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U S Nuclear Regulatory Commission
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PRAIRIE ISLAND NUCLEAR GENERATING PLANT
DOCKET NO. 50-282
LICENSE NO. DPR-42
UNIT 1, CYCLE 21 STEAM GENERATOR TUBE SUPPORT PLATE VOLTAGE BASED REPAIR CRITERIA 90-DAY REPORT

During the Unit 1 refueling outage following operating cycle 21, the Voltage Based Repair Criteria for Outside Diameter Stress Corrosion Cracking at Tube Support Plates (TSPs) was used in accordance with the requirements of NRC Generic Letter (GL) 95-05 and Amendment Number 133 to Facility Operating License Number DPR-42. GL 95-05, Attachment 1, Section 6.b, requires information to be submitted to the NRC staff within 90 days of each restart following a steam generator (SG) inspection. The attached report includes the required information.

The report notes the maximum voltage distorted signal indications were 1.73 Volts in SG 11 and 1.43 Volts in SG 12. The report concludes that present results support continued application of the 2.0 Volt repair criteria for TSP indications per GL 95-05.

This letter contains no new commitments and no revisions to existing commitments. Please contact Jeff Kivi (651-388-1121) if you have any questions related to this letter.

Joseph M. Solymossy
Joseph M. Solymossy
Site Vice President, Prairie Island Nuclear Generating Plant

CC Regional Administrator, USNRC, Region III
Project Manager, Prairie Island Nuclear Generating Plant, USNRC, NRR
NRC Resident Inspector – Prairie Island Nuclear Generating Plant

Attachment

A001

ForeLine
ASSOCIATES, LLC

FA - PI1 - 016
February, 2003
Revision 0

90-Day Report
Voltage-Based Repair Criteria
Prairie Island, Unit 1, EOC 21, BOC 22

FINAL

J. A. Begley, Framatome ANP, Inc.
T. F. Begley, ForeLine Associates, LLC
C. J. Begley, TCA Solutions, LLC

226 Paul Street
Pittsburgh, PA 15211
(412) 481-3363 Phone
(412) 481-3365 Fax

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Section 1

INTRODUCTION

This report describes the Bobbin Voltage Alternate Repair Criteria for steam generator tubing applied at Prairie Island Unit 1, EOC 21. Bobbin voltage data at tube support plates is summarized, with analyses of leak rate and probability of tube burst under postulated steam line break conditions both in terms of condition monitoring at EOC 21 and operational assessment for cycle 22. Projected bobbin voltage distributions for the conclusion of the next operating cycle are included along with calculated probabilities of burst and projected leak rates at postulated SLB conditions. The Bobbin Voltage–Based Repair Criteria has been applied since cycle 17 at Prairie Island Unit 1, and the methodologies used in preparing this report are consistent with NRC Generic Letter 95-05[1], the Safety Evaluation by the Office of Nuclear Reactor Regulation Related to Amendment Nos. 133 and 125 to Facility Operating License Nos. DPR-42 and DPR-60 for Prairie Island Nuclear Generating Plant[2], previous 90-day reports[3, 4] and standard industry practice[5, 6,7]. Present results support continued application of the 2.0 volt repair criteria for TSP indications per NRC Generic Letter 95-05.

Eddy current examination requirements for application of the Bobbin Voltage Alternate Repair Criteria are captured in Prairie Island Nuclear Generating Plant Maintenance Procedure D27.25[8]. A 100% eddy current inspection of all tube support plate intersections was performed for both steam generators at Prairie Island Unit 1. All distorted signal indications (DSI) were inspected by rotating pancake coil (RPC) probe to identify possible instances of wastage at ODSCC locations. No such indications with voltages greater than the 2.0-volt limit were found at EOC 21. RPC inspection was also performed for dents (DNT) greater then 5.0 volts, mixed residual indications (MRI) greater than 2.0 volts, indications not reportable (INR) greater than 1.5 volts, and cold leg thinning greater than 1.5 volts with a depth less than 40 percent through wall. All indications at TSP locations found at EOC 21 are included in Section 2 along with voltage growth rates. The largest voltages observed at EOC 21 are 1.73 volts in SG 11 and 1.43 volts in SG 12.

The latest available data for burst pressure and leak rate correlations has been applied[6]. This is discussed in Section 3. For burst probability calculations, the procedure is straightforward, new correlation coefficients are applied in performing Monte Carlo analyses according to a standardized procedure. Since a "p" value greater than 0.05 was obtained for the updated correlation of bobbin voltage with SLB leak rates at 2560 psi, several methodologies were used to obtain projected SLB leak rates incorporating a lack of correlation effect. These approaches are consistent with a methodology previously presented to the NRC[9] and are described in Section 4. Leak rate and burst probability results are presented in Section 5.

Section 2

EOC 21 INSPECTION RESULTS AND GROWTH RATES

The distributions of bobbin voltage indications of axial ODSCC at tube support plate intersections are presented in Figures 2.1 and 2.2. This data is summarized in Table 2.1 below. As expected from past results, the distribution of EOC bobbin voltages is about the same in both steam generators but the number of indications is greater in SG 11 compared to SG 12. The as found numbers of indications are less than those

Table 2.1

EOC 21 Inspection Results Summary

SG 11				SG 12			
Top of Bin	Number in Bin	Number of New Indications	Number of PP Confirmations	Top of Bin	Number in Bin	Number of New Indications	Number of PP Confirmations
0.1	1	0	0	0.1	1	0	0
0.2	21	2	0	0.2	10	2	0
0.3	44	2	0	0.3	31	12	1
0.4	71	9	0	0.4	50	13	4
0.5	76	7	0	0.5	35	5	1
0.6	62	6	0	0.6	26	3	2
0.7	37	2	0	0.7	23	5	0
0.8	29	1	1	0.8	10	2	0
0.9	9	0	0	0.9	7	2	0
1	8	1	0	1	3	0	0
1.1	2	0	0	1.1	4	1	0
1.2	1	0	0	1.2	2	0	0
1.3	1	0	0	1.3	0	0	0
1.4	1	0	0	1.4	1	0	0
1.5	1	1	0	1.5	1	0	0
1.6	0	0	0	1.6	0	0	0
1.7	0	0	0	1.7	0	0	0
1.8	1	0	0	1.8	0	0	0
1.9	0	0	0	1.9	0	0	0
2	0	0	0	2	0	0	0
	Total 365	Total 31	Total 1		Total 204	Total 45	Total 8

expected from using a POD value of 0.6. There are 365 indications in SG11 compared to a projected EOC 21 value of 572. In SG 12 these numbers are 204 and 272 respectively. The progression of degradation in both steam generators is relatively mild in terms of number of indications. The severity of degradation is also relatively mild. The largest EOC 21 bobbin voltage in SG 11 was 1.73 volts which is comparable to a value of 1.8 volts for EOC 20. In SG 12 these maximum voltage values are 1.43 volts at EOC 21 compared to 1.27 volts at EOC 20. The number of indications greater than 1.0 volts is 7 in SG 11 at EOC 21 versus 10 at EOC 20. For SG 12 there were 8 indications greater than 1.0 volts at EOC 21 compared to 4 at EOC 20. Another measure of degradation severity in the number of indications that are confirmed with the Plus Point probe. There were a total of 9 confirmations with the Plus Point probe at EOC 21 compared to 11 confirmations at EOC 20. In each of the last two cycles of operation, the maximum Plus Point confirmation voltage was 0.17 volts. From a database in the latest revision of the EPRI In Situ Testing Guidelines[10], the expected maximum depth of axial ODSCC is 50% TW at a Plus Point voltage of 0.17 volts. The upper 90 % predictions interval value is 63% TW. From the above considerations, the instances and severity of degradation at TSP intersections at Prairie Island Unit 1 continues to be mild.

One OD axial Plus Point indication was found in SG 12 at 01H with no corresponding DSI bobbin signal. It exhibited a Plus Point voltage of 0.11 volts. Using the Prairie Island data of Figure 2.3, it was assigned a bobbin voltage of 0.73 volts, the top of the scatter band, and included in the burst probability and SLB leakage calculations.

