Enclosure A
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Beaver Valley Unit 2 End-of-Cycle 17 Analysis and Prediction for End-of-Cycle 18
Voltage-Based Repair Criteria 90-Day Report
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Beaver Valley Unit 2 End-of-Cycle 17 Analysis and Prediction for End-of-Cycle 18 Voltage-Based Repair Criteria 90-Day Report

Westinghouse

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Beaver Valley Unit 2
End-of-Cycle 17 Analysis and Prediction for End-of- Cycle 18 Voltage-Based Repair Criteria 90-Day Report

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July 2014

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0	See EDMS	Original
1	See EDMS	Typographical errors corrected pages 3-4, 3-15, 7-1. Added last two sentences of Section 3.1 for clarification.

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1 INTRODUCTION

This report provides a summary of the Beaver Valley Unit 2 steam generator (SG) bobbin and **+Point™**[1] probe inspections at tube support plate (TSP) intersections from the Spring 2014, 2R17 outage, together with postulated Steam Line Break (SLB) leak rate and tube burst probability analyses. The 2R17 outage represents the second application of the Generic Letter (GL) 95-05 (Reference 1) voltage based repair criteria, and implementation of its requirements, to the Beaver Valley Unit 2 SGs. Information required by the GL 95-05 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 17, projection of EOC-18 bobbin coil voltage distributions, as well as the associated SG tube leak rates and burst probabilities through EOC-18 conditions.

The condition monitoring analysis at End-of-Cycle 17 (EOC-17) was carried out using the actual bobbin coil voltage distributions measured during the EOC-17 outage. These results show that the EOC-17 condition monitoring leak rates and conditional burst probabilities for all three SGs are well within their respective allowable limits. A comparison with the projections made in the previous 90 Day Report at the EOC-16 outage (Reference 2) shows that the predictions were very conservative. These evaluations utilized the Westinghouse generic methodology that uses Monte Carlo analysis techniques (Reference 3).

The operational assessment analysis was performed to project leak rates and tube burst probabilities for postulated SLB conditions at the end of the ongoing cycle (EOC-18) based on the 2.0 volt repair criteria for 7/8-inch diameter tubes. These analyses utilized bobbin voltage distributions measured during the recent (EOC-17) inspection and a growth rate distribution bounding the last two inspections (EOC-16 and EOC-17). Leak and burst analyses for the operational assessment were performed using the Reference 4 default value primary-to-secondary pressure differential of 2560 psi. The Cycle 18 operational assessment predicts that SG C will be the limiting SG for projected leakage. With a Cycle 18 period of operation estimated at 493 effective full power days (EFPD), the limiting EOC-18 maximum leak rate is for SG C and projected to be 0.373 gpm (room temperature), which is well below the allowable limit of 2.2 gpm for the faulted SG. The corresponding maximum tube burst probability for the limiting SG (also SG C) of 4.75×10^{-5} is well below the GL 95-05 limit of 1.0×10^{-2}. Thus, the GL 95-05 requirements are predicted to be satisfied at the EOC-18. The operating period of 493 EFPD was provided by FENOC via email dated July 8, 2014.

[1] +Point™ is a trademark of Zetec, Inc.

2 SUMMARY AND CONCLUSIONS

A total of 1026 distorted support indications (DSI) in all three SGs combined were reported during the Beaver Valley Power Station Unit 2 (BVPS2) EOC-17 bobbin coil inspection. Per GL 95-05, only those DSI signals with a bobbin coil signal amplitude of 2.0 volts or greater are required to be inspected using a +Point (or equivalent) probe. All DSI signals were less than 2.0 volts, so no indications were required to be tested with the +Point probe. However, some indications were tested with the +Point probe to assist in the selection of tubes to be pulled to satisfy the tube pull requirements of GL 95-05. The maximum voltage indication in all three SGs was 1.41 volts on R34 C26 at the tube support plate designated as 02H in SG-C. This indication was inspected with a +Point probe and outside diameter stress corrosion cracking (ODSCC) was not detected. No circumferential indications or axial indications extending outside the tube support plate (TSP) were identified by +Point probe inspection at DSI locations.

SLB leak rate and tube burst probability analyses were performed using the actual EOC-17 bobbin voltage distributions (condition monitoring analysis) as well as the projected EOC-18 bobbin voltage distributions (operational assessment). The SLB leak rates from the condition monitoring analysis show significant margins relative to the faulted SG allowable limit of 2.2 gpm (room temperature), Reference 11. The corresponding condition monitoring tube burst probability values are well below the allowable limit of 1.0×10^{-2}.

The largest SLB leak rate in the condition monitoring analysis is calculated for SG-C, with a magnitude of 0.111 gpm, which is well below the allowable SLB leakage limit of 2.2 gpm in the faulted SG. All leak rate values quoted are equivalent volumetric rates at room temperature. The limiting conditional tube burst probability from the condition monitoring analysis, 2.19×10^{-5} also predicted for SG-C, is well below the Nuclear Regulatory Commission (NRC) reporting guideline of 1.0×10^{-2}. Thus, the condition monitoring results are well within the allowable limit/reporting guideline.

SLB leak rate and tube burst probability projections at the EOC-18 conditions were performed using the latest alternate repair criteria (ARC) database available for 7/8 inch outside diameter (OD) tubing (Addendum-7 update), which is documented in Reference 4. Leak and burst analyses for the Cycle 18 operational assessment were performed using the Reference 4 default primary-to-secondary pressure differential of 2560 psi. SG-C is predicted to be the limiting SG. For a projected Cycle 18 duration of 493 EFPD, the EOC-18 leak rate projected for SG-C using the GL 95-05 constant probability of detection (POD) of 0.6 is 0.373 gpm (at room temperature), which is less than the current limit of 2.2 gpm in the faulted SG. This leak rate projection utilized the leak rate calculation methodology of References 5 and 6. The limiting EOC-18 burst probability of 4.75×10^{-5} is also calculated for SG-C and is well below the allowable limit of 1.0×10^{-2}. Therefore, all acceptance criteria of Reference 1 will be satisfied throughout Cycle 18.

3 EOC-17 INSPECTION RESULTS AND VOLTAGE GROWTH RATES

3.1 EOC-17 Inspection Results

For outages prior to EOC-16, the alternate repair criterion per GL 95-05 had been approved for BVPS2, but was not implemented. FirstEnergy Nuclear Operating Company (FENOC) had not implemented the criterion due to the small number of bobbin indications at TSP intersections which were confirmed to contain axial outside diameter stress corrosion cracking (ODSCC) using a +Point probe. The 2R16 initial inspection plan did not include application of GL 95-05; the criterion was implemented at 2R16 due to an increase in the number of DSIs confirmed to contain axial ODSCC from +Point probe examination. However, for 2R16, and prior outages the bobbin probe analysis utilized the guidance and requirements of GL 95-05. Since the initial 2R16 (and prior outages) inspection plan did not assume that GL 95-05 would be implemented, all bobbin coil DSIs were inspected using a +Point probe. Note that under GL 95-05, only DSI signals with a 400/100 mix (hereafter referred to simply as the mix channel) signal amplitude of greater than 2.0 volts are required to be inspected using a +Point probe. This requirement was implemented in the EOC-17 inspection.

In accordance with the guidance provided by the NRC GL 95-05, the EOC-17 inspection of the Beaver Valley Unit 2 SGs consisted of a complete, 100% eddy current (EC) bobbin probe full length examination of the tube bundles in all three SGs. All hot and cold leg TSP intersections were inspected using 0.720 inch diameter bobbin probes, with the exception of those hot leg TSP intersections in Row 3 tubes which contain SG tube sleeves at the hot leg top-of-tubesheet. In these tubes (3) a 0.640 inch diameter wide groove bobbin probe was used for DSI detection. If a DSI was observed using the 0.640 inch wide groove bobbin probe, an attempt was made to obtain an inspection of these locations using a 0.720 inch diameter bobbin probe from the cold leg side. If this probe could not pass over the U-bend, the tube was to be plugged as FENOC has not received NRC approval to utilize the 0.640 inch wide groove results in the analysis. Prior evaluation of DSIs from other plants which were inspected using both the 0.640 inch wide groove and 0.720 standard bobbin probe show that the voltage response from the 0.640 inch wide groove is conservative compared to the voltage response of the 0.720 inch standard bobbin probe.

To assess depth growth, the 2R16 DSIs with +Point probe confirmation were also inspected at 2R17, even though none were required to be inspected with a +Point probe due to the low bobbin amplitudes. This inspection showed little or no change in the +Point probe signal character was observed, thus implying little or no depth growth of the indication. In order to help identify tube pull candidates, additional locations with DSI reports on these (2R16 confirmed tubes), as well as other DSIs, were inspected with a +Point probe. The largest +Point probe signal amplitude in the 300 kHz channel from the confirmed DSI indications is only 0.26 volt, which represents a depth of 56% through-wall (TW) using the sizing protocol of Electric Power Research Institute (EPRI) ETSS I28432. Long term trending of the Unit 2 DSI population has shown a limited growth potential. For Cycles 10 through 17, the mean DSI voltage growth has been essentially zero. Additionally, the +Point amplitudes for DSI signals confirmed as axial ODSCC have been much less than 1.0 volt, suggesting that a shallow depth

of penetration exists. This in turn suggests the DSI voltage growth will remain minimal and not move to "extreme" over the next operating cycle. Thus, it can be concluded that, the character of DSI indications reported to date has been associated with a depth of penetration well below 100% TW.

In addition, the 2R17 eddy current inspection plan included 100% +Point probe inspection of all dents >5 volts (as measured from the bobbin probe) commensurate with the GL 95-05 requirements, 100% +Point probe inspection of dents with indication (DNI) and 25% of support plate residuals (SPR), as defined by FENOC. The DNI call is generated using an auto data screening (ADS) process, and identifies any TSP intersection with a mix channel voltage of greater than or equal to 1.25 volts with a phase angle of less than or equal to 55 degrees. This screening is performed for the detection of signals which could be confirmed as axial primary water stress corrosion cracking (PWSCC) indications at TSP intersections. The identification of a DNI call is not solely restricted to the ADS output; the manual data analysis can also report DNI indications. SPRs are defined as bobbin coil signals which do not contain flaw-like components but have a signal amplitude of $\geq$ 1.5 volts and phase angles >55 degrees. Axial ODSCC indications were not reported in these populations based on the +Point probe analysis. No axial PWSCC or circumferential stress corrosion cracking (SCC) was reported at any TSP intersection. The +Point probe inspection program for dents, DNIs, and SPRs was extensive. In SG-A, 16 >5V dents, 551 DNIs, and 395 SPRs, in SG B, 35 >5V dents, 171 DNIs, and 60 SPRs, and in SG-C, 16 >5V dents, 291 DNIs, and 96 SPRs were inspected with a +Point probe. Thus, over 1600 TSP intersections were inspected with a +Point probe at 2R17.

The requirements of applicability of the GL 95-05 methodology in Section 1.b of Reference 1 are all satisfied. Tube intersections with the flow distribution baffle are excluded from this GL 95-05 analysis. There are no other excluded tube support plate intersections (Reference 7). None of the indications included in this analysis were detected in dents greater than 5.0 volts, as measured by bobbin. All SPR indications were tested with the +Point probe so that no ODSCC indications greater than 1.0 volt would be missed or misread, as discussed earlier. No copper signal interference was detected.

Tables 3-1 through 3-3 present the EOC-17 bobbin voltage data for the TSP intersections in the three SGs with distorted support indications (DSIs). A total of 1026 TSP locations had DSI indications in all three SGs combined, of which only 34 indications had amplitudes above 1.0 volt and no indications exceeded 1.5 volts. No DSI was above the GL 95-05 lower voltage repair limit of 2.0 volts.

Tables 3-1 through 3-3 tabulate the number of field bobbin indications, the number of those indications that were +Point probe RPC inspected, the number of +Point probe RPC confirmed indications, and the number of indications 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. The distribution of EOC-17 indications is also shown in Figures 3-1, 3-2 and 3-3 for SG-A, SG-B, and SG-C, respectively.

The distribution of EOC-17 indications as a function of support plate location is summarized in Table 3-4 and shown in Figure 3-4. The data show a strong predisposition of ODSCC to occur in

the first few hot leg TSPs although the mechanism extended to higher TSPs. Only six indications were detected on the cold leg side. This distribution is consistent with that observed at other plants and is commonly attributed to the temperature dependence of ODSCC.

Appendix A provides a listing of all DSIs reported at the BVPS 2R17 outage, whether axial ODSCC was confirmed (SAI/MAI in Comment column), and whether the tube contained the indication(s) was plugged (Comment column). No sleeves were installed at the 2R17 outage.

3.2 Voltage Growth Rates

For projection of leak rates and tube burst probabilities at EOC-18, voltage growth rates were developed from the EOC-16 and EOC-17 inspection bobbin data. Growth is determined when the same indication can be identified in two successive inspections. Since there can be new indications in one outage, the number of indications for which a growth can be defined is less than the number of indications detected. Table 3-4 shows a distribution of growth as a function of TSP number. Table 3-5 shows the frequency and cumulative probability distribution of growth as a function of voltage change in each BVPS2 steam generator during Cycle 17.

The average bobbin coil voltage growth rates for each SG during Cycle 17 are given in Table 3-6. The average growth rates over the entire voltage range are negative indicating essentially no voltage growth. The Cycle 17 growth rates on an EFPY basis for each SG are shown in Figure 3-5. A magnification of the upper tail of this growth distribution is shown in Figure 3-6. Also shown in Figure 3-5 and in Figure 3-6 is a curve which bounds all of the growth curves for both Cycle 17 and Cycle 16 (Reference 2). The Cycle 17 bounding curve is used in the operational assessment analysis to project the indication voltages at EOC-18.

Table 3-7 lists the top 15 indications on the basis of Cycle 17 growth rate in descending order. This confirms that Cycle 17 had only modest growth. The growth during Cycle 17 for all indications was under 0.55 volts. Table 3-7 also shows the voltage change between 2R15 and 2R17. The similarity of the voltage change for one cycle and the voltage change for two cycles indicates that the apparent growth may be more of an issue of measurement repeatability, not true growth.

To determine if BVPS2 growth rates exhibited a potential dependency on the BOC voltage, the growth rate data for Cycle 17 was plotted against BOC voltage, and the resulting plot is shown in Figure 3-7. The Cycle 17 growth data do not show any tendency to increase with the BOC voltage; if at all, the growth seems to decrease with increasing 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) was applied during the EOC-17 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 re-inspected with a good probe. As the repair limit for Beaver Valley Unit 2 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. Since no indications had amplitudes over 1.5 volts no tubes were retested due to the probe wear criteria.

