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KEWAUNEE

CYCLE 22 ALTERNATE REPAIR CRITERIA 90 DAY REPORT

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1.0 INTRODUCTION

This report provides the Kewaunee steam generator tube support plate (TSP) bobbin voltage data summary, together with postulated Steam Line Break (SLB) leak rate and tube burst probability analysis results, in support of the implementation of a 2.0 volt Alternate Repair Criteria (ARC) for Cycle 22 as outlined in the NRC Generic Letter 95-05, Reference 9.1. Information required by the Generic Letter is provided in this report including projections of bobbin voltage distributions, leak rates and burst probabilities for Cycle 22 operation. The methodology used in these evaluations is consistent with the NRC SER (Reference 9.2) and Westinghouse generic methodology described in Reference 9.3.

Eddy current (EC) and repair data for TSP indications are provided in Section 3. Growth rates for the last operating cycle (Cycle 21) established using reevaluated bobbin voltages from the current and last inspections are compared with prior cycle growth data in Section 3. The actual measured EOC-21 voltage distributions as well as leak rates and tube burst probabilities based on those distributions are compared with the projections for EOC-21 conditions performed during the last outage using EOC-20 data. During the current inspection, a number of previously repaired tubes were returned to service after repairing the tube or sleeve. The indication population returned to service from deplugged tubes are included in the Cycle 22 analyses. Leak rates and burst probabilities for the projected EOC-22 voltage distributions are reported in Section 7 and compared with allowable limits. The predicted steam generator (SG) tube leak rate and probability of burst during a postulated SLB event at EOC-22 meet the regulatory requirements outlined in the NRC SER (Reference 9.2).

2.0 SUMMARY AND CONCLUSIONS

SLB leak rate and tube burst probability analyses were performed for the actual measured EOC-21 bobbin voltage distributions and for projected EOC-22 distributions. SG-B had the highest number of indications (710) as well as the largest indication detected (2.24 volts) found during this inspection; therefore, it is the limiting SG at EOC-21. This result is consistent with the tube integrity projections performed during the last (EOC-20) outage. The total number of indications found at TSPs during the current inspections are significantly less than those projected at the beginning of the cycle using a POD of 0.6 for both SGs. Actual peak voltages, and leakage rates and tube burst probabilities calculated using the actual measured voltages are also lower than projected with the exception of burst probability for SG-A as described below.

The largest SLB leak rate based on the actual EOC-21 bobbin voltage distributions, is calculated for SG-B and its magnitude is 1.2 gpm. The calculated leak rate represents equivalent volumetric rate at room temperature. The allowable SLB leak limit for Kewaunee Cycle 21 is 34 gpm (22.6 gpm at room temperature). Therefore, the largest calculated leak rate for the actual EOC-21 conditions is well below the allowable limit. The corresponding EOC-21 conditional tube burst probability is 3.1×10^{-5}, and it is also much lower than the NRC reporting guideline of 10^{-2}. The EOC-21 projections performed during the last outage for SG-B with a POD of 0.6 are conservatively high with a leak rate of 2.2 gpm (at room temperature) and burst probability of 1.2×10^{-4}. The corresponding SG-B projections based on a voltage-dependent POD from an EPRI study are 1.9 gpm (at room temperature) and 7.7×10^{-5}, and they are also conservative relative to the values calculated from the measured distribution. The burst probability for the non-limiting SG-A exceeds its projection by a small amount ($< 1.5\times10^{-5}$); a difference of this maguitude may be attributed to different seeds used to generate the random numbers in the Monte Carlo calculations for the two cases, and it is acceptable. Because of large margins found in the leak and burst results for EOC-21, SLB leak rate and tube probability projections for the EOC-22 conditions are also expected to be well within the allowable limits.

A total of 968 indications were found at the TSP intersections in tubes in service during Cycle 21 of which only 4 were above 2 volts. The largest number of indications (710) were found in SG-B, which also had the indication with the largest bobbin voltage (2.24 volts). Eight TSP indications, including the 4 above 2 volts, were inspected with a Rotating Pancake Coil (RPC) probe; they were all confirmed as flaws. No circumferential, PWSCC or volumetric-type RPC signals were found at TSP intersections in which ARC was applied in the current inspection.

During the recent inspections at some plants with 7/8" SG tubes, relatively high growth rates were observed for indications in tubes deplugged and returned to service at the beginning of their last operating cycle. Since during the EOC-20 outage about 80 deplugged tubes were returned to service, growth rates during Cycle 21 were calculated separately for those tubes and compared with the growth rates for previously active tubes. However, no discernible differences could be found in the growth rates for EOC-20 deplugged and active tubes; therefore, no distinction was made between both sets of tubes in calculating Cycle 21 growth rates and separate analyses are not required for EOC-22 projections.

During this outage, a large number of tubes in both SGs previously plugged were returned to service after repairing the tube or sleeve. As a result, 23 additional indications were added to the indication population for tubes returned to service for Cycle 22 operation. SG-B is again predicted to be limiting at EOC-22, with the highest number of indications, bobbin voltage amplitude, and leak rate and tube burst probability for postulated SLB conditions. Using the NRC recommended POD value (0.6) and leak rate correlation requirement to calculate the performance of the limiting SG during the next Kewaunee operating cycle (Cycle 22), the SLB tube leak rate is projected to be 2.9 gpm (at room temperature) for SG-B and the corresponding tube burst probability is projected to be 8.6×10^{-5} at EOC-22. These results meet the Kewaunee ARC requirement for allowable tube leakage (22.6 gpm at room temperature) and the NRC guideline for tube burst probability (1×10^{-2}); accordingly Cycle 22 operation of Kewaunee is in compliance with the requirements of the NRC SER of Reference 9.2.

3.0 EOC-21 INSPECTION RESULTS AND VOLTAGE GROWTH RATES

3.1 EOC-21 INSPECTION RESULTS

In accordance with the ARC guidance provided by the NRC Generic Letter 95-05 (Reference 9.1), the EOC-21 inspection of the Kewaunee SGs consisted of a complete, 100% EC bobbin probe, full length examination of the tube bundles in both SGs. A 0.720 inch diameter probe was used for all hot and cold leg TSPs where ARC was applied. Subsequently, RPC examination was performed for all indications with an amplitude 2 volts and above. Only 4 indications had a bobbin voltage above 2 volts; they were all confirmed as flaws by RPC inspection and removed from service by tube repairs.

An augmented RPC inspection was also performed consistent with the NRC requirements. It consisted of examining a sample of 100 TSP intersections including those with a dent voltage greater than 5 volts, those indicating copper deposits or large mixed residual that could mask a 1 volt bobbin signal. No indications were detected during the augmented RPC inspection. Also, no RPC circumferential indications at the TSPs, no indications extending outside the TSPs, and no RPC indications with potential ID phase angles were detected during this inspection.

A summary of EC indications for both steam generators is shown on Table 3-1, which tabulates the number of field bobbin indications, the number of those indications that were RPC inspected, the number of RPC confirmed indications, the number of indications removed from service due to tube repairs, and the number of indications added due to deplugged tubes returned to service. The indications that remain active for Cycle 22 operation is the sum of the population observed during the inspection and those in the deplugged tubes returned to service minus the ones removed from service due to tube repairs. A large number of tubes in both SGs previously plugged were deplugged and returned to service after repairing the tube or sleeve. An inspection summary for the deplugged tubes is shown in Table 3-2. A total of 23 indications, all below the ARC repair limit, were present in the deplugged tubes returned to service for Cycle 22 operation.

Overall, the combined data for the Kewaunee steam generators show the following:

- A total of 968 bobbin siguals were identified as TSP indications during the inspection, and they were called PIs. Only 100 indications had a voltage

above 1 volt and 4 indications above 2 volts. The largest indication was found in SG-B, and it had a bobbin amplitude of 2.24 volts.

- Eight indications were RPC inspected, 7 of which were above 1 volt, and they were all confirmed.

- One hundred and two TSP indications were removed from service due to tube repairs in the present outage. Only 4 ODSCC indications required repair based on exceeding 2 volts, and the remaining 98 indications were in tubes repaired for non-OSDCC causes. Consistent with the 2 volt ARC, indications with bobbin amplitude less than or equal 2.0 volts are not considered for removal from service, regardless of RPC data.

- Additionally, 23 indications were found in deplugged tubes recovered and returned to service, for a total of 889 indications returned to service for Cycle 22 operation in accordance with the ARC criteria.

A review of Table 3-1 indicates that more indications (a quantity of 643, with 72 indications above 1.0 volt) would be returned to service in SG-B than SG-A, thereby it potentially will be the limiting SG at EOC-22. It is also noted that SG-B had the largest indication (2.24 volts) found in the EOC-21 inspection.

Figure 3-1 shows the actual bobbin voltage distribution from the EOC-21 EC inspection. Figure 3-2 shows the population distribution of those EOC-21 indications removed from service due to tube repairs. Figure 3-3 shows the indications returned to service for Cycle 22 operation, including those in deplugged tubes returned to service.

The distribution of EOC-21 indications as a function of support plate elevation, summarized in Table 3-3 and illustrated on Figure 3-4, shows the predisposition of ODSCC to occur at the cold leg TSPs (672 of the 968 PIs, or about 69%, occurred at the cold leg TSPs). This distribution is in contrast to the typical pattern observed at other plants where ODSCC occurs in the first few hot leg TSPs. However, this distribution has been found in the past Kewaunee inspections and has remained essentially unchanged.

3.2 VOLTAGE GROWTH RATES

The bobbin voltage growth rates for the Kewaunee steam generators during Cycle 21 are shown in Table 3-4 in the form of cumulative probability distribution functions (CPDF), and the same data is presented in a graphical form on Figure 3-5. Growth rate distributions for the last operating cycle (Cycle 20) are also shown for comparison (in the table only). The growth rates are presented on an EFPY basis to account for the difference in the length of the two operating periods. The two growth distributions are also shown in Figure 3-6. Cycle 21 growth rates are developed from the 1996 EOC-21 inspection data and a reevaluation of the same indications from the previous (1995, EOC-20) inspection EC siguals. Only data relevant to PIs are considered. For Cycle 21 operation, SG-B has a slightly larger average voltage growth, but SG-A has the indication with the largest voltage growth. During the last cycle (Cycle 20), SG-A had a slightly larger average growth (Reference 9.6). It is evident from Figure 3-6 that the composite growth rates for Cycle 20 are higher than those for Cycle 21; the highest growth rate for Cycle 21 is only 0.5 volt/EFPY whereas it is 1.1 volt/EFPY for Cycle 20. In general, growth rates observed for the Kewaunee SGs are significantly lower than those seen for most other SGs with 7/8" diameter tubing.

Table 3-5 shows average growth rates for each SG during Cycle 21. The observed growth rates for the two SGs are 3.2% and 4.2%, with an overall average of 3.9%, on an EFPY basis. The average growth for indications with a beginning of cycle (BOC) bobbin voltage above 0.75 volt is smaller than those for indications below 0.75 volt. This growth comparison is believed to be distorted by a large number of small and negative growth values found for indications above 0.75 BOC volts rather than indicating a trend. Table 3-6 shows top 30 indications on the basis of Cycle 21 growth rates, and they all show only a modest growth.

Composite growth distributions for the last nine operating cycles are shown in Table 3-7. The average growth rates have decreased substantially since 1992, and that trend was maintained during Cycle 21. Average growth rates on an EFPY basis for Cycle 21 are slightly lower than those observed for Cycle 20. The NRC generic letter recommends that the more conservative growth distribution from the last two cycles be used for projecting EOC distributions for the next cycle. Accordingly, it would be conservative to use Cycle 20 bobbin voltage growth rates for predicting EOC-22 conditions.

About 17% of the indications observed in EOC-21 inspection were found in tubes deplugged and returned to service during the EOC-20 outage. During recent inspections in some plants with 7/8" SG tubes, relatively high growth rates were

observed for indications in tubes deplugged and returned to service at the beginning of their last operating cycle. To determine if such a trend is also noted during Kewaunee Cycle 21, growth rates were calculated separately for the tubes that were active during Cycle 20 and those deplugged and returned to service at EOC-20. The results are summarized in Tables 3-8 and also illustrated in Figure 3-7. It is evident that there is no discernible difference between the growth rates for EOC-20 deplugged and Cycle 20 active tubes. Hence, it is appropriate to combine Cycle 21 growth data for both sets of tubes.

Since growth rates for Cycle 20 are slightly higher than Cycle 21 growth rates, the former should be applied to project EOC-22 SLB leak rates and burst probabilities. Figure 3-8 shows a plot of voltage growth, ΔV, versus the BOC voltage, V_{BOC}, for all Cycle 20 growth data. The data does not show increased growth rate for larger BOC indications, and actually the growth decreases somewhat above 1 volt. The three largest values, which are within 0.05 volt of each other, are more or less evenly spread out in the 0 to 1 volt V_{BOC} range. Therefore, it is appropriate to assume that growth rates are independent of V_{BOC} in the EOC-22 SLB leak and burst projection analyses.

According to the Westinghouse ARC analysis methodology presented in Reference 9.3, the larger of the composite growth rate for all SGs and the SG-specific growth rate should be used in projecting SLB leak rate and tube burst probability for individual SGs. Since SG-A growth rates are below the composite growth rate and SG-B growth rates are higher, the composite growth should be applied to SG-A and its own growth rate for SG-B. However, as SG-B growth rates are only slightly above the composite growth rate (see Table 3-4), the SG-B growth rate is applied to both two SGs to provide a conservative basis for predicting EOC-22 conditions. Since Cycle 21 growth rates for EOC-20 deplugged tubes and previously active tubes are essentially the same, the same growth distribution was applied to indications in both sets of tubes.

3.3 PROBABILITY OF PRIOR CYCLE DETECTION (POPCD)

The inspection results at EOC-21 permit an evaluation of the probability of detection (POD) at the prior EOC-20 inspection. For ARC applications, the important indications are those that could significantly contribute to EOC leakage or burst probability. These significant indications can be expected to be detected by bobbin and confirmed by RPC inspection. Thus, the population of interest for ARC POD assessments is the EOC RPC confirmed indications that were detected or not detected

at the prior inspection. The probability of prior cycle detection (POPCD) for the EOC-20 inspection can then be defined as follows.

$$\text{POPCD (EOC-20)} = \frac{\text{EOC-20 cycle reported indications confirmed by RPC in EOC-21 inspection} + \text{Indications confirmed and repaired in EOC-20 inspection}}{\{\text{Numerator}\} + \text{New indications RPC confirmed in EOC-21 inspection}}$$

POPCD is evaluated at the 1995 EOC-20 voltage values (from 1996 reevaluation for growth rate) since it is an EOC-20 POPCD assessment. The indications at EOC-20 that were RPC confirmed and plugged are included as it can be expected that these indications would also have been detected and confirmed at EOC-21. It is also appropriate to include the plugged tubes for ARC applications since POD adjustments to define the BOC distribution are applied prior to reduction of the EOC indication distribution for plugged tubes. Indications in tubes deplugged and returned to service at EOC-20 are included in the evaluation since these indications are detected, and other TSP intersections in those tubes are potential sites for new indications in the subsequent inspection. Deplugged tubes that were replugged because they had indications which did not meet the 2 volt repair criteria or because of other reasons are excluded. Inclusion of tubes deplugged at the beginning of the cycle for which POPCD is being evaluated was recommended in Reference 9.4.

It should be noted that the above POPCD definition includes all new EOC-21 indications not reported in the EOC-20 inspection. The new indications include EOC-20 indications present at detectable levels but not reported, indications present at EOC-20 below detectable levels and indications that initiated during Cycle 21. Thus, this definition, by including newly initiated indications, differs from the traditional POD definition. Since the newly initiated indications are appropriate for ARC applications, POPCD is an acceptable definition and eliminates the need to adjust the traditional POD for new indications.

The above definition for POPCD would be entirely appropriate if all EOC-21 indications were RPC inspected. Since only a fraction of bobbin indications are generally RPC inspected, POPCD could be distorted by using only the RPC inspected indications. Thus, a more appropriate POPCD estimate can be made by assuming that all bobbin indications not RPC inspected would have been RPC confirmed. This

definition is applied only for the 1996 EOC-21 indications not RPC inspected since inclusion for the EOC-20 inspection could increase POPCD by including indications on a tube plugged for non-ODSCC causes which could be RPC NDD indications. In addition, the objective of using RPC confirmation for POPCD is to distinguish detection of indications at EOC_{n-1} that could contribute to burst at EOC_n so that the emphasis is on EOC_n RPC confirmation. This POPCD can be obtained by replacing the EOC-21 RPC confirmed by RPC confirmed plus not RPC inspected in the above definition of POPCD. For this report, both POPCD definitions are evaluated for Kewaunee.

The POPCD evaluation for the 1995 EOC-20 inspection data is summarized in Table 3-9 and illustrated on Figure 3-9. Both results based on RPC confirmed indications only as well as RPC confirmed plus not RPC inspected indications are shown in Figure 3-9. Also shown in the figure is a generic POPCD distribution developed using similar data from 11 inspections at 8 plants including the data for Kewaunee EOC-19 inspection (Reference 9.5). Both POPCD distributions for Kewaunee EOC-20 inspection are significantly above the generic POPCD distribution. Below 0.8 volts, POPCD values could not be calculated for RPC confirmed only indications since there are no indications in that population group. However, as the values over 0.8 volts are above the generic distribution, the same trend can be expected below 0.8 volts also. It can be noted that the high POPCD found at Kewaunee is consistent with the projections made for EOC-21 (see Table 6-3) that resulted in projecting more indications than found in the inspection.

In summary, the Kewaunee EOC-20 POPCD distribution supports a voltage dependent POD higher than the NRC mandated POD value of 0.6 approaching unity at about 2 volts. It is concluded that the POD applied for ARC leak and burst projections needs to be upgraded from the constant POD value of 0.6 to a voltage dependent POD.

3.4 NDE UNCERTAINTIES

The NDE uncertainties applied for the EOC-21 voltage projections in this report are the same as those given in the prior Kewaunee ARC reports (Reference 9.6). 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 used to project the EOC-21 voltage distributions.

