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ATTN: Document Control Desk
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SUBJECT:
Beaver Valley Power Station, Unit No. 2
Docket No. 50-412, License No. NPF-73
Steam Generator Inspection Reports – Fall 2018 Refueling Outage

In accordance with Beaver Valley Power Station, Unit No. 2 Technical Specifications 5.6.6.2.2 and 5.6.6.2.4, FirstEnergy Nuclear Operating Company hereby submits two reports containing steam generator inspection results. The enclosed reports provide information required by the technical specifications that were obtained during the fall 2018 refueling outage inspections. No steam generator tube intersections were removed during the inspections, and therefore, metallurgical examinations were not performed.

There are no regulatory commitments contained in this submittal. If there are any questions or if additional information is required, please contact Mr. Phil H. Lashley, Acting Manager - Nuclear Licensing and Regulatory Affairs, at 330-315-6808.

Sincerely,

Richard D. Bologna

Enclosures:
A. Beaver Valley Unit 2 End-of-Cycle 20 Analysis and Prediction for End-of-Cycle 21 Voltage-Based Repair Criteria 90-Day Report, Revision 0
B. Unit #2 – 2R20 Steam Generator F* (F Star) Report

cc: NRC Region I Administrator
NRC Resident Inspector
NRC Project Manager
Director BRP/DEP
Site BRP/DEP Representative

Enclosure A
L-19-034

Beaver Valley Unit 2 End-of-Cycle 20 Analysis and Prediction for End-of-Cycle 21
Voltage-Based Repair Criteria 90-Day Report, Revision 0

(77 Pages Follow)

SG-SGMP-18-24
Revision 0

January 2019

Beaver Valley Unit 2 End-of-Cycle 20 Analysis and Prediction for End-of-Cycle 21 Voltage-Based Repair Criteria 90-Day Report

SG-SGMP-18-24
Revision 0

Beaver Valley Unit 2
End-of-Cycle 20 Analysis and Prediction for End-of-Cycle 21 Voltage-Based Repair Criteria 90-Day Report

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RECORD OF REVISIONS

Revision	Date	Description
0	See EDMS	Original

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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 fall 2018, 2R20 outage, together with postulated Steam Line Break (SLB) leak rate and tube burst probability analyses. The 2R20 outage represents the fifth 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 Model 51M SGs. The criteria were implemented during the 2R16 outage. Information required by the GL 95-05 is provided in this report, including steam line break (SLB) leak rates and tube burst probabilities calculated using the end-of-cycle (EOC) conditions for the recently completed Cycle 20, representing a condition monitoring (CM) assessment of bobbin coil signal amplitudes for observed possible indications. In addition, a projection of EOC-20 bobbin coil voltage distributions, as well as the associated SG tube leak rates and burst probabilities through EOC-21 conditions is provided.

The condition monitoring analysis at End-of-Cycle 20 (EOC-20) was carried out using the actual bobbin coil voltage distributions measured during the 2R20 outage. These results show that the 2R20 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 2R19 outage (Reference 2) shows that the predictions were conservative. These evaluations utilized the Westinghouse generic methodology that uses Monte Carlo analysis techniques (Reference 3).

The Operational Assessment (OA) analysis was performed to project leak rates and tube burst probabilities for postulated SLB conditions at the end of the upcoming cycle (EOC-21) based on the 2.0 volt repair criteria for 7/8-inch diameter tubes. These analyses utilized bobbin voltage distributions measured during the recent (2R20) inspection and a growth rate distribution bounding the last two inspections (2R19 and 2R20). 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 21 operational assessment predicts that SG-B will be the limiting SG for projected leakage. With a Cycle 21 period of operation estimated at 525 effective full power days (EFPD), the limiting EOC-21 maximum leak rate for SG-B is projected to be 0.166 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 (SG-C) of 2.43×10^{-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-21.

[1] *+POINT is a trademark or registered trademark of Zetec, Inc. Other names may be trademarks of their respective owners.*

2 SUMMARY AND CONCLUSIONS

A total of 1161 distorted support indications (DSI) in all three SGs combined were reported during the Beaver Valley Power Station Unit 2 (BVPS2) 2R20 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 reported during 2R20 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 confirm the minimal bobbin coil voltage growth condition. These indications were confirmed as axial outside diameter stress corrosion cracking (ODSCC) using the +POINT probe during the 2R16 inspection and have been inspected with a +POINT probe at each successive outage. In addition, in response to a prior Nuclear Regulatory Commission (NRC) question all DSIs greater than one volt were inspected with a +POINT probe. The maximum bobbin coil voltage indication in all three SGs was 1.46 volts on R5 C28 at the 04H tube support plate in SG-A.

SLB leak rate and tube burst probability analyses were performed using the actual 2R20 bobbin voltage distributions (condition monitoring analysis) as well as the projected EOC-21 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}.

At 2R20, the largest SLB leak rate in the condition monitoring analysis is calculated for SG-B, with a magnitude of 0.0587 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, 1.57×10^{-5} calculated for SG-C, is well below the 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-21 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 21 operational assessment were performed using the Reference 4 default primary-to-secondary pressure differential of 2560 psi. SG-B is predicted to be the limiting SG for leakage while SC-C is predicted to be the limited SG for probability of burst. For a projected Cycle 21 duration of 525 EFPD, the EOC-20 leak rate projected for SG-B using the GL 95-05 constant probability of detection (POD) of 0.6 is 0.166 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-20 burst probability of 2.43×10^{-5} is 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 21.

3 2R20 INSPECTION RESULTS AND VOLTAGE GROWTH RATES

3.1 2R20 Inspection Results

For outages prior to 2R16, 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 criterion was implemented at 2R16 due to an increase in the number of distorted support plate indications (DSIs) confirmed to contain axial ODSCC from +POINT probe examination. It should be noted, 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.

In accordance with the guidance provided by GL 95-05, the 2R20 inspection of the Beaver Valley Unit 2 SGs consisted of a 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 Rows 3 and 4 which contain SG tube sleeves at the hot leg top-of-tubesheet (TTS). In these two tubes, a 0.630 inch diameter wide groove bobbin probe was used for DSI detection. If a DSI was observed using the 0.630 inch wide groove bobbin probe and the DSI could not be re-examined with a qualified rotating coil technique, the tube was to be plugged or repaired per the Beaver Valley Unit 2 SG Examination Guidelines (Reference 13). During the 2R20 outage, two DSI indications were observed with the 0.630 inch wide groove probe; both in SG-B, at R4 C36 04H and R4 C48 03H. Both of these tube-to-TSP intersections were re-examined with a +POINT probe. The DSI at R4C48 03H was characterized as no defect found (NDF) after being inspected with a +POINT probe, while the DSI at R4C36 04H was confirmed to be a single axial indication (SAI) with a +POINT voltage of 0.14V. GL 95-05 states that smaller or larger diameter probes can be used to inspect tubes when it is impractical to utilize a nominal-size probe provided that the probes and procedures have been demonstrated to give an equivalent voltage response and detection capability when compared to the nominal (in this case 0.720 inch) probe. Probe equivalency testing between the nominal 0.720 inch probe and 0.640 inch wide-groove probe has been performed and it was demonstrated that the wide-groove probe met the equivalency requirements of Appendix H of the EPRI PWR Examination Guidelines (Reference 14). Due to thicker walled sleeves at Beaver Valley Unit 2, an electrically similar 0.630 inch wide-groove probe was used in place of the 0.640 inch probe. Other plants have used multiple wide-groove bobbin proves with similar difference in probe size where equivalent detection performance was documented. Therefore, the 0.630 inch probe provides similar detection capabilities of the 0.640 inch probe.

To assess depth growth, the 2R19 DSIs with +POINT probe confirmation were also inspected at 2R20, 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, thus implying little or no depth growth of the indication. The largest +POINT probe signal amplitude in the 300 kHz channel from the confirmed DSI indications is only 0.44 volts (SG-A at R31 C74 02H), which represents a depth of 64% through-wall (TW) using the sizing protocol of Electric Power Research Institute (EPRI) Examination Technique Specification Sheet (ETSS) ETSS I28431. This particular indication was reported at 0.31 volts by +POINT probe during 2R19, which represents a 59% TW depth per ETSS I28431. Long term trending of the Unit 2 DSI population has shown a limited growth potential. For Cycles 10 through 20, the mean DSI voltage growth has been essentially zero. Additionally, the +POINT probe 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 EOC-20 eddy current inspection plan included 100% +POINT probe inspection of all hot leg and cold leg dents ≥5 volts (as measured from the bobbin probe), since GL 95-05 alternate repair criterion (ARC) does not apply to these tube-to-TSP intersections. The 2R20 eddy current inspection plan also included 100% +POINT probe inspection of dents with indication (DNI) due to this being a primary water stress corrosion cracking (PWSCC) concern and 25% of support plate residuals (SPR) due to this being an ODSCC concern. The DNI call can be generated by manual analysis or by using a tertiary auto analysis. As can be seen in Table 3-1, 1358 total DNI indications were tested using a rotating pancake coil (RPC) probe. No new instances of PWSCC or ODSCC were detected as a result of these tests. One tube location in SG-C (R13 C65 05H) has a historical SAI and DSI indication, with a bobbin DNI signal (1.72V) being newly identified during the 2R20 inspection.

SPRs are defined as bobbin coil signals which do not contain flaw-like components but have a signal amplitude of ≥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. The following table provides the number of +POINT probe exams performed at TSP intersections as a result of these program requirements during 2R20.

Table 3-1 2R20 RPC Examinations due to Bobbin Calls

SG	>5V Dents	DNI		SPR	
		Total	RPC Tested	Total	RPC Tested
A	14	771	771	325	149
B	34	120	120	164	54
C	12	467	467	226	79

The requirements 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 >5.0 volts, as measured by bobbin. All SPR indications >2V were tested with the +POINT probe so that no ODSCC indications >1.0 volt would be missed or misread. No copper signal interference was detected.

Table 3-2, Table 3-3 and Table 3-4 present the 2R20 bobbin voltage data for the TSP intersections in the three SGs with distorted support indications (DSIs). A total of 1161 TSP locations had DSI indications in all three SGs combined, of which only 22 indications had amplitudes greater than 1.0 volt and no indications were greater than 1.5 volts. For the analyses, the DSI indications are binned in 0.1 volt intervals where the numeric value of the bin represents the upper range of the bin. Therefore, the 1.0 volt bin contains DSI voltages from 0.91 to 1.00 volt. No DSI voltage exceeded the GL 95-05 lower voltage repair limit of 2.0 volts. For 2R20, all DSIs with a voltage amplitude greater than or equal to 1.0 volt were automatically tested using +POINT probe, which exceeds the requirement by GL 95-05 to test all DSIs with a voltage amplitude greater than or equal to 2.0 volts. Comparing the inspection results from 2R19 to 2R20, the following observations were made:

- There were 74 new DSI indications in 2R20
    - 36 in SG-A
    - 14 in SG-B
    - 24 in SG-C
- There were eleven new SAI/MAI indications confirmed by +POINT probe in 2R20, with the largest of these being recorded at 0.25V.
    - Six (6) in SG-A
    - One (1) in SG-B
    - Four (4) in SG-C

Table 3-2, Table 3-3 and Table 3-4 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 the tubes to service after inspection in accordance with the alternate repair criteria. The distribution of 2R20 indications is also shown in Figure 3-1, Figure 3-2, and Figure 3-3 for SG-A, SG-B, and SG-C, respectively.