3.4 NDE Uncertainties

The NDE uncertainties applied for the Cycle 17 voltage distributions in the Monte Carlo analyses for leak rate and burst probabilities are the same as those in the NRC Generic Letter 95-05 (Reference 1). The probe wear uncertainty has a standard deviation of 7.0% about a mean of zero and has a cut-off at 15% based on implementation of the probe wear standard. If the random sample of probe wear selected during the Monte Carlo simulations exceeds 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 cut-off. These nondestructive examination (NDE) uncertainty distributions are included in the Monte Carlo analyses for SLB leak rates and tube burst probabilities based on the EOC-17 actual voltage distributions as well as for the EOC-18 projections.

3.5 Tube Removal

Attachment 1, Section 4 of GL 95-05 states in part: "Implementation of a voltage based repair criteria should include a program of tube removals for the purpose of (1) confirming axial ODSCC as the dominant degradation mechanism, (2) monitoring the degradation mechanism over time, (3) providing additional data to enhance burst pressure probability of leakage and conditional leak rate correlations, and (4) assessing inspection capabilities. The proposed program requires two pulled tube specimens (minimum of four tube support plate intersections) during the outage that implements the voltage based repair criteria or during an outage preceding the initial application of these criteria." Due to the low voltage response of the BVPS2 DSI population, FENOC received approval from the NRC to forego the tube pull operations until 2R17.

During EOC-17, two tubes were pulled to meet the GL 95-05 requirements. The eddy current result summary of the DSIs in the pulled tubes is provided below. The cut location was below the 05H TSP intersection on R24 C41 and below the 03H TSP intersection on R19 C38. The DSI at 05H on R19 C38 was not harvested. Thus a total of four TSP intersections (two with DSIs, two NDD) were removed for destructive examination. The DSI at 02H on R19 C38 and the DSI at 04H on R24 C41 were confirmed to contain axial ODSCC based on the +Point probe examination.

	Row	Col	TSP	DSI Voltage
SG C	19	38	02H	0.62
			05H	1.05
	24	41	02H	1.19
			04H	0.47

The results of the tube examination are not available as of the time this document was prepared. Therefore the results will be provided in a separate report.

Table 3-1 EOC-17 DSI Voltage Distribution for SG-A							
Voltage Bin	**Number of Indications**	**+Point Confirmed**	**+Point Tested But Not Confirmed**	**Not +Point Tested**	**Plugged**	**Returned to Service**	**In-Service, +Point Confirmed or +Point Not Tested**
0.1	0	0	0	0	0	0	0
0.2	36	1	0	35	0	36	36
0.3	74	4	0	70	0	74	74
0.4	57	2	0	55	2	55	55
0.5	43	3	0	40	0	43	43
0.6	38	0	0	38	1	37	37
0.7	18	0	0	18	0	18	18
0.8	11	1	0	11	0	11	11
0.9	8	1	0	7	0	8	8
1	6	0	0	6	0	6	6
1.1	3	0	0	3	0	3	3
1.2	2	0	0	2	0	2	2
1.3	1	0	0	1	0	1	1
1.4	0	0	0	0	0	0	0
1.5	0	0	0	0	0	0	0
Total	297	12	0	285	3	294	294

Average voltage = 0.421 volts

Table 3-2 EOC-17 DSI Voltage Distribution for SG-B							
Voltage Bin	**Number of Indications**	**+Point Confirmed**	**+Point Tested But Not Confirmed**	**Not +Point Tested**	**Plugged**	**Returned to Service**	**In-Service, +Point Confirmed or +Point Not Tested**
0.1	2	0	0	2	0	2	2
0.2	37	0	0	37	0	37	37
0.3	95	5	0	90	0	95	95
0.4	89	2	1	86	0	89	88
0.5	53	3	0	50	0	53	53
0.6	48	4	1	43	1	47	46
0.7	25	1	2	22	1	24	23
0.8	23	2	1	20	0	23	22
0.9	11	0	0	11	0	11	11
1	6	0	0	6	1	5	5
1.1	4	0	0	4	0	4	4
1.2	3	0	0	3	0	3	3
1.3	0	0	0	0	0	0	0
1.4	1	0	0	1	0	1	1
1.5	0	0	0	0	0	0	0
Total	397	17	5	375	3	394	389

Average voltage = 0.432 volts

Table 3-3 EOC-17 DSI Voltage Distribution for SG-C							
Voltage Bin	Number of Indications	+Point Confirmed	+Point Tested But Not Confirmed	Not +Point Tested	Plugged	Returned to Service	In-Service, +Point Confirmed or +Point Not Tested
0.1	1	0	0	1	0	1	1
0.2	24	1	0	23	0	24	24
0.3	54	1	0	53	0	54	54
0.4	65	4	0	61	0	65	65
0.5	49	2	0	47	2	47	47
0.6	38	2	0	36	0	38	38
0.7	30	2	0	28	1	29	29
0.8	27	1	0	26	1	26	26
0.9	14	1	0	13	0	14	14
1	10	1	0	9	0	10	10
1.1	10	0	2	8	1	9	8
1.2	6	0	1	5	1	5	5
1.3	3	0	0	3	0	3	3
1.4	0	0	0	0	0	0	0
1.5	1	0	0	1	0	1	1
Total	332	15	3	314	6	326	325

Average voltage = 0.507 volts

Table 3-4 Indication Distribution as Function of Tube Support Plate

SG-A

TSP	Number of Indications	Max. Volts	Ave. Volts	Largest Growth, Volts	Average Growth, Volts
02H	111	1.27	0.440	0.53	-0.009
03H	84	1.07	0.455	0.30	-0.042
04H	40	0.96	0.394	0.22	-0.048
05H	40	0.87	0.397	0.23	-0.003
06H	8	0.50	0.300	0.04	-0.080
07H	4	0.52	0.375	-0.09	-0.022
08H	7	0.40	0.243	0.03	0
04C					
06C	2	0.33	0.22		
08C	1	0.26	0.26	0.03	+0.030
Total	297				

SG-B

TSP	Number of Indications	Max. Volts	Ave. Volts	Largest Growth, Volts	Average Growth, Volts
02H	171	1.40	0.464	0.41	-0.003
03H	125	1.09	0.445	0.50	-0.038
04H	45	0.80	0.401	0.32	+0.008
05H	32	0.98	0.329	0.11	-0.065
06H	9	0.40	0.317	0.12	+0.010
07H	8	0.43	0.311	0.11	-0.048
08H	4	0.73	0.493	0.44	+0.148
04C	1	0.12	0.12		
06C	1	0.20	0.20		
08C	1	0.26	0.26		
Total	397				

SG-C

TSP	Number of Indications	Max. Volts	Ave. Volts	Largest Growth, Volts	Average Growth, Volts
02H	137	1.41	0.580	0.47	-0.012
03H	98	1.23	0.494	0.54	-0.011
04H	40	0.90	0.375	0.43	-0.025
05H	29	1.05	0.497	0.41	+0.021
06H	13	0.61	0.319	0.17	-0.033
07H	7	0.60	0.389	0.17	+0.007
08H	8	1.14	0.544	0.38	+0.048
04C					
06C					
08C					
Total	332				

Composite

TSP	Number of Indications	Max. Volts	Ave. Volts	Largest Growth, Volts	Average Growth, Volts
02H	419	1.41	0.495	0.53	-0.008
03H	307	1.23	0.464	0.54	-0.031
04H	125	0.96	0.390	0.43	-0.021
05H	101	1.05	0.404	0.41	-0.015
06H	30	0.61	0.313	0.17	-0.034
07H	19	0.60	0.353	0.17	-0.057
08H	19	1.14	0.422	0.44	+0.057
04C	1	0.12	0.120		
06C	3	0.33	0.213		
08C	2	0.26	0.260	0.03	+0.030
Total	1026				

Table 3-5 Voltage Growth Cumulative Distribution

	SG-A		SG-B		SG-C		Composite	
Voltage Change: EOC-17 minus EOC-16	Number of Indications	Cumulative Probability Distribution	Number of Indications	Cumulative Probability Distribution	Number of Indications	Cumulative Probability Distribution	Number of Indications	Cumulative Probability Distribution
-0.8<ΔV≤-0.7	1	0.0036	1	0.0027	0		2	0.0021
-0.7<ΔV≤-0.6	0		1	0.0054	0		1	0.0031
-0.6<ΔV≤-0.5	0		2	0.0108	0		2	0.0052
-0.5<ΔV≤-0.4	5	0.0254	5	0.0243	2	0.0063	12	0.0177
-0.4<ΔV≤-0.3	6	0.0436	3	0.0324	5	0.0220	14	0.0332
-0.3<ΔV≤-0.2	13	0.0909	24	0.0973	22	0.0912	59	0.0945
-0.2<ΔV≤-0.1	40	0.236	52	0.238	55	0.264	147	0.246
-0.1 <ΔV≤-0.0	89	0.560	119	0.559	103	0.588	311	0.569
0.0<ΔV≤0.1	88	0.880	98	0.824	72	0.814	258	0.840
0.1<ΔV≤0.2	21	0.956	45	0.946	33	0.918	99	0.940
0.2<ΔV≤0.3	11	0.996	13	0.981	12	0.956	36	0.979
0.3<ΔV≤0.4	0		3	0.989	8	0.984	11	0.989
0.4<ΔV≤0.5	0		4	1.0	5	0.997	9	0.998
0.5<ΔV≤0.6	1	1.0	0		1	1.0	2	1.0
Number of Indications with Growth	275		370		318		963	

Table 3-6 Growth Rate as Function of BOC Voltage Range

Voltage Range		Number of Indications for Growth	Average BOC Voltage	Average Voltage Growth per Cycle 17	Average Voltage Growth per EFPY	Voltage Growth as Percent of BOC Volts per Cycle 17	Voltage Growth as Percent of BOC Volts per EFPY
Composite							
entire range		963	0.475	-0.017	-0.012	0.811%	0.573%
Vboc<0.75		841	0.410	-0.005	-0.003	2.431%	1.720%
Vboc≥0.75		122	0.929	-0.102	-0.072	-10.36%	-7.33%
SG-A							
entire range		275	0.455	-0.027	-0.019	-1.036%	-0.733%
Vboc<0.75		241	0.386	-0.008	-0.006	1.147%	0.811%
Vboc≥0.75		34	0.946	-0.160	-0.113	-16.57%	-11.7%
SG-B							
entire range		370	0.455	-0.017	-0.012	2.440%	1.726%
Vboc<0.75		331	0.397	-0.002	-0.001	4.444%	3.143%
Vboc≥0.75		39	0.943	-0.144	-0.102	-14.56%	-10.30%
SG-C							
entire range		318	0.517	-0.009	-0.006	0.511%	0.362%
Vboc<0.75		269	0.405	-0.006	-0.004	1.106%	0.782%
Vboc≥0.75		49	0.906	-0.029	-0.021	-2.75%	-1.95%

Table 3-7 Indications with the Largest Growth in Cycle 17

SG	Row	Col	TSP #	EOC-17 Volts	EOC-16 Volts	C17 Growth, Volts	+Point Tested?	EOC-15 Volts	EOC-15 to EOC-17 Growth, Volts
C	26	70	03H	1.20	0.66	0.54	No	0.55	0.67
A	4	50	02H	0.87	0.34	0.53	No	1.16	-0.29
B	18	38	03H	0.79	0.29	0.50	No	0.28	0.51
C	24	41	02H	1.19	0.72	0.47	Yes, but not confirmed	0.86	0.33
B	24	51	08H	0.73	0.29	0.44	No	0.18	0.55
C	40	53	04H	0.67	0.24	0.43	No		
C	34	26	02H	1.41	0.98	0.43	No		
C	25	47	03H	0.85	0.44	0.41	No	0.85	0
C	26	39	05H	0.95	0.54	0.41	No	0.60	0.35
B	13	53	02H	0.80	0.39	0.41	No	0.81	-0.01
B	10	6	02H	0.57	0.16	0.41	No	0.54	0.03
B	19	50	03H	1.06	0.68	0.38	No	0.72	0.34
C	25	33	08H	0.57	0.19	0.38	No		
C	25	34	05H	1.04	0.67	0.37	No		
C	9	35	02H	0.95	0.58	0.37	No	0.54	0.41

