probe was used in lieu of the bobbin probe for the row 1 and 2 U-bend regions) of the tube bundles in all four SGs. A 0.610 inch diameter probe was used for hot and cold leg TSPs where a voltage-based repair criterion was applied. The largest indication found among the 4 SGs had 1.09 volts amplitude and was found in SG-4. It was inspected with an RPC probe and confirmed to have a single axial indication; the tube containing that indication was plugged. All ODSCC indications detected at TSPs were on the hot leg side and no indications were detected on the cold leg side.

No circumferential ODSCC was reported at tube support plates. Also, no ODSCC indications extending outside the TSP edges were found. Bobbin mixed residual signals with voltages large enough to potentially mask a 1.0-volt bobbin indication (residual signal voltage 1.5 volts or greater) were detected at 1 TSP intersection in SG-1, 18 TSP intersections in SG-2, 3 TSP intersections in SG-3, and 7 TSP intersections in SG-4. All of these intersections were inspected with an RPC probe, and no ODSCC was detected. No signal interference was found from copper deposits. All dents over 5 volts within TSPs on the hot leg side identified in the present inspection were also RPC inspected, and no degradation was detected.

A summary of EC indications for all four SGs is provided in Table 3-1. It lists the number of field bobbin indications, the number of those indications that were RPC inspected, the number of RPC confirmed indications, and the number of indications removed from service due to tube repairs. The indications that remain active for Cycle 11 operation is the difference between the observed and those removed from service plus those in the deplugged tubes that were returned to service at BOC-11. Only one tube with an indication just over the repair limit, and confirmed by RPC, was repaired to meet the GL 95-05 requirements. However, an addition tube in SG-4 in with 0.98 volts amplitude was repaired for conservatism. Also, one tube in SG-2 with 0.58 volts amplitude was repaired for a partially collapsed sleeve at top of tubesheet. One tube in SG-4 with 0.54 volts amplitude was RPC tested and confirmed but not repaired. Figure 3-1 shows the actual bobbin voltage distribution determined from the EOC-10 EC inspection. A total of 3 ODSCC indications in Cycle 10 active tubes were removed from service because of tube repairs for all causes.

A review of Table 3-1 indicates that SG-4 had the highest number of indications returned to service for Cycle 11 operation (198 indications, 184 discounting

deplugged tubes returned to service, a column in Table 3-1 summarizes the deplugged tubes returned to service). Therefore, SG-4 is likely to be the limiting SG at EOC-11 from the standpoint of SLB leak rate and tube burst probability.

The distribution of EOC-10 indications as a function of support plate location is summarized in Table 3-2 and plotted in Figure 3-2. The data shows a strong predisposition of ODSCC to occur in the first two hot leg TSPs (255 out of 273 indications occurred at the hot leg intersections in the two TSPs above the flow distribution baffle plate), although the mechanism extended to higher TSPs. No ODSCC indications were found on the cold leg side. In summary, the distribution of indication population at TSPs in Comanche Peak Unit-1 show the predominant temperature dependence of ODSCC, similar to that observed at other plants.

The TSP ODSCC mechanism at Comanche Peak Unit-1 is still relatively benign. As a comparison, a plant with Model E2 steam generators reported 3580 indications, with 102 indications over 3 volts after 8 cycles of operation, and another plant with Model D4 steam generators reported 5719 indications, with 7 indications over 3 volts, after 7 cycles of operation. The application of chemical cleaning at Comanche Peak Unit-1 1RF05 outage appears to have had a significant beneficial impact upon ODSCC initiation and growth rates.

3.2 Voltage Growth Rates

Voltage growth rates during Cycle 10 were developed from EOC-10 (April 2004) inspection data and a reevaluation of the EOC-9 (October 2002) inspection EC signals for the same indications. Table 3-3 shows the cumulative probability distribution (CPDF) for growth rate in Comanche Peak Unit-1 SG-4 and all 4 SGs combined during Cycle 10 on an EFPY basis, along with the corresponding Cycle 9 growth distributions. The Cycle 10 data for all 4 SGs are also plotted on Figure 3-3.

Average growth rates for SG-4 and all 4 SGs combined during Cycle 10 are summarized in Table 3-4. With the exception of the largest SG-4 indications (EOC-10 voltage over 0.75 volt) most indications had insignificant growth during Cycle 10, which is consistent with growth data for the prior three cycles. Table 3-5 shows the average composite voltage growth data from all four steam generators for the last four operating periods.

The NRC guidelines in Generic Letter 95-05 stipulate that the growth rate distribution used in the SLB leak rate and tube burst probability analyses to support voltage-based repair criteria must contain at least 200 data points that are established using bobbin voltages measured in two consecutive inspections. The Comanche Peak Unit 1 growth data for Cycles 9 and 10 contain more than 200 data

points. As evident from Table 3-3 and Figure 3-4, the growth distribution for Cycles 9 and 10 are close to each other, and the Cycle 10 distribution envelops Cycle 9 distribution. Therefore, Cycle 10 growth data was used for Cycle 11 projections.

Table 3-6 lists the largest 30 indications on the basis of Cycle 10 growth rates in the descending order. The largest growth during Cycle 10 was 0.4 volt. All other growth during Cycle 10 was below 0.3 volt. The EOC-9 voltages used to estimate growth rates for new indications were obtained by revaluating the last inspection data.

3.3 NDE Uncertainties

The NDE uncertainties applied for the EOC-10 voltage distributions in the Monte Carlo analyses for leak rate and burst probabilities are consistent with the requirements of the NRC Generic Letter 95-05 (Reference 8-1). They are presented in Table 3-7 as well as graphically illustrated on Figure 3-5. The probe wear uncertainty has a standard deviation of 7.0% about a mean of zero and has a cutoff at 15% based on implementation of the probe wear standard. The analyst variability uncertainty has a standard deviation of 10.3% about a mean of zero with no cutoff. These NDE uncertainty distributions are included in the Monte Carlo analyses for SLB leak rates and tube burst probabilities based on the EOC-10 actual voltage distributions as well as for the EOC-11 projections.

3.4 Probability of Prior Cycle Detection (POPCD)

Since the ODSCC indication population in Comanche Peak Unit-1 is still relatively small, adequate data does not exist to establish a POPCD distribution. If a significantly larger number of indications are detected in future inspections, then a POPCD evaluation may be performed.

3.5 Probe Wear Criteria

An alternate probe wear criteria approved by the NRC (Reference 8-5) was applied during the EOC-10 inspection. When a probe does not pass the 15% wear limit, this alternate criteria requires that only tubes with indications above 75% of the repair limit since the last successful probe wear check be reinspected. As the repair limit is 1 volt, all tubes containing indications for which worn probe voltage was above 0.75 volt require reinspection. Only 7 indications detected had a field bobbin voltage over 0.75 volt and none of those indications were inspected with a worn probe. Therefore, no reinspection was required.

The alternate probe wear criteria used in the EOC-10 inspection is consistent with the NRC guidance provided in Reference 8-5.