The results of bobbin voltage growth rate analyses over the last two cycles of operation are presented in Figures 2.4 through 2.7. Voltage growth rates are modest, as shown in the Figures 2.4 and 2.5. About 50% of the time, voltage growth is negative. Growth rates distributions are about the same at EOC 21 and EOC 20. The maximum observed growth rate is 0.420 volts / EFPY. Although SG 12 exhibits fewer indications than SG 11, the voltage growth is somewhat faster. Hence, a composite growth rate distribution was used for analyses for SG 11, even though there were 334 growth data points for SG 11. Although there were 160 growth data points for SG 12, compared to the standard minimum value of 200[5], the growth distribution for SG 12 EOC 21 was used because it is more conservative than the composite growth rate distribution. The voltage growth rate distributions for Cycle 21 are marginally more adverse than for Cycle 20. Average voltage growth rates as a percentage of the average BOC voltage are presented in Table 2.2. This information supports the description of growth rates at Prairie Island Unit 1 as modest.

Figures 2.6 and 2.7 show plots of voltage growth rates versus BOC voltage for SG's 11 and 12 over the last two cycles of operation. There is no evidence of voltage accelerated growth rates. Degradation at Prairie Island Unit 1 has not evolved to the point where this may be an issue. The relatively low number of indications, particularly the low number of indications greater than 1.0 volts and the trending of observed indications less than the projected numbers based on a POD of 0.6 signifies than the possible onset of voltage dependent growth is at least several cycles into the future.

Table 2.2

Average BOC Voltages and Average Voltage Growth Rates

	SG 11			SG 12			Composite		
Cycle	Average Voltage (volts)	Average Growth, All %/EFPY	Average Growth, >=0 %/EFPY	Average Voltage (volts)	Average Growth, All %/EFPY	Average Growth, >=0 %/EFPY	Average Voltage (volts)	Average Growth, All %/EFPY	Average Growth, >=0 %/EFPY
Cycle 21	0.498	-0.54	10.24	0.488	0.37	15.37	0.494	-0 26	11.94
Cycle 20	0.498	-0.74	10.84	0 484	-0.91	17.97	0.494	-0.79	12.75

The actual binned voltage growth rate distribution data used in structural and leakage integrity calculations are presented in Figure 2.8. The data used to construct these plots was derived from binning of Cycle 21 growth rates. A composite Cycle 21 growth rate distribution was applied to SG 11, while a Cycle 21 generator specific growth rate distribution was applied to SG 12. These binned growth rates are listed in Table 2.3

Table 2.3

Binned Voltage Growth Rates

SG 11 Composite Data Cycle 21		SG 12 SG Specific Data Cycle 21	
Top of Growth Rate Bin (volts/EFPY)	Cumulative Fraction	Top of Growth Rate Bin (volts/EFPY)	Cumulative Fraction
0	0.5162	0	0.5063
0.1	0.9089	0.1	0.8625
0.2	0.9777	0.2	0.9625
0.3	0.9939	0.3	0.9813
0.4	0.9980	0.4	0.9938
0.5	1.0000	0.5	1.0000

No tubes were plugged at EOC 21 due to exceeding the bobbin voltage ARC repair limit of 2.0 volts at TSP locations. Several tubes were plugged due to indications of other degradation mechanisms. Table 2.4 lists the distribution of TSP bobbin voltage indications returned to service at BOC 22.

Table 2.4

Number of Indications Found, Plugged and Returned to Service

SG 11				SG 12			
Top of Bin	Number at EOC 21	Number Plugged	Number at BOC 22	Top of Bin	Number at EOC 21	Number Plugged	Number at BOC 22
0.1	1	0	1	0.1	1	0	1
0.2	21	0	21	0.2	10	0	10
0.3	44	0	44	0.3	31	0	31
0.4	71	1	70	0.4	50	4	46
0.5	76	0	76	0.5	35	3	32
0.6	62	1	61	0.6	26	1	25
0.7	37	0	37	0.7	23	3	20
0.8	29	0	29	0.8	10	1	9
0.9	9	0	9	0.9	7	1	6
1	8	0	8	1	3	1	2
1.1	2	0	2	1.1	4	0	4
1.2	1	0	1	1.2	2	0	2
1.3	1	0	1	1.3	0	0	0
1.4	1	0	1	1.4	1	0	1
1.5	1	0	1	1.5	1	0	1
1.6	0	0	0	1.6	0	0	0
1.7	0	0	0	1.7	0	0	0
1.8	1	0	1	1.8	0	0	0
1.9	0	0	0	1.9	0	0	0
2	0	0	0	2	0	0	0
	Total 365	Total 2	Total 363		Total 204	Total 14	Total 190