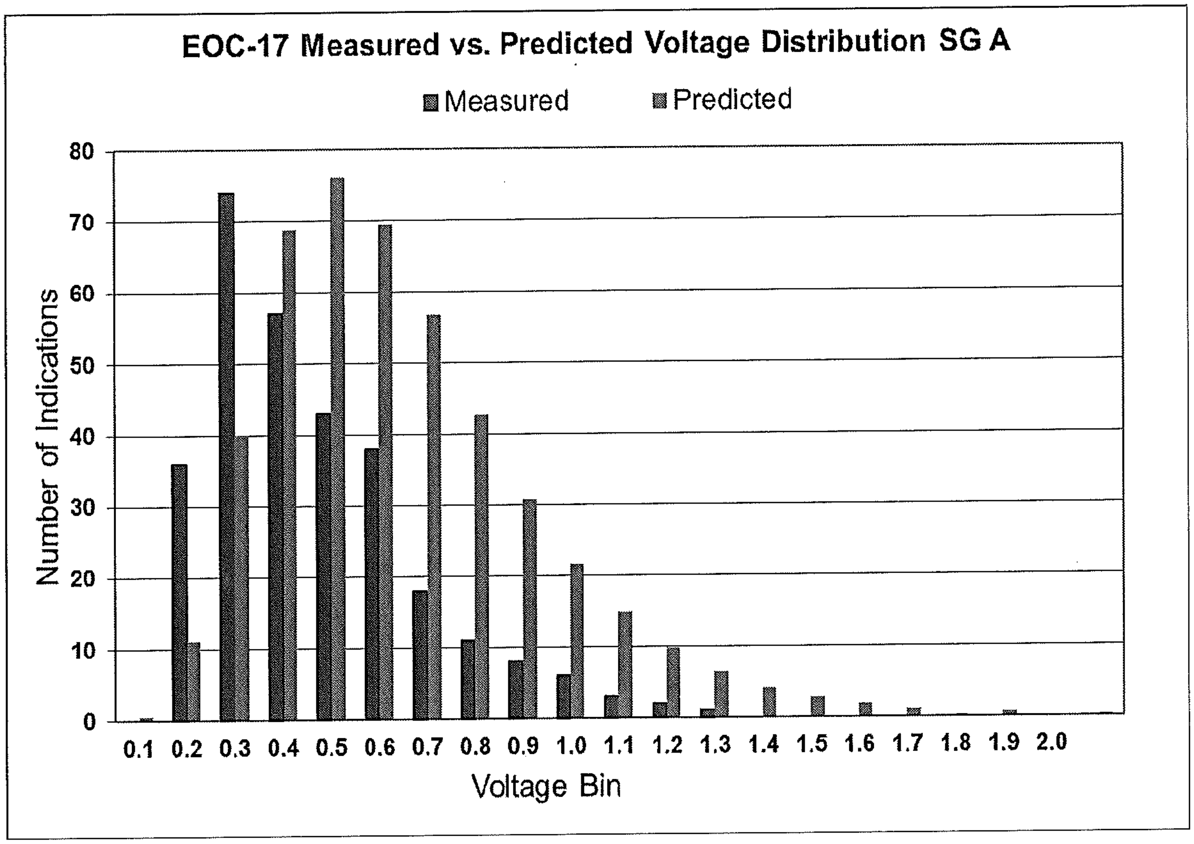

Figure 3-1 Measured Bobbin DSI Voltage, EOC-17 SG-A

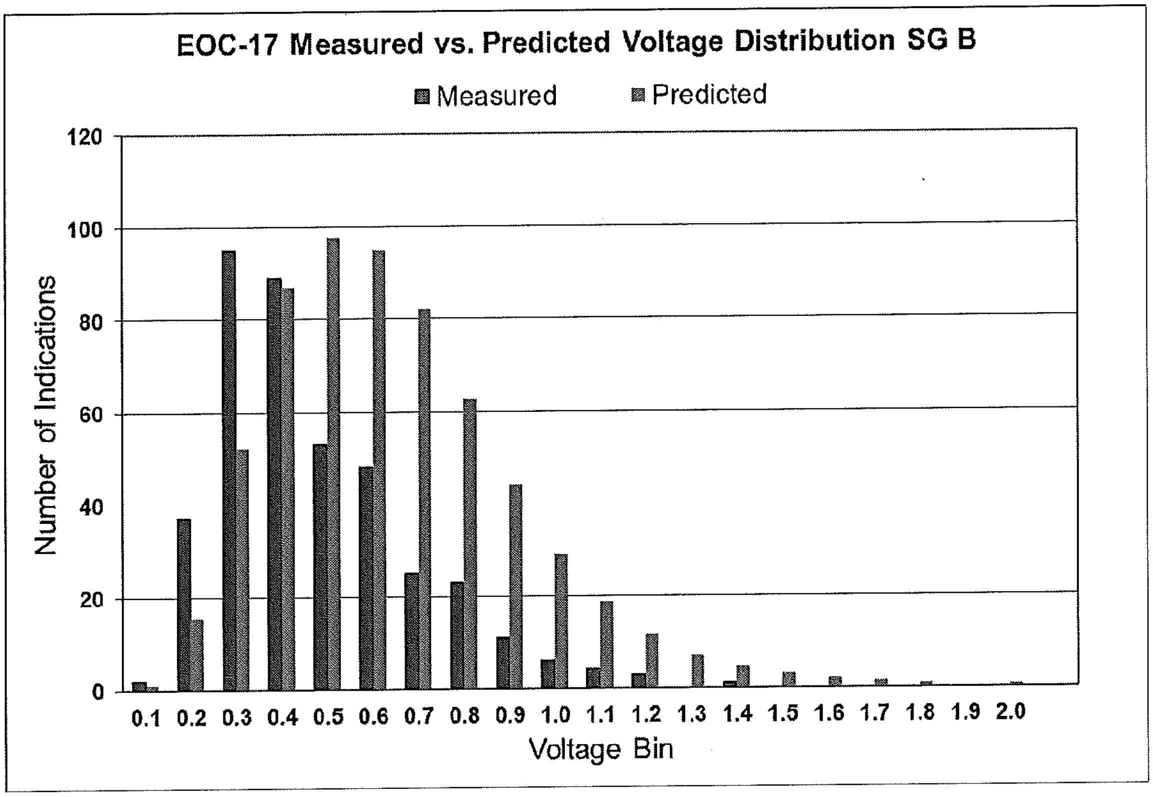

Figure 3-2 Measured Bobbin DSI Voltage, EOC-17 SG-B

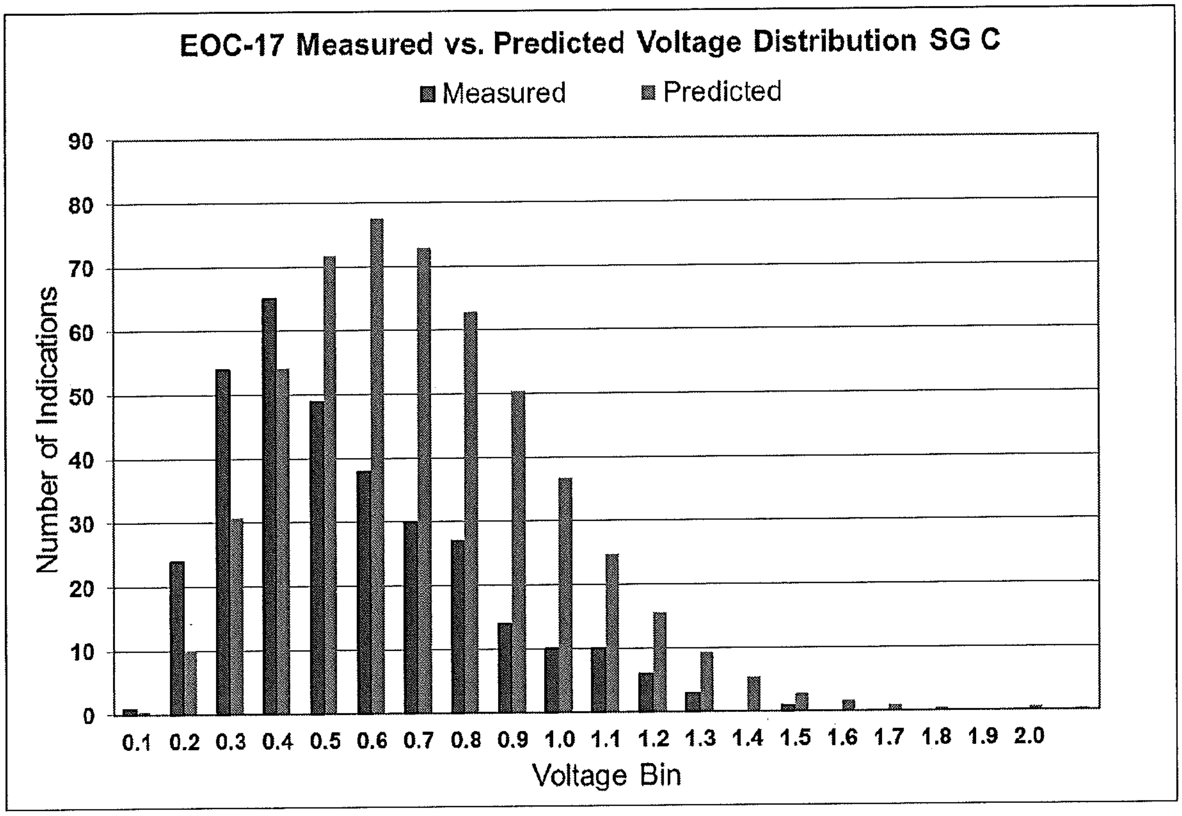

Figure 3-3 Measured Bobbin DSI Voltage, EOC-16 SG-C

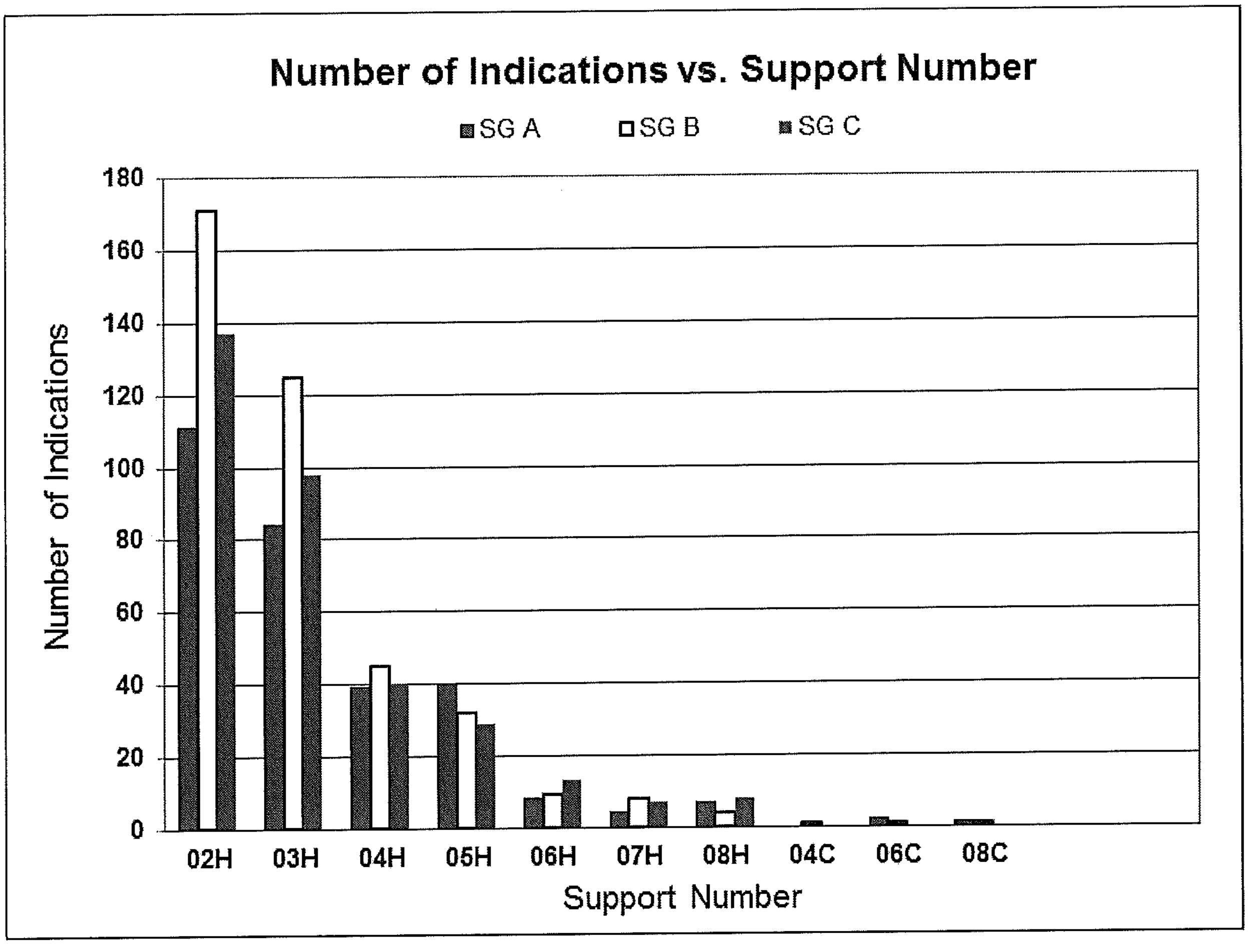

Figure 3-4 Number of Measured Bobbin DSI as Function of TSP

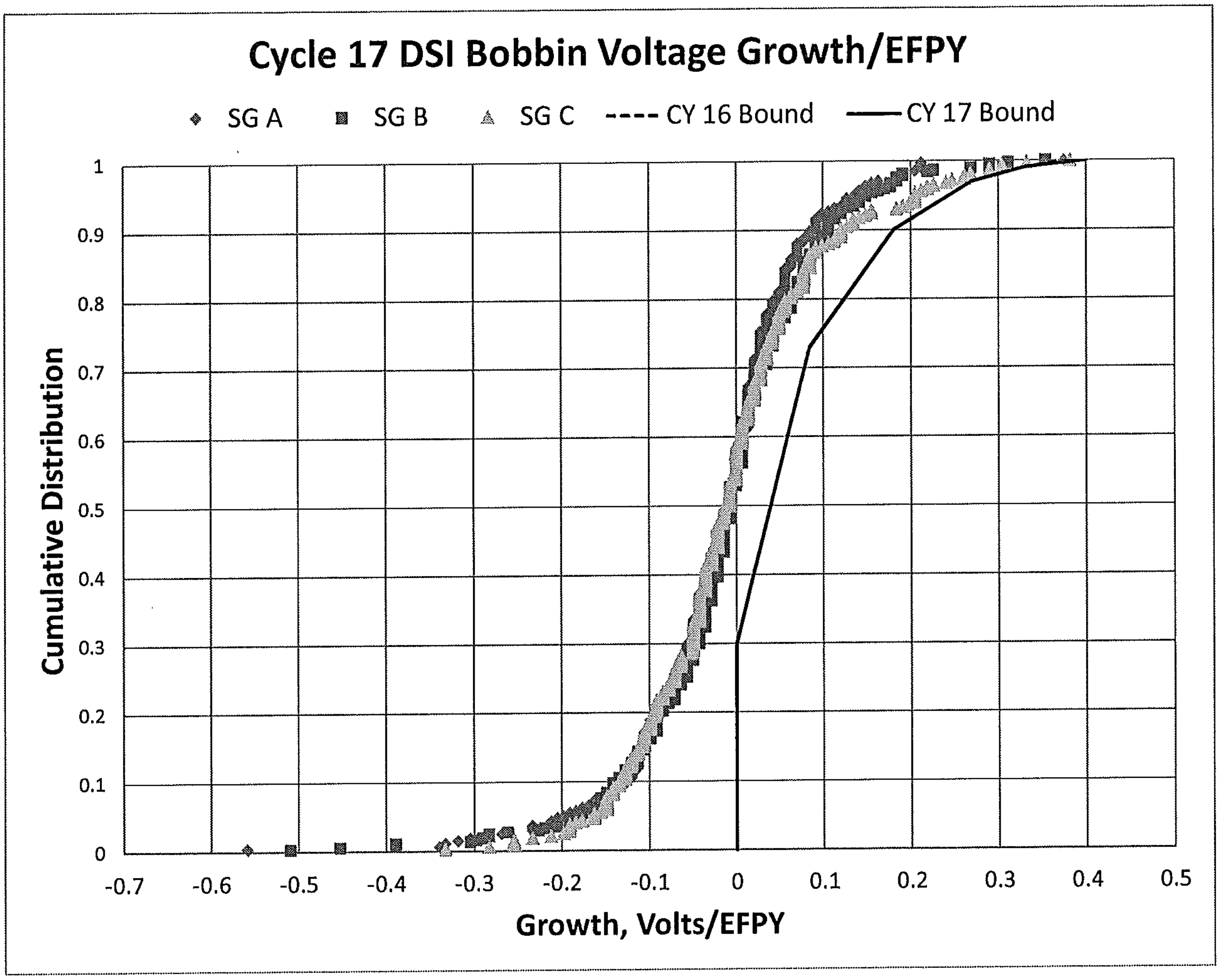

Figure 3-5 Voltage Growth during Cycle 17

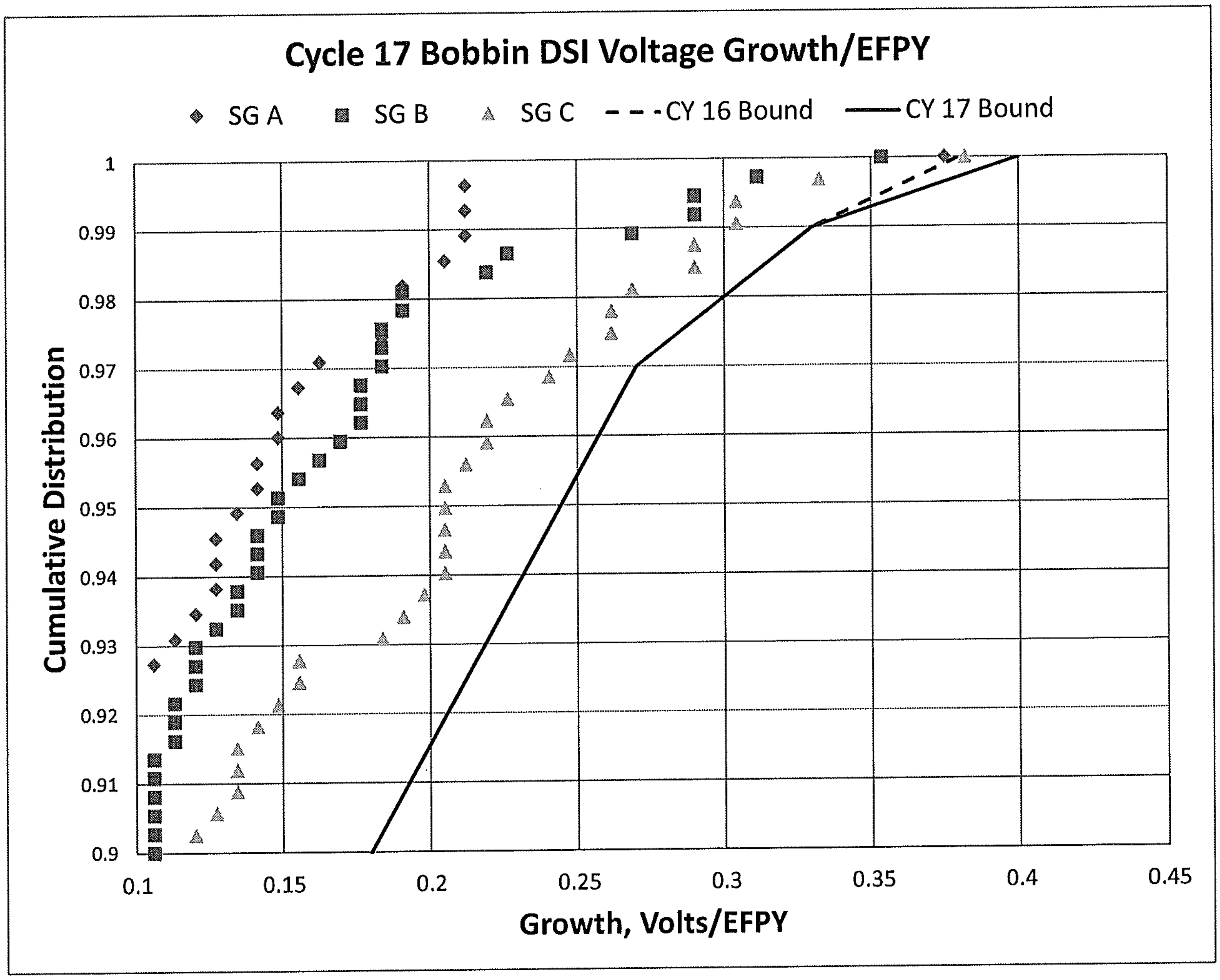

Figure 3-6 Expansion of Figure 3-5 at Extreme Voltage Growth during Cycle 17

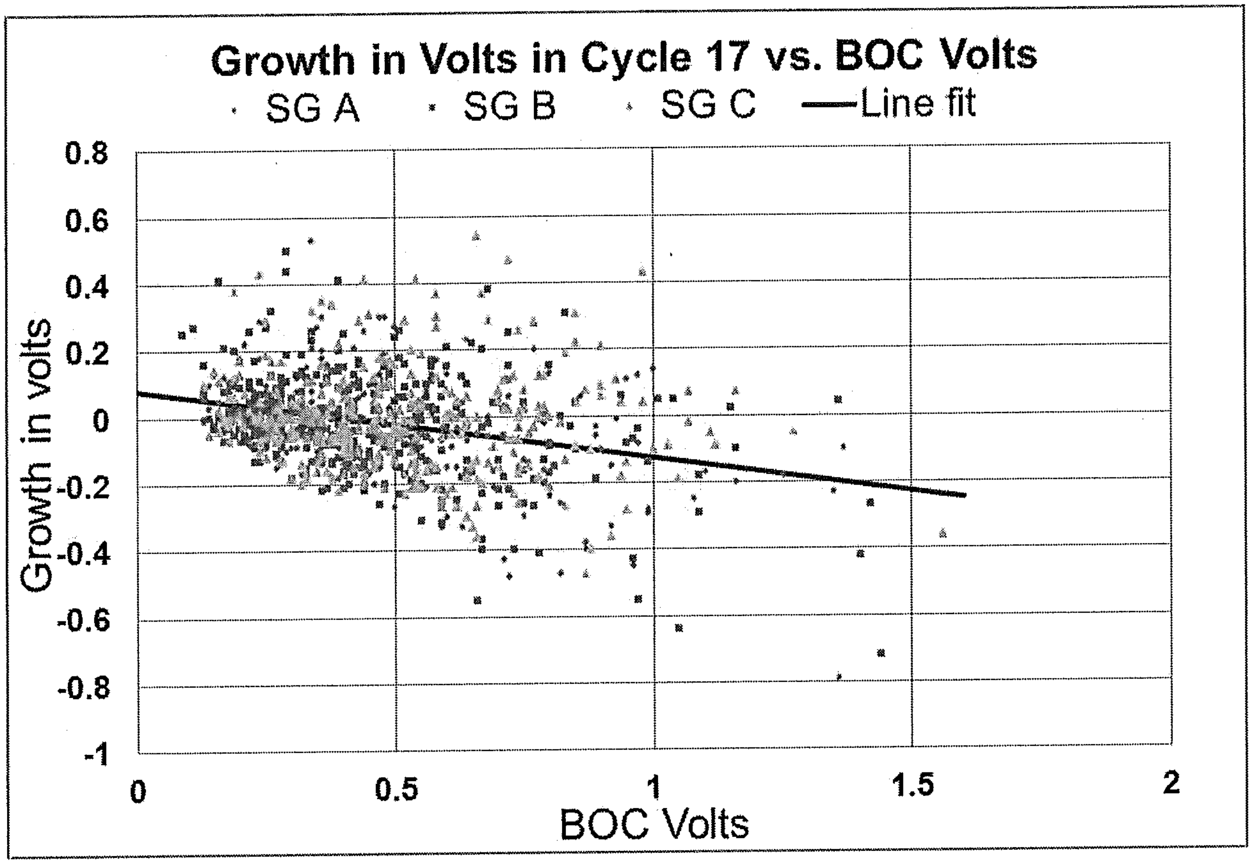

Figure 3-7 Voltage Growth in Cycle 17 vs. BOC Voltage

4 DATABASE APPLIED FOR LEAK AND BURST CORRELATIONS

4.1 Tube Material Properties

The tube material properties are provided in Table 4-1 of Reference 4 for 7/8-inch diameter tubes at 650°F. The parameters used in the analysis are the flow stress mean (sum of yield and ultimate strengths divided by 2) of 68.78 ksi and the flow stress standard deviation of 3.1725 ksi.

4.2 Burst Correlation

The burst pressure, P_b, is normalized to a material with a flow stress of 68.78 ksi, which is the mean of the Westinghouse 7/8-inch tube data. The actual material property values for Beaver Valley Unit 2 are slightly higher than the average of all Westinghouse data. The correlation parameters shown in Table 4-1 are taken from Reference 4.

4.3 Leak Rate Correlation

The steam line break pressure to be applied is 2560 psi unless a lower pressure can be justified. Therefore the leak correlation for pressure of 2560 psi from Reference 4 is used for the leakage predictions. The parameters are shown in Table 4-2. The leak rate criterion is given in terms of gallons per minute as condensed liquid at room temperature.

4.4 Probability of Leak Correlation

The probability of leak as a function of indication voltage is taken from Reference 4. The parameters are shown in Table 4-3. In the Monte Carlo analysis leakage is quantified only if the indication is computed to be a leaker, based on the probability of leak correlation.

4.5 NDE Uncertainties

The NDE uncertainties applied for the EOC-17 and EOC-18 voltage projections are described in Reference 1. The probe wear uncertainty has a standard deviation of 7% about a mean of zero and has a cut-off at 15% based on implementation of the probe wear standard. The analyst variability uncertainty has a standard deviation of 10.3% about a mean of zero with no cut-off. These NDE uncertainty distributions are used in the Monte Carlo analysis to predict the burst probabilities and accident leak rates at EOC-17 and EOC-18. The voltages reported were adjusted to account for differences between the laboratory standard and the standard used in the field.

4.6 Upper Voltage Repair Limit

Per Table 5.4-20 of Reference 12, the BVPS-2 Updated Final Safety Analysis Report (UFSAR), the pressurizer safety relief valves have a nominal setting of 2485 psig, or the RCS design pressure. Applying a 3% allowance for accumulation per Section 2 of Attachment 1 to GL 95-05, the applicable SLB conditions pressure differential across the SG tubes is then 2560 psid, which is the traditional pressure differential used for prior GL 95-05 analyses. The upper

voltage repair limit of 7.51 volts is based on the structural limit in Table 4-1 for a pressure differential of 2560 psi with a safety factor of 1.4. It must be reduced by considering the projected voltage growth during the next cycle and NDE uncertainty. The maximum average percentage growth rate as a percentage of BOC voltage values for any steam generator is seen from Table 3-6 to be very small. According to Reference 1, the minimum growth adjustment is 30% per EFPY (40.5% per cycle for the anticipated 493 EFPD Cycle 18). Therefore the specific maximum growth value of 40.5% and 20% for NDE uncertainty was used to estimate the upper voltage repair limit. This results in an upper voltage repair limit of 7.51 / (1 + 0.405 + 0.20) = 4.7 volts. No indications equal to or greater than this voltage were left in service.