Table 3-1
Comanche Peak Unit 1 - April 2004 Outage
Summary of Inspection and Repair for Tubes in Service During Cycle 10

Voltage Bin	Steam Generator 1							Steam Generator 2						
	In-Service During Cycle 10				RTS for Cycle 11			In-Service During Cycle 10				RTS for Cycle 11		
	Field Bobbin Indications	RPC Inspected	RPC Confirmed	Indications Repaired	Deplugged Tubes	All Indications	Confirmed & Not Inspected Indications Only	Field Bobbin Indications	RPC Inspected	RPC Confirmed	Indications Repaired	Deplugged Tubes	All Indications	Confirmed & Not Inspected Indications Only
0.1	1	0	0	0	0	1	1	0	0	0	0	0	0	0
0.2	8	0	0	0	0	8	8	6	0	0	0	0	6	6
0.3	17	0	0	0	0	17	17	8	0	0	0	0	8	8
0.4	4	0	0	0	0	4	4	3	0	0	0	0	3	3
0.5	1	0	0	0	0	1	1	6	0	0	0	0	6	6
0.6	1	0	0	0	0	1	1	3	0	0	1	0	2	2
0.7	0	0	0	0	0	0	0	1	0	0	0	0	1	1
0.8	0	0	0	0	0	0	0	2	0	0	0	1	3	3
0.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	32	0	0	0	0	32	32	29	0	0	1	1	29	29
>1 V	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Voltage Bin	Steam Generator 3							Steam Generator 4						
	In-Service During Cycle 10				RTS for Cycle 11			In-Service During Cycle 10				RTS for Cycle 11		
	Field Bobbin Indications	RPC Inspected	RPC Confirmed	Indications Repaired	Deplugged Tubes	All Indications	Confirmed & Not Inspected Indications Only	Field Bobbin Indications	RPC Inspected	RPC Confirmed	Indications Repaired	Deplugged Tubes	All Indications	Confirmed & Not Inspected Indications Only
0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.2	3	0	0	0	0	3	3	18	0	0	0	1	19	19
0.3	9	0	0	0	0	9	9	39	0	0	0	2	41	41
0.4	4	0	0	0	0	4	4	47	0	0	0	1	48	48
0.5	6	0	0	0	0	6	6	37	0	0	0	2	39	39
0.6	2	0	0	0	0	2	2	20	1	0	0	5	25	24
0.7	1	0	0	0	0	1	1	16	0	0	0	1	17	17
0.8	1	0	0	0	0	1	1	6	0	0	0	2	8	8
0.9	0	0	0	0	0	0	0	1	0	0	0	0	1	1
1	0	0	0	0	0	0	0	1	0	0	1	0	0	0
1.1	0	0	0	0	0	0	0	1	1	1	1	0	0	0
Total	26	0	0	0	0	26	26	186	2	1	2	14	198	197
>1 V	0	0	0	0	0	0	0	1	1	1	1	0	0	0

Voltage Bin	Composite of All SGs						
	In-Service During Cycle 10				RTS for Cycle 11		
	Field Bobbin Indications	RPC Inspected	RPC Confirmed	Indications Repaired	Deplugged Tubes	All Indications	Confirmed & Not Inspected Indications Only
0.1	1	0	0	0	0	1	1
0.2	35	0	0	0	1	36	36
0.3	73	0	0	0	2	75	75
0.4	58	0	0	0	1	59	59
0.5	50	0	0	0	2	52	52
0.6	26	1	0	1	5	30	29
0.7	18	0	0	0	1	19	19
0.8	9	0	0	0	3	12	12
0.9	1	0	0	0	0	1	1
1	1	0	0	1	0	0	0
1.1	1	1	1	1	0	0	0
Total	273	2	1	3	15	285	284
>1 V	1	1	1	1	0	0	0

Table 3-2
Comanche Peak Unit 1 - April 2004 Outage
TSP ODSCC Indication Distributions for Tubes in Service During Cycle 10

Tube Support Plate	Steam Generator 4					Composite of All SGs				
	Number of Indications	Maximum Voltage	Average Voltage	Largest Growth	Average Growth	Number of Indications	Maximum Voltage	Average Voltage	Largest Growth	Average Growth
03H	102	0.88	0.42	0.22	0	162	0.88	0.39	0.22	-0.01
05H	72	1.09	0.4	0.4	0.01	94	1.09	0.37	0.4	0
07H	11	0.54	0.34	0.08	-0.01	13	0.54	0.32	0.08	-0.01
08H	1	0.16	0.16	-0.08	-0.08	3	0.55	0.4	0.21	0.14
10H	0	-	-	-	-	1	0.21	0.21	-0.03	-0.03
Total	186					273				

Note: 01H is the flow distribution baffle (FDB).

Table 3-3
Comanche Peak Unit 1 - April 2004 Outage
Signal Growth Statistics for Cycle 10 on an EFPY Basis

Delta Volts	Steam Generator 4				Composite of All SGs			
	Cycle 9		Cycle 10		Cycle 9		Cycle 10	
	No. of Inds.	CPDF	No. of Inds.	CPDF	No. of Inds.	CPDF	No. of Inds.	CPDF
-0.3	1	0.0084	0	0	1	0.0056	0	0
-0.2	1	0.0168	0	0	1	0.0111	0	0
-0.1	11	0.1092	3	0.0161	17	0.1056	5	0.0184
0	67	0.6723	100	0.5538	108	0.7056	160	0.6066
0.1	37	0.9832	78	0.9731	49	0.9778	100	0.9743
0.2	1	0.9916	4	0.9946	2	0.9889	6	0.9963
0.3	1	1.0	1	1.0	2	1.0	1	1.0
0.4	0	1.0	0	1.0	0	1.0	0	1.0

Table 3-4
Comanche Peak Unit 1 - April 2004 Outage
Average Voltage Growth During Cycle 10

Voltage Range	Number of Indications	Average Voltage BOC	Average Voltage Growth		Percent Growth	
			Entire Cycle	Per EFPY#	Entire Cycle	Per EFPY#
Composite of All Steam Generator Data						
Entire Voltage Range	273	0.38	-0.0048	-0.0038	-1.47%	-1.16%
V_{BOC} < .75 Volts	266	0.37	-0.0093	-0.0073	-2.15%	-1.69%
V_{BOC} ≥ .75 Volts	7	0.70	0.166	0.131	24.91%	19.58%
Steam Generator 4						
Entire Voltage Range	186	0.40	0.00027	0.0002	-0.20%	-0.16%
V_{BOC} < .75 Volts	181	0.39	-0.0046	-0.0036	-0.92%	-0.72%
V_{BOC} ≥ .75 Volts	5	0.72	0.18	0.14	25.92%	20.38%

Based on Cycle 10 duration 464.42 EFPD (1.272 EFPY)

Table 3-5
Comanche Peak Unit 1 - April 2004 Outage
Average Voltage Growth for Cycle 10
Composite of All Steam Generator Data