Table 3-1
Kewaunee October 96 Outage
Summary of Inspection and Repair For Tubes in Service During Cycle 21

Steam Generator A

Voltage Bin	In-Service During Cycle: Field Bobbin Indications	RPC Inspected	RPC Confirmed	Indications Repaired	BOC-22: All Tubes RTS	EOC-21: Deplugged Tubes Returned to Service#	Cycle - 22: All Tubes Returned to Service
0.1	1	0	0	0	1	1	2
0.2	21	0	0	2	19	2	21
0.3	46	0	0	2	44	1	45
0.4	31	0	0	3	28	3	31
0.5	47	0	0	4	43	0	43
0.6	33	0	0	4	29	2	31
0.7	24	0	0	3	21	1	22
0.8	13	0	0	4	9	1	10
0.9	20	0	0	2	18	0	18
1	7	0	0	1	6	0	6
1.1	2	0	0	0	2	1	3
1.2	2	0	0	0	2	0	2
1.3	3	0	0	0	3	1	4
1.4	2	0	0	0	2	0	2
1.5	2	0	0	0	2	0	2
1.6	0	0	0	0	0	0	0
1.7	1	0	0	0	1	0	1
1.8	0	0	0	0	0	0	0
1.9	3	0	0	0	3	0	3
2	0	0	0	0	0	0	0
2.1	0	0	0	0	0	0	0
2.2	0	0	0	0	0	0	0
2.3	0	0	0	0	0	0	0
Total	258	0	0	25	233	13	246
>1v	15	0	0	0	15	2	17

Steam Generator B

In-Service During Cycle: Field Bobbin Indications	RPC Inspected	RPC Confirmed	Indications Repaired	BOC-22: All Tubes RTS	EOC-21: Deplugged Tubes Returned to Service#	Cycle - 22: All Tubes Returned to Service
2	0	0	1	1	0	1
29	0	0	2	27	0	27
76	0	0	10	66	0	66
102	0	0	3	99	2	101
113	0	0	13	100	0	100
84	0	0	7	77	2	79
65	0	0	10	55	1	56
75	0	0	9	66	3	69
42	1	1	4	38	0	38
37	0	0	3	34	0	34
28	1	1	1	27	1	28
17	1	1	3	14	0	14
16	0	0	1	15	1	16
5	1	1	1	4	0	4
5	0	0	2	3	0	3
6	0	0	1	5	0	5
2	0	0	1	1	0	1
1	0	0	0	1	0	1
0	0	0	0	0	0	0
1	0	0	1	0	0	0
2	2	2	2	0	0	0
1	1	1	1	0	0	0
1	1	1	1	0	0	0
710	8	8	77	633	10	643
85	7	7	15	70	2	72

Composite of All Steam Generators

Voltage Bin	In-Service During Cycle: Field Bobbin Indications	RPC Inspected	RPC Confirmed	Indications Repaired	BOC-22: All Tubes RTS	EOC-21: Deplugged Tubes Returned to Service#	Cycle - 22: All Tubes Returned to Service
0.1	3	0	0	1	2	1	3
0.2	50	0	0	4	46	2	48
0.3	122	0	0	12	110	1	111
0.4	133	0	0	6	127	5	132
0.5	160	0	0	17	143	0	143
0.6	117	0	0	11	106	4	110
0.7	89	0	0	13	76	2	78
0.8	88	0	0	13	75	4	79
0.9	62	1	1	6	56	0	56
1	44	0	0	4	40	0	40
1.1	30	1	1	1	29	2	31
1.2	19	1	1	3	16	0	16
1.3	19	0	0	1	18	2	20
1.4	7	1	1	1	6	0	6
1.5	7	0	0	2	5	0	5
1.6	6	0	0	1	5	0	5
1.7	3	0	0	1	2	0	2
1.8	1	0	0	0	1	0	1
1.9	3	0	0	0	3	0	3
2	1	0	0	1	0	0	0
2.1	2	2	2	2	0	0	0
2.2	1	1	1	1	0	0	0
2.3	1	1	1	1	0	0	0
Total	968	8	8	102	866	23	889
>1v	100	7	7	15	85	4	89

Table 3-2
Kewaunee October 96 Outage
Summary of Inspection and Repair For Tubes Deplugged Duriug EOC- 21 Inspection

Voltage Bin	Steam Generator A					Steam Generator B				
	Deplugged During EOC- 21 Inspection				RTS for Cycle 22	Deplugged During EOC- 21 Inspection				RTS for Cycle 22
	Field Bobbin Indications	RPC Inspected	RPC Confirmed	Indications Repaired	All Indications	Field Bobbin Indications	RPC Inspected	RPC Confirmed	Indications Repaired	All Indications
0.1	1	0	0	0	1	0	0	0	0	0
0.2	2	0	0	0	2	1	0	0	1	0
0.3	1	0	0	0	1	1	0	0	1	0
0.4	3	0	0	0	3	2	0	0	0	2
0.5	0	0	0	0	0	1	0	0	1	0
0.6	3	0	0	1	2	3	0	0	1	2
0.7	1	0	0	0	1	1	0	0	0	1
0.8	1	0	0	0	1	3	0	0	0	3
0.9	0	0	0	0	0	1	0	0	1	0
1.1	1	0	0	0	1	2	0	0	1	1
1.3	1	0	0	0	1	1	0	0	0	1
Total	14	0	0	1	13	16	0	0	6	10
>1v	2	0	0	0	2	3	0	0	1	2

Voltage Bin	Composite of All SGs				
	Deplugged During EOC- 21 Inspection				RTS for Cycle 22
	Field Bobbin Indications	RPC Inspected	RPC Confirmed	Indications Repaired	All Indications
0.1	1	0	0	0	1
0.2	3	0	0	1	2
0.3	2	0	0	1	1
0.4	5	0	0	0	5
0.5	1	0	0	1	0
0.6	6	0	0	2	4
0.7	2	0	0	0	2
0.8	4	0	0	0	4
0.9	1	0	0	1	0
1.1	3	0	0	1	2
1.3	2	0	0	0	2
Total	30	0	0	7	23
>1v	5	0	0	1	4

Table 3-3
Kewaunee October 1996
TSP ODSCC Indication Distributions for Tubes in Service During Cycle 21

Tube Support Plate	Steam Generator A					Steam Generator B				
	Number of Indications	Maximum Voltage	Average Voltage	Largest Growth	Average Growth	Number of Indications	Maximum Voltage	Average Voltage	Largest Growth	Average Growth
1H	50	1.84	0.71	0.59	0.05	23	1.43	0.77	0.21	0.03
2H	19	1.39	0.52	0.22	0.04	21	1.10	0.46	0.25	0.00
3H	9	0.96	0.50	0.17	0.07	29	1.29	0.58	0.29	0.05
4H	5	1.00	0.57	0.16	0.10	26	1.53	0.54	0.26	0.02
5H	7	0.51	0.40	0.51	0.06	28	1.00	0.49	0.21	0.01
6H	12	0.86	0.40	0.13	0.02	21	0.89	0.42	0.37	-0.01
7H	14	0.90	0.38	0.11	-0.02	32	1.01	0.49	0.14	-0.03
7C	43	1.49	0.49	0.26	0.01	83	2.18	0.68	0.45	0.06
6C	28	1.45	0.50	0.34	0.01	116	2.24	0.71	0.47	0.03
5C	8	0.89	0.56	0.13	0.03	45	1.21	0.66	0.37	0.05
4C	3	0.40	0.26	0.12	-0.02	46	1.56	0.60	0.42	0.04
3C	5	0.42	0.29	0.09	-0.02	38	1.68	0.55	0.23	0.04
2C	27	1.14	0.46	0.22	0.00	121	1.62	0.62	0.52	0.05
1C	28	1.16	0.56	0.27	0.00	81	1.77	0.62	0.37	0.01
Total	258					710				

Tube Support Plate	Composite of All SGs				
	Number of Indications	Maximum Voltage	Average Voltage	Largest Growth	Average Growth
1H	73	1.84	0.73	0.59	0.04
2H	40	1.39	0.49	0.25	0.02
3H	38	1.29	0.56	0.29	0.05
4H	31	1.53	0.54	0.26	0.03
5H	35	1.00	0.47	0.51	0.02
6H	33	0.89	0.42	0.37	0.00
7H	46	1.01	0.45	0.14	-0.03
7C	126	2.18	0.62	0.45	0.04
6C	144	2.24	0.66	0.47	0.03
5C	53	1.21	0.65	0.37	0.04
4C	49	1.56	0.58	0.42	0.04
3C	43	1.68	0.52	0.23	0.03
2C	148	1.62	0.59	0.52	0.04
1C	109	1.77	0.60	0.37	0.01
Total	968				

Table 3-4
Kewaunee October 96
Voltage Growth Statistics For Cycle 21 on an EFPY Basis

Delta Volts	Steam Generator A			Steam Generator B			Cumulative		
	Cycle 20	Cycle 21		Cycle 20	Cycle 21		Cycle 20	Cycle 21	
	CPDF	No. of Inds	CPDF	CPDF	No. of Inds	CPDF	CPDF	No. of Inds	CPDF
-0.5	0.0	0	0.0	0.006	0	0.0	0.004	0	0.0
-0.4	0.006	0	0.0	0.009	0	0.0	0.008	0	0.0
-0.3	0.011	1	0.004	0.028	1	0.001	0.024	2	0.002
-0.2	0.046	3	0.016	0.079	6	0.01	0.071	9	0.011
-0.1	0.154	20	0.093	0.227	50	0.08	0.209	70	0.084
0	0.389	89	0.438	0.449	235	0.411	0.434	324	0.418
0.1	0.766	115	0.884	0.712	287	0.815	0.725	402	0.834
0.2	0.891	25	0.981	0.875	103	0.961	0.879	128	0.966
0.3	0.937	3	0.992	0.925	23	0.993	0.928	26	0.993
0.4	0.977	1	0.996	0.953	5	1.0	0.959	6	0.999
0.5	0.994	1	1.0	0.978	0		0.982	1	1.0
0.6	1.0	0		0.989	0		0.992	0	
0.7		0		0.996	0		0.997	0	
1		0		0.998	0		0.999	0	
1.1		0		1.0	0		1.0	0	
Total		258			710			968	

Table 3-5
Kewauuee - October 1996 Outage
Average Voltage Growth During Cycle 21

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	968	0.56	0.029	0.022	5.1%	3.9%
V_{BOC} < .75 Volts	741	0.42	0.036	0.028	8.4%	6.5%
≥ .75 Volts	227	1.02	0.006	0.004	0.6%	0.4%
	Steam Generator A					
Entire Voltage Range	258	0.50	0.021	0.016	4.1%	3.2%
V_{BOC} < .75 Volts	211	0.40	0.025	0.020	6.3%	4.9%
≥ .75 Volts	47	0.98	0.000	0.000	0.0%	0.0%
	Steam Generator B					
Entire Voltage Range	710	0.58	0.032	0.024	5.4%	4.2%
V_{BOC} < .75 Volts	530	0.43	0.040	0.031	9.2%	7.1%
≥ .75 Volts	180	1.03	0.007	0.006	0.7%	0.5%

Based on Cycle 21 duration of 471.8 EFPD (1.292 EFPY)

Table 3-6
Kewaunee October 1996
Summary of Largest Voltage Growth Rates for BOC-21 to EOC-21

Steam Generator				Bobhin Voltage			RPC	New
SG	Row	Col	Elevation	EOC	BOC	Growth	Confirmed ?	Indication ?
A	33	16	01H	1.82	1.23	0.59	N	N
B	20	45	02C	0.83	0.31	0.52	N	Y
A	28	79	05H	0.51	0.001	0.509	N	Y
B	35	70	06C	1.22	0.75	0.47	N	N
B	43	42	07C	1.94	1.49	0.45	N	N
B	37	43	04C	0.91	0.49	0.42	N	N
B	38	45	06C	1.06	0.65	0.41	N	N
B	15	40	01C	1.1	0.73	0.37	N	N
B	19	49	05C	0.73	0.36	0.37	N	Y
B	35	77	06H	0.85	0.48	0.37	N	N
A	43	42	06C	0.9	0.56	0.34	N	N
B	19	90	04C	1.56	1.22	0.34	N	N
B	38	36	06C	0.93	0.59	0.34	N	N
B	23	32	06C	0.75	0.42	0.33	N	Y
B	10	2	01C	0.95	0.62	0.33	N	N
B	38	42	05C	1.17	0.84	0.33	N	Y
B	40	24	07C	0.82	0.49	0.33	N	N
B	43	44	06H	0.72	0.39	0.33	N	N
B	12	50	05C	0.82	0.5	0.32	N	N
B	35	33	06C	0.79	0.48	0.31	N	N
B	35	66	06C	1.02	0.71	0.31	N	N
B	16	25	02C	1.62	1.33	0.29	N	N
B	20	29	01C	0.77	0.48	0.29	N	N
B	36	69	06C	0.76	0.47	0.29	N	N
B	33	56	03H	0.84	0.55	0.29	N	Y
A	35	53	01H	0.82	0.54	0.28	N	N
B	35	33	04C	0.81	0.53	0.28	N	N
B	37	46	07C	0.88	0.6	0.28	N	N
B	44	34	01C	0.72	0.44	0.28	N	N
A	9	10	01C	0.99	0.72	0.27	N	Y

Table 3-7
Kewaunee October 1996
Average Voltage Growth for Cycle 21
Composite of All Steam Geuerator Data

Bobbin Voltage Range	Number of Indications	Average Voltage BOC	Average Voltage Growth		Average Percentage Growth	
			Entire Cycle	Per EFPY	Entire Cycle	Per EFPY
	Cycle 21 (1995 - 1997) - 471.8 EFPD					
Entire Voltage Range	968	0.56	0.029	0.022	5.1	3.9
V_{BOC} < .75 Volts	741	0.42	0.036	0.028	8.4	6.5
≥ .75 Volts	227	1.02	0.006	0.004	0.6	0.4
	Cycle 20 (1994 - 1995) - 319 EFPD					
Entire Voltage Range	709	0.54	0.028	0.032	5.1	5.9
V BOC < .75	576	0.42	0.031	0.035	7.3	8.4
≥ .75 Volts	133	1.09	0.016#	0.018	-1.5	-1.7
	Cycle 19 (1993 - 1994) - 325.7 EFPD					
Entire Voltage Range	572	0.61	0.002	0.003	0.4	0.4
V BOC < .75	425	0.45	0.015	0.016	3.2	3.6
≥ .75 Volts	147	1.08	-0.033 #	-0.037	-3.1	-3.4
	Cycle 18 (1992 - 1993) - 308.9 EFPD					
Entire Voltage Range	450	0.75	0.04	0.047	5.3	6.3
V BOC < .75	279	0.49	0.05	0.059	10.2	12.1
≥ .75 Volts	171	1.17	0.03	0.035	2.6	3.0
	Cycle 17 (1991 - 1992) - 317.8 EFPD					
Entire Voltage Range	382	0.69	0.12	0.150	18.0	22.4
V BOC < .75	261	0.49	0.12	0.150	24.0	29.9
≥ .75 Volts	121	1.11	0.13	0.162	12.0	15.0
	Cycle 16 (1990 - 1991) - 309.7 EFPD					
Entire Voltage Range	187	1.2	-0.24	-0.276	-20	-23.0
	Cycle 15 (1989 - 1990) - 309.7 EFPD					
Entire Voltage Range	52	0.95	0.14	0.165	15	17.4
	Cycle 14 (1988 - 1989) - 297.5 EFPD					
Entire Voltage Range	35	0.93	0.13	0.160	14	17.2
	Cycle 13 (1987 - 1988) - 325.4 EFPD					
Entire Voltage Range	20	0.87	0.11	0.123	13	14.2

Top five (5) negative growth data (below - 0.5 volt) for Steam Generator B are not included

Table 3-8
Kewaunee Growth Statistics
Comparison of Cycle 21 Growth Rates for Tubes Deplugged EOC-20 versus those In Service Cycle 20

Delta Volts	Steam Generator A						Steam Generator B					
	In Service Cycle 20		Deplugged EOC-20		All Indications		In Service Cycle 20		Deplngged EOC-20		All Indlcations	
	No. of Obs	CPDF	No. of Obs	CPDF	No. of Obs	CPDF	No. of Obs	CPDF	No. of Obs	CPDF	No. of Obs	CPDF
-0.3	1	0.005	0	0.000	1	0.004	1	0.002	0	0.000	1	0.001
-0.2	1	0.009	2	0.045	3	0.016	5	0.010	1	0.009	6	0.010
-0.1	18	0.094	2	0.091	20	0.093	38	0.074	12	0.111	50	0.080
0	74	0.437	16	0.455	90	0.440	200	0.411	35	0.410	235	0.411
0.1	97	0.892	18	0.864	115	0.887	240	0.816	47	0.812	287	0.815
0.2	19	0.981	6	1.000	25	0.984	87	0.963	16	0.949	103	0.961
0.3	3	0.995	0	1.0	3	0.996	18	0.993	5	0.991	23	0.993
0.4	0	0.995	0		0	0.996	4	1.0	1	1.0	5	1.0
0.5	1	1.0	0		1	1.0	0		0		0	
Total	214		44		258		593		117		710	

Delta Volts	Composite of Both SG Data					
	In Service Cycle 20		Deplugged EOC-20		All tubes	
	No. of Obs	CPDF	No. of Obs	CPDF	No. of Obs	CPDF
-0.3	2	0.002	0	0.000	2	0.002
-0.2	6	0.010	3	0.019	9	0.011
-0.1	56	0.079	14	0.106	70	0.084
0	274	0.418	51	0.422	325	0.419
0.1	337	0.836	65	0.826	402	0.835
0.2	106	0.968	22	0.963	128	0.967
0.3	21	0.994	5	0.994	26	0.994
0.4	4	0.999	1	1.0	5	0.999
0.5	1	1.0	0		1	1.0
Total	807		161		968	

Table 3-9
Kewaunee 1996 Outage
EOC-21 Evaluation for Probability of Detection for EOC-20 Inspection
Composite of All Steam Generator Data