The analysis takes no credit for power operated relief valve (PORV) actuation even though the PORVs, block valves, and associated testing programs have been shown to satisfy the requirements of GL 90-06, as indicated in the NRC Safety Evaluation Report dated May 15, 1995. Crediting the PORVs would effectively increase the upper voltage repair limit by limiting the maximum pressure differential during a postulated SLB event and would also reduce the calculated SLB conditions by limiting the maximum pressure differential.

Considering the inspection history of the BVPS2 SGs, it is unlikely that a bobbin coil DSI voltage of >4.7 volts will be observed within the BVPS2 SGs.

Table 4-1 7/8" Tube Burst Pressure vs. Bobbin Amplitude Correlation Parameters

$$P_B = a_0 + a_1 \log(Volts)$$

Parameter	Addendum 7 Database Value
Intercept, a_0	7.4801
Slope, a_1	-2.4002
Index of Deter., r^2	79.67%
Std. Deviation, σ_{Error}	0.8802
Mean of Log(*V*)	0.3111
SS of Log(*V*)	51.6595
N (data pairs)	100
Str. Limit (2560 psi) (1)	7.51V
Str. Limit (2405 psi)	9.40V
p Value for a_1 (2)	$5.60 \cdot 10^{-36}$
Reference σ_f	68.78 ksi (3)

Notes: (1) Values reported correspond to applying a safety factor of 1.4 on the differential pressure associated with a postulated SLB event.

(2) Numerical values are reported only to demonstrate compliance with the requirement that the value be less than 0.05.

(3) This is the flow stress value to which all data were normalized prior to performing the regression analysis. This affects the coefficient and standard error values. The corresponding values for a flow stress of 75.0 ksi can be obtained from the above values by multiplying by 1.0904.

Table 4-2 Tube Leak Rate vs. Bobbin Amplitude Correlation Parameters

$$Q = 10^{[b_3 + b_4 \log(Volts)]}$$

Parameter	Addendum 7 Database Value
SLB ΔP = 2560 psi	
Intercept, b_3	-0.33476
Slope, b_4	0.95311
Index of Determination, r^2	12.4%
Residuals, σ_{Error} (b_5)	0.8175
Mean of Log(Q)	0.7014
SS of Log(Q)	22.8754
p Value for b_4	2.4%
SLB ΔP = 2405 psi	
Intercept, b_3	-0.8039
Slope, b_4	1.2077
Index of Determination, r^2	20.0%
Residuals, σ_{Error} (b_5)	0.7774
Mean of Log(Q)	0.5090
SS of Log(Q)	22.6667
p Value for b_4	0.5%
Common Data	
Data Pairs, N	32
Mean of Log(V)	1.0871
SS of Log(V)	3.1116

Table 4-3 7/8" Tube Probability of Leak Correlation Parameters

$$Pr(\,Leak\,) = \frac{1}{1 + e^{-[b_1 + b_2 \log(\,Volts\,)]}}$$

Parameter	Addendum 7 Database Value
Logistic Intercept, b_1	-4.9847
Logistic Slope, b_2	7.6110
Intercept Variance, V_{11} (1)	1.2904
Covariance, V_{12}	-1.7499
Slope Variance, V_{22}	2.8181
Number of Data, N	120
Deviance	33.66
Pearson SD	62.9%
MSE	0.285

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

5 SLB ANALYSIS METHODS

A Monte Carlo analysis technique is used to calculate the SLB leak rates and tube burst probabilities for both actual EOC-17 and projected EOC-18 voltage distributions. The Monte Carlo analysis accounts for parameter uncertainty. The analysis methodology is described in the Westinghouse generic methods report of Reference 4 as supplemented by References 5 and 6. The Monte Carlo computer program used to implement this method is documented in Reference 9. Essentially the same methodology was applied to leak and burst analyses performed for the original Beaver Valley Unit 1 SGs, Reference 10.

In general, the methodology involves application of correlations for burst pressure, probability of leakage and leak rate to a measured or calculated EOC voltage 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 probability of detection (POD) used to generate the BOC voltage distributions considers both detection uncertainty and the likely occurrence of new indications. 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.

6 BOBBIN VOLTAGE DISTRIBUTIONS

This section describes the input data used to calculate EOC bobbin voltage distributions and presents results of calculations to project EOC-18 voltage distributions.