Voltage Range	Number of Indications	Average Voltage BOC	Average Voltage Growth		Percent Growth	
			Entire Cycle	Per EFPY	Entire Cycle	Per EFPY
Cycle 10 (2002 - 2004) - 464.42 EFPD						
Entire Voltage Range	273	0.38	-0.0048	-0.0035	-1.47%	-1.08%
V_{BOC} < .75 Volts	266	0.37	-0.0093	-0.0068	-2.15%	-1.58%
V_{BOC} ≥ .75 Volts	7	0.70	0.166	0.122	24.91%	18.28%
Cycle 9 (2001 - 2002) - 508.5 EFPD						
Entire Voltage Range	234	0.44	-0.037	-0.027	-8.5%	-6.1%
V_{BOC} < .75 Volts	220	0.41	-0.034	-0.024	-8.1%	-5.8%
V_{BOC} ≥ .75 Volts	14	0.85	-0.094	-0.067	-11.0%	-7.9%
Cycle 8 (1999 - 2001) - 506.3 EFPD						
Entire Voltage Range	260	0.44	0.001	0.001	0.3%	0.2%
V_{BOC} < .75 Volts	241	0.41	0.00	0.003	0.9%	0.6%
V_{BOC} ≥ .75 Volts	19	0.87	-0.027	-0.019	-3.1%	-2.2%
Cycle 7 (1998 - 1999) - 510 EFPD						
Entire Voltage Range	104	0.49	0.015	0.011	3.1%	2.2%
V_{BOC} < .75 Volts	90	0.43	0.02	0.01	0.0%	0.0%
V_{BOC} ≥ .75 Volts	14	0.89	-0.014	-0.010	-1.6%	-1.2%

Table 3-6
Comanche Peak Unit 1 - April 2004
Summary of Largest Voltage Growth Rates for BOC-10 to EOC-10

Steam Generator				Bobbin Voltage			RPC Confirmed?	New Indication?
SG	Row	Col	Elevation	EOC	BOC	Growth		
4	37	81	05H	1.09	0.69	0.4	Y	N
4	37	38	03H	0.78	0.56	0.22	N	N
4	27	49	05H	0.52	0.34	0.18	N	Y
3	24	62	05H	0.77	0.6	0.17	N	Y
1	39	17	08H	0.55	0.4	0.15	N	N
4	30	80	05H	0.98	0.83	0.15	N	N
4	28	48	03H	0.62	0.48	0.14	N	Y
2	29	64	03H	0.41	0.28	0.13	N	N
4	30	62	03H	0.33	0.21	0.12	N	N
3	25	62	03H	0.39	0.27	0.12	N	Y
4	25	52	03H	0.71	0.59	0.12	N	N
4	26	47	03H	0.65	0.53	0.12	N	N
4	30	39	05H	0.55	0.44	0.11	N	N
2	26	64	03H	0.78	0.67	0.11	N	N
4	30	61	05H	0.41	0.3	0.11	N	N
4	20	43	03H	0.57	0.48	0.09	N	N
4	24	45	03H	0.57	0.48	0.09	N	N
4	26	46	03H	0.41	0.32	0.09	N	N
4	37	38	05H	0.48	0.39	0.09	N	N
4	25	43	07H	0.33	0.25	0.08	N	N
4	30	54	03H	0.5	0.42	0.08	N	N
4	32	75	03H	0.54	0.46	0.08	Y	N
1	26	65	05H	0.22	0.14	0.08	N	Y
3	25	24	03H	0.31	0.23	0.08	N	Y
4	31	59	05H	0.6	0.52	0.08	N	Y
4	38	35	03H	0.7	0.62	0.08	N	N
4	26	75	05H	0.54	0.47	0.07	N	N
2	28	89	03H	0.42	0.35	0.07	N	Y
4	31	49	03H	0.44	0.37	0.07	N	N
4	29	42	03H	0.47	0.4	0.07	N	N

Table 3-7
Probe Wear and Analyst Variability - Tabulated Values

Analyst Variability Std. Dev. = 10.3% Mean = 0.0% No Cutoff	
Value	Cumul. Prob.
-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

Probe Wear Variability Std. Dev. = 7.0% Mean = 0.0% Cutoff at +/- 15%	
Value	Cumul. Prob.
<-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

Figure 3-1
Comanche Peak Unit 1 - April 2004 Outage
Bobbin Voltage Distributions at EOC-10 for Tubes in Service During Cycle 10

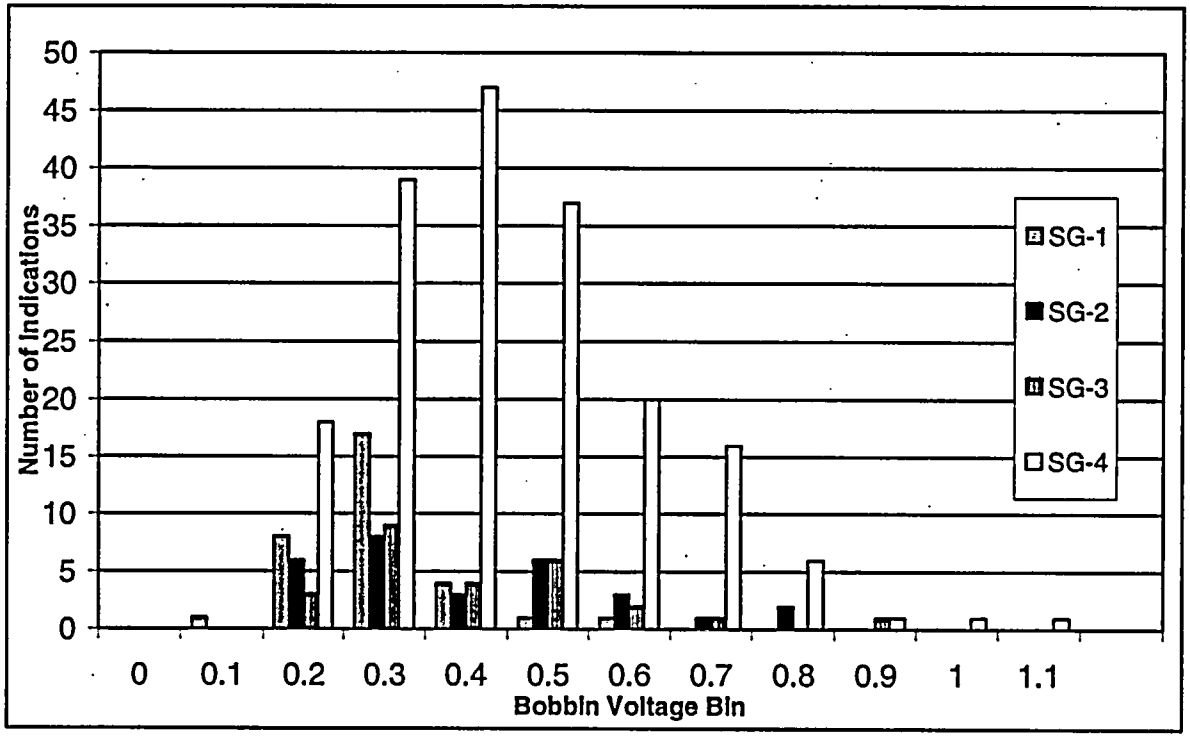


Figure 3-2
Comanche Peak Unit 1 - April 2004
ODSCC Axial Distributions for Tubes in Service During Cycle 10