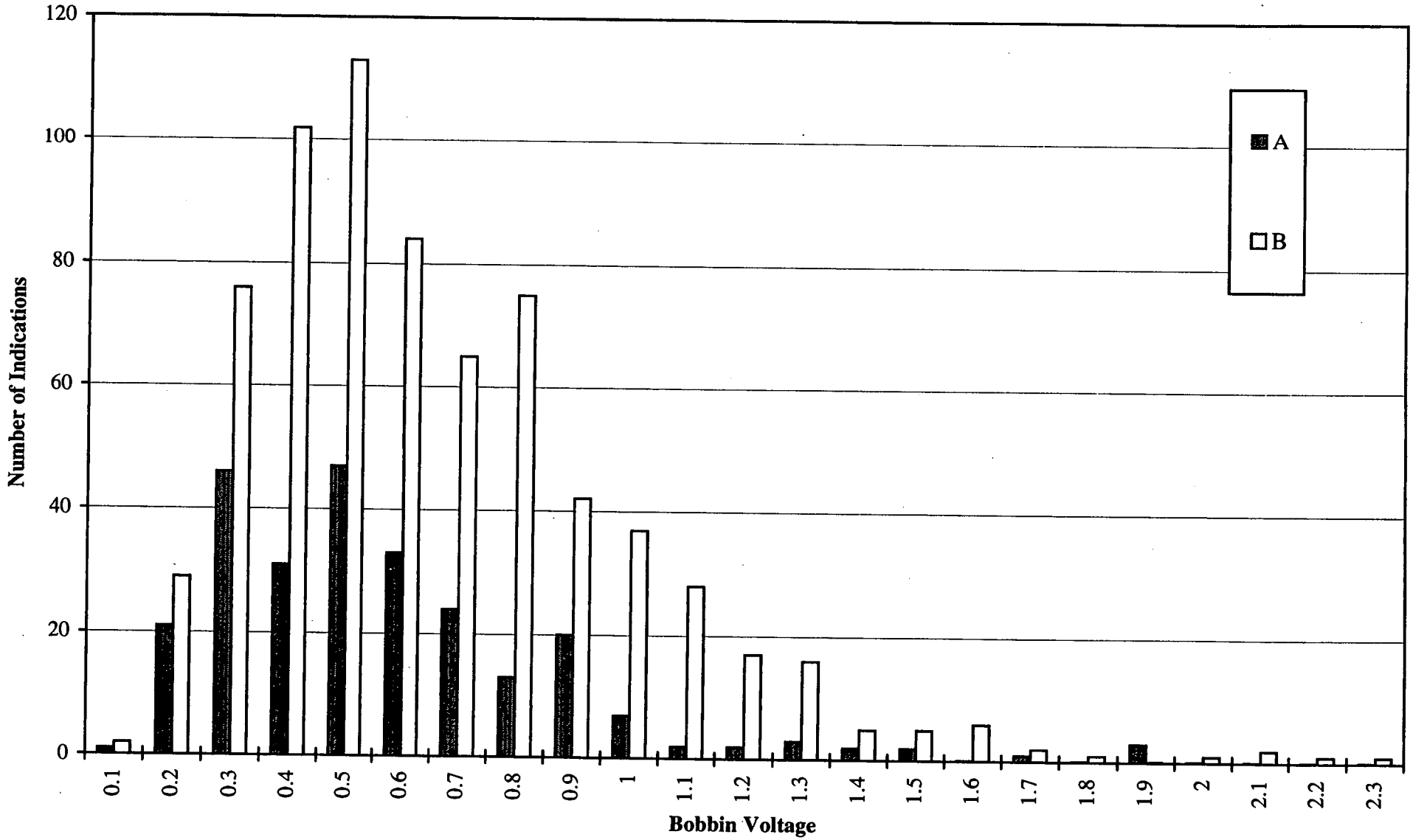
Voltage Bin	New Indications		Indications Detected Both in EOC-21 and EOC-20 Inspections		EOC-20 Inspection	POPCD			
	EOC-21 Inspection RPC Confirmed	EOC-21 Inspection RPC Confirmed plus not Inspected	EOC-21 Inspection RPC Confirmed	EOC-21 Inspection RPC Confirmed plus not Inspected	RPC Confirmed and Plugged	RPC Confirmed		RPC Confirmed Plus Not Inspected	
						Frac.	Count	Frac.	Count
> 0 - 0.2	0	6	0	73	0	-	0 / 0	0.924	73 / 79
0.2 - 0.4	0	68	0	253	0	-	0 / 0	0.788	253 / 321
0.4 - 0.6	0	42	0	222	0	-	0 / 0	0.841	222 / 264
0.6 -0 .8	0	27	0	123	0	-	0 / 0	0.820	123 / 150
0.8 - 1.0	0	11	2	63	0	1.0	2 / 2	0.851	63 / 74
1.0 - 1.5	0	3	2	68	0	1.0	2 / 2	0.958	68 / 71
1.5 - 2	0	0	3	8	0	1.0	3 / 3	1.0	8 / 8
2. - 3.2	0	0	1	1	0	1.0	1 / 1	1.0	1 / 1
TOTAL	0	157	8	811	0				
> 1V	0	3	6	77	0				

Table 3-10
Kewaunee
Analysis of RPC Data from EOC-20 and EOC-21 Inspections
Combined Data from All Steam Generators

Group of Indications	Total EOC-20 Inspection Bobbin Indication	Total EOC-21 Inspection Bobbin Indication	Total EOC-21 Inspection RPC Inspected	Total EOC-21 Inspection RPC Confirmed	Percent EOC-21 Inspection RPC Confirmed
Less than or Equal to 1.0 Volt in EOC-21 Inspection					
EOC-20 Inspection Bobbin Left in Service	744	718	1	1	100.0
- EOC-20 Inspection RPC Confirmed	19	19	0	0	-
- EOC-20 Inspection RPC NDD	3	3	0	0	-
- EOC-20 Inspection RPC Not Inspected	696	696	1	1	100.0
- No EOC-21 Inspection Bobbin *	26	-	-	-	-
New EOC-21 Inspection Indication	-	150	0	0	-
Sum of All EOC-21 Inspection Indication	744	868	1	1	100.0
Greater than 1.0 Volt in EOC-21 Inspection					
EOC-20 Inspection Bobbin Left in Service	95	93	7	7	100.0
- EOC-20 Inspection RPC Confirmed	7	7	3	3	100.0
- EOC-20 Inspection RPC NDD	0	0	0	0	-
- EOC-20 Inspection RPC Not Inspected	86	86	4	4	100.0
- No EOC-21 Inspection Bobbin *	2	-	-	-	-
New EOC-21 Inspection Indication	-	7	0	0	-
Sum of All EOC-21 Inspection Indication	95	100	7	7	100.0
All Voltages in EOC-21 Inspection					
EOC-20 Inspection Bobbin Left in Service	839	811	8	8	100.0
- EOC-20 Inspection RPC Confirmed	26	26	3	3	100.0
- EOC-20 Inspection RPC NDD	3	3	0	0	-
- EOC-20 Inspection RPC Not Inspected	782	782	5	5	100.0
- No EOC-21 Inspection Bobbin *	28	-	-	-	-
New EOC-21 Inspection Indication	-	157	0	0	-
Sum of All EOC-21 Inspection Indication	839	968	8	8	100.0

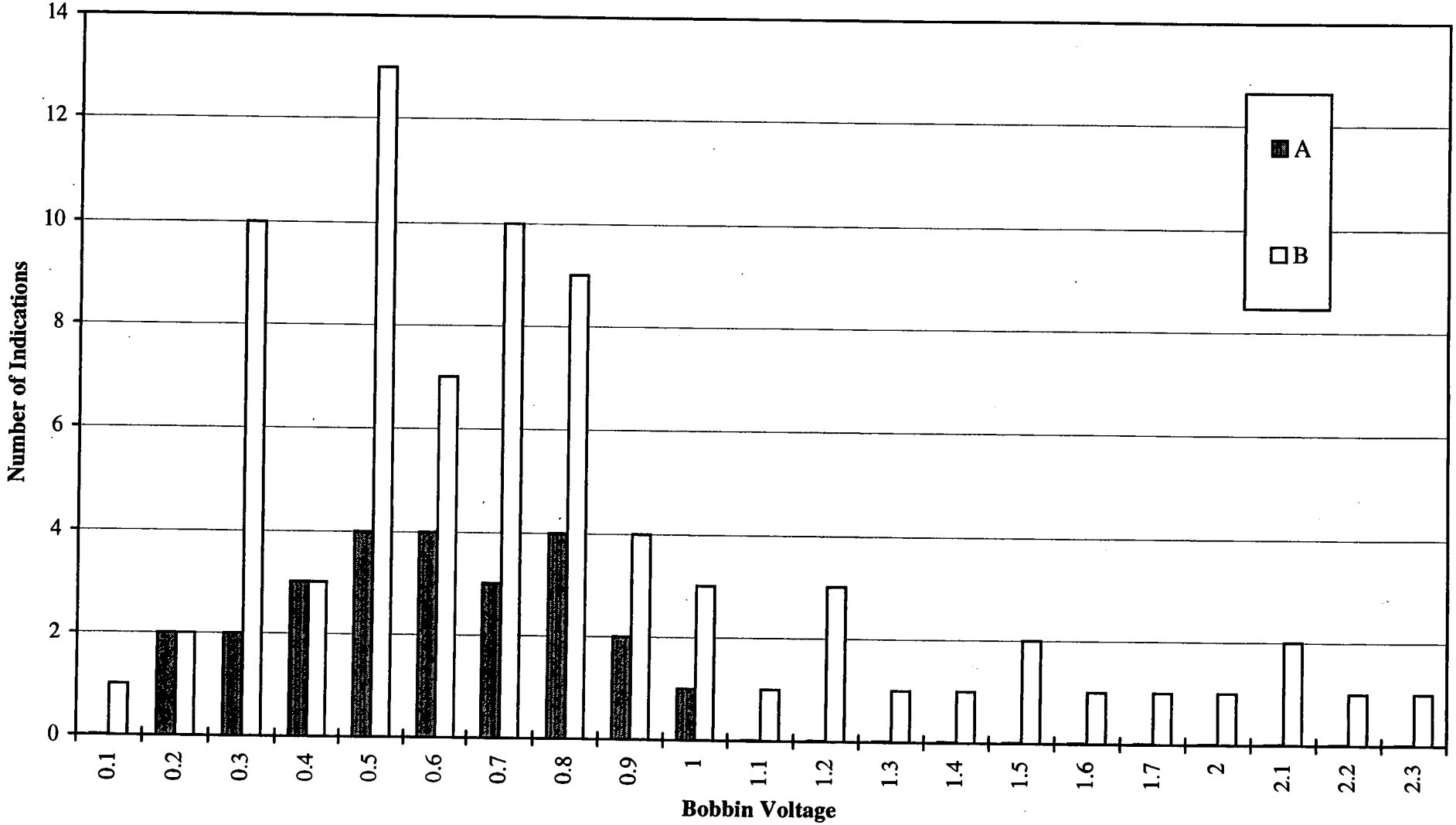
* Indications split is based on 1995 insp bobbin voltage

Figure 3-1
Kewaunee October 96
Outage Bobbin Voltage Distributions at EOC-21 for Tubes in Service During Cycle 21



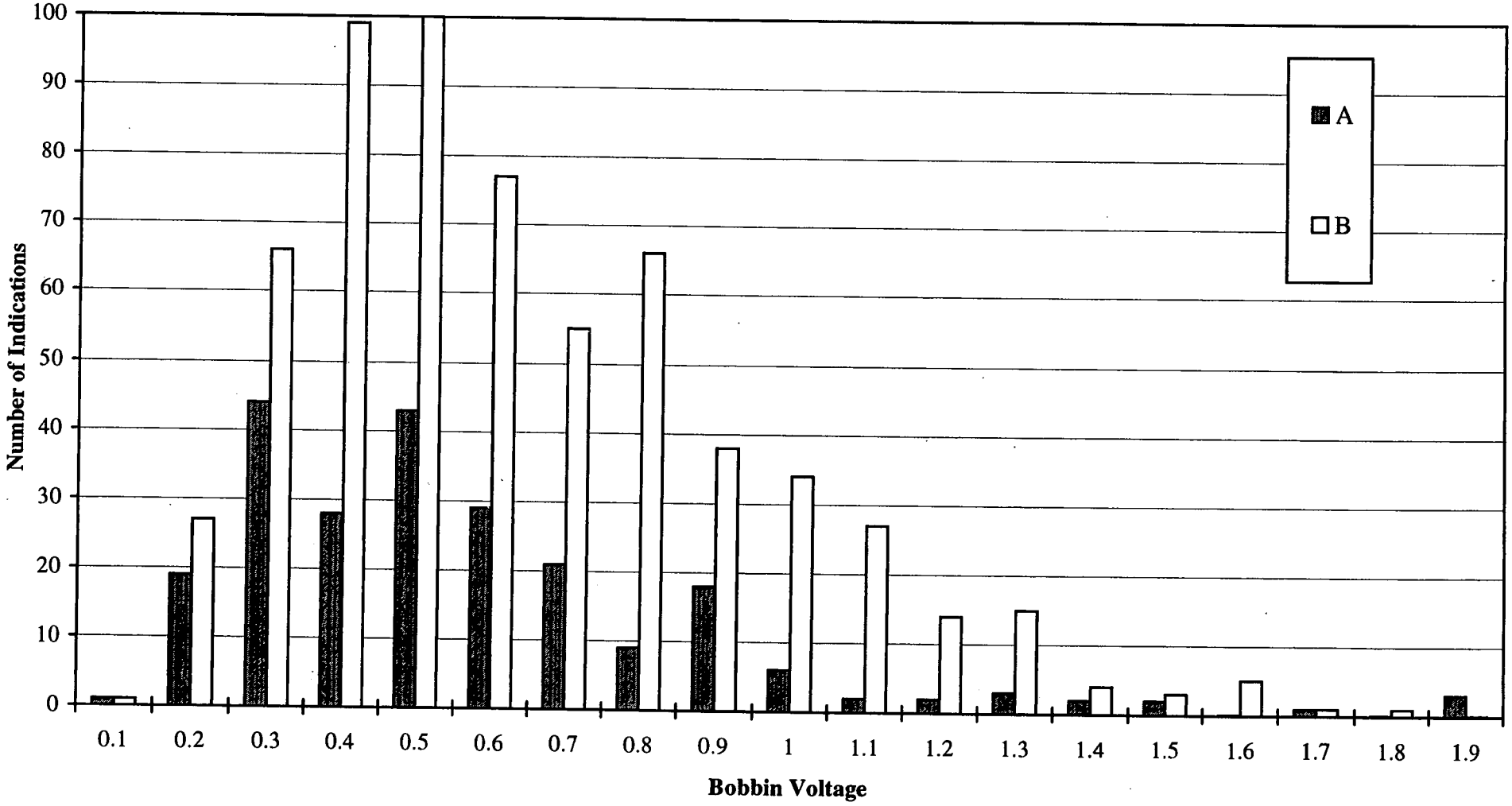
BcbnrpcFig1 7/26/97 3:02 PM

Figure 3-2
Kewaunee October '96 Outage
Bobbin Voltage Distribution for Tubes Plugged After Cycle 21 Service



BobnrpcFig2 8/11/97 3:07 PM

Figure 3-3
Kewaunee October '96 Outage
Bobbin Voltage Distributions for Tubes Returned to Service for Cycle 22



BobnrpcFig3 8/11/97 3:01 PM

Figure 3-4
Kewaunee - October 1996 Outage
ODSCC Axial Distributions for Tubes in Service During Cycle 21