6.1 Calculation of Voltage Distributions

The analysis for EOC-18 voltage distribution starts with an initial voltage distribution which is projected to the end-of-cycle conditions based on the growth rate and the anticipated cycle operating duration. 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 using a POD, which accounts for both the detection uncertainty and the development 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 by inspection 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 the beginning of Cycle 18 (BOC-18); therefore, $N_{deplugged} = 0$. Nine tubes with 11 indications at the TSP were plugged, therefore $N_{repaired} = 11$. EOC-17 RPC "no degradation found" (NDF) indications were included in establishing the BOC-18 indication distributions shown in Table 6-1. During the Monte Carlo simulations, voltages for bins with several indications are selected by randomly sampling the voltage bins. For a few higher voltage indications in each SG, 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-18 bobbin voltage frequency distributions is described in Reference 3, and it is essentially the same as that used in the original Beaver Valley Unit 1 SGs, Reference 10.

6.2 Probability of Detection (POD)

The Generic Letter 95-05 (Reference 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. In this report the Reference 1 POD value of 0.6 is used.

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. For conservatism, a growth rate curve which bounded the growth rates of both cycles was used. 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 17 - 516.39 EFPD or 1.41 EFPY (actual)

Cycle 18 - 493 EFPD or 1.35 EFPY (projected)

6.5 Projected EOC-18 Voltage Distribution

Calculations for the EOC-18 bobbin voltage projections were performed for all three SGs based on the EOC-17 distributions shown in Table 6-1. The BOC-18 distributions were adjusted to account for probability of detection as described above, and the adjusted number of indications at BOC-18 is also shown in Table 6-1. Calculations were performed using a constant POD of 0.6 and 1,000,000 Monte Carlo trials. The distribution of indications at BOC-18 and the distribution of indications projected to EOC-18 are shown in Figures 6-1, 6-2, and 6-3 for SG-A, SG-B, and SG-C, respectively. SG-B has the largest number of indications at BOC-18. Reporting the maximum predicted voltage is not required by GL 95-05, but it is arbitrarily chosen to be the voltage where the integration of the upper tail of the voltage distribution reaches a 0.3 fractional indication.

Table 6-1 Predicted Voltage Distribution at EOC-18

	SG-A Number of Indications			SG-B Number of Indications			SG-C Number of Indications		
Volt Bins	Measured	Input	Predicted	Measured	Input	Predicted	Measured	Input	Predicted
	EOC-17	BOC-18	EOC-18	EOC-17	BOC-18	EOC-18	EOC-17	BOC-1	EOC-18
0.1	0	0	0.87	2	3.33	1.85	1	1.67	1.06
0.2	36	60	19.11	37	61.67	21.85	24	40	13.61
0.3	74	123.33	57.13	95	158.33	69.25	54	90	42.27
0.4	57	93	81.02	89	148.33	108.28	65	108.33	69.69
0.5	43	71.67	81.22	53	88.33	111.9	49	79.67	80.34
0.6	38	62.33	73.25	48	79	97.88	38	63.33	76.35
0.7	18	30	58.91	25	40.67	79.07	30	49	66.77
0.8	11	18.33	41.92	23	38.33	58.53	27	44	55.03
0.9	8	13.33	28.33	11	18.33	40.84	14	23.33	42.77
1	6	10	18.87	6	9	27.01	10	16.67	31.73
1.1	3	5	12.39	4	6.67	17.13	10	15.67	23.10
1.2	2	3.33	7.96	3	5	10.59	6	9	16.49
1.3	1	1.67	4.94	0	0	6.35	3	5	11.30
1.4			2.92	1	1.67	3.68	0	0	7.31
1.5			1.62			2.08	1	1.67	4.44
1.6			0.53			1.16			2.53
1.7			0.70			0.23			1.34
1.8			0.30			0.70			0.21
1.9						0.30			0.70
2									0.30
Total	297	492	492	397	659	659	332	547	547

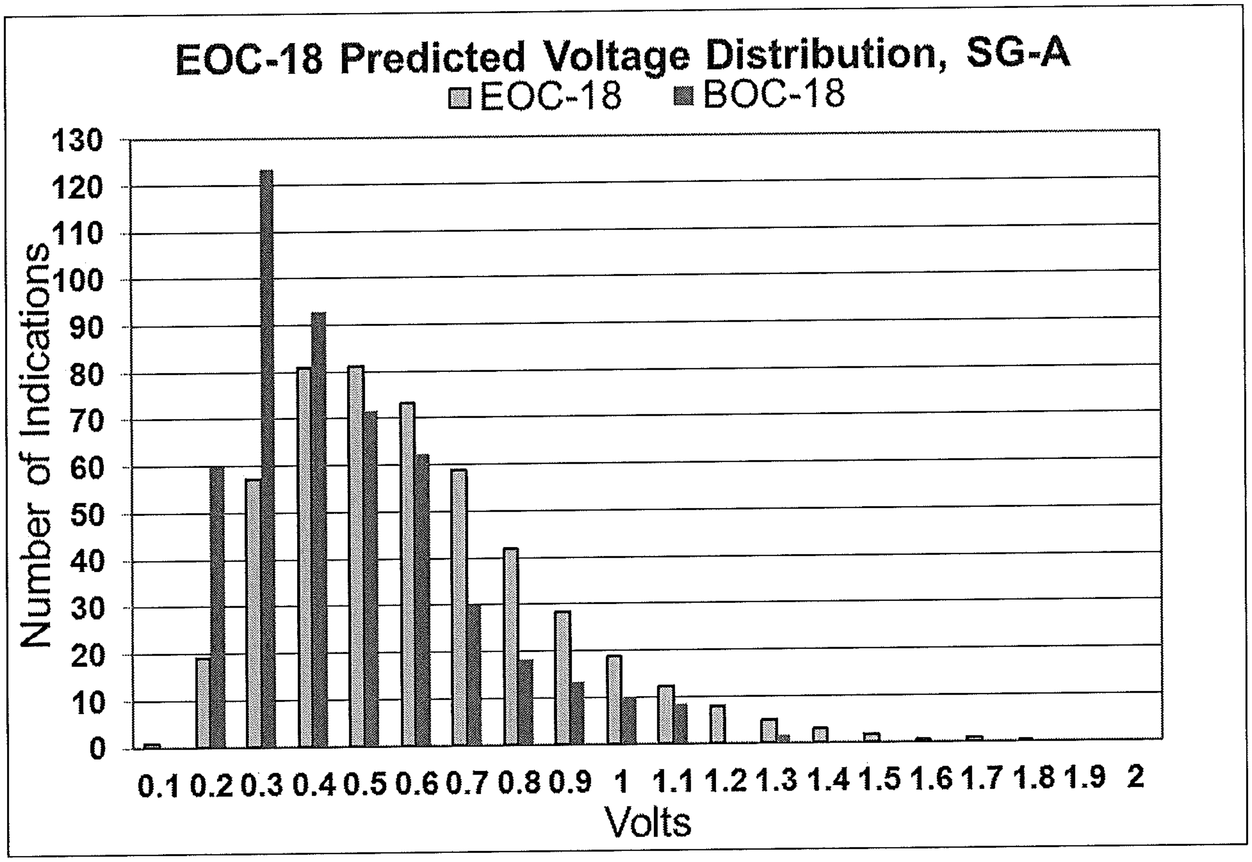

Figure 6-1 Predicted Voltage Distribution at EOC-18, SG-A

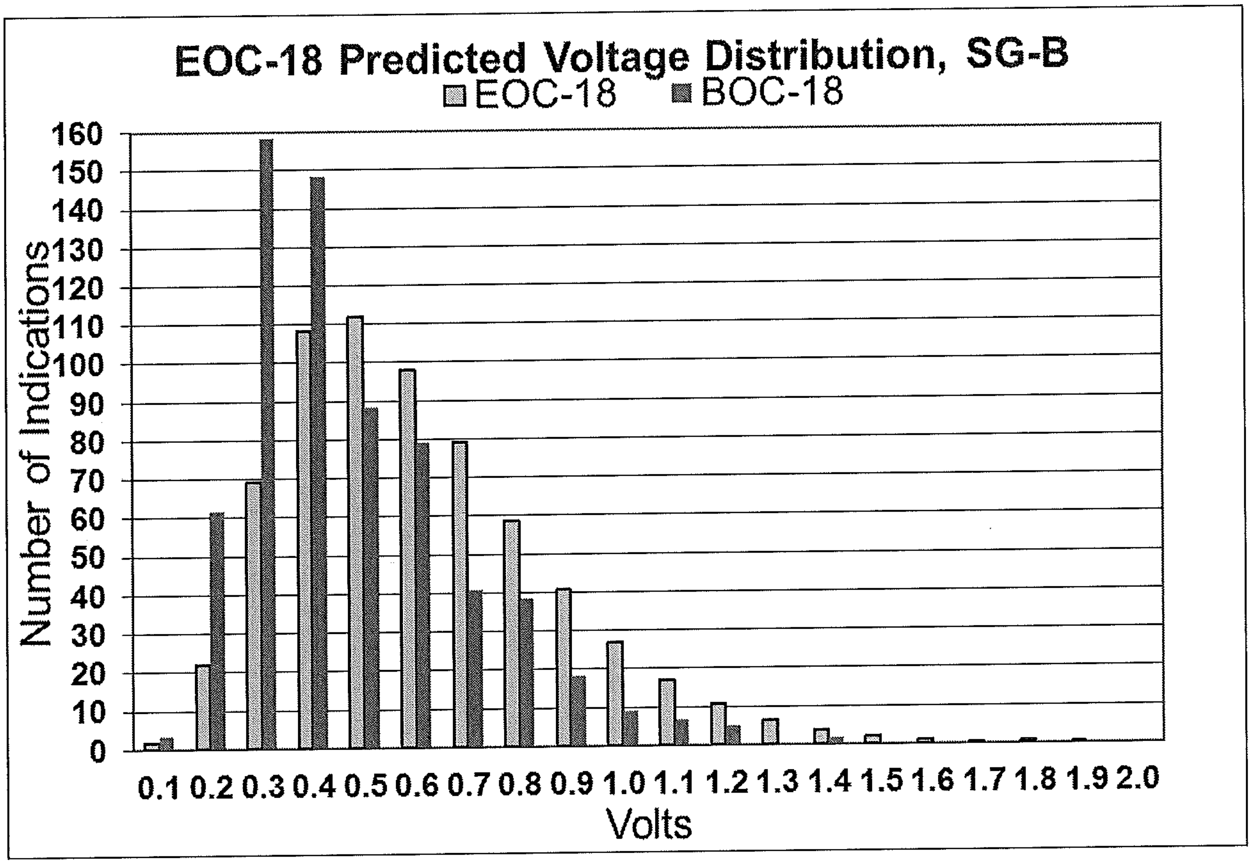

Figure 6-2 Predicted Voltage Distribution at EOC-18, SG-B

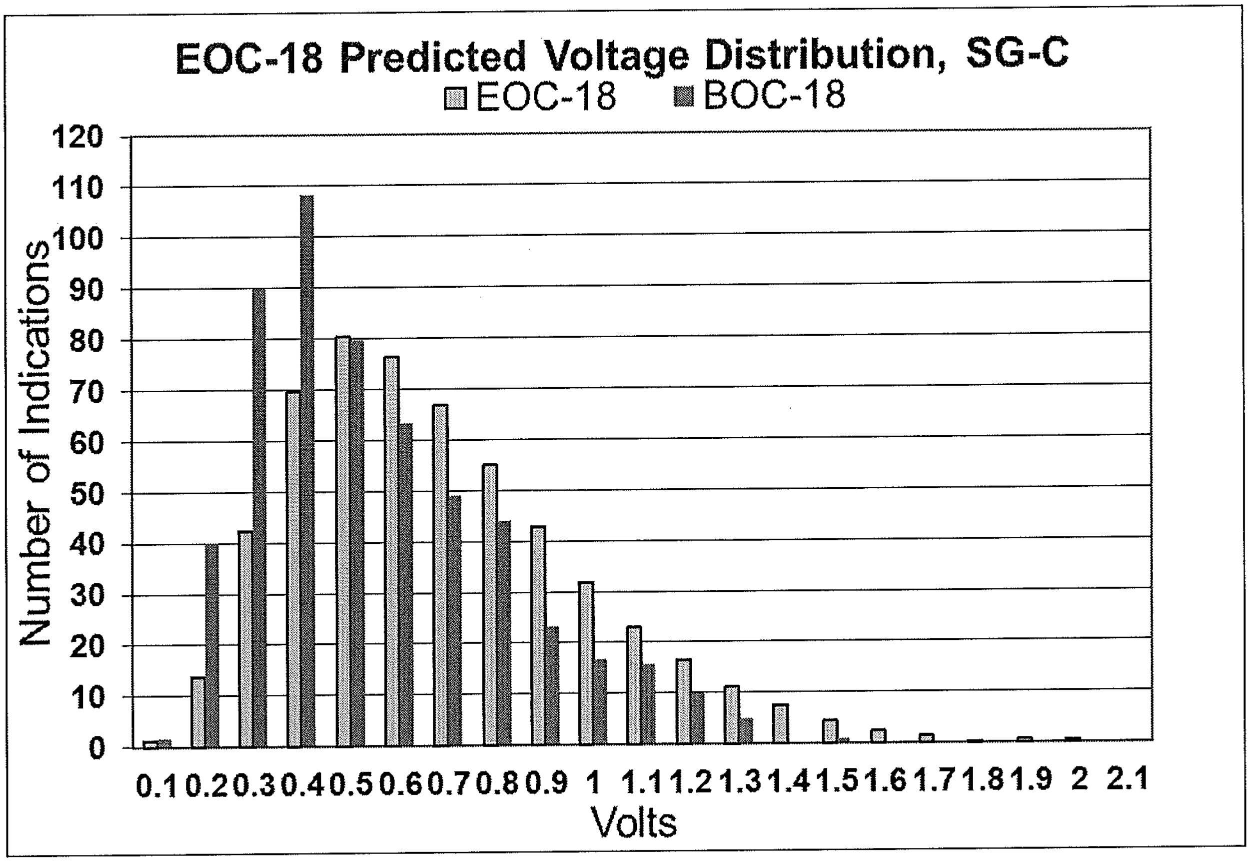

Figure 6-3 Predicted Voltage Distribution at EOC-18, SG-C

7 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-17 inspection (condition monitoring assessment) as well as for the projected EOC-18 voltage distributions (operational assessment). The methodology used in these analyses is described in Section 6.

7.1 EOC-17 Condition Monitoring Leak Rate and Tube Burst Probability

Analyses to calculate the EOC-17 SLB leak rates and tube burst probabilities were performed using the actual bobbin voltage distributions presented in Tables 3-1 to 3-3. The results of the Monte Carlo calculations are summarized in Table 7-1.