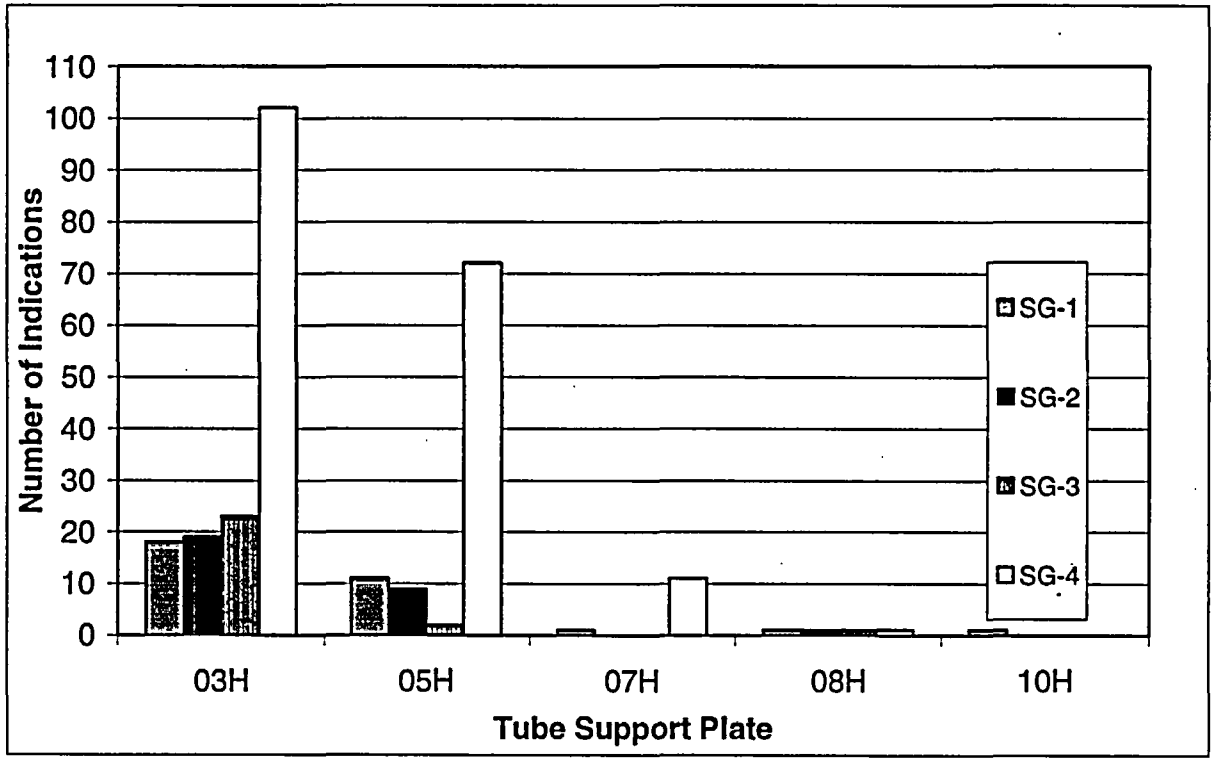


Figure 3-3
Comanche Peak Unit 1 Cycle 10 (October 2002 to April 2004)
Cumulative Probability Distributions for Voltage Growth on an EFPY Basis

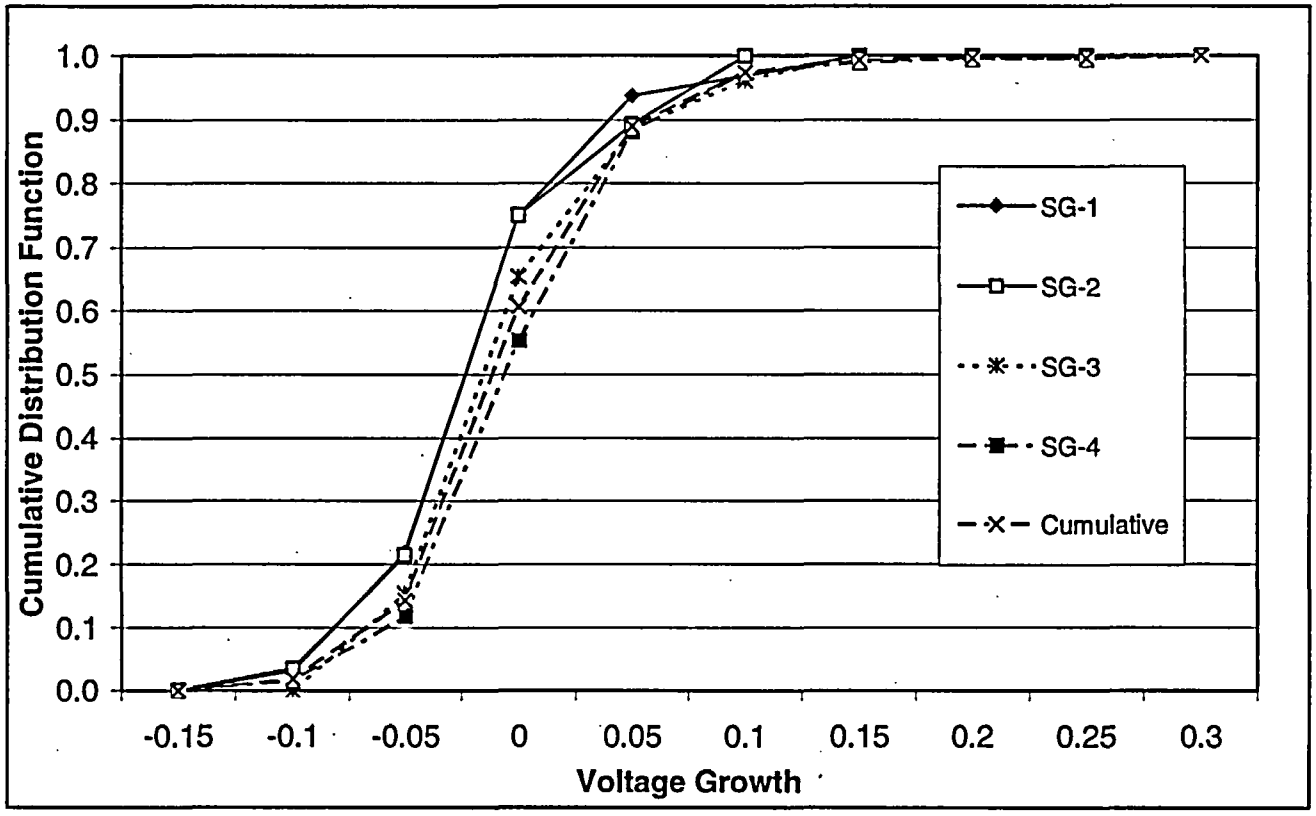


Figure 3-4
Comanche Peak Unit 1 - April 2004
Bobbin Signal Growth History - Cumulative Probability Distributions on an EFPY Basis
Composite of All Steam Generators