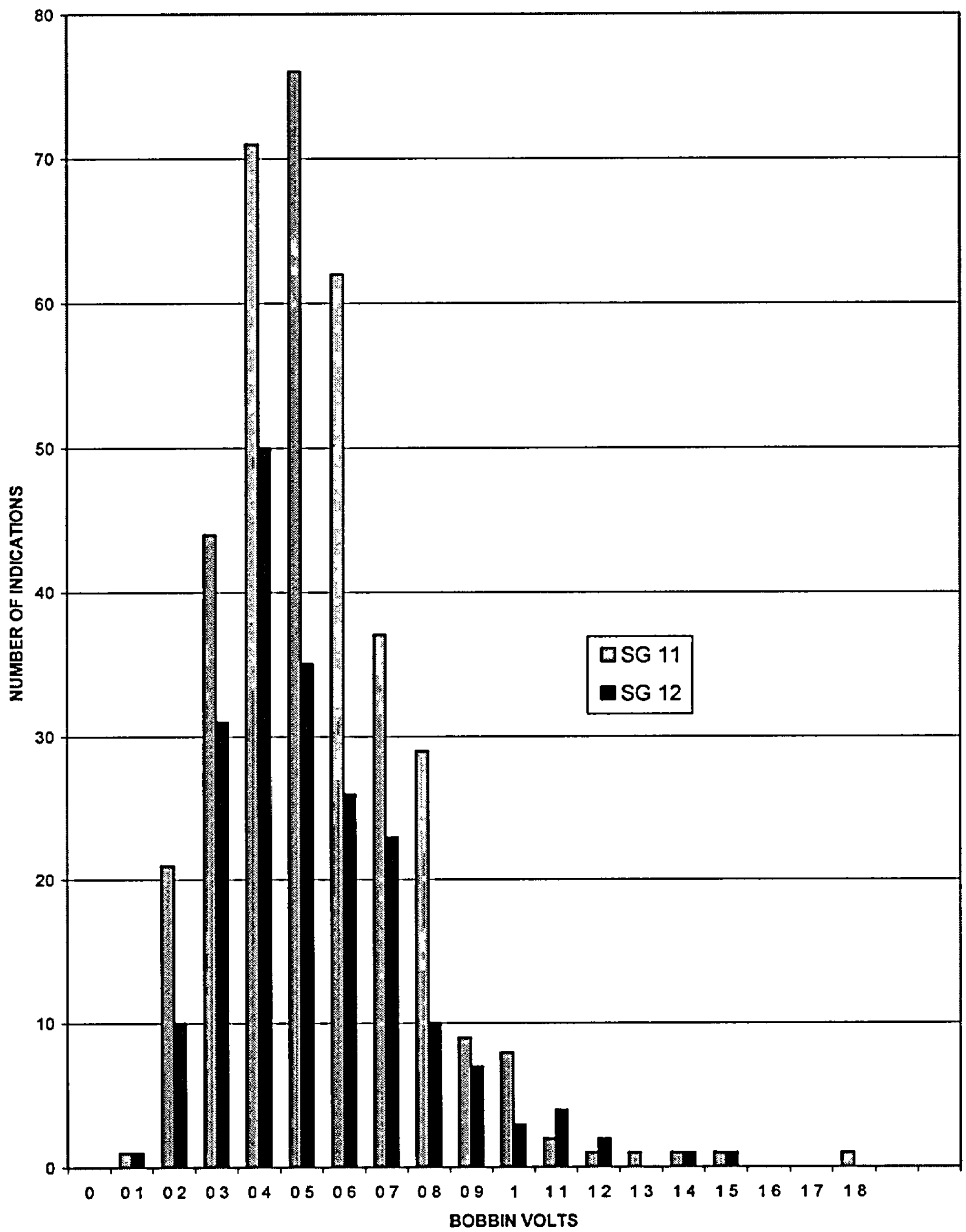

Figure 2.1 Bobbin Voltages Observed at Prairie Island Unit 1, EOC 21

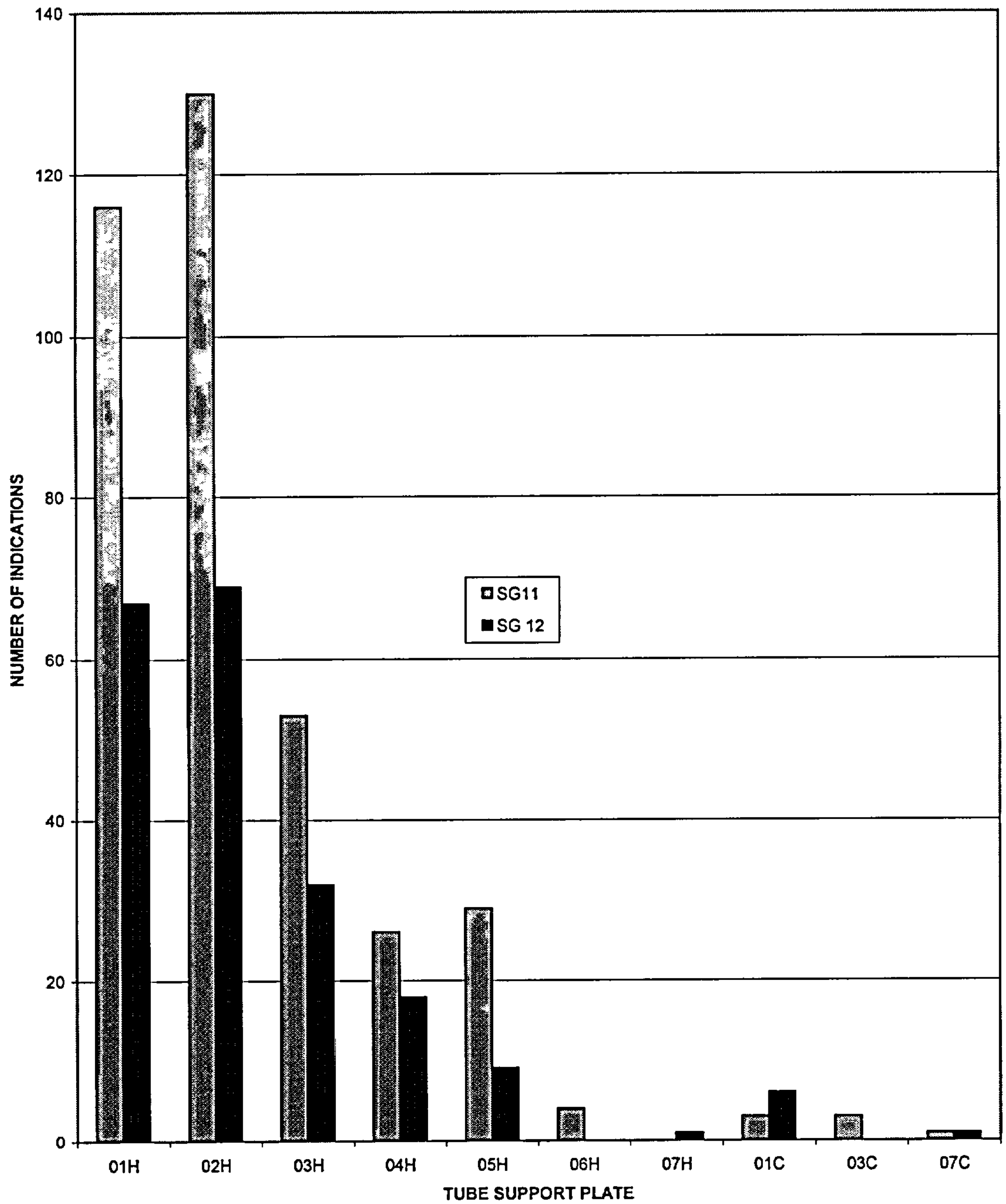

Figure 2.2 Distribution of ODSCC TSP Indications by Location

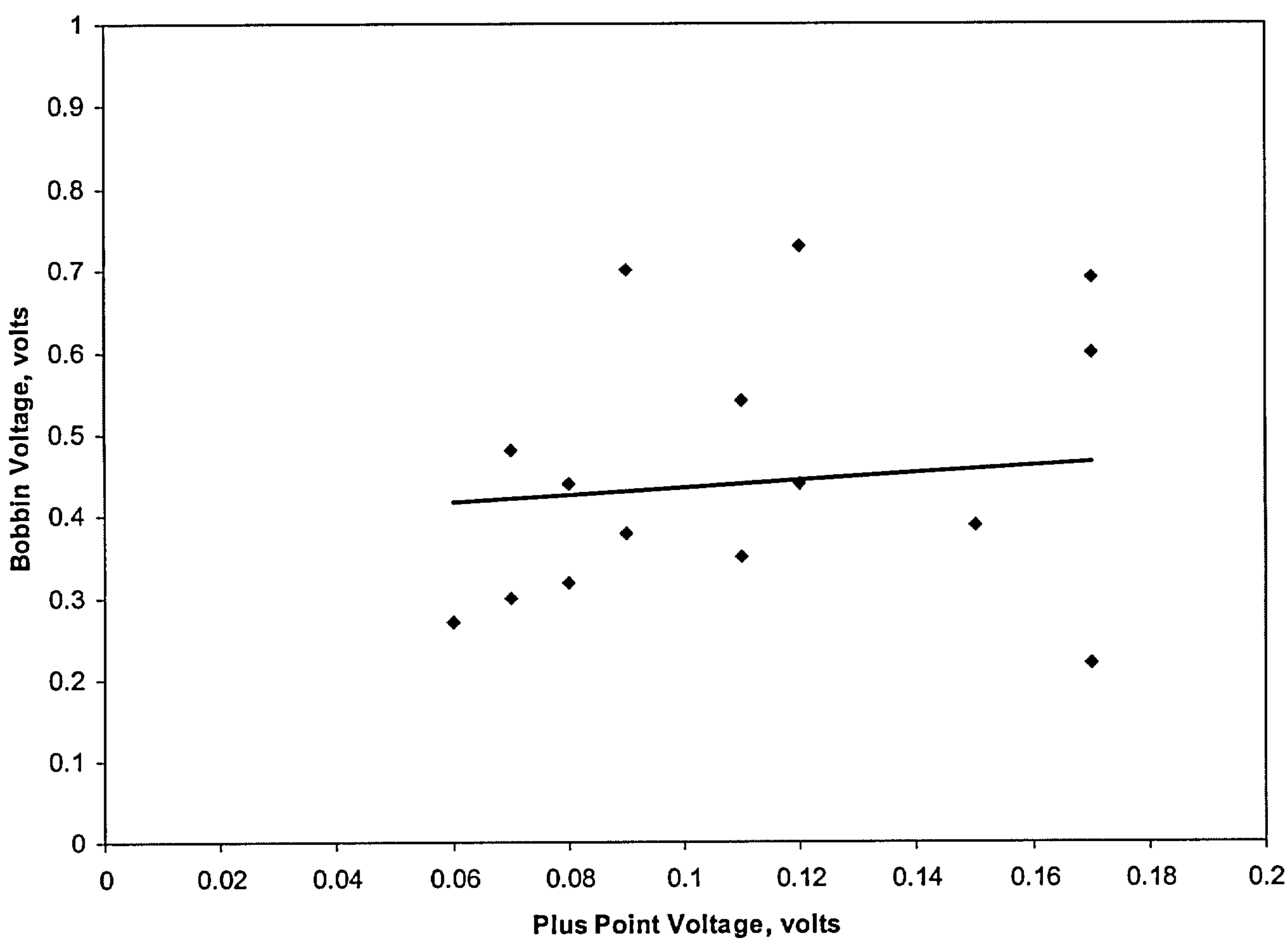

Figure 2.3 Bobbin Voltage versus Plus Point Voltage, Prairie Island Unit 1, EOC 21. Top of Scatter Band Used to Assign a Bobbin Voltage to a 0.11 Volt Plus Point Indication