The SLB leak rates and tube burst probabilities, calculated using the actual measured EOC-17 voltage distributions using 1,000,000 Monte Carlo trials, are shown in Table 7-1. The methodology used for these calculations is documented in WCAP-14277, Rev. 1. The probability of leak, leak rate and burst pressure correlations for 7/8 inch tubes presented in the latest addendum to the EPRI Alternate Repair Criteria (ARC) Database, Reference 3, were used. The SLB primary-to-secondary pressure differential applied in the analysis is 2560 psi. The maximum EOC-17 leak rate of 0.111 gpm and the maximum conditional burst probability of 2.19×10^{-5} are well below their respective allowable limits (2.2 gpm per Reference 11, and 1.0×10^{-2} per Reference 1, respectively). Therefore, the condition monitoring performance criteria are satisfied.

7.2 Cycle 18 Operational Assessment Leak Rate and Tube Burst Probability

The SLB leak rate and tube burst probability projection for the Cycle 18 operational assessment was carried out using the latest update to the ARC database documented in Reference 4, the POD of 0.60, and 1,000,000 Monte Carlo trials. The EOC-18 leak and burst analyses were performed using a primary-to-secondary pressure differential of 2560 psi, even though it is likely that PORV actuation will occur prior to the pressurizer safety relief valve lift setting.

The EOC-18 projections, considering a 493 EFPD operation cycle, using POD = 0.6 are shown in Table 7-2. Both the maximum projected EOC-18 leak rate of 0.373 gpm and the maximum conditional burst probability of 4.75×10^{-5} are well below their respective allowable limits (2.2 gpm and 1.0×10^{-2}, respectively). Therefore, the operational assessment performance criteria for the DSI indications are satisfied for Cycle 18.

Table 7-1 Condition Monitoring Leak and Burst Results for EOC-17				
	Number of Indications at EOC-17	Maximum Volts at EOC-17	Probability of 1 or More Burst at 95% Confidence	SLB Leak Rate at 95/95 (gpm)
SG-A	297	1.27	1.31×10^{-5}	0.0471
SG-B	397	1.40	1.05×10^{-5}	0.0739
SG-C	332	1.41	2.19×10^{-5}	0. 111

Table 7-2 Operational Assessment Leak and Burst Results for EOC-18 (POD = 0.6)					
	Growth Rate Used in Projection	Number of Indications at EOC-18	Maximum Volts at EOC-18	Probability of 1 or More Burst	SLB Leak Rate at 95/95 (gpm)
SG-A	Cycle 17 Bound	492	1.8	2.07×10^{-5}	0.201
SG-B	Cycle 17 Bound	659	1.9	3.49×10^{-5}	0.294
SG-C	Cycle 17 Bound	547	2.0	4.75×10^{-5}	0.373

8 REFERENCES

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

2. Westinghouse Report, SG-SGMP-13-2, Rev. 1, "Beaver Valley Unit 2 End of Cycle 16 Voltage-Based Repair Criteria 90-Day Report," January 2013.

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.

4. EPRI Report 1018047, Addendum 7 to NP-7480-L Database, "Steam Generator Tubing Outside Diameter Stress Corrosion Cracking at Tube Support Plates Database for Alternate Repair Limits," September 2008.

5. Letter from A. Marion, Nuclear Energy Research Institute, to B. Sheron, Nuclear Regulatory Commission, "Refining the Leak Rate Sampling Methodology for ODSCC ARC Applications (Generic Letter 95-05)," March 15, 2002.

6. Letter from W. Bateman, Nuclear Regulatory Commission, to A. Marion, Nuclear Energy Research Institute, "Refining the Leak Rate Sampling Methodology for Generic Letter 95-05 Voltage-Based Alternate Repair Criteria Application," March 27, 2002.

7. Westinghouse Letter DLC-96-184, "Duquesne Light Company Beaver Valley Power Station Unit 2 Steam Generator LOCA Plus SSE Loads," June 17, 1996.

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

9. Westinghouse Letter LTR-CDME-08-167, "Software Release Letter for CycleSim Version 3.2," July 30, 2008.

10. Westinghouse Report SG-SGDA-05-1, Rev. 1, "Beaver Valley Unit 1 Cycle 17 Voltage-Based Repair Criteria 90-Day Report," January 2005.

11. FENOC Letter BVTS-0109, "2R16 Steam Generator 90 Day Alternate Repair Criteria Report Input Data Validation," January 2, 2013.

12. Beaver Valley Power Station Unit 2, Updated Final Safety Analysis Report, Revision 20

APPENDIX A

Table A-1: DSI Indications for EOC-17 in SG-A

SG	Row	Col	Locn	Volts	Comment
2A	11	2	03H	0.97	
2A	10	7	02H	0.83	
2A	10	7	03H	0.27	
2A	18	7	04H	0.16	
2A	19	7	02H	0.68	
2A	22	7	02H	0.32	
2A	10	8	03H	0.59	
2A	19	8	03H	0.22	
2A	4	9	03H	0.86	
2A	4	9	04H	0.51	
2A	20	9	03H	0.37	
2A	5	10	02H	1.27	
2A	5	10	03H	0.44	
2A	5	10	04H	0.46	
2A	9	10	02H	0.77	
2A	17	10	03H	0.3	
2A	18	10	03H	0.66	
2A	18	10	04H	0.2	
2A	20	10	04H	0.23	
2A	5	11	04H	0.64	
2A	16	11	05H	0.27	SAI
2A	23	11	02H	1.14	
2A	23	11	03H	0.42	
2A	20	12	02H	0.29	
2A	9	13	02H	0.83	
2A	28	13	03H	0.23	
2A	7	14	03H	0.29	
2A	9	14	03H	0.27	
2A	31	14	04H	0.2	
2A	3	15	03H	0.75	
2A	6	15	02H	0.28	
2A	14	15	04H	0.33	
2A	19	15	03H	0.24	
2A	19	15	04H	0.21	
2A	26	15	03H	0.34	
2A	9	16	02H	0.56	
2A	9	16	03H	0.93	
2A	9	16	04H	0.45	
2A	24	16	02H	0.29	
2A	24	16	03H	0.18	
2A	4	18	05H	0.56	
2A	7	18	03H	0.59	
2A	7	18	05H	0.24	
2A	21	18	04H	0.43	
2A	31	18	02H	1.06	
2A	31	18	03H	0.54	
2A	33	18	02H	0.2	
2A	33	18	03H	0.39	
2A	7	19	03H	0.3	
2A	8	19	02H	0.55	
2A	10	19	04H	0.32	
2A	23	19	02H	0.92	
2A	26	19	04H	0.29	
2A	30	19	02H	0.32	
2A	14	20	03H	0.45	
2A	23	20	02H	0.19	
2A	4	21	03H	0.62	
2A	22	21	02H	0.53	
2A	22	21	03H	0.25	
2A	23	21	03H	0.42	
2A	25	21	02H	0.23	
2A	9	22	03H	0.38	Plug
2A	20	22	02H	0.5	
2A	20	22	03H	0.29	
2A	20	22	08H	0.39	
2A	25	22	02H	0.77	
2A	30	22	02H	0.6	
2A	32	22	02H	0.47	
2A	5	23	02H	0.33	Plug
2A	22	23	02H	0.19	
2A	24	23	05H	0.78	SAI
2A	39	23	02H	1.12	

SG	Row	Col	Locn	Volts	Comment
2A	4	24	02H	0.38	
2A	24	24	02H	0.31	
2A	29	24	04H	0.57	
2A	5	25	05H	0.6	
2A	14	25	05H	0.3	
2A	21	25	03H	0.36	
2A	22	25	02H	0.3	
2A	4	26	02H	0.35	
2A	5	26	02H	0.62	
2A	5	26	03H	0.73	
2A	10	26	04H	0.33	
2A	21	26	05H	0.51	
2A	28	26	04H	0.47	
2A	6	27	06H	0.33	
2A	7	27	05H	0.39	
2A	14	27	05H	0.33	
2A	15	27	05H	0.25	
2A	17	27	04H	0.37	
2A	18	27	07H	0.23	
2A	32	27	03H	0.38	
2A	8	28	02H	0.32	
2A	30	28	03H	0.29	
2A	36	28	03H	0.47	
2A	36	28	04H	0.43	
2A	5	29	02H	0.89	MAI
2A	8	29	02H	0.28	
2A	5	30	03H	0.57	
2A	25	30	04H	0.58	
2A	14	31	02H	0.21	
2A	6	32	02H	0.19	
2A	8	32	03H	0.29	
2A	13	32	02H	0.15	
2A	17	32	05H	0.48	
2A	27	32	02H	0.39	
2A	24	33	03H	0.28	
2A	27	33	03H	0.62	

SG	Row	Col	Locn	Volts	Comment
2A	4	34	03H	0.24	
2A	6	34	02H	0.29	
2A	8	34	03H	1.07	
2A	9	34	02H	0.24	SAI
2A	12	34	02H	0.44	
2A	21	34	02H	0.34	
2A	27	34	04H	0.6	
2A	6	35	02H	1.09	
2A	6	35	03H	0.77	
2A	6	35	05H	0.35	
2A	9	35	02H	0.54	
2A	44	35	03H	0.7	
2A	35	36	03H	0.51	Plug
2A	10	37	03H	0.33	
2A	40	37	03H	0.77	
2A	9	38	05H	0.87	
2A	30	38	02H	0.2	
2A	32	38	03H	0.29	
2A	4	39	02H	0.31	
2A	13	39	05H	0.38	
2A	37	39	03H	0.49	
2A	6	40	03H	0.25	
2A	6	40	04H	0.12	
2A	9	40	03H	0.39	
2A	14	40	05H	0.42	SAI
2A	38	40	05H	0.49	
2A	6	41	08H	0.25	SAI
2A	28	41	02H	0.46	
2A	8	42	02H	0.34	
2A	26	42	02H	0.56	
2A	27	42	04H	0.31	SAI
2A	27	42	05H	0.55	
2A	33	42	05H	0.25	
2A	37	42	03H	0.59	
2A	39	42	02H	0.7	
2A	6	43	02H	0.61	

SG	Row	Col	Locn	Volts	Comment
2A	21	43	02H	0.2	
2A	36	44	03H	0.48	
2A	38	44	02H	0.59	
2A	40	44	06C	0.11	
2A	28	45	02H	0.34	
2A	32	45	02H	0.35	
2A	33	45	07H	0.3	
2A	35	45	02H	0.67	
2A	17	46	02H	0.62	
2A	21	46	02H	0.26	
2A	28	46	03H	0.48	
2A	36	46	06H	0.16	
2A	39	46	02H	0.46	
2A	18	47	02H	0.25	
2A	18	47	05H	0.8	
2A	27	47	02H	0.48	
2A	11	48	02H	0.92	
2A	11	48	08H	0.4	
2A	12	48	05H	0.56	
2A	14	48	05H	0.26	
2A	7	49	02H	0.22	
2A	13	49	04H	0.21	
2A	4	50	02H	0.87	
2A	4	50	03H	0.77	
2A	4	50	04H	0.51	
2A	14	50	03H	0.27	
2A	7	51	02H	0.58	
2A	9	51	04H	0.41	SAI
2A	32	51	05H	0.22	
2A	16	52	02H	0.78	
2A	24	52	02H	0.19	
2A	34	52	02H	0.13	
2A	46	52	06H	0.28	
2A	5	53	02H	0.21	
2A	14	53	02H	0.14	
2A	16	53	03H	0.36	

SG	Row	Col	Locn	Volts	Comment
2A	23	53	02H	0.49	SAI
2A	32	53	03H	0.53	
2A	34	53	02H	0.28	
2A	4	54	02H	0.42	
2A	4	54	04H	0.43	
2A	4	54	05H	0.56	
2A	14	54	02H	0.28	
2A	28	54	02H	0.33	
2A	29	54	03H	0.4	MAI
2A	33	54	06H	0.28	
2A	37	54	05H	0.26	
2A	21	55	02H	0.12	
2A	9	56	02H	0.61	
2A	9	56	04H	0.3	
2A	19	56	03H	0.28	
2A	28	56	03H	0.31	
2A	34	56	05H	0.62	
2A	37	56	02H	0.25	
2A	37	56	03H	0.53	
2A	9	57	02H	0.2	
2A	9	57	03H	0.52	
2A	18	57	02H	0.7	
2A	19	57	02H	0.52	
2A	19	57	04H	0.16	
2A	20	57	02H	0.14	
2A	33	57	04H	0.39	
2A	39	57	03H	0.42	
2A	7	58	03H	0.26	
2A	14	58	02H	0.3	
2A	30	58	04H	0.33	
2A	44	58	06H	0.21	
2A	3	59	02H	0.61	
2A	14	59	02H	0.3	
2A	14	59	03H	0.35	
2A	14	59	06H	0.5	
2A	16	59	04H	0.96	

SG	Row	Col	Locn	Volts	Comment
2A	17	59	02H	0.28	
2A	17	59	05H	0.14	
2A	4	60	02H	0.18	
2A	4	60	06H	0.42	
2A	13	60	02H	0.26	
2A	19	60	02H	0.42	
2A	16	62	08H	0.17	
2A	20	62	05H	0.43	
2A	4	63	02H	0.5	
2A	15	63	02H	0.53	
2A	24	63	05H	0.38	
2A	30	63	08H	0.15	
2A	27	64	02H	0.15	
2A	42	64	04H	0.55	
2A	3	65	07H	0.52	
2A	14	65	03H	0.3	
2A	29	65	02H	0.24	
2A	16	66	03H	0.33	
2A	28	66	04H	0.12	SAI
2A	33	66	02H	0.52	
2A	13	67	06C	0.33	
2A	15	67	02H	0.63	
2A	14	68	02H	0.41	
2A	30	68	02H	0.31	
2A	8	69	02H	0.24	
2A	12	69	03H	0.34	
2A	12	70	03H	0.46	
2A	14	70	03H	0.63	
2A	16	70	03H	0.22	
2A	7	71	03H	0.49	
2A	13	71	04H	0.48	
2A	15	71	02H	0.36	
2A	12	72	02H	0.3	
2A	15	72	02H	0.35	
2A	16	72	02H	0.14	
2A	21	72	03H	0.47	
2A	12	73	05H	0.17	
2A	15	73	05H	0.32	
2A	21	73	03H	0.86	
2A	9	74	03H	0.19	
2A	12	74	02H	0.4	
2A	12	74	03H	0.49	
2A	15	74	03H	0.89	
2A	15	75	02H	0.36	
2A	15	75	08H	0.21	SAI
2A	20	75	05H	0.11	
2A	27	75	05H	0.21	
2A	8	76	05H	0.36	
2A	16	76	02H	0.46	
2A	11	77	05H	0.67	
2A	16	77	05H	0.13	
2A	4	78	05H	0.4	
2A	11	78	06H	0.22	
2A	20	78	04H	0.19	
2A	21	78	08H	0.13	
2A	3	79	07H	0.45	
2A	5	80	05H	0.18	
2A	13	80	03H	0.32	
2A	14	80	03H	0.25	
2A	26	80	05H	0.28	
2A	3	81	03H	0.93	
2A	17	81	03H	0.21	
2A	17	81	04H	0.28	
2A	5	82	03H	0.39	
2A	3	84	03H	0.56	
2A	13	84	02H	0.58	
2A	3	85	04H	0.71	
2A	4	85	08C	0.26	
2A	8	85	02H	0.2	
2A	13	85	02H	0.57	
2A	20	85	03H	0.26	
2A	13	86	03H	0.34	
2A	14	86	04H	0.56	

