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U. S. Nuclear Regulatory Commission
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Washington, DC 20555

SUBJECT: COMANCHE PEAK STEAM ELECTRIC STATION (CPSES)-UNIT 1
DOCKET NOS. 50-445
SUBMITTAL OF UNIT 1 SEVENTH REFUELING OUTAGE (1RF07)

This letter forwards the 90-day report pursuant to the requirements 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".

Please note that the section 3 of the report titled, "Comanche Peak Unit-1 2000 Pulled Tube Data for TSP Locations", is not available. This section and a complete report will be provided to the staff within the next 60 days.

A001

This communication contains no new licensing basis commitments regarding CPSES Unit 1. If you have any questions, please contact Mr. Obaid Bhatty at (254) 897-5839.

Sincerely,

C. L. Terry

By: 

J. J. Kelley, Jr.
Vice President, Nuclear Engineering
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Attachment

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ATTACHMENT TO TXX-00036

COMANCHE PEAK UNIT - 1

CYCLE 8 VOLTAGE-BASED REPAIR CRITERIA REPORT

REVISION 0

February 2000

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COMANCHE PEAK UNIT - 1

CYCLE 8 VOLTAGE-BASED REPAIR CRITERIA REPORT

1.0 Introduction

This report provides a summary of the Comanche Peak Unit-1 steam generator (SG) bobbin and rotating pancake coil (RPC) probe inspection at tube support plate (TSP) intersections, together with leak rate and tube burst probability analysis results for a postulated steam line break (SLB) accident. The results support implementation of a voltage-based repair criteria for Cycle 8 as outlined in the NRC Generic Letter 95-05 (Reference 9-1). A 1.0-volt repair criterion for outside diameter stress corrosion cracking (ODSCC) indications at the TSP intersections has been approved for implementation starting with the current cycle (Cycle 8, Reference 9-2). Information required by the Generic Letter to support a 1-volt repair criterion is provided in this report.

A relatively small number of ODSCC indications were detected during the EOC-7 inspection (a total of 104 indications from all 4 SGs combined) and a majority of those indications (65) was found in SG-4. Therefore, leak and burst analysis based on the actual bobbin voltage distribution (condition monitoring analysis) was carried only for SG-4 as it clearly bounds the other 3 SGs. Westinghouse generic methodology based on Monte Carlo simulations presented in Reference 9-3 was used, and this methodology has been utilized for all leak and burst analyses performed todate by the industry in support of Generic Letter 95-05.

Analyses were also performed to project leak rates and tube burst probabilities for a postulated SLB condition at the end of the ongoing cycle (Cycle 8) applying the 1.0 volt repair criteria. Because of a relatively small indication population detected during the recent (EOC-7) inspection, adequate data is not yet available to define a reliable growth distribution for Comanche Peak Unit-1. Therefore, a bounding growth distribution based on growth data for ¾" tube plants during cycles that utilized a 1-volt repair criterion was applied for the EOC-8 projections.

Two tube segments (R31C81 and R25C81) in SG-4 each with 2 TSP intersections were pulled during this inspection for detailed laboratory examination. Results from leak and burst tests and metallurgical examination are presented in Section 3. Eddy current and repair data for EOC-7 TSP indications are provided in Section 4. The leak and burst databases applied and the Monte Carlo analysis used to estimate leak rate and tube burst probability are briefly described in Sections 5 and 6. The EOC-8 voltage distributions projected using the bounding growth distribution are presented in Section 7. Leak rates and burst probabilities for the actual EOC-7 voltage distributions and projected EOC-8 voltage distributions are reported in Section 8 and compared with allowable limits.

2.0 Summary and Conclusions

Only a total of 104 indications were found in the EOC-7 inspection, a majority of which (65) was in SG-4. All indications detected were on the hot leg side. Only one indication over 1 volt was detected in all 4 SGs combined. It was found in SG-4 and was inspected with a RPC probe. The indication was confirmed as a flaw, and the tube containing it was pulled for detailed laboratory examination. No ID or circumferential indications at the TSP intersections or indications extending outside the TSP were found in this inspection. Also, no indications with a mixed residual signal that could potentially mask a 1.0 volt bobbin indication (residual signal voltage 1.5 volts or greater) were detected.

SLB leak rate and tube burst probability analyses were performed for the actual EOC-7 bobbin voltage distributions as well as the projected EOC-8 bobbin voltage distributions. Since about 63% of the combined EOC-7 TSP ODSCC population from all 4 SGs (65 out of a total of 104) was found in SG-4, the leak and burst analysis results based on the actual bobbin voltage distribution for SG-4 should bound those for the other 3 SGs. Therefore, the condition monitoring analysis was carried only for SG-4. The limiting SLB leak rate (1.4×10^{-4}) and tube burst probability (1.2×10^{-5}) values obtained using the actual measured EOC-7 voltages for SG-4 are relatively small, and they are 3 to 5 orders of magnitude below the corresponding acceptance limits (27.79 gpm at room temperature and 10^{-2}).

The leak rate and tube burst probability projections at the EOC conditions for the current cycle (Cycle 8) are also well within their acceptable limits. The limiting EOC-8 SLB leak rate projected using the standard analysis methodology (Reference 9-3) and a constant POD of 0.6 is 0.14 gpm. This value is predicted for SG-4 which had the largest number of indications among the 4 SGs in the EOC-7 inspection. Because the ODSCC indication population observed thus far in Comanche Peak Unit-1 is relatively small, a meaningful plant-specific growth distribution is not yet available. Therefore, in accordance with GL 95-05 a bounding growth distribution based on growth data for ¾" tube plants during cycles that utilized a 1-volt repair criterion was applied. The bounding growth distribution utilized is very conservative, and the actual growth during Cycle 8 is expected to be substantially below the bounding distribution applied. Even with a conservative growth distribution, the limiting EOC-8 leak rate projected (0.14 gpm, in SG-4) is more than 2 orders of magnitude below the allowable EOC-8 leakage limit of 27.79 gpm (room temperature). The corresponding tube burst probability, 1.9×10^{-3}, is about $1/5^{th}$ of the NRC reporting guideline of 10^{-2}. Thus, the GL 95-05 requirements for continued plant operation for the projected duration of Cycle 8 are met.

3.0 Comanche Peak Unit-1 2000 Pulled Tube Data for TSP Locations

TO BE PROVIDED LATER

4.0 EOC-7 Inspection Results and Voltage Growth Rates

4.1 EOC-7 Inspection Results

According to the guidance provided by the NRC Generic Letter 95-05, the EOC-7 inspection of the Comanche Peak Unit-1 SGs consisted of a complete, 100% eddy current (EC) bobbin probe full length examination of the tube bundles in all four SGs. A 0.610 inch diameter probe was used for hot and cold leg TSPs where voltage-based repair criterion was applied. RPC examination was performed for all indications with amplitude above 1 volt. Only one indication in the combined population from all 4 SGs exceeded 1 volt. It was confirmed as a flaw, and the tube containing it was pulled for detailed laboratory examination. All ODSCC indications detected at TSPs were on the hot leg side and no indication was detected on the cold leg side.

No RPC circumferential indications at the TSPs, no indications extending outside the TSPs, and no RPC indications with potential ID phase angles were found in this inspection. Also, no signal interference from copper deposits or mixed residual signal (MRI) that could potentially mask a 1.0 volt bobbin indication (MRI voltage 1.5 volts or greater) were found.

A summary of EC indications for all four SGs is shown on Table 4-1, which tabulates 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 8 operation is the difference between the observed and the ones removed from service. Only one tube was repaired to meet the GL 95-05 requirement. Figure 4-1 shows the actual bobbin voltage distribution determined from the EOC-7 EC inspection. Since only a total 3 ODSCC indications were removed from service because of tube repairs for all causes, the distribution in Figure 4-1 also approximates the distribution for indications returned to service for Cycle 8.

A review of Table 4-1 indicates that SG-4 had the highest number of indications returned to service for Cycle 8 operation (62 indications, none above 1.0 volt). Therefore, SG-4 is likely to be the limiting SG at EOC-8 from the standpoint of SLB leak rate and tube burst probability.

The distribution of EOC-7 indications as a function of support plate location is summarized in Table 4-2 and plotted in Figure 4-2. The data show a strong predisposition of ODSCC to occur in the first few hot leg TSPs (99 out of 104 indications occurred at 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.

All dented TSP intersections above 5 volts were inspected with a RPC probe in this inspection, and no degradation was found at those locations.

4.2 Voltage Growth Rates

Voltage growth rates during Cycle 7 were developed from EOC-7 (September 1999) inspection data and a reevaluation of the EOC-6 (April 1998) inspection EC signals for the same indications. Table 4-3 shows the cumulative probability distribution (CPDF) for growth rate in each Comanche Peak Unit-1 steam generators during Cycle 7 on an EFPY basis, and they are also plotted in Figure 4-3. The curve labelled 'cumulative' in Figure 4-3 represents composite growth data from all four SGs. No growth rate evaluation was performed for prior cycles because a voltage-based criterion was not used prior to the current cycle.

Average growth rates for each SG during Cycle 7 are summarized in Table 4-4. It is evident that the magnitude of average voltage growth in all SGs is relatively small (about 0.1 volt or less). In terms of growth as a percent of the BOC voltage, the data for SG-3 stands out (21.1%); but this value is based on data from only 9 indications and, thus, does not indicate a trend.

The NRC guidelines in Generic Letter 95-05 stipulate that the growth rate distribution(s) used in the SLB leak rate and tube 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. Since the composite growth data in Table 4-3 is based on only 104 indications, the Cycle 7 growth data do not meet the above NRC requirement. In the absence of an acceptable plant-specific growth database, Generic Letter 95-05 requires the use of a bounding growth rate distribution established based on data available from similarly designed and operated plants. Therefore, a bounding growth distribution was developed using available growth data for plants with ¾ inch diameter tubes and applied to the Comanche Peak Unit-1 EOC-8 projections.

Prior to Comanche Peak Unit-1, voltage-based repair criteria for ODSCC indications have been applied to five units with ¾ inch diameter tubes. Growth data from these 5 units were used to develop a bounding growth distribution for ¾" tube plants. Only the growth data for operating periods during which a 1-volt repair criterion was in effect were included. The growth data from different plants were expressed as growth rates per EFPY to account for different plant operating periods. The largest growth rates for each of these 5 units in a cycle when a 1 volt repair criterion was in effect, expressed as a cumulative probability distribution, are shown in Table 4-5; they are also plotted in Figure 4-4. The plant codes used in Table 4-5 and Figure 4-4 are same as those in the EPRI documents cited in Reference 9-4. All of the bobbin voltage data used in the growth data considered have been evaluated using the inspection guidelines employed since 1992 to support voltage-based repair criteria. It is evident that the largest growth rates for the individual units vary significantly.

Using the growth distributions for the 5 units, a bounding growth distribution for plants with 3/4 inch diameter tubes was obtained so as to envelope all five growth rate distributions considered; it is shown in Table 4-5 as well as plotted in Figure 4-4. This bounding distribution follows the growth rates observed during the first half of Cycle 5 for Plant AA, but it also includes the highest growth value in the 5 distributions, which occurred in Plant-AB. The bounding growth distribution thus obtained is also compared with the CPDF distribution for Cycle 7 operation of Comanche Peak Unit-1 in Table 4-5 and Figure 4-4, and it is clearly evident that the Comanche Peak Unit-1 growth rates are much smaller than the bounding values. The CPDF values defining the bounding distribution are utilized to predict the EOC-8 voltage distributions used in SLB leak rate and tube burst analyses.