The distribution of 2R20 indications as a function of support plate location is summarized in Table 3-5 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 23 indications were detected on the cold leg side; three of these exceeded 0.5 volt, but do not exceed 0.75 volt. 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 2R20 outage in the form of tables (Table A-1, Table A-2, and Table A-3), whether axial ODSCC was confirmed (SAI/MAI in Comment column), whether the tube containing the indication(s) was plugged (Comment

column), and whether the indication was tested and no defect was found (NDF in Comment column).

3.2 Voltage Growth Rates

For projection of leak rates and tube burst probabilities at EOC-21, voltage growth rates were developed from the 2R19 and 2R20 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 3-5 shows a distribution of growth as a function of TSP number. Table 3-6 shows the frequency and cumulative probability distribution of growth as a function of voltage change in each BVPS2 steam generator during Cycle 20 on a per EFPY basis. The difference in the total number of DSIs between these two tables is due to new DSIs.

The average bobbin coil voltage growth rates for each SG during Cycle 20 are given in Table 3-7. The average growth rates over the entire voltage range are negative indicating essentially no overall voltage growth. The Cycle 20 growth rates on an EFPY basis for each SG are shown in Figure 3-5, Figure 3-6 and Figure 3-7. A general observation is that the cumulative growth observed during 2R20 is slightly less than that during 2R19 to varying degrees in each SG. The growth figures also include curves which bound the growth observed during both Cycle 19 and Cycle 20 in SGs A, B and C, respectively, and the bounding growth curve was used in the OA. Figure 3-8, Figure 3-9 and Figure 3-10 provide a magnified view of the upper 5% tail of the growth curves for SG-A, SG-B and SG-C, respectively.

Table 3-8 lists the top 15 indications based on Cycle 20 growth rate in descending order. The average growth rates over the entire voltage range for Cycle 20 are negative indicating essentially no voltage growth, but Table 3-8 shows that in cases of positive growth rates, that Cycle 20 had only modest growth. The growth during Cycle 20 for all indications was under 1.0 volts, with only five indications greater than 0.5 volts.

To determine if BVPS2 growth rates exhibited a potential dependency on the BOC voltage, the growth rate data for Cycle 20 was plotted against BOC voltage, and the resulting plot is shown in Figure 3-11. The Cycle 20 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

The probe wear criteria approved by the NRC (Reference 8) was applied during the 2R20 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 being exceeded.

3.4 NDE Uncertainties

The NDE uncertainties applied for the Cycle 20 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 2R20 actual voltage distributions as well as for the EOC-21 projections.

Table 3-2 2R20 DSI Voltage Distribution for SG-A

Voltage Bin	Number of Indications	+POINT Probe Confirmed	+POINT Probe Tested But Not Confirmed	Not +POINT Probe Tested	Plugged	Returned to Service
0.1	20	0	0	20	0	20
0.2	95	4	0	91	0	95
0.3	96	6	2	88	0	96
0.4	67	4	0	63	0	67
0.5	26	2	1	23	0	26
0.6	18	2	0	16	0	18
0.7	7	0	0	7	0	7
0.8	7	1	0	6	0	7
0.9	5	0	0	5	0	5
1	3	0	0	3	0	3
1.1	1	0	1	0	0	1
1.2	2	2	0	0	0	2
1.3	0	0	0	0	0	0
1.4	0	0	0	0	0	0
1.5	1	0	1	0	0	1
Total	348	21	5	322	0	348

Average voltage = 0.310 volts

Table 3-3 2R20 DSI Voltage Distribution for SG-B

Voltage Bin	Number of Indications	+POINT Probe Confirmed	+POINT Probe Tested But Not Confirmed	Not +POINT Probe Tested	Plugged	Returned to Service
0.1	18	0	0	18	0	18
0.2	104	4	0	100	0	104
0.3	115	5	0	110	1	114
0.4	69	2	0	67	0	69
0.5	59	4	0	55	0	59
0.6	36	1	0	35	0	36
0.7	15	2	1	12	0	15
0.8	11	0	1	10	0	11
0.9	7	0	0	7	0	7
1	7	1	0	6	0	7
1.1	4	1	3	0	0	4
1.2	1	0	1	0	0	1
1.3	2	0	2	0	0	2
1.4	1	0	1	0	0	1
Total	449	20	9	420	1	448

Average voltage = 0.348 volts

Table 3-4 2R20 DSI Voltage Distribution for SG-C

Voltage Bin	Number of Indications	+POINT Probe Confirmed	+POINT Probe Tested But Not Confirmed	Not +POINT Probe Tested	Plugged	Returned to Service
0.1	13	0	0	13	0	13
0.2	68	2	0	66	0	68
0.3	90	5	1	84	0	90
0.4	62	4	0	58	0	62
0.5	56	3	4	49	0	56
0.6	29	4	1	24	0	29
0.7	25	2	3	20	0	25
0.8	7	0	0	7	0	7
0.9	4	2	0	2	0	4
1	3	0	1	2	0	3
1.1	1	0	1	0	0	1
1.2	1	0	1	0	0	1
1.3	3	0	3	0	0	3
1.4	1	1	0	0	0	1
1.5	1	0	1	0	0	1
Total	364	23	16	325	0	364

Average voltage = 0.372 volts

Table 3-5 Indication Distribution as Function of Tube Support Plate

SG-A

TSP	Number of Indications	Max. Volts	Average Volts	Largest Growth, Volts	Average Growth, Volts
02H	126	1.18	0.312	0.51	-0.042
03H	90	1.04	0.343	0.86	-0.043
04H	46	1.46	0.296	0.19	-0.05
05H	46	0.83	0.316	0.11	-0.048
06H	13	0.51	0.235	0.07	0.007
07H	5	0.72	0.364	0.01	-0.064
08H	12	0.43	0.239	0.14	-0.059
03C	0	-	-	-	-
04C	0	-	-	-	-
05C	2	0.22	0.2	n/a	n/a
06C	3	0.24	0.167	-0.07	-0.075
07C	1	0.22	0.22	n/a	n/a
08C	4	0.24	0.138	-0.02	-0.07
Total	348				

SG-B

TSP	Number of Indications	Max. Volts	Average Volts	Largest Growth, Volts	Average Growth, Volts
02H	180	1.4	0.377	0.59	-0.036
03H	135	1.04	0.367	0.55	-0.030
04H	61	1.07	0.298	0.28	-0.016
05H	38	0.75	0.272	0.06	-0.061
06H	7	0.61	0.319	0.24	-0.013
07H	11	0.61	0.285	0.02	-0.033
08H	7	0.51	0.21	0.03	-0.026
03C	1	0.24	0.24	-0.01	-0.01
04C	1	0.12	0.12	0	0
05C	1	0.24	0.24	0	0
06C	3	0.55	0.357	0.15	-0.02
07C	2	0.54	0.515	-0.03	-0.1
08C	2	0.41	0.315	0.08	0.05
Total	449				

SG-C

TSP	Number of Indications	Max. Volts	Average Volts	Largest Growth, Volts	Average Growth, Volts
02H	137	1.33	0.429	0.42	-0.025
03H	105	1.22	0.392	0.39	-0.016
04H	52	1.44	0.293	0.85	0.023
05H	32	0.77	0.297	0.25	-0.071
06H	17	0.4	0.227	0.08	-0.034
07H	10	0.51	0.297	0.1	-0.024
08H	8	0.85	0.316	0.09	-0.041
03C	0	-	-	-	-
04C	0	-	-	-	-
05C	1	0.51	0.51	-0.04	-0.04
06C	0	-	-	-	-
07C	1	0.34	0.34	n/a	n/a
08C	1	0.43	0.43	n/a	n/a
Total	364				

Composite

TSP	Number of Indications	Max. Volts	Average Volts	Largest Growth, Volts	Average Growth, Volts
02H	443	1.4	0.375	0.59	-0.034
03H	330	1.22	0.368	0.86	-0.029
04H	159	1.46	0.296	0.85	-0.014
05H	116	0.83	0.296	0.25	-0.059
06H	37	0.61	0.247	0.24	-0.017
07H	26	0.72	0.305	0.1	-0.038
08H	27	0.85	0.254	0.14	-0.043
03C	1	0.24	0.24	-0.01	-0.01
04C	1	0.12	0.12	0	0
05C	4	0.51	0.288	0	-0.02
06C	6	0.55	0.262	0.15	-0.042
07C	4	0.54	0.398	-0.03	-0.1
08C	7	0.43	0.23	0.08	-0.022
Total	1161				

Table 3-6 Voltage Growth Cumulative Distribution

	SG-A		SG-B		SG-C		Composite	
Voltage Change: EOC-20 minus EOC-19 per EFPY	**Number of Indications**	**Cumulative Probability Distribution**	**Number of Indications**	**Cumulative Probability Distribution**	**Number of Indications**	**Cumulative Probability Distribution**	**Number of Indications**	**Cumulative Probability Distribution**
-0.79<ΔV≤-0.7	1	0.003205	0	0	2	0.005882	3	0.00276
-0.69<ΔV≤-0.6	1	0.00641	1	0.002299	1	0.008824	3	0.00552
-0.59<ΔV≤-0.5	3	0.016026	0	0.002299	5	0.023529	8	0.012879
-0.49<ΔV≤-0.4	5	0.032051	2	0.006897	5	0.038235	12	0.023919
-0.39<ΔV≤-0.3	7	0.054487	6	0.02069	8	0.061765	21	0.043238
-0.29<ΔV≤-0.2	12	0.092949	14	0.052874	6	0.079412	32	0.070837
-0.19<ΔV≤-0.1	39	0.217949	63	0.197701	39	0.194118	141	0.202392
-0.09 <ΔV≤0.0	151	0.701923	213	0.687356	116	0.535294	480	0.643974
0.01<ΔV≤0.1	75	0.942308	112	0.944828	122	0.894118	309	0.927323
0.11<ΔV≤0.2	11	0.977564	15	0.97931	22	0.958824	48	0.972401
0.21<ΔV≤0.3	2	0.983974	7	0.995402	8	0.982353	17	0.98804
0.31<ΔV≤0.4	1	0.987179	0	0.995402	3	0.991176	4	0.99172
0.41<ΔV≤0.5	2	0.99359	0	0.995402	2	0.997059	4	0.9954
0.51<ΔV≤0.6	1	0.996795	2	1.0	0	0.997059	3	0.99816
0.61<ΔV≤0.7	1	1.0	0	--	0	0.997059	0	0.99816
0.71<ΔV≤0.8	0	--	0	--	0	0.997059	0	0.99816
0.81<ΔV≤0.9	0	--	0	--	1	1.0	2	1.0
Number of Indications with Growth	312		435		340		1087	