SG	Row	Col	Locn	Volts	Comment
2A	2	88	02H	0.28	
2A	18	88	05H	0.43	
2A	8	91	04H	0.45	
2A	13	91	05H	0.35	
2A	2	92	03H	0.41	
2A	3	92	02H	0.28	
2A	13	92	04H	0.52	
2A	7	94	02H	0.31	

Table A-2: DSI Indications for EOC-17 in SG-B

SG	Row	Col	Locn	Volts	Comment
2B	8	2	03H	0.51	
2B	9	4	03H	0.3	SAI
2B	9	5	03H	0.23	
2B	10	6	02H	0.57	
2B	9	8	03H	0.22	
2B	11	8	03H	0.25	
2B	11	8	04H	0.17	
2B	14	8	03H	0.2	
2B	8	9	02H	0.31	
2B	8	9	03H	0.21	
2B	11	9	06H	0.34	
2B	11	9	07H	0.35	
2B	10	10	02H	0.18	
2B	12	10	02H	0.48	
2B	9	11	02H	0.6	
2B	9	11	03H	0.34	
2B	20	11	02H	1.14	
2B	5	12	03H	0.27	
2B	15	12	03H	0.1	
2B	18	12	03H	0.23	
2B	22	12	03H	0.14	
2B	14	13	02H	0.37	
2B	5	14	03H	0.64	
2B	10	14	02H	0.31	
2B	10	15	02H	0.4	
2B	12	15	02H	0.26	
2B	12	15	03H	0.6	
2B	14	15	03H	0.37	
2B	19	15	02H	0.32	
2B	19	15	04H	0.12	
2B	6	16	03H	0.32	
2B	9	16	03H	0.21	
2B	12	16	03H	0.21	
2B	13	16	02H	0.59	
2B	13	16	03H	0.18	
2B	13	16	06H	0.39	
2B	20	16	03H	0.33	
2B	30	16	04H	0.22	
2B	9	17	02H	0.32	
2B	9	17	03H	0.39	
2B	10	17	02H	0.35	
2B	25	17	02H	0.28	
2B	8	18	02H	0.34	
2B	8	18	03H	0.31	
2B	9	18	02H	0.33	
2B	9	18	03H	0.48	
2B	10	18	02H	0.53	
2B	11	18	02H	0.74	
2B	14	18	02H	0.47	
2B	18	18	02H	0.22	
2B	22	18	03H	0.72	SAI
2B	20	19	04H	0.11	
2B	5	20	03H	0.34	
2B	8	20	02H	0.36	
2B	11	20	02H	0.64	
2B	29	20	03H	0.87	
2B	30	20	04H	0.22	
2B	11	21	03H	0.33	
2B	31	21	07H	0.29	
2B	5	22	04H	0.63	
2B	8	22	02H	0.29	
2B	12	22	02H	0.43	
2B	4	23	02H	0.27	
2B	4	23	06H	0.26	
2B	6	23	04H	0.25	
2B	20	23	02H	0.22	SAI
2B	31	23	02H	0.58	
2B	2	24	02H	0.44	
2B	12	24	02H	0.55	
2B	12	24	04H	0.45	
2B	25	24	03H	0.7	
2B	37	24	05H	0.12	
2B	11	25	03H	0.41	SAI

SG	Row	Col	Locn	Volts	Comment
2B	14	25	02H	0.44	
2B	36	25	05H	0.29	
2B	6	26	02H	0.21	
2B	9	26	02H	0.55	
2B	9	26	03H	0.66	
2B	10	26	02H	0.59	
2B	15	26	03H	0.39	
2B	15	26	07H	0.34	
2B	6	27	03H	0.29	SAI
2B	14	27	03H	0.26	
2B	15	27	02H	0.29	
2B	16	27	03H	0.38	
2B	29	27	03H	0.66	
2B	30	27	02H	0.44	
2B	2	28	02H	0.57	
2B	5	28	02H	0.62	
2B	14	28	05H	0.2	
2B	18	28	04H	0.28	
2B	18	29	02H	0.81	
2B	19	29	02H	0.91	
2B	19	29	03H	0.93	
2B	24	29	05H	0.27	
2B	25	29	02H	0.23	
2B	32	29	05H	0.21	
2B	18	30	04H	0.25	
2B	24	30	03H	0.29	
2B	26	30	03H	0.75	
2B	16	31	02H	0.46	
2B	16	31	07H	0.29	
2B	29	31	05H	0.24	
2B	32	31	02H	0.3	SAI
2B	33	31	07H	0.33	
2B	39	31	05H	0.14	
2B	40	31	05H	0.14	
2B	41	31	05H	0.23	
2B	3	32	03H	0.28	

SG	Row	Col	Locn	Volts	Comment
2B	4	32	03H	0.13	
2B	14	32	02H	0.38	
2B	24	32	03H	0.36	
2B	29	32	03H	0.1	
2B	29	32	05H	0.27	
2B	30	32	03H	0.16	
2B	31	32	03H	0.37	
2B	31	32	05H	0.37	
2B	33	32	02H	0.42	
2B	34	32	02H	0.27	
2B	37	32	03H	0.75	
2B	17	33	02H	0.61	Plug
2B	17	33	03H	0.6	Plug
2B	23	33	03H	0.45	
2B	39	33	03H	0.23	
2B	29	34	03H	0.39	
2B	11	35	02H	0.16	
2B	14	35	06H	0.24	
2B	17	35	03H	0.54	
2B	29	35	04H	0.44	SAI
2B	34	35	03H	0.36	
2B	38	35	02H	0.37	
2B	14	36	03H	0.27	
2B	15	36	02H	0.29	
2B	18	36	03H	1.09	
2B	19	36	02H	1	
2B	22	36	03H	0.22	
2B	27	36	06H	0.25	
2B	8	37	03H	0.53	
2B	10	37	03H	0.23	
2B	13	37	03H	0.3	
2B	16	37	02H	0.5	
2B	16	37	04H	0.52	SAI
2B	18	37	03H	0.52	
2B	23	37	04H	0.59	SAI
2B	29	37	03H	0.72	

SG	Row	Col	Locn	Volts	Comment
2B	31	37	03H	0.5	
2B	33	37	04H	0.2	
2B	34	37	03H	0.45	
2B	18	38	03H	0.79	
2B	29	38	02H	0.48	MAI
2B	13	39	07H	0.16	
2B	14	39	02H	0.16	
2B	19	39	03H	0.89	
2B	19	39	04H	0.63	
2B	26	39	03H	0.16	
2B	31	39	02H	0.38	
2B	31	39	03H	0.59	
2B	29	40	03H	0.87	
2B	35	40	02H	0.43	
2B	4	41	04H	0.23	
2B	10	41	07H	0.3	
2B	28	41	02H	0.59	
2B	29	41	02H	0.43	
2B	11	42	03H	0.16	
2B	17	42	03H	0.53	
2B	18	42	02H	0.39	
2B	24	42	02H	0.87	
2B	36	42	03H	0.25	
2B	40	42	02H	0.37	
2B	1	43	02H	0.5	
2B	4	43	02H	0.3	
2B	4	44	02H	0.35	
2B	16	44	02H	0.4	
2B	17	44	02H	0.4	SAI
2B	33	44	02H	0.65	
2B	19	45	02H	0.42	
2B	21	45	04H	0.38	
2B	27	46	06H	0.33	
2B	13	47	02H	0.29	SAI
2B	3	48	05H	0.98	Plug
2B	4	48	03H	0.55	
2B	34	48	02H	0.6	SAI
2B	34	48	03H	0.66	NDF
2B	34	48	04H	0.37	NDF
2B	44	48	02H	0.62	
2B	10	50	02H	0.29	
2B	10	50	03H	0.24	
2B	19	50	03H	1.06	
2B	30	50	04H	0.75	
2B	12	51	02H	0.15	
2B	15	51	02H	0.34	SAI
2B	19	51	02H	0.74	
2B	19	51	03H	0.5	
2B	24	51	08H	0.73	
2B	34	51	02H	0.72	
2B	34	51	03H	0.87	
2B	42	51	04H	0.39	
2B	1	52	02H	0.45	
2B	4	52	03H	0.58	
2B	5	52	02H	0.6	
2B	6	52	02H	0.17	
2B	7	52	02H	0.97	
2B	9	52	02H	0.51	
2B	9	52	03H	0.32	
2B	10	52	02H	1.17	
2B	10	52	04H	0.37	
2B	12	52	02H	0.57	
2B	12	52	03H	0.74	
2B	15	52	02H	0.65	
2B	22	52	02H	0.27	
2B	22	52	03H	0.29	
2B	24	52	02H	0.47	
2B	27	52	04H	0.48	
2B	31	52	02H	0.69	
2B	41	52	08C	0.26	
2B	6	53	02H	0.35	
2B	6	53	03H	0.4	

SG	Row	Col	Locn	Volts	Comment
2B	8	53	02H	0.8	
2B	10	53	02H	0.48	
2B	11	53	02H	0.43	
2B	13	53	02H	0.8	
2B	18	53	03H	0.52	
2B	18	53	04H	0.33	
2B	21	53	03H	0.42	
2B	21	53	05H	0.21	
2B	22	53	02H	0.16	
2B	27	53	03H	0.35	
2B	32	53	02H	0.81	
2B	2	54	04H	0.29	
2B	3	54	02H	0.62	
2B	4	54	02H	0.52	
2B	5	54	02H	0.4	
2B	5	54	03H	0.24	
2B	7	54	02H	0.19	
2B	10	54	02H	0.28	
2B	14	54	02H	0.57	
2B	14	54	03H	0.48	
2B	21	54	02H	1.4	
2B	3	55	02H	0.77	
2B	16	55	05H	0.27	
2B	30	55	03H	0.4	
2B	32	55	02H	0.71	
2B	32	55	05H	0.31	
2B	1	56	02H	0.4	
2B	4	56	04H	0.34	
2B	5	56	03H	0.53	
2B	7	56	02H	0.74	
2B	8	56	03H	0.39	
2B	10	56	02H	0.43	
2B	13	56	03H	0.33	
2B	23	56	02H	0.57	
2B	24	56	02H	0.55	
2B	29	56	02H	1.06	

SG	Row	Col	Locn	Volts	Comment
2B	1	57	04H	0.73	
2B	4	57	02H	0.49	
2B	4	57	04H	0.29	
2B	11	57	03H	0.25	
2B	14	57	02H	0.59	
2B	14	57	03H	0.49	
2B	18	57	03H	0.14	
2B	34	57	02H	0.45	
2B	37	57	02H	0.35	
2B	37	57	05H	0.15	
2B	4	58	02H	0.54	
2B	5	58	02H	0.24	
2B	6	58	02H	0.65	
2B	10	58	05H	0.22	
2B	11	58	03H	0.29	
2B	18	58	02H	0.62	
2B	24	58	03H	0.28	
2B	36	58	05H	0.24	
2B	4	59	02H	0.32	
2B	4	59	03H	0.33	
2B	8	59	02H	0.32	
2B	9	59	03H	0.4	
2B	9	59	05H	0.34	
2B	30	59	04H	0.24	
2B	3	60	02H	0.72	
2B	3	60	03H	0.66	
2B	5	60	02H	0.3	
2B	3	61	06H	0.31	
2B	6	61	08H	0.33	
2B	11	61	02H	1.15	
2B	11	61	03H	0.52	
2B	12	61	03H	0.89	
2B	14	61	02H	0.29	
2B	14	61	03H	0.79	
2B	14	61	05H	0.68	
2B	16	61	02H	0.5	

SG	Row	Col	Locn	Volts	Comment
2B	18	61	03H	0.37	
2B	23	61	02H	0.25	
2B	32	61	02H	0.41	
2B	32	61	05H	0.39	
2B	2	62	03H	0.64	
2B	3	62	03H	0.48	
2B	3	62	04H	0.26	
2B	22	62	03H	0.5	
2B	24	62	03H	0.51	
2B	33	62	02H	0.83	
2B	2	63	04H	0.44	
2B	3	63	02H	0.95	
2B	3	63	03H	0.68	
2B	4	63	04H	0.69	
2B	5	63	04H	0.19	
2B	6	63	02H	0.19	
2B	7	63	07H	0.43	
2B	10	63	02H	0.31	
2B	14	63	03H	0.52	
2B	23	63	03H	0.31	
2B	23	63	05H	0.19	
2B	24	63	03H	0.48	
2B	28	63	03H	0.52	
2B	38	63	03H	0.21	
2B	5	64	02H	0.38	
2B	5	64	03H	0.38	
2B	9	64	04H	0.7	SAI
2B	11	64	03H	0.55	
2B	17	64	02H	0.15	
2B	18	64	03H	0.39	
2B	22	64	02H	0.54	
2B	25	64	06H	0.33	
2B	2	67	06H	0.4	
2B	23	67	05H	0.26	
2B	5	68	02H	0.43	
2B	17	68	02H	0.57	NDF

SG	Row	Col	Locn	Volts	Comment
2B	17	68	03H	0.74	NDF
2B	17	68	04H	0.8	SAI
2B	24	68	08H	0.34	
2B	27	68	02H	0.3	
2B	18	69	05H	0.33	
2B	2	70	05H	0.82	
2B	14	70	02H	0.57	
2B	20	70	02H	0.14	
2B	10	71	05H	0.35	
2B	15	71	05H	0.59	
2B	16	71	02H	0.3	
2B	19	71	05H	0.47	
2B	24	71	05H	0.39	
2B	31	71	05H	0.22	
2B	3	72	03H	0.65	
2B	2	73	03H	0.25	
2B	2	73	04H	0.48	
2B	5	73	02H	0.49	
2B	13	73	02H	0.3	
2B	19	74	02H	0.4	
2B	5	75	04H	0.2	
2B	7	75	02H	0.19	
2B	11	75	02H	0.85	
2B	15	75	02H	0.21	
2B	15	75	04H	0.34	
2B	21	75	02H	0.29	
2B	18	76	03H	0.49	
2B	19	76	02H	0.57	
2B	31	76	02H	0.46	
2B	13	77	03H	0.77	
2B	32	77	02H	0.41	
2B	10	78	04H	0.27	
2B	13	78	02H	0.11	
2B	19	78	02H	0.24	
2B	26	78	02H	0.31	
2B	30	78	02H	0.5	

