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

Subject: Beaver Valley Power Station, Unit No. 1 and No. 2
BV-1 Docket No. 50-334, License No. DPR-66
Cycle 16 Steam Generator Tube Inspection 90 Day Report

Reference 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," August 3, 1995.

Enclosed is a copy of the "Beaver Valley Unit 1, Cycle 16 Voltage-Based Repair Criteria 90 Day Report," which supports continued implementation of the 2.0 volt repair criteria as outlined in Reference 1. This report provides a summary of the steam generator inspections performed during the fifteenth refueling outage at tube support plate intersections along with postulated steam line break leak rate and tube burst probability analysis results.

The NRC issued a request for additional information (RAI) dated June 4, 2003, pertaining to various previously submitted reports summarizing the steam generator tube inspections performed during the 1R15 and 2R09 refueling outages at Beaver Valley Power Station (BVPS) Units 1 and 2, respectively. The appendix to the enclosed "Beaver Valley Unit 1, Cycle 16 Voltage-Based Repair Criteria 90 Day Report" provides the FirstEnergy Nuclear Operating Company (FENOC) response to the requested information in Enclosure 3 from the NRC letter dated June 4, 2003, for BVPS Unit 1 regarding follow-up questions from the 1R15 steam generator outage conference call. The FENOC responses to the requested information in Enclosures 1 and 2 from the NRC letter dated June 4, 2003 were previously provided in FENOC letter L-03-110, dated July 18, 2003.

A047

New regulatory commitments are listed in Attachment 1. If there are any questions concerning this matter, please contact Mr. Larry R. Freeland, Manager, Regulatory Affairs/Performance Improvement at 724-682-5284.

Sincerely,

Thomas S Cosgrove for

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Attachments

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SG-SGDA-03-25

BEAVER VALLEY UNIT - 1

CYCLE 16 VOLTAGE-BASED REPAIR CRITERIA 90-DAY REPORT

July 2003

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SG-SGDA-03-25

BEAVER VALLEY UNIT - 1

CYCLE 16 VOLTAGE-BASED REPAIR CRITERIA 90-DAY REPORT

July 2003

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Table of Contents

		Page No.
1.0	Introduction	1-1
2.0	Summary and Conclusions	2-1
3.0	EOC-15 Inspection Results and Voltage Growth Rates	3-1
	3.1 EOC-15 Inspection Results	3-1
	3.2 Voltage Growth Rates	3-2
	3.3 Probe Wear criteria	3-3
	3.4 NDE Uncertainties	3-4
	3.5 Probability of Prior Cycle Detection (POPCD)	3-5
	3.6 Assessment of RPC Confirmation Rates	3-6
4.0	Database Applied for Leak and Burst Correlations	4-1
5.0	SLB Analysis Methods	5-1
6.0	Bobbin Voltage Distributions	6-1
	6.1 Calculation of Voltage Distributions	6-1
	6.2 Probability Of Detection (POD)	6-2
	6.3 Limiting Growth Rate Distribution	6-2
	6.4 Cycle Operating Period	6-3
	6.5 Projected EOC-16 Voltage Distributions	6-3
	6.6 Comparison of Actual and Projected EOC-15 Voltage Distributions	6-3
7.0	SLB Leak Rate and Tube Burst Probability Analyses	7-1
	7.1 EOC-15 Condition Monitoring Leak Rate and Tube Burst Probability	7-1
	7.2 Cycle 16 Operational Assessment Leak Rate and Tube Burst Probability	7-2
8.0	References	8-1
Appendix	Response to the NRC's Request for Additional Information (RAI) As Requested in the NRC Letter (Colburn to Pearce) Enclosure 3 Dated June 4, 2003	A-1

Beaver Valley Unit - 1
Cycle 16 Voltage-Based Repair Criteria
90-Day Report

1.0 Introduction

This report provides a summary of the Beaver Valley Unit-1 steam generator (SG) bobbin and RPC (+Pt) probe inspections at tube support plate (TSP) intersections together with postulated Steam Line Break (SLB) leak rate and tube burst probability analysis results. These results support continued implementation of the 2.0 volt voltage-based repair criteria for Cycle 16 as outlined in the NRC Generic Letter 95-05 (Reference 8-1). Information required by the Generic Letter is provided in this report including SLB leak rates and tube burst probabilities calculated using the end of cycle (EOC) conditions for the recently completed cycle (EOC-15 condition monitoring analysis) and projection of bobbin voltage distributions, leak rates and burst probabilities for the ongoing cycle (Cycle 16 operational assessment).

Condition monitoring analysis at EOC-15 was carried out using the actual bobbin voltage distributions measured during the EOC-15 outage and the results compared with corresponding values from the projections performed based on the last (EOC-14) bobbin voltage data (presented in Reference 8-2). These evaluations utilized the Westinghouse generic Monte Carlo methodology presented in Reference 8-3.

Operational assessment analysis was performed to project leak rates and tube burst probabilities for postulated SLB conditions at the end of the ongoing cycle (Cycle 16) based on the 2.0 volt repair criteria. These analyses utilized bobbin voltage distributions measured during the recent (EOC-15) inspection and a limiting growth rate distribution from the last two inspections (EOC-14 and EOC-15 inspections). Leak and burst analyses for operational assessment were performed using a primary-to-secondary pressure differential of 2405 psi since credit can be taken for operability of pressurizer PORV during a SLB event (Reference 8-7).

During the EOC-15 inspection, several conference calls were held between the Beaver Valley Unit-1 plant engineers and NRC to discuss the approach used to detect and disposition large mix residual signals (i.e., of sufficient magnitude to cause a 1.0 volt ODSCC indication, as measured with a bobbin probe, to be missed or misread). Subsequently, a number of follow-on questions were received from the NRC. The formal responses to those questions are documented in the appendix to this report.

2.0 Summary and Conclusions

A total of 3977 axial outside diameter stress corrosion cracking (ODSCC) indications were found during the EOC-15 inspection in all three SGs combined, of which 935 were inspected with a RPC probe, and 860 were confirmed as flaws. The RPC confirmed indications included 271 indications above 1.0 volt. The largest number of bobbin indications, 1775 indications, was found in SG-A; 405 of those were inspected by RPC, and 391 were confirmed as flaws. A total of 19 indications were found above 2 volts in all SGs combined. All those indications were inspected with a RPC probe, and all but one indication were confirmed as flaws. No circumferential indications or axial indications extending outside TSP were identified by RPC inspection at TSP distorted signal indication (DSI) locations. Four axial ODSCC indications were detected during the RPC inspection of dented intersections (3 in SG-A and one in SG-B). The largest +Point amplitude for these 4 indications was 0.36 volt, which corresponds to less than 1 volt DSI based on +Point to bobbin voltage correlation. The tubes containing these 4 indications were repaired. Five single volumetric indications (SVIs) were found during RPC inspection of TSP intersections (3 in SG-A and one each in SGs B and C), and the tubes containing those indications were removed from service.

SLB leak rate and tube burst probability analyses were performed using the actual EOC-15 bobbin voltage distributions (condition monitoring analysis) as well as the projected EOC-16 bobbin voltage distributions (operational assessment). The actual number of indications detected during the EOC-15 inspection for all SGs are below their corresponding projections based on both constant POD of 0.6 as well as voltage dependent POPCD. With the exception of a single indication in SG-A, the EOC-15 measured voltages were bounded by the voltage distributions projected using both POD=0.6 and POPCD. SG-A was predicted to be the limiting SG at EOC-15 as it had a slightly higher projected SLB leak rate and burst probability than other 2 SGs, and it was also found have the largest leak rate based on the measured EOC-15 voltages. The SLB leak rates from the condition monitoring analysis show significant margins relative to the corresponding operational assessment values based on a constant POD of 0.6; they are also well below the allowable limit of 14.5 gpm (room temperature). The corresponding condition monitoring tube burst probability values are slightly higher than the operational assessment values; but they still an order of magnitude below the NRC reporting guideline of 10^{-2}. The maximum difference between the tube burst probabilities from operational assessment and condition monitoring analyses is less than 5% of the reporting guideline, and therefore is not significant.

The EOC- 15 projections for both leak rates and tube burst probabilities based on the voltage dependent POPCD are slightly below the corresponding condition monitoring values. The largest difference between the projections and condition monitoring results for both leak rate and burst probability is within about 7% of their respective acceptance limits, which is not significant.

The largest SLB leak rate in the condition monitoring analysis is calculated for SG-A, and its magnitude is 5.0 gpm, which is only about a 1/3rd of the allowable SLB leakage limit of 14.5 gpm. All leak rate values quoted are equivalent volumetric rates at room temperature. The limiting conditional tube burst probability from the condition monitoring analysis, 8.2×10^{-4} predicted for SG-A, is an order of magnitude below the NRC reporting guideline of 10^{-2}. Thus, the condition monitoring results are well within the allowable limit/reporting guideline.

SLB leak rate and tube probability projections at the EOC-16 conditions were performed using the latest ARC database available (Addendum-5 update), which is documented in Reference 8-5. Since credit can be taken for the operability of the pressurizer PORV during a SLB event, leak and burst analyses for Cycle 16 operational assessment were performed using a primary-to-secondary pressure differential of 2405 psi. SG-A is again predicted to be the limiting SG. For Cycle 16 duration of 560 EFPD, the EOC-16 leak rate projected for SG-A using the NRC mandated constant POD of 0.6 is 3.58 gpm (room temperature), which is less than one-fourth of the current licensing limit of 14.5 gpm. This leak rate projection utilized a revised leak rate calculation methodology (Reference 8-4) wherein a test is made during each SG simulation to determine whether or not a correlation exists between leak rate and bobbin voltage. A regression correlation is applied for (1-p) fraction of the SG simulations, where "p" is the p-value for the leak rate correlation slope parameter. In the remaining simulations, leak rate is assumed independent of bobbin voltage and is determined using the mean and standard deviation of the leak data. The limiting EOC-16 burst probability is also calculated for SG-A; its magnitude is 1.0×10^{-3}, an order of magnitude below the NRC reporting guideline of 10^{-2}.

Probability of detection (POPCD) for the last (EOC-14) inspection was assessed using EOC-14 and EOC-15 inspection results, and the data strongly supports a voltage dependent POD substantially higher than the NRC mandated POD value of 0.6. POPCD exceeds 0.8 for all indications above 0.5 volt. The Beaver Valley-1 EOC-14 POPCD distribution is better than the generic POPCD distribution presented in Reference 8-5.

The EOC-15 RPC confirmation rate for RPC NDD indications left in service during Cycle 15 is only about 36%, which is same as that for the EOC-14 inspection. Although Beaver Valley Unit-1 has the option of considering a fraction of RPC NDD (with a minimum of 70%) for leak and burst projections, 100% of RPC NDD indications were included in the EOC-16 projections presented in this report.

3.0 EOC-15 Inspection Results and Voltage Growth Rates

3.1 EOC-15 Inspection Results

According to the guidance provided by the NRC Generic Letter 95-05, the EOC-15 inspection of the Beaver Valley Unit-1 SGs consisted of a complete, 100% eddy current (EC) bobbin probe full length examination of the tube bundles in all three SGs. RPC examination was also performed for all indications with amplitude 2 volts and above and 100 indications per SG with amplitude below 2 volts. Among the indications above 2 volts, all but one were confirmed as flaws, and the tube containing them were removed from service. Only a total of 15 ODSCC indications were found on the cold leg side at the TSPs from all 3 SGs combined. There were no circumferential indications at TSPs, and no indications extending outside TSPs. Dents 2 volts or larger on the hot leg side of the first three TSPs and all other TSP dents over 5 volts were also inspected with RPC; four axial ODSCC indications were detected at dents with bobbin voltages 2.91 volts, 2.49 volts, 3.1 volts and 9.36 volts. The largest +Point amplitude for these four indications was 0.36 volt, which corresponds to less than 1 volt DSI based on +Point to bobbin voltage correlation. The tubes containing these 4 indications were repaired. Additionally, 100 DSIs less than 2 volts were randomly selected for RPC inspection in each SG to confirm morphology. Only axial ODSCC was reported in these additionally tested indications.

A summary of the EC indications for all three SGs 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, and the number of indications removed from service due to tube repairs. The indications that remain active for Cycle 16 operation is the difference between the observed and the ones removed from service. No tubes were deplugged in the current inspection with the intent of returning them to service after inspection in accordance with the alternate repair criteria (ARC).

Overall, the combined data for all three SGs of Beaver Valley Unit-1 show the following:

- Out of a total of 3977 TSP indications identified during the inspection, a total of 935 were RPC inspected.
- Of the 935 RPC inspected, 860 were confirmed as flaws.
- Nineteen indications exceeded the 2 volt repair limit.
- A total of 3675 indications were returned to service for Cycle 16 operation.

A review of Table 3-1 indicates that more indications (a quantity of 1635, with 336 indications above 1.0 volt) were returned to service in SG-A than the other SGs; thereby

it potentially will be the limiting SG at EOC-16.

Figure 3-1 shows the actual bobbin voltage distribution determined from the EOC-15 EC inspection; Figure 3-2 shows the population distribution of those EOC-15 indications removed from service due to tube repairs; Figure 3-3 shows the distribution for indications returned to service for Cycle 16 operation. Of the 230 indications removed from service, only 20 indications were repaired due to ODSCC at TSPs. The rest of the indications are in tubes plugged for degradation mechanisms other than ODSCC at TSPs. Among the 20 TSP ODSCC indications removed from service, 18 exceeded the repair limit and confirmed by +Point; the other two indications were exactly 2 volts in magnitude, but had a relatively high +Point voltage (over 1volt).

The distribution of EOC-15 indications as a function of support plate location is summarized in Table 3-2 and plotted in Figure 3-4. The data show a strong predisposition of ODSCC to occur in the first few hot leg TSPs (3665 out of 3977 indications occurred at the hot leg intersections in the first three TSPs), although the mechanism extended to higher TSPs. Only a total of 15 indications were detected on the cold leg side in all 3 SGs combined. This distribution indicates the predominant temperature dependence of ODSCC at Beaver Valley Unit-1, consistent with the data from the previous inspections at Beaver Valley Unit-1 as well as other plants.

3.2 Voltage Growth Rates

For projection of leak rates and tube burst probabilities at the end of Cycle 16 operation, voltage growth rates were developed from the EOC-15 inspection data and a reevaluation of the EOC-14 inspection EC signals for the same indications. Table 3-3 shows the cumulative probability distribution for growth rate in each Beaver Valley Unit-1 steam generator during Cycle 15 (October 2001 - March 2003) on an EFPY basis, along with the corresponding Cycle 14 growth rate distributions. Cycle 15 growth data for all 3 SGs are also plotted in Figure 3-5. The curve labeled "cumulative" in Figure 3-5 represents averaged composite growth data from all three SGs.

Average growth rates for each SG during Cycle 15 are summarized in Table 3-4, and all three SGs show comparable average growth rates, as in the last cycle. The average growth rates over the entire voltage range vary between 5.0 % and 7.6% (of the BOC voltage) per EFPY, between the SGs, with an overall average of 6.2% per EFPY. SG-A had a slightly higher growth than the other two SGs. Table 3-5 provides a comparison of the average growth data for the last 9 operating cycles. The Cycle 15 growth rates are less than the Cycle 14 growth rates, which in turn is less than the Cycle 13 growth rates. This growth rate reduction may be a residual effect of the chemical cleaning crevice cleaning process applied at the 1R14 outage.

The bobbin voltage growth distributions for the last two cycles in the form of cumulative probability distribution functions (CPDF) are shown in Table 3-3, and the same data is presented in a graphical form on Figure 3-6. The growth data are presented on an EFPY basis to account for the difference in the length of the two operating periods. Since the Cycle 14 growth distribution in Figure 3-6 lies to the right of the Cycle 15 distribution and has a slightly higher peak growth, it is considered more limiting. Therefore, Cycle 16 operational assessment analysis was carried out using the Cycle 14 growth distribution.

Table 3-6 lists the top 30 indications on the basis of Cycle 15 growth rate in descending order, and the data confirms that Cycle 15 had only modest growth. With the exception of one indication, the total growth during Cycle 15 for all indications was under 1.4 volts; the same observation was made in the Cycle 14 growth data also. Among the 30 highest growth indications for Cycle 14, 16 were found in previously plugged tubes that were deplugged and returned to service at BOC-14; however, only 5 out of the top 30 growth indications for Cycle 15 were in those deplugged tubes. This indicates that growth rate for a deplugged tube returned to service becomes normal after showing increased growth rate during one cycle of operation.

Some plants have experienced growth rates that demonstrated a potential dependency on the BOC voltages of previously identified indications. Large growths were observed primarily in indications with a BOC voltage over 1.5 volts. To determine if Beaver Valley Unit-1 exhibited a similar trend, the growth rate data for Cycle 15 was plotted against BOC voltage, and the resulting plot is shown in Figure 3-7. Although there is one indication with a substantially higher growth than the rest of the population, its BOC voltage is well below 1.5 volts. The rest of Cycle 15 growth data do not show any trend to increase with the BOC voltage. Therefore, growth can be assumed independent of voltage in the Monte Carlo analysis for the operational assessment.

3.3 Probe Wear Criteria

An alternate probe wear criteria approved by the NRC (Reference 8-6) was applied during the EOC-15 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 inspected since the last successful probe wear check be reinspected with a good probe. As the repair limit for Beaver Valley Unit-1 is 2 volts, all tubes containing indications for which the worn probe voltage is above 1.5 volts are to be inspected with a new probe. A total of 25 indications with a bobbin voltage above 1.5 volts were found in the calibration groups that failed probe wear check, and the tubes containing those indications were reinspected with a new probe. One indication had its voltage increase above the repair limit when reinspected with a good probe (R02C49 01H in SG-C). It was inspected with a RPC probe and confirmed as a flaw. The tube containing that flaw was repaired. For indications with a worn probe voltage above 1.5 volts, the average difference between the

worn and new probe voltages is only about 0.11 volt. Figure 3-8 shows plots of the worn probe voltages plotted against the new probe voltages for all three SGs. The data for SG-B and SG-C are shown in the same plot. The data in Figure 3-8 show a consistent relationship between the two voltages, with worn probe voltages being generally higher.

Composite data from all three SGs are plotted in Figure 3-9. Also shown in Figure 3-9 as a solid line is a linear regression for the data, dotted lines representing tolerance limits that bound 90% of the population at 95% confidence, and chained lines representing ±25% band for the new probe voltages. The mean regression line has a slope slightly above 45° indicating that, on the average, worn probe voltages are slightly higher than the new probe voltages. The dashed horizontal line at 1.5 worn probe volts demarcates indications requiring retest from those that do not. The shaded area at the bottom shows the region where a tube requiring repair may be left in service because of probe wear. In the Beaver Valley-1 EOC-15 inspection, there are no occurrences for which a worn probe was less than 1.5 volts and the new probe voltage exceeded the plugging limit, i.e., no pluggable tubes were missed due to probe wear considerations. Among the indications requiring retesting (worn probe volts > 1.5 volts), only 2 indications fall outside the 90%/95% tolerance limit bands. However, the worn probe voltages for both of those indications are higher than the corresponding new probe voltages, i.e., the worn probe voltages are conservative. Therefore the data for these indications are acceptable.

Overall, it is concluded that the criteria to retest tubes with worn probe voltages above 75% of the repair limit is adequate. The alternate probe wear criteria used in the EOC-15 inspection is consistent with the NRC guidance provided in Reference 8-6.

As required by Reference 8-6, the number of new indications detected in the present inspection in tubes that were inspected with a worn probe in the last inspection was also determined. Out of a total of 628 new indications found in the current inspection, only 6 are in tubes inspected with a worn probe in the last inspection, which indicates that tubes inspected with worn probes during the last inspection do not contain disproportionately larger number of new indications. Also, the actual indication population distributions from the current inspection were compared against the projected distributions based on the prior cycle data presented in Reference 8-2, and the projections were found to be conservative (see Section 6.0 for details). Thus, the requirements specified in Reference 8-6 for applying the alternate probe wear criteria are met.

3.4 NDE Uncertainties

The NDE uncertainties applied for the Cycle 15 voltage distributions in the Monte Carlo analyses for leak rate and burst probabilities are the same as those previously reported in the Beaver Valley Unit-1 voltage-based repair criteria report of Reference 8-2 and NRC Generic Letter 95-05 (Reference 8-1). 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. If the random sample of probe wear selected during the Monte Carlo simulations exceed 15%, sampling of the probe wear distribution is continued until a value less than 15% is picked. 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-15 actual voltage distributions as well as for the EOC-16 projections. In the EOC-16 projection analysis, NDE uncertainty adjustment is applied to the BOC voltage before growth is added to obtain EOC voltage.

3.5 Probability of Prior Cycle Detection (POPCD)

The inspection results at EOC-15 permit an evaluation of the probability of detection at the last (EOC-14) inspection. POPCD evaluation has been carried out for the last 5 inspections at Beaver Valley Unit-1. Recently, several of meetings were held between the NRC and another utility regarding the definition and application of POPCD. As a result, the following changes were made to the definition and method calculating of POPCD (Reference 8-4).

1) Prior POPCD evaluations established two distributions for each inspection by considering two types of indications: a) RPC confirmed indications only, and b) RPC confirmed plus not RPC inspected indications. The revised method will determine only the POPCD distribution based on RPC confirmed plus not inspected indications.
2) Prior POPCD evaluations considered only indications detected by bobbin inspection. However, ODSCC indications may be determined as a result of other inspection activities such as RPC inspection of dented intersections. The revised method includes RPC detected ODSCC indications along with the new indications detected by bobbin.
3) The revised POPCD table shows indications that were excluded from the POPCD evaluation because they are not determined to be true flaws.
4) All indications will be binned in 0.1 volt intervals and bins in the tail with few indications will be not be combined.

The probability of prior cycle detection (POPCD) for the EOC-14 inspection based on the revised definition is as follows.

$$\underset{(\text{EOC }14)}{\text{POPCD}} = \frac{\begin{array}{c}\text{EOC-14 bobbin}\\ \text{indication RPC}\\ \text{confirmed at EOC-15}\end{array} + \begin{array}{c}\text{EOC-14 bobbin}\\ \text{indication not RPC}\\ \text{inspected at EOC-15}\end{array} + \begin{array}{c}\text{Indications}\\ \text{confirmed and}\\ \text{repaired in EOC-14}\\ \text{inspection}\end{array}}{\{\text{Numerator}\} + \begin{array}{c}\text{New EOC-15 bobbin}\\ \text{indication confirmed}\\ \text{at EOC-15}\end{array} + \begin{array}{c}\text{New EOC-15 bobbin}\\ \text{indication not RPC}\\ \text{inspected at EOC-15}\end{array} + \begin{array}{c}\text{New EOC-15}\\ \text{indications found}\\ \text{only by RPC}\\ \text{inspection}\end{array}}$$

The indications detected at EOC-14 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-15. It is also appropriate to include the plugged tubes for voltage-based repair criteria applications since POD adjustments to define the BOC distribution are applied prior to reduction of the EOC indication distribution for plugged tubes.