4.3 NDE Uncertainties

The NDE uncertainties applied for the Cycle 7 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 9-1). They are presented in Table 4-6 as well as graphically illustrated in Figure 4-5. 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-7 actual voltage distributions as well as for the EOC-8 projections.

4.4 Probability of Prior Cycle Detection (POPCD)

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

4.6 Probe Wear Criteria

An alternate probe wear criteria approved by the NRC (Reference 9-5) was applied during the EOC-7 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 11 indications detected had a field bobbin voltage over 0.75 volts 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-7 inspection is consistent with the NRC guidance provided in Reference 9-5.

Table 4-1
Comanche Peak Unit 1 September 99 Outage
Summary of Inspection and Repair For Tubes in Service During Cycle 7

Voltage Bin	Steam Generator 1						Steam Generator 2					
	In-Service During Cycle 7				RTS for Cycle 8		In-Service During Cycle 7				RTS for Cycle 8	
	Field Bobbin Indications	RPC Inspected	RPC Confirmed	Indications Repaired	All Indications	Confirmed & Not Inspected Indications Only	Field Bobbin Indications	RPC Inspected	RPC Confirmed	Indications Repaired	All Indications	Confirmed & Not Inspected Indications Only
0.2	2	0	0	0	2	2	1	0	0	0	1	1
0.3	1	0	0	0	1	1	3	0	0	0	3	3
0.4	5	0	0	0	5	5	3	0	0	0	3	3
0.5	1	0	0	0	1	1	5	0	0	0	5	5
0.6	1	0	0	0	1	1	2	0	0	0	2	2
0.7	1	0	0	0	1	1	4	0	0	0	4	4
0.8	0	0	0	0	0	0	0	0	0	0	0	0
0.9	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	1	0	0	0	1	1
1.2	0	0	0	0	0	0	0	0	0	0	0	0
Total	11	0	0	0	11	11	19	0	0	0	19	19
>1v	0	0	0	0	0	0	0	0	0	0	0	0

Voltage Bin	Steam Generator 3						Steam Generator 4					
	In-Service During Cycle 7				RTS for Cycle 8		In-Service During Cycle 7				RTS for Cycle 8	
	Field Bobbin Indications	RPC Inspected	RPC Confirmed	Indications Repaired	All Indications	Confirmed & Not Inspected Indications Only	Field Bobbin Indications	RPC Inspected	RPC Confirmed	Indications Repaired	All Indications	Confirmed & Not Inspected Indications Only
0.2	1	0	0	0	1	1	1	0	0	0	1	1
0.3	1	0	0	0	1	1	14	0	0	0	14	14
0.4	2	0	0	0	2	2	7	0	0	0	7	7
0.5	2	0	0	0	2	2	5	0	0	0	5	5
0.6	1	0	0	0	1	1	14	0	0	0	14	14
0.7	1	0	0	0	1	1	13	2	0	2	11	11
0.8	1	0	0	0	1	1	4	0	0	0	4	4
0.9	0	0	0	0	0	0	3	0	0	0	3	3
1	0	0	0	0	0	0	3	0	0	0	3	3
1.2	0	0	0	0	0	0	1	1	1	1	0	0
Total	9	0	0	0	9	9	65	3	1	3	62	62
>1v	0	0	0	0	0	0	1	1	1	1	0	0

Table 4-2
Comanche Peak Unit 1 September 1999
TSP ODSCC Indication Distributions for Tubes in Service During Cycle 7

Tube Support Plate	Steam Generator 1					Steam Generator 2				
	Number of Indications	Maximum Voltage	Average Voltage	Largest Growth	Average Growth	Number of Indications	Maximum Voltage	Average Voltage	Largest Growth	Average Growth
H3	7	0.59	0.32	0.04	-0.03	13	0.92	0.54	0.13	-0.01
H5	4	0.62	0.42	0.07	0.01	5	0.38	0.32	0.02	0.00
H7	0	-	-	-	-	0	-	-	-	-
H10	0	-	-	-	-	1	0.44	0.44	0.15	0.15
Total	11					19				
Tube Support Plate	Steam Generator 3					Steam Generator 4				
	Number of Indications	Maximum Voltage	Average Voltage	Largest Growth	Average Growth	Number of Indications	Maximum Voltage	Average Voltage	Largest Growth	Average Growth
H3	9	0.75	0.44	0.38	0.10	43	0.97	0.54	0.22	-0.01
H5	0	-	-	-	-	18	1.20	0.53	0.13	0.01
H7	0	-	-	-	-	4	0.62	0.38	0.03	0.01
H10	0	-	-	-	-	0	-	-	-	-
Total	9					65				

Table 4-3
Comanche Peak Unit 1 September 99
Signal Growth Statistics For Cycle 7 on an EFPY Basis

Delta Volts	Steam Generator 1		Steam Generator 2		Steam Generator 3		Steam Generator 4		Cumulative	
	No. of Inds	CPDF	No. of Inds	CPDF	No. of Inds	CPDF	No. of Inds	CPDF	No. of Inds	CPDF
-0.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
-0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
-0.1	0	0.0	0	0.0	0	0.0	1	0.015	1	0.01
0	7	0.636	10	0.526	1	0.111	38	0.6	56	0.548
0.1	4	1.0	8	0.947	7	0.889	22	0.938	41	0.942
0.2	0		1	1.0	0	0.889	4	1.0	5	0.99
0.3	0		0		1	1.0	0		1	1.0
0.8	0		0		0		0		0	
Total	11		19		9		65		104	

Table 4-4
Comanche Peak Unit 1 - September 1999 Outage
Average Voltage Growth During Cycle 7

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	104	0.49	0.003	0.002	0.6%	0.4%
V BOC < .75 Volts	90	0.43	0.012	0.009	2.8%	2.0%
³ .75 Volts	14	0.89	-0.056	-0.040	-6.4%	-4.6%
	Steam Generator 1					
Entire Voltage Range	11	0.38	-0.019	-0.014	-5.1%	-3.6%
V BOC < .75 Volts	11	0.38	-0.019	-0.014	-5.1%	-3.6%
³ .75 Volts	0	0.00	0.000	0.000	-	-
	Steam Generator 2					
Entire Voltage Range	19	0.48	-0.002	-0.001	-0.3%	-0.2%
V BOC < .75 Volts	16	0.41	0.018	0.013	4.3%	3.1%
³ .75 Volts	3	0.84	-0.103	-0.074	-12.3%	-8.8%
	Steam Generator 3					
Entire Voltage Range	9	0.34	0.101	0.072	29.5%	21.1%
V BOC < .75 Volts	9	0.34	0.101	0.072	29.5%	21.1%
³ .75 Volts	0	0.00	0.000	0.000	-	-
	Steam Generator 4					
Entire Voltage Range	65	0.53	-0.006	-0.004	-1.1%	-0.8%
V BOC < .75 Volts	54	0.46	0.002	0.001	0.4%	0.3%
³ .75 Volts	11	0.90	-0.044	-0.031	-4.9%	-3.5%

Based on Cycle 7 duration of 510.4 EFPD (1.397 EFPY)

Table 4-5
Distribution of Highest Growth Rates in 3/4" Tube Plants While a 1 volt Repair Criterion was in Effect

Delta Volts	Plant AA	Plant AB	Plant AC-1	Plant AC-2	Plant R	Bounding Distribution	Comanche Peak Unit-1, Cycle 7
	Cumulative Probability Distributions						
-0.5	0.0000	0.0003	0.0000	0.0000	0.0049	0.0000	
-0.4	0.0015	0.0010	0.0000	0.0009	0.0101	0.0000	
-0.3	0.0064	0.0052	0.0006	0.0010	0.0182	0.0000	
-0.2	0.0193	0.0237	0.0052	0.0018	0.0327	0.0000	0.0000
-0.1	0.0659	0.0598	0.0354	0.0133	0.0683	0.0000	0.0096
0.0	0.2109	0.1285	0.3041	0.1026	0.1778	0.1026	0.5481
0.1	0.3648	0.2927	0.7964	0.4439	0.4115	0.2927	0.9423
0.2	0.5100	0.4761	0.9343	0.7573	0.6436	0.4761	0.9904
0.3	0.6290	0.6332	0.9774	0.8687	0.7978	0.6290	1.0000
0.4	0.7225	0.7551	0.9897	0.9218	0.8842	0.7225	
0.5	0.7902	0.8449	0.9929	0.9456	0.9341	0.7902	
0.6	0.8401	0.9021	0.9955	0.9580	0.9611	0.8401	
0.7	0.8836	0.9398	0.9968	0.9668	0.9746	0.8836	
0.8	0.9099	0.9616	0.9968	0.9695	0.9842	0.9099	
0.9	0.9264	0.9763	0.9974	0.9735	0.9909	0.9264	
1.0	0.9408	0.9828	0.9987	0.9770	0.9933	0.9408	
1.1	0.9534	0.9850	0.9987	0.9792	0.9953	0.9534	
1.2	0.9616	0.9883	0.9987	0.9801	0.9971	0.9616	
1.3	0.9694	0.9896	0.9987	0.9819	0.9977	0.9694	
1.4	0.9758	0.9919	0.9987	0.9832	0.9979	0.9758	
1.5	0.9802	0.9935	0.9987	0.9863	0.9982	0.9802	
1.6	0.9817	0.9948	0.9987	0.9881	0.9984	0.9817	
1.7	0.9848	0.9954	0.9987	0.9889	0.9990	0.9848	
1.8	0.9858	0.9964	0.9987	0.9898	0.9990	0.9858	
1.9	0.9884	0.9964	0.9987	0.9907	0.9990	0.9884	
2.0	0.9889	0.9967	0.9987	0.9907	0.9990	0.9889	
2.1	0.9902	0.9967	0.9994	0.9916	0.9995	0.9902	
2.2	0.9915	0.9967	1.0	0.9929	0.9995	0.9915	
2.3	0.9925	0.9974		0.9934	0.9995	0.9925	
2.4	0.9938	0.9980		0.9934	0.9995	0.9934	
2.5	0.9949	0.9980		0.9938	0.9995	0.9934	
2.6	0.9954	0.9980		0.9938	0.9997	0.9938	
2.7	0.9961	0.9980		0.9943	0.9997	0.9938	
2.8	0.9967	0.9980		0.9956	0.9997	0.9956	
2.9	0.9977	0.9984		0.9969	0.9997	0.9969	
3.0	0.9977	0.9987		0.9978	0.9997	0.9977	
3.1	0.9982	0.9987		0.9978	0.9997	0.9978	
3.2	0.9987	0.9987		0.9978	0.9997	0.9978	
3.3	0.9990	0.9987		0.9978	0.9997	0.9978	
3.4	0.9992	0.9987		0.9987	0.9997	0.9978	
3.8	0.9995	0.9987		0.9991	0.9997	0.9987	
4.0	0.9997	0.9987		0.9991	0.9997	0.9987	
4.1	0.9997	0.9987		1.0	0.9997	0.9987	
4.3	0.9997	0.9990			0.9997	0.9987	
4.7	0.9997	0.9993			1.0	0.9987	
5.3	0.9997	0.9997				0.9997	
5.7	1.0	0.9996748				0.9997	
7.8		1.0				1.0	