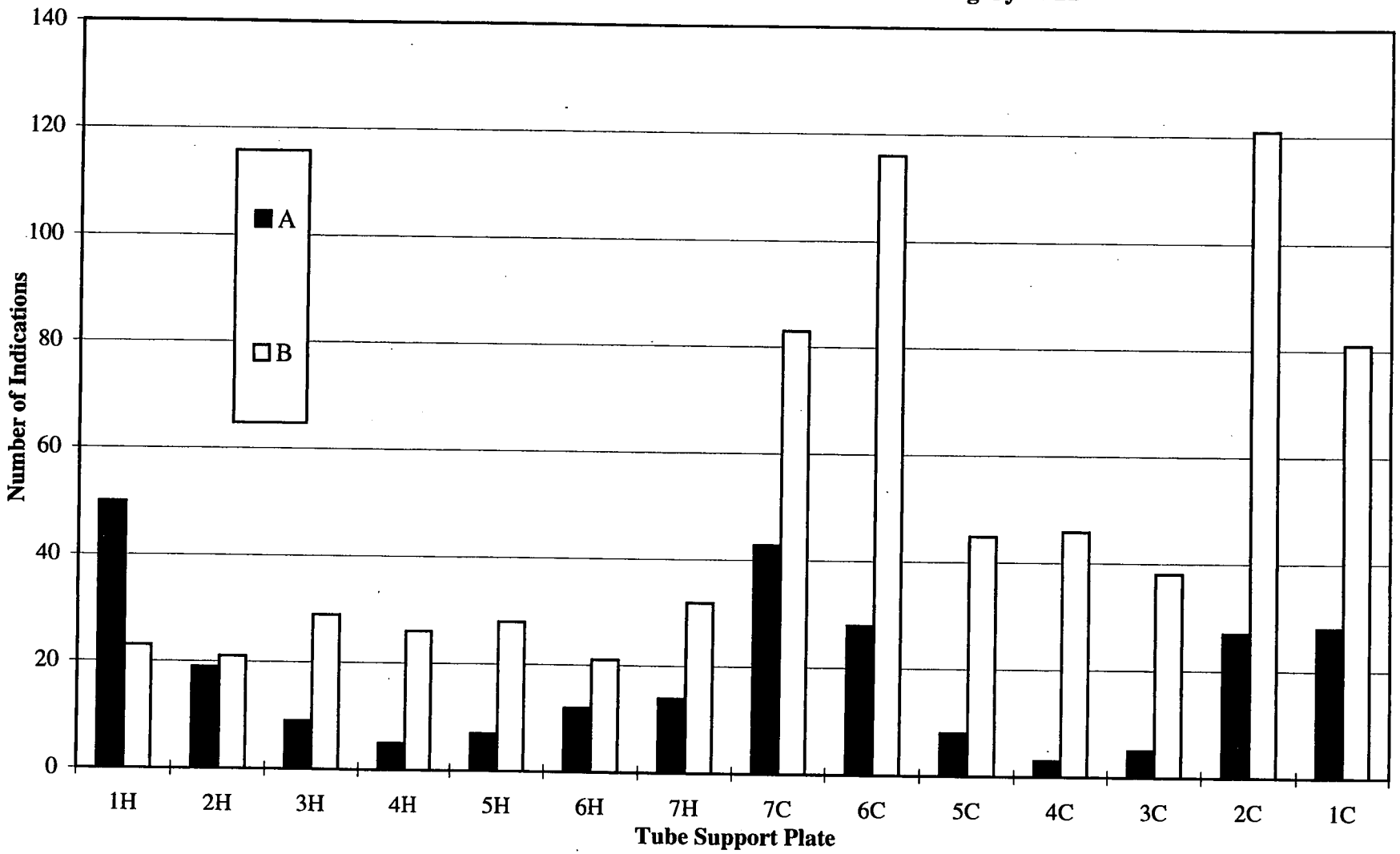
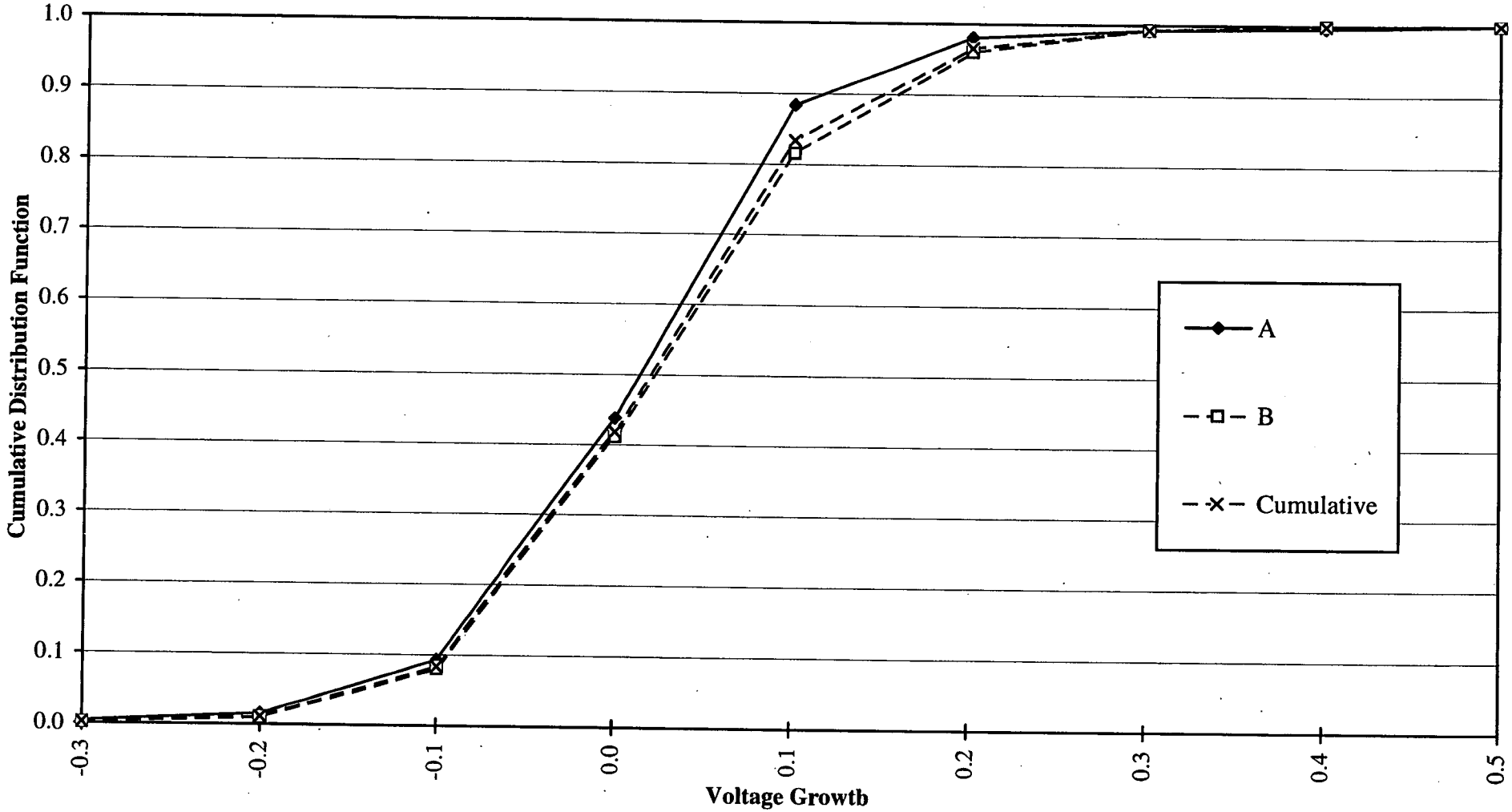


Figure 3-5
Kewaunee Cycle 21 (May 1995 to Sept. 1996)
Cumulative Probability Distributions for Voltage Growth on an EFPY Basis



Growth Fig2 8/11/97 2:29 PM

Figure 3-6
Kewaunee - October 1996
Bobbin Signal Growth History - Cumulative Probability Distributions on an EFPY Basis
Composite of All Steam Generators

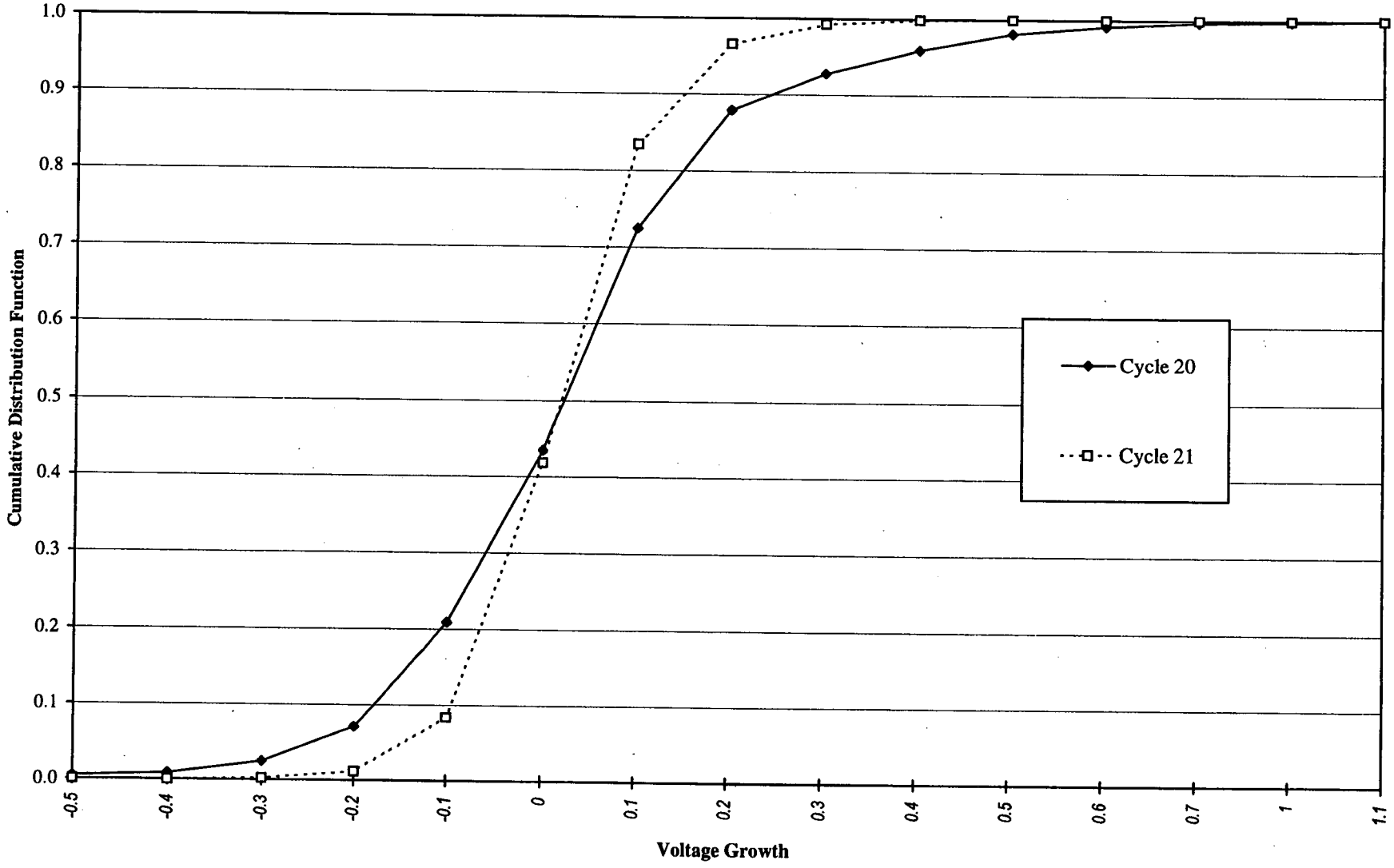


Figure 3-7
Kewaunee October 1996 Inspection (EOC-21)
Cumulative Probability Distributions for Voltage Growth [on an EFPY Basis]

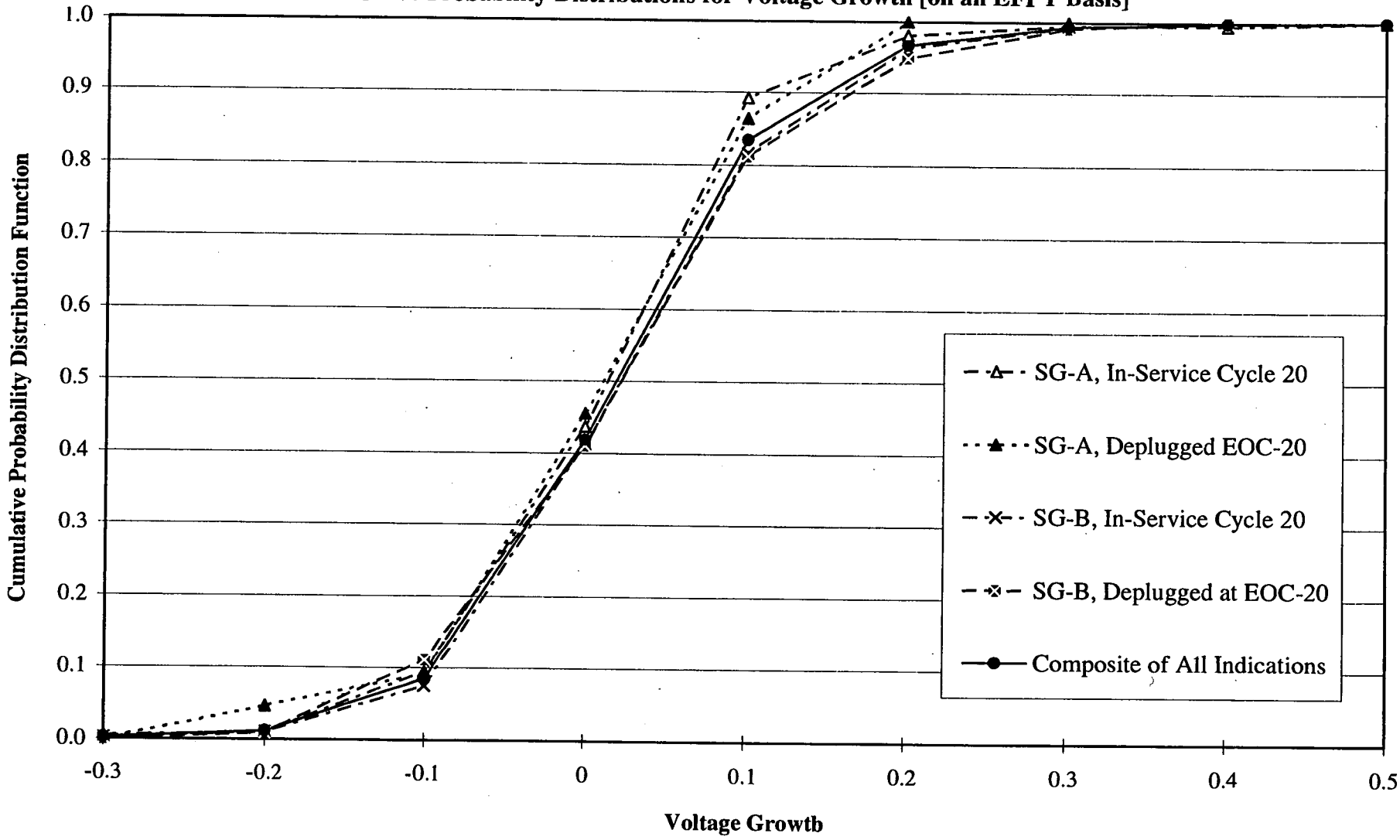


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Figure 3-8
Kewaunee Growth data
Voltage Growth During Cycle 20 vs BOC-20 voltage

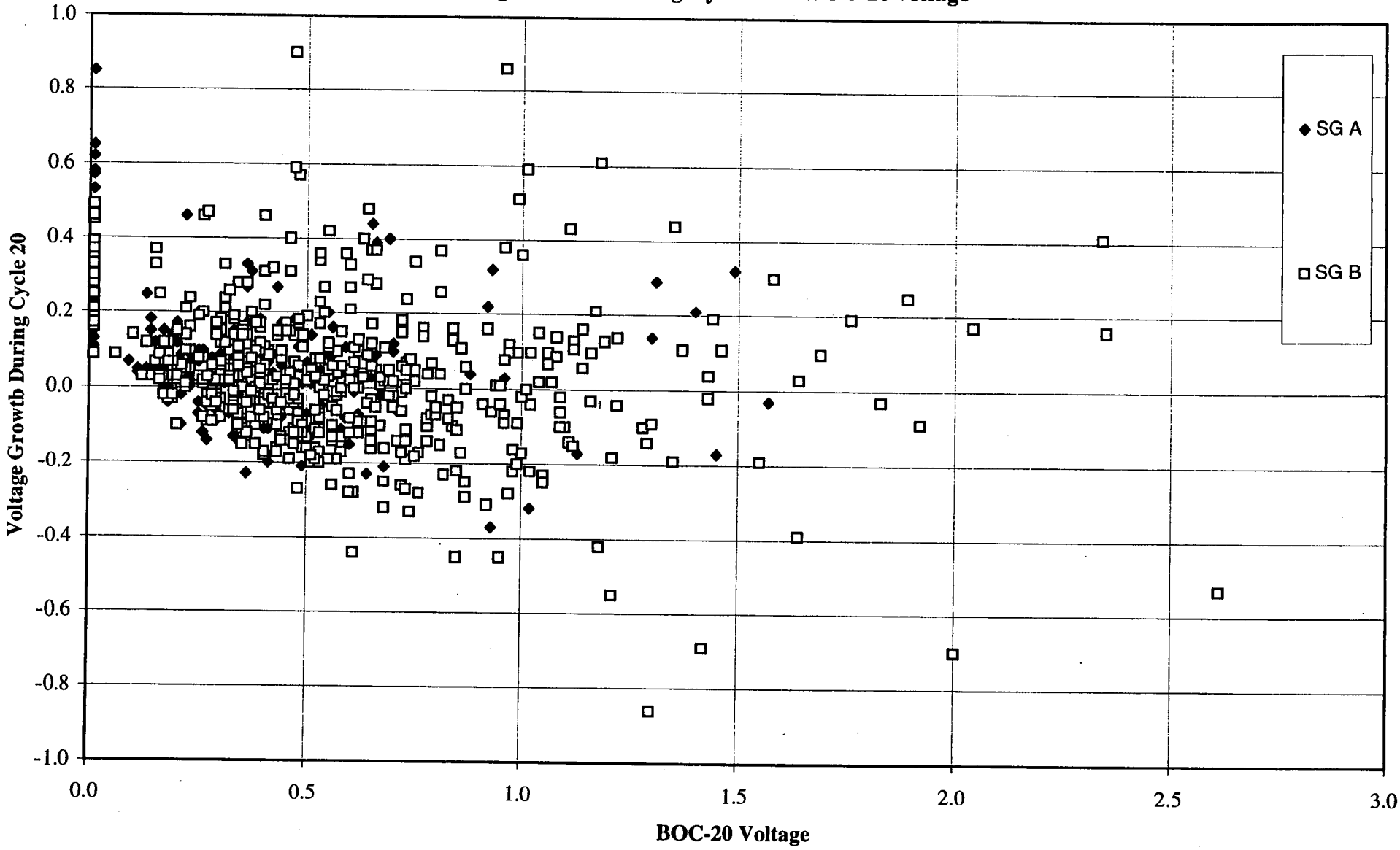

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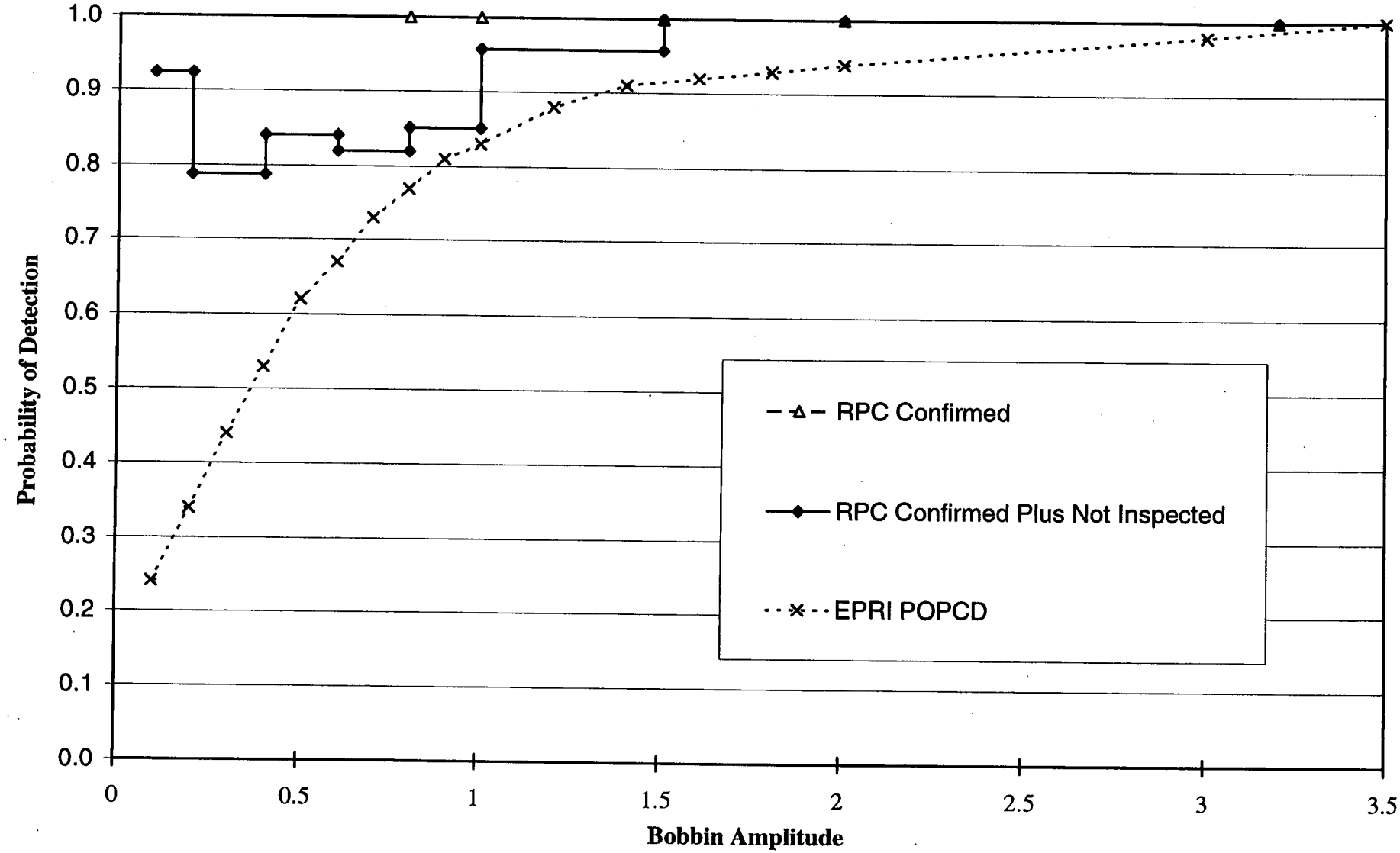
Figure 3-9
Kewaunee 1996
1996 EOC-21 Evaluation for POPCD at EOC-20