POPCD is evaluated at 2001 EOC-14 voltage values (from 2003 reevaluation for growth rate) since it is an EOC-14 POPCD assessment. Six ODSCC indications were detected in the EOC-15 inspection during the RPC inspection of large mixed residual bobbin signals. Bobbin voltages for these indications were assigned using a RPC to bobbin voltage correlation. As the EOC-14 RPC data is not available for these indications, the EOC-14 voltages for incorporation into POPCD evaluation were obtained by subtracting average Cycle 15 growth from the EOC-15 bobbin voltages inferred from the RPC voltages.

It should be noted that the above POPCD definition includes all new EOC-15 indications not reported in the EOC-14 inspection. The new indications include EOC-14 indications present at detectable levels but not reported, indications present at EOC-14 below detectable levels and indications that initiated during Cycle 15. Thus, this definition, by including newly initiated indications, differs from the traditional POD definition. Since the newly initiated indications are appropriate for voltage-based repair criteria applications, POPCD is an acceptable definition and eliminates the need to adjust the traditional POD for new indications.

The POPCD evaluation for the 2001 EOC-14 inspection data is shown on Figure 3-10 and summarized in Table 3-7. A generic POPCD distribution developed by analyzing data from 37 inspections in 13 plants, presented in Table 6-4 of Reference 8-5, is also shown in Figure 3-10. The EOC-14 POPCD values for all voltage bins above 0.4 volt exceeds 0.8 and reaches unity at 2.0 volts.

In summary, the Beaver Valley Unit-1 EOC-14 POPCD strongly supports a voltage dependent POD substantially higher than the NRC mandated POD value of 0.6. POPCD exceeds 0.8 beyond 0.4 volt and reaches unity at about 2.0 volts. The Beaver Valley Unit-1 EOC-14 POPCD is also better than the generic POPCD distribution presented in Reference 8-5.

3.6 Assessment of RPC Confirmation Rates

This section tracks the 2001 EOC-14 indications left in service at BOC-15 relative to RPC inspection results in 2003 at EOC-15. Composite results for all SGs are given in Table 3-8. For the 2001 bobbin indications left in service, the indications are tracked relative to 2001 RPC confirmed, 2001 RPC NDD, 2001 bobbin indications not RPC inspected and 2001 bobbin indications with no indication found in 2003. Also included are new 2003 indications. The table shows, for each category of indications, the number

of indications RPC inspected and RPC confirmed in 2003 as well as the percentage of RPC confirmed indications.

Out of a total of 33 RPC NDD indications from all three SGs left in service in 2001, 22 were RPC tested in 2003 and 8 of those were confirmed. Thus, the overall RPC confirmation rate for 2001 RPC NDD indications is about 36%. The same overall confirmation rate was observed for RPC NDD indications tested in the last (September 2001) inspection, and confirmation rate in the prior Beaver Valley Unit-1 outages is typically less than 40%.

The NRC SER for Beaver Valley-1 (Reference 8-8) allows for consideration of only a fraction of RPC NDD indications from current inspection in establishing BOC voltage distribution for the next cycle. The fractional value applicable is the largest RPC confirmation rate for prior cycle RPC NDD indications found during the last two outages, but it may not be less than 0.7. However, all EOC-15 RPC NDD indications were included in the Cycle 16 operational assessment.

Table 3-1
Beaver Valley Unit 1 April 2003 Outage
Summary of Inspection and Repair For Tubes in Service During Cycle 15

Voltage Bin	Steam Generator A						Steam Generator B					
	In-Service During Cycle 15				RTS for Cycle 16		In-Service During Cycle 15				RTS for Cycle 16	
	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
0.1	0	0	0	0	0	0	0	0	0	0	0	0
0.2	15	3	3	0	15	15	17	0	0	1	16	16
0.3	64	9	9	1	63	63	62	12	7	1	61	56
0.4	133	21	19	8	125	124	119	6	5	8	111	110
0.5	168	19	18	4	164	163	152	6	6	2	150	150
0.6	250	49	49	11	239	239	158	24	21	7	151	148
0.7	215	46	44	8	207	205	153	44	39	5	148	143
0.8	228	36	36	7	221	221	151	55	51	4	147	143
0.9	181	30	29	10	171	170	130	43	38	4	126	121
1	112	44	41	10	102	99	81	21	19	4	77	75
1.1	114	44	43	15	99	98	70	20	19	9	61	60
1.2	72	26	25	12	60	59	45	12	12	5	40	40
1.3	56	19	19	6	50	50	29	8	7	3	26	25
1.4	42	13	12	7	35	34	26	7	7	4	22	22
1.5	34	8	8	8	26	26	20	6	6	5	15	15
1.6	31	12	11	4	27	26	19	5	5	3	16	16
1.7	19	6	6	3	16	16	10	3	3	1	9	9
1.8	11	5	5	3	8	8	6	3	3	2	4	4
1.9	12	2	2	0	12	12	7	1	1	3	4	4
2	8	3	3	1	7	7	6	2	2	2	4	4
2.1	5	5	4	4	1	0	3	3	3	3	0	0
2.2	2	2	2	2	0	0	0	0	0	0	0	0
2.3	1	1	1	1	0	0	1	1	1	1	0	0
2.4	1	1	1	1	0	0	0	0	0	0	0	0
2.5	0	0	0	0	0	0	0	0	0	0	0	0
4.6	1	1	1	1	0	0	0	0	0	0	0	0
Total	1775	405	391	127	1648	1635	1265	282	255	77	1188	1161
>1 v	409	148	143	68	341	336	242	71	69	41	201	199
>2 v	10	10	9	9	1	0	4	4	4	4	0	0

Voltage Bin	SG-C						Composite of All SGs					
	In-Service During Cycle 15				RTS for Cycle 16		In-Service During Cycle 15				RTS for Cycle 16	
	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
0.1	2	0	0	0	2	2	2	0	0	0	2	2
0.2	13	2	2	1	12	12	45	5	5	2	43	43
0.3	55	4	3	1	54	53	181	25	19	3	178	172
0.4	85	11	9	1	84	83	337	38	33	17	320	317
0.5	91	6	5	0	91	90	411	31	29	6	405	403
0.6	114	24	19	0	114	109	522	97	89	18	504	496
0.7	116	40	34	2	114	108	484	130	117	15	469	456
0.8	101	40	35	3	98	93	480	131	122	14	466	457
0.9	86	36	31	1	85	80	397	109	98	15	382	371
1	59	20	17	2	57	54	252	85	77	16	236	228
1.1	34	11	11	3	31	31	218	75	73	27	191	189
1.2	38	11	10	0	38	37	155	49	47	17	138	136
1.3	29	8	7	1	28	27	114	35	33	10	104	102
1.4	31	11	9	3	28	26	99	31	28	14	85	82
1.5	22	7	6	2	20	20	76	21	20	15	61	61
1.6	14	2	2	0	14	14	64	19	18	7	57	56
1.7	20	5	4	1	19	18	49	14	13	5	44	43
1.8	12	3	3	0	12	12	29	11	11	5	24	24
1.9	6	2	2	0	6	6	25	5	5	3	22	22
2	4	0	0	0	4	4	18	5	5	3	15	15
2.1	1	1	1	1	0	0	9	9	8	8	1	0
2.2	0	0	0	0	0	0	2	2	2	2	0	0
2.3	3	3	3	3	0	0	5	5	5	5	0	0
2.4	0	0	0	0	0	0	1	1	1	1	0	0
2.5	1	1	1	1	0	0	1	1	1	1	0	0
4.6	0	0	0	0	0	0	1	1	1	1	0	0
Total	937	248	214	26	911	879	3977	935	860	230	3747	3675
>1 v	215	65	59	15	200	195	866	284	271	124	742	730
>2 v	5	5	5	5	0	0	19	19	18	18	1	0

Table 3-2
Beaver Valley Unit 1 April 2003
TSP ODSCC Indication Distributions for Tubes in Service During Cycle 15

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
01H	887	4.57	0.84	3.25	0.09	620	2.07	0.80	1.05	0.04
02H	588	2.11	0.77	0.59	0.06	375	2.05	0.74	0.69	0.06
03H	175	1.62	0.75	0.70	0.06	145	2.26	0.62	0.70	0.06
04H	61	2.08	0.67	0.34	0.05	80	1.44	0.64	0.28	0.06
05H	32	1.22	0.54	0.27	0.05	28	1.80	0.52	0.21	0.05
06H	9	1.06	0.51	0.13	0.02	11	0.74	0.35	0.14	0.02
07H	14	0.95	0.40	0.28	0.07	4	0.45	0.34	0.05	-0.01
07C	8	0.68	0.37	0.20	0.03	2	0.28	0.27	0.02	0.02
04C	0	-	-	-	-	0	-	-	-	-
02C	0	-	-	-	-	0	-	-	-	-
01C	1	0.53	0.53	-0.12	-0.12	0	-	-	-	-
Total	1775					1265				

Tube Support Plate	Steam Generator C					Composite of All SGs				
	Number of Indications	Maximum Voltage	Average Voltage	Largest Growth	Average Growth	Number of Indications	Maximum Voltage	Average Voltage	Largest Growth	Average Growth
01H	460	2.50	0.89	1.33	0.05	1967	4.57	0.84	3.25	0.06
02H	313	2.24	0.72	0.70	0.05	1276	2.24	0.75	0.70	0.06
03H	102	1.63	0.66	0.35	0.05	422	2.26	0.69	0.70	0.05
04H	25	1.45	0.60	0.24	0.03	166	2.08	0.64	0.34	0.05
05H	20	0.67	0.37	0.27	0.04	80	1.80	0.49	0.27	0.05
06H	12	0.65	0.39	0.21	0.07	32	1.06	0.41	0.21	0.04
07H	1	0.39	0.39	0.03	0.03	19	0.95	0.39	0.28	0.05
07C	0	-	-	-	-	10	0.68	0.35	0.20	0.02
04C	2	0.35	0.34	0.01	0.01	2	0.35	0.34	0.01	0.01
02C	2	0.46	0.37	0.07	0.06	2	0.46	0.37	0.07	0.06
01C	0	-	-	-	-	1	0.53	0.53	-0.12	-0.12
Total	937					3977				

Table 3-3
Beaver Valley Unit 1 April 03
Signal Growth Statistics For Cycle 15 on an EFPY Basis

Delta Volts	Steam Generator A			Steam Generator B			Steam Generator C			Cumulative		
	Cycle 14	Cycle 15		Cycle 14	Cycle 15		Cycle 14	Cycle 15		Cycle 14	Cycle 15	
	CPDF	No. of Inds	CPDF	CPDF	No. of Inds	CPDF	CPDF	No. of Inds	CPDF	CPDF	No. of Inds	CPDF
-0.6	0.0	0	0.0	0.0	1	0.001	0.0	0	0.0		1	0.0
-0.5	0.001	1	0.001	0.0	0	0.001	0.0	0	0.0	0.0	1	0.001
-0.4	0.003	0	0.001	0.0	0	0.001	0.0	0	0.0	0.001	0	0.001
-0.3	0.008	0	0.001	0.004	0	0.001	0.0	3	0.003	0.005	3	0.001
-0.2	0.022	16	0.01	0.016	7	0.006	0.01	3	0.006	0.017	26	0.008
-0.1	0.078	54	0.04	0.07	55	0.05	0.044	49	0.059	0.067	158	0.048
0	0.321	474	0.307	0.299	391	0.359	0.319	303	0.382	0.314	1168	0.341
0.1	0.744	804	0.76	0.75	592	0.827	0.727	395	0.804	0.742	1791	0.792
0.2	0.908	290	0.923	0.904	172	0.963	0.904	127	0.939	0.905	589	0.94
0.3	0.962	91	0.975	0.974	27	0.984	0.964	44	0.986	0.966	162	0.98
0.4	0.984	24	0.988	0.99	10	0.992	0.99	4	0.99	0.987	38	0.99
0.5	0.99	10	0.994	0.995	5	0.996	0.996	4	0.995	0.993	19	0.995
0.6	0.991	7	0.998	0.996	3	0.998	0.997	4	0.999	0.994	14	0.998
0.7	0.993	1	0.998	0.996	1	0.999	0.999	0	0.999	0.995	2	0.999
0.8	0.995	2	0.999	0.998	1	1.0	0.999	0	0.999	0.997	3	0.999
0.9	0.997	0	0.999	0.999	0		0.999	0	0.999	0.998	0	0.999
1	0.998	0	0.999	1.0	0		0.999	1	1.0	0.9989	1	0.9997
1.1	1.0	0	0.999		0		0.999	0		0.9997	0	0.9997
2.5		1	1.0		0		0.999	0		0.9997	1	1.0
2.6		0			0		1.0	0		1.0	0	
Total		1775			1265			937			3977	

Table 3-4
Beaver Valley Unit 1 - April 2003 Outage
Average Voltage Growth During Cycle 15

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	3977	0.71	0.059	0.044	8.2%	6.2%
V_{BOC} < .75 Volts	2449	0.49	0.065	0.049	13.2%	9.9%
≥ .75 Volts	1528	1.06	0.049	0.037	4.6%	3.4%
	Steam Generator A					
Entire Voltage Range	1775	0.71	0.072	0.054	10.1%	7.6%
V_{BOC} < .75 Volts	1082	0.50	0.076	0.057	15.1%	11.4%
≥ .75 Volts	693	1.05	0.067	0.050	6.4%	4.8%
	Steam Generator B					
Entire Voltage Range	1265	0.70	0.046	0.035	6.6%	5.0%
V_{BOC} < .75 Volts	806	0.49	0.058	0.044	11.9%	8.9%
≥ .75 Volts	459	1.06	0.025	0.019	2.3%	1.8%
	Steam Generator C					
Entire Voltage Range	937	0.73	0.050	0.038	6.9%	5.2%
V_{BOC} < .75 Volts	561	0.48	0.055	0.041	11.3%	8.5%
≥ .75 Volts	376	1.10	0.044	0.033	4.0%	3.0%

Based on Cycle 15 duration of 485.3 EFPD (1.329 EFPY)

Table 3-5
Beaver Valley Unit 1 April 2003
Average Voltage Growth for Cycle 15
Composite of All Steam Generator 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 15 (2001 - 2003) - 485.3 EFPD					
Entire Voltage Range	3977	0.71	0.059	0.044	8.2%	6.2%
V_{BOC} < .75 Volts	2449	0.49	0.065	0.049	13.2%	9.9%
≥ .75 Volts	1528	1.06	0.049	0.037	4.6%	3.4%
	Cycle 14 (2000 - 2001) - 490 EFPD					
Entire Voltage Range	3533	0.67	0.076	0.057	11.4%	8.5%
V_{BOC} < .75 Volts	2371	0.48	0.080	0.060	16.6%	12.4%
≥ .75 Volts	1162	1.05	0.068	0.050	6.4%	4.8%
	Cycle 13 (1997 - 2000) - 500 EFPD					
Entire Voltage Range	3024	0.56	0.138	0.101	24.8%	18.1%
V_{BOC} < .75 Volts	2371	0.43	0.127	0.093	29.6%	21.7%
≥ .75 Volts	653	1.03	0.180	0.131	17.5%	12.8%
	Cycle 12 (1996 - 1997) - 415.4 EFPD					
Entire Voltage Range	2910	0.60	-0.025	-0.022	-4.3%	-3.8%
V_{BOC} < .75 Volts	2181	0.46	-0.020	-0.017	-4.4%	-3.8%
≥ .75 Volts	729	1.01	-0.042	-0.037	-4.1%	-3.6%
	Cycle 11 (1995 - 1996) - 352.94 EFPD					
Entire Voltage Range	1936	0.60	-0.005	-0.005	-0.8%	-0.9%
V_{BOC} < .75 Volts	1434	0.46	0.006	0.007	1.3%	1.4%
≥ .75 Volts	502	0.94	-0.037	-0.038	-4.0%	-4.1%
	Cycle 10 (1993 - 1995) - 435.79 EFPD					
Entire Voltage Range	1089	0.66	0.020	0.017	3.0%	2.5%
V_{BOC} < .75 Volts	751	0.50	0.040	0.034	8.0%	6.7%
≥ .75 Volts	338	1.01	-0.010	-0.008	-1.0%	-0.8%
	Cycle 9 (1991 - 1993) - 492.75 EFPD					
Entire Voltage Range	1125	0.57	0.090	0.067	15.8%	11.7%
V_{BOC} < .75 Volts	918	0.47	0.090	0.067	19.1%	14.2%
≥ .75 Volts	207	1.02	0.090	0.067	8.8%	6.5%
	Cycle 8 (1989 - 1991) - 390.82 EFPD					
Entire Voltage Range	952	0.95	0.180	0.168	18.9%	17.7%
V_{BOC} < .75 Volts	366	0.58	0.160	0.150	27.6%	25.8%
≥ .75 Volts	586	1.18	0.190	0.178	16.1%	15.0%
	Cycle 7 (1987 - 1989) - 438.3 EFPD					
Entire Voltage Range	918	0.66	0.290	0.242	43.9%	36.6%
V_{BOC} < .75 Volts	622	0.49	0.270	0.225	55.1%	45.9%
≥ .75 Volts	296	1.01	0.340	0.283	33.7%	28.1%

Table 3-6
Beaver Valley Unit 1 April 2003
Summary of Largest Voltage Growth Rates for BOC-15 to EOC-15

Steam Generator				Bobbin Voltage			RPC	New
SG	Row	Col	Elevation	EOC	BOC	Growth	Confirmed ?	Indication ?
A	11	77	01H	4.57	1.32	3.25	Y	N
C	2	49	01H	2.04	0.71	1.33	Y	N
B	3	16	01H	1.59	0.54	1.05	N	N
A	2	68	01H	1.52	0.51	1.01	N	N
A	10	66	01H	2.23	1.22	1.01	Y	N
A	20	36	01H	2.37	1.46	0.91	Y	N
B	2	19	01H	2	1.14	0.86	Y	N
A	21	42	01H	1.88	1.08	0.8	N	N
C	2	51	01H	1.61	0.86	0.75	Y	Y
A	15	28	01H	1.85	1.12	0.73	Y	N
C	1	45	01H	2.25	1.52	0.73	Y	N
C	10	48	01H	2.5	1.79	0.71	Y	N
A	6	70	03H	1.37	0.67	0.7	Y	Y
A	12	18	01H	1.43	0.73	0.7	Y	N
A	14	68	01H	1.01	0.31	0.7	N	Y
B	20	25	03H	0.98	0.28	0.7	N	N
C	7	46	02H	2.24	1.54	0.7	Y	N
A	21	51	01H	1.49	0.8	0.69	Y	N
B	1	14	02H	1.38	0.69	0.69	N	N
A	23	29	01H	1.38	0.7	0.68	N	N
B	1	17	02H	0.87	0.19	0.68	N	Y
C	3	50	01H	1.7	1.05	0.65	N	N
A	6	29	01H	1.68	1.04	0.64	Y	N
A	14	59	01H	1.67	1.04	0.63	N	N
C	5	49	01H	1.46	0.83	0.63	N	N
A	12	24	01H	1.2	0.59	0.61	Y	N
A	22	36	01H	1.93	1.32	0.61	Y	N
B	5	15	01H	1.03	0.42	0.61	Y	N
A	19	81	02H	0.86	0.27	0.59	N	N
C	3	47	01H	2.25	1.66	0.59	Y	N

Table 3-7
Beaver Valley Unit-1
Probability of Prior Cycle Inspection(POPCD) Evaluation for EOC-14 Inspection (1, 4)

Voltage Bin(3)	EOC-14 Bobbin Detected for POPCD Analysis(2)			EOC-14 Bobbin Detected Ind. Excluded from POPCD		New EOC-15 (Undetected at EOC-14) Ind. for POPCD Analysis			New EOC-15 Excluded from POPCD	POPCD Calculation(1)		
	EOC-14 Bobbin Ind. RPC Confirmed at EOC-15	EOC-14 Bobbin Ind. Not RPC Inspected at EOC-15	EOC-14 Bobbin Ind. Detected & Repaired at EOC-14	EOC-14 Bobbin Ind. RPC NDD at EOC-15	EOC-14 Bobbin Ind. INR(3) at EOC-15	New EOC-15 Bobbin Ind. RPC Confirmed at EOC-15	New EOC-15 Bobbin Ind. Not RPC Inspected at EOC-15	New EOC-15 Ind. Found Only(4) by RPC Inspection	New EOC-15 Bobbin Ind. RPC NDD at EOC-15	EOC-14 Bobbin Detected Ind.	New EOC-15 ODSCC Ind.	POPCD for Voltage Bin
0.01-0.10	0	3	0	0	0	0	1	0	0	3	1	0.750
0.11-0.20	0	51	0	0	0	14	28	0	2	51	42	0.548
0.21-0.30	1	173	1	0	1	19	47	0	1	175	66	0.726
0.31-0.40	6	348	0	3	0	34	54	0	2	354	88	0.801
0.41-0.50	32	393	1	0	0	36	58	0	0	426	94	0.819
0.51-0.60	68	394	0	0	0	51	43	0	2	462	94	0.831
0.61-0.70	91	304	1	0	1	44	23	0	4	396	67	0.855
0.71-0.80	78	287	2	6	0	39	22	1	0	367	62	0.855
0.81-0.90	74	211	2	2	0	24	6	4	2	287	34	0.894
0.91-1.00	41	148	0	5	0	15	5	1	0	189	21	0.900
1.01-1.10	30	101	4	3	0	14	5	0	0	135	19	0.877
1.11-1.20	34	85	0	3	0	9	0	0	0	119	9	0.930
1.21-1.30	21	74	4	2	0	6	2	0	0	99	8	0.925
1.31-1.40	16	50	2	5	0	6	0	0	0	68	6	0.919
1.41-1.50	11	41	0	1	0	5	0	0	0	52	5	0.912
1.51-1.60	14	33	2	1	0	1	0	0	0	49	1	0.980
1.61-1.70	6	19	2	0	0	2	0	0	0	27	2	0.931
1.71-1.80	10	14	0	1	0	1	0	0	0	24	1	0.960
1.81-1.90	5	13	2	1	0	1	0	0	0	20	1	0.952
1.91-2.00	1	6	0	0	0	0	0	0	0	7	0	1.000
2.01-2.10	0	0	11	0	0	0	0	0	0	11	0	1.000
2.11-2.20	0	0	3	0	0	0	0	0	0	3	0	1.000
2.21-2.30	0	0	0	0	0	0	0	0	0	0	0	-
2.31-2.40	0	0	0	0	0	0	0	0	0	0	0	-
2.41-2.50	0	0	1	0	0	0	0	0	0	1	0	1.000
2.51-2.60	0	0	0	0	0	0	0	0	0	0	0	-
2.61-2.70	0	0	0	0	0	0	0	0	0	0	0	-
2.71-2.80	0	0	1	0	0	0	0	0	0	1	0	1.000
Total	539	2748	39	33	2	321	294	6	13			