Table 4-6
Probe Wear and Analyst Variability - Tabulated Values

Analyst Variability		Probe Wear Variability	
Std. Dev = 10.3%	Mean = 0.0%	Std. Dev = 7.0%	Mean = 0.0%
No Cutoff		Cutoff at +/- 15%	
Value	Cumul. Prob.	Value	Cumul. Prob.
-40.0%	0.00005	< -15.0%	0.00000
-38.0%	0.00011	-15.0%	0.01606
-36.0%	0.00024	-14.0%	0.02275
-34.0%	0.00048	-13.0%	0.03165
-32.0%	0.00095	-12.0%	0.04324
-30.0%	0.00179	-11.0%	0.05804
-28.0%	0.00328	-10.0%	0.07656
-26.0%	0.00580	-9.0%	0.09927
-24.0%	0.00990	-8.0%	0.12655
-22.0%	0.01634	-7.0%	0.15866
-20.0%	0.02608	-6.0%	0.19568
-18.0%	0.04027	-5.0%	0.23753
-16.0%	0.06016	-4.0%	0.28385
-14.0%	0.08704	-3.0%	0.33412
-12.0%	0.12200	-2.0%	0.38755
-10.0%	0.16581	-1.0%	0.44320
-8.0%	0.21867	0.0%	0.50000
-6.0%	0.28011	1.0%	0.55680
-4.0%	0.34888	2.0%	0.61245
-2.0%	0.42302	3.0%	0.66588
0.0%	0.50000	4.0%	0.71615
2.0%	0.57698	5.0%	0.76247
4.0%	0.65112	6.0%	0.80432
6.0%	0.71989	7.0%	0.84134
8.0%	0.78133	8.0%	0.87345
10.0%	0.83419	9.0%	0.90073
12.0%	0.87800	10.0%	0.92344
14.0%	0.91296	11.0%	0.94196
16.0%	0.93984	12.0%	0.95676
18.0%	0.95973	13.0%	0.96835
20.0%	0.97392	14.0%	0.97725
22.0%	0.98366	15.0%	0.98394
24.0%	0.99010	> 15.0%	1.00000
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		

Figure 4-1
Comanche Peak Unit 1 September 1999 Outage
Bobbin Voltage Distributions at EOC-7 for Tubes in Service During Cycle 7

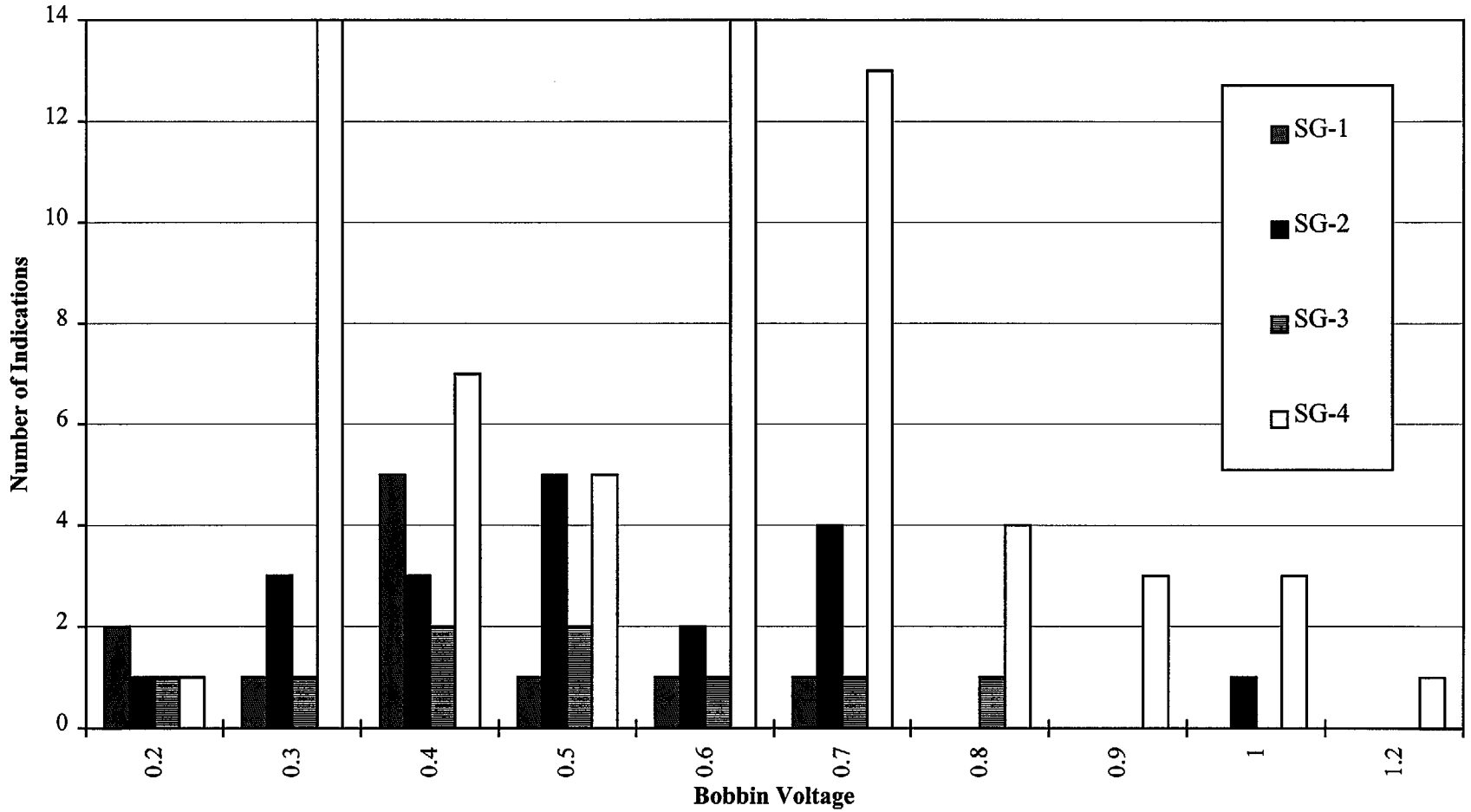


Figure 4-2
Comanche Peak Unit 1 - September 1999
ODSCC Axial Distributions for Tubes in Service During Cycle 7

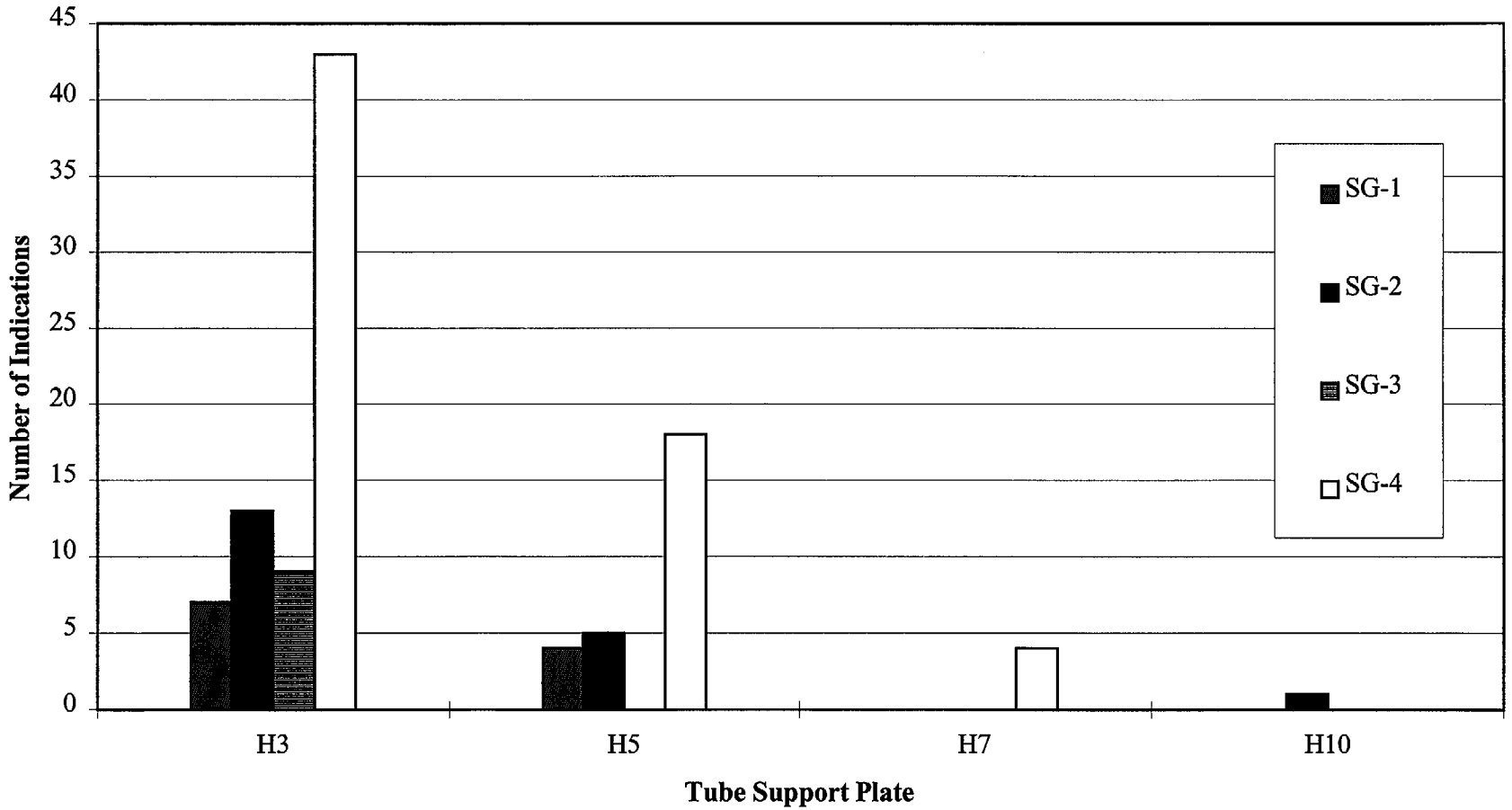


Figure 4-3
Comanche Peak Unit 1Cycle 7 (May 1998 to Sept. 1999)
Cumulative Probability Distributions for Voltage Growth on an EFPY Basis