PopcdlFigure 1|7/31/97|12:38 PM

4.0 DATA BASE APPLIED FOR ARC CORRELATIONS

Correlations have been developed for the evaluation of ODSCC indications at TSP locations in steam generators of nuclear power plants which relate bobbin voltage amplitudes, free span burst pressure, probability of leakage and associated leak rates. The methodology used to develop these correlations, documented in References 9.3 and 9.5, is consistent with NRC criteria and guidelines of References 9.1 and 9.2.

The database used for the ARC correlations that are applied in the analyses of this report are consistent with the NRC SER applicable to the Kewaunee EOC-21 inspection. This database is documented in Reference 9.7, and it includes Kewaunee pulled tube data. The leak rate values in the database represent room temperature measurement of leakage at prototypic SLB conditions (i.e., leakage at SLB conditions was condensed and measured at room temperature). Therefore, SLB leak rate calculated using ARC correlations provides a volumetric rate at room temperature.

For the SLB leak rate correlation, the NRC recommends that Model Boiler specimen 542-4 and Plant J-1 pulled tube R8C74, TSP1 be included in the database. This database is referred to as the NRC database and is applied for the leak rate analyses of this report. The SLB leak rate data do not satisfy the NRC guidelines for a voltage dependent correlation, as discussed in Section 5.0.

5.0 SLB ANALYSIS METHODS

Monte Carlo analyses are used to predict the EOC-22 voltage distributions and to calculate the SLB leak rates and tube burst probabilities for both the actual EOC-21 voltage distribution and the predicted EOC-22 voltage distribution. These methods are consistent with the requirements of the Kewaunee NRC SER (Reference 9.2) and are described in the generic methods report of WCAP-14277, Revision 1, (Reference 9.3) and are in accord with NRC Generic Letter 95-05 (Reference 9.1).

The NRC SER recommended leak rate database does not satisfy the requirement for applying the SLB leak rate versus bobbin voltage correlation. The NRC requirement is that the p value obtained from the regression for the slope parameter be less than or equal to 5%. For the NRC recommended database, the p value is about 5.6% and therefore a leak rate versus voltage correlation cannot be applied. The licensing basis analyses were carried out using a SLB leak rate correlation based on an average of all leak rate data independent of voltage. The analysis methods for applying this leak rate model are given in Section 4.6 of WCAP-14277 (Reference 9.3). A Monte Carlo analysis is applied to account for parameter uncertainties even though the leak rate is independent of voltage. This method of leak rate analysis is similar to that of draft NUREG-1477 except for the uncertainty treatment. Leak and burst database documented in Reference 9.7 was used in the present Monte Carlo analyses. All calculated leak rates are provided as gpm at room temperature and compared with an allowable leak rate in room temperature gpm.

6.0 BOBBIN VOLTAGE DISTRIBUTIONS

This section describes prediction of EOC voltage distribution used for evaluating tube leak rates and burst probabilities at the end of the operating period. The calculation consists of establishing the initial conditions (i.e., the bobbin indication population distribution) based on eddy current inspection data and projecting the indication growth over the operating period. Since indication growth is considered proportional to operating time, the limiting tube conditions occur at the end of any given time period or cycle.

The bobbin voltage distribution established for the BOC conditions is adjusted for measurement uncertainty using a quantity termed probability of detection, as described in the following paragraphs. Other input used for predicting the EOC voltage distribution and the results are presented below.

6.1 PROBABILITY OF DETECTION

The number of bobbin indications used to predict tube leak rate and burst probability is obtained by adjusting the number of reported indications to account for measurement uncertainty and confidence level in voltage correlations. This is accomplished by using a POD factor. Adjustments are also made for indications either removed from or returned to service. The calculation of projected bobbin voltage frequency distribution is based on a net total number of indications returned to service, defined as:

$$N_{Tot\ RTS} = \frac{N_i}{POD} - N_{Repaired} + N_{deplugged},$$

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 during the previous cycle) reported in the current inspection.

POD = Probability of Detection.

$N_{repaired}$ = Number of N_i which are repaired (plugged) after the last cycle.

$N_{deplugged}$ = Number of previously-plugged indications which are deplugged after the last cycle and are returned to service.

The NRC generic letter (Reference 9.1) requires the application of a POD = 0.6 to define the BOC distribution for the EOC voltage projections, unless an alternate POD is approved by the NRC.

6.2 CYCLE OPERATING TIME

The following operating period values are used in defining growth rates on an EFPY basis shown in this report:

Cycle 20 = 10.5 EFPM Cycle 21 = 15.5 EFPM Cycle 22 = 15.5 EFPM (projected)

6.3 CALCULATION OF VOLTAGE DISTRIBUTIONS

Bobbin voltage projections start with a cycle initial voltage distribution which is projected to the corresponding cycle final voltage distribution, based on the growth rate adjusted for the anticipated cycle operating time period. The overall growth rates for each of the Kewaunee steam generators for the last two operating cycles, as represented by their CPDFs, are shown on Figure 3-6. A Generic Letter 95-05 requirement is that limiting growth rate for the past two cycles of operation should be used in the projections. The 1995 - 1996 operation (Cycle 21) growth rates are slightly below those of the 1994 - 1995 (Cycle 20) operation, and therefore Cycle 20 growth data are used to predict the EOC-22 bobbin voltage distributions. As described in Section 3.4, SG-B growth rates, which are slightly higher the SG-A growth rates, were conservatively applied to both SGs in projecting EOC-22 voltage distributions.

For each SG, the initial bobbin voltage distribution of indications being returned to service for the next cycle (BOC-22) is derived from the actual EOC-21 inspection results adjusted for tubes that are either (a) taken out of service by plugging, or (b) have been recovered for Cycle 22 service by deplugging of tubes plugged in previous outages based on prior repair criteria. The Cycle 22 bobbin voltage population data is summarized on Table 6-1. It shows EOC-21 bobbin voltage indications; the subsequent plugged indications (which were in service for Cycle 21 and then taken out of service, albeit not all for reasons of ODSCC at TSP); those indications recovered for service from previously plugged tubes, which were deplugged during this outage, inspected and returned to service in accordance with applicable tube repair criteria (otherwise they were replugged); and the BOC-22 indications corresponding to a constant POD value of 0.6 and voltage dependent POPCD distribution shown in Table 7-4 of Reference 9.5.

6.4 PREDICTED EOC-22 VOLTAGE DISTRIBUTIONS

The licensing-basis calculation for the predicted EOC-22 bobbin voltage distributions is performed for both SGs with a constant POD value of 0.6 in accordance with NRC direction. In addition, calculations were also performed using the voltage dependent POPCD distribution shown in Reference 9.5. An updated POPCD distribution that includes the latest Kewaunee inspection (EOC-20) data is shown in Section 8, but was not used in the present analysis.

A slightly modified treatment of growth data that yields more conservative results than the method utilized for the last 90-day report was applied to predict the EOC-22 performance. In the previous methodology, growth data supplied in the form of CPDF was treated piece-wise continuous and the data was interpolated to pick growth rates. Such a procedure may not utilize the maximum growth value provided for the simulations at the frequency associated with the growth value. In the modified procedure, growth data is represented by a histogram and all simulations selecting the last growth bin utilize the highest growth rate inputted. Thus the modified procedure yields slightly larger EOC voltages and, thus, more conservative leak and burst results. This level of analysis detail is below that described in the methodology report (Reference 9.3).

The Kewaunee steam generators BOC-22 voltage distributions used to predict the EOC-22 voltages are shown in Table 6-1. As mentioned earlier, SG-B Cycle 20 growth rate data shown in Table 3-4 were applied to both SGs. The EOC-22 voltage distributions thus projected are summarized in Table 6-2. As anticipated, the largest number of indications is predicted for SG-B, about 1116 indications for a constant POD of 0.6. The assumed BOC-22 and the predicted EOC-22 bobbin voltage frequency distributions are also graphically illustrated on Figures 6-1 and 6-2 for both SGs. The maximum bobbin voltage predicted for EOC-22 is 2.9 volts for a constant POD of 0.6, in SG-B, and this value is well below the structural limit of 8.6 volts.

6.5 COMPARISON OF PREDICTED AND ACTUAL EOC-21 VOLTAGE DISTRIBUTIONS

The actual EOC-21 bobbin voltage distributions and the corresponding predictions (performed during the last outage) are compared on Table 6-3 and illustrated on Figure 6-3. SG-B was predicted to be limiting for EOC-21 which is consistent with the actual measurement since this SG has the highest number of indications. The total number of indications detected in SG-B is below the prediction (710 actual vs 981 predicted) for a POD of 0.6, and the largest indication was found in SG-B as

predicted. The actual peak voltage is also well below the prediction (2.24 volts vs. 3.1 volts for SG-B). Projections for a constant POD of 0.6 overpredicted the actual EOC-21 bobbin voltage population in virtually every voltage bin for SGs, which demonstrates conservatism in the projection methodology.

Table 6 - 1
Kewaunee October 1996 Outage
Summary of Inspection and Repair For Tubes in Service During Cycle 21

Voltage Bin	Steam Generator A					Steam Generator B				
	In-Service During Cycle 21		Deplugged Tubes Returned to Service for Cycle 22	BOC-22		In-Service During Cycle 21		Deplugged Tubes Returned to Service for Cycle 22	BOC-22	
	Field Bobbin Indications	Indications Repaired		POD=0.6	POPCD	Field Bobbin Indications	Indications Repaired		POD=0.6	POPCD
0.1	1	0	1	2.67	5.17	2	1	0	2.33	7.33
0.2	21	2	2	35.00	61.76	29	2	0	46.33	83.29
0.3	46	2	1	75.67	103.55	76	10	0	116.67	162.73
0.4	31	3	3	51.67	58.49	102	3	2	169.00	191.45
0.5	47	4	0	74.33	71.81	113	13	0	175.33	169.26
0.6	33	4	2	53.00	47.25	84	7	2	135.00	120.37
0.7	24	3	1	38.00	30.88	65	10	1	99.33	80.04
0.8	13	4	1	18.67	13.88	75	9	3	119.00	91.40
0.9	20	2	0	31.33	22.69	42	4	0	66.00	47.85
1	7	1	0	10.67	7.43	37	3	0	58.67	41.58
1.1	2	0	1	4.33	3.34	28	1	1	46.67	32.75
1.2	2	0	0	3.33	2.27	17	3	0	25.33	16.32
1.3	3	0	1	6.00	4.35	16	1	1	26.67	17.88
1.4	2	0	0	3.33	2.20	5	1	0	7.33	4.49
1.5	2	0	0	3.33	2.19	5	2	0	6.33	3.46
1.6	0	0	0	0	0	6	1	0	9.00	5.52
1.7	1	0	0	1.67	1.08	2	1	0	2.33	1.16
1.8	0	0	0	0	0	1	0	0	1.67	1.08
1.9	3	0	0	5.00	3.21	0	0	0	0	0
2	0	0	0	0	0	1	1	0	0.67	0.06
2.1	0	0	0	0	0	2	2	0	1.33	0.12
2.2	0	0	0	0	0	1	1	0	0.67	0.05
2.3	0	0	0	0	0	1	1	0	0.67	0.05
Total	258	25	13	418.00	441.55	710	77	10	1116.33	1078.26
> 1V	15	0	2	27.00	18.64	85	15	2	128.67	82.95

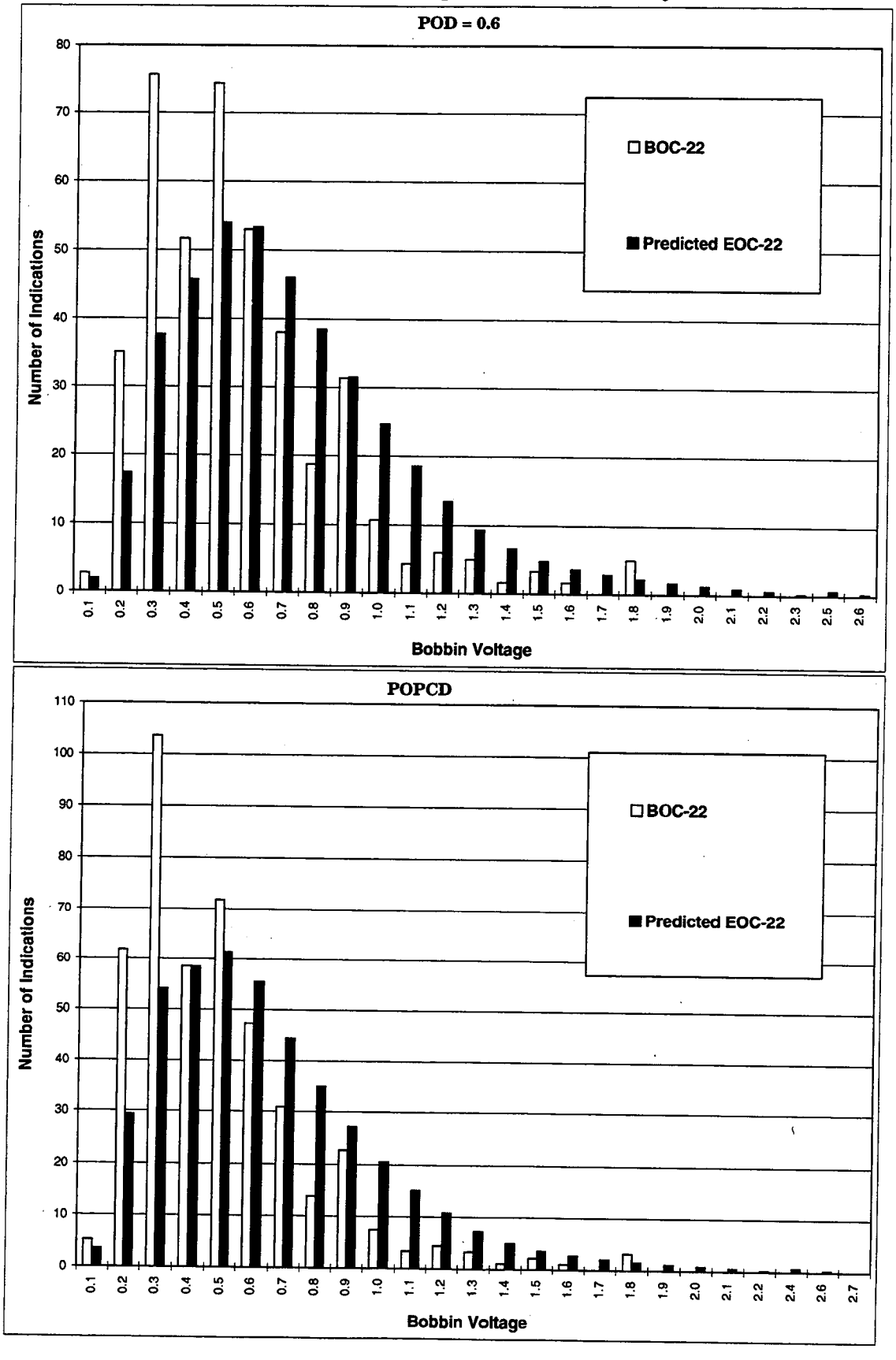
Table 6-2
Kewaunee
Voltage Distribution Projection for EOC - 22