Table 3-7 Growth Rate as a Function of BOC Voltage Range					
Voltage Range		**Number of Indications for Growth**	**Average BOC Voltage**	**Average Voltage Cycle 20 Growth**	**Average Voltage Growth per EFPY**
Composite					
Entire Range		1087	0.380	-0.032	-0.023
Vboc<0.75		1004	0.333	-0.020	-0.015
Vboc≥0.75		83	0.950	-0.176	-0.128
SG-A					
Entire Range		312	0.363	-0.044	-0.032
Vboc<0.75		292	0.321	-0.029	-0.021
Vboc≥0.75		20	0.970	-0.265	-0.192
SG-B					
Entire Range		435	0.382	-0.032	-0.024
Vboc<0.75		403	0.337	-0.027	-0.020
Vboc≥0.75		32	0.950	-0.095	-0.069
SG-C					
Entire Range		340	0.394	-0.021	-0.015
Vboc<0.75		309	0.339	-0.003	-0.002
Vboc≥0.75		31	0.937	-0.204	-0.148

Table 3-8 Indications with the Largest Growth in Cycle 20

SG	Row	Column	TSP No.	EOC-19 Volts	EOC-20 Volts	C20 Growth Volts	+POINT Probe Tested
SG-A	15	74	03H	0.18	1.04	0.86	Yes (NDF)
SG-C	15	5	04H	0.59	1.44	0.85	Yes (NDF)
SG-B	9	80	02H	0.36	0.95	0.59	No
SG-B	4	48	03H	0.17	0.72	0.55	Yes (NDF)
SG-A	9	57	02H	0.23	0.74	0.51	No
SG-A	4	50	03H	0.22	0.7	0.48	No
SG-A	6	35	02H	0.72	1.14	0.42	Yes (SAI)
SG-C	22	20	02H	0.27	0.69	0.42	No
SG-C	17	48	02H	0.58	1.0	0.42	Yes (NDF)
SG-C	10	72	03H	0.12	0.51	0.39	No
SG-C	20	76	03H	0.82	1.17	0.35	Yes (NDF)
SG-C	24	48	03H	0.88	1.22	0.34	Yes (NDF)
SG-A	35	45	02H	0.48	0.8	0.32	No

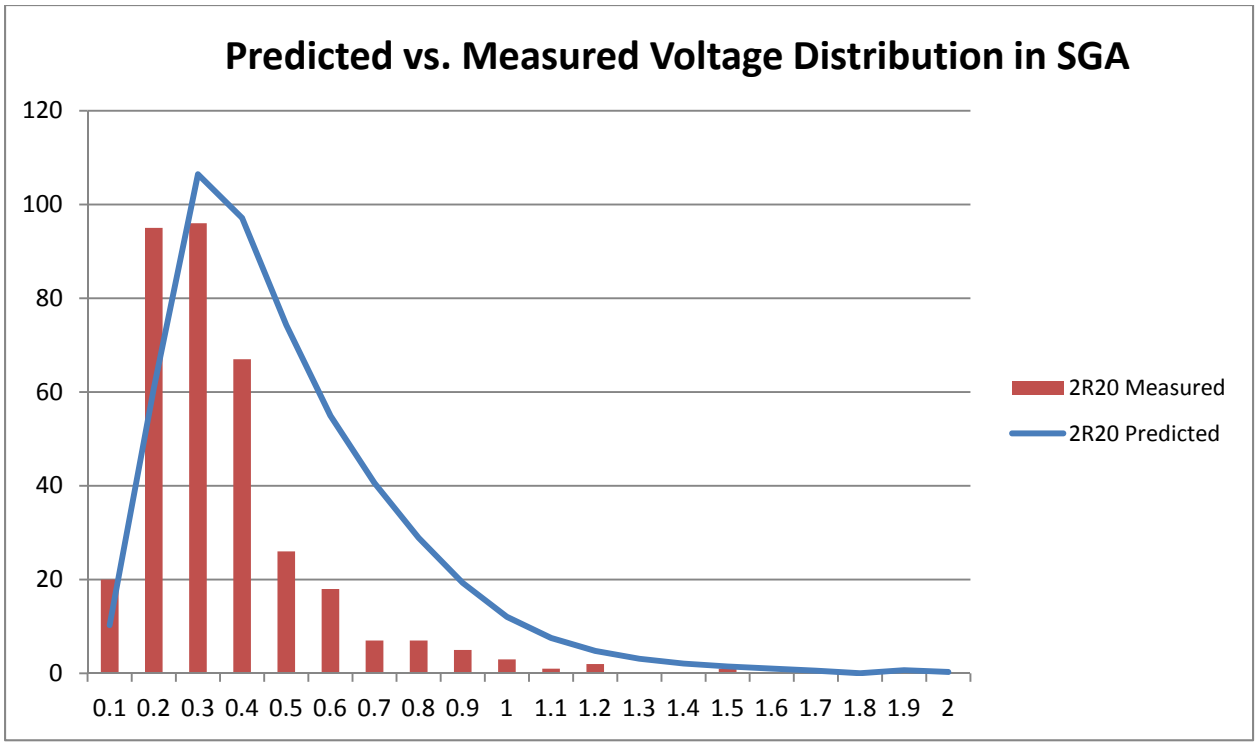

Figure 3-1 Voltage Distribution in SG A (Measured vs. Predicted)

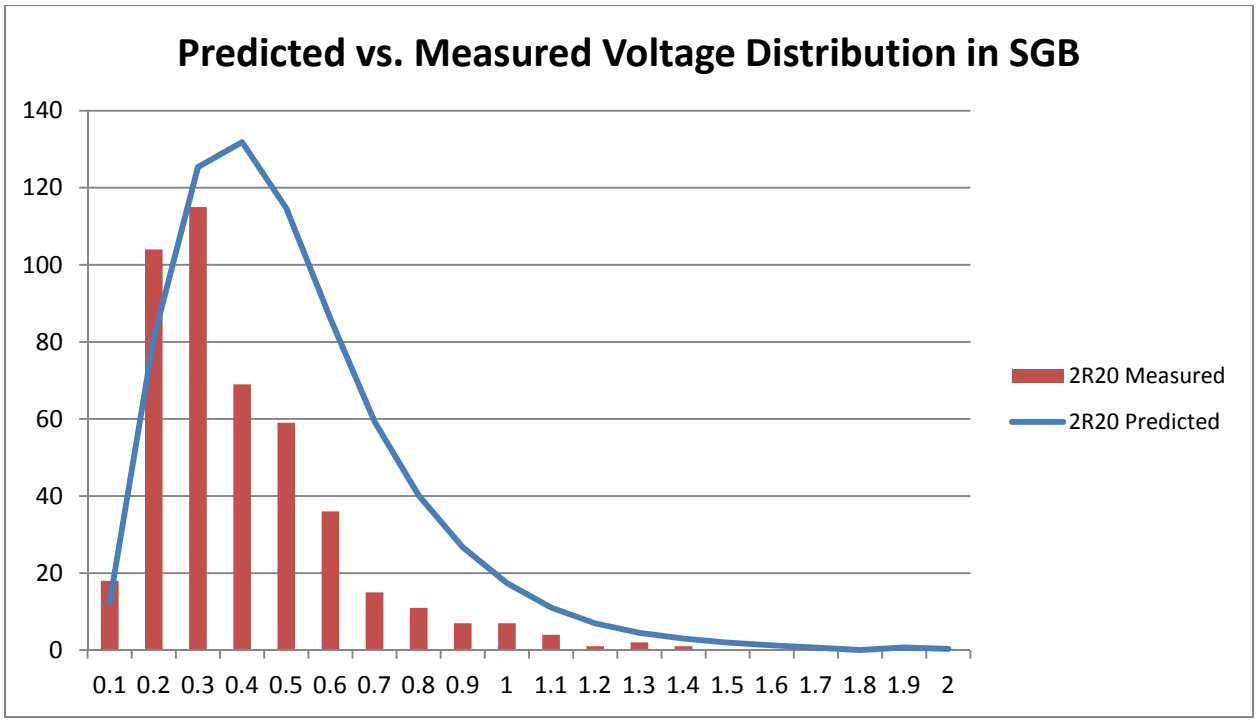

Figure 3-2 Voltage Distribution in SG B (Measured vs. Predicted)

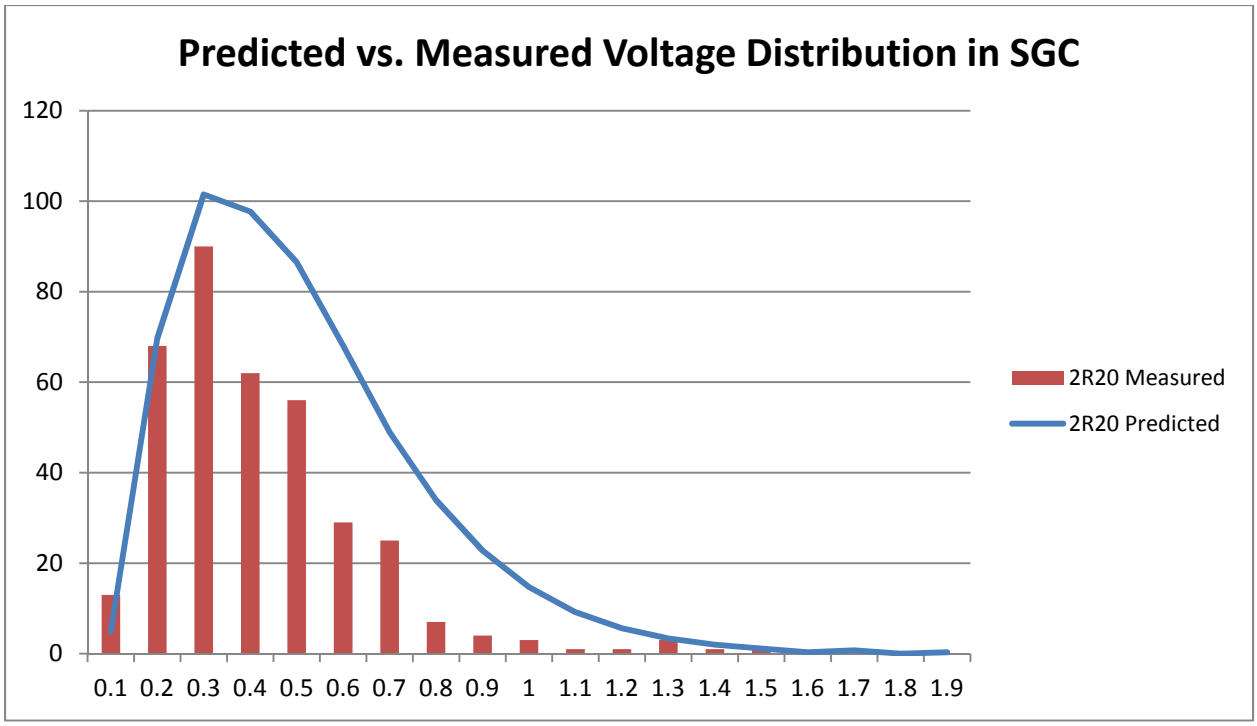

Figure 3-3 Voltage Distribution in SG C (Measured vs. Predicted)