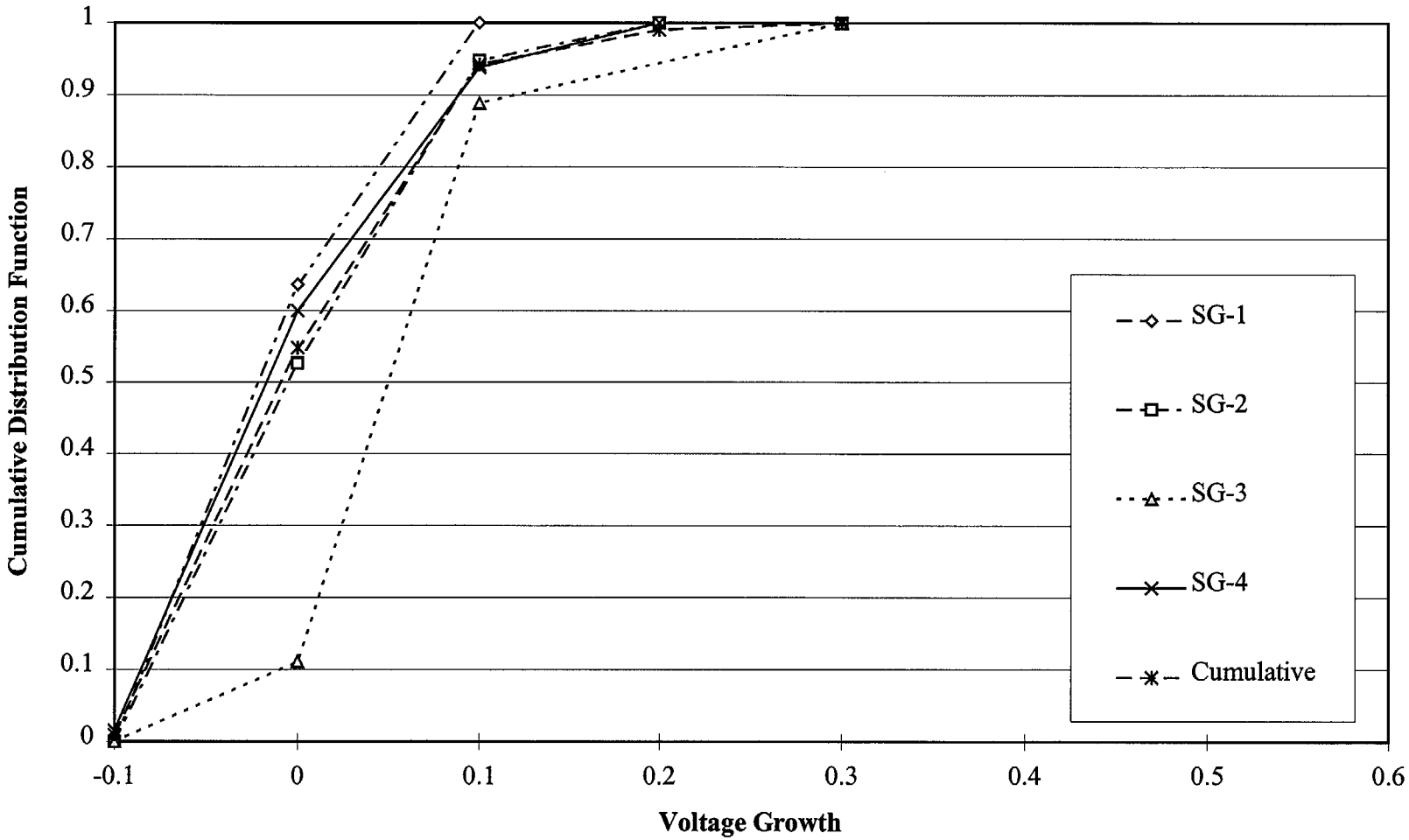


Figure 4-4
Distribution of Largest Growth Rates Observed in 3/4" Tube Plants
While a 1-volt Repair Criterion was Applied
Cumulative Probability Distributions for Voltage Growth on EFPY Basis

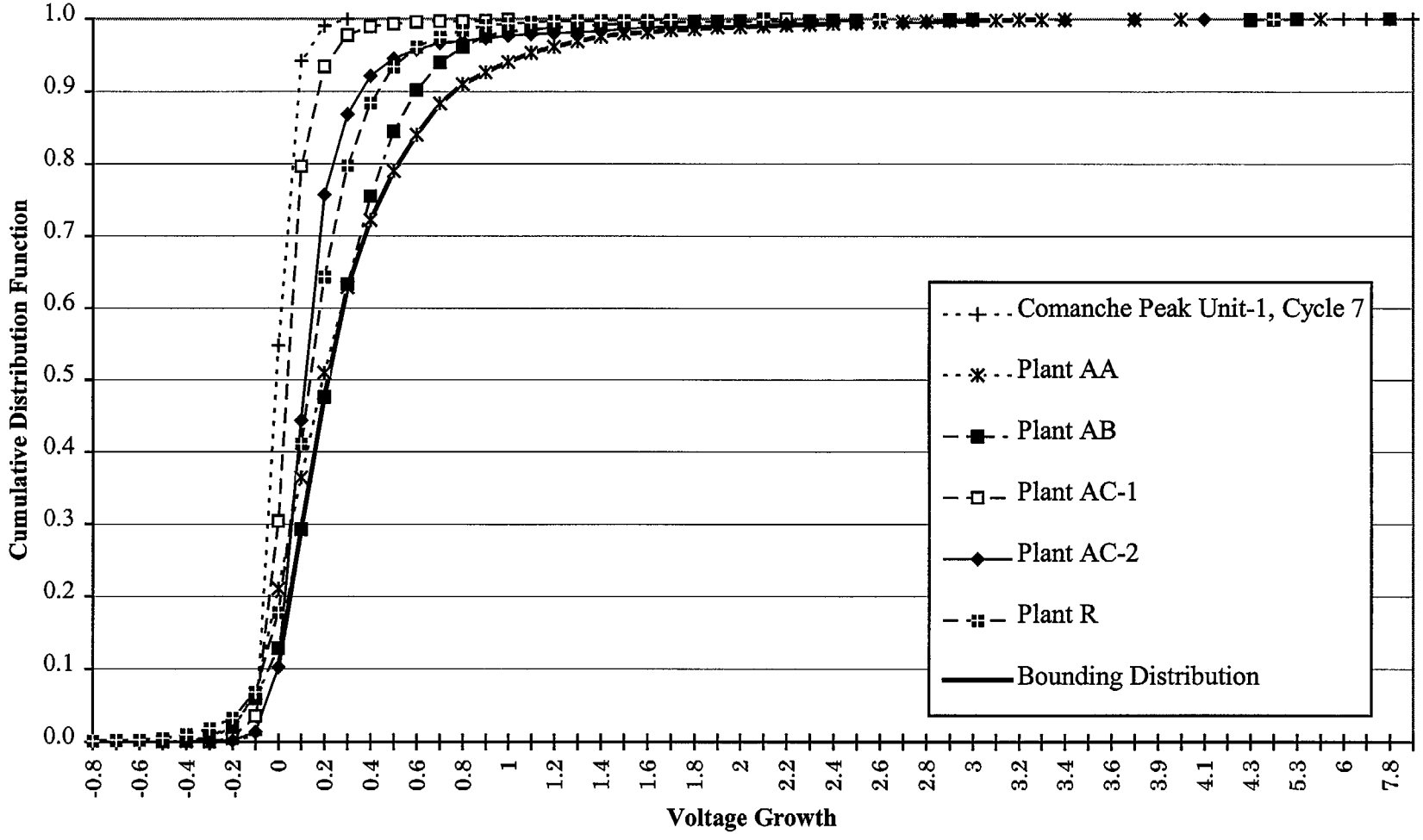
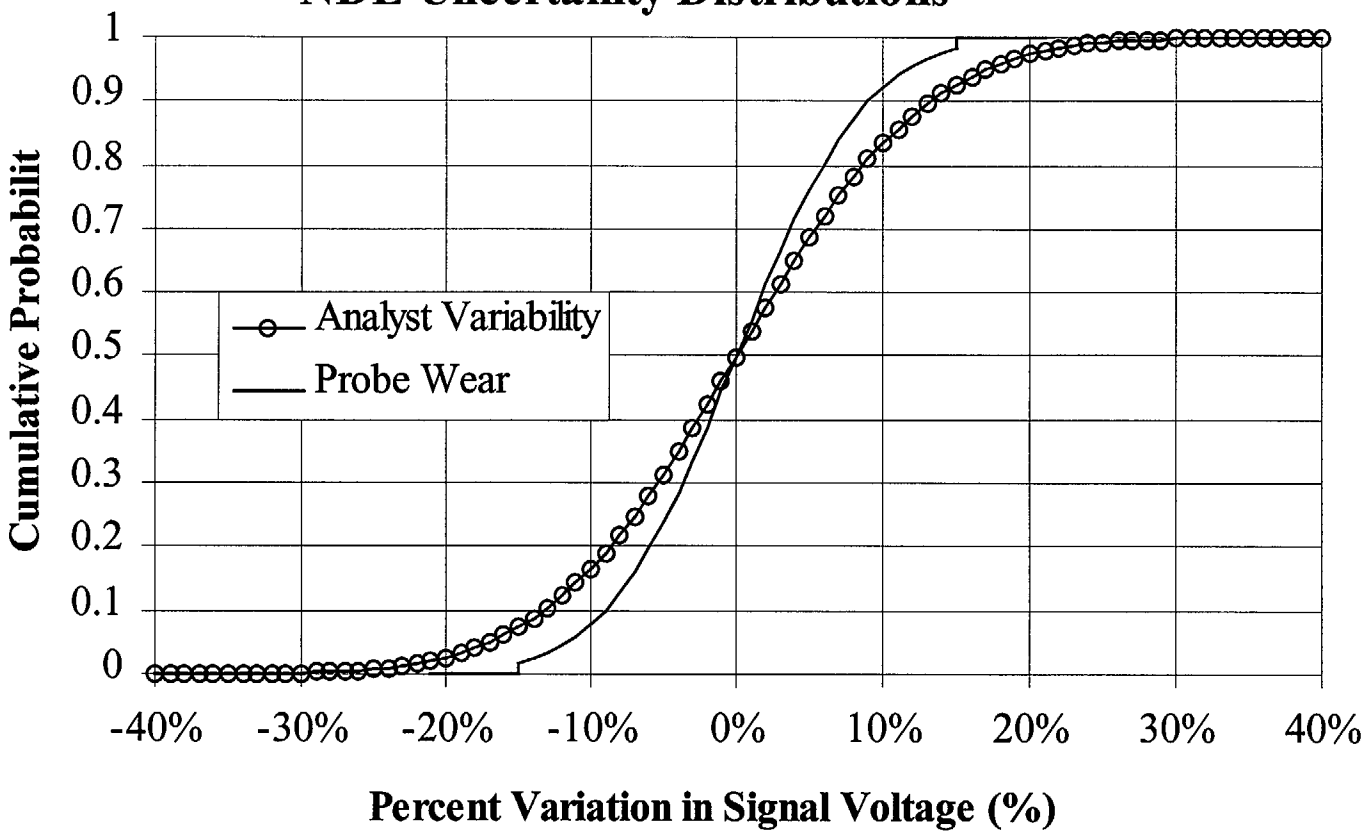


Figure 4-5

NDE Uncertainty Distributions



5.0 Database Applied for Leak and Burst Correlations

Leak and burst correlations based on the latest available database for ¾" tubes are applied in the analyses presented in this report, and these correlations are documented in Reference 9-6. The database does not include the leak and burst data for tubes pulled recently from Comanche Peak Unit-1. However, regression analyses show that inclusion of the Comanche Peak Unit-1 pulled data has [to be proved later] insignificant effect on the leak and burst correlations.