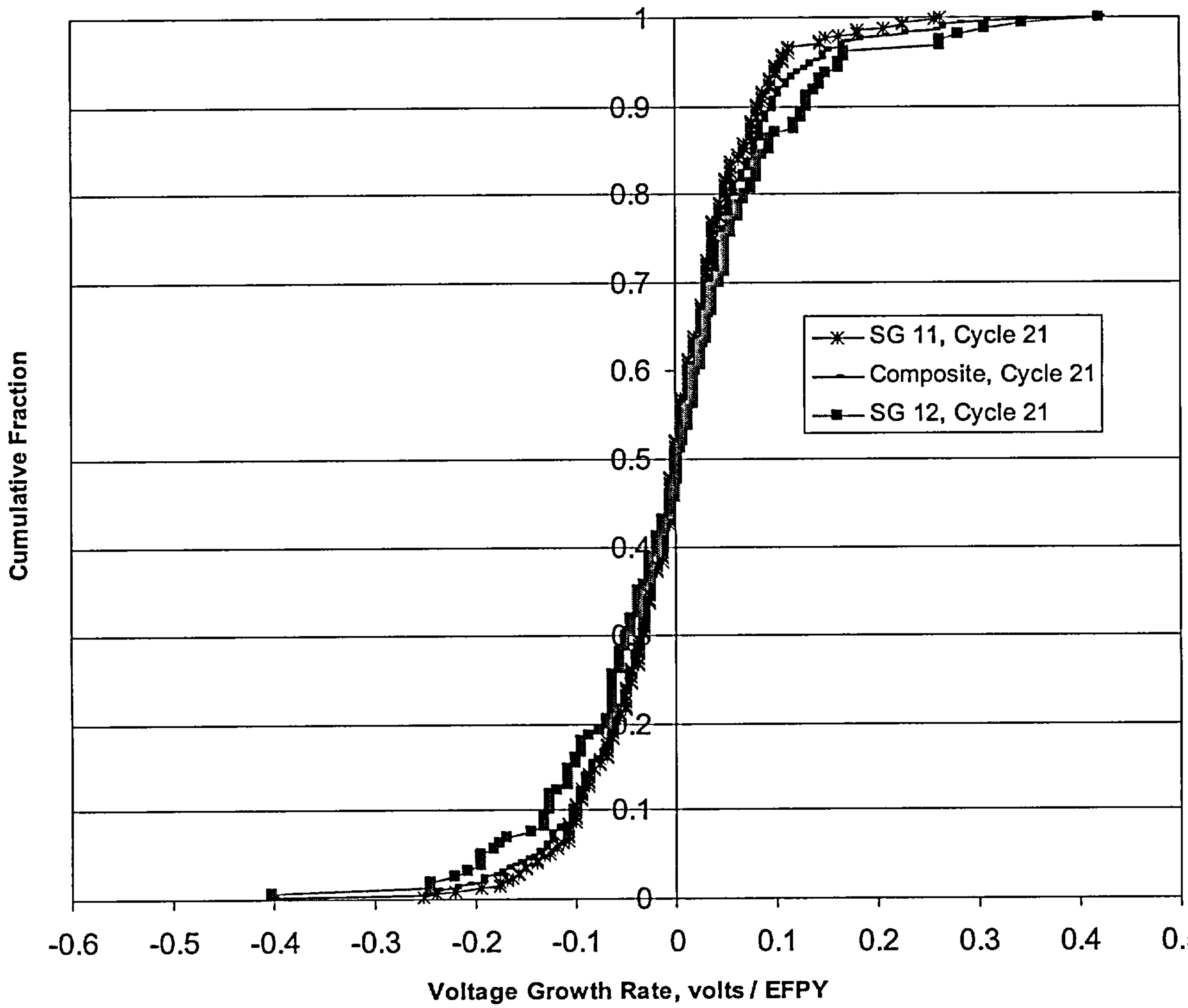

Figure 2.4 Observed Bobbin Voltage Growth Rate Distributions at Prairie Island Unit 1, Cycle 21

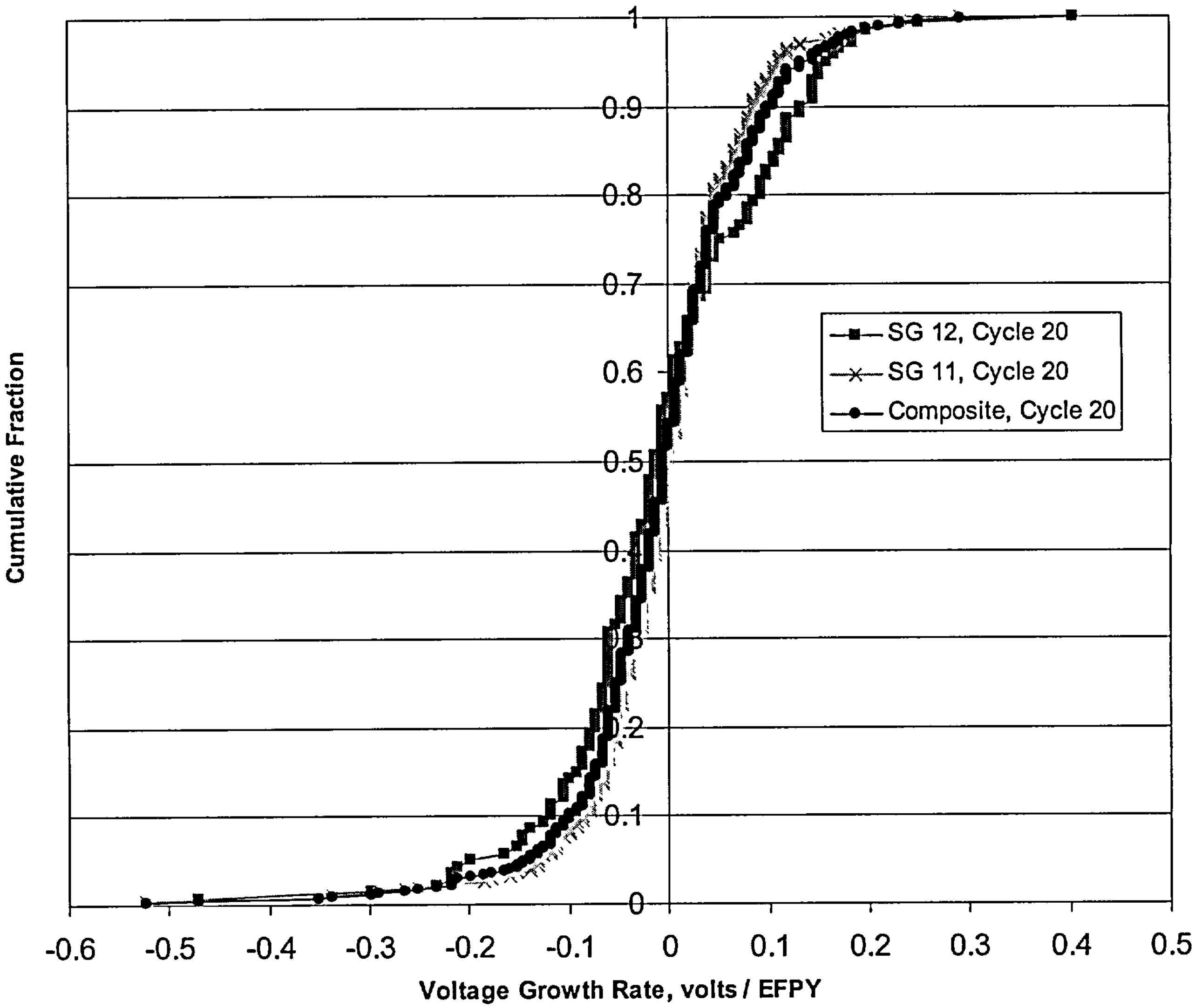

Figure 2.5 **Observed Bobbin Voltage Growth Rate Distributions at Prairie Island Unit 1, Cycle 20**