Voltage Bin	Steam Generator A		Steam Generator B	
	Projected Number of Indications at EOC - 22			
	POD 0.6	EPRI POPCD	POD 0.6	EPRI POPCD
0.1	1.90	3.55	2.01	4.95
0.2	17.29	29.31	24.09	40.60
0.3	37.64	54.10	66.89	88.25
0.4	45.78	58.44	112.42	125.27
0.5	54.00	61.38	138.11	139.73
0.6	53.35	55.51	137.37	132.38
0.7	46.10	44.45	125.21	115.66
0.8	38.48	34.96	111.20	97.61
0.9	31.47	27.24	94.90	80.08
1.0	24.64	20.59	77.80	64.73
1.1	18.53	15.17	61.32	51.36
1.2	13.42	10.76	46.91	39.33
1.3	9.37	7.26	34.97	29.13
1.4	6.61	4.98	25.49	20.98
1.5	4.82	3.57	18.21	14.92
1.6	3.68	2.72	12.77	10.62
1.7	2.87	2.11	8.79	7.56
1.8	2.25	1.61	5.97	5.25
1.9	1.74	1.22	4.00	3.53
2.0	1.29	0.89	2.66	2.30
2.1	0.92	0.62	1.78	1.49
2.2	0.64	0.22	1.19	0.96
2.3	0.20	0.00	0.80	0.61
2.4	0.00	0.70	0.49	0.00
2.5	0.70	0	0.00	0.70
2.6	0.30	0.30	0.70	0
2.7	0	0	0	0.30
2.8	0	0	0.30	0
TOTAL	417.99	441.66	1116.35	1078.30
> 1 V	67.34	52.13	226.35	189.04
> 2 V	2.76	1.84	5.26	4.06

Table 6 - 3
Kewaunee
Comparison of Predicted and Actual EOC-21 Bobbin Distributions

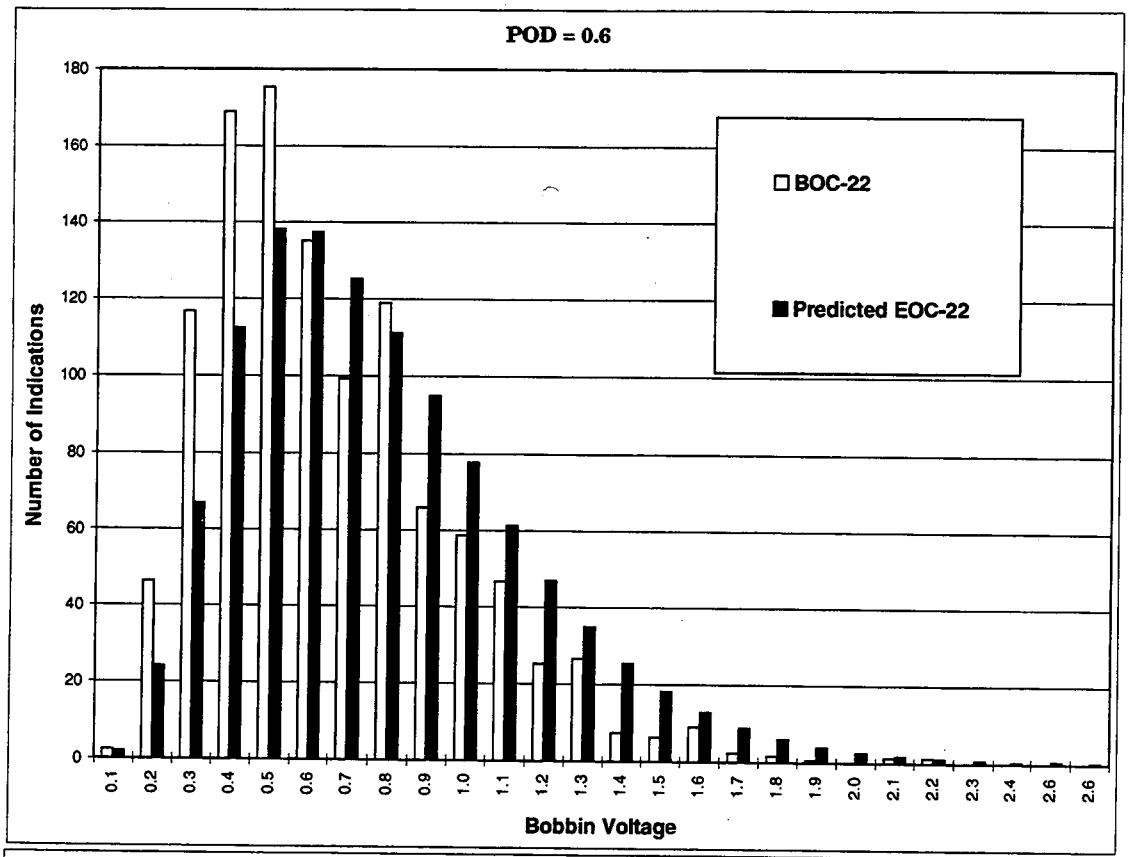
Voltage Bin	Steam Geuerator A		Steam Geuerator B	
	Predicted (POD=0.6)	Actual	Predicted (POD=0.6)	Actual
0.1	0.63	1	2.55	2
0.2	26.15	21	27.6	29
0.3	50.33	46	86.42	76
0.4	62.14	31	122.72	102
0.5	51.1	47	126.85	113
0.6	42.85	33	120.76	84
0.7	39.91	24	102.82	65
0.8	27.69	13	85.14	75
0.9	18.35	20	66.47	42
1	12.84	7	52.23	37
1.1	8.95	2	43.19	28
1.2	6.38	2	35.2	17
1.3	5.04	3	27.79	16
1.4	3.9	2	21.3	5
1.5	2.99	2	15.82	5
1.6	2.48	0	11.26	6
1.7	2.01	1	7.87	2
1.8	1.54	0	5.99	1
1.9	1.14	3	4.96	0
2	0.82	0	3.99	1
2.1	0.41	0	2.94	2
2.2	0	0	2.02	1
2.3	0.7	0	1.38	1
2.4	0	0	0.96	0
2.5	0.3	0	0.7	0
2.6	0	0	0.53	0
2.7	0	0	0.54	0
3	0	0	0.7	0
3.1	0	0	0.3	0
Total	368.65	258	981	710
> 1V	36.66	15	187.44	85
> 2V	0.3	0	3.73	0

Figure 6-1
Kewaunee SG-A
Predicted Bobbin Voltage Distribution for Cycle 22



Predcomp Fig6-1 8/14/97 9:29 AM

Figure 6-2
Kewaunee SG-B
Predicted Bobbin Voltage Distribution for Cycle 22



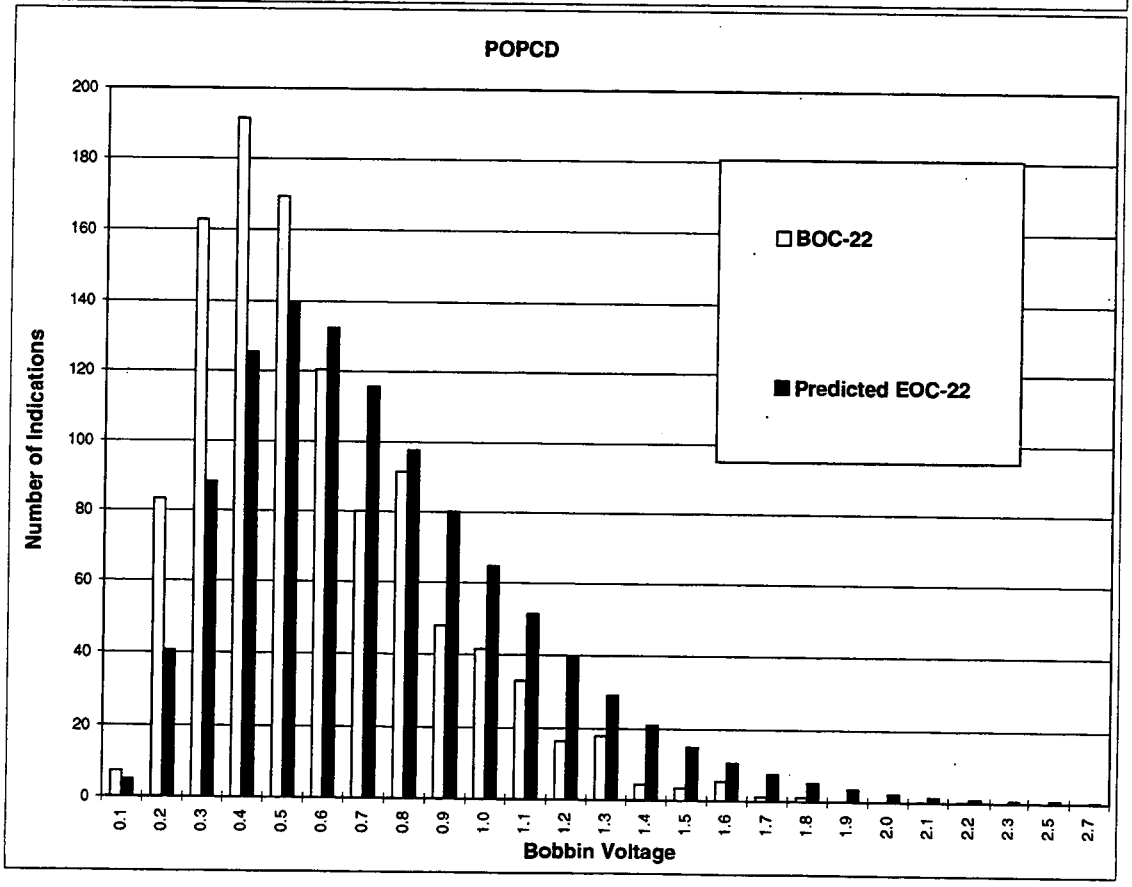
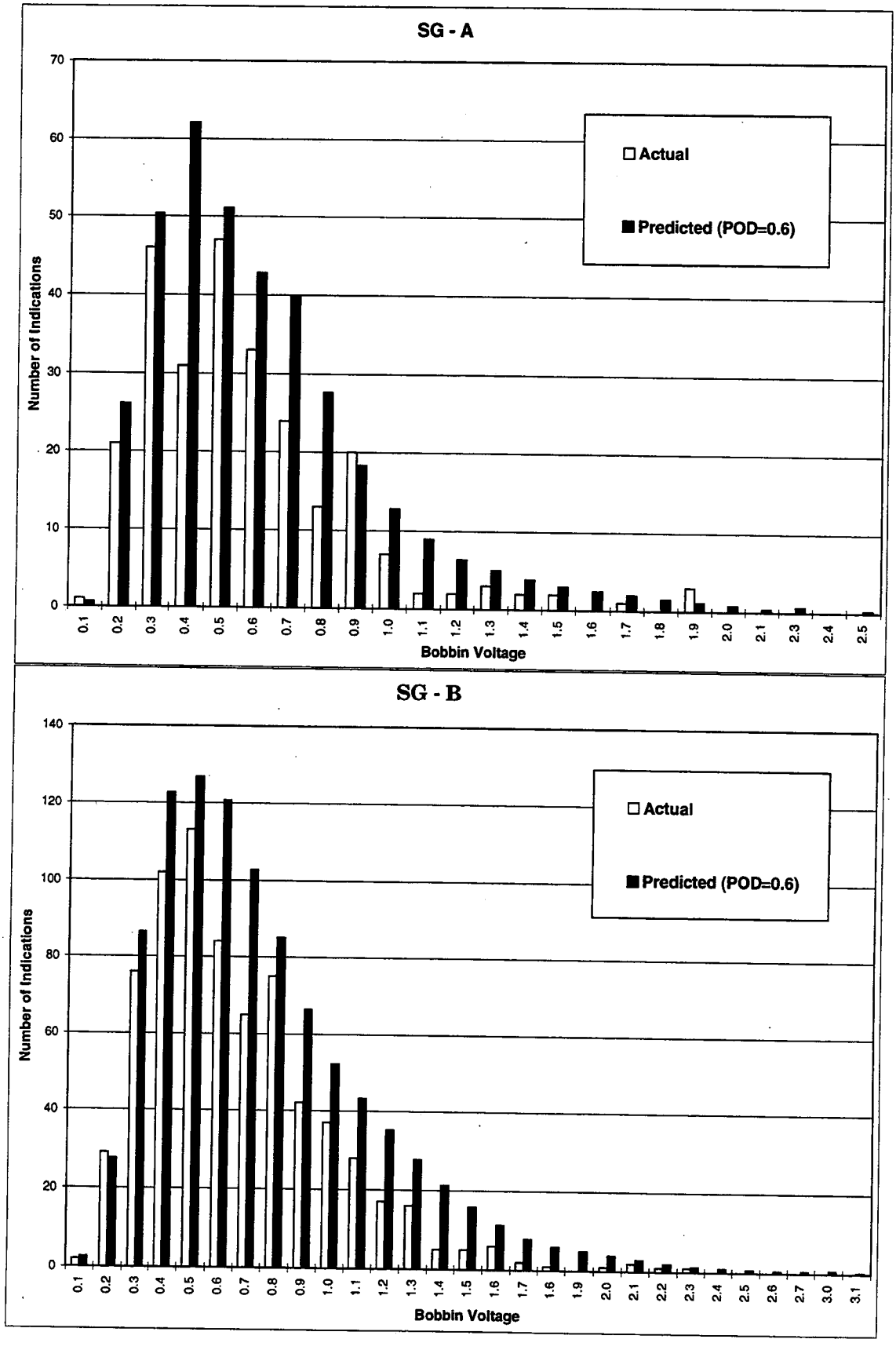


Figure 6-3
Kewaunee
Comparison of Actual and Predicted Bobbin Voltage Distribution for Cycle 21



Predcomp Fig6-3 7/31/97 12:41 PM

7.0 TUBE LEAK RATE AND TUBE BURST PROBABILITIES

7.1 CALCULATION OF LEAK RATE AND TUBE BURST PROBABILITIES

This section discusses tube leak and burst probability analyses using voltage distributions projected for the end of the operating period. The calculation utilizes correlations relating bobbin voltage amplitudes (either measured or calculated) to free span burst pressure, probability of leakage and associated leak rates for ODSCC indications at TSP locations. The methodology used is documented in Reference 9.3, and is consistent with NRC criteria and guidelines of References 9.1 and 9.2.

7.2 PREDICTED AND ACTUAL LEAK RATE AND TUBE BURST PROBABILITY FOR EOC-21

Analyses were performed to calculate EOC-21 SLB tube leak rate and probability of burst based on the actual bobbin voltage distribution from this inspection (presented in Section 3.1). The results of Monte Carlo calculations performed for the actual voltage distributions including NDE uncertainties are compared to the prior predictions based on the EOC-20 data, as shown on Table 7-1. The SLB leak rate values shown in Table 7-1 are equivalent volumetric rates at room temperature

A comparison of the EOC-21 actuals with the corresponding projections indicates the following:

1. For the limiting SG B, the projected peak voltage, leak rate and tube burst probability presented in the last 90-day report (Reference 9.6) are all conservatively higher than the corresponding results based on actual measured EOC-21 voltage distribution.

2. The largest SLB leak rate based on the actual EOC-21 bobbin voltage distributions is calculated for SG-B and its magnitude is 1.2 gpm (at room temperature). The allowable SLB leak limit for Kewaunee Cycle 21 is 34 gpm (22.6 gpm at room temperature). Therefore, the largest calculated leak rate for EOC-21 conditions is well below the allowable limit. The corresponding EOC-21 predicted conditional tube burst probability is 3.1×10^{-5}, and it is also much lower than the NRC reporting guideline of 10^{-2}.

3. The EOC-21 projections provided in the last 90-day report for SG-B with a POD of 0.6 are conservatively high with a leak rate of 2.2 gpm (at room temperature) and burst probability of 1.2×10^{-4}. The corresponding projections based on a voltage-dependent POD from an EPRI study are 1.9 gpm (at room temperature)

and 7.7×10^{-5}, and they are also conservative relative to the values calculated from the measured distribution.

4. The burst probability for the non-limiting SG-A exceeds its projection by a small amount ($< 1.5\times10^{-5}$); a difference of this magnitude may be attributed to different seeds used to generate the random numbers used in Monte Carlo calculations for the two cases and is acceptable.

7.3 PROJECTED LEAK RATE AND TUBE BURST PROBABILITY FOR EOC-22

Using the methodology previously described, calculations were also performed to predict the EOC-22 performance of both steam generators in Kewaunee, and the results are summarized in Table 7-2. EOC-22 bobbin voltage distributions as well as leak rates and tube burst probabilities based on those distributions are predicted. Two sets of results are shown in Table 7-2: one set based on a constant POD of 0.6, and a second set based on the voltage-dependent POPCD.

The EOC-22 predictions shown in Table 7-2 for both SGs meet the ARC acceptance for Kewaunee. As expected, SG-B with largest number of BOC-22 indications and highest Cycle 21 growth rate is predicted to be the limiting SG. The predicted EOC-22 SLB leak rate for SG-B based on the present licensing-basis database and method (constant POD of 0.6 and a leak rate independent of voltage) is 2.9 gpm (at room temperature) which is very small in comparison to the Kewaunee allowable SLB limit of 22.6 gpm at room temperature. The EOC-22 SLB tube burst probabilities for both SGs are well below the NRC reporting guideline for tube burst probability of 1.0×10^{-2}. In summary, the EOC-22 SLB leak rates and tube burst probabilities calculated for both SGs using the present NRC-approved database and method meet the SER limits for Kewaunee.

Table 7-1
Kewaunee EOC-21 Outage
Summary of Calculations of Tube Leak Rate and Burst Probability

Steam Generator	POD	Number of Indications[1]	Max. Volts[2]	Burst Probability		SLB Leak Rate (gpm)
				1 Tube	2 Tubes	
EOC - 21 PROJECTIONS						
A	0.6	369	2.5	$< 4 \times 10^{-6}$	$< 4 \times 10^{-6}$	0.4
B	0.6	981	3.1	1.2×10^{-4}	$< 4 \times 10^{-6}$	2.2
	EPRI	1163	2.8	7.7×10^{-5}	$< 4 \times 10^{-6}$	1.9
	1	607	2.7	4.6×10^{-5}	$< 4 \times 10^{-6}$	1.2
EOC - 21 ACTUALS						
A	1	257	2.3	1.9×10^{-5}	$< 4 \times 10^{-6}$	0.3
B	1	710	2.7	3.1×10^{-5}	$< 4 \times 10^{-6}$	1.2

Note:
(1) Adjusted for POD.
(2) Voltages include NDE uncertainties from Monte Carlo analyses and exceed measured voltages.