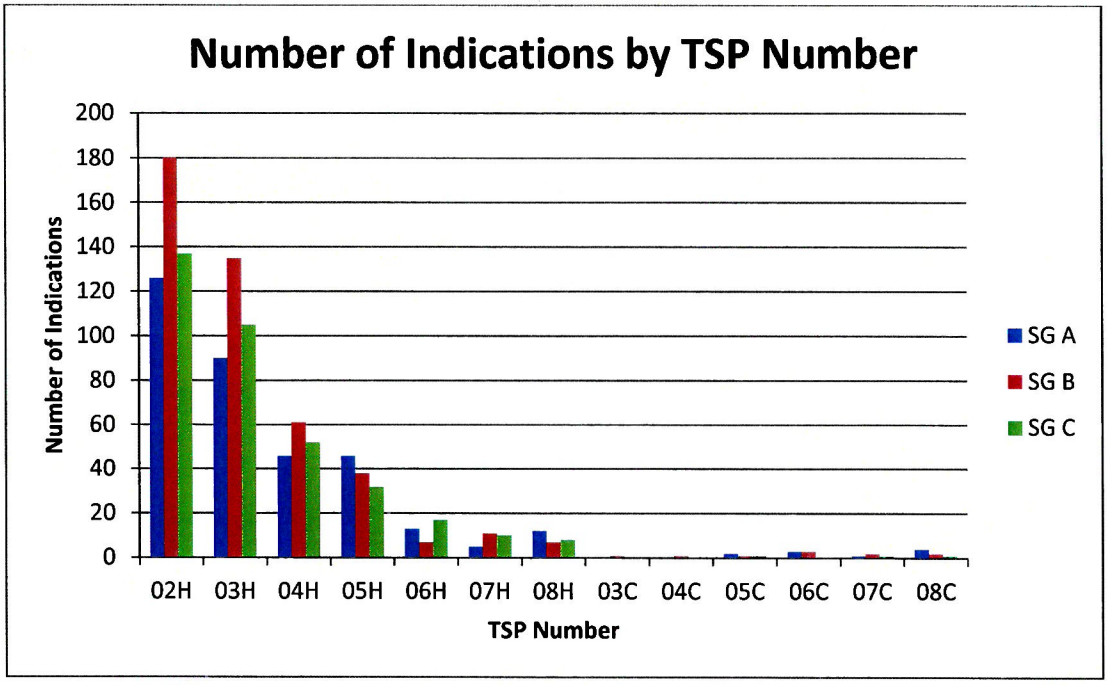

Figure 3-4 Number of Measured Bobbin DSI as a Function of TSP

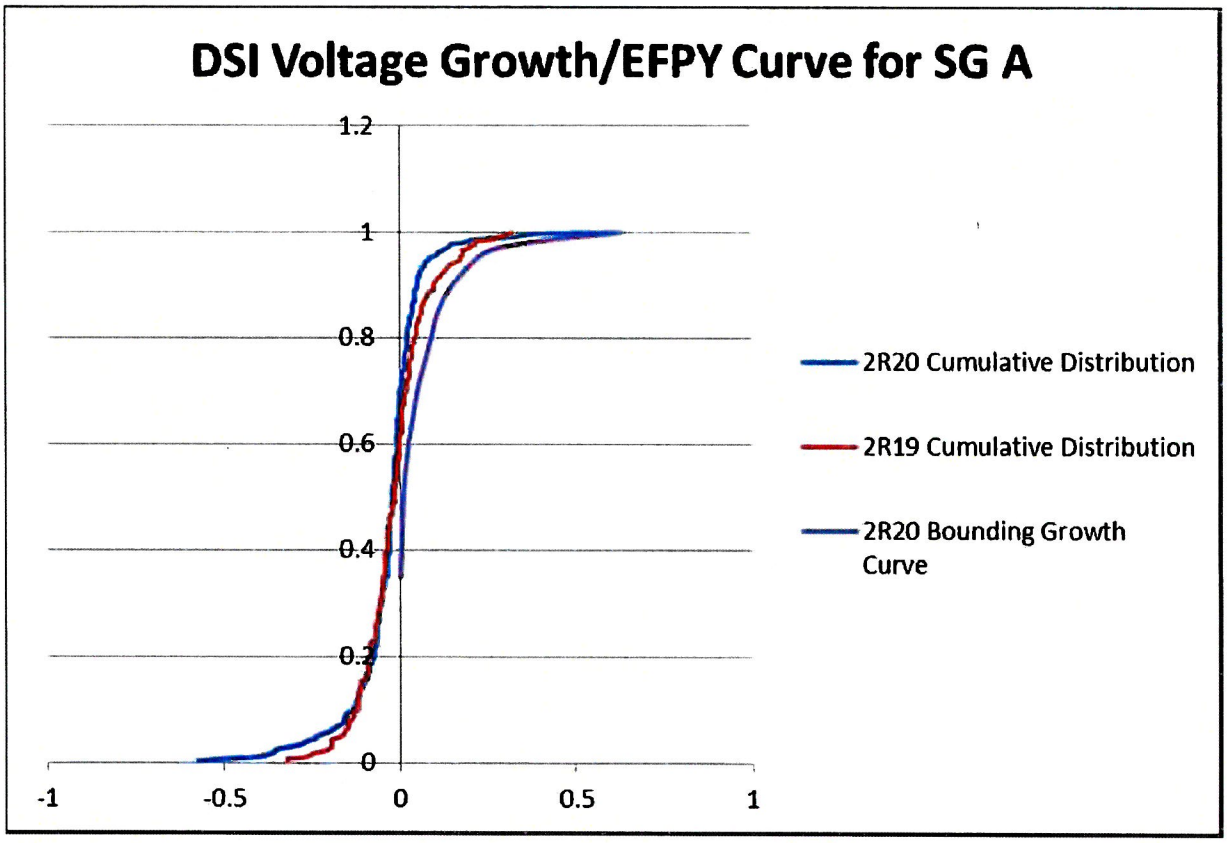

Figure 3-5 Voltage Growth / EFPY in SG-A during Cycle 20

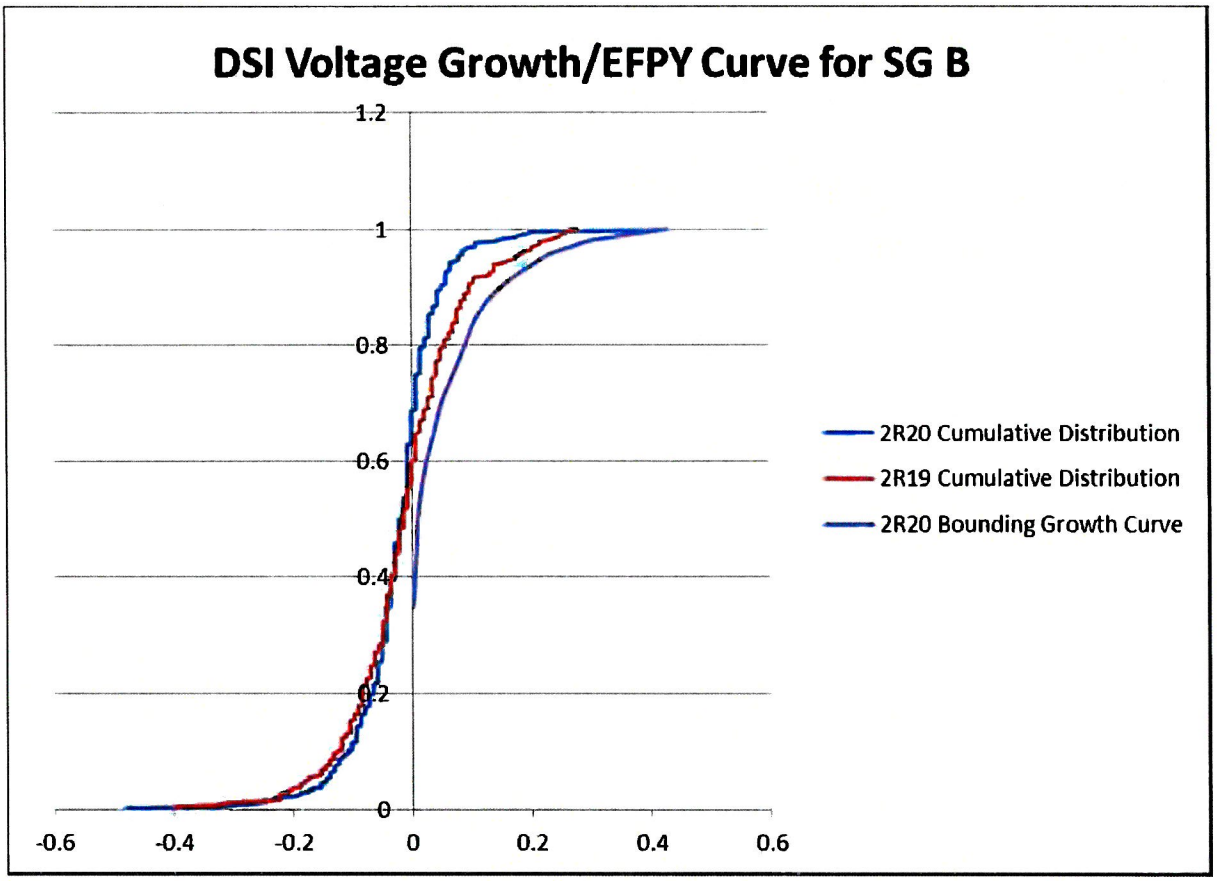

Figure 3-6 Voltage Growth / EFPY in SG-B during Cycle 20

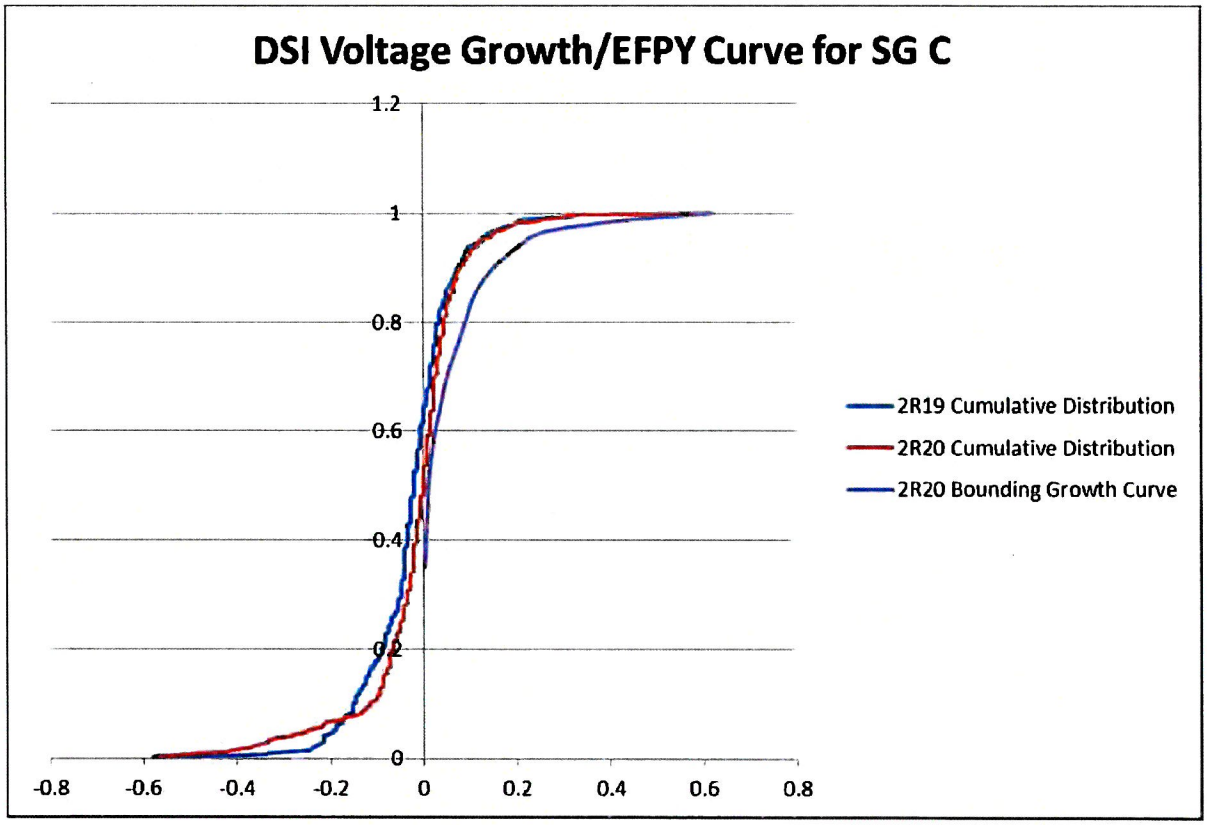

Figure 3-7 Voltage Growth / EFPY in SG-C during Cycle 20

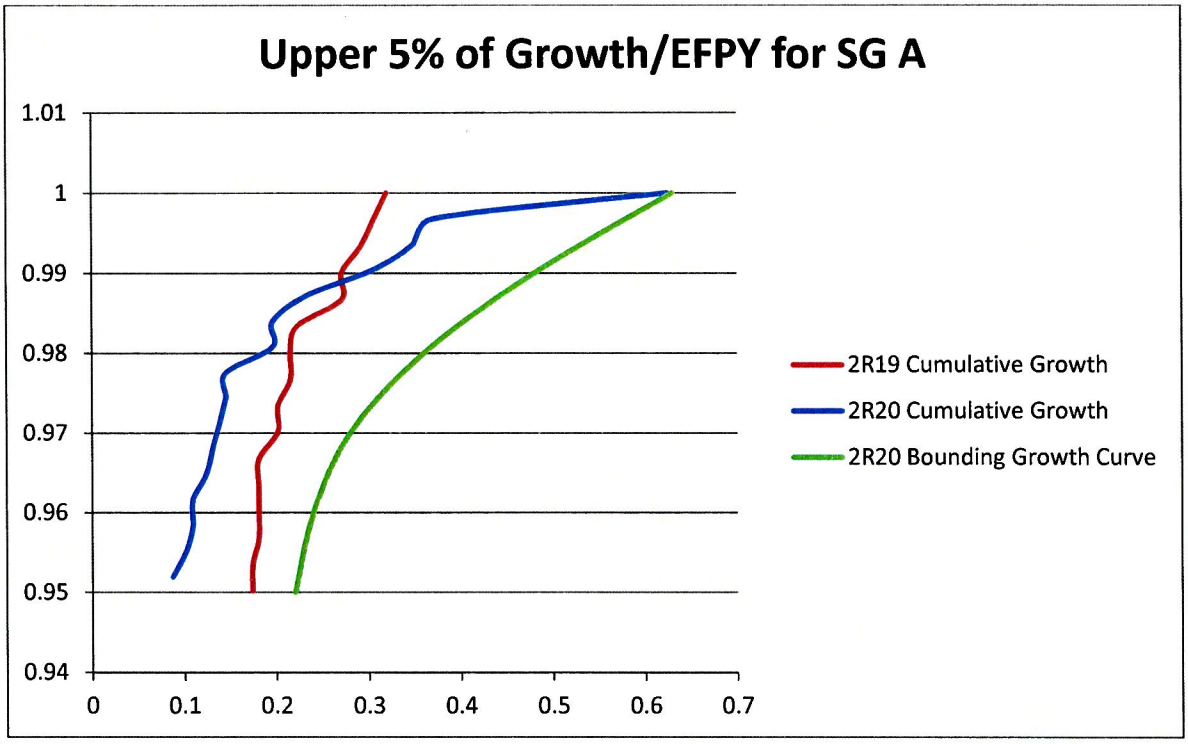

Figure 3-8 Upper 5% of Growth/EFPY for SG-A

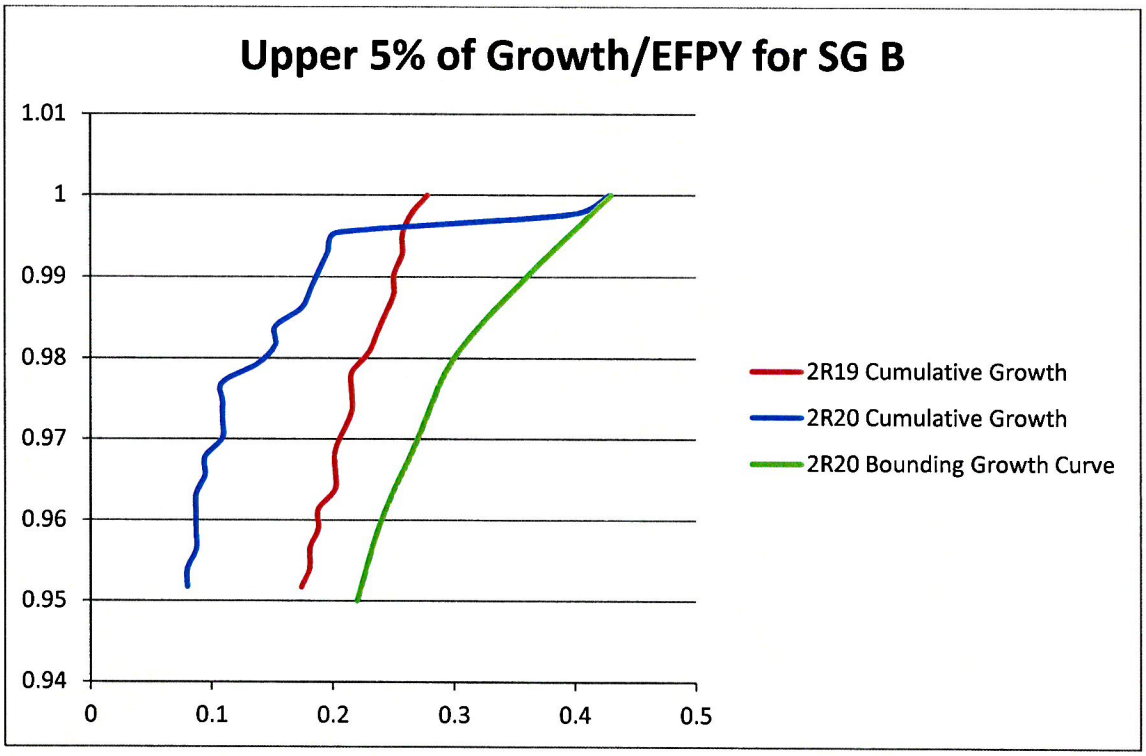

Figure 3-9 Upper 5% of Growth/EFPY for SG-B

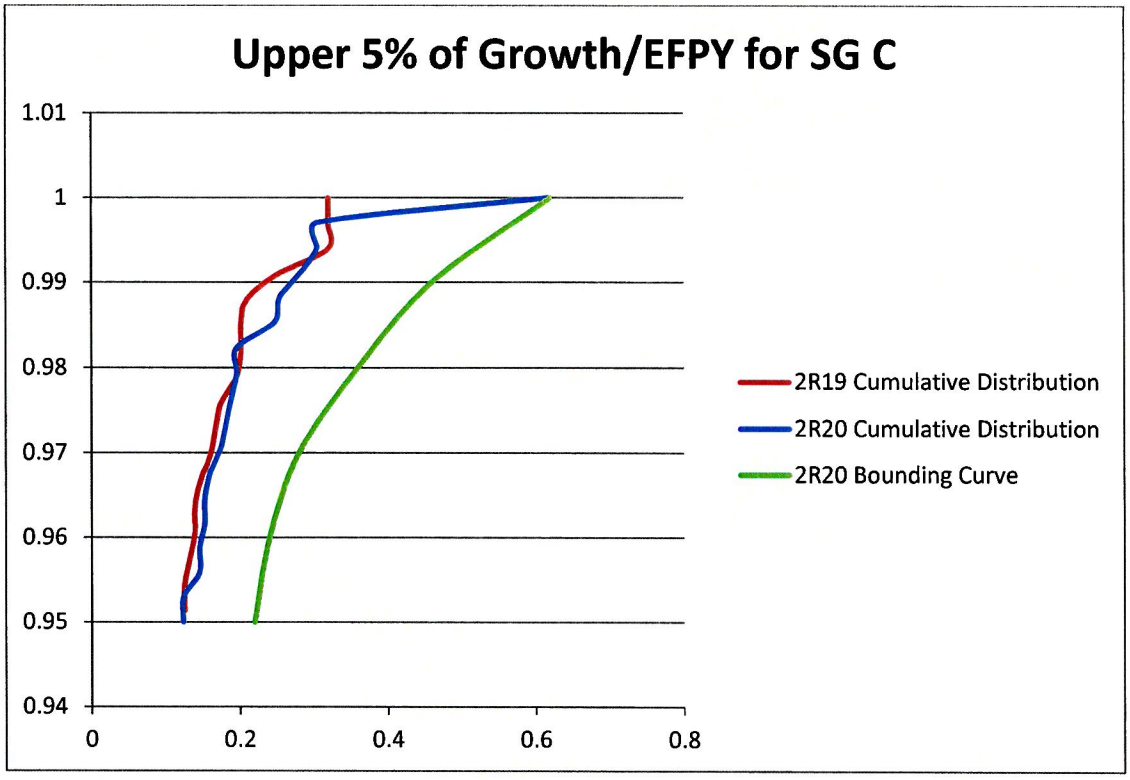

Figure 3-10 Upper 5% of Growth/EFPY for SG-C

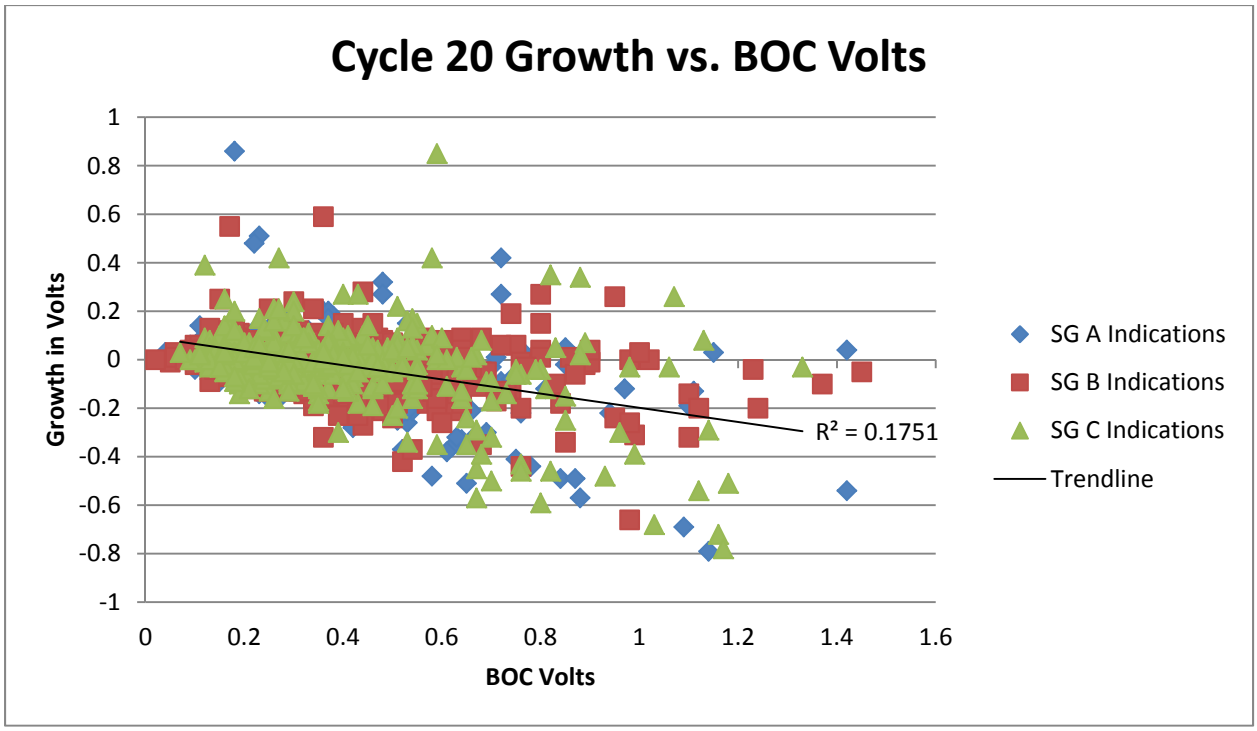

Figure 3-11 Cycle 20 Voltage Growth vs. BOC Voltage

4 DATABASE APPLIED FOR LEAK AND BURST CORRELATIONS

4.1 Tube Material Properties

The tube material properties are provided in Table 6-4 of Reference 4 for 7/8-inch diameter tubes. The normalized mean flow stress (sum of yield and ultimate strengths divided by 2) used in the analysis is 68.78 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-20 and EOC-21 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-20 and EOC-21. 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 BVPS2 Updated Final Safety Analysis Report (UFSAR), the pressurizer safety relief valves have a nominal setting of 2485 psig, or the Reactor Coolant System (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 psig, which is the traditional pressure differential used for prior GL 95-05

analyses. The upper voltage repair limit of 4.60 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 applied to the differential pressure. The upper voltage repair limit considers 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 (43.2% per cycle for the bounding 525 EFPD Cycle 20). Therefore, the specific maximum growth value of 43.2% 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 + 0.432 + 0.20) = 4.60 volts. No indications greater than this voltage were left in service; the largest DSI voltage reported at 2R20 was 1.46 volts.