The latest database meets the NRC requirement that the p value obtained from the regression analysis of leak rate be less than or equal to 5%. Therefore, a SLB leak rate versus voltage correlation is applied for the leak rate analyses of this report. The following are the correlations for burst pressure, probability of leakage and leak rate used in this report (Reference 9-6).

$$\text{Burst Pressure } (ksi) = 7.40278 - 2.91382 \times \log(volts)$$

$$\text{Probability of Leak} = \frac{1}{1 + e^{\left(4.8082 - 8.4215 \times \log(volts)\right)}}$$

$$\text{Leak Rate } (l/hr) = 10^{\left(-1.63838 + 2.94093 \times \log(volts)\right)}$$

The upper voltage repair limit applied at the EOC-7 inspection, documented in Reference 9-7, was developed using the database presented in Reference 9-4. Since a more recent database is available now, the upper voltage repair limit data is revised below. The structural limit (V_{sl}) for the TSP indications established using 1.43 times the SLB Delta P of 2560 psid is 4.70 volts, and V_{sl} for the FDB intersections using 3 times normal operation Delta P value (3810 psid) is 4.20 volts. Using the minimum growth rate specified in the Generic Letter 95-05 (30%/EFPY) and a expected duration of 1.36 EFPY (496 EFPD) for Cycle 8, the growth allowance becomes 41%. The allowance for NDE uncertainty is 20% per Generic Letter 95-05. The upper voltage repair limits then become 2.92 volts for TSP indications and 2.61 volts for FDB indications. The bobbin voltage for the largest ODSCC indication found during the EOC-7 inspection (1.2 volts) is substantially below the revised upper repair limits.

6.0 SLB Analysis Methods

Monte Carlo analyses are used to calculate the SLB leak rates and tube burst probabilities for both actual EOC-7 and projected EOC-8 voltage distributions. The Monte Carlo analyses account for parameter uncertainty. The analysis methodology is described in the Westinghouse generic methods report of Reference 9-3, and it is consistent with the guidelines provided in the Generic Letter 95-05 (Reference 9-1).

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 9-3 was used to determine the true BOC voltage.

7.0 Bobbin Voltage Distributions

This section describes the salient input data used to calculate EOC bobbin voltage distributions and presents results of calculations to project EOC-8 voltage distributions. Since a voltage-based repair criteria was not applied during the last cycle (Cycle 7), EOC-7 projections are not available and therefore a comparison of the actual measured and projected EOC-7 voltages cannot be made.

7.1 Calculation of Voltage Distributions

The analysis for EOC voltage distribution starts with a cycle initial voltage distribution, which is projected, to the end of cycle conditions applying growth appropriate for the anticipated cycle operating period. The number of indications assumed in the analysis to project EOC voltage distributions, and to perform tube leak rate and burst probability analyses, is obtained by adjusting the number of reported indications to account for detection uncertainty and initiation of new indications over the projection 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 POD based on historic data, and the value used herein is discussed in Section 7-2. 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.

There are no deplugged tubes returned to service at BOC-8; therefore, $N_{deplugged} = 0$.

The methodology used in the projection of bobbin voltage frequency predictions is described in Reference 9-3. Salient input data used for projecting EOC-8 bobbin voltage frequency are further discussed below.

7.2 Probability of Detection (POD)

The Generic Letter 95-05 (Reference 9-1) 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 a more accurate prediction of voltage distributions consistent with voltage-based repair criteria experience. In this report both NRC mandated constant POD of 0.6 as well as a voltage-dependent POD developed for EPRI (POPCD) are used. The EPRI POPCD is developed by analyses of 18 inspections in 10 plants and is presented in Table 7-4 of Reference 9-4. The POPCD values represent a lower 95% confidence bound, and their distribution is presented in Table 7-1 and graphically illustrated in Figure 7-1.

7.3 Limiting Growth Rate Distribution

As discussed in Section 4.2, the NRC guidelines in Generic Letter 95-05 stipulate that the growth rate distribution(s) used in the SLB leak rate and tube probability analyses must contain at least 200 data points that are established using bobbin voltages measured

in two consecutive inspections. Since Cycle 7 growth distribution is based on data from only 104 indications, it does not meet the above NRC requirement. In the absence of an acceptable plant-specific growth database, Generic Letter 95-05 requires the use of a bounding growth distribution established based on data available from similarly designed and operated plants. Prior to Comanche Peak Unit-1, a 1 volt repair criterion has been applied to 5 units with ¾" diameter tubes, and the growth data for these 5 units were used to establish a bounding growth distribution for ¾" plants. Details are provided in Section 4.2 and the bounding distribution is shown in Table 4-5. The CPDF values defining the bounding distribution are utilized to predict EOC-8 voltage distributions that are used in the SLB leak rate and tube burst analyses.

7.4 Cycle Operating Period

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

Cycle 7 - BOC-7 to EOC-7 - 510.4 EFPD or 1.40 EFPY (actual)
Cycle 8 - BOC-8 to EOC-8 - 496 EFPD or 1.36 EFPY (estimated)

7.5 Projected EOC-8 Voltage Distribution

Calculations for EOC-8 bobbin voltage projections were performed for all four SGs based on the EOC-7 distributions shown in Table 7-2. The BOC distributions were adjusted to account for probability of detection as described above, and the adjusted number of indications at BOC-8 are also shown in Table 7-2. Calculations were performed using a constant POD of 0.6 as well as the EPRI POPCD distribution (presented in Table 7-1). As discussed in Section 7-2, a bounding growth distribution for ¾" tube plants, shown in Table 4-5, was applied. The EOC-8 voltage distributions thus projected for all four SGs are summarized on Table 7-3. These results are also shown graphically on Figures 7-2 to 7-5. For the limiting SG, SG-4, the results based on a constant POD of 0.6 are more conservative than those using the voltage-dependent EPRI POPCD.

As discussed in Section 4.2, the growth rates utilized to project EOC-8 voltages are substantially higher than those observed during Cycle 7 (see Table 4-5 and Figure 4-4). There is no reason to expect a substantial increase in growth rate during Cycle 8. Therefore, the peak voltages in the EOC-8 voltage distributions shown in Figures 7-2 to 7-5 are believed to be substantially overestimated.

Table 7-1
EPRI POPCD Distribution
Based on Data from 18 Inspections in 10 Plants

Voltage Bin	EPRI POPCD#
0.1	0.26
0.2	0.36
0.3	0.46
0.4	0.54
0.5	0.63
0.6	0.68
0.7	0.74
0.8	0.78
0.9	0.81
1	0.84
1.2	0.87
1.4	0.90
1.6	0.91
1.8	0.92
2	0.93
3	0.98
3.5	1.0

Data from Table 7-4 in Reference 9-4.

Table 7-2
Comanche Peak Unit 1 September 1999
EOC-7 Bobbin and Assumed BOC-8 Bobbin Distributions in SLB Leak Rate and Tube Burst Analyses

Voltage Bin	Steam Generator 1				Steam Generator 2			
	EOC - 7		BOC - 8		EOC - 7		BOC - 8	
	Field Bobbin Indications	Indications Repaired	POD 0.6	POPCD	Field Bobbin Indications	Indications Repaired	POD 0.6	POPCD
0.2	2	0	3.33	5.56	1	0	1.67	2.78
0.3	1	0	1.67	2.17	3	0	5.00	6.52
0.4	5	0	8.33	9.26	3	0	5.00	5.56
0.5	1	0	1.67	1.59	5	0	8.33	7.94
0.6	1	0	1.67	1.45	2	0	3.33	2.90
0.7	1	0	1.67	1.33	4	0	6.67	5.33
0.8	0	0	0.00	0.00	0	0	0.00	0.00
0.9	0	0	0	0	0	0	0.00	0.00
1	0	0	0	0	1	0	1.67	1.19
1.2	0	0	0	0	0	0	0.00	0.00
Total	11	0	18.33	21.36	19	0	31.67	32.21
> 1V	0	0	0	0	0	0	0	0

Voltage Bin	Steam Generator 3				Steam Generator 4			
	EOC - 7		BOC - 8		EOC - 7		BOC - 8	
	Field Bobbin Indications	Indications Repaired	POD 0.6	POPCD	Field Bobbin Indications	Indications Repaired	POD 0.6	POPCD
0.2	1	0	1.67	2.78	1	0	1.67	2.78
0.3	1	0	1.67	2.17	14	0	23.33	30.43
0.4	2	0	3.33	3.70	7	0	11.67	12.96
0.5	2	0	3.33	3.17	5	0	8.33	7.94
0.6	1	0	1.67	1.45	14	0	23.33	20.29
0.7	1	0	1.67	1.33	13	2	19.67	15.33
0.8	1	0	1.67	1.27	4	0	6.67	5.06
0.9	0	0	0	0	3	0	5.00	3.66
1	0	0	0	0	3	0	5.00	3.57
1.2	0	0	0	0	1	1	0.67	0.15
Total	9	0	15.00	15.88	65	3	105.33	102.18
> 1V	0	0	0	0	1	1	0.67	0.15

Table 7-3
Comanche Peak Unit 1 September 1999

Voltage Distribution Projection for EOC - 8

Voltage Bin	Steam Generator 1		Steam Generator 2		Steam Generator 3		Steam Generator 4	
	Projected Number of Indications at EOC - 8							
	POD 0.6	POPCD	POD 0.6	POPCD	POD 0.6	POPCD	POD 0.6	POPCD
0.1	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01
0.2	0.28	0.49	0.20	0.31	0.19	0.34	0.38	0.54
0.3	0.44	0.70	0.69	0.96	0.31	0.51	2.22	2.95
0.4	1.42	2.05	1.38	1.75	0.72	1.09	4.30	5.46
0.5	1.96	2.71	2.15	2.53	1.15	1.58	5.79	6.90
0.6	2.03	2.62	2.95	3.26	1.33	1.64	7.94	8.80
0.7	2.06	2.50	3.38	3.51	1.55	1.76	10.00	10.36
0.8	2.05	2.48	3.38	3.36	1.66	1.82	10.42	10.10
0.9	1.60	1.89	3.12	3.02	1.50	1.59	10.17	9.42
1.0	1.23	1.41	2.69	2.56	1.25	1.28	9.53	8.64
1.1	1.01	1.14	2.23	2.10	1.04	1.04	8.32	7.40
1.2	0.86	1.02	1.81	1.69	0.87	0.91	6.87	6.04
1.3	0.65	0.75	1.47	1.37	0.65	0.67	5.59	4.89
1.4	0.50	0.57	1.18	1.10	0.51	0.51	4.50	3.90
1.5	0.39	0.45	0.93	0.86	0.42	0.42	3.59	3.07
1.6	0.32	0.37	0.73	0.67	0.33	0.34	2.86	2.43
1.7	0.24	0.29	0.57	0.53	0.25	0.26	2.26	1.93
1.8	0.19	0.22	0.45	0.43	0.20	0.20	1.80	1.57
1.9	0.11	0.20	0.37	0.34	0.06	0.12	1.41	1.22
2.0	0.00	0.12	0.30	0.28	0.00	0.00	1.14	0.99
2.1	0.00	0.00	0.25	0.24	0.00	0.00	0.96	0.85
2.2	0.70	0.00	0.22	0.21	0.70	0.70	0.81	0.72
2.3	0.00	0.70	0.18	0.16	0.00	0.00	0.67	0.59
2.4	0.00	0.00	0.04	0.00	0.00	0.00	0.54	0.47
2.5	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.37
2.6	0.00	0.00	0.00	0.00	0.00	0.00	0.39	0.34
2.7	0.00	0.00	0.70	0.70	0.00	0.00	0.29	0.25
2.8	0.00	0.00	0.00	0.00	0.30	0.30	0.23	0.20
2.9	0.30	0.00	0.00	0.00			0.21	0.19
3.0		0.00	0.00	0.00			0.16	0.14
3.1		0.30	0.00	0.00			0.14	0.12
3.2			0.00	0.00			0.13	0.12
3.3			0.00	0.00			0.11	0.11
3.4			0.00	0.00			0.10	0.09
3.5			0.00	0.00			0.07	0.00
3.6			0.30	0.30			0.00	0.00
3.9							0.00	0.70
4.0							0.70	0.00
4.7							0.30	0.30
TOTAL	18.34	22.98	31.68	32.25	14.99	17.08	105.35	102.18
> 1 V	5.27	6.13	11.73	10.98	5.33	5.47	44.59	39.00
> 2 V	1.00	1.00	1.69	1.61	1.00	1.00	6.25	5.56