Table 7-2
Kewaunee
Summary of Projected Tube Leak Rate and Burst Probability for EOC-22
Leak Rate Independent of Bobbin Voltage

Steam Generator	POD	No. of Indications[1]	Max. Volts	Burst Probability		SLB Leak Rate (gpm)
				1 Tube	One or More Tubes	
EOC - 22 PROJECTIONS[2,3]						
A	0.6	418.0	2.6	3.7×10^{-5}	3.7×10^{-5}	0.9
B		1116.3	2.9	8.6×10^{-5}	8.6×10^{-5}	2.9
A	POPCD	441.7	2.6	3.4×10^{-5}	3.4×10^{-5}	0.7
B		1078.3	2.7	4.9×10^{-5}	4.9×10^{-5}	2.2

Notes

(1) Number of indications adjusted for POD.

(2) Based on a Projected Cycle 22 length of 15.5 EFPM (Actual Cycle 21 duration is 15.5 EFPM)

(3) SG-B Cycle 20 growth rate distribution applied (Cycle 20 growth rates are higher than Cycle 21 growth rates, and SG-B growth rates are larger than the all SG composite growth rates).

8.0 PROBABILITY OF PRIOR CYCLE DETECTION FOR 18 INSPECTIONS IN 8 PLANTS

The evaluation of the POPCD for Kewaunee EOC-20 inspection is described in Section 3.3. At this time, POPCD evaluations are available for 18 inspections at 8 plants, including two evaluations for Kewaunee. The available data include 12 inspections of plants with 7/8" diameter tubing and 6 inspections of plants with 3/4" diameter tubing. This section summarizes these POPCD evaluations for comparison with results of a EPRI study that examined detection probability for a dual analyst team. The POPCD evaluations performed since 1992 show significant improvement over the earlier assessments which represent the first ARC inspections. Bobbin data analysis guidelines (Appendix A guidelines) have been revised since the first inspections to reflect the initial ARC experience. Thus, it is appropriate to assess POPCD for inspections performed since 1992. Fourteen of the 18 inspections for which POPCD has been evaluated were performed since 1992.

Table 8-1 shows the combined POPCD evaluation for plants with 7/8" diameter tubing and includes results for 8 inspections performed since 1992. These data are also plotted in Figure 8-1, and they include data from the present Kewaunee assessment (EOC-20 results representing 1995 inspection) as well as the data for EOC-19 inspection. These results tend to support a POD approaching unity above about 3 volts. The POPCD evaluation in Figure 8-1 is in good agreement with the results of EPRI study on detection probability for a dual analyst team except in the one to two volt range where POPCD is essentially constant at about 0.85 and the EPRI POD study results increases from about 0.83 to about 0.98. The average POPCD independent of voltage is about 0.69 which is significantly higher the NRC Generic Letter 95-05 proposed voltage independent POD of 0.60.

Table 8-2 and Figure 8-2 show the combined POPCD evaluation for the 6 plants with 3/4" tubing and inspections performed since 1992. These results tend to support a POD approaching unity above about 3 volts. The average value is about 0.62. The POPCD assessment is in very good agreement with the results from the EPRI study on detection probability for a dual analyst team.

The definition of POPCD includes indications which were not present at the prior inspection and thus could be expected to be somewhat lower than the EPRI dual analyst detection probability which is based on "expert" evaluations of inspection results and does not include indications clearly below detectable levels.

The combined data for the 14 inspections since 1992 are given in Table 8-3 and Figure 8-3 for RPC confirmed plus not inspected indications. It is seen that the inspections since 1992 yield a POPCD distribution in good agreement with the EPRI dual analyst detection probability which was a 1994 evaluation. POPCD supports a POD approaching unity at about 3.5 volts while the EPRI dual analyst detection probability is about 0.98 at 2 volts and unity at 3 volts. Figure 8-3 also includes POPCD evaluated at the lower 95% confidence limit on the data for individual voltage bins.

The POPCD evaluations shown in Figures 8-1 to 8-3 are based on the definition of "truth" as RPC confirmed plus not RPC inspected indications. Since many of the indications not RPC inspected would be expected to be found NDD if inspected, this represents a lower bound POPCD evaluation. Figure 8-4 shows the POPCD evaluation for all 14 inspections since 1992 based only on RPC confirmed indications. This results in a significant increase in POPCD below 1.0 volt and a modest increase above 1.0 volt. The data of Table 8-3 show 600 to 22,000 indications in all voltage bins below 2 volts, more than 250 between 2.0 and 3.2 volts and about 5 indications above about 3.2 volts. Thus, the collective data provide a substantial database for defining a POD.

The results of Figure 8-3 clearly support an increase in the POD for ARC applications above the POD = 0.6, independent of voltage, required by NRC Generic Letter 95-05. For indications above 1.0 volt, the POD exceeds 0.9 and is 0.97 to near unity at 2.0 volts. A POD of 0.6 is only applicable to indications below about 0.6 volts.

A voltage dependent POD distribution has been developed for ARC application by evaluating POPCD at the lower 95% confidence level and the mid-voltage of each voltage bin. The result is then smoothed to obtain the POPCD distribution as shown in Figure 8-5. This POPCD distribution is tabulated in Table 8-4 and compared with the EPRI dual analyst detection probability in Figure 8-6. Table 8.4 shows both the POPCD distribution presented originally in Reference 9.5 and the updated POPCD distribution presented in this section which includes results for 4 more inspections including the Kewaunee EOC-21 inspection. Although the updated distribution includes data from another 7000 indications, the difference between the two sets of POPCD does not exceed 0.01 which provides confidence that the POPCD distribution is based on a sufficiently large database.

Table 8-1
Evaluation for POPCD for Plants witb 7/8'' SG Tubes
Combined Data from 8 Post-92 ('93 and later) Inspections

Voltage Bin	New Indications		Bobbin Call in Both Inspections		First Inspection	POPCD			
	RPC Confirmed	RPC Confirmed plus not Inspected	RPC Confirmed	RPC Confirmed plus not Inspected	Confirmed and Plugged	RPC Confirmed		RPC Confirmed Plus Not Inspected	
						Frac.	Count	Frac.	Ccunt
>0 - 0.2	2	140	0	110	5	0.714	5 / 7	0.451	115 / 255
0.2 - 0.4	8	806	3	823	70	0.901	73 / 81	0.526	893 / 1699
0.4 - 0.6	13	867	10	1399	152	0.926	162 / 175	0.641	1551 / 2418
0.6 -0 .8	13	524	20	1346	124	0.917	144 / 157	0.737	1470 / 1994
0.8 - 1.0	10	250	28	891	72	0.909	100 / 110	0.794	963 / 1213
1.0 - 1.2	17	116	42	464	91	0.887	133 / 150	0.827	555 / 671
1.2 - 1.6	19	79	88	362	79	0.898	167 / 186	0.848	441 / 520
1.6 - 2.0	9	18	50	82	35	0.904	85 / 94	0.867	117 / 135
2.0 - 2.2	0	0	11	11	8	1.000	19 / 19	1.000	19 / 19
2.2 - 2.5	2	2	4	4	4	0.800	8 / 10	0.800	8 / 10
2.5 - 3.2	0	0	5	5	12	1.000	17 / 17	1.000	17 / 17
3.2 - 3.5	0	0	0	0	0	-	0 / 0	-	0 / 0
TOTAL	93	2802	261	5497	652				
Total > 1V	47	215	200	928	229				

Table 8-2
Evaluation for POPCD for Plants with 3/4'' SG Tubes
Combined Data from 6 Post-92 ('93 and later) Inspections

Voltage Bin	New Indications		Bobbin Call in Both Inspections		First Inspection	POPCD			
	RPC Confirmed	RPC Confirmed plus not Inspected	RPC Confirmed	RPC Confirmed plus not Inspected	RPC Confirmed and Plugged	RPC Confirmed		RPC Confirmed Plus Not Inspected	
						Frac.	Count	Frac.	Count
> 0 - 0.2	12	1238	1	494	0	0	1 / 13	0.285	494 / 1732
0.2 - 0.4	112	5095	28	3661	32	0.349	60 / 172	0.420	3693 / 8788
0.4 - 0.6	119	3330	148	5054	93	0.669	241 / 360	0.607	5147 / 8477
0.6 -0 .8	96	1275	343	3858	120	0.828	463 / 559	0.757	3978 / 5253
0.8 - 1.0	90	483	470	2381	114	0.866	584 / 674	0.838	2495 / 2978
1.0 - 1.2	51	148	211	844	884	0.955	1095 / 1146	0.921	1728 / 1876
1.2 - 1.6	39	82	245	482	778	0.963	1023 / 1062	0.939	1260 / 1342
1.6 - 2.0	6	9	82	87	246	0.982	328 / 334	0.974	333 / 342
2.0 - 2.2	3	3	17	17	54	0.959	71 / 74	0.959	71 / 74
2.2 - 2.5	1	1	9	9	42	0.981	51 / 52	0.981	51 / 52
2.5 - 3.2	2	2	9	9	67	0.974	76 / 78	0.974	76 / 78
3.2 - 3.5	0	0	0	0	5	1.000	5 / 5	1.000	5 / 5
TOTAL	531	11666	1563	16896	2435				
Total > 1V	102	245	573	1448	2076				

Table 8-3
Combined POPCD Evaluation for 14 Assessments Conducted After 1992
POPCD Based on RPC Confirmed Plus Not Inspected Indications

Voltage Bin	New Indications		Bobbin Call In Both Inspections		First Inspection	POPCD			
	RPC Confirmed	RPC Confirmed plus not Inspected	RPC Confirmed	RPC Confirmed plus not Inspected	RPC Confirmed and Plugged	RPC Confirmed		RPC Confirmed Plus Not Inspected	
						Frac.	Count	Frac.	Count
> 0 - 0.2	14	1378	1	604	5	0.300	6 / 20	0.306	609 / 1987
0.2 - 0.4	120	5901	31	4484	102	0.526	133 / 253	0.437	4586 / 10487
0.4 - 0.6	132	4197	158	6453	245	0.753	403 / 535	0.615	6698 / 10895
0.6 -0 .8	109	1799	363	5204	244	0.848	607 / 716	0.752	5448 / 7247
0.8 - 1.0	100	733	498	3272	186	0.872	684 / 784	0.825	3458 / 4191
1.0 - 1.2	68	264	253	1308	975	0.948	1228 / 1296	0.896	2283 / 2547
1.2 - 1.6	58	161	333	844	857	0.954	1190 / 1248	0.914	1701 / 1862
1.6 - 2.0	15	27	132	169	281	0.965	413 / 428	0.943	450 / 477
2.0 - 2.2	3	3	28	28	62	0.968	90 / 93	0.968	90 / 93
2.2 - 2.5	3	3	13	13	46	0.952	59 / 82	0.952	59 / 62
2.5 - 3.2	2	2	14	14	79	0.979	93 / 95	0.979	93 / 95
3.2 - 3.5	0	0	0	0	5	1.0	5 / 5	1.0	5 / 5
TOTAL	624	14468	1824	22393	3087				
Total > 1V	149	460	773	2376	2305				

Table 8-4
Comparison of EPRI POPCD with EPRI POD Study

Voltage Bin	EPRI# POD Study	EPRI POPCD	
		NP-7480-L Addendum-1	Updated
0.1	0.30	0.24	0.24
0.2	0.38	0.34	0.34
0.3	0.49	0.44	0.43
0.4	0.57	0.53	0.52
0.5	0.62	0.62	0.61
0.6	0.66	0.67	0.67
0.7	0.71	0.73	0.73
0.8	0.76	0.77	0.77
0.9	0.80	0.81	0.81
1	0.83	0.83	0.83
1.2	0.90	0.88	0.87
1.4	0.93	0.91	0.90
1.6	0.96	0.92	0.91
1.8	0.98	0.93	0.92
2	0.984	0.94	0.93
3	1.00	0.98	0.98
3.5	1.00	1.0	1.0

Dual analyst detection probability study

Figure 8-1
Combined POPCD Evaluation for 8 Post-92 Inspections for 7/8" Dia Plants
POPCD Based on RPC Confirmed Plus Not Inspected Indications

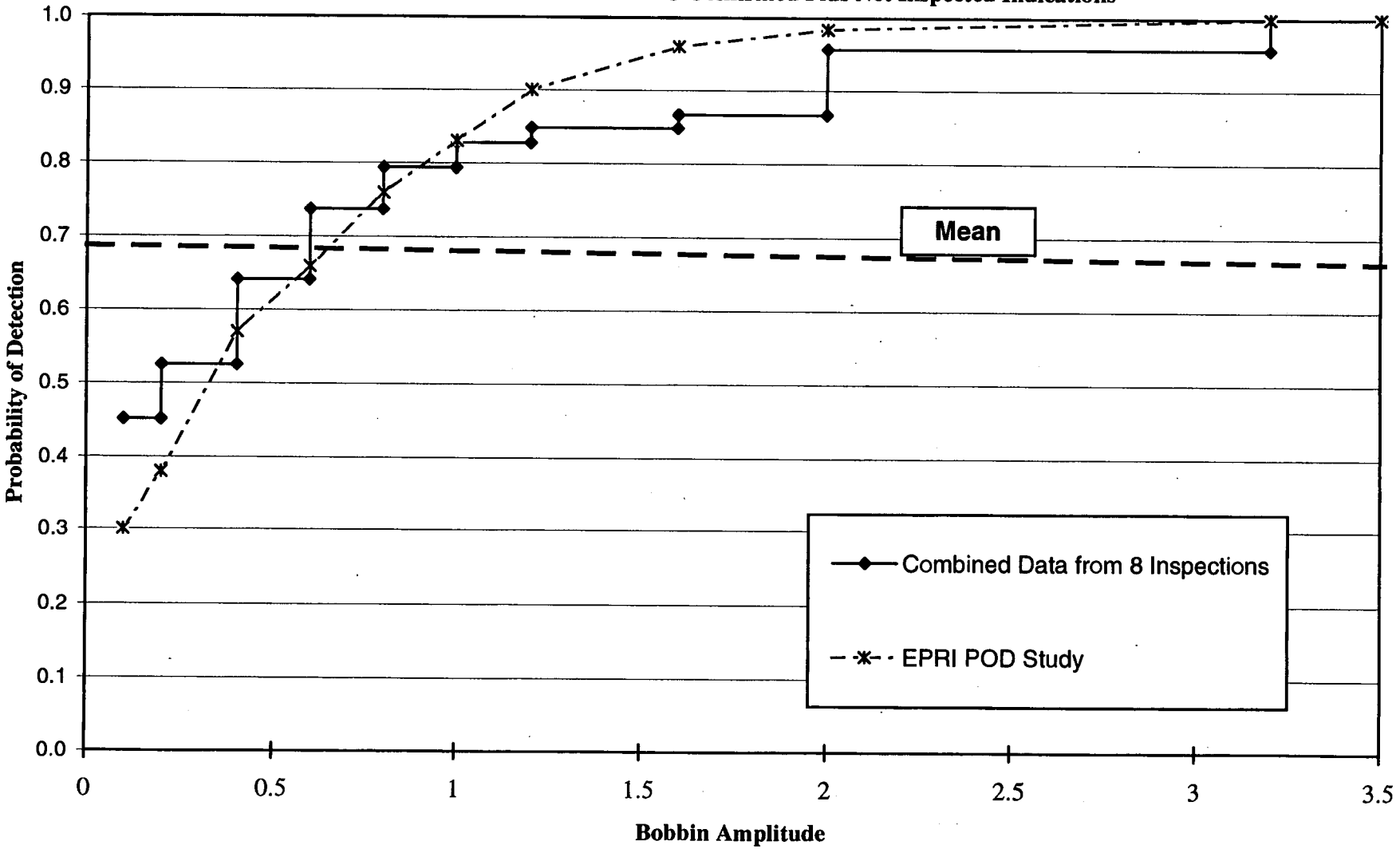


Figure 8-2
Combined POPCD Evaluation for 6 Post-92 Inspections for 3/4" Dia Plants
POPCD Based on RPC Confirmed Plus Not Inspected Indications