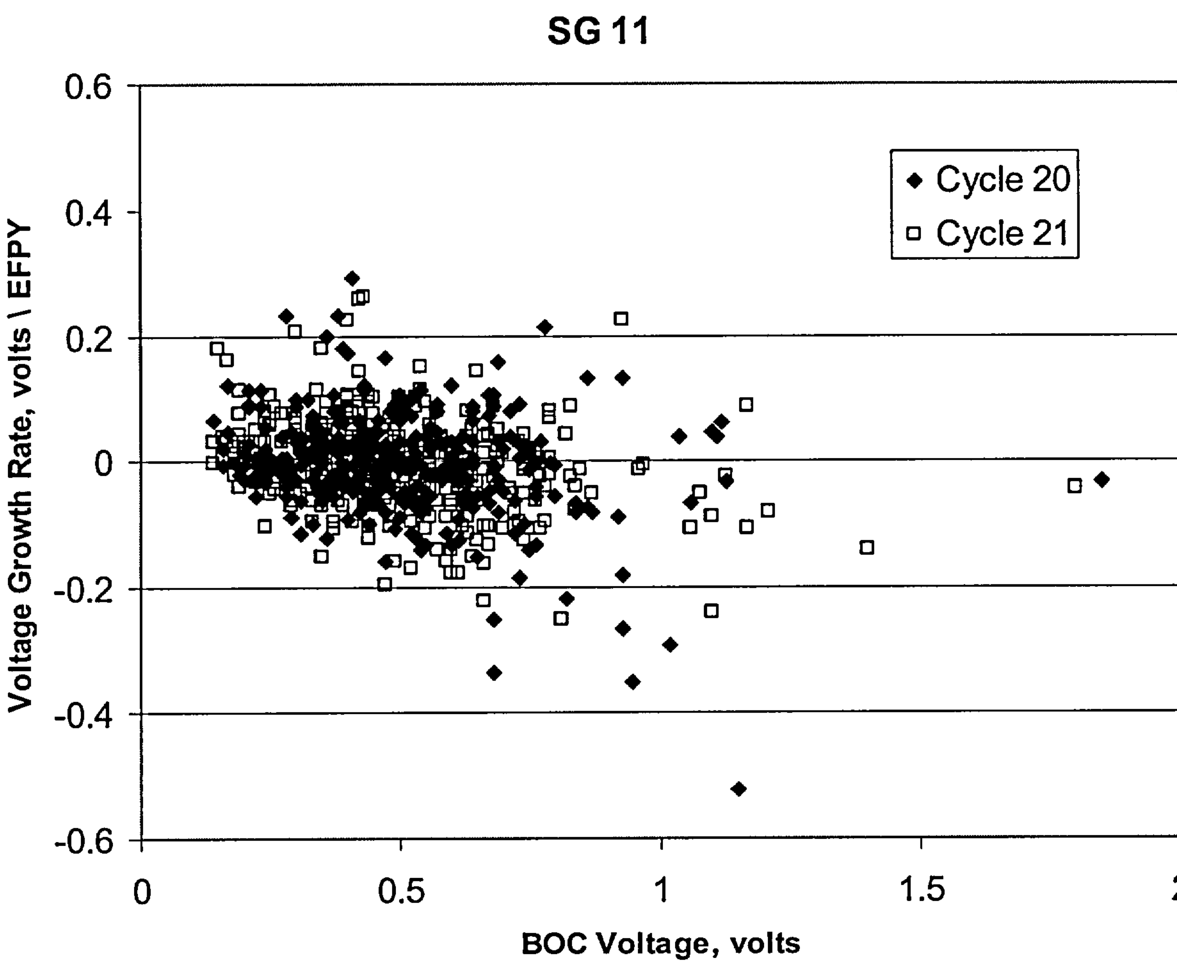

Figure 2.6 Voltage Growth Rate Versus BOC Voltage, SG 11

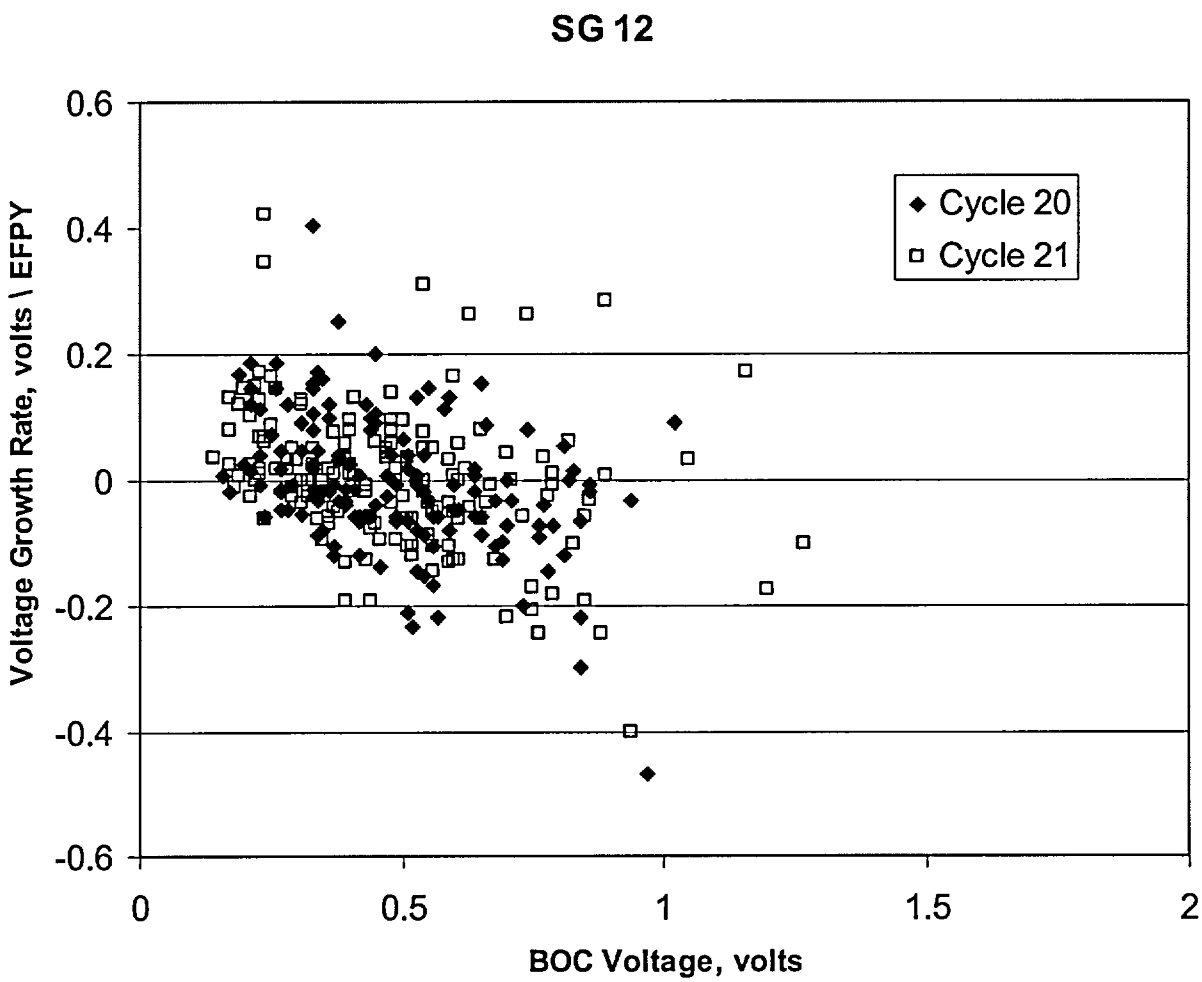

Figure 2.7 Voltage Growth Rate Versus BOC Voltage, SG 12

Section 3
EOC 22 Voltage Projections

The standard methodology to develop EOC projections of bobbin voltage indications for application of a voltage based ARC consists of using a constant probability of detection (POD) value of 0.6, consideration of probe wear and analyst variation effects on voltage measurements uncertainties and finally voltage growth over the cycle of interest. The number of projected indications is given by:

$$N = \frac{N_D}{POD} - N_P$$

where N is the projected number of indications, N_D, is the detected number of indications in the prior cycle, N_P is the number of these indications removed from service and POD is the probability of detection, taken as a constant of 0.6. This almost always provides a conservative projection as is historically true at Prairie Island Unit 1. If the number of tubes removed from service is small, the above equation predicts a 66.6% increase in indications from one cycle to the next. At EOC 21, the increase in number of indications was 6.4% in SG 11 and 25.1% in SG 12. The projected number of indications for Cycle 22 is 605 in SG 11 and 326 in SG 12.