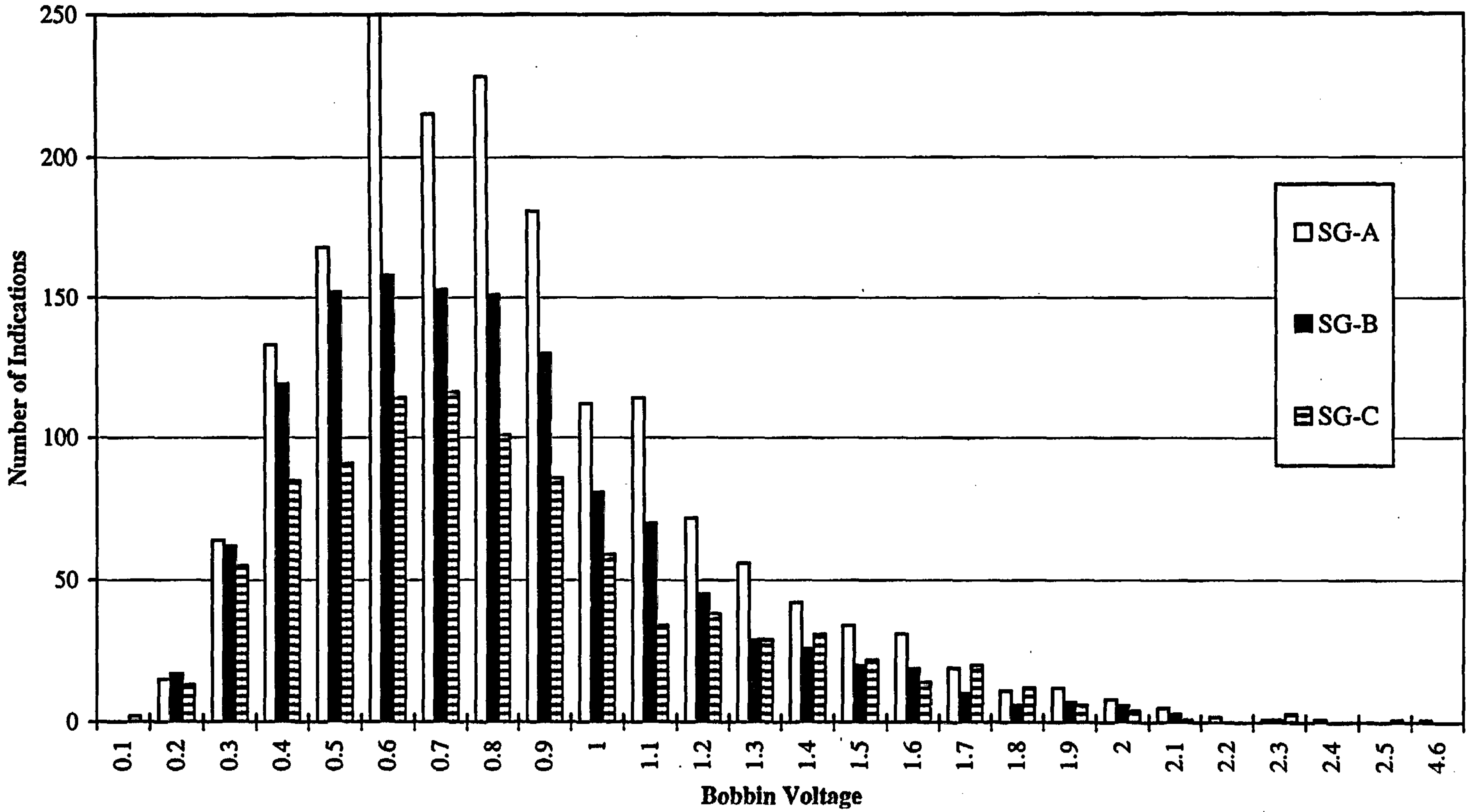
Notes:
1. POPCD for each voltage bin calculated as (EOC-14 Bobbin Detected for POPCD Analysis)/(EOC-14 Bobbin Detected for POPCD Analysis + New EOC-15 Ind. for POPCD Analysis).
2. EOC-14 detection based on inspection records for EOC-14. Voltages obtained fromEOC-14 inspection records.
3. INR = Bobbin indication found at EOC-15 but not reported at EOC-14, including resolution analyst review, to assign indication as INR.
4. Includes new indications at EOC-15 not reported in the bobbin inspection and found by RPC inspection of dents, mixed residuals or other reasons for the RPC inspection.

Table 3-8
Beaver Valley Unit 1
Analysis of RPC Data from 2001 and 2003 Inspections
Combined Data from All Steam Generators

Group of Indications	Total 2001 Inspection Bobbin Indication	Total 2003 Inspection Bobbin Indication	Total 2003 Inspection RPC Inspected	Total 2003 Inspection RPC Confirmed	Percent 2003 Inspection RPC Confirmed
Less than or Equal to 1.0 Volt in 2003 Inspection					
2001 Inspection Bobbin Left in Service	2560	2558	378	329	87.0
- 2001 Inspection RPC Confirmed	71	71	33	32	97.0
- 2001 Inspection RPC NDD	13	13	7	2	28.6
- 2001 Inspection RPC Not Inspected	2474	2474	338	295	87.3
- No 2003 Inspection Bobbin *	2	-	-	-	-
New 2003 Inspection Indication	-	553	273	260	95.2
Sum of All 2003 Inspection Indication	2560	3111	651	589	90.5
Greater than 1.0 Volt in 2003 Inspection					
2001 Inspection Bobbin Left in Service	791	791	223	210	94.2
- 2001 Inspection RPC Confirmed	326	326	108	108	100.0
- 2001 Inspection RPC NDD	20	20	15	6	40.0
- 2001 Inspection RPC Not Inspected	445	445	100	96	96.0
- No 2003 Inspection Bobbin *	0	-	-	-	-
New 2003 Inspection Indication	-	75	61	61	100.0
Sum of All 2003 Inspection Indication	791	866	284	271	95.4
All Voltages in 2003 Inspection					
2001 Inspection Bobbin Left in Service	3351	3349	601	539	89.7
- 2001 Inspection RPC Confirmed	397	397	141	140	99.3
- 2001 Inspection RPC NDD	33	33	22	8	36.4
- 2001 Inspection RPC Not Inspected	2919	2919	438	391	89.3
- No 2003 Inspection Bobbin *	2	-	-	-	-
New 2003 Inspection Indication	-	628	334	321	96.1
Sum of All 2003 Inspection Indication	3351	3977	935	860	92.0

* Indications split is based on 2001 Inspection bobbin voltage

Figure 3-1
Beaver Valley Unit 1 April 2003 Outage
Bobbin Voltage Distributions at EOC-15 for Tubes in Service During Cycle 15



BobnrpcFig1]

Figure 3-2
Beaver Valley Unit 1 April 2003 Outage
Bobbin Voltage Distribution for Tubes Plugged After Cycle 15 Service

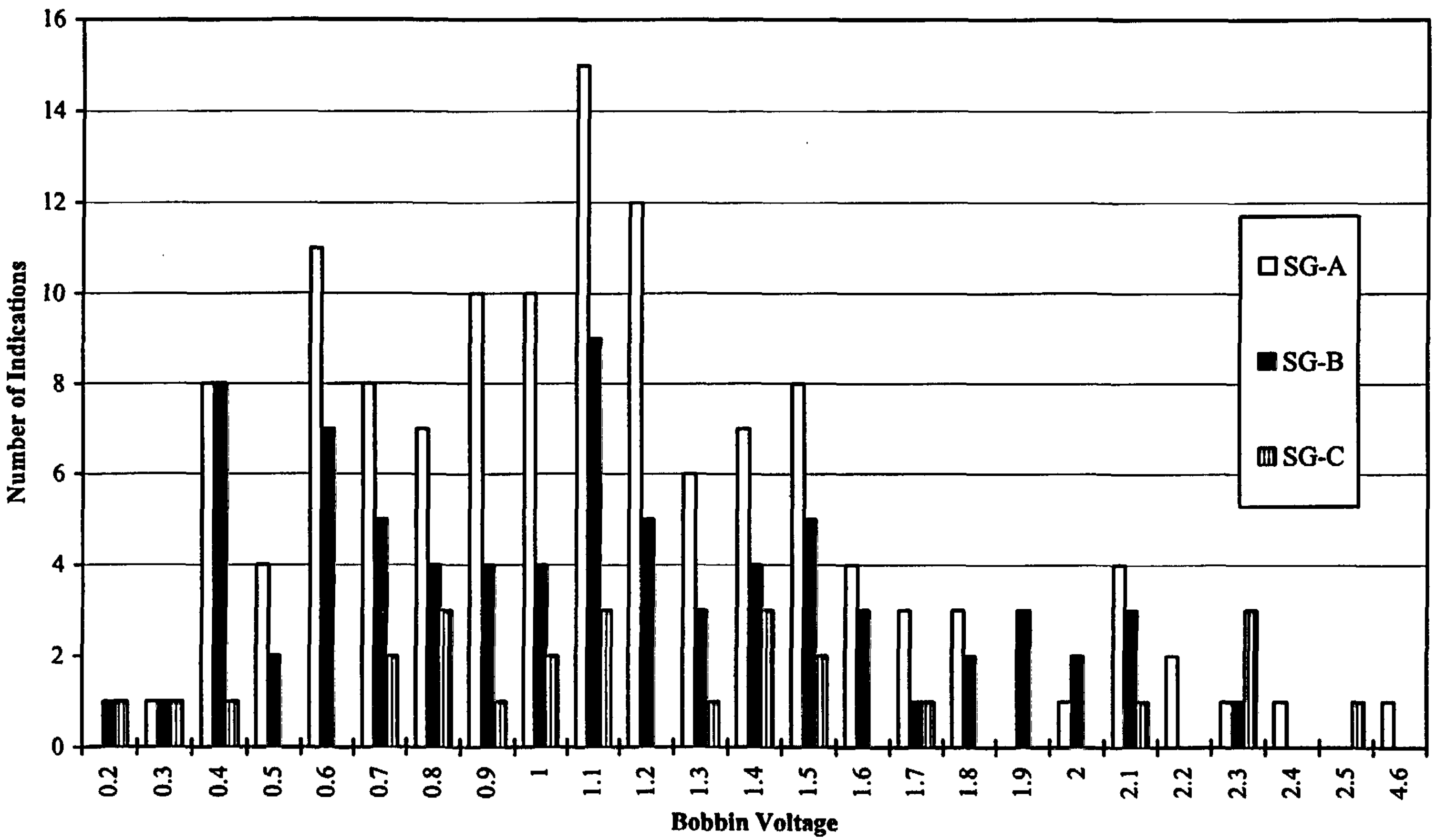


Figure 3-3
Beaver Valley Unit 1 April 2003 Outage
Bobbin Voltage Distributions for Tubes Returned to Service for Cycle 16

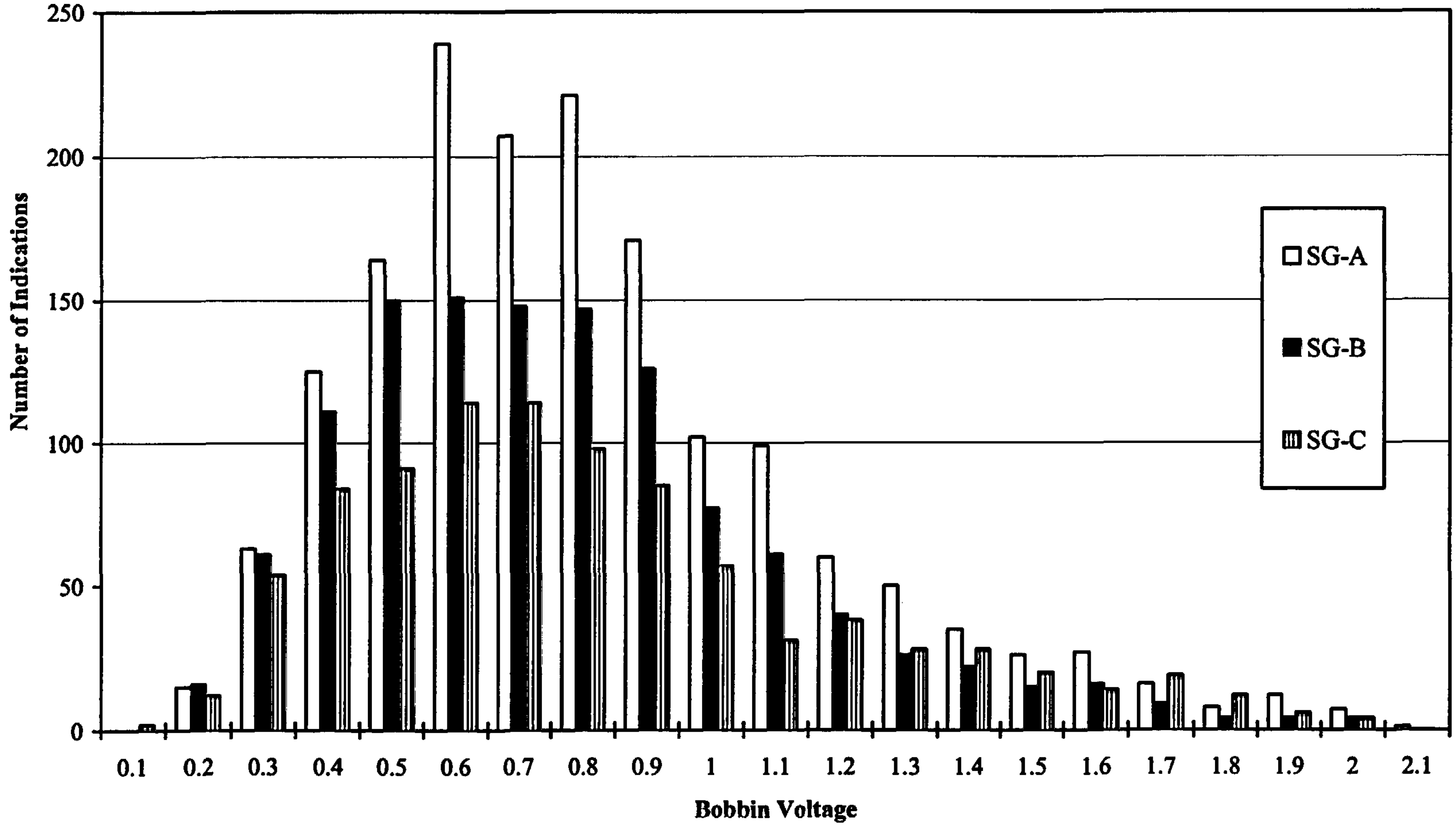


Figure 3-4
Beaver Valley Unit 1 - April 2003
ODSCC Axial Distributions for Tubes in Service During Cycle 15

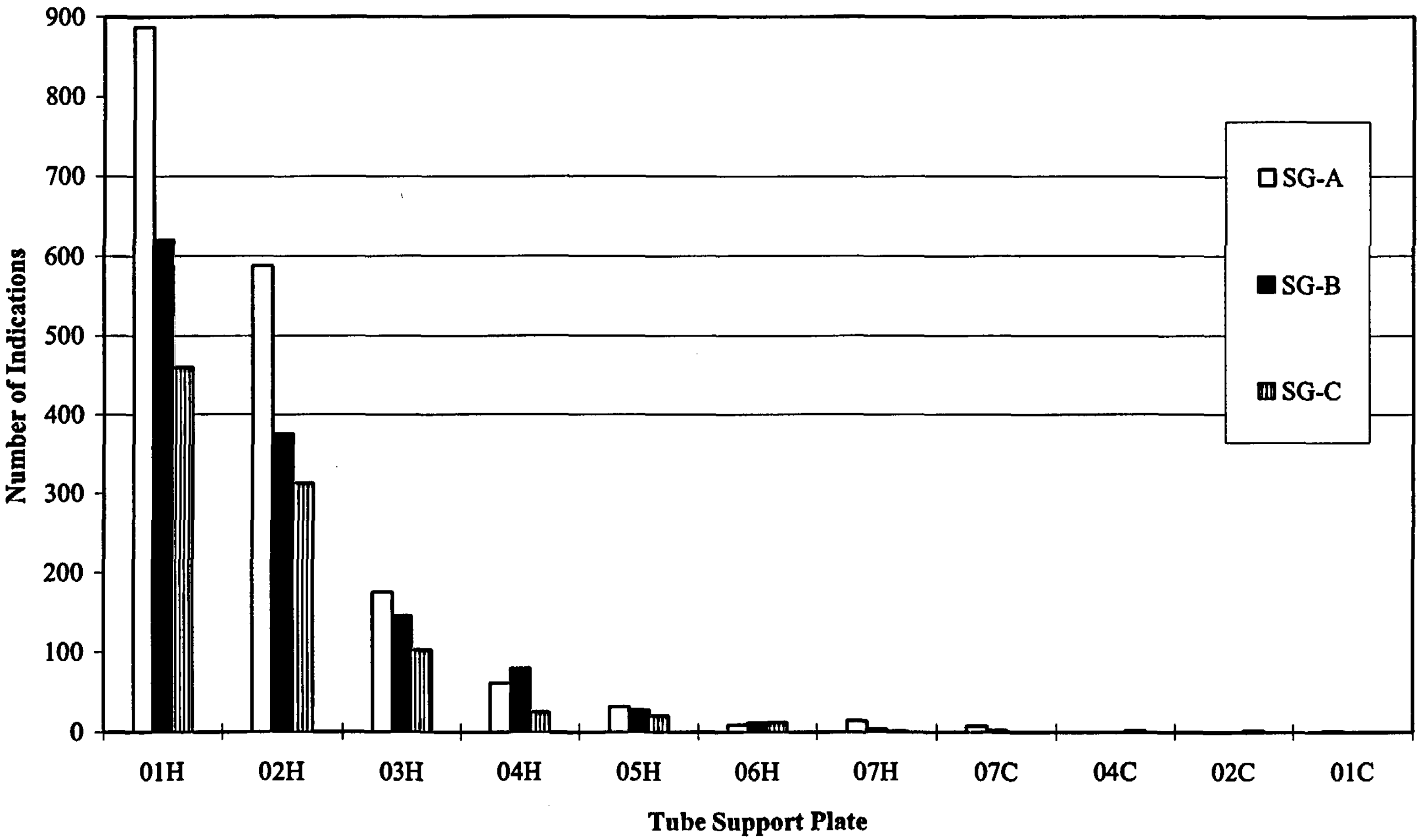


Figure 3-5
Beaver Valley Unit 1 Cycle 15 (Oct. 2001 to April 2003)
Cumulative Probability Distributions for Voltage Growth on an EFPY Basis

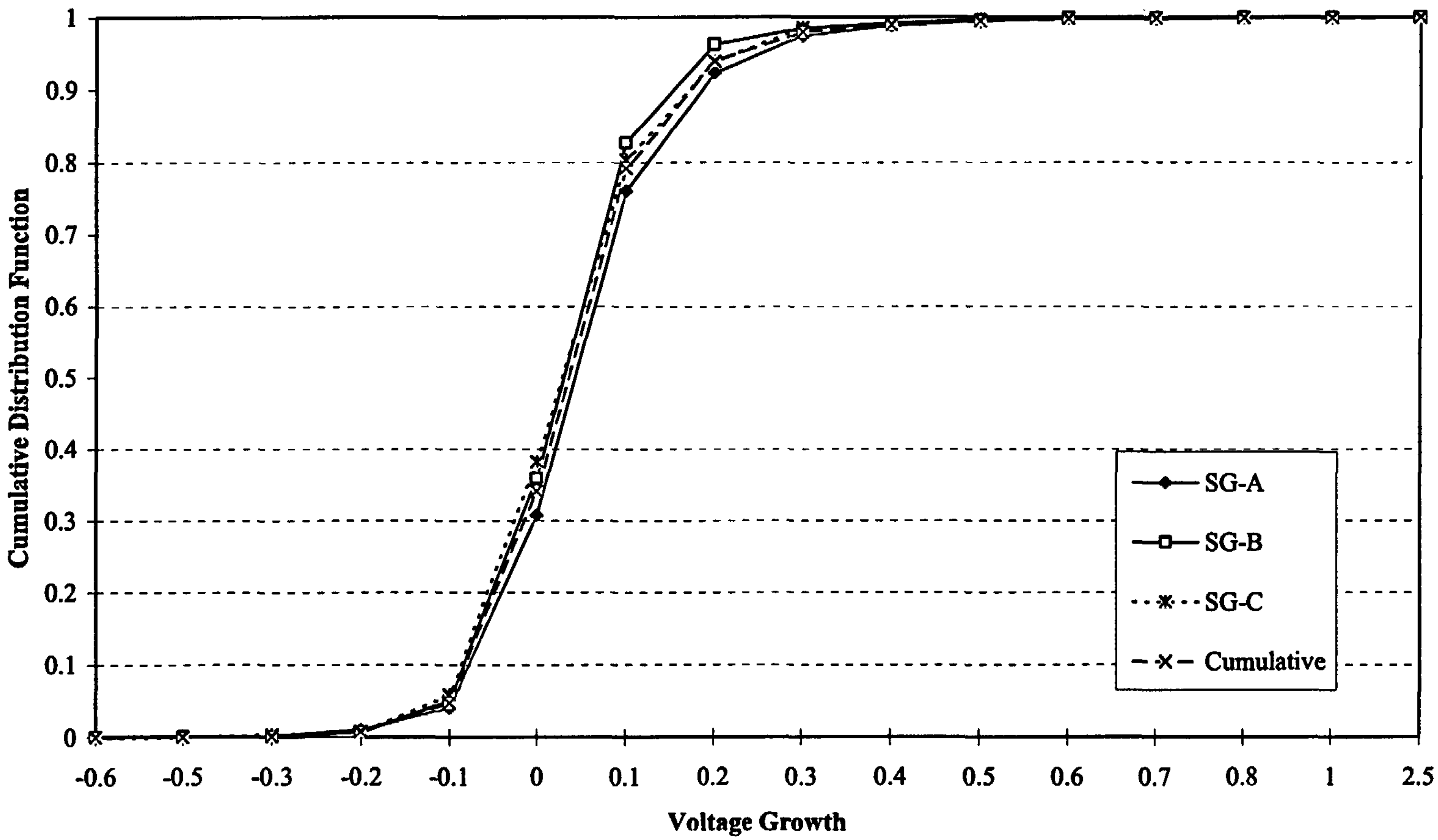


Figure 3-6
Beaver Valley Unit 1 - April 2003
Bobbin Signal Growth History - Cumulative Probability Distributions on an EFPY Basis
Composite of All Steam Generators