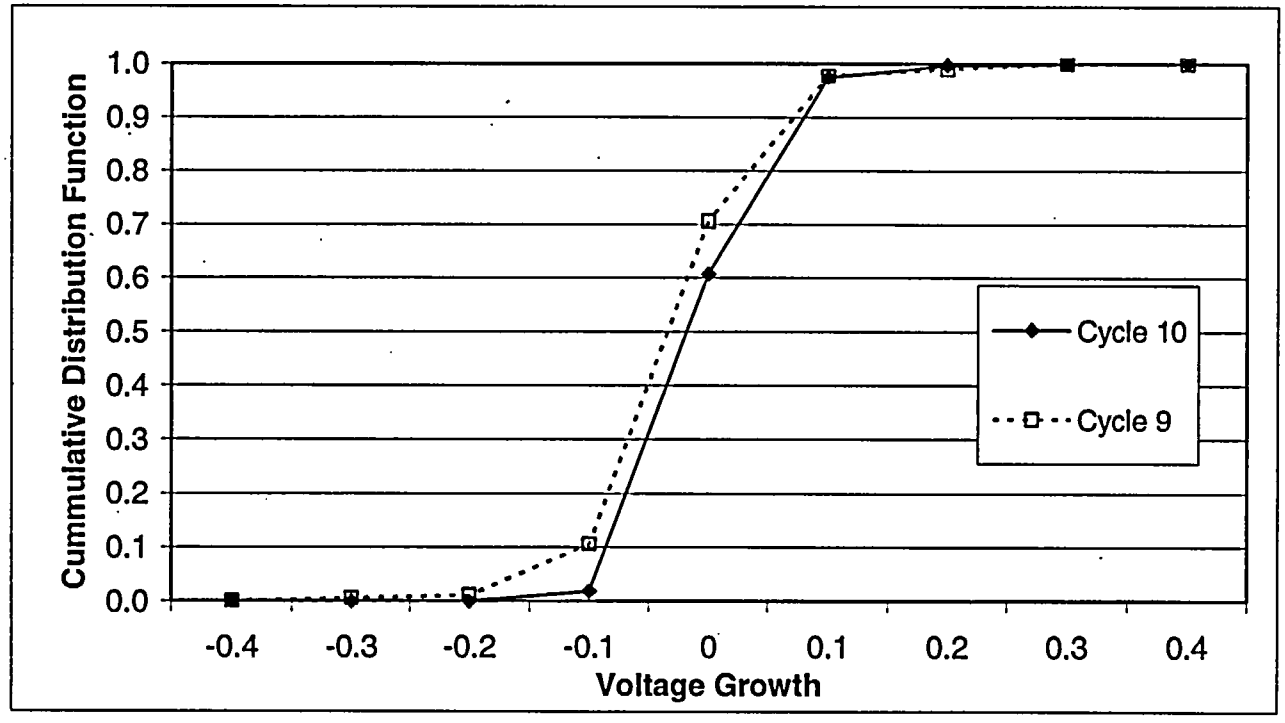
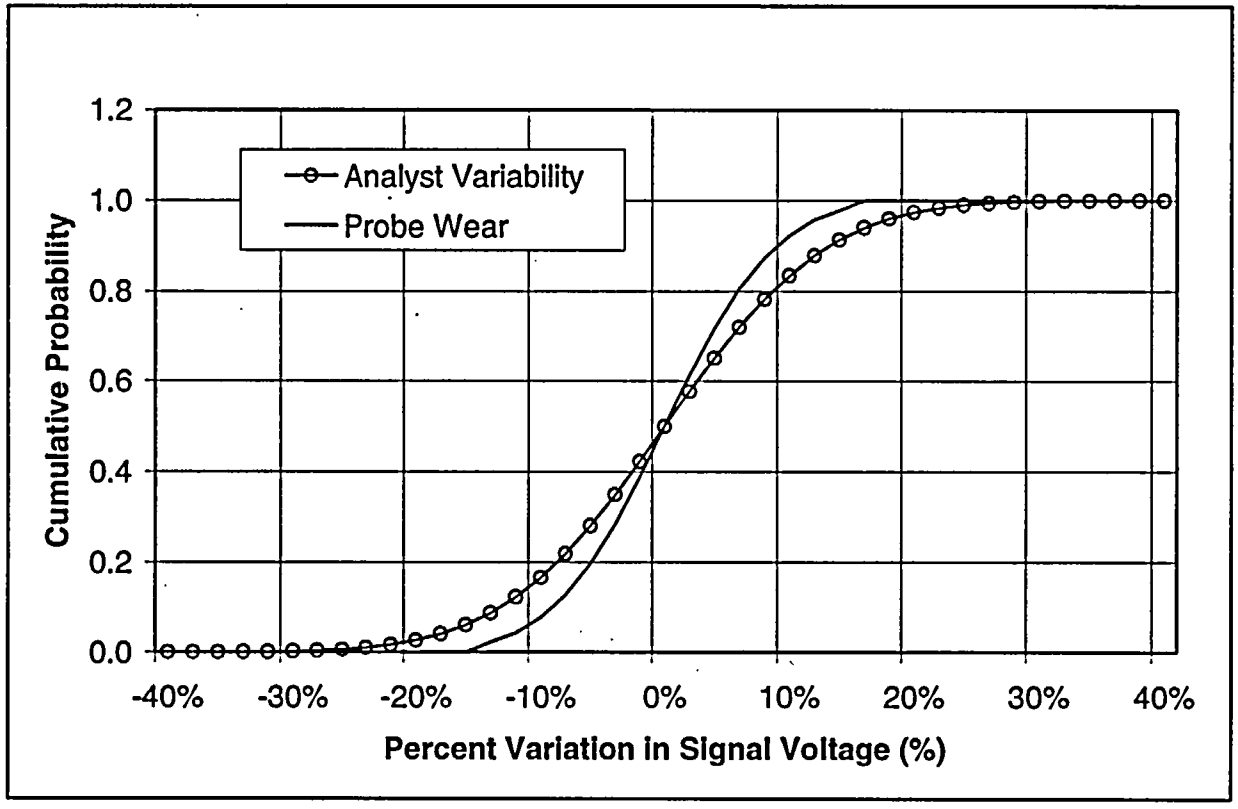


Figure 3-5
NDE Uncertainty Distributions



4.0 Database Applied for Leak and Burst Correlations

Leak and burst correlations based on the latest available database for ¾" tubes are applied for the EOC-11 projections (operational assessment). These correlations are documented in Reference 8-6. The leak rates and burst probabilities based on the measured EOC-10 voltages (condition monitoring assessment) were also calculated using the correlations in Reference 8-6.

The following are the correlations for burst pressure, probability of leakage and leak rate used for the EOC-11 operational assessment as well as the EOC-10 condition monitoring assessment (Reference 8-6).

$$\text{Burst Pressure } (ksi) = \quad 7.4605 - 2.9572 \times \log(volts)$$

$$\text{Probability of Leak} = \frac{1}{1 + e^{(4.8270 - 8.4488 \times \log(volts))}}$$

$$\text{Leak Rate } (l/hr) = \quad 10^{(-1.6384 + 2.9409 \times \log(volts))}$$

The upper voltage repair limit applied at the EOC-10 inspection, documented in Reference 8-7, was developed using NRC-reviewed database presented in Reference 8-6. The structural limit (V_{sl}) for the TSP indications established using 1.4 times the SLB ΔP of 2560 psid is 4.69 volts, and V_{sl} for the FDB intersections using 3 times normal operation ΔP value (3885 psid) is 3.72 volts. Applying NDE uncertainty and growth allowance, the upper voltage repair limits then become 2.88 volts for TSP indications and 2.30 volts for FDB indications. The bobbin voltage for the largest ODSCC indication found during the EOC-10 inspection (1.09 volts) is substantially below the above upper repair limits.