SG	Row	Col	Locn	Volts	Comment
2B	30	78	04H	0.35	
2B	31	78	02H	0.34	
2B	31	78	03H	1.06	
2B	25	79	08H	0.57	
2B	30	79	02H	0.38	
2B	9	80	02H	0.49	
2B	10	80	03H	0.2	
2B	15	80	04H	0.48	
2B	5	81	05H	0.33	
2B	20	81	02H	0.24	
2B	28	81	02H	0.27	
2B	30	81	03H	0.29	
2B	10	82	03H	0.25	
2B	11	83	03H	0.43	
2B	11	83	04H	0.73	
2B	17	83	06C	0.2	
2B	14	84	04H	0.22	
2B	24	84	05H	0.3	
2B	9	85	02H	0.63	
2B	13	85	02H	0.48	
2B	19	85	02H	0.27	
2B	13	86	02H	0.14	
2B	23	86	02H	0.28	
2B	15	87	02H	0.28	
2B	3	88	04H	0.58	
2B	10	88	04C	0.12	
2B	14	88	02H	0.3	
2B	3	89	04H	0.54	
2B	10	89	02H	0.4	
2B	20	89	02H	0.33	
2B	13	91	02H	0.35	
2B	5	92	02H	0.4	
2B	9	92	02H	0.41	
2B	5	93	03H	0.28	
2B	9	93	02H	0.35	
2B	2	94	04H	0.51	

Table A-3: DSI Indications for EOC-17 in SG-C

SG	Row	Col	Locn	Volts	Comment
2C	8	2	08H	0.4	
2C	4	3	04H	0.31	
2C	15	5	04H	0.48	
2C	5	6	03H	0.65	
2C	5	6	04H	0.24	
2C	5	7	02H	0.23	
2C	5	7	03H	0.85	
2C	11	7	02H	0.58	
2C	3	8	04H	0.29	
2C	10	8	02H	0.95	
2C	3	9	06H	0.16	
2C	10	9	03H	0.42	
2C	11	9	03H	0.65	
2C	12	9	02H	0.37	
2C	17	9	04H	0.36	SAI
2C	10	10	02H	0.8	
2C	10	10	03H	0.53	
2C	23	10	02H	0.47	
2C	29	11	05H	0.46	
2C	30	12	03H	0.25	
2C	15	14	03H	0.43	
2C	17	14	04H	0.25	
2C	31	14	05H	0.27	
2C	5	15	03H	0.27	
2C	16	15	03H	0.65	
2C	18	15	06H	0.17	
2C	11	17	02H	1.06	
2C	16	17	02H	0.35	
2C	17	17	02H	0.2	
2C	25	17	03H	0.35	
2C	31	17	04H	0.3	
2C	3	18	03H	0.32	
2C	5	18	02H	0.56	
2C	10	18	04H	0.23	
2C	17	18	02H	0.37	
2C	21	18	02H	0.34	
2C	21	18	03H	0.37	
2C	22	18	02H	0.43	
2C	5	19	02H	0.68	
2C	5	19	03H	0.29	
2C	32	19	05H	0.15	
2C	9	20	04H	0.38	
2C	22	20	02H	0.94	
2C	27	20	02H	0.62	
2C	36	20	03H	0.72	
2C	27	22	02H	0.37	
2C	31	22	02H	0.34	
2C	35	22	02H	0.35	
2C	6	23	02H	0.46	
2C	8	23	02H	0.77	
2C	8	24	02H	0.61	
2C	10	24	03H	0.48	
2C	17	24	04H	0.12	
2C	22	24	03H	0.4	
2C	26	24	06H	0.33	
2C	27	24	04H	0.35	
2C	30	24	02H	0.43	
2C	34	24	07H	0.21	
2C	21	25	04H	0.11	
2C	30	25	04H	0.17	
2C	32	25	03H	0.27	
2C	40	25	03H	0.23	
2C	4	26	03H	0.91	
2C	9	26	03H	0.54	
2C	17	26	03H	0.19	
2C	19	26	03H	0.31	
2C	25	26	04H	0.13	
2C	29	26	05H	0.75	
2C	34	26	02H	1.41	
2C	36	26	05H	0.66	
2C	37	26	05H	0.09	
2C	28	27	05H	0.24	

SG	Row	Col	Locn	Volts	Comment
2C	36	27	05H	0.45	
2C	39	27	04H	0.46	
2C	41	27	04H	0.28	
2C	23	28	03H	0.51	
2C	14	29	04H	0.18	SAI
2C	19	29	02H	0.43	
2C	25	29	03H	0.51	
2C	29	29	03H	0.96	
2C	31	29	04H	0.3	
2C	6	30	02H	0.36	
2C	6	30	03H	0.39	
2C	9	30	02H	0.35	
2C	12	30	02H	0.48	
2C	27	30	02H	0.68	
2C	25	31	02H	0.53	
2C	30	31	03H	0.48	
2C	30	31	04H	0.33	
2C	9	32	02H	0.72	
2C	13	32	02H	0.24	
2C	42	32	04H	0.25	
2C	4	33	02H	1.02	
2C	22	33	02H	0.51	
2C	25	33	08H	0.57	
2C	24	34	08H	0.48	
2C	25	34	02H	1.16	
2C	25	34	03H	1.04	
2C	25	34	05H	1.04	
2C	33	34	06H	0.33	
2C	35	34	03H	0.32	
2C	35	34	04H	0.16	
2C	3	35	05H	0.21	
2C	9	35	02H	0.95	
2C	12	35	04H	0.37	
2C	15	35	02H	0.23	
2C	15	35	03H	0.44	
2C	17	35	03H	0.9	SAI

SG	Row	Col	Locn	Volts	Comment
2C	28	35	02H	0.89	
2C	37	35	03H	0.34	
2C	10	36	02H	0.22	
2C	11	36	02H	0.47	
2C	9	37	02H	0.39	
2C	10	37	02H	0.76	
2C	23	37	02H	0.83	
2C	29	37	02H	0.45	
2C	9	38	03H	0.33	
2C	10	38	07H	0.34	
2C	14	38	02H	0.43	
2C	15	38	04H	0.45	SAI
2C	18	38	02H	0.5	Plug
2C	19	38	02H	0.62	Pull/SAI
2C	19	38	05H	1.05	Plug
2C	26	38	05H	0.66	
2C	29	38	05H	0.65	
2C	35	38	07H	0.43	
2C	3	39	07H	0.43	
2C	4	39	07H	0.6	SAI
2C	9	39	05H	0.34	
2C	14	39	05H	0.39	
2C	15	39	02H	0.58	
2C	15	39	03H	0.71	
2C	23	39	02H	0.52	
2C	23	39	05H	0.56	
2C	26	39	05H	0.95	
2C	34	39	05H	0.25	
2C	40	39	03H	0.24	
2C	7	40	03H	0.37	
2C	7	40	04H	0.39	
2C	9	41	02H	0.44	
2C	24	41	02H	1.19	Pull/NDF
2C	24	41	04H	0.47	Pull/SAI
2C	30	41	02H	0.24	
2C	11	42	02H	1.11	

SG	Row	Col	Locn	Volts	Comment
2C	23	42	02H	0.34	
2C	23	42	03H	0.67	
2C	26	42	02H	0.47	
2C	28	42	02H	0.36	
2C	28	42	04H	0.33	
2C	38	42	05H	0.24	
2C	8	43	03H	0.29	
2C	10	43	02H	0.27	
2C	13	43	02H	0.35	
2C	13	43	03H	0.36	
2C	17	43	02H	0.78	
2C	29	43	03H	0.32	
2C	9	44	03H	0.27	
2C	10	44	02H	0.4	
2C	26	44	06H	0.26	
2C	28	44	02H	0.43	
2C	41	44	04H	0.18	
2C	3	45	02H	0.6	
2C	9	45	05H	0.5	
2C	9	45	06H	0.3	
2C	16	46	04H	0.74	
2C	9	47	02H	0.66	
2C	18	47	03H	0.7	
2C	25	47	03H	0.85	
2C	25	47	08H	0.81	
2C	29	47	02H	1.02	
2C	4	48	02H	0.2	
2C	17	48	02H	0.7	
2C	18	48	02H	0.98	
2C	18	48	03H	0.74	
2C	18	48	04H	0.8	
2C	19	48	02H	0.61	
2C	19	48	03H	0.74	
2C	24	48	03H	1.23	
2C	29	48	05H	0.26	
2C	4	49	03H	0.6	

SG	Row	Col	Locn	Volts	Comment
2C	7	49	02H	0.43	
2C	7	49	03H	0.35	
2C	11	49	02H	0.56	
2C	11	49	03H	1.05	
2C	17	49	02H	0.57	
2C	31	49	02H	0.52	
2C	14	50	02H	0.85	
2C	17	50	03H	0.59	SAI
2C	18	50	02H	0.32	
2C	24	50	02H	0.43	
2C	28	50	03H	0.29	
2C	41	50	08H	0.14	
2C	10	51	02H	1.2	
2C	10	51	05H	0.82	
2C	18	51	02H	0.81	
2C	37	52	06H	0.18	
2C	18	53	02H	0.86	
2C	35	53	06H	0.19	
2C	36	53	02H	0.97	SAI
2C	40	53	04H	0.67	
2C	6	54	03H	0.57	
2C	9	54	02H	0.72	
2C	9	54	04H	0.9	
2C	10	54	02H	1.07	
2C	10	54	03H	0.99	
2C	14	54	02H	0.7	
2C	18	54	02H	0.67	
2C	18	54	03H	0.71	
2C	19	54	02H	0.43	
2C	25	54	02H	0.37	
2C	6	55	02H	0.17	
2C	12	55	02H	0.59	
2C	16	55	06H	0.58	
2C	18	55	02H	0.66	
2C	34	55	03H	0.16	
2C	24	56	03H	0.8	

SG	Row	Col	Locn	Volts	Comment
2C	16	57	03H	0.44	
2C	19	57	04H	0.51	
2C	19	57	05H	0.71	
2C	24	57	02H	0.34	
2C	29	57	05H	0.32	
2C	3	58	02H	1.22	
2C	7	58	02H	0.67	
2C	34	58	02H	0.62	
2C	34	58	05H	0.3	
2C	13	59	03H	0.33	
2C	14	59	03H	0.42	
2C	34	59	02H	0.76	
2C	3	60	02H	0.48	
2C	3	60	03H	0.38	
2C	25	60	02H	0.32	
2C	27	60	02H	0.74	
2C	30	60	02H	0.68	
2C	31	60	02H	0.35	
2C	33	60	07H	0.23	
2C	15	61	02H	0.39	
2C	17	61	02H	1.03	
2C	17	61	03H	0.45	
2C	22	61	03H	0.27	
2C	24	61	02H	0.66	
2C	25	61	02H	0.6	
2C	30	61	02H	0.6	
2C	30	61	04H	0.38	SAI
2C	31	61	03H	0.54	
2C	5	62	02H	0.19	
2C	11	62	03H	0.73	
2C	15	62	02H	0.25	
2C	18	62	02H	0.58	
2C	18	62	03H	0.53	
2C	18	62	04H	0.27	
2C	21	62	02H	0.41	
2C	25	62	04H	0.48	

SG	Row	Col	Locn	Volts	Comment
2C	6	63	02H	0.73	
2C	8	63	06H	0.45	
2C	13	63	02H	0.5	
2C	16	63	02H	0.27	
2C	17	63	02H	0.77	
2C	24	63	04H	0.36	
2C	29	63	05H	0.78	
2C	30	63	04H	0.78	Plug
2C	32	63	03H	0.34	SAI
2C	3	64	02H	0.29	
2C	3	64	03H	0.74	
2C	13	64	02H	0.54	
2C	22	64	03H	0.28	
2C	31	64	04H	0.61	SAI
2C	9	65	06H	0.61	
2C	25	65	02H	0.66	
2C	26	65	03H	0.25	
2C	5	66	03H	0.63	
2C	17	66	02H	0.58	
2C	31	66	02H	0.59	
2C	31	66	05H	0.46	
2C	7	67	02H	0.82	
2C	17	67	02H	0.65	
2C	18	67	02H	0.76	
2C	18	67	03H	0.56	
2C	21	67	07H	0.48	
2C	17	68	02H	0.35	
2C	4	69	03H	0.34	
2C	23	69	03H	0.37	
2C	27	69	02H	0.33	
2C	11	70	03H	0.55	
2C	12	70	02H	0.42	
2C	12	70	03H	0.27	
2C	14	70	08H	0.22	
2C	26	70	03H	1.2	
2C	5	71	02H	0.42	

SG	Row	Col	Locn	Volts	Comment
2C	8	72	03H	0.4	
2C	10	72	02H	0.46	
2C	10	72	03H	0.25	
2C	11	72	03H	0.48	
2C	26	72	08H	0.59	
2C	16	73	02H	0.65	
2C	18	73	03H	0.31	
2C	28	73	03H	0.23	
2C	25	74	02H	0.31	SAI
2C	20	75	02H	0.5	
2C	31	75	02H	0.21	SAI
2C	4	76	03H	0.15	
2C	5	76	03H	0.88	
2C	20	76	02H	0.75	SAI
2C	20	76	03H	1.01	NDF
2C	25	76	02H	0.71	
2C	25	76	05H	0.3	
2C	27	76	03H	0.59	
2C	22	77	03H	0.17	
2C	23	77	02H	0.4	
2C	31	77	06H	0.3	
2C	2	78	03H	0.12	
2C	6	78	03H	1	
2C	10	78	03H	0.29	
2C	19	79	02H	0.81	
2C	25	79	02H	0.34	
2C	2	80	03H	0.19	
2C	3	80	02H	0.46	
2C	7	80	03H	0.3	
2C	15	80	03H	0.29	
2C	31	81	02H	1.27	
2C	12	83	03H	0.12	
2C	6	84	03H	0.48	
2C	8	84	03H	0.56	
2C	2	85	03H	0.48	
2C	20	85	03H	0.24	

SG	Row	Col	Locn	Volts	Comment
2C	28	85	02H	0.39	
2C	5	86	08H	1.14	
2C	15	87	03H	0.33	
2C	11	88	05H	0.54	
2C	5	89	02H	0.58	
2C	3	90	06H	0.29	
2C	6	92	04H	0.32	
2C	3	93	04H	0.29	