Figure 7-1
Generic POPCD Distribution Based on 18 Inspections in 10 Plants

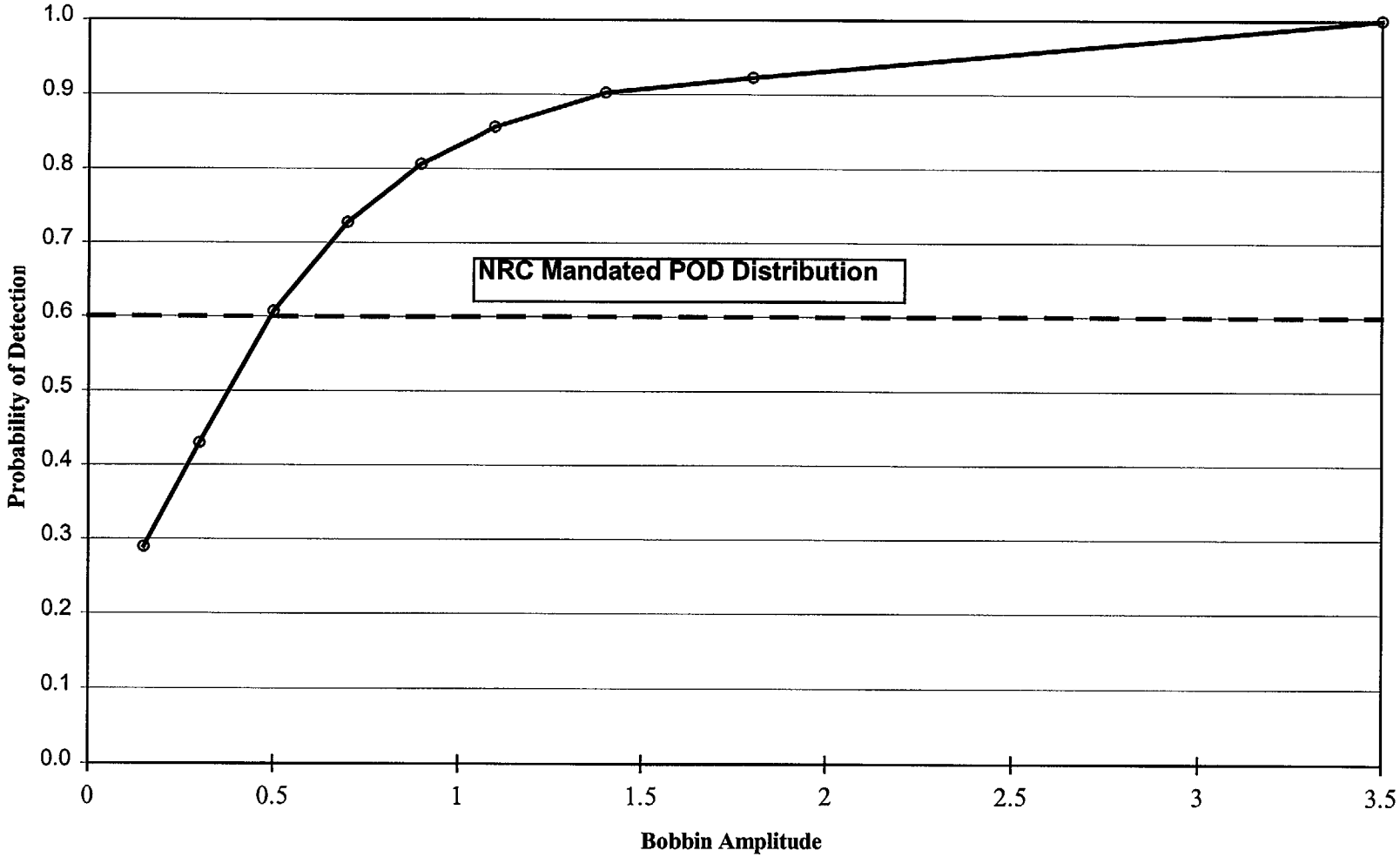


Figure 7-2
Comanche Peak Unit 1 SG-1
Predicted Bobbin Voltage Distribution for Cycle 8

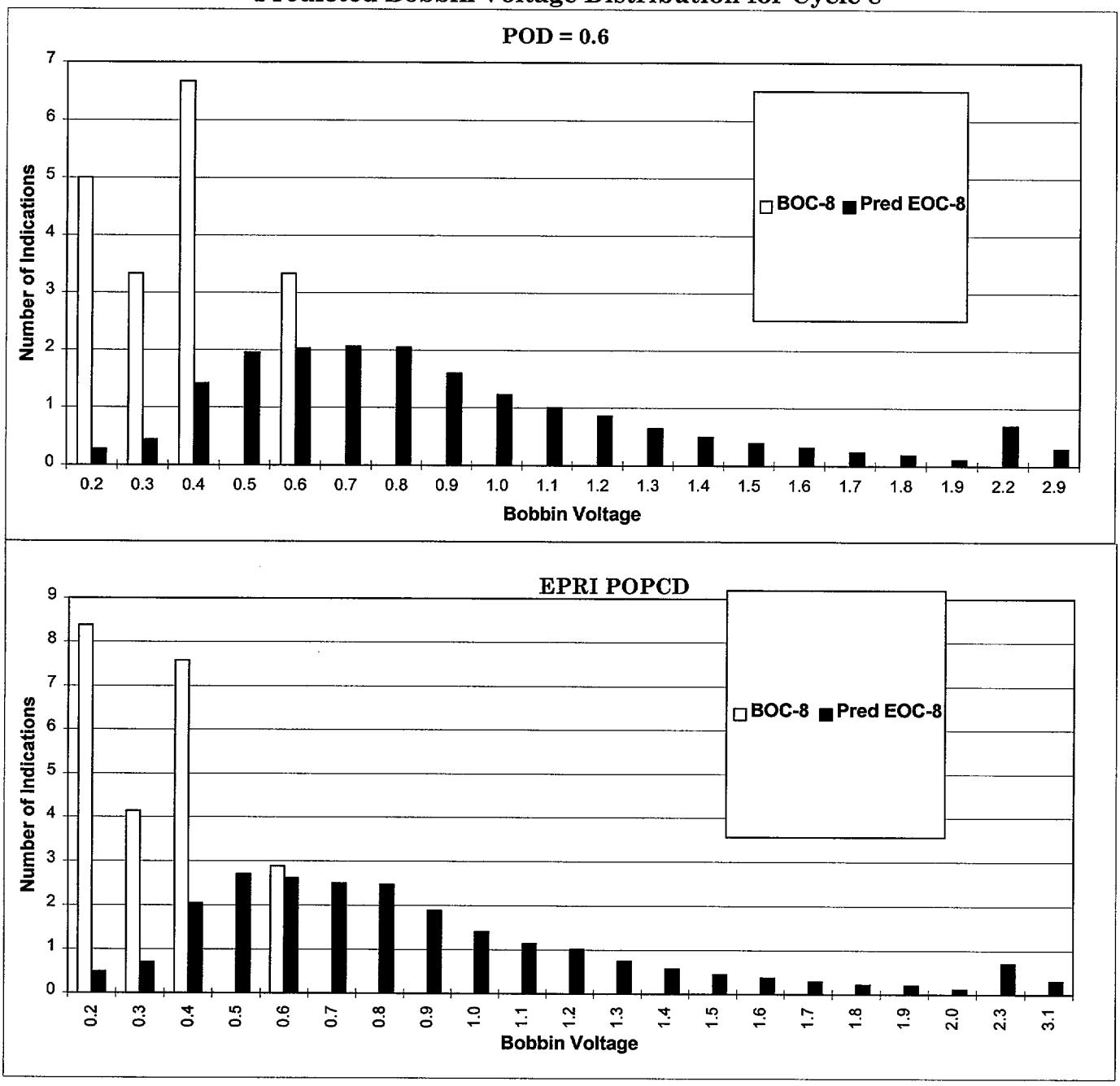
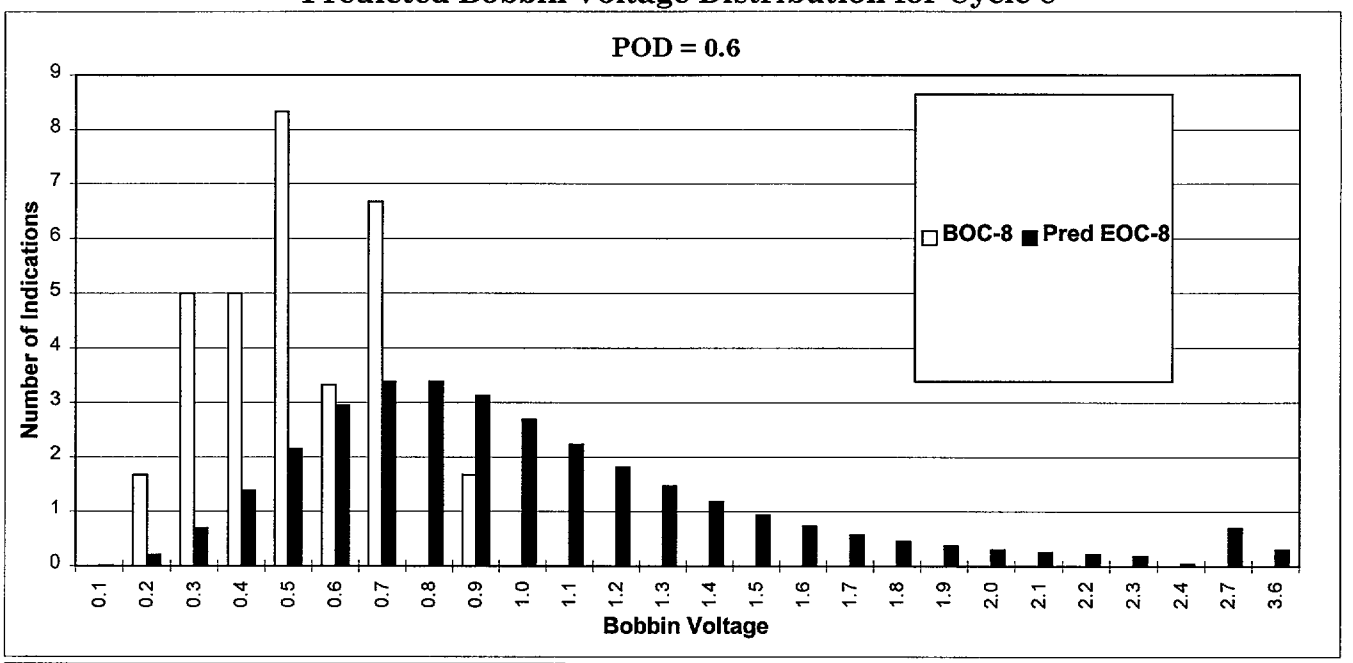