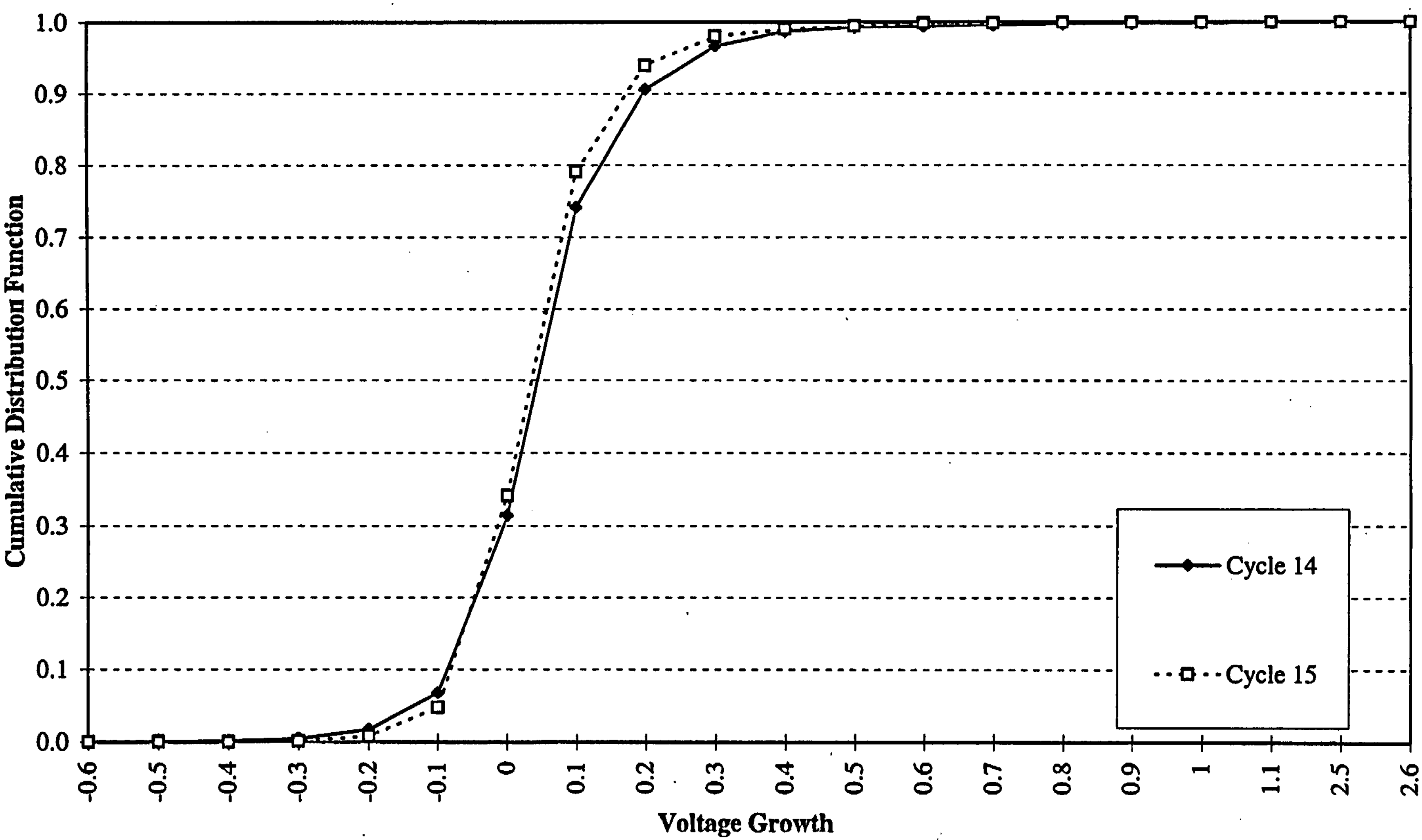
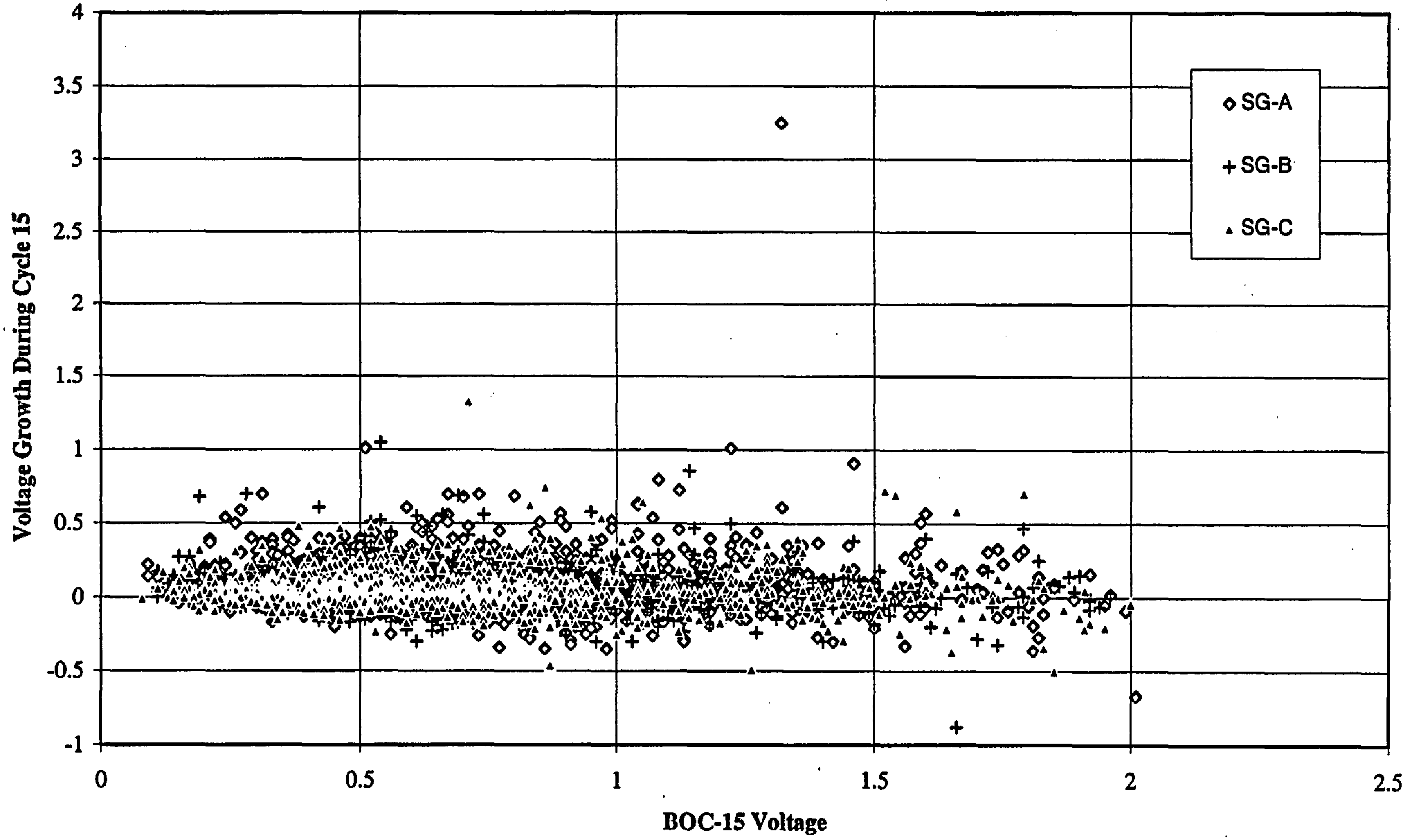


Figure 3-7
Beaver Valley Unit -1 March 2003 Outage
Voltage Growth During Cycle 15 vs BOC-15 Voltage -- All SG Data



GrowthFig3-76/14/03 12:27 PM

Figure 3-8
Beaver Valley Unit-1 EOC-15 Inspection
Comparison of Worn Probe Voltage Against New Probe Voltage

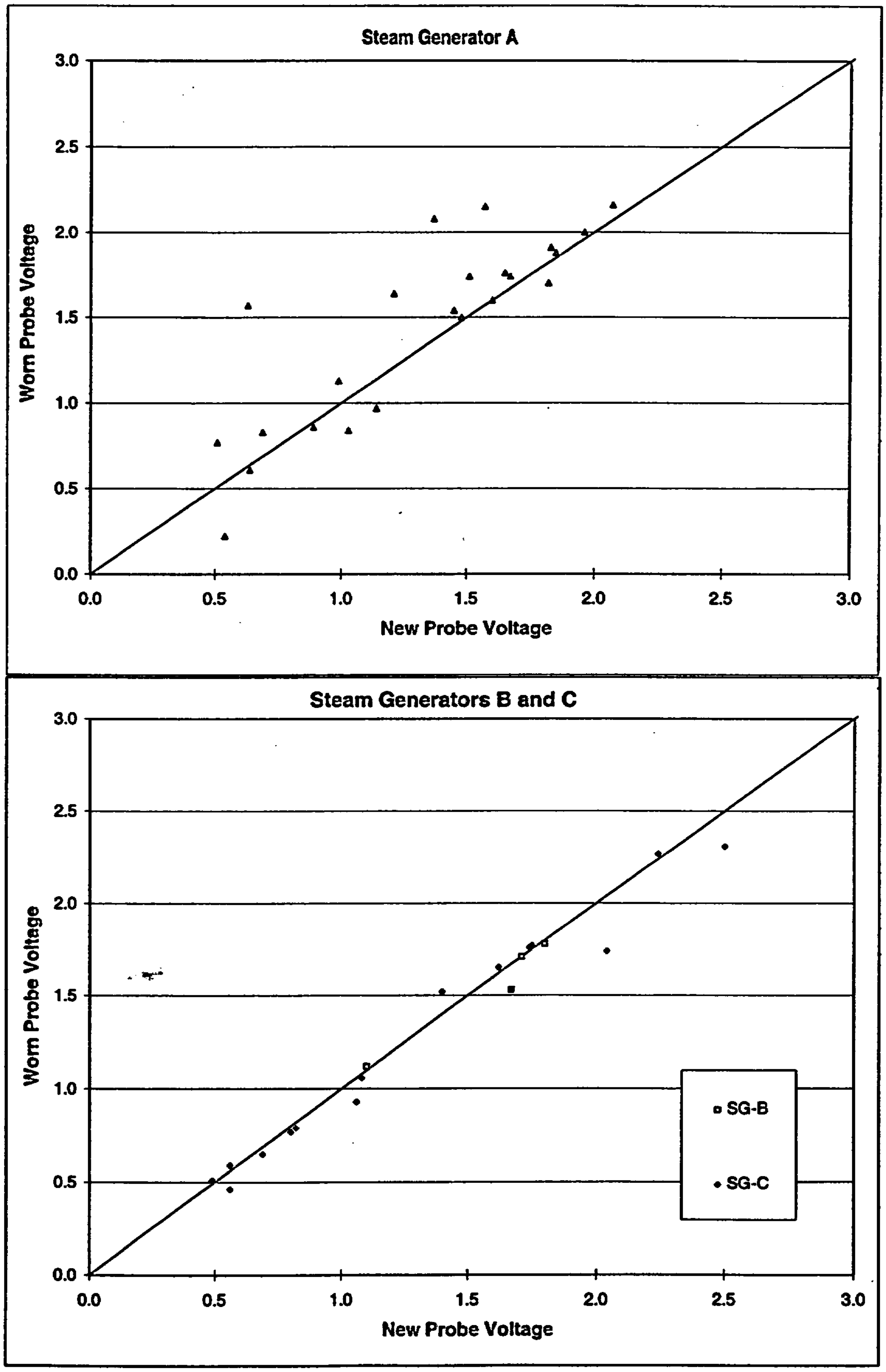
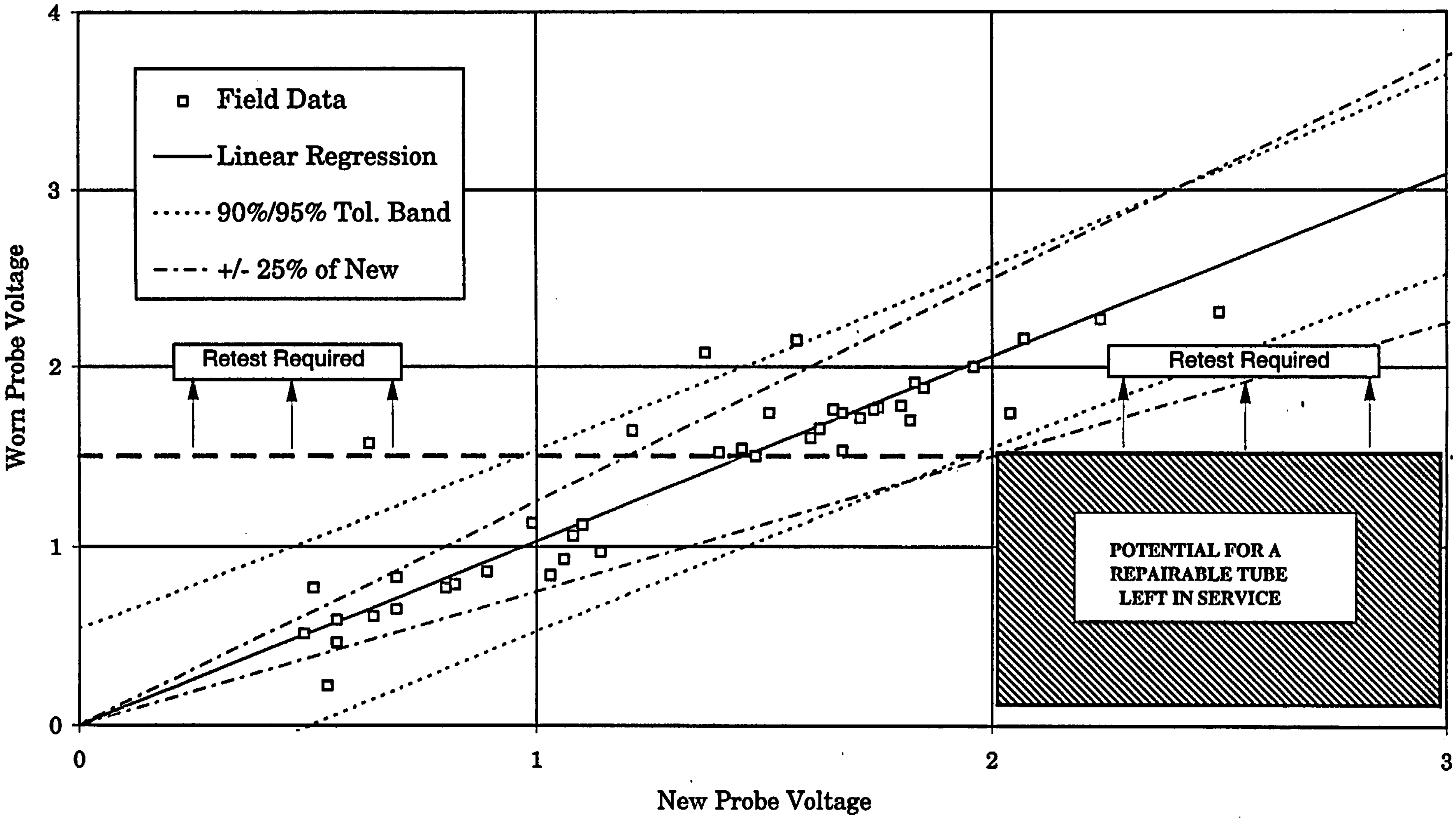
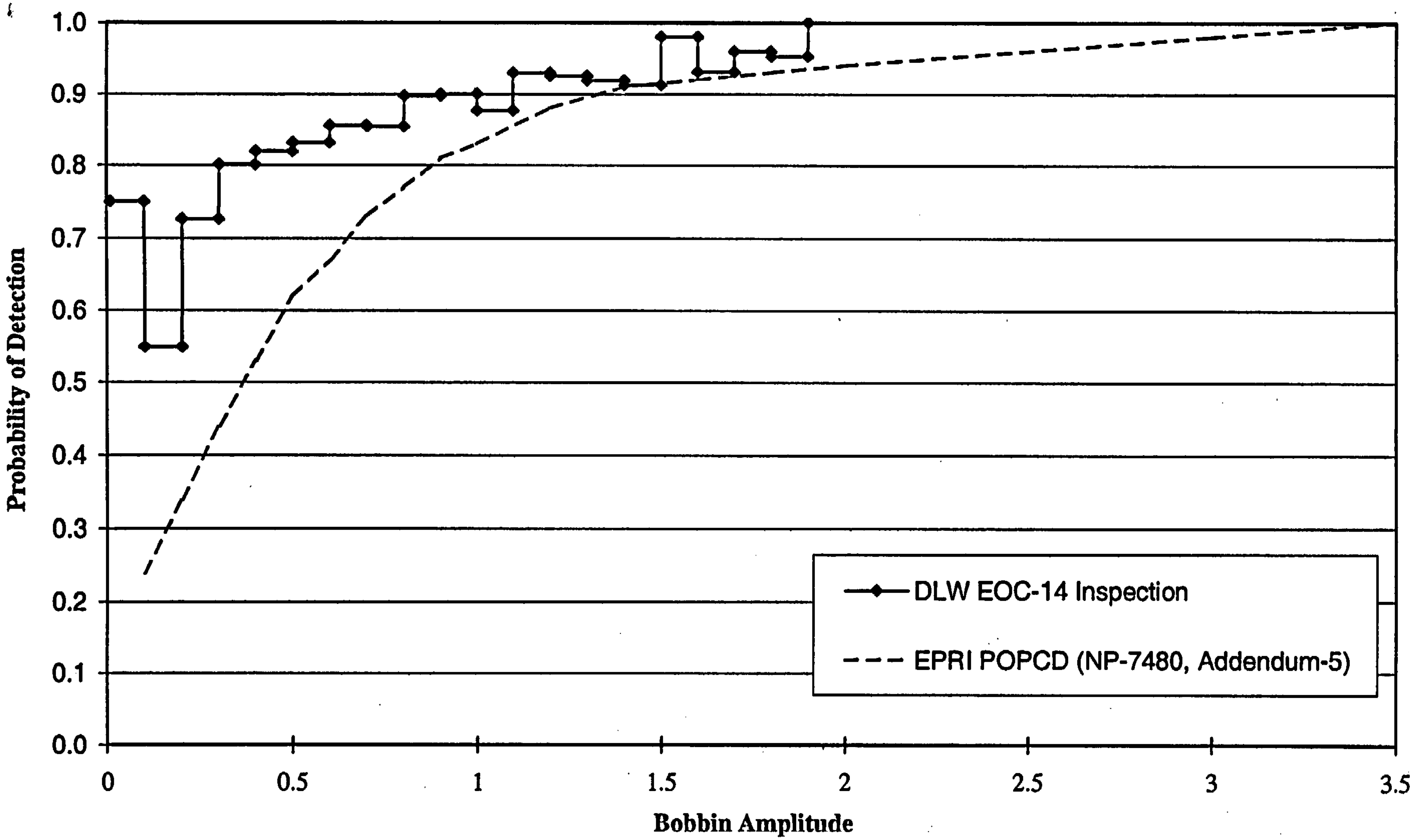


Figure 3-9
Beaver Valley Unit-1 April 2003
Worn Probe Volts vs New Probe Volts



[ProbeWear] Fig3-9 6/16/03 4:42 PM

Figure 3-10
Beaver Valley Unit 1
2003 EOC-15 Evaluation for POPCD at EOC-14



4.0 Database Applied for Leak and Burst Correlations

Leak and burst correlations based the latest update to the ARC database documented in Reference 8-5 (Addendum-5 update) were utilized to perform leak and burst calculations for both EOC-15 condition monitoring and Cycle 16 operational assessment.

The following are the correlations for burst pressure, probability of leakage and leak rate used in the reference analyses for this report (Reference 8-5).

$$\text{Burst Pressure } (ksi) = 7.4934 - 2.3775 \times \log(volts)$$

$$\text{Probability of Leak} = \frac{1}{1 + e^{-(-5.1017 + 7.3483 \times \log(\text{volts}))}}$$

$$\text{Leak Rate } (l/hr) = 10^{(-0.0691 + 0.7170 \times \log(volts))} \quad \text{at } \Delta P = 2560 \text{ psi}$$

$$\text{Leak Rate } (l/hr) = 10^{(-0.5348 + 0.9699 \times \log(\text{volts}))} \quad \text{at } \Delta P = 2405 \text{ psi}$$

The leak rate correlation shown for a primary-to-secondary pressure differential of 2560 psi was used for EOC-15 condition monitoring analysis. Cycle 16 operational assessment was carried out using the leak rate equation for 2405 psi pressure differential since the pressurizer PORV can be considered operational during a SLB event (Reference 8-7).

The upper voltage repair limit applied at the EOC-15 inspection was developed using the database presented in Reference 8-5, which is the latest database available for 7/8" diameter tubes prior to the 1R15 outage. The structural limit is 9.62 volts for a SLB differential pressure of 2405 psi (Reference 8-5). The allowance for growth is 30%/EFPY, which bounds the Beaver Valley Unit-1 historical growth data and is the minimum growth allowance required by Generic Letter 95-05 (Reference 8-1). For the expected Cycle 16 duration of 560 EFPD, the growth allowance becomes 46%. The allowance for NDE uncertainty is 20% per Generic Letter 95-05. The upper voltage repair limit is then 9.62/1.62=5.79 volts.

5.0 SLB Analysis Methods

A Monte Carlo analysis technique is used to calculate the SLB leak rates and tube burst probabilities for both actual EOC-15 and projected EOC-16 voltage distributions. The Monte Carlo analysis accounts for parameter uncertainty. The analysis methodology is described in the Westinghouse generic methods report of Reference 8-3, and the same methodology was applied to leak and burst analyses performed during the EOC-14 outage.

In general, the methodology involves application of correlations for burst pressure, probability of leakage 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. Uncertainties associated with burst pressure, leak rate probability and leak rate correlations' parameters are explicitly included by sampling distributions for the parameter uncertainties through the Monte Carlo sampling process. NDE uncertainties are also included. The voltage distributions used in the leak and burst projections 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 for a number of plants have shown that the Monte Carlo analysis technique yields conservative estimates for EOC voltage distribution as well as leak and burst results based on those distributions.

The leak rate calculation methodology has been revised recently (Reference 8-5) to change the logic used to determine whether or not a leak rate correlation can be applied, and the revised methodology was used to project EOC-16 leak rate. During the Monte Carlo simulations a test is made during each SG simulation to determine whether or not a correlation exists between leak rate and bobbin voltage. A regression correlation is applied for (1-p) fraction of the SG simulations, where "p" is the p-value for the leak rate correlation slope parameter. In the remaining simulations leak is assumed to be independent of bobbin voltage, and the leak rate is based on the mean and standard deviation of the leak data.

Equation 3.5 in Reference 8-3 was used to determine the true BOC voltage. The method of treating fractional indications is discussed in Section 3.6 of Reference 8-3. Fractional indications in the EOC voltage bins are retained, and the tail of the distribution is integrated to define discrete values corresponding to the last 1/3rd and 2/3rd of an indication.

6.0 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-16 voltage distributions. Also, EOC-15 voltage projections performed during the last outage based on the EOC-14 inspection bobbin voltage data are compared with the actual bobbin distributions from the current inspection.

6.1 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 based on the growth rate and the anticipated cycle operating period. The number of indications assumed in the analysis to project EOC voltage distributions, SLB leak rates and tube burst probabilities is obtained by adjusting the number of reported indications to account for detection uncertainty and birth 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 6.2. The calculation of projected bobbin voltage frequency distribution is based on a net total number of indications returned to service, defined as follows.