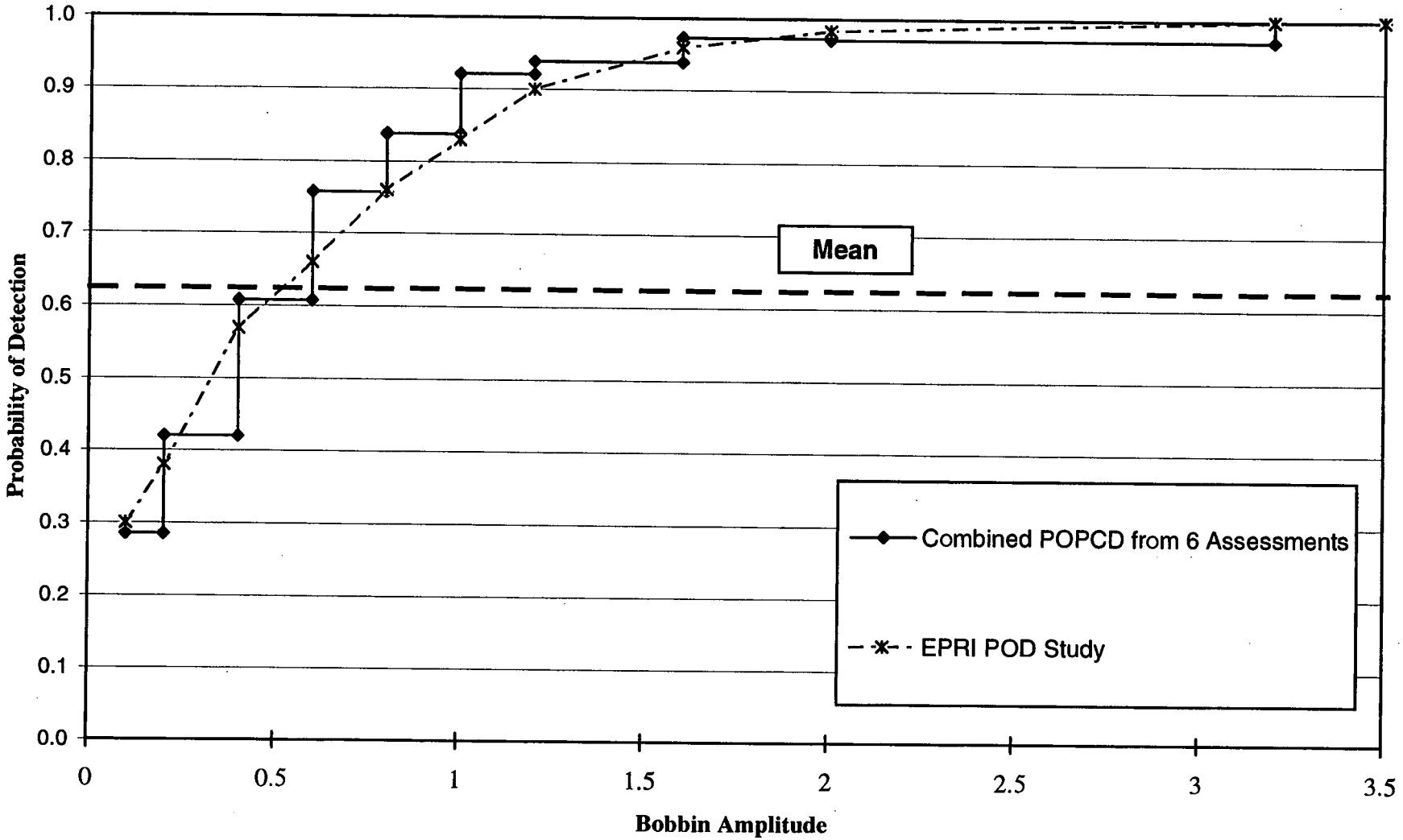


Figure 8-3
Combined POPCD Evaluatiou for 14 Post-'92 Inspections
POPCD Based on RPC Confirmed Plus Not Inspected Indications

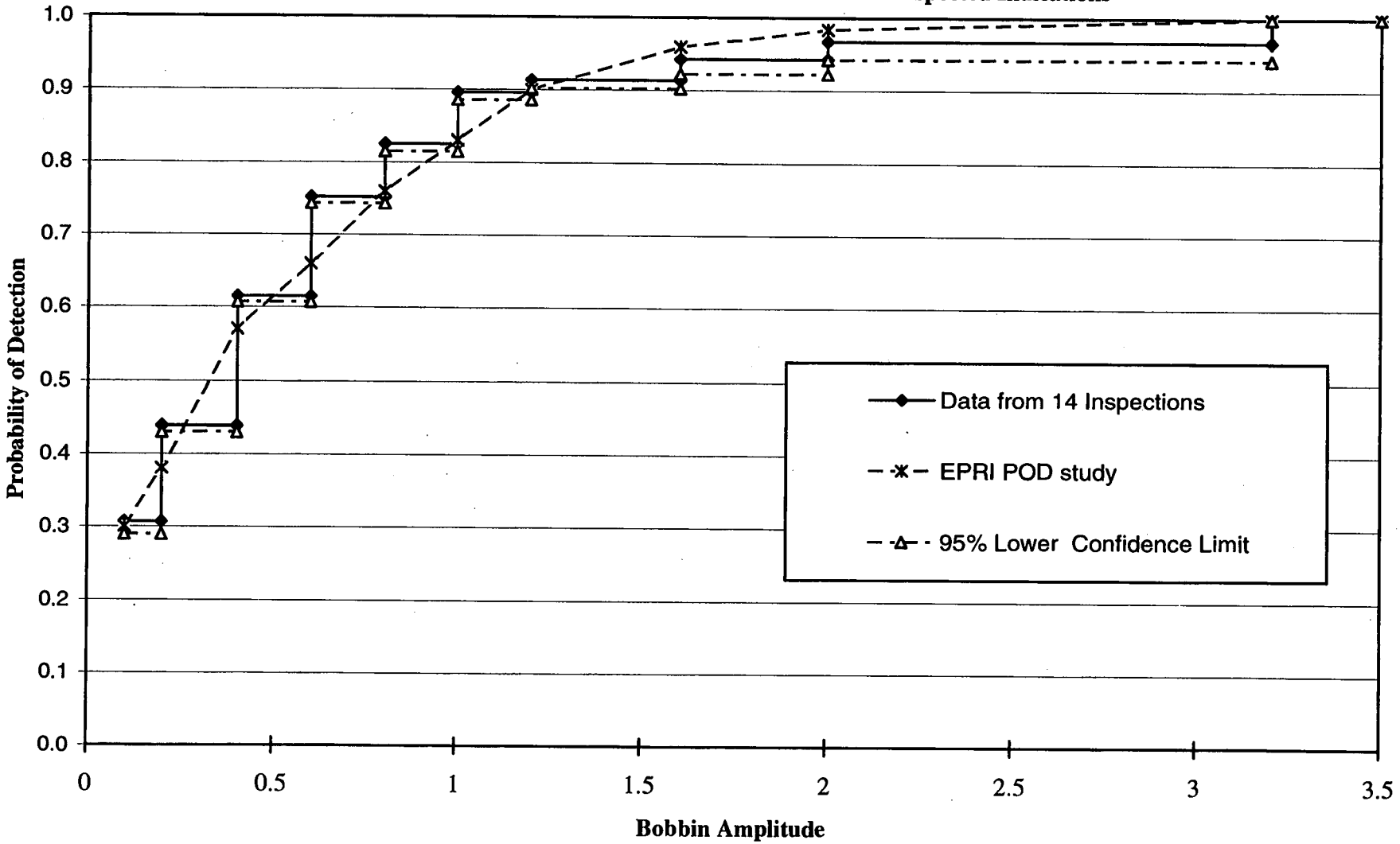


Figure 8-4
Combined POPCD Evaluation for 14 Post-'92 Iuspectious
POPCD Based on RPC Confirmed Indications Only

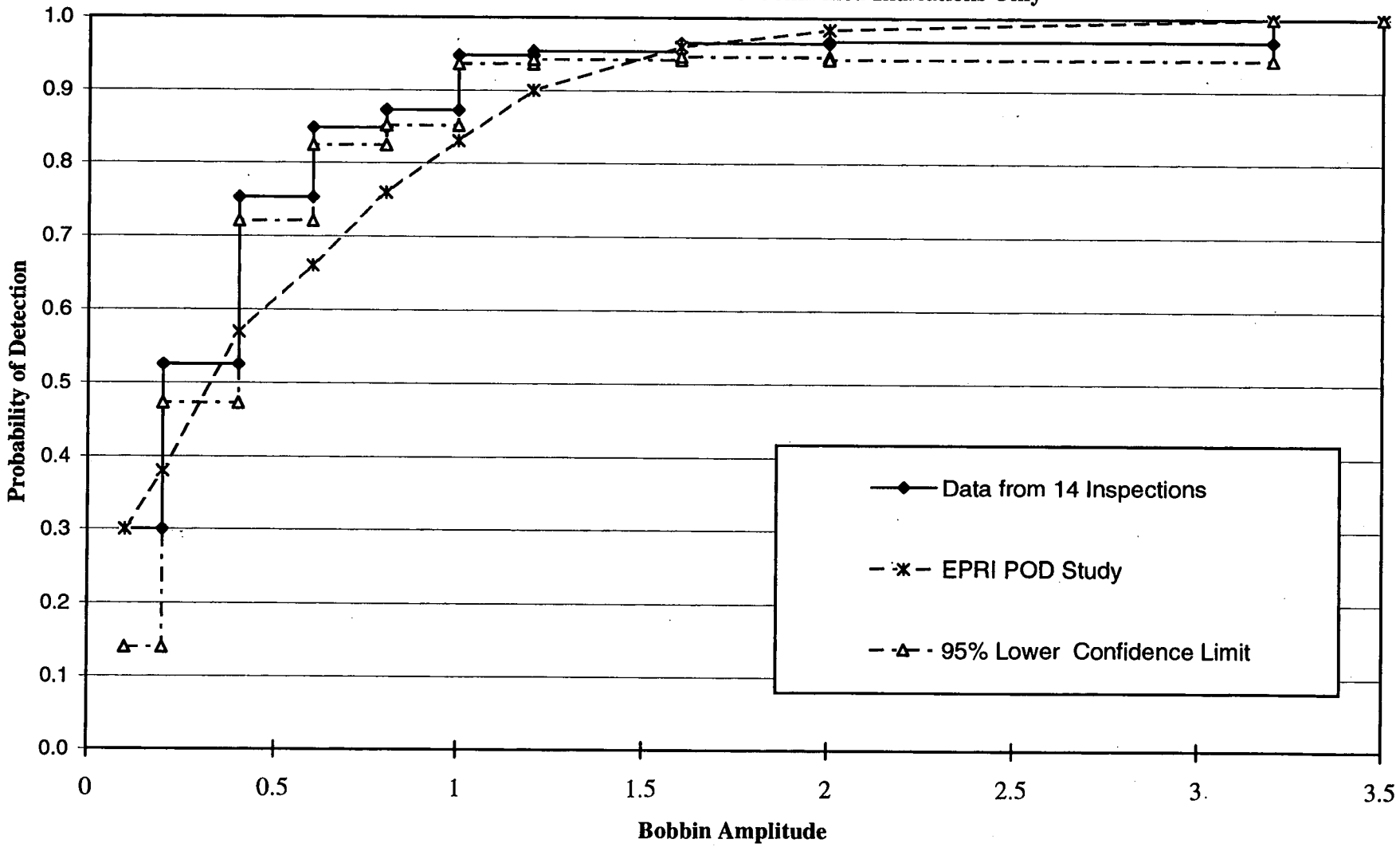


Figure 8-5
Combined POPCD Evaluation for 14 Post-'92 Inspections
POPCD Based on RPC Confirmed Plus Not Inspected Indications

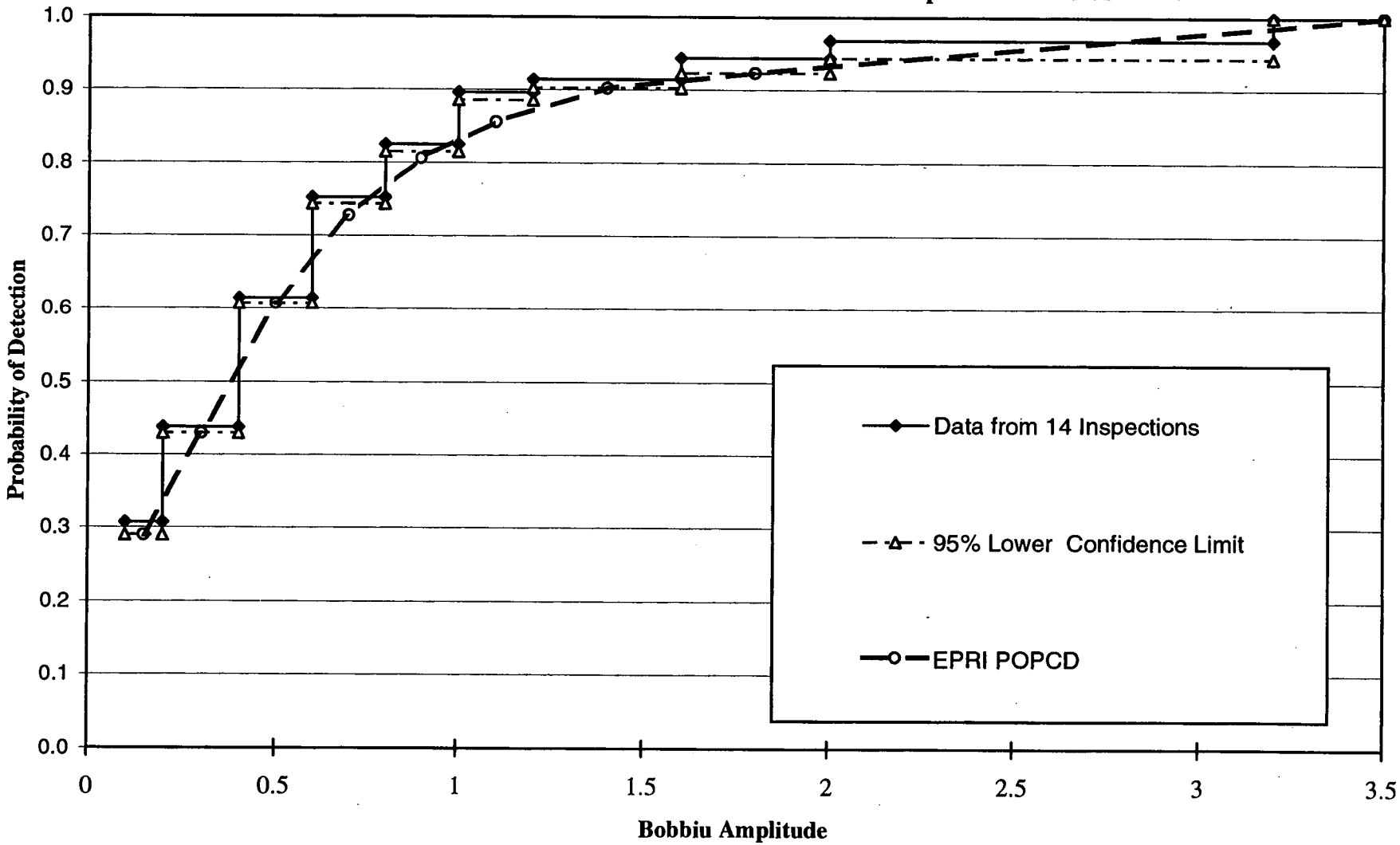
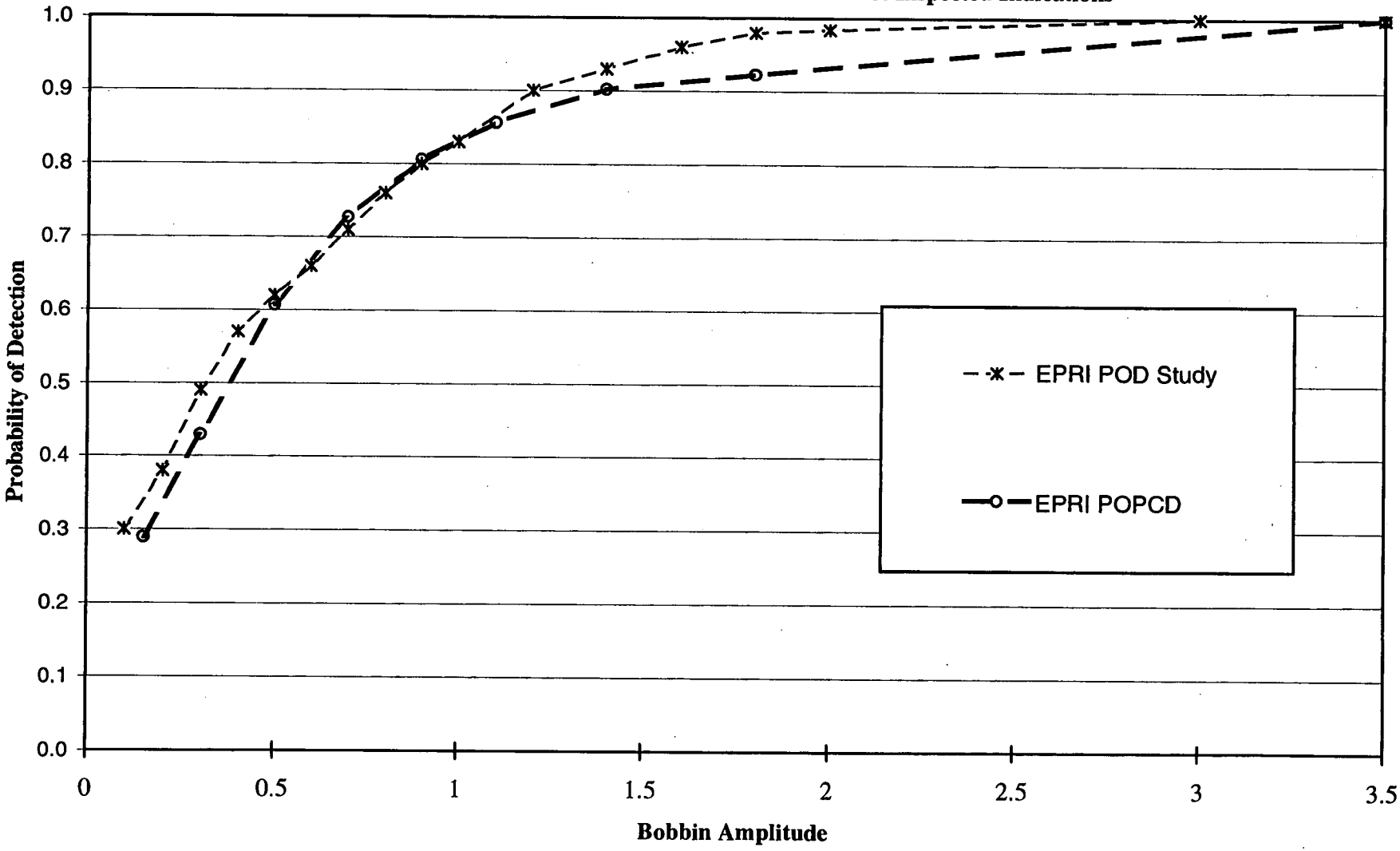


Figure 8-6
Comparisou Alternate POPCD with EPRI POD
POPCD Based on RPC Confirmed Plus Not Inspected Indications



Popcdt&flFig8-6l7/30/97l3:24 PM

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9.4 SG-97-03-001, "Farley Unit-2, 1996 Alternate Repair Criteria 90 Day Report," Westinghouse Electric Corporation, March 1997.

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9.7 NSD-SGD-1212, "EPRI ARC Databases for 3/4" and 7/8" Dia. Tubes and Updated ARC Correlation for 7/8" Dia. Tubes," Westinghouse memorandum dated February 26, 1996 transmitted to Duquesne Light Company and Tennessee Valley Authority.