The projected magnitude of these indications in terms of bobbin voltage is presented in Figure 3.1 as a bar chart of number of indications in voltage bins with 0.1 volt steps. In developing these projections via a Monte Carlo approach, voltage measurement uncertainties were included as a percentage of the reported BOC voltage and added to the reported BOC voltage. The mean uncertainty for probe wear and analyst variation effects was taken as 0 %. For probe wear, the measurement uncertainty was taken from a normal distribution with a standard deviation of 7.0 %. These uncertainty percentage values were truncated at +/- 15%. No truncation was applied to the analyst uncertainty in bobbin voltage measurement. Again, this uncertainty is expressed as a percentage of the reported bobbin voltage. The analyst uncertainties are sampled from a normal distribution with a mean of 0 % and a standard deviation of 10.3%.

After probe wear and analyst uncertainties are applied to a BOC bobbin indication, voltage growth is selected using a growth rate from one of the growth rate distributions of Figure 2.4. **The projected operating time for Cycle 22 at Prairie Island Unit 1 is 1.695 EFPY.** Voltage projections are determined for each projected indication in the SG of interest producing one simulation of a steam generator operating cycle. Burst pressures and SLB leak rates are determined for each projected EOC indication in a steam generator. Typically 100,000 simulations of a steam generator operating cycle are performed creating the statistics to calculate the probability of burst at SLB differential pressure with a 95% confidence and a projected 95th percentile SLB leak rate at 95% confidence.

Figure 3.1 shows that the most likely voltage of an EOC indication for the upcoming Cycle 22 is about 0.5 volts. The maximum voltage observed in any simulation keeps increasing as the number of simulations increases since the analyst uncertainty is unbounded. Integrating the tail of projected fractional indications to about 0.5 leads to a reasonable projected maximum EOC voltage. These values for EOC 22 are 2.2 volts for SG 11 and 2.0 volts for SG 12. Previous projections for the past two cycles are about at these levels (> 2.0 volts) but no indication in the past two cycles at Prairie Island Unit 1 has exceeded 1.8 volts. Table.3.1 provides a tabulation of projected EOC 22 indications.

Table 3.1

Tabulation of Projected EOC 22 Voltage Distributions

SG11		SG12	
Top of Bin Volts	Projected Number at EOC 22	Top of Bin Volts	Projected Number at EOC 22
0.1	1.69	0.1	1.21
0.2	19.36	0.2	9.97
0.3	43.85	0.3	28.71
0.4	76.55	0.4	45.84
0.5	97.11	0.5	51.28
0.6	99.77	0.6	49.90
0 7	86.26	0.7	41.17
0.8	65.27	0.8	31.05
0.9	44.59	0.9	21.72
1	28.31	1	14.84
1.1	16.87	1.1	10.12
1.2	9.76	1.2	6.92
1.3	5 69	1.3	4.71
1.4	3.42	1.4	3.16
1.5	2.17	1.5	2.08
1.6	1.45	1.6	1.34
1.7	1.01	1.7	0.84
1.8	0.72	1.8	0.50
1.9	0.52	1.9	0.29
2	0.36	2	0.16
2.1	0.24	2.1	0.09
2.2	0.15	2.2	0.05
2.3	0 09	2.3	0 03
2 4	0.05	2.4	0 01
2.5	0.03	2.5	0.01
2.6	0.01	2.6	0.00
2.7	0.01	2.7	0.00
2.8	0.00	2.8	0.00
2 9	0.00	2.9	0.00
3	0.00	3	0.00
3.1	0.00	3.1	0.00
3.2	0.00		
3.3	0.00		
3.4	0.00		
3.5	0.00		
3.6	0.00		
3.7	0.00		
Total	605	Total	326