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

where,

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

There are no deplugged tubes returned to service at BOC-16; therefore, Ndeplugged = 0. As noted in Section 3-6, an NRC SER for Beaver Valley-1 (Reference 8-8) allows for consideration of only a fraction of the RPC NDD indications from the current inspection in establishing the BOC voltage distribution for the next cycle. The fractional value applicable is the largest RPC confirmation rate for the prior cycle RPC NDD indications found during the last two outages, but it may not be less than 0.7. The RPC confirmation rates for prior inspection RPC NDD indications in the last two inspections were about 36%; therefore, it would be justified to consider only 0.7 of EOC-15 RPC NDD indications in the Monte Carlo

analysis for tube integrity. However, all EOC-15 RPC NDD indications were conservatively included in establishing the BOC-16 indication distributions shown in Table 6-2. During the Monte Carlo simulations, voltages for bins with 3 or more indications are selected by randomly sampling the voltage bins. For bins with fewer than 3 indications, each indication is considered to be in a separate bin, and the actual indication voltage is utilized in the calculations.

The methodology used in the projection of EOC-16 bobbin voltage frequency distributions is described in Reference 8-3, and it is same as that used in performing EOC-15 predictions during the last (EOC-14) outage (Reference 8-2). The salient input data used for projecting EOC-16 bobbin voltage frequency are further discussed below.

6.2 Probability of Detection (POD)

The Generic Letter 95-05 (Reference 8-1) requires the application of a constant POD value of 0.6 to define the BOC distribution for EOC voltage projections, unless an alternate POD is approved by the NRC. A POD value of 1.0 represents the ideal situation where all indications are detected. A voltage-dependent POD provides a more accurate prediction of voltage distributions consistent with the 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 37 inspections in 13 plants and is presented in Table 6-4 of Reference 8-5. The POPCD values applied represent a lower 95% confidence bound, and they are reproduced here in Table 6-1 as well as graphically illustrated in Figure 6-1.

6.3 Limiting Growth Rate Distribution

As discussed in Section 3.2, the NRC guidelines in Generic Letter 95-05 stipulate that the more conservative growth rate distributions from the past two inspections should be utilized for projecting EOC distributions for the next cycle. Since the Cycle 14 growth distribution in Figure 3-6 lies to the right of the Cycle 15 distribution and has a slightly larger peak growth among the two cycles, it is considered more limiting. Therefore, Cycle 16 operational assessment analysis was carried out using the Cycle 14 distribution. Since the growth distributions for all 3 SGs are close each other for both Cycles 14 and 15, all SG composite growth distribution was used for all 3 SGs.

Growth distributions used in the Monte Carlo calculations are specified in the form of a histogram, so no interpolation is performed between growth bins. This assures that the largest growth value in the distribution is utilized in the Monte Carlo simulations.

6.4 Cycle Operating Period

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

Cycle 15 - 485 EFPD or 1.33 EFPY (actual)
Cycle 16 - 560 EFPD or 1.53 EFPY (projected)

6.5 Projected EOC-16 Voltage Distribution

Calculations for the EOC-16 bobbin voltage projections were performed for all three SGs based on the EOC-15 distributions shown in Table 6-2. The BOC distributions were adjusted to account for probability of detection as described above, and the adjusted number of indications at BOC-16 is also shown in Table 6-2. Calculations were performed using a constant POD of 0.6 as well as the EPRI POPCD distribution (presented in Table 6-1). SG A has the largest number of indications at BOC-16.

Cycle 14 growth distribution was found to be more limiting than the Cycle 15 distribution. The projected EOC-16 voltage distributions for all three SGs based on the Cycle 14 growth distribution are summarized on Table 6-3. These results are also shown graphically on Figures 6-2 to 6-4. In general, the results based on a constant POD of 0.6 are slightly more conservative (slightly larger number of indications in most voltage bins) than those using the voltage-dependent EPRI POPCD.

6.6 Comparison of Actual and Projected EOC-15 Voltage Distributions

Table 6-4 and Figure 6-5 provide a comparison of the EOC-15 actual measured bobbin voltage distributions with the corresponding projections performed using the last (EOC-14) inspection bobbin voltage data and presented in Reference 8-2. The EOC-15 projections based on a constant POD of 0.6 as well as the voltage-dependent POPCD are shown. As predicted in Reference 8-2, SG-A has the largest number of indications.

A comparison of the actual and projected voltage distributions in Figure 6-5 show that with the exception of a single indication in SG-A the indication population above 0.6 volt is substantially overestimated in the projections based on a constant POD of 0.6 as well as EPRI POPCD. Although a POD value of 0.6 is non- conservative for voltages below about 0.5 volt as seen in Figure 6-1, the reason for underestimating indications below 0.6 volts is due to the assumption that all new indications appear at the beginning of cycle. Full cycle growth is applied to all new indications in the Monte Carlo simulations, whereas in reality new indications are initiated throughout the cycle and experience only a fraction of the full cycle growth. Therefore, the Monte Carlo projection is conservative.

Table 6-1
EPRI POPCD Distribution
Based on Data from 37 Inspections in 13 Plants

Voltage Bin	EPRI POPCD#
0.1	0.29
0.2	0.40
0.3	0.51
0.4	0.59
0.5	0.66
0.6	0.72
0.7	0.77
0.8	0.80
0.9	0.83
1	0.85
1.2	0.88
1.4	0.89
1.6	0.91
1.8	0.93
2	0.94
3	0.98
3.5	1.0

Data from Table 7-4 in Reference 8-5

Table 6-2
Beaver Valley Unit 1 April 2003
EOC-15 Bobbin and Assumed BOC-16 Bobbin Distributions in SLB Leak Rate and Tube Burst Analyses

Voltage Bin	Steam Generator A				Steam Generator B				Steam Generator C			
	EOC - 15		BOC - 16		EOC - 15		BOC - 16		EOC - 15		BOC - 16	
	Field Bobbin Indications	Indications Repaired	POD 0.6	POPCD	Field Bobbin Indications	Indications Repaired	POD 0.6	POPCD	Field Bobbin Indications	Indications Repaired	POD 0.6	POPCD
0.1	0	0	0.0	0.0	0	0	0.0	0.0	2	0	3.3	6.9
0.2	15	0	25.0	37.5	17	1	27.3	41.5	13	1	20.7	31.5
0.3	64	1	105.7	124.5	62	1	102.3	120.6	55	1	90.7	106.8
0.4	133	8	213.7	217.4	119	8	190.3	193.7	85	1	140.7	143.1
0.5	168	4	276.0	250.5	152	2	251.3	228.3	91	0	151.7	137.9
0.6	250	11	405.7	336.2	158	7	256.3	212.4	114	0	190.0	158.3
0.7	215	8	350.3	271.2	153	5	250.0	193.7	116	2	191.3	148.6
0.8	228	7	373.0	278.0	151	4	247.7	184.8	101	3	165.3	123.3
0.9	181	10	291.7	208.1	130	4	212.7	152.6	86	1	142.3	102.6
1	112	10	176.7	121.8	81	4	131.0	91.3	59	2	96.3	67.4
1.1	114	15	175.0	116.8	70	9	107.7	71.9	34	3	53.7	36.3
1.2	72	12	108.0	69.8	45	5	70.0	46.1	38	0	63.3	43.2
1.3	56	6	87.3	57.3	29	3	45.3	29.8	29	1	47.3	31.8
1.4	42	7	63.0	40.2	26	4	39.3	25.2	31	3	48.7	31.8
1.5	34	8	48.7	29.8	20	5	28.3	17.2	22	2	34.7	22.4
1.6	31	4	47.7	30.1	19	3	28.7	17.9	14	0	23.3	15.4
1.7	19	3	28.7	17.7	10	1	15.7	9.9	20	1	32.3	20.7
1.8	11	3	15.3	8.8	6	2	8.0	4.5	12	0	20.0	12.9
1.9	12	0	20.0	12.8	7	3	8.7	4.5	6	0	10.0	6.4
2	8	1	12.3	7.5	6	2	8.0	4.4	4	0	6.7	4.3
2.1	5	4	4.3	1.3	3	3	2.0	0.2	1	1	0.7	0.1
2.2	2	2	1.3	0.1	0	0	0.0	0.0	0	0	0	0
2.3	1	1	0.7	0.1	1	1	0.7	0.1	3	3	2.0	0.2
2.4	1	1	0.7	0	0	0	0	0	0	0	0	0
2.5	0	0	0	0	0	0	0	0	1	1	0.7	0
3.2	0	0	0	0	0	0	0	0	0	0	0	0
4.6	1	1	0.7	0	0	0	0	0	0	0	0	0
Total	1775	127	2831.3	2237.5	1265	77	2031.3	1650.4	937	26	1535.7	1251.9
> 1V	409	68	613.7	392.2	242	41	362.3	231.6	215	15	343.3	225.5
> 2V	10	9	7.7	1.5	4	4	2.7	0.2	5	5	3.3	0.3

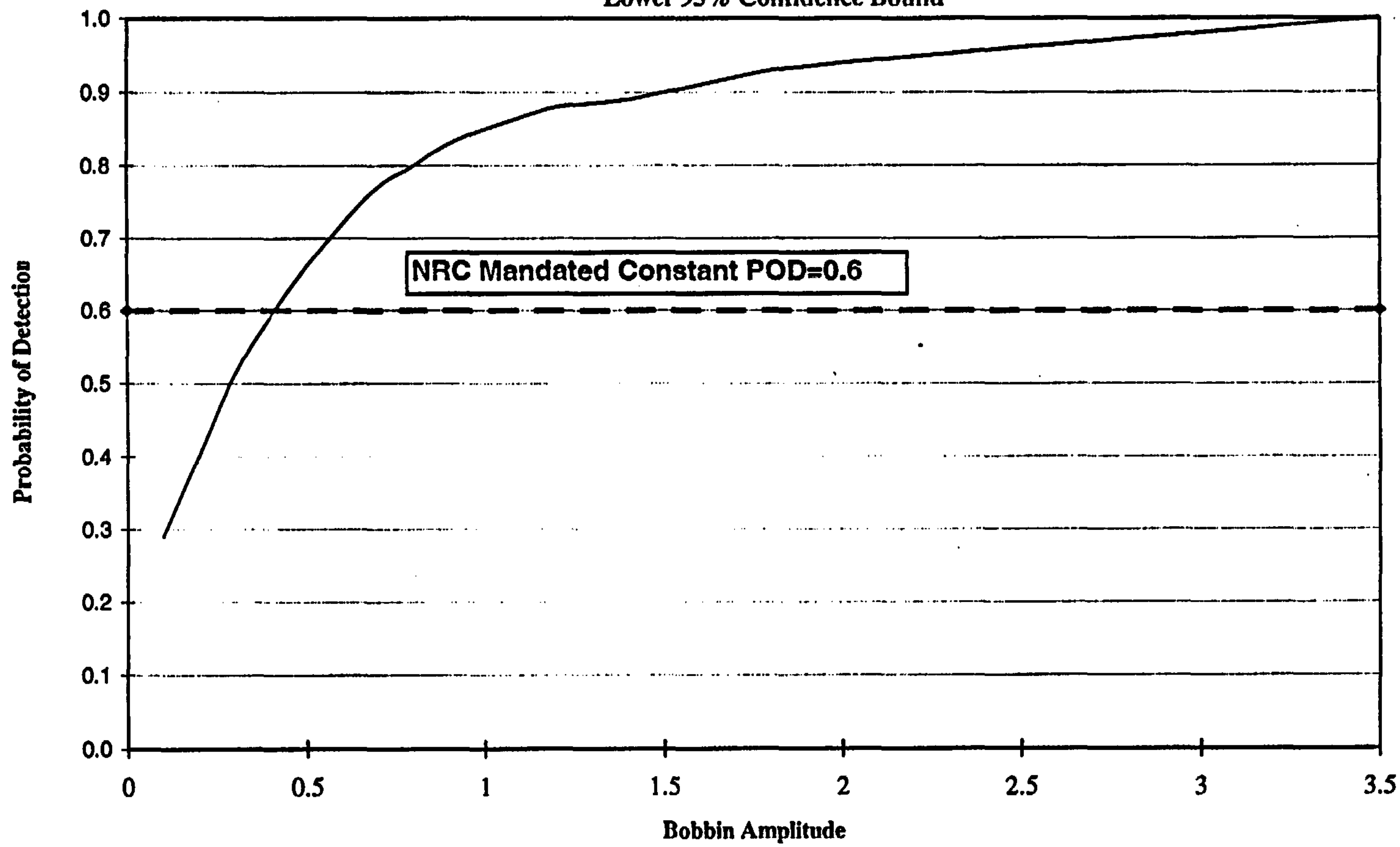
Table 6-3
Beaver Valley Unit 1 April 2003
Projected Voltage Distribution Projection for EOC - 16

Voltage Bin	Steam Generator A		Steam Generator B		Steam Generator C	
	Projected Number of Indications at EOC - 16					
	POD 0.6	POPCD	POD 0.6	POPCD	POD 0.6	POPCD
0.1	0.4	0.6	0.4	0.6	1.3	2.5
0.2	9.9	13.8	10.5	14.8	9.0	13.2
0.3	40.7	48.2	39.3	47.1	33.5	40.7
0.4	93.8	100.2	86.6	93.6	66.3	72.9
0.5	165.4	161.9	143.0	142.3	102.9	103.8
0.6	238.4	216.0	190.4	175.5	134.5	124.9
0.7	294.2	250.0	218.8	188.7	154.7	133.8
0.8	319.1	257.9	228.3	186.4	162.2	132.8
0.9	312.4	242.5	220.3	172.2	155.0	121.7
1.0	280.9	210.7	197.0	148.8	136.6	103.7
1.1	236.8	172.4	164.4	120.6	113.6	83.8
1.2	191.8	135.8	130.4	93.2	91.8	66.1
1.3	151.5	104.7	100.2	69.9	74.3	52.3
1.4	118.0	79.8	75.8	51.8	61.1	42.2
1.5	91.4	60.8	57.2	38.4	50.7	34.5
1.6	70.8	46.4	43.4	28.6	42.3	28.4
1.7	54.9	35.5	33.0	21.4	35.0	23.3
1.8	42.5	27.2	25.0	16.0	28.6	18.9
1.9	32.7	20.7	18.9	11.9	22.8	15.0
2.0	24.8	15.5	14.2	8.7	17.5	11.4
2.1	18.5	11.5	10.4	6.3	13.0	8.4
2.2	13.5	8.2	7.5	4.4	9.3	5.9
2.3	9.6	5.8	5.3	3.1	6.5	4.0
2.4	6.7	3.9	3.6	2.0	4.4	2.6
2.5	4.5	2.6	2.5	1.3	2.9	1.7
2.6	3.0	1.7	1.6	0.9	1.9	1.1
2.7	1.9	1.1	1.0	0.6	1.3	0.7
2.8	1.3	0.7	0.7	0.3	0.8	0.4
2.9	0.8	0.4	0.4	0.1	0.6	0.1
3.0	0.5	0.3	0.3	0.0	0.4	0.0
3.1	0.3	0.1	0.1	0.0	0.2	0.0
3.2	0.2	0.0	0.0	0.7	0.0	0.7
3.3	0.1	0.0	0.0	0.0	0.0	0.0
3.4	0.1	0.0	0.0	0.0	0.7	0.0
3.5	0.1	0.0	0.7	0.0	0.0	0.0
3.6	0.0	0.7	0.0	0.0	0.0	0.0
3.7	0.0	0.0	0.0	0.0	0.0	0.0
3.8	0.0	0.0	0.0	0.0	0.0	0.0
3.9	0.0	0.0	0.0	0.0	0.0	0.0
4.0	0.0	0.0	0.0	0.0	0.0	0.0
4.1	0.0	0.0	0.0	0.0	0.0	0.0
4.2	0.0	0.0	0.0	0.0	0.0	0.0
4.3	0.1	0.0	0.0	0.0	0.0	0.0
4.4	0.1	0.0	0.0	0.0	0.0	0.0
4.5	0.1	0.0	0.0	0.0	0.0	0.3
4.6	0.1	0.0	0.0	0.3	0.0	
4.7	0.0	0.0	0.0		0.3	
4.8	0.0	0.3	0.3			
4.9	0.7					
5.0	0.0					
5.1	0.0					
5.2	0.0					
5.3	0.3					
TOTAL	2833.0	2237.5	2031.4	1650.5	1535.7	1251.9
> 1 V	1077.7	735.9	696.9	480.5	579.8	401.9
> 2 V	62.7	37.1	34.4	20.0	42.2	26.0

Table 6-4
Beaver Valley Unit 1 April 2003
Comparison of Predicted and Actual EOC-15 Voltage Distributions

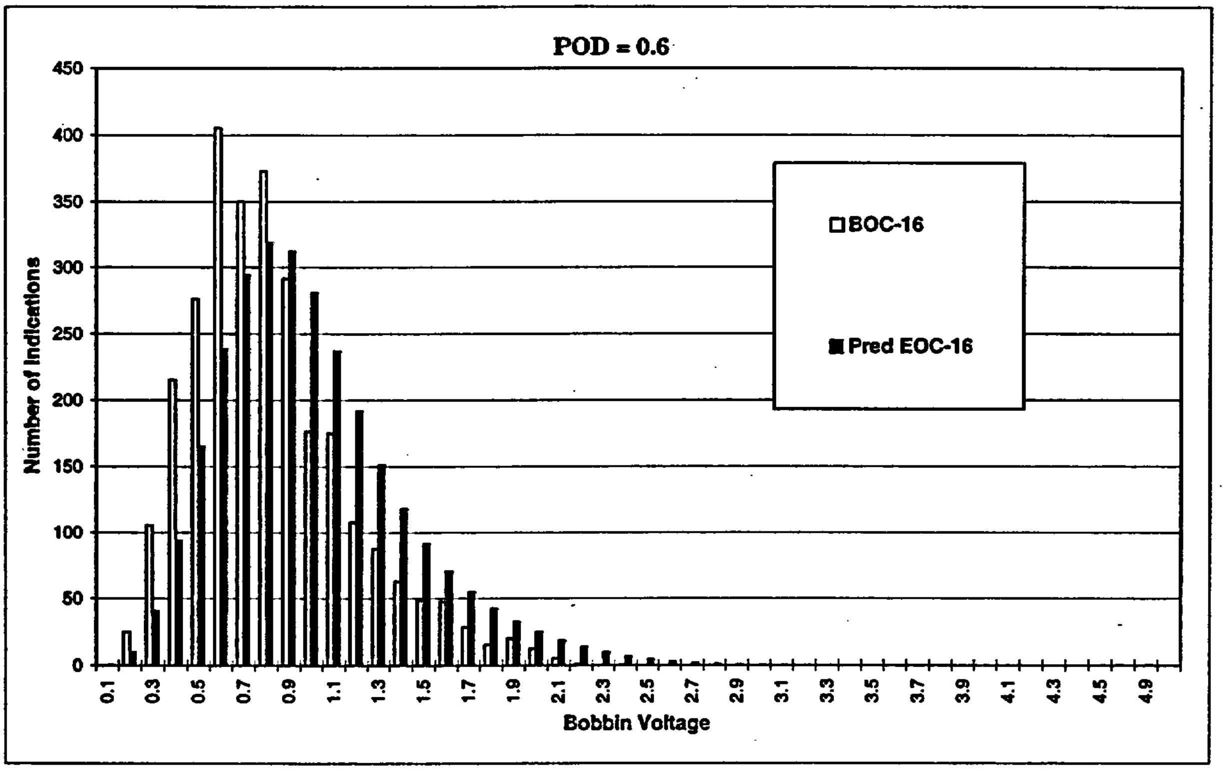
Voltage Bin	Steam Generator A			Steam Generator B			Steam Generator C		
	Number of Indications								
	EOC-15 Prediction		EOC-15 Actual	EOC-15 Prediction		EOC-15 Actual	EOC-15 Prediction		EOC-15 Actual
	POD = 0.6	POPCD		POD = 0.6	POPCD		POD = 0.6	POPCD	
0.1	0.2	0.4	0	0.2	0.2	0	0.3	0.5	2
0.2	2.4	3.5	15	3.5	5.0	17	3.3	5.0	13
0.3	14.4	18.3	64	17.6	23.6	62	14.9	20.2	55
0.4	54.5	63.2	133	48.1	57.6	119	39.8	48.2	85
0.5	122.3	130.7	168	103.4	113.1	152	81.7	90.0	91
0.6	205.4	202.9	250	159.1	158.4	158	119.1	119.8	114
0.7	263.7	242.3	215	205.1	189.6	153	146.6	136.5	116
0.8	289.7	249.9	228	221.3	191.9	151	155.2	134.8	101
0.9	285.9	233.3	181	210.5	173.3	130	154.4	126.3	86
1.0	261.1	203.0	112	184.6	145.1	81	142.2	110.7	59
1.1	223.0	166.7	114	153.3	115.9	70	120.8	90.6	34
1.2	181.1	131.1	72	122.2	89.5	45	96.6	70.3	38
1.3	142.4	100.6	56	94.7	67.7	29	75.9	53.6	29
1.4	109.8	76.2	42	72.7	50.9	26	60.7	42.1	31
1.5	83.7	57.1	34	55.8	38.5	20	49.6	33.9	22
1.6	63.2	42.6	31	42.9	29.2	19	40.9	27.6	14
1.7	47.6	31.8	19	32.9	22.1	10	33.6	22.4	20
1.8	35.8	23.6	11	25.1	16.7	6	27.3	18.0	12
1.9	26.7	17.5	12	19.0	12.4	7	21.7	14.2	6
2.0	19.8	12.8	8	14.2	9.2	6	16.9	10.9	4
2.1	14.4	9.1	5	10.6	6.6	3	12.8	8.1	1
2.2	10.2	6.3	2	7.7	4.7	0	9.3	5.8	0
2.3	7.0	4.2	1	5.4	3.2	1	6.6	4.0	3
2.4	4.7	2.7	1	3.7	2.1	0	4.4	2.6	0
2.5	3.1	1.7	0	2.4	1.3	0	2.9	1.7	1
2.6	2.0	1.0	0	1.5	0.8	0	1.8	1.0	0
2.7	1.3	0.3	0	0.9	0.0	0	1.1	0.3	0
2.8	0.9	0.0	0	0.2	0.7	0	0.6	0.7	0
2.9	0.6	0.7	0	0.7	0.3	0	0.4	0.0	0
3.0	0.2	0.3	0	0.0		0	0.1	0.3	0
3.1	0.0		0	0.3		0	0.0		0
3.2	0.7		0			0	0.0		0
3.3	0.0		0			0	0.0		0
3.4	0.3		0			0	0.7		0
3.5			0			0	0.0		0
3.6			0			0	0.0		0
3.7			0			0	0.0		0
3.8			0			0	0.0		0
3.9			0			0	0.0		0
4.0			0			0	0.0		0
4.1			0			0	0.0		0
4.2			0			0	0.0		0
4.3			0			0	0.0		0
4.4			0			0	0.0		0
4.5			0			0	0.0		0
4.6			1			0	0.0		0
4.7			0			0	0.0		0
4.8			0			0	0.0		0
4.9			0			0	0.0		0
5.0			0			0	0.0		0
5.1			0			0	0.0		0
5.2			0			0	0.0		0
5.3			0			0	0.0		0
5.4			0			0	0.0		0
5.5			0			0	0.0		0
5.6			0			0	0.0		0
5.7			0			0	0.0		0
5.8			0			0	0.00		0
5.9			0			0	0.30		0
TOTAL	2478.0	2033.6	1775.0	1819.5	1529.3	1265.0	1442.3	1200.2	937.0
> 1 V	978.4	686.2	409.0	666.1	471.6	242.0	584.8	408.4	215.0
> 2 V	45.3	26.3	10.0	33.2	19.5	4.0	40.9	24.5	5.0