Figure 7-3
Comanche Peak Unit 1 SG-2
Predicted Bobbin Voltage Distribution for Cycle 8



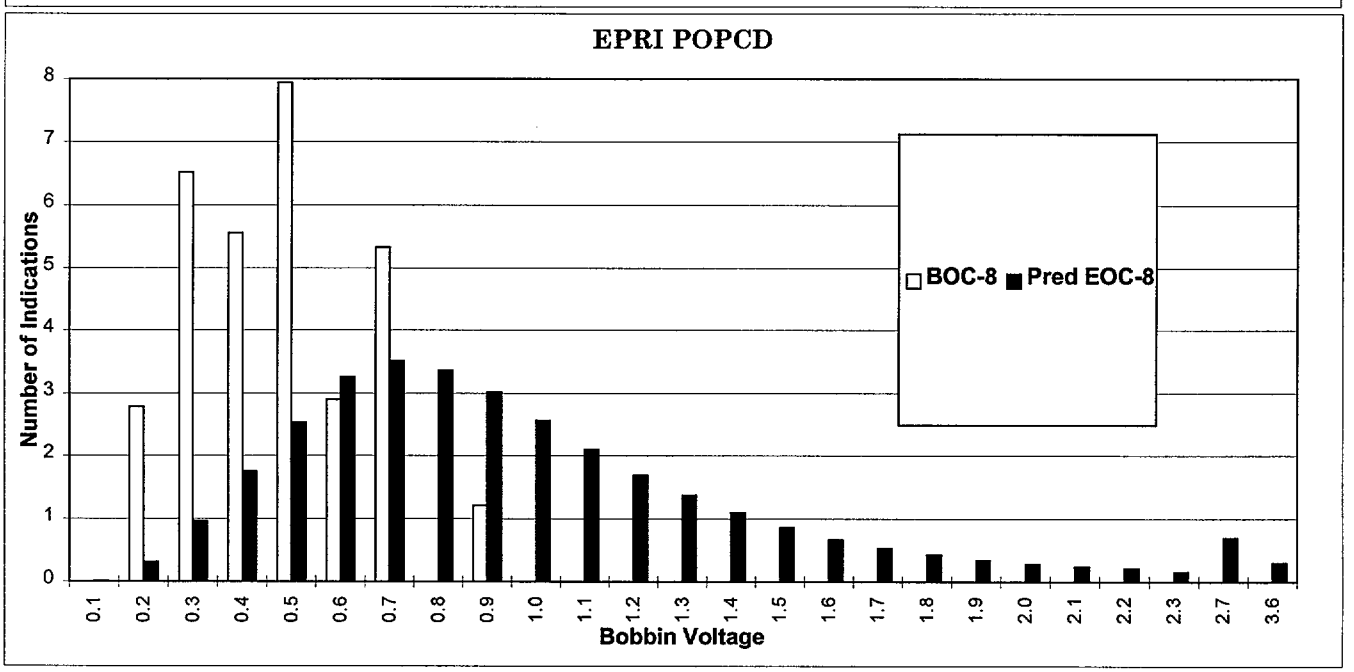
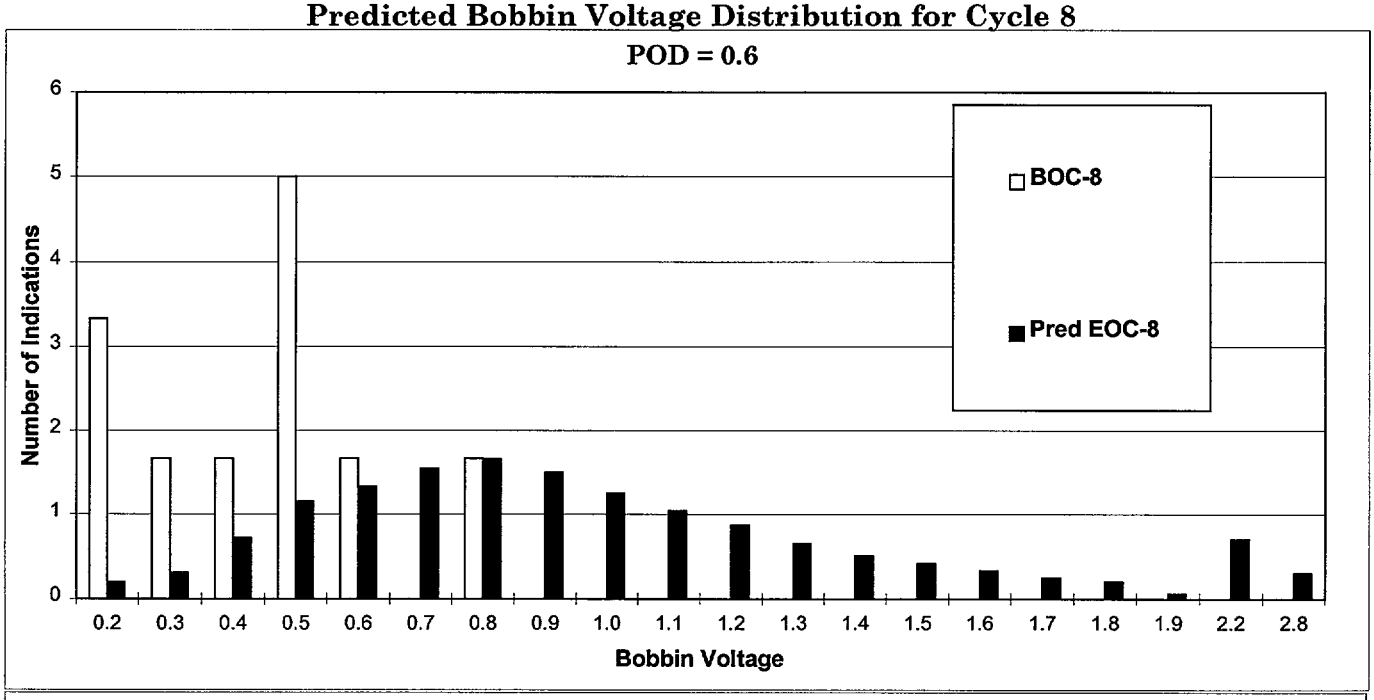


Figure 7-4
Comanche Peak Unit 1 SG-3
Predicted Bobbin Voltage Distribution for Cycle 8