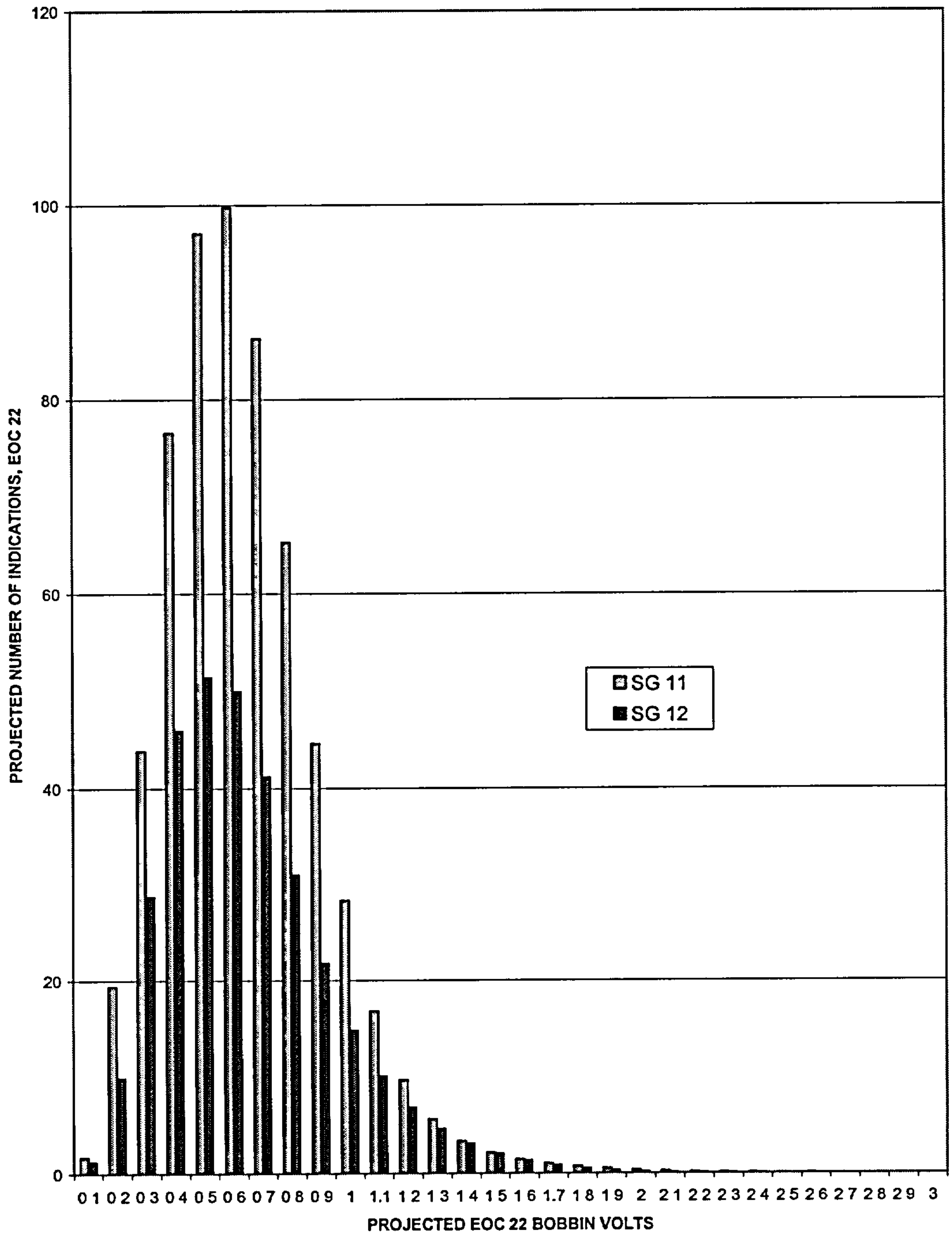

Figure 3.1 Projected EOC 22 Voltage Distributions, SG 11 and SG 12

Section 4

LEAK AND BURST ANALYSIS METHODOLOGIES

Pulled tube leak rate test results have led to an updating of correlation coefficients used in the application of the bobbin voltage based repair criteria[6]. Updated correlations of burst pressure with bobbin voltage have relatively little impact on structural integrity analyses. The probability of leakage at SLB conditions versus bobbin voltage has also changed based on tube pull results over the past year. However, these changes are not dramatic and do not require any changes to the standard calculation methodology[5]. New leak rate measurements at 2560 psi SLB differential pressure conditions have resulted in new correlation coefficients between SLB leak rate and bobbin voltage. While the absolute changes are not substantial, the degree of correlation between SLB leak rate and bobbin voltage, expressed as the "p" value, has exceeded the accepted value of 0.05 needed to apply a linear correlation between the log of the SLB leak rate and the log of the bobbin voltage. The revised value of p is 0.076. The p value for the correlation of log leak rate and log voltage for an SLB differential pressure of 2405 psi remains below 0.05. Hence, by previous standardized procedures, a leak rate correlation could be applied at a differential pressure of 2405 psi but not at 2560 psi. This runs counter to physical behavior and the use of a leak rate correlation for 0.750 inch diameter tubing at either pressure differential. Sampling of an SLB leak rate distribution which is uncorrelated with bobbin voltage leads to grossly overestimating SLB leak rates. In this approach a very high leak rate would be just as probable for extremely low-level bobbin voltages as for voltages that exceeded the 2.0 volt limit by an order of magnitude.

At an NEI/NRC meeting in February, 2002[9] a proposal was advanced to sample the slope of the log leak rate/ log voltage correlation, as is done in the standard calculation methodology, but when the slope is zero or less, no correlation is assumed. When the slope is greater than zero, the correlation is applied. The approach can be considered as sampling of the p value. The net effect is using uncorrelated leak rates a fraction of the time. This fraction is about p. With the revised database, the value of p is 0.076.

Thus, an uncorrelated leak rate effect is included and the basic requirement of not using a leak rate correlation with a p value less than 0.05 is essentially met.

The above procedure was followed in the present analysis for calculations at a differential SLB pressure of 2560 psi. Prairie Island has established the basis to implement an SLB pressure differential of 2405 psi but has not made a submittal to the NRC. SLB leak rate calculations are presented in this report at 2405 psi for information purposes. Use of an SLB leak rate correlation for all calculations at 2405 psi is justified by the revised leak rate correlations with a p value of 0.023.

When Monte Carlo sampling leads to conditions requiring use of an uncorrelated leak rates at 2560 psi, the distribution of leak rates in Figure 4.1 is sampled, regardless of the bobbin voltage. The ordinate is the cumulative distribution function and the abscissa is the log of the SLB leak rate expressed in terms of liters per hours at room temperature density. The logarithm values are to the base 10. The irregular line is the revised 2560 psi SLB leak rate database. The dotted smooth curve is the inferred parent population of SLB leak rates given by a log normal distribution using best estimate mean and standard deviation values from the test database. The smooth solid curve is generated from 100,000 Monte Carlo simulations of SLB leak rates applying Student "t" statistics to the mean leak rate estimates and Chi Squared statistics to the standard deviation. It is seen that the variation added to the distribution of leak rates from a relatively complete statistical treatment is rather small.

Figures 4.2 contains the latest revised probability of leak and leak rate correlations parameters used for calculations at 2560 psi. The Monte Carlo simulation methodology, other than for occasional use of uncorrelated leak rate selections, followed standard practice and was benchmarked versus Bobbin Voltage ARC Round Robin results.

The burst pressure analysis methodology followed standard practice per WCAP 14277. The latest burst pressure database correlation coefficients were applied. These parameters are presented in Figure 4.2. Section 5 presents the results of SLB leak rate and burst pressure calculations.

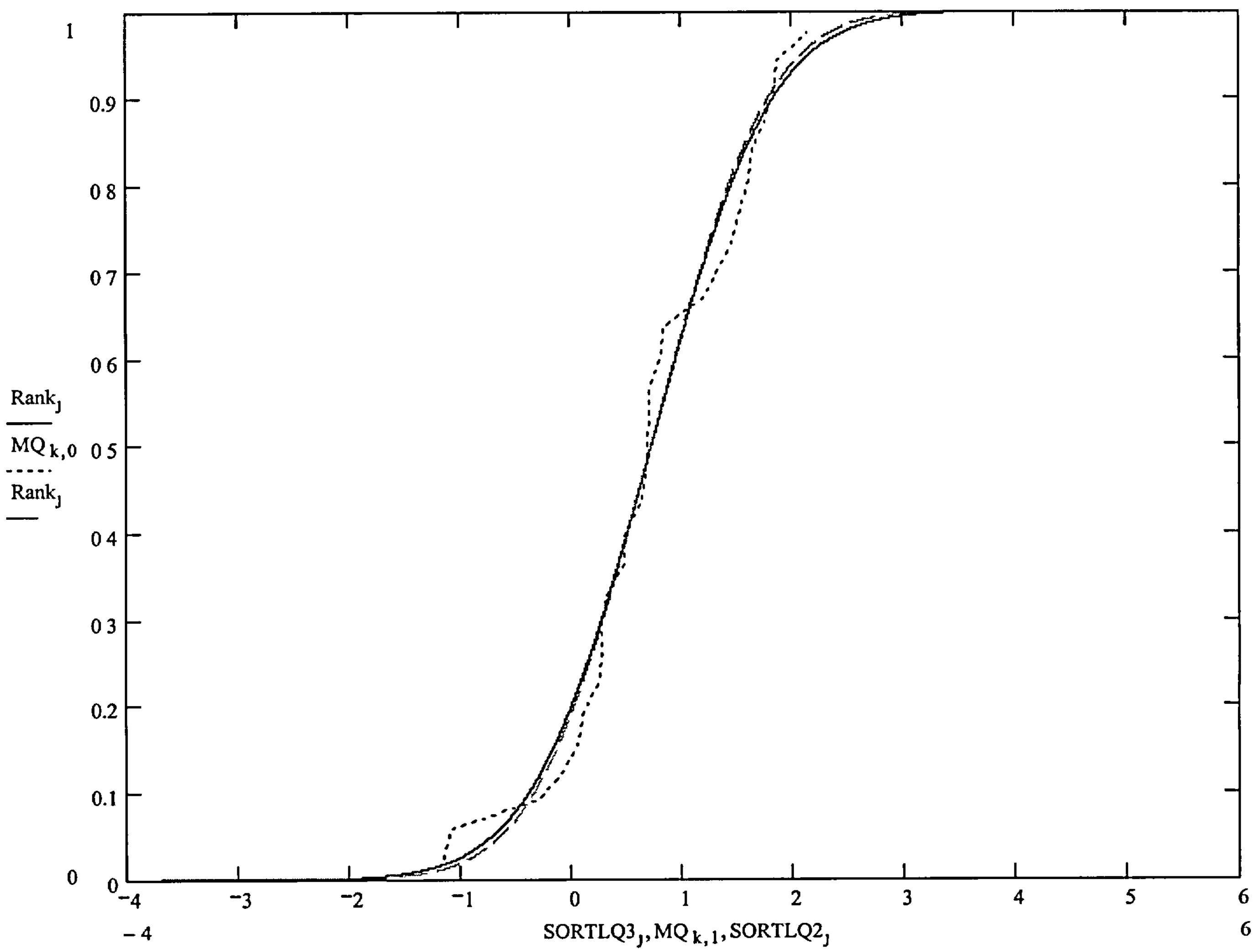

Figure 4.1 Distribution of SLB Leak Rates at 2560 psi for Use in Calculations Without a Leak Rate Correlation Equation, Abcissa and Ordinate Described in Text