5.0 SLB Analysis Methods

Monte Carlo analyses are used to calculate the SLB leak rates and tube burst probabilities for both actual EOC-10 and projected EOC-11 voltage distributions. The Monte Carlo analyses account for parameter uncertainty. The analysis methodology is described in the Westinghouse generic methods report of Reference 8-3, and it is consistent with the guidelines provided in the Generic Letter 95-05 (Reference 8-1).

In general, the methodology involves application of correlations for burst pressure, probability of leak and leak rate to a measured or calculated EOC distribution to estimate the likelihood of tube burst and primary-to-secondary leakage during a postulated SLB event. NDE uncertainties and uncertainties associated with burst pressure, leak rate probability and leak rate correlations are explicitly included by considering many thousands of voltage distributions through a Monte Carlo sampling process. The voltage distributions used in the projection analyses for the next operating cycle are obtained by applying growth data to the BOC distribution. The BOC voltage distributions include an adjustment for detection uncertainty and occurrence of new indications, in addition to the adjustments for NDE uncertainties. Comparisons of projected EOC voltage distributions with actual distributions after a cycle of operation have shown that the Monte Carlo analysis technique yields conservative estimates for EOC voltage distributions; therefore, leak and burst results based on those distributions are also conservative. Equation 3.5 in Reference 8-3 was used to determine the true BOC voltage.

6.0 Bobbin Voltage Distributions

This section describes the salient input data used to calculate EOC bobbin voltage distributions and presents projected EOC-11 voltage distributions. Also, actual measured voltage distributions from the EOC-10 inspection are compared with the projections performed after the last (EOC-9) outage.

6.1 Calculation of Voltage Distributions

The analysis for the EOC voltage distribution starts with a beginning of cycle (BOC) voltage distribution. The BOC distribution is projected to the EOC conditions by applying growth appropriate for the anticipated cycle operating period. The numbers of indications assumed in the analysis to project the EOC voltage distributions, and to perform tube leak rate and burst probability analyses, are obtained by adjusting the numbers of reported indications to account for detection uncertainty and initiation of new indications over the projected period. This is accomplished by using a POD factor, which is defined as the ratio of the actual number of indications detected to total number of indications present. A conservative value is assigned to the POD based on historic data, and the value used herein is discussed in Section 6.2. The calculation of projected bobbin voltage frequency distribution is based on a net total number of indications returned to service, defined as follows.

$$N_{Tot\,RTS} = N_i / POD - N_{repaired} + N_{deplugged}$$

where,

$N_{Tot\,RTS}$	=	Number of bobbin indications being returned to service for the next cycle,
N_i	=	Number of bobbin indications (in tubes in service) identified after the previous cycle,
POD	=	Probability of detection,
$N_{repaired}$	=	Number of N_i which are repaired (plugged) after the last cycle,
$N_{deplugged}$	=	Number of indications in tubes deplugged after the last cycle and returned to service in accordance with voltage-based repair criteria.

Several deplugged tubes were returned to service at BOC-11;15 of them had an ODSCC indication at TSP intersections; therefore, $N_{deplugged} = 15$.

The methodology used in the projection of bobbin voltage frequency predictions is described in Reference 8-3. Salient input data used for projecting EOC-11 bobbin.

voltage frequency are further discussed below.

6.2 Probability of Detection (POD)

The Generic Letter 95-05 (Reference 8-1) requires the application of a constant POD value of 0.6 to define the BOC distribution for EOC voltage projections, unless an alternate POD is approved by the NRC. A POD value of 1.0 represents the ideal situation where all indications are detected. A voltage-dependent POD would yield a more accurate prediction of voltage distributions consistent with voltage-based repair criteria experience. Since the absolute magnitude of EOC-11 SLB leak rates and burst probabilities are expected to be small, the differences in the projections based on constant POD=0.6 and voltage-dependent POPCD are not expected to be significant. Therefore, only analyses based on the NRC required constant POD of 0.6 were performed.

6.3 Growth Rate Distribution

As discussed in Section 3.2, the NRC guidelines in Generic Letter 95-05 stipulate that the growth rate distribution used in the SLB leak rate and tube burst probability analyses must contain at least 200 data points that are established using bobbin voltages measured in two consecutive inspections. Since the growth distributions for both Cycles 9 and 10 contain more than 200 data points, the above criterion is met. The cumulative probability distribution function for Cycle 10 envelops the Cycle 9 distribution; therefore, Cycle 10 growth distribution was applied for EOC-11 projections.

6.4 Cycle Operating Period

The operating periods used in the growth rate/EFPY calculations and voltage projections are as follows.

Cycle 10	- EOC-9 to EOC-10	- 464.42 EFPD	or 1.27 EFPY (actual)
Cycle 11	- EOC-10 to EOC-11	- 497.72 EFPD	or 1.36 EFPY (planned)

6.5 Projected EOC-11 Voltage Distribution

Calculations for the EOC-11 bobbin voltage projections were performed for SG-4 and for all four SGs combined using the measured EOC-10 voltage data. Steam generators 1, 2, and 3 were not analyzed separately since there were so few indications in these generators. The BOC distributions were adjusted to account for probability of detection as described above. The adjusted number of indications at BOC-11 are shown in Table 6-1. As discussed in Section 3-2, all SG composite growth distribution for Cycle 10, shown in Table 3-3, was applied to all SGs. The EOC-11 voltage distributions thus projected for all four SGs combined and SG-4 are

summarized on Table 6-2. These results are also shown graphically on Figure 6-1. The largest voltage projected at EOC-11 is only 1.4 volts and is predicted in SG-4.

6.6 Comparison of Actual and Projected EOC-10 Voltage Distributions

Table 6-3 and Figure 6-2 provide a comparison of the EOC-10 actual measured bobbin voltage distributions for SG-4 with the corresponding projections performed using the last (EOC-9) inspection bobbin voltage data. The EOC-10 projections shown are based on a constant POD of 0.6. As reported in the last 90-day report (Reference 8-4), SG-4 was projected to have the highest number of indications, which is consistent with the EOC-10 inspections data. The projections SG-4 overestimates the number of indications, see Figures 6-2 and Table 6-3. The largest indication found in SG-4 in the EOC-10 inspection (1.09 volt) is well below the largest projected value (1.4 volt). Thus, the methodology used for the EOC-10 projections, which is also used for EOC-11 projection, is conservative.