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 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 >4.5 volts will be observed within the BVPS2 SGs.

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

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

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.

(4) Reference is Table 6-4 from Reference 4.

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
Notes: (1) Reference is Table 6-6 from Reference 4.	

Table 4-3 7/8-Inch 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, $\beta_{i,}$ of the regression equation.

(2) Reference is Table 6-5 from Reference 4.

5 SLB ANALYSIS METHODS

A Monte Carlo analysis technique is used to calculate the SLB leak rates and tube burst probabilities for both actual 2R20 and projected EOC-21 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 correlation 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-21 voltage distributions.

6.1 Calculation of Voltage Distributions

The analysis for EOC-21 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 probability of detection (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 historical 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 21 (BOC-21); therefore, $N_{deplugged} = 0$. One (1) tube with one (1) indication at a TSP was plugged, therefore, $N_{repaired} = 1$. The tube was plugged for reasons other than the presence of the DSI signal. 2R20 RPC “no degradation found” (NDF) indications were included in establishing the BOC-21 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-21 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 for the EOC-21 projection.

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 (Figure 3-5, Figure 3-6 and Figure 3-7). 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 20 - 502.9 EFPD or 1.377 EFPY (actual)

Cycle 21* - 515 EFPD or 1.410 EFPY (projected)

* A conservative cycle length of 525 EFPD is applied in the Monte Carlo simulations for calculation of leak rate and burst probability.

6.5 Projected EOC-21 Voltage Distribution

Calculations for the EOC-21 bobbin voltage projections were performed for all three SGs based on the 2R20 distributions shown in Table 6-1. The BOC-21 distributions were adjusted to account for probability of detection as described above, and the adjusted number of indications at BOC-21 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-21 and the distribution of indications projected to EOC-21 are shown in Figure 6-1, Figure 6-2 and Figure 6-3 for SG-A, SG-B and SG-C, respectively. SG-B has the largest number of indications at BOC-21. 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-21

	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-20	**BOC-21**	**EOC-21**		**EOC-20**	**BOC-21**	**EOC-21**		**EOC-20**	**BOC-21**	**EOC-21**
0.1	20	33.33	23.59		18	30.0	21.82		13	21.67	15.6
0.2	95	158.33	106.22		104	173.33	115.36		68	113.33	77.14
0.3	96	160.0	136.64		115	190.67	156.76		90	150.0	118.0
0.4	67	111.67	116.34		69	115.0	133.65		62	103.33	110.58
0.5	26	43.33	74.13		59	98.33	107.55		56	93.33	93.38
0.6	18	30.0	43.95		36	60.0	77.42		29	48.33	68.39
0.7	7	11.67	26.46		15	25.0	48.61		25	41.67	46.91
0.8	7	11.67	17.4		11	18.33	29.87		7	11.67	29.04
0.9	5	8.33	12.58		7	11.67	19.35		4	6.67	16.96
1.0	3	5.0	8.5		7	11.67	13.2		3	5.0	9.98
1.1	1	1.67	5.38		4	6.67	8.91		1	1.67	6.17
1.2	2	3.33	3.29		1	1.67	5.84		1	1.67	4.35
1.3	0	0	2.04		2	3.33	3.77		3	5.0	3.36
1.4	0	0	1.29		1	1.67	2.36		1	1.67	2.56
1.5	1	1.67	0.86		0	0	1.39		1	1.67	1.78
1.6	0	0	0.35		0	0	0.46		0	0	1.12
1.7	0	0	0		0	0	0.7		0	0	0.37
1.8	0	0	0.7		0	0	0		0	0	0
1.9	0	0	0.3		0	0	0.3		0	0	0.7
2.0	0	0	0		0	0	0		0	0	0.3
Total	384	580	580		449	747.33	747.33		364	606.67	606.67