Figure 6-1
EPRI Probability of Detection Distribution
Lower 95% Confidence Bound



C:\data\dlw_01\report\Cycle14_90d.doc

Figure 6-2
Beaver Valley Unit 1 SG-A
Predicted Bobbin Voltage Distribution for Cycle 16



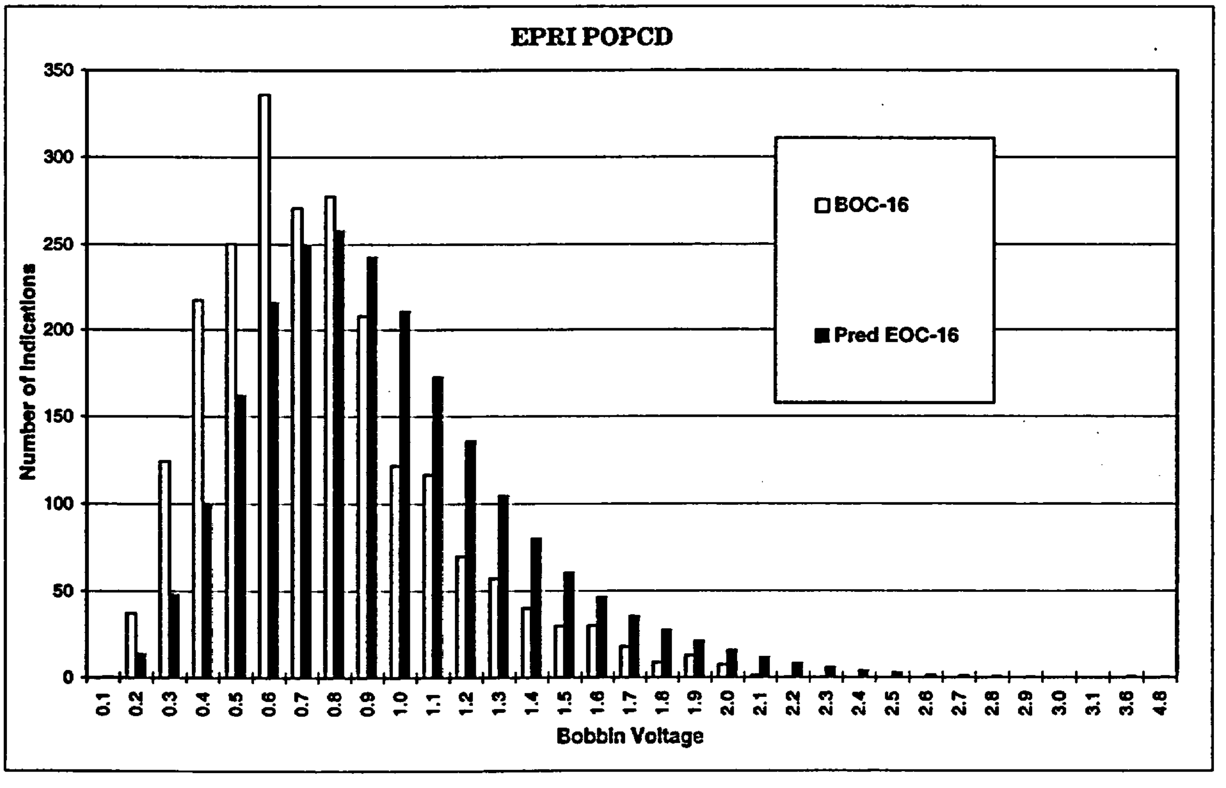
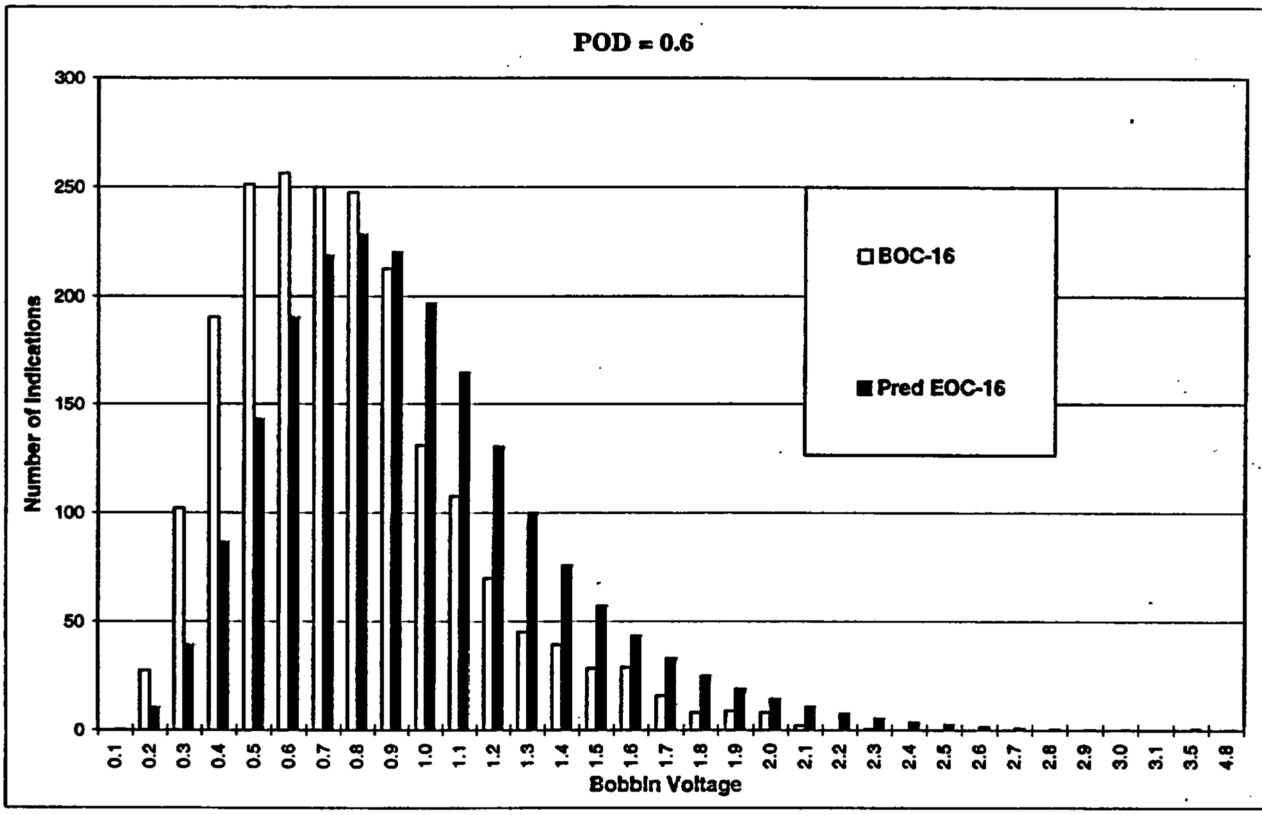


Figure 6-3
Beaver Valley Unit 1 SG-B

Predicted Bobbin Voltage Distribution for Cycle 16



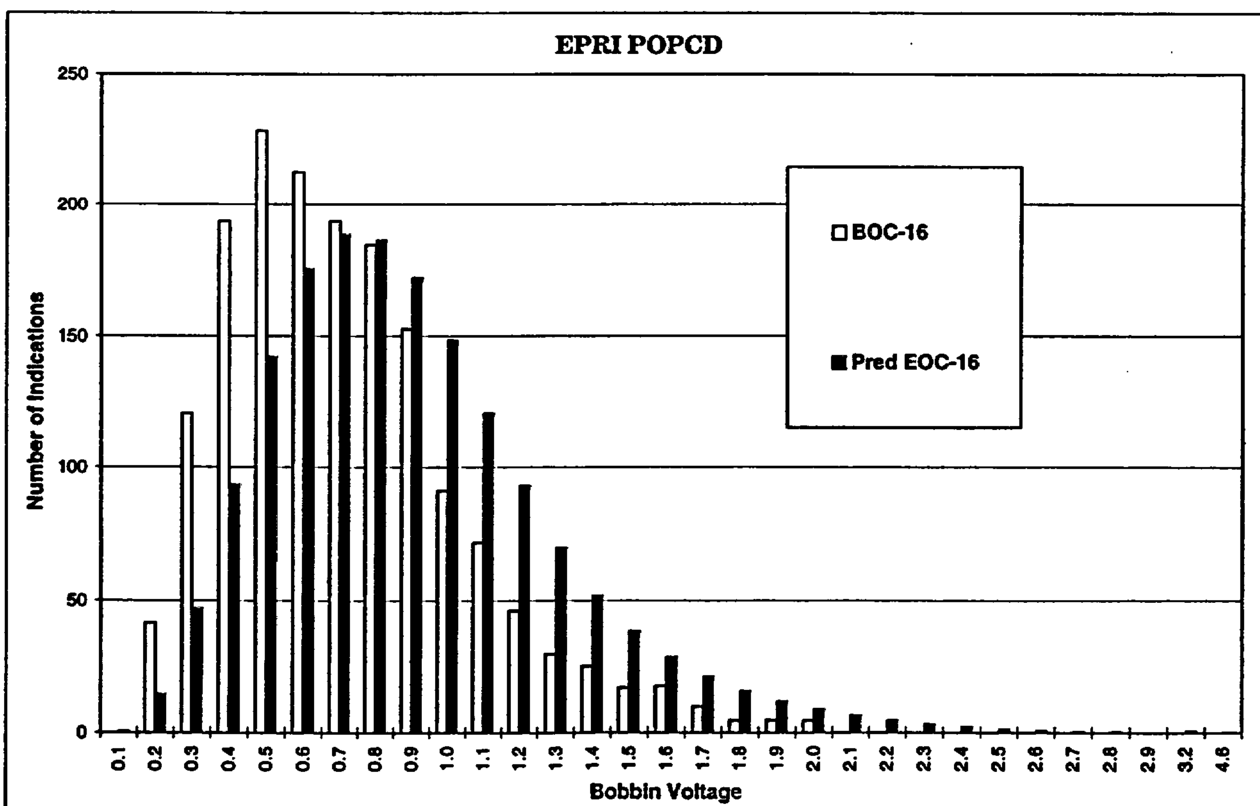
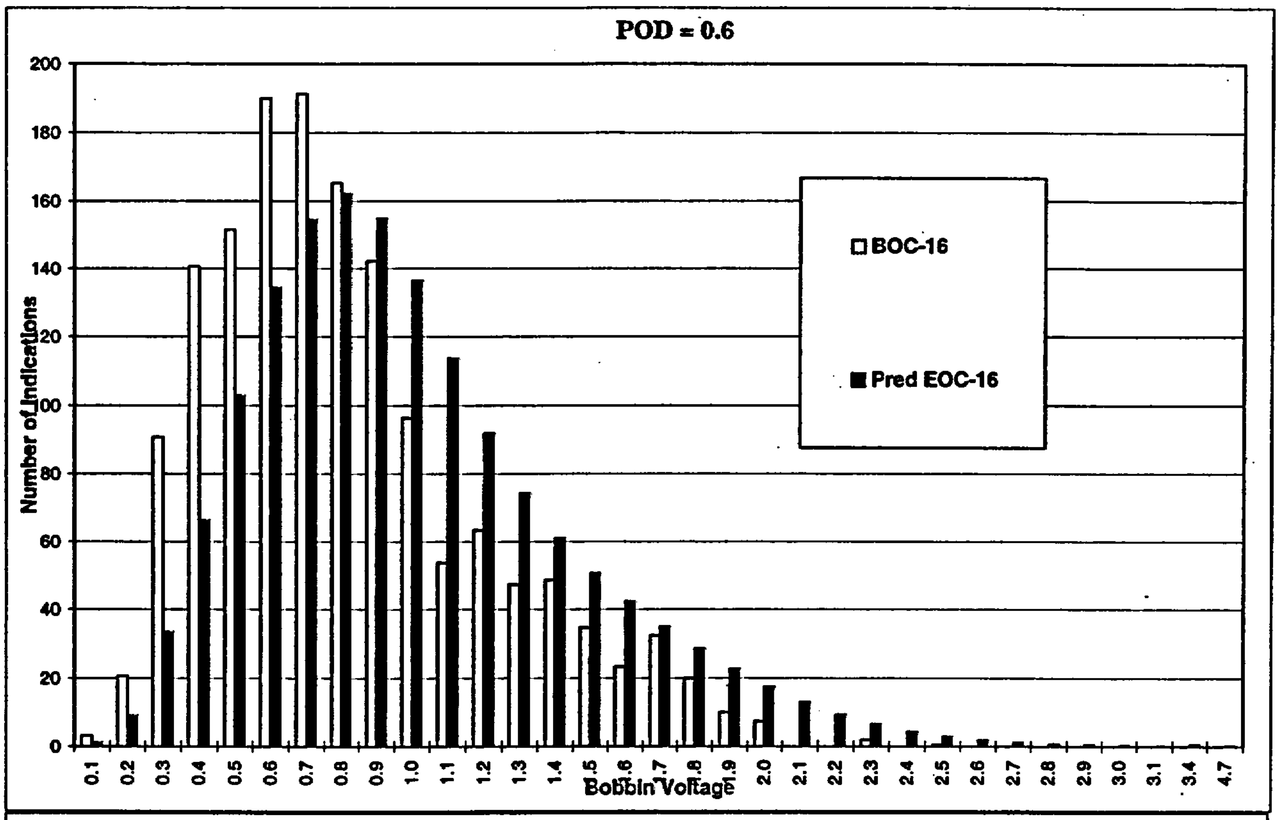


Figure 6-4
Beaver Valley Unit 1 SG-C
Predicted Bobbin Voltage Distribution for Cycle 16



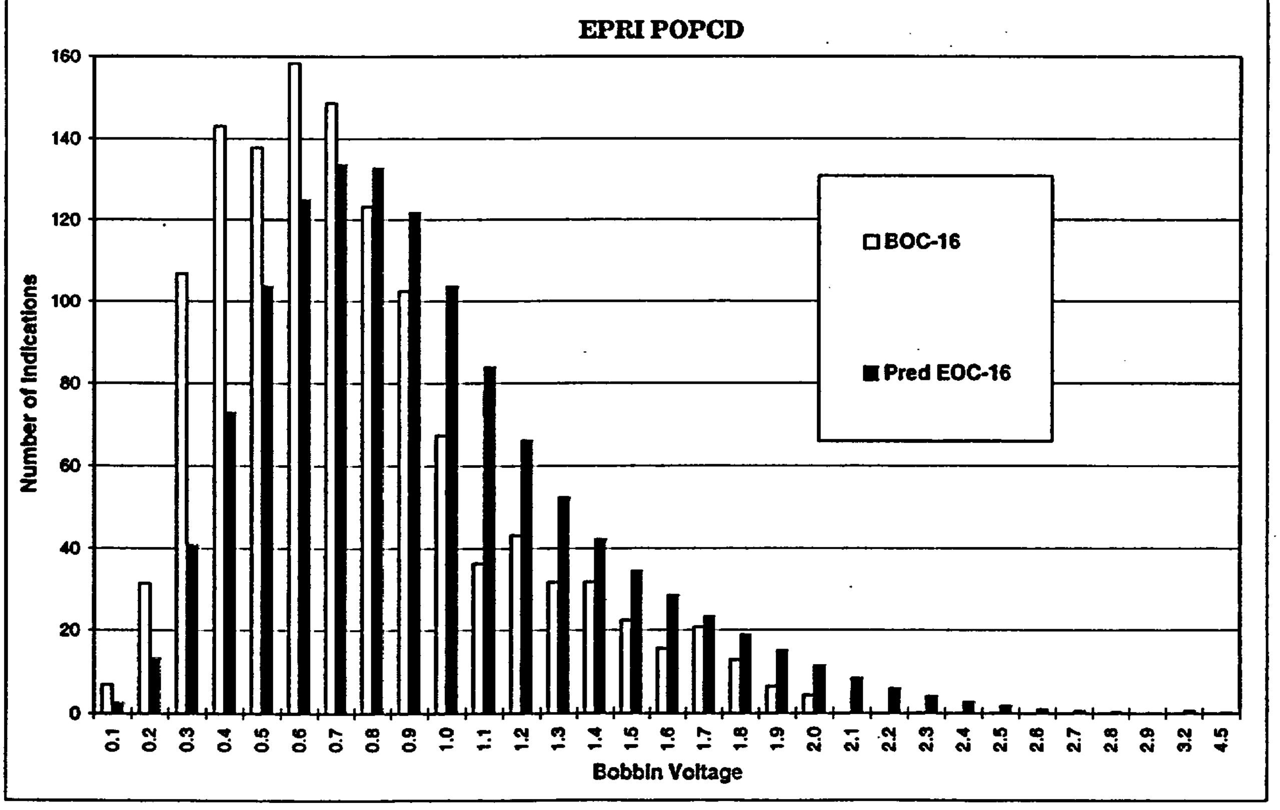
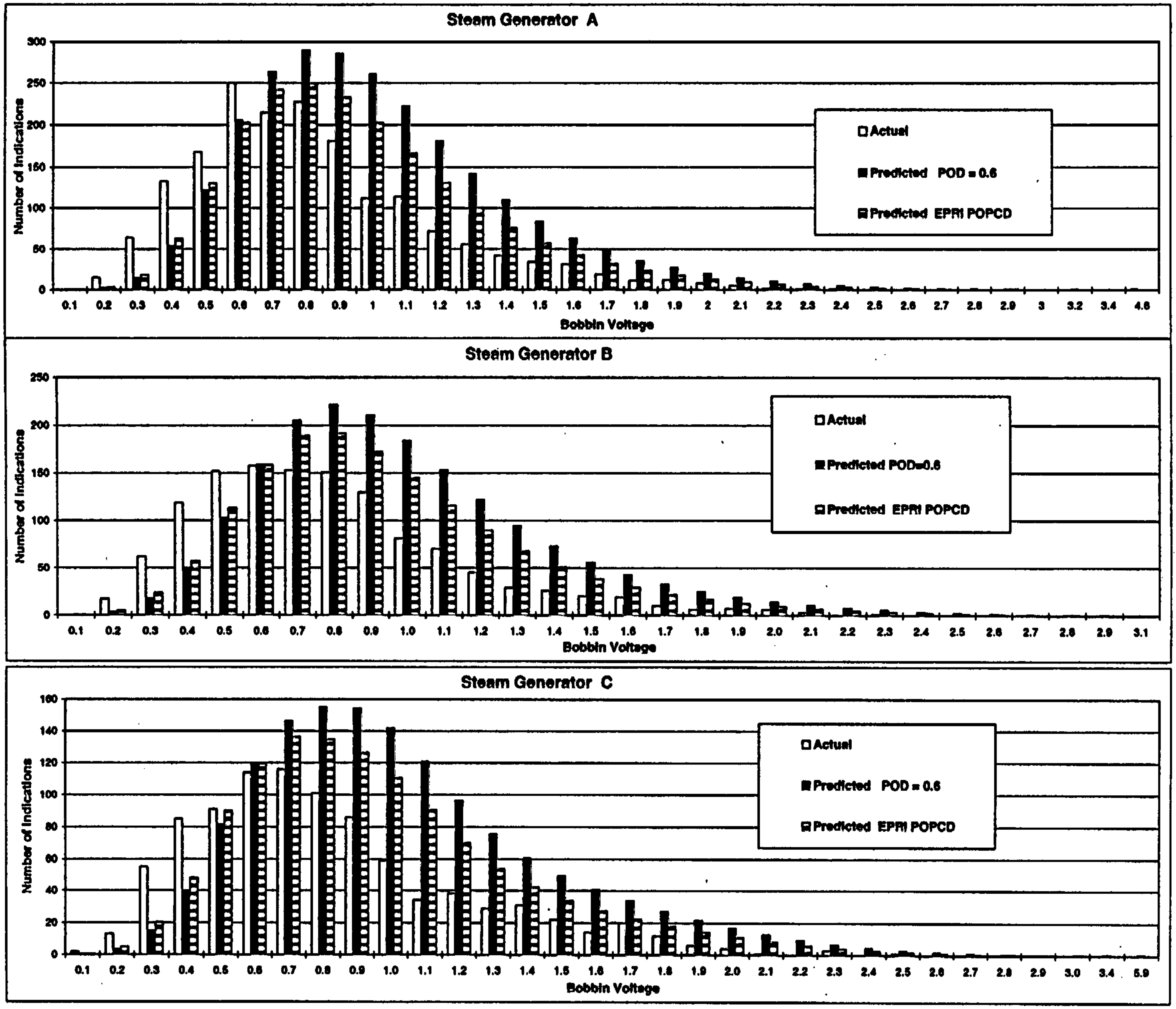


Figure 6-5
Beaver Valley Unit 1 April 2003
Bobbin Voltage Distributions for Cycle 15



Predcomp Fig_6 6/15/03 3:02 PM

7.0 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 at the postulated SLB conditions using the actual voltage distributions from the EOC-15 inspection (condition monitoring assessment) as well as for the projected EOC-16 voltage distributions (operational assessment). The methodology used in these analyses is described in Section 6.0. SG-A with the largest total number of indications as well as indications over 1 volt is expected to yield the limiting SLB leak rate and burst probability for Cycle 16.

7.1 EOC-15 Condition Monitoring Leak Rate and Tube Burst Probability

Analyses to calculate the EOC-15 SLB leak rates and tube burst probabilities were performed using the actual bobbin voltage distributions presented in Table 6-2. The results of Monte Carlo calculations are summarized on Table 7-1. A comparison of the EOC-15 condition monitoring results in Table 7-1 with the corresponding Cycle 15 operational assessment, also shown in Table 7-1, indicates the following.

a) Total number of indications found in the EOC-15 inspection for all three SGs are well below their projections based on POD=0.6 as well as EPRI POPCD. With the exception of a single indication in SG-A, the measured voltages are well below their projected values based on both Cycles 13 and 14 growth data.

b) The leak rates from the Cycle 15 operational assessment (based on a constant POD of 0.6) are conservative relative to EOC-15 condition monitoring values for all SGs. The corresponding tube burst probability values are slightly below the condition monitoring values; but they still an order of magnitude below the NRC reporting guideline of 10^{-2}. The maximum difference between the tube burst probabilities from operational assessment and condition monitoring analyses is less than 5% of the reporting guideline, and therefore is not significant.

c) The EOC- 15 projections for both leak rates and tube burst probabilities based on the voltage dependent POPCD are slightly below the corresponding condition monitoring values. The largest difference between the projections and condition monitoring results for both leak rate and burst probability is within about 7% of their respective acceptance limits, which is not significant.

d) As predicted, SG-A was confirmed as the limiting steam generator at EOC-15 based on the SLB leak rate and tube burst probability analysis using the actual EC bobbin measurements for EOC-15.

e) The limiting values for SLB leak rate (5.0 gpm at room temperature) and tube burst

probability (8.2×10^{-4}) obtained using the actual measured voltages are well below the allowable SLB leakage limit effective at EOC-15 (14.5 gpm) and the NRC reporting guideline of 10^{-2} for the tube burst probability.