Table 6-1
Comanche Peak Unit 1 - April 2004 Outage
EOC-10 Bobbin and Assumed BOC-11 Bobbin Distributions Is
SLB Leak Rate and Tube Burst Analyses

Voltage Bin	Steam Generator 4				All SGs Combined			
	EOC-10			BOC-11	EOC-10			BOC-11
	Field Bobbin Indications	Indications Repaired	Deplugged Tubes	POD 0.6	Field Bobbin Indications	Indications Repaired	Deplugged Tubes	POD 0.6
0.1	0	0	0	0.0	1	0	0	1.7
0.2	18	0	1	31.7	35	0	1	60.0
0.3	39	0	2	68.3	73	0	2	125.0
0.4	47	0	1	80.0	58	0	1	98.3
0.5	37	0	2	65.0	50	0	2	86.7
0.6	20	0	5	41.7	26	1	5	50.7
0.7	16	0	1	28.3	18	0	1	31.7
0.8	6	0	2	13.3	9	0	3	20.0
0.9	1	0	0	1.7	1	0	0	1.7
1	1	1	0	0.7	1	1	0	0.7
1.1	1	1	0	0.7	1	1	0	0.7
Total	186	2	14	331.3	273	3	15	477.0
> 1V	1	1	0	0.7	1	1	0	0.7

Note: The Cyclesim Code does not differentiate between deplugged and non-deplugged tubes. Therefore, all indications (including deplugged tubes) are divided by the POD. This leads to conservative leak rates and tube burst probabilities.

Table 6-2
Comanche Peak Unit 1 - April 2004 Outage
Voltage Distribution Projection for EOC-11

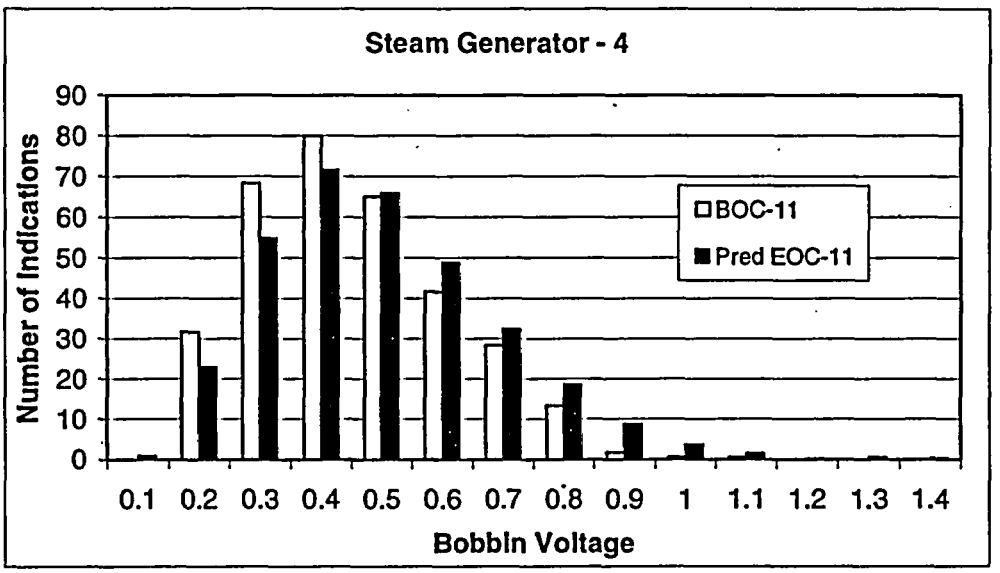
Voltage Bin	Steam Generator 4	All 4 SGs Combined
	Projected Number of Indications at EOC-11 POD = 0.6	
0.1	0.9	2.9
0.2	23.1	46.2
0.3	54.8	98.6
0.4	71.6	102.0
0.5	65.9	85.6
0.6	48.9	61.4
0.7	32.5	39.2
0.8	18.6	22.8
0.9	8.7	10.9
1	3.6	4.4
1.1	1.5	1.7
1.2	0.2	0.2
1.3	0.7	0.7
1.4	0.3	0.3
TOTAL	331.3	477.0
> 1 V	2.7	2.9

Note: The Cyclesim Code does not differentiate between deplugged and non-deplugged tubes. Therefore, all indications (including deplugged tubes) are divided by the POD. This leads to conservative leak rates and tube burst probabilities.

Table 6-3
Comanche Peak Unit 1 - April 2004 Outage
Comparison of Predicted and Actual EOC-10 Voltage Distributions

Voltage Bin	Steam Generator 4	
	Number of Indications	
	EOC-10 Prediction POD = 0.6	EOC-10 Actual
0.1	0.2	0
0.2	7.1	18
0.3	39.6	39
0.4	54.5	47
0.5	54.6	37
0.6	39.8	20
0.7	25.1	16
0.8	14.2	6
0.9	7.5	1
1	3.6	1
1.1	1.4	1
1.2	0.0	0
1.3	0.7	0
1.4	0.3	0
TOTAL	248.7	186
> 1 V	2.4	1

Figure 6-1
Comanche Peak Unit 1
Predicted Bobbin Voltage Distribution for Cycle 11
POD = 0.6



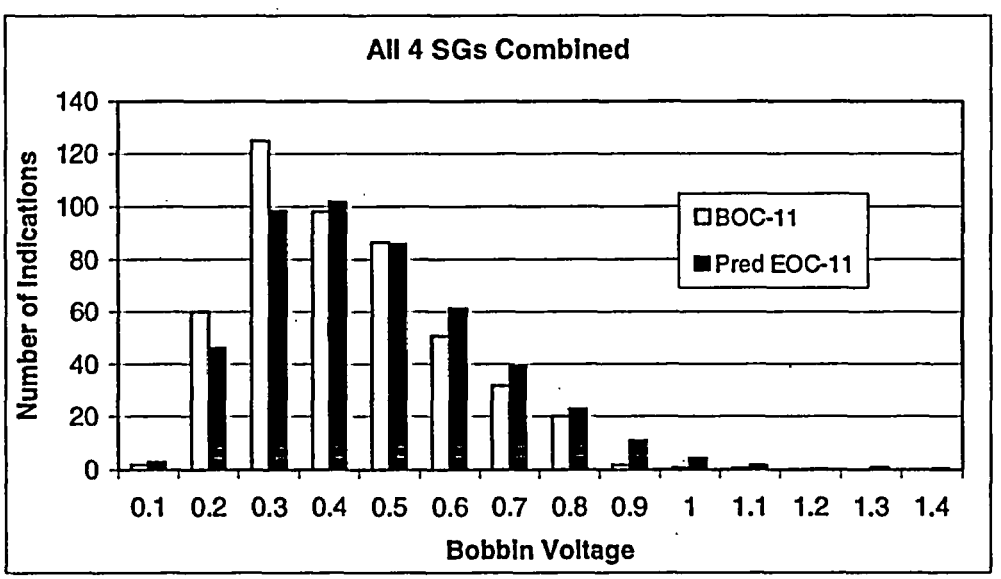
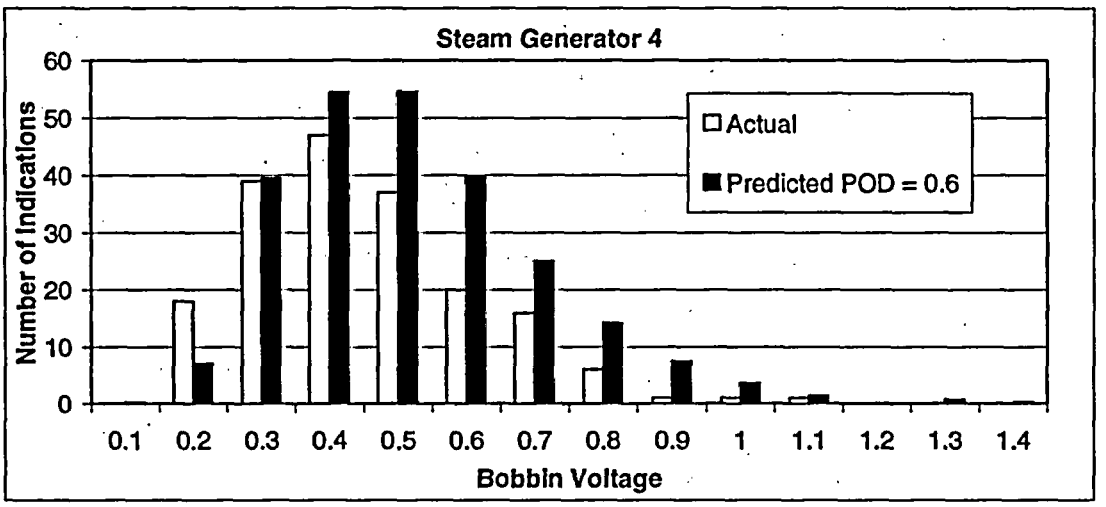