SGDB Variable	Value
Burst Intercept	7.4934
Burst Slope	-2.3775
Burst Sig	0.8861
Burst V(0)	0.009427291
Burst V(1)	-0.004564115
Burst V(2)	0.015630532
Burst DOF	95
Leak Intercept	-0.0691
Leak Slope	0.717
Leak Sig	0.8108
Leak V(0)	0.310201604
Leak V(1)	-0.260564345
Leak V(2)	0.236125369
Leak DOF	27
POL Intercept	-5.1017
POL Slope	7.3483
POL V(0)	1.3742
POL V(1)	-1.7365
POL V(2)	2.6428
POL DOF	113

Figure 4.2 Latest Revised Leak rate and Burst Pressure Correlation Parameters

Section 5

LEAK AND BURST ANALYSIS RESULTS

The as found distributions of bobbin voltage DSI indications at TSP intersections at EOC 21 were used to perform condition monitoring evaluations. See Table 2.1 and Figure 2.1. Voltage measurement uncertainties were applied to each indication and then leak rate and burst pressures calculations were performed. SLB leak rates on a per generator basis were developed and the 95th percentile SLB leak rate was determined at 95% confidence. The probability of burst at SLB pressures was determined at 95% confidence. SLB leak rates are reported in terms of room temperature density with units of gpm. The SLB leak rate calculation of record is based on the "p value sample" method and is highlighted and listed in Table 5.1 as the 92.4% correlation. For information purposes, 95/95 SLB leak rates are reported for a differential pressure of 2405 psi and 100% use of the leak rate correlation at 2560 psi.

Operational assessments considered the DSI indications returned to service and the undetected population of indications developed from a POD of 0.6. Voltage measurement uncertainties were applied and then voltage growth was added via a Monte Carlo process. The projection numbers and voltages of indications at EOC 22 were then used in leak rate and burst pressure calculations.

Condition monitoring calculations are presented in Table 5.1. The probability of burst is well below the allowable value of 0.01 at EOC 21. The 95/95 SLB leak rates are well below the Prairie Island Unit 1 limit of 1.0 gpm.

Operational assessment calculation results for a cycle length of 1.695 EFPY are listed in Table 5.2. The probability of burst at EOC 22 is small compared to the allowable limit of 0.01. The projected 95/95 SLB leak rate at 2560 psi is 0.833 gpm

Table 5.1

Summary of Condition Monitoring Calculations

Parameter	SG 11	SG 12
BOC 21 Number of Indications	365	204
Probability of Burst at 2560 psi	**0.00006**	**0.00006**
Probability of Burst at 2405 psi	0.00095	0.00095
95/95 SLB Leak Rate at 2560 psi 92.4% Correlation p= 0.076 gpm at RT density	**0.261**	**0.113**
95/95 SLB Leak Rate at 2405 psi 100% Correlation gpm at RT density	0.0499	0.0272
95/95 SLB Leak Rate at 2560 psi 100% Correlation gpm at RT density	0.183	0.0862

Table 5.2

Summary of Operational Assessment Calculations

Parameter	SG 11	SG 12
EOC 22 Number of Indications	605	326
Probability of Burst at 2560 psi	**0.000126**	**0.000095**
Probability of Burst at 2405 psi	0.000095	0.00006
95/95 SLB Leak Rate at 2560 psi 92.4% Correlation p= 0.076 gpm at RT density	**0.833**	**0.429**
95/95 SLB Leak Rate at 2405 psi 100% Correlation gpm at RT density	0.163	0.091
95/95 SLB Leak Rate at 2560 psi 100% Correlation gpm at RT density	0.585	0.306

at EOC 22 for SG 11. Projected SLB leakage from other sources is 0.057 gpm. A total of 0.890 gpm meets the 1.0 gpm limit for SG 11. At 2405 psi the projected SLB leak rate drops to 0.163 gpm. The effect of uncorrelated leak rates is seen to increase the projected SLB leak at 2560 psi by a factor of 1.42 compared to use of fully correlated leak rates. The projected 95/95 SLB leak rate in SG 12 is less than half of the allowable limit.

As a final measure of degradation severity the upper voltage repair limit, based on a 1.695 EFPY cycle length and a default voltage growth rate of 30% and measurement uncertainty of 20% is 4.49 volts.

Section 6
SUMMARY AND CONCLUSIONS

This report describes the Bobbin Voltage Alternate Repair Criteria for steam generator tubing applied at Prairie Island Unit 1, EOC 21. Bobbin voltage data at tube support plates is summarized, with analyses of leak rate and probability of tube burst under postulated steam line break conditions both in terms of condition monitoring at EOC 21 and operational assessment for cycle 22. Projected bobbin voltage distributions for the conclusion of the next operating cycle are included along with calculated probabilities of burst and projected leak rates at postulated SLB conditions. The latest available data for burst pressure and leak rate correlations has been applied. Present results support continued application of the 2.0-volt repair criteria for TSP indications per NRC Generic Letter 95-05.

The maximum voltage DSI indications were 1.73 volts in SG 11 and 1.43 volts in SG 12. The composite population voltage growth rate was -0.13 volts per EFPY for Cycle 21. The Upper Voltage Repair Limit for a projected cycle length of 1.695 EFPY using default voltage growth and measurement uncertainties is 4.49 volts. Condition monitoring burst probabilities were 6E-5 for both SG 11 and SG 12. Projected SLB burst probabilities for EOC 22 are 1.26E-4 and 9.5E-5 for SG's 11 and 12 respectively. Condition monitoring 95/95 SLB leak rates at 2560 psi is 0.261 gpm for SG 11 and 0.113 gpm for SG 12. Inclusion of a lack of leak rate correlation effect led to a projected 0.833 gpm 95/95-leak rate for SG 11 at EOC 22 at 2560 psi. This value drops to 0.163 gpm at 2405 psi. Consideration of other leakage sources leads to a total projected leak rate of 0.890 gpm in SG 11 at EOC 22 for a pressure differential of 2560 psi. This meets the 1.0 gpm limit. The projected 95/95 SLB leak rate for SG 12 at EOC 22 is 0.429 gpm.

Section 7

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. NRC Safety Evaluation Related to Amendment Nos. 133 and 125 to Facility Operating License Nos. DPR-42 and DPR-60, Northern States Power Company, Prairie Island Nuclear Generating Plant Unit Nos. 1 and 2, Docket Nos. 50-282 and 50-306, November 18, 1997.

3. SG-98-03-002, "Prairie Island Unit-1 Cycle 19 Voltage Based Repair Criteria 90 Day Report, "Westinghouse Nuclear Services Division, March, 1998.

4. SG-99-07-006, "Prairie Island Unit-1 Cycle 20 Voltage-Based Repair Criteria 90 Day Report, "Westinghouse Nuclear Services Division, July, 1999.

5. WCAP-14277, Revision 1, "SLB Leak Rate and Tube Burst Probability Analysis Methods for ODSCC at TSP Intersections," Westinghouse Nuclear Services Division, March, 1998.

6. Addendum-5 to EPRI Report NP-7480-L, "Steam Generator Outside Diameter Stress Corrosion Cracking at Tube Support Plates – Database for Alternate Repair Criteria, " to bee published.

7. "Steam Generator Integrity Assessment Guidelines: Revision 1", EPRI Report TR-107621-R1, March, 2000.

8. NMC Procedure, "Eddy Current Examination Requirements for the Steam Generator Voltage Based Repair Criteria", Prairie Island Nuclear Generating Plant Maintenance Procedure, D27.25, November 29, 2001.

9. Keating, R. F., "ODSCC ARC Leak Rate Correlation and Simulation by Monte Carlo Methods", NEI/NRC Meeting, February 21, 2002.

10. "Appendix B to Steam Generator In Situ Pressure Test Guidelines", EPRI Report TR-107620-R1, to be published.