In summary, the EOC-15 condition monitoring results are in reasonable agreement with the Cycle 15 operational assessment results obtained using the NRC mandated probability of detection of 0.6 and are well within the allowable limits.

7.2 Cycle 16 Operational Assessment Leak Rate and Tube Burst Probability

The SLB leak rate and tube burst probability projection for the Cycle 16 operational assessment was carried out using the latest update to the ARC database documented in Reference 8-5. Since credit can be taken for operability of the pressurizer PORV during a SLB event (Reference 8-7), the EOC-16 leak and burst analyses were performed using a primary-to-secondary pressure differential of 2405 psi.

SG-A is again predicted to be the limiting SG. Reference calculations for the EOC-16 SLB leak rate using the ARC database documented in Reference 8-5 show that for a cycle duration of 560 EFPD the limiting EOC-16 leak rate, calculated for SG-A using the NRC mandated constant POD of 0.6, is equal to 3.58 gpm (room temperature), which is less than one-fourth of the current limit of 14.5 gpm. This limiting leak rate is below the peak leak rate from the condition monitoring analysis because the operational assessment is based on a primary-to-secondary differential pressure of 2405 psi where as the condition monitoring analysis is based on 2560 psi pressure differential. The limiting burst probability for SG-A, also calculated with POD=0.6, is 1.0×10^{-3}, which is an order of magnitude below the NRC reporting guideline of 10^{-2}. Table 7-2 provides the SLB leak rates and tube burst probabilities calculated for all 3 SGs using the constant POD of 0.6 as well as the voltage dependent EPRI POPCD distribution. The application of more realistic EPRI POPCD distribution to establish the BOC-16 voltage distributions results in a reduction of reference SLB leak rates and tube burst probabilities by about 30% relative to the projections based on a constant POD of 0.6.

Table 7-1
Beaver Valley Unit 1 2003 EOC-15 Outage
Summary of Calculations of Tube Leak Rate and Burst Probability

Steam Generator	POD	Number of Indications[1]	Max. Volts	Burst Probability		SLB Leak Rate [gpm[2]]
				1 Tube	1 or More Tubes	
Cycle 15 Operational Assessment (Leak rates and burst probabilities were calculated using both Cycle 13 and Cycle 14 growth data and the larger values for the two growth cases are presented) Leak and burst database and correlations presented in Reference 8-9 (Addendum-4 database) Applied						
A	0.6	2481	3.4[3]/4.8[4]	2.5×10^{-4} [4]	2.8×10^{-4} [4]	5.50[3]
B		1823	3.1[3]/4.6[4]	1.9×10^{-4} [3]	1.9×10^{-4} [3]	3.84[3]
C		1452	5.9[3]/5.8[4]	3.1×10^{-4} [3]	3.1×10^{-4} [3]	3.40[3]
A	POPCD	2036	3.0[3]/4.6[4]	1.8×10^{-4} [4]	1.8×10^{-4} [4]	3.95[3]
B		1532	2.9[3]/4.5[4]	1.5×10^{-4} [4]	1.5×10^{-4} [4]	2.81[3]
C		1207	3.0[3]/4.3[4]	1.7×10^{-4} [3]	1.7×10^{-4} [3]	2.42[3]
EOC-15 Condition Monitoring Leak and burst database and correlations presented in Reference 8-5 (Addendum-5 database) Applied						
A	1	1775	4.57	8.1×10^{-4}	8.2×10^{-4}	5.0
B		1265	2.26	4.3×10^{-4}	4.3×10^{-4}	2.9
C		937	2.50	3.5×10^{-4}	3.5×10^{-4}	2.6

Notes:

1. Number of indications adjusted for POD.
2. Volumetric leak rate adjusted to room temperature.
3. Based on Cycle 13 all SG composite growth rate distribution.
4. Based on Cycle 14 all SG composite growth rate distribution.

Table 7-2
Beaver Valley Unit-1 Cycle 16 Operational Assessment
Tube Leak Rate and Burst Probability at EOC-16
(Based on a projected Cycle 16 length 560 EFPD)

Steam Generator	POD	No. of Indic-ations[1]	Max Volts	Burst Probability		SLB Leak Rate (gpm)[2]	Comments
				1 Tube	One or More Tubes		
Leak and Burst Database and Correlations Reported in Reference 8-5 (Addendum-5) Applied (Leak rates and burst probabilities were calculated at 2405 psi pressure differential)							
A	0.6	2833	5.3	1.0×10^{-3}	1.0×10^{-3}	3.58	Leak rate Correlation applied
B		2031	4.8	5.4×10^{-4}	5.4×10^{-4}	2.24	
C		1536	4.7	5.4×10^{-4}	5.4×10^{-4}	2.04	
A	POPCD	2236	4.8	6.3×10^{-4}	6.3×10^{-4}	2.42	
B		1650	4.6	3.7×10^{-4}	3.7×10^{-4}	1.53	
C		1252	4.5	4.0×10^{-4}	4.0×10^{-4}	1.37	

Notes

1. Number of indications adjusted for POD.
2. Volumetric leak rate adjusted to room temperature.

8.0 References

8-1 NRC Generic Letter 95-05, "Voltage-Based Repair Criteria for the Repair of Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking," USNRC Office of Nuclear Reactor Regulation, August 3, 1995.

8-2 SG-SGDA-01-04, "Beaver Valley Unit-1 Cycle 15 Voltage-Based Repair Criteria 90-Day Report," Westinghouse Electric Company, December 2001.

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

8-4 NRC letter from William H. Bateman to Alex Marion (NEI), "Refining the Leak Rate sampling Methodology for Generic Letter 95-05 Voltage-Based Alternate Repair Criteria Application," March 27, 2002.

8-5 EPRI Report 1007660, "Steam Generator Tubing Outside Diameter Stress Corrosion Cracking at Tube Support Plates Database for Alternate repair Limits, NP 7480-L, Addendum 5, 2002 Database, " November 2002.

8-6 Letter from B. W. Sheron, Nuclear Regulatory Commission, to A. Marion, Nuclear Energy Research Institute, February 9, 1996.

8-7 Beaver Valley Unit-1, Updated Final Safety Analysis Report, March 2002.

8-8 U.S. N.R.C. Report, "Safety Evaluation by the Office of Nuclear Reactor Regulation Related to Amendment No. 198 to Facility Operating License DPR-66 Duquesne Light Company, Ohio Edison Company and Pennsylvania Power Company, Beaver Valley Power Station, Unit No. 1 Docket No. 50-334", April 1, 1996.

8-9 EPRI Report NP 7480-L, Addendum 4, "Steam Generator Tubing Outside Diameter Stress Corrosion Cracking at Tube Support Plates Database for Alternate repair Limits," Electric Power Research Institute, March 2001.

Appendix

**Response to the NRC's Request for Additional Information (RAI)
As Requested in the NRC Letter (Colburn to Pearce)
Enclosure 3 Dated June 4, 2003**

(Note: NRC discussion and RAIs are in italics)
During conference calls with Beaver Valley (BV) Unit 1 during their March 2003 steam generator inspection, the staff discussed a variety of topics with BV personnel. A summary of the items discussed during the calls will be provided in a separate communication. The BV approach used to detect and disposition large mix residual signals (i.e., of sufficient magnitude to cause a 1.0 volt ODSCC indication, as measured with a bobbin probe, to be missed or misread) was reviewed in detail.

Our understanding of the BV mix residual data review process is as follows. In your response please identify any incorrect assumptions.

> *SPR Identification and Screening: Computer data screening (CDS) parameters are set to identify support plate residual (SPR) indications with amplitudes greater than 1.5 volts at the tube support plates (TSPs). SPR indications flagged by CDS undergo manual analysis to determine (1) if the SPR code is valid, (2) if further evaluation with the +Point™ probe is warranted, or (3) whether the SPR indication should be changed to a distorted support indication (DSI), in which case a +Point™ examination would not be performed (unless the bobbin flaw indication amplitude exceeded 2 volts).*
>
> FENOC Point of Clarification: SPR signals reported by CDS should not be considered indications. The CDS process is designed to identify ANY signal response at the TSP intersection of >1.5 volts. This signal may or may not be determined to contain a flaw.
>
> *Flaw Identification: Independently, primary / secondary analysts evaluate the bobbin data and identify flaws. These primary / secondary analysts do not identify SPR indications. All discrepancies between primary / secondary analysts are evaluated by a resolution analyst.*
>
> *SPR +Point Examination: At the beginning of the outage, the +Point examination criteria included all SPRs greater than 2 volts, the 100 largest SPRs that could mask a flaw, and all SPRs with phase angles less than 50 degrees. These criteria were changed during the outage to all SPR's > 1.5 volts. If the +Point probe examination resulted in the identification of a flaw, the bobbin coil 200 kHz frequency data was reviewed to determine if an indication could be identified at*

that location. If a flaw is identified in the 200 kHz bobbin data, a Distorted Support Plate with Possible Indication (DSI) call results. Once the flaw is located on the 200 kHz channel, a reference amplitude is extracted from the 400 / 100 kHz mix channel (this sizing method is referred to below as the 200 kHz sizing method). If a flaw is not identified in the 200 kHz bobbin data, the tube was plugged. Flaws were also sized using a correlation between +Point amplitude and bobbin voltage (this sizing method is referred to below as the +Point correlation sizing method) for comparison to the 200 kHz method.. All SPRs with flaws identified during the +Point probe examination with a resulting bobbin voltage greater than 1.0 volt were repaired.

<u>FENOC Point of Clarification</u>: The +Pt correlation was used only to show the similarity of the ODSCC responses for signals initially classified as DSI and signals initially classified as SPR and subsequently changed to DSI after either additional review or +Pt examination. The +Pt correlation was not used for identification of ODSCC amplitude for repair considerations.

To help clarify the technical basis for disposition of mix residual indications, the staff requests information based on two broad concerns: 1) the ability of the analysis technique to adequately detect flaws influenced by a large mix residual signal, and (2) once detected, the ability to accurately establish the amplitude of these flaws. Please provide the following information in the BV 90 day outage report summary.

1. *How many SPR indications were originally flagged by CDS during 1R15? Provide a breakdown of how these original SPR indications from CDS were dispositioned. For example, how many SPRs were dispositioned as non-valid, how many were changed to DSIs call, and how many were determined to require +Point examination? Of the SPR indications identified by CDS and judged to be valid SPR signals, indicate how many of these locations were called DSIs during the manual "Flaw Identification Process". Of the SPR indications subsequently called DSIs based on initial screening of the CDS data (i.e., during the SPR Identification and Screening process), indicate how many were called DSIs during the "Flaw Identification Process". Provide plots of these results. Discuss any trends in the data.*

<u>FENOC Response:</u> A total of 1228 SPR signals were reported during the 1R15 outage. The use of CDS to identify these signals is resulting in a gross overestimate of what may be considered "true" mix residuals, i.e., a TSP intersection with a non-perfectly formed ODSCC signal in the mix channel but a signal response in 200 kHz. It was recognized many outages ago that BVPS Unit1 did not contain large voltage mix residual signals similar to those that had been observed at other plants. The largest mix residual signal reported at BVPS Unit 1 is 3.27 volts. The largest mix residual signal reported at BVPS Unit 1 that has confirmed by +Pt examination is 2.8 volts. Signals called DSI, i.e., those

with clearly formed ODSCC signals in the mix channel have total residual components in the mix channel that exceed 3 volts. This is part of the basis that concludes that the signals called SPR at BVPS Unit 1 are not "large mix residuals" as defined by GL 95-05.

A total of 115 signals initially called SPR by CDS were reclassified as DSI as part of the manual analysis process. These signals were not +Pt inspected as part of the SPR evaluation methodology. BVPS Unit 1 has implemented an aggressive SPR +Pt inspection program, much more aggressive than the rest of the industry. The philosophy behind this inspection program was to utilize the +Pt coil inspection results to *definitively* identify the source of the 200kHz response. This was done to ensure that mechanisms not addressed by GL 95-05 were not inadvertently included in the GL 95-05 calculations and to aggressively investigate these signals to ensure that new degradation mechanisms were not present within the BVPS Unit 1 SGs. As it had been established that the ODSCC components within the +Pt confirmed SPR signals were accurately being measured in the 200 kHz channel, and the SPR signals at BVPS Unit 1 were not "large mix residuals" as defined by GL 95-05, BVPS was ensuring that all pertinent indications were being included in the GL 95-05 calculations.

Of the 1228 total SPR signals, 388 were subsequently dispositioned as DSI signals and included in the GL 95-05 calculations. Thus, it can be concluded that 840 SPR signals were determined to be non-valid, either by evaluation of the bobbin data by the resolution/lead analyst or based on +Pt examination.

Observed trends in this data show that the SPR signals ultimately determined to contain ODSCC were few in number compared to the DSI population, that the amplitude of the ODSCC signals within these intersections were bounded by the DSI population, and that the magnitude of the mix residual for SPR intersections determined to contain ODSCC were less than the residual component of those intersections called DSI from the analysis process. Also, the percentage of SPR signals determined to contain ODSCC was small.

The actions performed at BVPS Unit 1 can be considered to have gone over and above the recommendations of GL 95-05 to ensure that ODSCC indications that could influence the GL 95-05 calculations were included.

2. *Please summarize the total number of SPRs identified, the number that were inspected with the +Point probe, and the number of flaws identified at these locations during the +Point probe examination. For those indications where a flaw was identified during the +Point probe examination, indicate whether the flaw was identifiable in the 200 kHz bobbin coil data and the resultant voltage from the mix channel. For all flaws identified with a +Point probe at SPRs, provide the voltage of these flaws using the +Point amplitude to bobbin voltage correlation.*

Provide a plot of the "resultant" bobbin probe flaw voltage as a function of SPR voltage. Discuss any trends. Plots of the "resultant" bobbin probe voltage should be from both the 200 kHz sizing method and the +Point correlation sizing method.

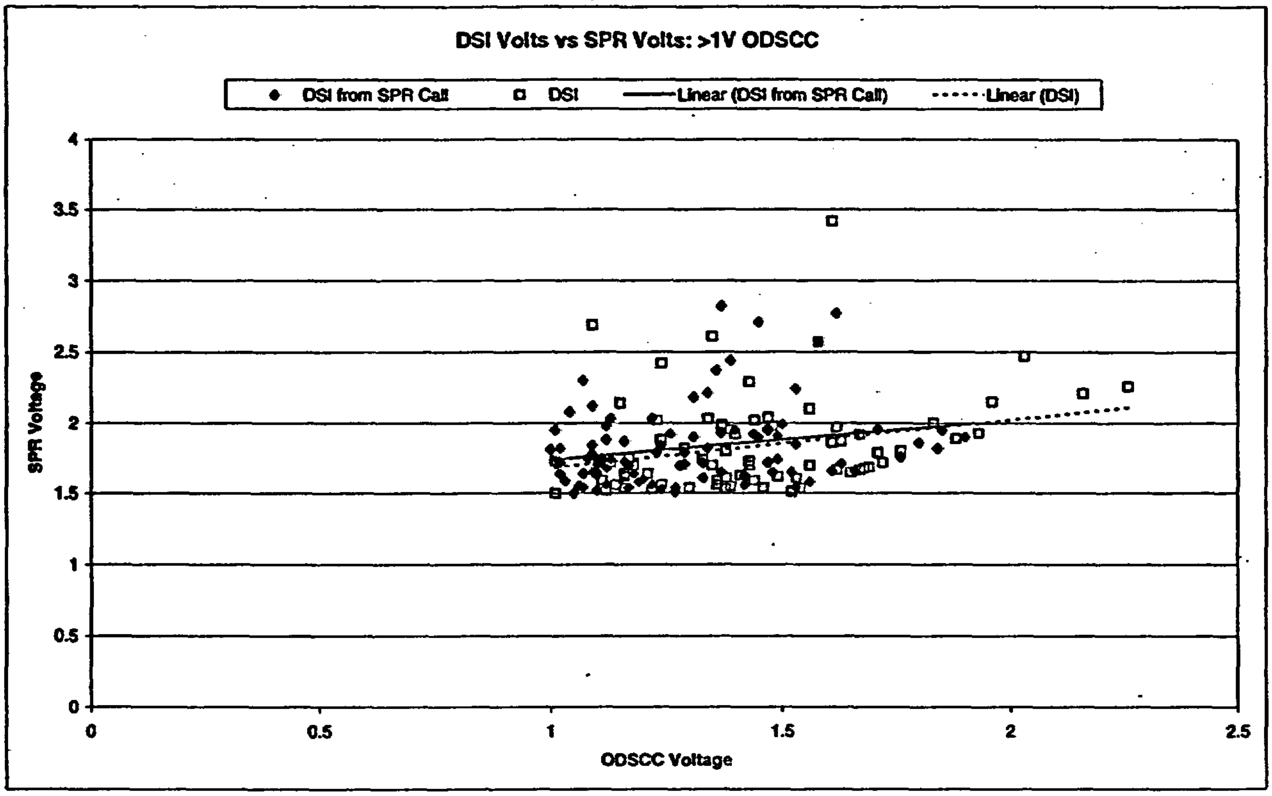
Provide a plot of the 200 kHz sizing method flaw voltage as a function of the +Point correlation sizing method flaw voltage. Discuss any trends.

FENOC Response: A total of 1228 SPR signals were reported for the 1R15 outage, 1056 were inspected with +Pt, and 273 were confirmed to contain ODSCC based on +Pt testing. Thus, about 22% of all SPR signals were confirmed to contain ODSCC based on +Pt examination. These confirmation rates are uncharacteristically low compared to the +Pt examination of those signals initially called DSI. For the past 4 inspections at BVPS Unit 1, no DSI signal reported at >2V by bobbin have resulted in a NDD inspection by +Pt. The +Pt confirmation rate for DSIs signals ≥1V is approximately 91%. This further supports the conclusion that the CDS process is resulting in an overestimation of true mix residuals, i.e., those that may contain ODSCC.

Figure A-1 presents the ODSCC measurement from SPR calls made by CDS and ODSCC measurement of those signals called DSI by manual analysis against the total residual measurement for these intersections. These data show that for the magnitude of the SPR signals at BVPS Unit 1, that this magnitude is not affecting the ODSCC measurement compared to those signals initially called DSI, and the magnitude of ODSCC in those signals called SPR by CDS is not greater than the ODSCC measurement in those signals called DSI compared to the total residual measurement. Linear regressions are provided for each of these 2 datasets. The regressions are essentially equal for both datasets. To provide for a consistent comparison, the DSI dataset includes only those signals with total residual measurements ≥ 1.5 volts.

A total of 6 SPR signals reported from the 0.720" bobbin probe with 0.720" +Pt confirmation had no reportable signal response in 200 kHz. These tubes were repaired. The +Pt amplitudes of these signals were determined to represent ODSCC of <1V when the +Pt amplitude versus DSI amplitude correlation is applied. The maximum +Pt coil amplitude for these 6 signals was 0.44 volts. Based on a correlation of +Pt amplitude to ODSCC maximum depth, the depth of this indication is estimated to be 63%TW.

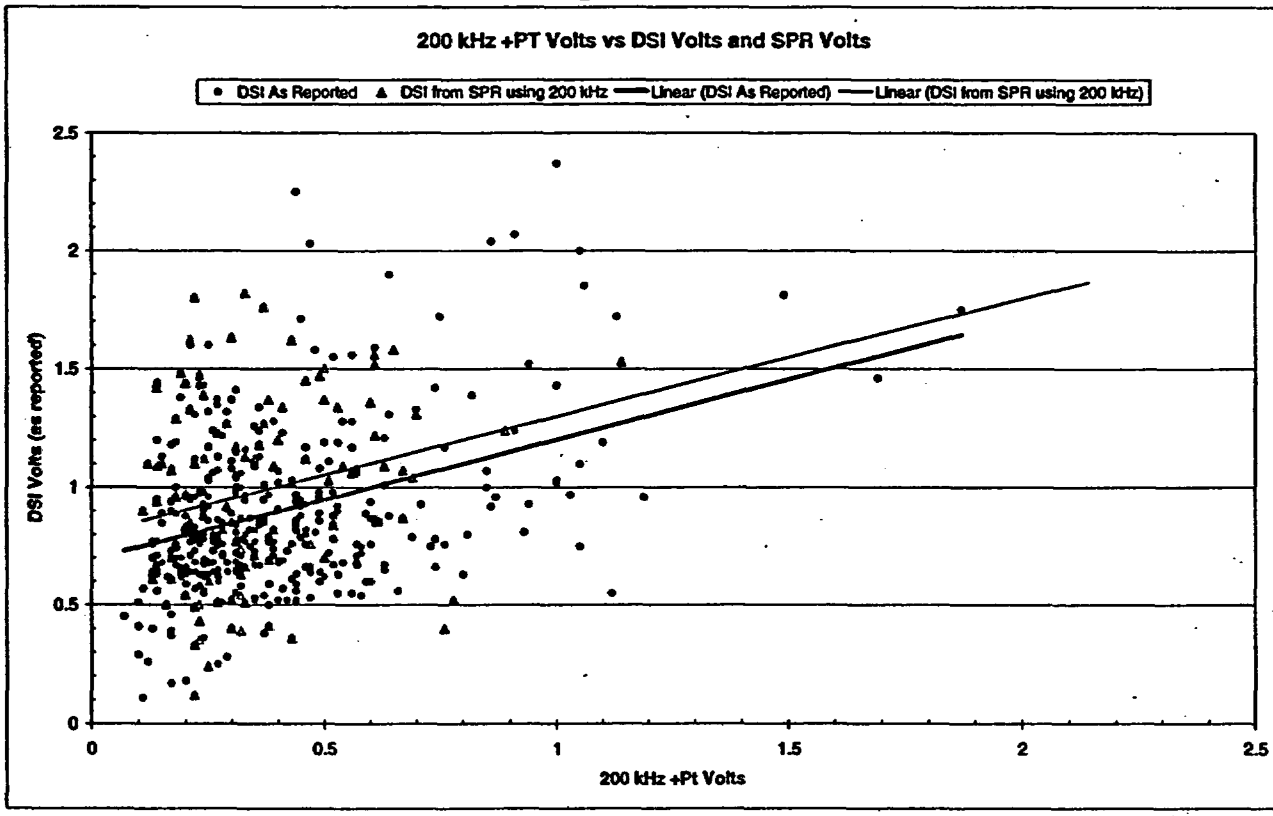
Figure A-1



In general, the ODSCC measurement using 200 kHz bobbin resulted in larger ODSCC amplitudes compared to the +Pt correlation. As such, the +Pt correlation was not used. The recommended methodology for development of the +Pt correlation can result in overestimation of the DSI amplitude for low voltage +Pt responses due to the plotting methodology. Figure A-2 presents the DSI estimate from +Pt amplitude for the 1st SPR sample and all DSI signals +Pt inspected. This plot shows essentially no difference between the datasets. The 1st SPR sample included all SPR signals >2V, the 100 largest SPR signals per SG that could contain a flaw, and SPR signals with phase angle of <50°.