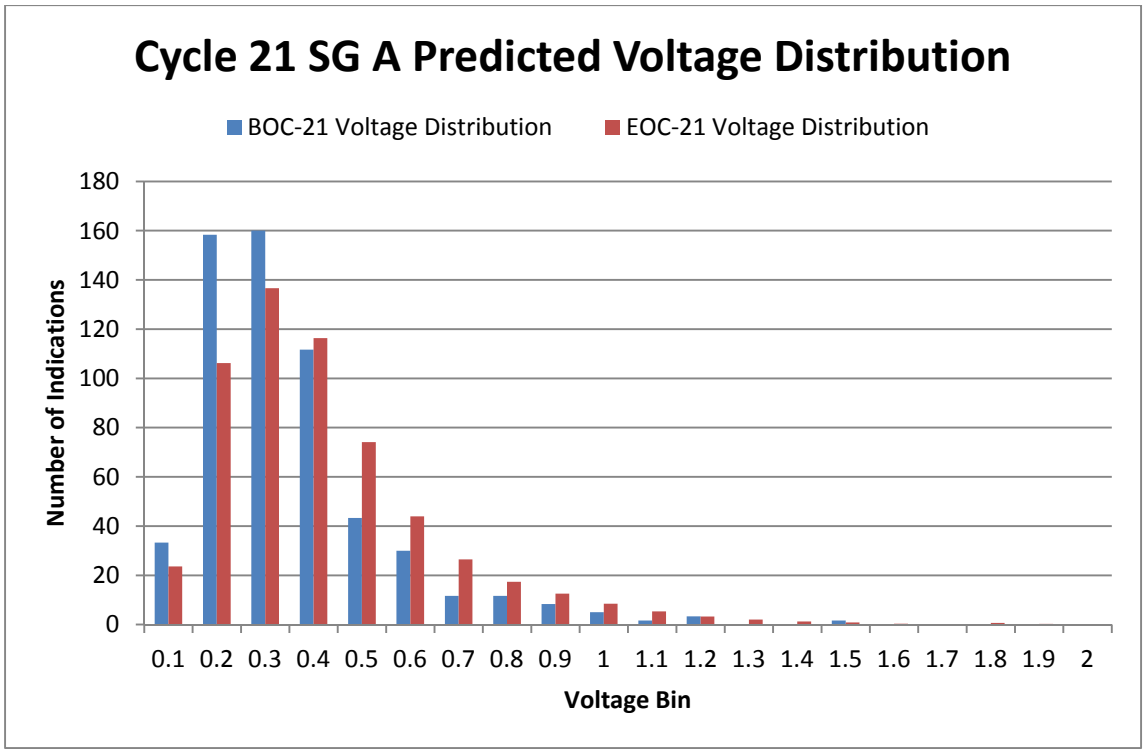

Figure 6-1 SG-A Predicted Voltage Distribution at EOC-21

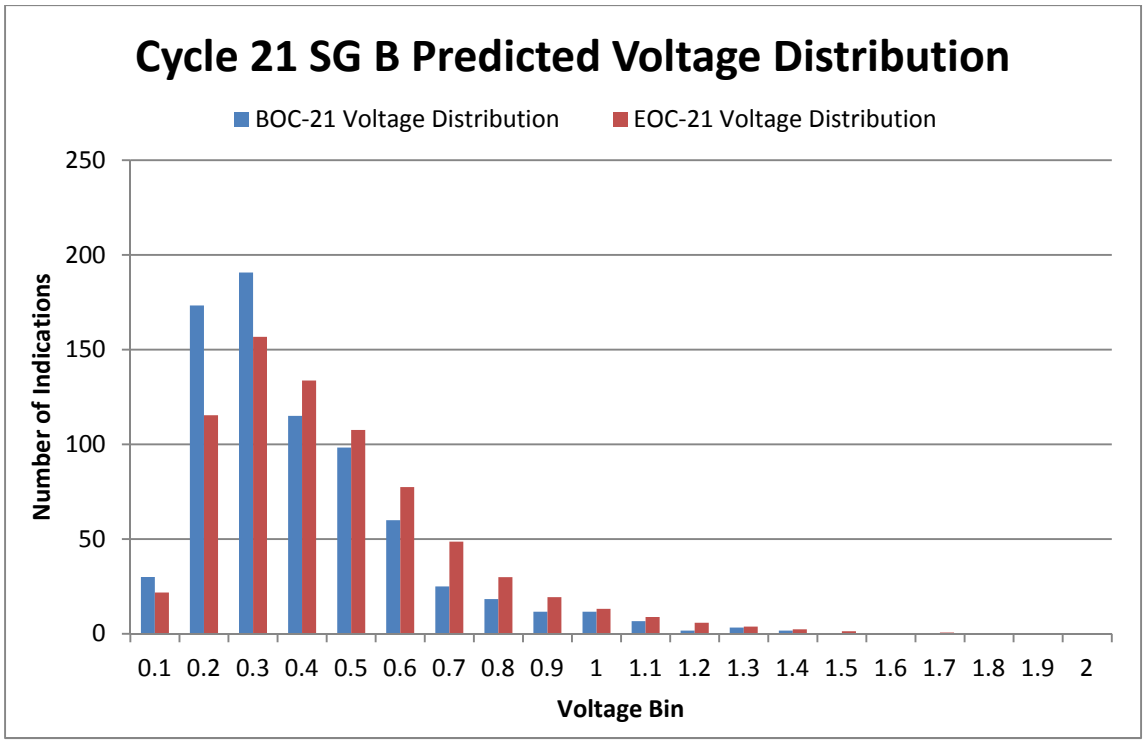

Figure 6-2 SG-B Predicted Voltage Distribution at EOC-21

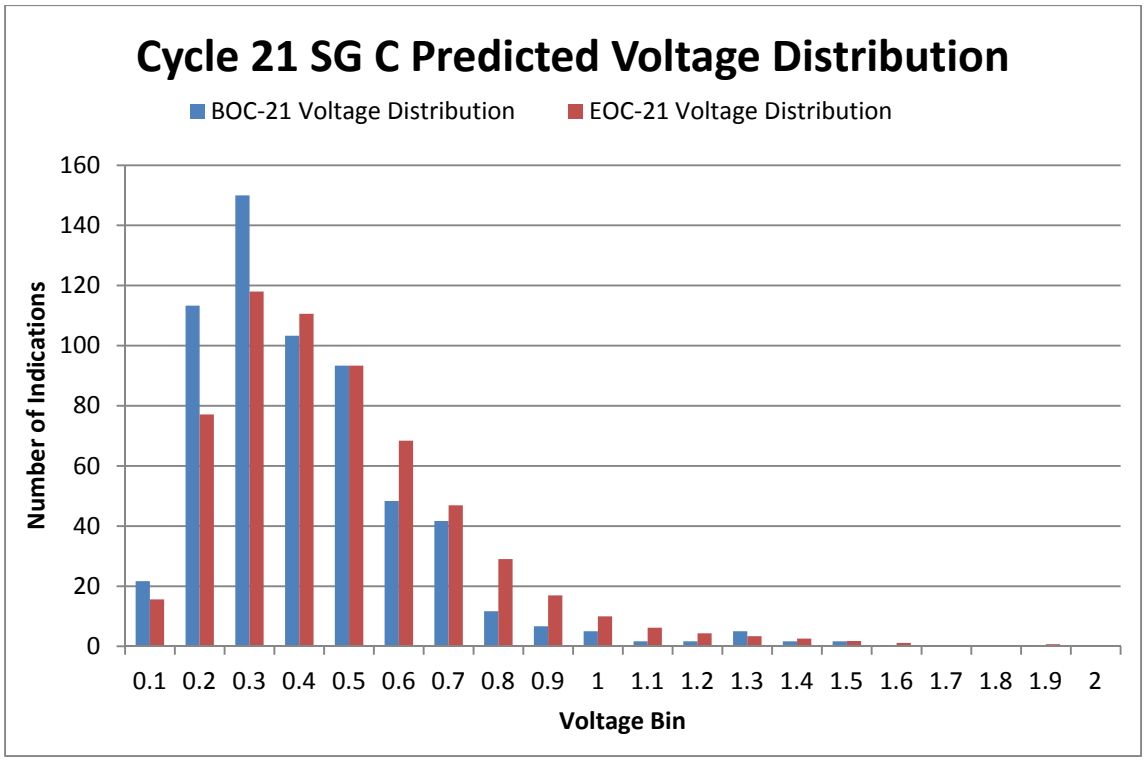

Figure 6-3 SG-C Predicted Voltage Distribution at EOC-21

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 2R20 inspection (condition monitoring assessment) as well as for the projected EOC-21 voltage distributions (operational assessment). The methodology used in these analyses is described in Section 6.

7.1 2R20 Condition Monitoring Leak Rate and Tube Burst Probability

Analyses to calculate the 2R20 SLB leak rates and tube burst probabilities were performed using the actual bobbin voltage distributions presented in Table 3-2, Table 3-3 and Table 3-4. The results of the Monte Carlo calculations are summarized in Table 7-1, in addition to the 2R20 predictions from the EOC-19 OA performed in Reference 2. As evident from the results in Table 7-1, the methodology utilized for the OA is conservative in the prediction of the number and size of indications by the end of the following operating cycle. As a result, the OA produces conservative results for leak rate and burst probability by the end of the next operating cycle.

The SLB leak rates and tube burst probabilities, calculated using the actual measured 2R20 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, Revision 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 4, were used. The SLB primary-to-secondary pressure differential applied in the analysis is 2560 psi. The maximum 2R20 leak rate of 0.0587 gpm and the maximum conditional burst probability of 1.57×10^{-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 21 Operational Assessment Leak Rate and Tube Burst Probability

The SLB leak rate and tube burst probability projection for the Cycle 21 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-21 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-21 projections, considering a 525 EFPD operation cycle and using POD = 0.6 are shown in Table 7-2. Both the maximum projected EOC-21 leak rate of 0.166 gpm and the maximum conditional burst probability of 2.43×10^{-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 21.

Table 7-1 Condition Monitoring Leak and Burst Results for 2R20								
	OA Performed at EOC-19		EOC-20 Actual		OA Performed at EOC-19		EOC-20 Actual	
SG	Predicted Number of Indications at EOC-20	Predicted Max. Voltage	Actual Number of Indications at EOC-20	Actual Max. Voltage	Predicted SLB Leak Rate at 95/95 (gpm)	Predicted Probability of Burst at 95% Confidence	Actual SLB Leak Rate at 95/95 (gpm)	Actual Probability of Burst at 95% Confidence
A	526	2.0	348	1.46	0.149	2.31×10^{-5}	0.0283	6.30×10^{-6}
B	725	2.0	449	1.40	0.220	2.67×10^{-5}	0.0587	9.16×10^{-6}
C	571	1.9	364	1.44	0.158	2.31×10^{-5}	0.0526	1.57×10^{-5}

Table 7-2 Operational Assessment Leak and Burst Results for EOC-21 (POD = 0.6)					
SG	Growth Rate Used in Projection	Number of Indications at EOC-21	Maximum Volts at EOC-21	SLB Leak Rate at 95/95 (gpm)	Probability of Burst at 95% Confidence
SG-A	Cycle 20 Bound	580	1.9	0.096	1.44×10^{-5}
SG-B	Cycle 20 Bound	748	1.9	0.166	1.82×10^{-5}
SG-C	Cycle 20 Bound	607	2.0	0.153	2.43×10^{-5}

Note: The growth rate used for the OA of each SG bounds both Cycles 19 and 20 growth rates.

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-17-21, Rev. 0, "Beaver Valley Unit 2 End-of-Cycle 19 Analysis and Prediction for End-of-Cycle 20 Voltage-Based Repair Criteria 90-Day Report," July 2017.

3. Westinghouse Report 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.

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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. (Attached in EDMS)

12. Beaver Valley Power Station Unit 2, Updated Final Safety Analysis Report, Revision 23.

13. FENOC Procedure ISIE1-8, Revision 18, "Beaver Valley Power Station Unit 2 Steam Generator Examination Guidelines," October 8, 2018. (Attached in EDMS)

14. *Steam Generator Management Program: Pressurized Water Reactor Steam Generator Examination Guidelines, Revision 8*. EPRI, Palo Alto, CA: 2016. 3002007572.

APPENDIX A

Table A-1 SG-A 2R20 DSI Indications

SG	Row	Col	Locn	2R20 Volts	Comment
2A	2	24	07H	0.32	
2A	2	88	02H	0.21	
2A	3	15	03H	0.31	
2A	3	59	02H	0.46	
2A	3	65	07H	0.72	
2A	3	77	08H	0.43	SAI
2A	3	79	07H	0.44	
2A	3	81	03H	0.56	
2A	3	84	03H	0.5	
2A	3	85	04H	0.66	
2A	3	92	02H	0.19	
2A	4	9	03H	0.9	
2A	4	9	04H	0.2	
2A	4	18	05H	0.34	
2A	4	21	03H	0.35	
2A	4	24	02H	0.25	
2A	4	26	02H	0.23	
2A	4	28	03H	0.54	
2A	4	34	03H	0.4	
2A	4	39	02H	0.06	
2A	4	50	02H	0.28	
2A	4	50	03H	0.7	
2A	4	50	04H	0.39	
2A	4	54	02H	0.3	
2A	4	54	04H	0.31	
2A	4	54	05H	0.37	
2A	4	60	02H	0.26	
2A	4	60	06H	0.32	
2A	4	63	02H	0.34	
2A	4	70	03H	0.18	
2A	4	78	05H	0.22	
2A	4	85	08C	0.11	
2A	4	86	03H	0.19	
2A	5	10	02H	0.72	
2A	5	10	03H	0.85	
2A	5	10	04H	0.46	

SG	Row	Col	Locn	2R20 Volts	Comment
2A	5	11	04H	0.31	
2A	5	18	06H	0.51	SAI
2A	5	25	05H	0.56	
2A	5	26	02H	0.51	
2A	5	26	03H	0.32	
2A	5	28	04H	1.46	NDF
2A	5	29	02H	1.18	SAI
2A	5	30	03H	0.15	
2A	5	53	02H	0.57	
2A	5	80	05H	0.17	
2A	5	82	03H	0.27	
2A	6	15	02H	0.34	
2A	6	20	04H	0.36	
2A	6	27	06H	0.24	
2A	6	32	02H	0.21	
2A	6	34	02H	0.56	
2A	6	35	02H	1.14	SAI
2A	6	35	03H	0.31	
2A	6	35	05H	0.47	
2A	6	35	08H	0.42	NDF
2A	6	40	03H	0.26	
2A	6	40	04H	0.29	
2A	6	41	08H	0.25	SAI
2A	6	43	02H	0.3	
2A	7	14	03H	0.23	
2A	7	18	02H	0.26	
2A	7	18	03H	0.35	
2A	7	18	05H	0.34	
2A	7	19	02H	0.46	
2A	7	19	03H	0.44	
2A	7	27	05H	0.42	
2A	7	49	02H	0.17	
2A	7	51	02H	0.2	
2A	7	51	05H	0.53	
2A	7	94	02H	0.2	
2A	8	19	02H	0.39	
2A	8	28	02H	0.26	
2A	8	29	02H	0.26	
2A	8	32	03H	0.33	