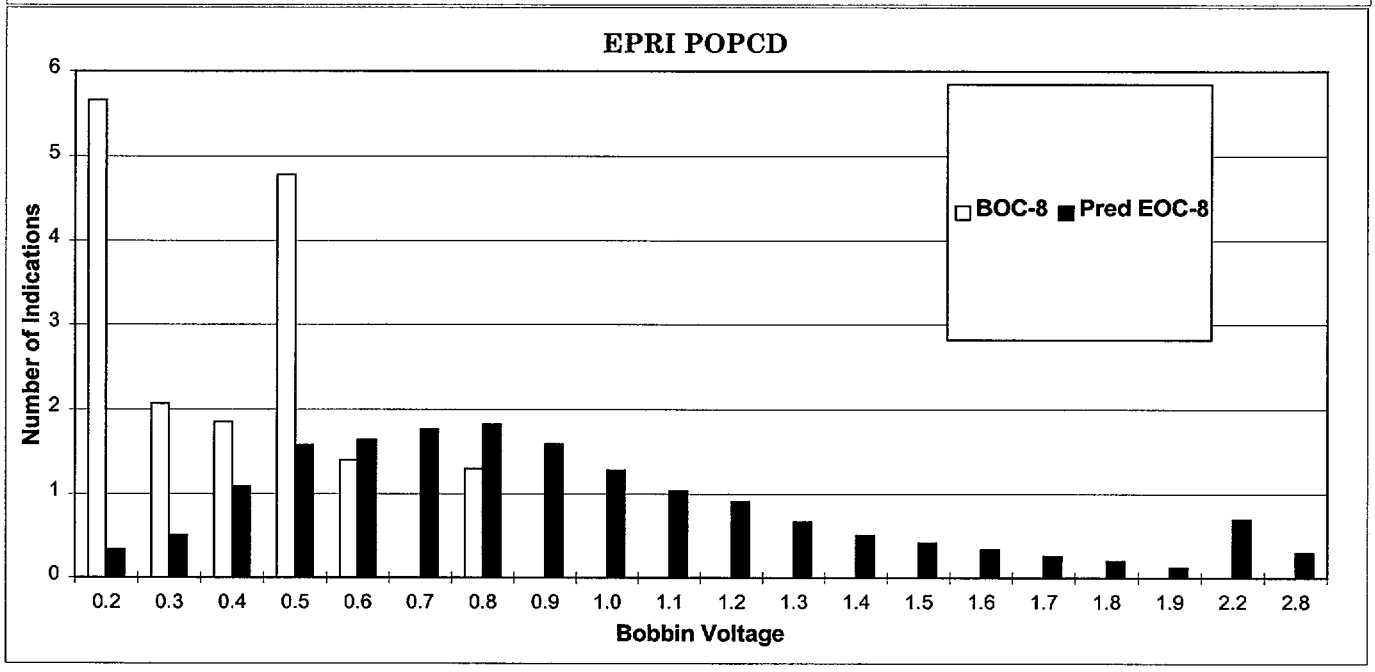
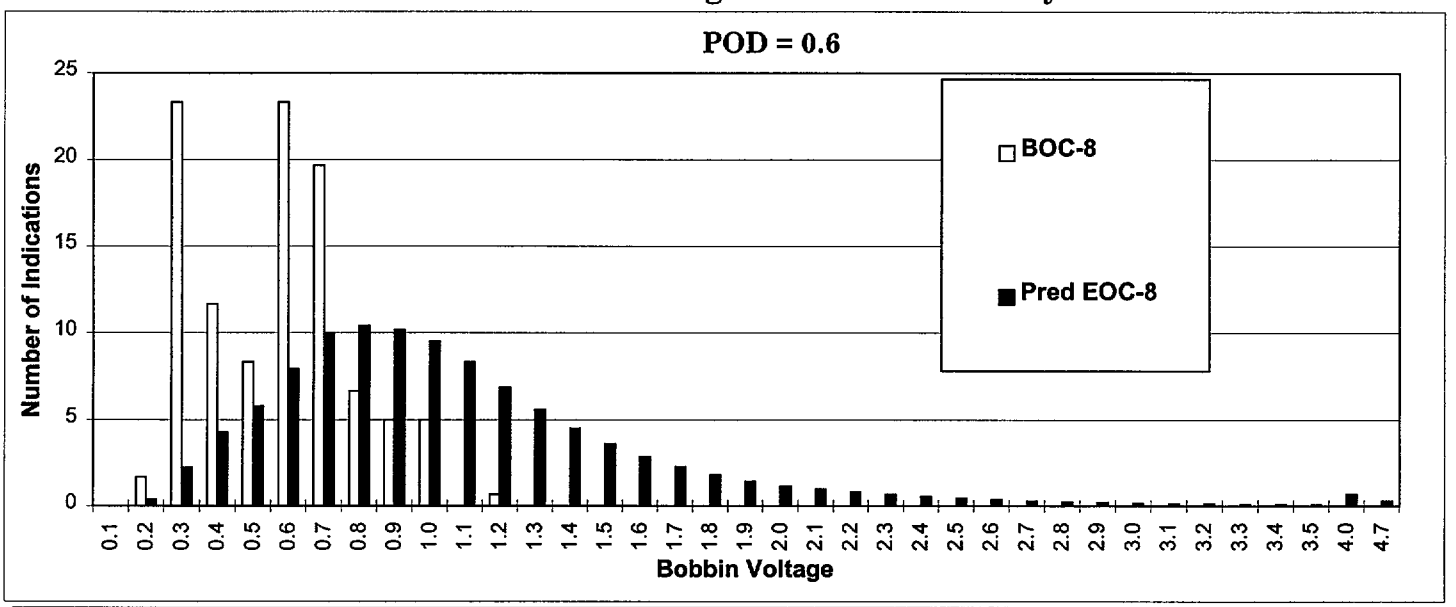
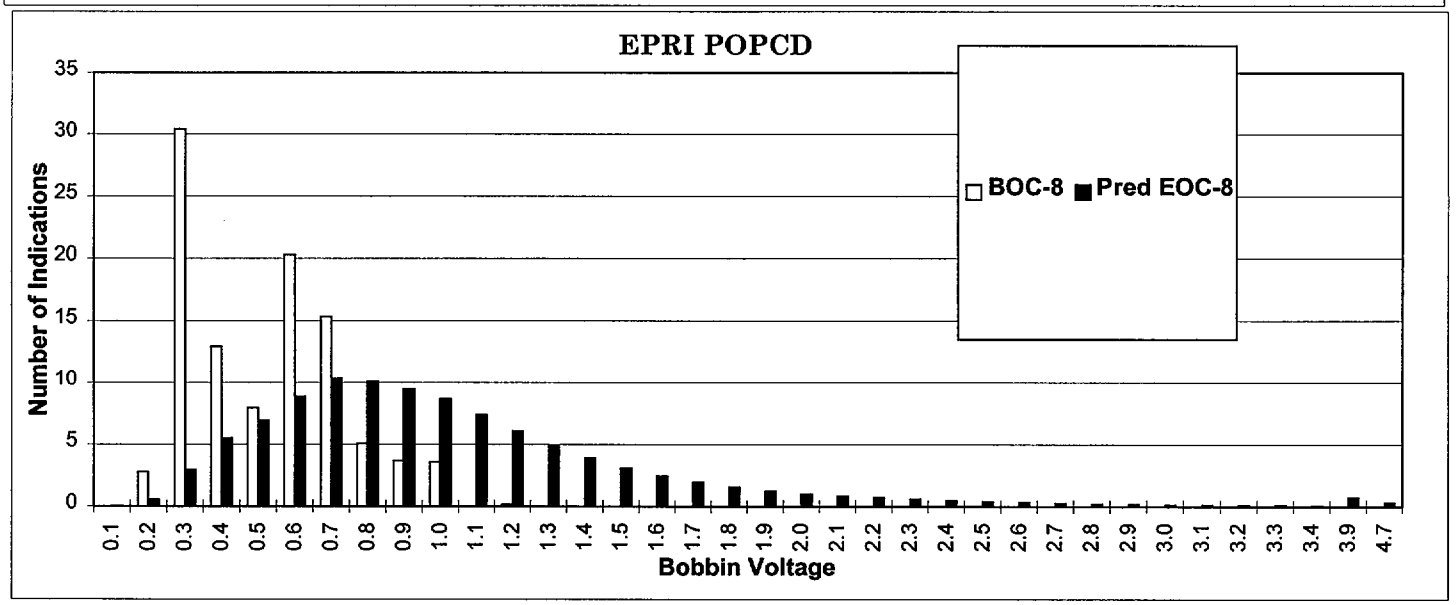


Figure 7-5
Comanche Peak Unit 1 SG-4
Predicted Bobbin Voltage Distribution for Cycle 8





8.0 SLB Leak Rate and Tube Burst Probability Analyses

This section presents the results of the analyses carried out to predict leak rates and tube burst probabilities for postulated SLB conditions using the actual voltage distributions from EOC-7 inspection (condition monitoring analysis) as well as for the projected EOC-8 voltage distributions (operational assessment evaluation). The methodology used in these analyses is described in Section 6.0. SG-4 with the largest total number of indications is expected to yield the limiting SLB leak rate and burst probability for Cycle 8.

8.1 Leak Rate and Tube Burst Probability for EOC-7

About 63% of all the TSP ODSCC indications found in all 4 SGs (65 out of a total of 104) during the EOC-7 inspection were in SG-4, and hence the leak and burst analysis results based on the actual bobbin voltage distribution for SG-4 should bound those for the other 3 SGs. Therefore, the condition monitoring analysis was carried only for SG-4. The limiting SLB leak rate (1.4×10^{-4}) and tube burst probability (1.2×10^{-5}) values obtained using the actual EOC-7 conditions for SG-4 are relatively small, and they are 3 to 5 orders of magnitude below the corresponding acceptance limits (27.79 gpm at room temperature and 10^{-2}).

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

8.2 Leak Rate and Tube Burst Probability for EOC-8

Calculations to predict SLB leak rate and tube burst probability for all 4 SGs in Comanche Peak Unit-1 at the EOC-8 conditions (operational assessment) were carried out using two values for POD: 1) NRC required constant value of 0.6, 2) voltage dependent EPRI POPCD distribution. The projected results for the EOC-8 conditions are summarized in Table 8-1. With the standard calculation methodology presented in Reference 9-3 and a constant POD of 0.6, the largest EOC-8 SLB leak rate projected is 0.14 gpm (room temperature), and it is predicted for SG-4 which had the largest number of indications returned to service for Cycle 8 operation. This limiting SLB leak rate value is 2 orders of magnitude below the allowable SLB leakage limit for Cycle 8 of 27.79 gpm (room temperature). The highest tube burst probability, also predicted for SG-4, is 1.9×10^{-3}, and it is about $1/5^{th}$ of the NRC reporting guideline of 10^{-2}.

When the EPRI POPCD distribution is used for POD, the total number of indications predicted are slightly higher than those for POD=0.6 for SGs 1 to 3. The reason for this is that below about 0.5 volt the detection probability calculated from the EC inspection data could be significantly below 0.6 as shown by the EPRI POPCD distribution in Table 7-1 and Figure 7-1. Nearly 40 to 60% percent of the indications returned to service for Cycle 8 operations in SGs 1 to 3 are below 0.5 volt. The SLB leak rate and burst probability values based on EPRI POPCD for these SGs (with the exception of SG-

2 leak rate and SG-3 burst probability) are also slightly higher those for POD=0.6.

As noted in Section 4.2, a bounding growth distribution based on the highest growth rates observed in 5 units with ¾" diameter tubes during cycles that utilized a 1 volt repair criterion was applied to project EOC-8 conditions. This bounding growth data is substantially higher than the actual growth during Cycle 7 (see Figure 4-4), and therefore the EOC-8 leak rate and burst probability estimates shown in Table 8-1 are believed to be very conservative.

Additional leak rate and tube burst pressure data are available from the tube specimens pulled during the recent inspection. An evaluation of the impact of the new data on the leak and burst correlations, described in Section 3.3 [to be provided at a later date], indicated that the new data [to be provided later] significantly affect tube burst probability and the SLB leak rate may increase slightly. In accordance with the NRC-NEI protocol for determining whether the voltage-based repair criteria leak and burst database should be updated to include the latest data, EOC-8 leak rate and tube burst probability calculations for SG-4 were repeated using correlations developed in Section 3.3 including new data, and these results are also included in Table 8.1. While the tube burst probability essentially remains the same, inclusion of the recent Comanche Peak Unit-1 pulled tube data in the leak and burst database increases SLB leak rate from 0.14 to [to be provided later]. Again, the increase in the SLB leak rate is negligibly small in comparison to the margin to the allowable leak rate

In summary, SLB leak rates and tube burst probabilities predicted for EOC-8 are well below their respective limits.

Table 8-1
Comanche Peak Unit-1 September 1999 Outage
Summary of Projected Tube Leak Rate and Burst Probability
for EOC-8 - 250k Simulations

Steam Generator	POD	No. of Indic-ations[1]	Max. Volts[2]	Burst Probability		SLB Leak Rate (gpm)[3]	Comments
				1 Tube	1 or More Tubes		
EOC - 8 PROJECTIONS (Based on a projected Cycle 8 duration of 496 EFPD)							
A	0.6	18.3	2.9	3.5×10^{-4}	3.5×10^{-4}	1.5×10^{-2}	Standard leak rate nd tube burst robability ethodology Addendum-3 atabase
B		31.7	3.6	5.5×10^{-4}	5.5×10^{-4}	3.4×10^{-2}	
C		15.0	2.8	3.5×10^{-4}	3.5×10^{-4}	1.2×10^{-2}	
D		105.3	4.7	1.9×10^{-3}	1.9×10^{-3}	0.14	
A	POPCD	23	3.1	4.2×10^{-4}	4.2×10^{-4}	1.9×10^{-2}	Standard leak rate nd tube burst robability ethodology Addendum-3 database
B		32.2	3.6	5.6×10^{-4}	5.6×10^{-4}	3.3×10^{-2}	
C		17.1	2.8	3.3×10^{-4}	3.3×10^{-4}	1.4×10^{-2}	
D		102.2	4.7	1.61×10^{-3}	1.6×10^{-3}	0.13	

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.

9.0 References

9-1 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.

9-2 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.

9-3 WCAP-14277, Revision 1, "SLB Leak Rate and Tube Burst Probability Analysis Methods for ODSCC at TSP Intersections", Westinghouse Nuclear Services Division, December.1996.

9-4 EPRI Report NP 7480-L, Addendum 2, "Steam Generator Tubing Outside Diameter Stress Corrosion Cracking at Tube Support Plates Database for Alternate repair Limits," Electric Power Research Institute, April 1998.

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

9-6 EPRI Report NP 7480-L, Addendum 3, "Steam Generator Tubing Outside Diameter Stress Corrosion Cracking at Tube Support Plates Database for Alternate repair Limits," Electric Power Research Institute, May 1999.

9-7 SG-99-08-006, "Comanche Peak Steam Electric Station Unit 1, Steam Generator Degradation Assessment 1RF07 Refueling Outage," Westinghouse Electric Company, August 1999.