In telephone conferences between FENOC and NRC during the 1R15 outage, the issue of the scatter in the data was brought up by the NRC. The scatter in the below data is entirely typical of DSI signals contained within the GL 95-05 database. The bobbin coil integrates the total signal response at a particular elevation. As the ODSCC morphology can contain multiple initiation sites at a particular elevation, the bobbin coil amplitude can be increased from one intersection to the next merely due to the number of initiation sites. Thus, a fair amount of scatter can be expected in the bobbin amplitude measurement. Figure A-2 clearly shows that for the BVPS Unit 1 population of DSIs and SPRs determined to contain ODSCC that the +Pt coil amplitude response is consistent, regardless of the bobbin indication call.

Figure A-2



3. *What is the percentage of total SPRs that contained flaws with a "resultant" bobbin voltage greater than 1.0 volt. Discuss how this compares to the percentage of total DSIs (with either no or negligible SPR signals) with a reference bobbin voltage greater than 1.0 volt. Note: for this question and following questions, specify how the analyst defines a negligible SPR signal or dent signal.*

FENOC Response: A total of 388 SPRs were determined to contain ODSCC based on either +Pt confirmation or manual analysis classifying the intersection as DSI. A total of 91 of these, or 23.5%, were found to contain ODSCC of ≥1V. The SPR measurement for these signals ranged from 1.83 to 2.82 volts. The entire DSI population, excluding SPR subsequently changed to DSI, indicates 3591 total DSI, with 801 ≥1V, for 22.3% of the DSI population having ≥1V ODSCC. Thus, the percentage of SPRs with ODSCC and the percentage of DSIs with ≥1V ODSCC are essentially equal.

Of the approximate total DSIs of 3600, a sample of 166 were evaluated to identify the residual component. The maximum residual component for this sample was 3.42 volts, with an ODSCC component of 1.61 volts. The largest SPR signal determined to contain ODSCC was 2.82 volts. As the largest residual component of the 166 sample was 3.42 volts, it is reasonable to assume that the total DSI population could contain residuals larger than 3.42 volts. This is further support for the conclusion that the SPR signals

reported at BVPS Unit 1 are not considered to be "large mix residuals" as defined by GL 95-05.

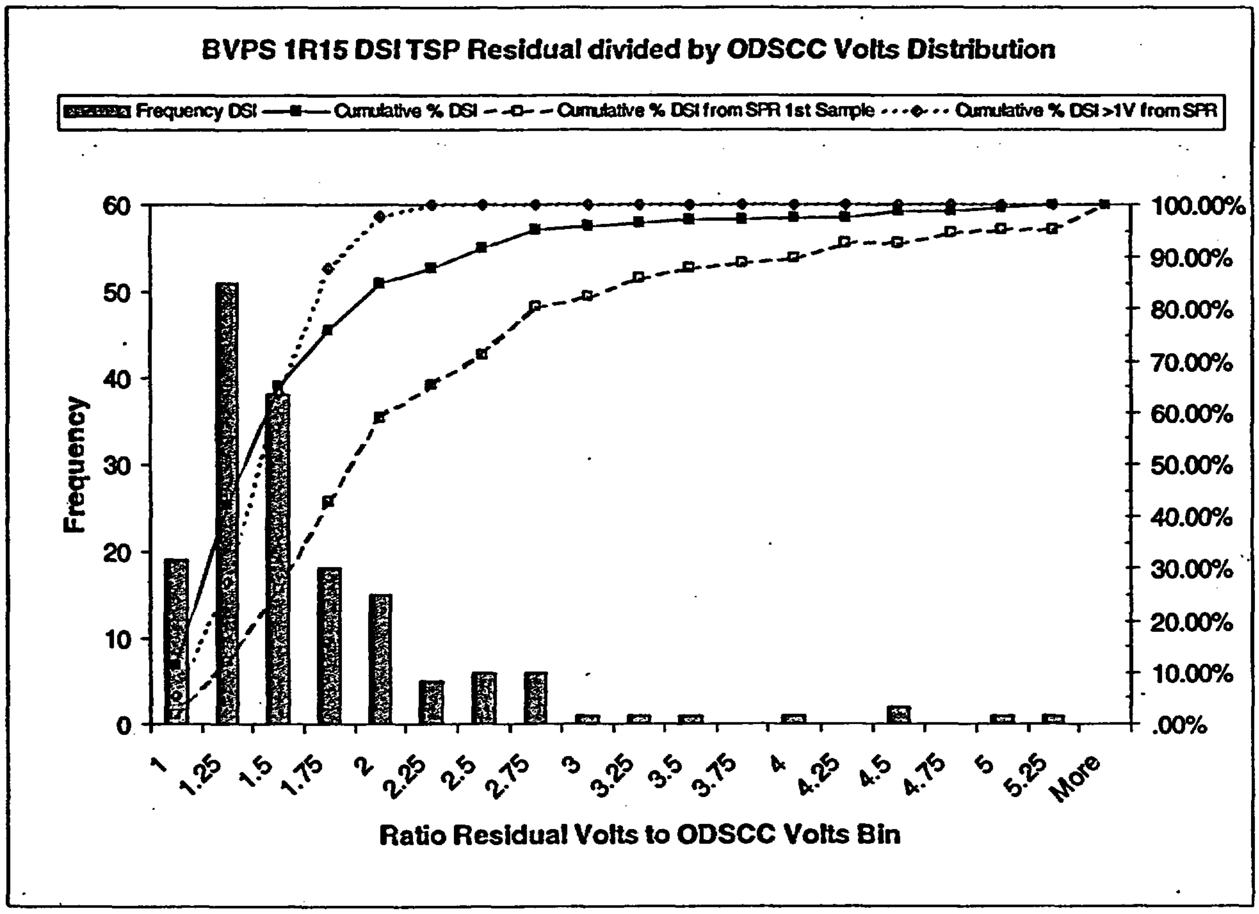
A negligible SPR signal can be considered one with no signal response in 200 kHz bobbin.

Dent signals are identified by horizontal signal responses in the mix channel or 400 kHz single frequency channel.

4. *Plot the relationship between the 200 kHz bobbin amplitude and the 400 / 100 kHz mix amplitude for: (1) DSIs with no or negligible SPR signals (and no or negligible dent signals), and (2) DSIs associated with an SPR (or dent) signals. Compare the two graphs and discuss any trends.*

<u>FENOC Response</u>: It must be noted that signals initially called DSI contain a total residual signal that is larger than the DSI ODSCC voltage measurement. The magnitude of this residual can be several times larger than the ODSCC measured within the intersection. As the largest SPR confirmed to contain ODSCC was 2.82 volts, the ratio of residual to ODSCC measurements for DSIs is similar to that for SPR determined to contain ODSCC. A random sample of 166 DSI signals was investigated to determine the distribution of residual and ODSCC measurements. Figure A-3 presents a cumulative distribution plot of the ratio of the residual to ODSCC measurement for indications initially reported as DSI. To compare DSIs with no or negligible SPR signal would result in an indirect comparison of the two datasets.

Figure A-3



As seen from Figure A-3, DSI signals were found to contain residual components as large as 5.25 times the ODSCC component. For the initial SPR sampling program, 95% of the intersections had a SPR divided by DSI ratio within this range, whereas for all intersections initially called SPR and subsequently changed to DSI, 91% of the indications were bounded by a ratio of 5.25. For those SPR intersections determined to contain an ODSCC component >1V, the ratio of SPR to DSI amplitude was entirely bounded by the range of ratios for the 166 DSI sample. Thus, for the SPRs signals determined to contain ODSCC >1V, the total residual was less than the total residual for indications initially called DSI.

Figure A-3 shows that for the initial SPR sample, which included all SPRs >2V as well as 100 SPRs per SG that could mask or cause a 1.0 volt ODSCC signal to be masked or misread, the ODSCC component was generally closer to the SPR amplitude than for the remainder of the SPR data set. The majority of the indications repaired by plugging at 1V ODSCC component came from the first SPR sample.

The largest SPR signal amplitude reported at the 1R15 outage was 3.27 volts in SGA,

3.88 volts in SGB, and 2.66 volts in SGC. All three of these signals were inspected with +Pt. None contained degradation. The largest SPR signals in SGB and SGC were located in Row 2 tubes at the top TSP, and are likely an artifact of U-bend heat treatment.

The Beaver Valley Unit 1 SPR/DSI data was also compared with the ETSS 96007.1 "Detection of IGA/ODSCC at non-dented Drilled Tube Support Plates" dataset with regard to total TSP residual and P1 channel ODSCC measurement. Figure A-4 presents the data of Figure A-3 for >1V ODSCC by bobbin with the ETSS data added. The ETSS data set shows that the total TSP residual components were generally greater than the TSP residual and SPR data from Beaver Valley Unit 1.

Figure A-4

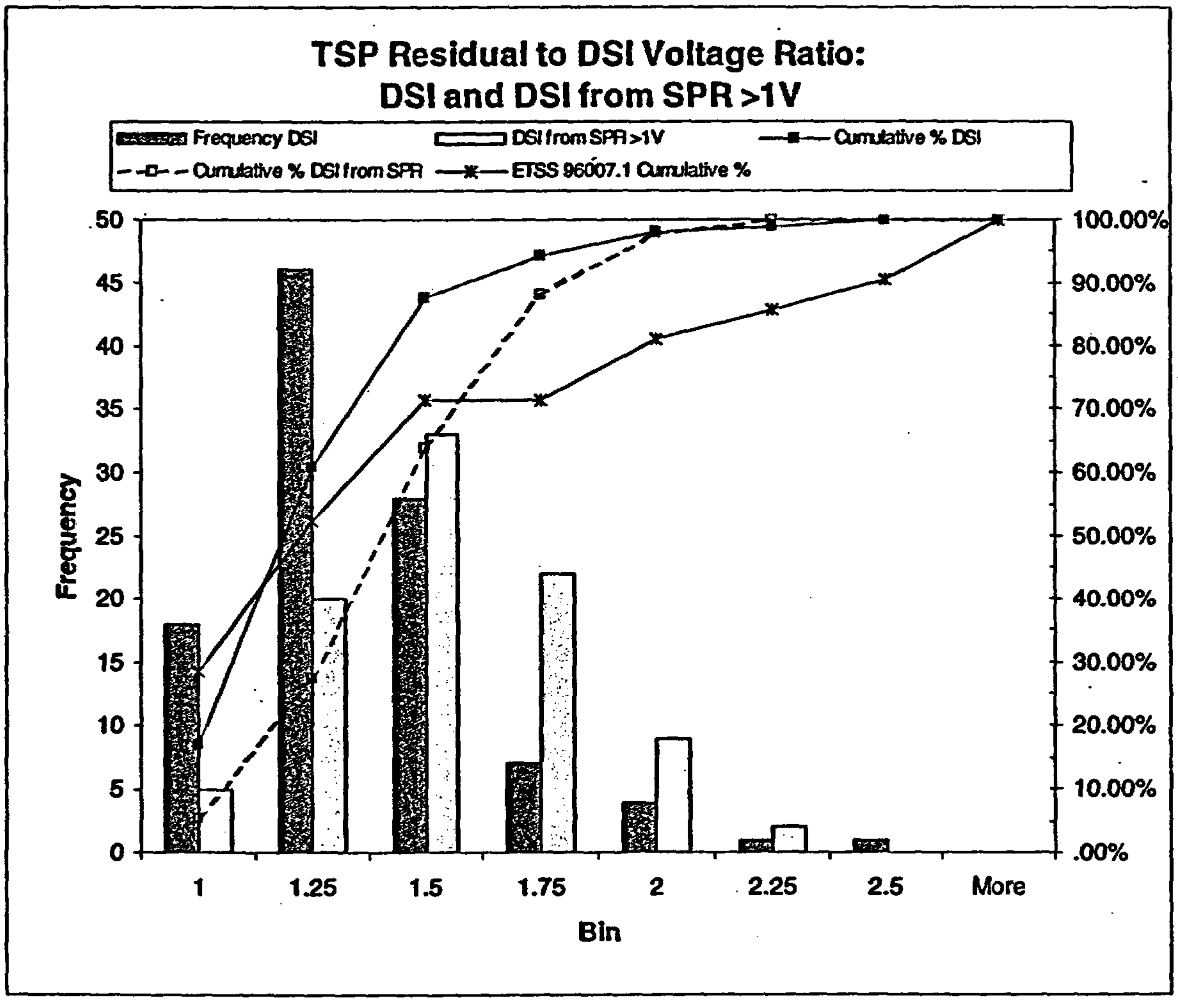
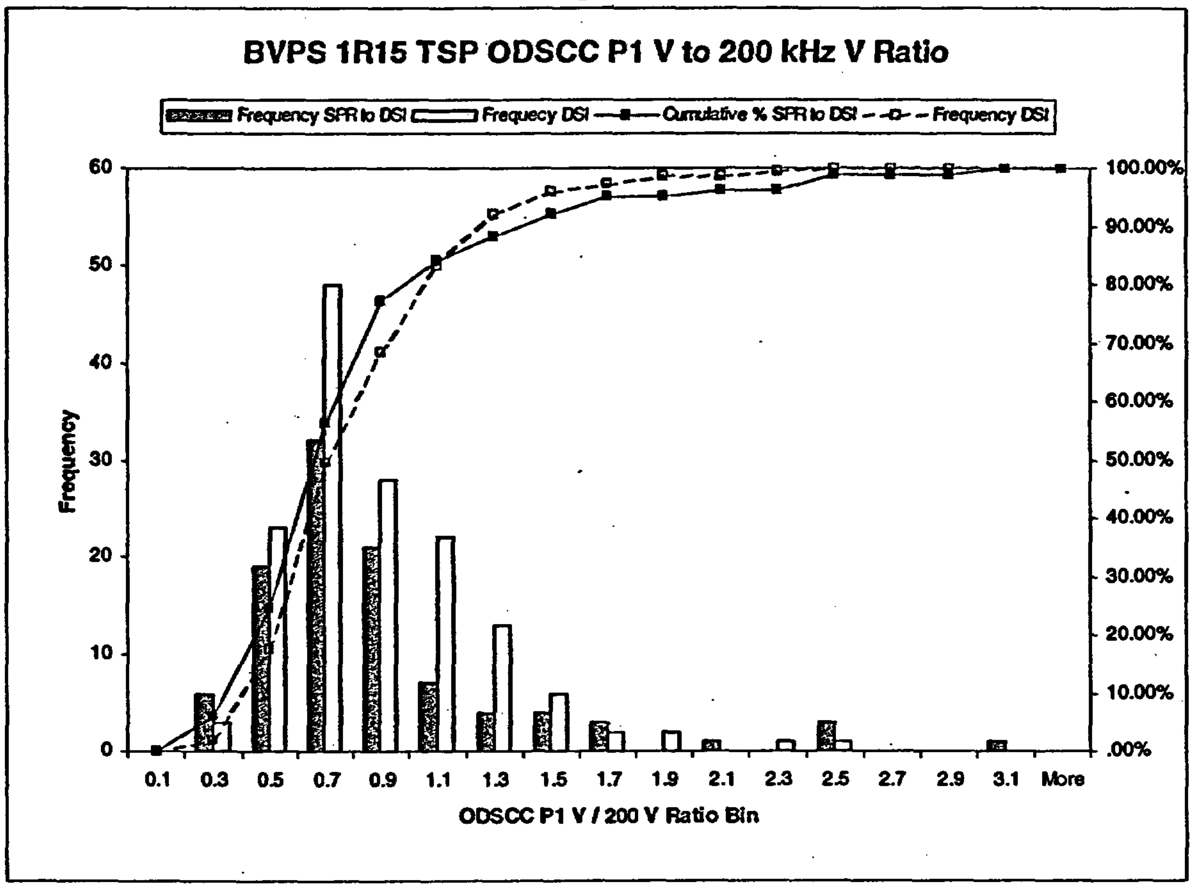


Figure A-5 provides a cumulative probability distribution function of the 400/100 mix channel ODSCC amplitude divided by the 200 kHz amplitude for a sampling of 166 DSIs and SPRs subsequently changed to DSI from the first SPR sample.

Figure A-5



This plot clearly shows that the ratio of the mix channel ODSCC measurement divided by the 200 kHz signal measurement is essentially equal for both DSIs and the SPRs changed to DSI that came from the first SPR sample. Figure A-5 confirms the FENOC position that the intersections at BVPS Unit 1 called SPR, and subsequently changed to DSI based on +Pt examination are not being misread.

5. *BV personnel indicated the evaluation process of SPRs used during 1R15 was similar to prior outages. What percentage of the SPR population that remains in service following an outage is identified as a SPR indication at the following outage? Please trend the number of SPR signals identified over time including total number of SPR signals identified by CDS and total number of SPR signals where +Point identified a flaw.*

FENOC Response: If an indication initially reported as SPR was confirmed to contain ODSCC and the 200 kHz channel exhibited a signal that could be observed in the 200 kHz channel, the indication was classified as DSI, and tracked as such in future outages. At the 1R14 outage, all SPRs confirmed to contain ODSCC had observable 200 kHz signals. A total of 73 indications were returned to service at the 1R14 outage that originally were called SPR and subsequently changed to DSI.

Therefore, all historical SPRs found to contain ODSCC were tracked as DSIs in subsequent outages.

6. *Please provide the cycle-to-cycle voltage growth for each DSI that was associated with an SPR and was left in service. Assess the growth rate for SPR indications where the reference bobbin voltage was obtained from the 200 kHz sizing method and from the +Point correlation sizing method. Compare this voltage growth rate to the growth rate of all DSIs not associated with SPRs or dents.*

FENOC Response: At the 1R14 outage, 73 SPR signals determined to contain ODSCC were returned to service, with approximately half of these in SGA. These signals were reclassified as DSIs, and included in the DSI data evaluated as part of the ARC. The Cycle 15 average ODSCC growth of these signals as a percentage of the beginning of cycle voltage is 7.79%; the largest singular ODSCC growth was 0.35 volts. The BOC-15 average voltage for these indications was 0.93 volts, while the average EOC-15 voltage for these indications was 0.92 volts. The Cycle 15 average growth as a percentage of the beginning of cycle voltage for all DSIs is 7.6% for SGA, 5.0% for SGB, and 5.2% for SGC. The largest singular growth for DSIs was approximately 3 volts.

As the +Pt correlation was not used to assess ODSCC component for the BVPS Unit 1 plant, ODSCC data in this reference is not provided. In general, DSI amplitude estimation from the +Pt volts correlation gave slightly reduced values compared to the 200 kHz process.

7. *Given the evaluations performed above and other historical information, what screening procedure will be used for identifying SPR indications in future outages?*

FENOC Response: Flowcharts describing bobbin analysis of TSP signals contained in the site specific data analysis guidelines will be revised. Senior/Lead analysts will be given more flexibility to review suspect data prior to assigning mix residual calls (SPR) to support plate intersections. The steam generator inspection logic charts, which complement the data analysis guidelines, will also be revised to reflect this approach.

Summary and Conclusions:

The SPR interrogation process at BVPS Unit 1 has resulted in the inclusion of all ODSCC signals pertinent to the GL 95-05 calculations supporting operation for the next cycle. This process is consistent with the intent of the SPR testing program initially noted by CRGR in 1995.

Evaluation of the signal response characteristics for DSIs and SPRs determined to contain ODSCC support the following:

1. SPR signals at BVPS Unit 1 that may contain ODSCC do not have residual components that exceed residual component measurements for those signals initially called DSI by the analysis process.

2. The ODSCC component as measured in both the mix channel and the 200 kHz single frequency channel show that the distributions for each data set produce essentially the same result; that is, that whether an indication is called DSI or an indication is called SPR and subsequently determined to contain ODSCC, that the ODSCC is being measured consistently. Thus, the SPR signals reported at BVPS Unit 1 that were determined to contain ODSCC do not meet the GL 95-05 definition of a "large mix residual" since the ODSCC is not being misread.

3. A total of 388 SPR signals were determined to contain ODSCC. A total of 6 were found to contain no ODSCC component in the 200 kHz channel based on testing with 0.720" diameter bobbin and +Pt probes. These tubes were repaired. As only those SPR signals with confirming +Pt examination and observable signal response in 200 kHz were permitted to remain in service at past outages, these signals were not masked, and again, these signals do not meet the definition of a "large mix residual" as defined by GL 95-05.

4. Furthermore, the scope and magnitude of the subject intersections should be considered. Approximately 3600 DSI signals remain in service at BVPS Unit 1. In question are approximately 91 signals initially called SPR and determined to contain ODSCC of >1V. At the 1R15 inspection, approximately 800 DSI signals >1V were reported by the initial analysis process. The application of a 0.6 POD accounts for an additional 480 intersections of >1V in the end of next cycle probability of burst and leakage predictions. The influence of these additional 91 intersections has no meaningful input to the accuracy of the end of next cycle predictions.

5. The average ratio of TSP total residual for indications called DSI to the

measurement of ODSCC in the P1 mix channel is 1.55. That is, on average, a 1V DSI signal would have a total TSP residual of 1.55 volts. The average ratio of DSI volts divided by 200 kHz volts is 0.80. For the 1st SPR sample, which included all SPR signals >2V as well an additional 100 SPRs per SG, the average ratio of SPR voltage to P1 mix channel ODSCC measurement is 2.3. The average ratio of ODSCC measurement in SPRs divided by the 200 kHz volts is 0.79. Thus, SPR signal amplitudes up to approximately 2.8 volts are shown to have no impact upon the ability to measure the accurately measure the ODSCC component within these intersections.

6. The 91 signals with >1V ODSCC in SPRs with confirming +Pt calls at 1R15 were repaired with no resulting commensurate increase in safety.

ATTACHMENT 1

Commitment List

The following list identifies those actions committed to by FirstEnergy Nuclear Operating Company (FENOC) for Beaver Valley Power Station (BVPS) Unit Nos. 1 and 2 in this document. Any other actions discussed in the submittal represent intended or planned actions by Beaver Valley. These other actions are described only as information and are not regulatory commitments. Please notify Mr. Larry R. Freeland, Manager, Regulatory Affairs/Performance Improvement, at Beaver Valley on (724) 682-5284 of any questions regarding this document or associated regulatory commitments.

Commitment	Due Date
As noted on Page A-11, flowcharts describing bobbin analysis of TSP signals contained in the site-specific data analysis guidelines will be revised. Senior/Lead analysts will be given more flexibility to review suspect data prior to assigning mix residual calls (SPR) to support plate intersections. The steam generator inspection logic charts, which complement the data analysis guidelines, will also be revised to reflect this approach.	As tracked through the Corrective Action Program.