Figure 6-2
Comanche Peak Unit 1 - April 2004 Outage
Bobbin Voltage Distributions at EOC-10



7.0 SLB Leak Rate and Tube Burst Probability Analyses

This section presents the results of the Monte Carlo analyses carried out to predict the leak rates and tube burst probabilities for the postulated SLB conditions using the actual voltage distributions from the EOC-10 inspection data (condition monitoring analysis) as well as the projected EOC-11 voltage distributions (operational assessment evaluation). The methodology used in these analyses is described in Section 5.0. About 2/3rds of all the TSP ODSCC indications found in all 4 SGs during the EOC-10 inspection (186 out of a total of 273) were in SG-4; hence, SG-4 is expected to yield the limiting SLB leak rate and burst probability for Cycle 11. Since so few indications were found in SGs 1, 2, and 3, only SG-4 was analyzed separately.

7.1 Leak Rate and Tube Burst Probability for EOC-10

Condition monitoring analyses for leak rates and burst probabilities were performed for SG-4 and the results compared with the projections performed after the last (EOC-9) outage. These results are shown in Table 7-1. The SLB leak rates and tube burst probabilities projected for the EOC-10 conditions were small relative to their acceptance limits, and those based on the as-measured EOC-10 voltages are even smaller. The limiting SLB leak rate (1.91×10^{-4}) and tube burst probability (1.2×10^{-5}) values obtained using the as-measured EOC-10 voltages are 3 to 5 orders of magnitude below the corresponding acceptance limits (27.79 gpm at room temperature and 10^{-2}, respectively).

In summary, the condition monitoring analysis results meet the requirements of the Generic Letter 95-05.

7.2 Leak Rate and Tube Burst Probability for EOC-11

Calculations to predict the SLB leak rates and tube burst probabilities for SG-4 in Comanche Peak Unit-1 at the EOC-11 conditions (operational assessment) were carried out using the NRC required POD value of 0.6 and Cycle 10 growth distribution. The projected results for the EOC-11 conditions are summarized in Table 7-2. Based on the standard calculation methodology presented in Reference 8-3 and a constant POD of 0.6, the largest EOC-11 SLB leak rate projected is 4.98×10^{-4} gpm (room temperature) for SG-4. The limiting SLB leak rate value is 5 orders of magnitude below the allowable SLB leakage limit for Cycle 11 of 27.79 gpm (room temperature). The highest tube burst probability predicted for SG-4 is 1.2×10^{-5}, and is 3 orders of magnitude below the NRC reporting guideline of 10^{-2}.

In summary, SLB leak rates and tube burst probabilities predicted for EOC-11 are substantially below their respective limits.

Table 7-1
Comanche Peak Unit-1 - April 2004 Outage
Comparison of EOC-10 Projected Tube Leak Rates and Burst Probabilities
With Results Based on Actual Measured Voltage Data

Steam Generator	POD	No. of Indications[1]	Max Volts[2]	Burst Probability		SLB Leak Rate (gpm)[3]
				1 Tube	1 or More Tubes	
EOC-10 Projections (Based on a projected Cycle 10 duration of 501 EFPD)						
4	0.6	248.7	1.4	3.1×10^{-5}	3.1×10^{-5}	4.0×10^{-4}
EOC-10 Actual						
4	1	186	1.1	1.2×10^{-5}	1.2×10^{-5}	1.91×10^{-4}

Notes: (1) Number of indications adjusted for POD.
(2) Voltages include NDE uncertainties from Monte Carlo analyses and exceed measured voltages.
(3) Equivalent volumetric rate at room temperature.

Table 7-2
Comanche Peak Unit-1 - April 2004 Outage
Summary of Projected Tube Leak Rate and Burst Probability
for EOC-11 - 250k Simulations

Steam Generator	POD	No. of Indications[1]	Max Volts[2]	Burst Probability		SLB Leak Rate (gpm)[3]
				1 Tube	1 or More Tubes	
EOC-11 Projections (Based on a projected Cycle 11 duration of 497.72 EFPD)						
4	0.6	331.3	1.4	1.2×10^{-5}	1.2×10^{-5}	4.98×10^{-4}

Notes: (1) Number of indications adjusted for POD.
(2) Voltages include NDE uncertainties from Monte Carlo analyses and exceed measured voltages.
(3) Equivalent volumetric rate at room temperature.

8.0 References

8-1 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.

8-2 NRC Letter "Comanche Peak Steam Electric Station (CPSES), Unit-1 – Issuance of Amendments Re: Implementation of the 1.0 Volt Steam Generator Tube Criteria (TAC Nos. MA 4843 and MA 4844," September 22, 1999.

8-3 WCAP-14277, Revision 1, "SLB Leak Rate and Tube Burst Probability Analysis Methods for ODSCC at TSP Intersections", Westinghouse Nuclear Services Division, December.1996.

8-4 SG-SGDA-03-4, Rev. 1 "Comanche Peak Unit-1, Cycle 10 Voltage-Based Repair Criteria Report," Westinghouse Electric Company, January 2003.

8-5 Letter from B. W. Sheron, Nuclear Regulatory Commission, to A. Marion, Nuclear Energy Institute, dated February 9, 1996.

8-6 EPRI Report NP 7480-L, Addendum 5, "Steam Generator Tubing Outside Diameter Stress Corrosion Cracking at Tube Support Plates Database for Alternate repair Limits, " Electric Power Research Institute, December 2002.

8-7 SG-SGDA-04-3, "SG Degradation Assessment for Comanche Peak Unit 1 Spring 2004 Outage (1RF10)," Westinghouse Electric Company, March 2004.

8-8 LTR-SGDA-04-126, "540 and 520 Wide Groove Bobbin Probe Evaluation," April 18, 2004.