SG	Row	Col	Locn	2R20 Volts	Comment
2A	8	32	05H	0.34	SAI
2A	8	34	03H	0.88	
2A	8	42	02H	0.15	
2A	8	67	02H	0.25	
2A	8	69	02H	0.26	
2A	8	76	05H	0.18	
2A	8	85	02H	0.07	
2A	8	91	04H	0.28	
2A	9	10	02H	0.91	
2A	9	13	02H	0.27	
2A	9	14	03H	0.13	
2A	9	16	02H	0.41	
2A	9	16	03H	0.42	
2A	9	16	04H	0.44	
2A	9	18	05H	0.3	
2A	9	34	02H	0.27	SAI
2A	9	35	02H	0.35	
2A	9	38	05H	0.6	
2A	9	40	03H	0.35	
2A	9	51	04H	0.52	SAI
2A	9	56	02H	0.2	
2A	9	56	04H	0.23	
2A	9	57	02H	0.74	
2A	9	57	03H	0.31	
2A	9	74	03H	0.21	
2A	10	7	02H	0.38	
2A	10	7	03H	0.32	
2A	10	8	03H	0.26	
2A	10	19	04H	0.25	
2A	10	26	04H	0.12	
2A	10	34	04H	0.77	SAI
2A	10	37	03H	0.1	
2A	10	58	04H	0.17	
2A	11	2	03H	0.68	
2A	11	48	02H	0.69	
2A	11	48	08H	0.35	
2A	11	77	05H	0.39	
2A	11	78	05H	0.15	
2A	11	78	06H	0.21	

SG	Row	Col	Locn	2R20 Volts	Comment
2A	12	16	02H	0.47	SAI
2A	12	34	02H	0.26	
2A	12	48	05H	0.28	
2A	12	69	02H	0.33	
2A	12	69	03H	0.23	
2A	12	70	03H	0.28	
2A	12	72	02H	0.31	
2A	12	73	05H	0.16	
2A	12	74	02H	0.32	
2A	12	74	03H	0.51	
2A	12	80	05H	0.13	
2A	13	32	02H	0.1	
2A	13	39	05H	0.39	
2A	13	49	04H	0.17	
2A	13	60	02H	0.37	
2A	13	65	06C	0.13	
2A	13	67	06C	0.24	
2A	13	71	04H	0.17	
2A	13	80	03H	0.45	
2A	13	84	02H	0.39	
2A	13	85	02H	0.33	
2A	13	86	03H	0.25	
2A	13	91	05H	0.79	
2A	13	92	04H	0.5	
2A	14	15	04H	0.26	
2A	14	20	03H	0.25	NDF
2A	14	25	05H	0.18	
2A	14	27	05H	0.45	
2A	14	31	02H	0.1	
2A	14	40	05H	0.2	SAI
2A	14	48	05H	0.39	
2A	14	50	03H	0.21	
2A	14	53	02H	0.11	
2A	14	54	02H	0.25	
2A	14	58	02H	0.31	
2A	14	59	02H	0.09	
2A	14	59	03H	0.2	
2A	14	59	06H	0.42	
2A	14	65	03H	0.36	

SG	Row	Col	Locn	2R20 Volts	Comment
2A	14	68	02H	0.31	
2A	14	70	02H	0.34	
2A	14	70	03H	0.75	
2A	14	72	06H	0.1	
2A	14	80	03H	0.2	
2A	14	86	04H	0.28	
2A	15	27	05H	0.17	
2A	15	31	04H	0.3	SAI
2A	15	63	02H	0.12	
2A	15	67	02H	0.27	
2A	15	71	02H	0.11	
2A	15	72	02H	0.15	
2A	15	73	03H	0.57	
2A	15	73	05H	0.17	
2A	15	74	03H	1.04	NDF
2A	15	75	02H	0.63	
2A	15	75	08H	0.39	SAI
2A	16	11	05H	0.23	SAI
2A	16	50	05C	0.22	
2A	16	52	02H	0.55	
2A	16	53	03H	0.17	
2A	16	60	02H	0.13	
2A	16	62	08H	0.06	
2A	16	66	03H	0.16	
2A	16	70	03H	0.31	
2A	16	72	02H	0.11	
2A	16	76	02H	0.32	
2A	16	77	05H	0.2	
2A	17	10	03H	0.33	
2A	17	27	04H	0.12	
2A	17	32	05H	0.25	
2A	17	46	02H	0.54	
2A	17	59	02H	0.26	
2A	17	59	05H	0.22	
2A	17	81	03H	0.1	
2A	17	81	04H	0.17	
2A	17	84	03H	0.11	
2A	18	7	04H	0.25	
2A	18	10	03H	0.6	

SG	Row	Col	Locn	2R20 Volts	Comment
2A	18	10	04H	0.21	
2A	18	27	07H	0.13	
2A	18	30	04H	0.08	
2A	18	47	02H	0.24	
2A	18	47	05H	0.38	
2A	18	57	02H	0.45	
2A	18	58	02H	0.56	
2A	18	88	05H	0.11	
2A	19	7	02H	0.35	
2A	19	7	03H	0.31	SAI
2A	19	8	03H	0.22	
2A	19	15	03H	0.21	
2A	19	15	04H	0.19	
2A	19	56	03H	0.47	
2A	19	57	02H	0.44	
2A	19	57	04H	0.18	
2A	19	60	02H	0.15	
2A	20	7	08C	0.09	
2A	20	9	03H	0.18	
2A	20	10	04H	0.2	
2A	20	12	02H	0.1	
2A	20	22	02H	0.3	
2A	20	22	03H	0.18	
2A	20	22	08H	0.22	
2A	20	57	02H	0.13	
2A	20	62	05H	0.4	
2A	20	72	07C	0.22	NDF
2A	20	75	05H	0.35	
2A	20	78	04H	0.14	
2A	20	85	03H	0.29	
2A	21	18	04H	0.41	
2A	21	25	03H	0.19	
2A	21	26	05H	0.35	
2A	21	34	02H	0.41	
2A	21	43	02H	0.28	
2A	21	46	02H	0.17	
2A	21	55	02H	0.05	
2A	21	61	08H	0.14	
2A	21	72	03H	0.3	

SG	Row	Col	Locn	2R20 Volts	Comment
2A	21	73	03H	0.9	
2A	21	78	08H	0.14	
2A	21	87	08C	0.11	
2A	22	7	02H	0.2	
2A	22	21	02H	0.12	
2A	22	21	03H	0.39	
2A	22	23	02H	0.25	
2A	22	24	02H	0.27	
2A	22	25	02H	0.17	
2A	23	11	02H	0.39	
2A	23	11	03H	0.15	
2A	23	19	02H	0.67	
2A	23	20	02H	0.22	
2A	23	21	03H	0.2	
2A	23	52	03H	0.29	
2A	23	53	02H	0.2	SAI
2A	23	87	04H	0.33	
2A	24	16	02H	0.39	
2A	24	16	03H	0.15	
2A	24	23	05H	0.83	
2A	24	24	02H	0.11	
2A	24	33	03H	0.21	
2A	24	39	02H	0.22	
2A	24	52	02H	0.2	
2A	24	63	05H	0.42	
2A	24	80	03H	0.19	
2A	25	21	02H	0.06	
2A	25	22	02H	0.42	
2A	25	30	04H	0.32	
2A	25	30	06H	0.1	
2A	25	50	08H	0.14	
2A	26	15	03H	0.17	
2A	26	19	04H	0.14	
2A	26	42	02H	0.33	
2A	26	80	05H	0.11	
2A	27	32	02H	0.21	
2A	27	33	03H	0.43	
2A	27	34	04H	0.21	
2A	27	42	04H	0.2	SAI

SG	Row	Col	Locn	2R20 Volts	Comment
2A	27	42	05H	0.27	
2A	27	47	02H	0.28	
2A	27	64	02H	0.22	
2A	27	75	05H	0.28	
2A	28	13	03H	0.33	
2A	28	26	04H	0.26	
2A	28	41	02H	0.2	
2A	28	45	02H	0.26	
2A	28	46	03H	0.1	
2A	28	54	02H	0.17	
2A	28	56	03H	0.6	
2A	28	66	04H	0.15	SAI
2A	29	24	02H	0.19	
2A	29	24	04H	0.14	
2A	29	30	05H	0.32	
2A	29	54	03H	0.21	SAI
2A	29	65	02H	0.1	
2A	30	22	02H	0.21	
2A	30	28	03H	0.23	
2A	30	38	02H	0.2	
2A	30	51	08C	0.24	
2A	30	58	04H	0.09	
2A	30	63	08H	0.17	
2A	30	68	02H	0.24	
2A	31	14	04H	0.31	
2A	31	18	02H	0.63	
2A	31	18	03H	0.31	
2A	31	74	02H	0.39	SAI
2A	32	22	02H	0.16	
2A	32	27	03H	0.56	
2A	32	35	06H	0.1	
2A	32	38	02H	0.16	
2A	32	38	03H	0.25	
2A	32	45	02H	0.39	
2A	32	51	05H	0.16	
2A	32	53	03H	0.21	
2A	33	18	02H	0.13	
2A	33	18	03H	0.29	
2A	33	22	02H	0.23	

SG	Row	Col	Locn	2R20 Volts	Comment
2A	33	27	06H	0.26	
2A	33	42	05H	0.25	
2A	33	45	07H	0.21	
2A	33	54	06H	0.23	
2A	33	57	04H	0.25	
2A	33	66	02H	0.3	
2A	34	24	03H	0.11	
2A	34	40	03H	0.21	
2A	34	52	02H	0.3	
2A	34	53	02H	0.26	
2A	34	56	05H	0.28	
2A	35	45	02H	0.8	
2A	36	28	03H	0.38	
2A	36	28	04H	0.1	
2A	36	44	03H	0.27	
2A	36	46	06H	0.19	
2A	37	30	08H	0.16	
2A	37	39	02H	0.18	
2A	37	39	03H	0.2	
2A	37	42	03H	0.28	
2A	37	54	05H	0.13	
2A	37	56	02H	0.15	
2A	37	56	03H	0.38	
2A	38	40	05H	0.32	
2A	38	44	02H	0.19	
2A	39	23	02H	0.98	
2A	39	42	02H	0.38	
2A	39	46	02H	0.34	
2A	39	47	02H	0.27	
2A	40	29	02H	0.11	
2A	40	37	03H	0.99	
2A	40	44	06C	0.13	
2A	41	27	03H	0.11	
2A	42	64	04H	0.26	
2A	44	35	03H	0.18	
2A	44	40	05C	0.18	
2A	44	58	06H	0.14	
2A	46	52	06H	0.23	

Table A-2 SG-B 2R20 DSI Indications

SG	Row	Col	Locn	2R20 Volts	Comment
2B	1	43	02H	0.4	
2B	1	52	02H	0.26	
2B	1	56	02H	0.22	
2B	1	57	04H	0.23	
2B	2	15	03H	0.68	SAI
2B	2	24	02H	0.26	Plugged
2B	2	28	02H	0.26	
2B	2	54	04H	0.12	
2B	2	63	04H	0.15	
2B	2	65	03H	0.27	
2B	2	67	06H	0.54	
2B	2	70	05H	0.74	
2B	2	73	03H	0.38	
2B	2	73	04H	0.18	
2B	2	94	04H	0.39	
2B	3	31	02H	0.63	
2B	3	32	03H	0.19	
2B	3	54	02H	0.56	
2B	3	55	02H	0.78	
2B	3	58	03H	0.28	
2B	3	60	02H	0.46	
2B	3	60	03H	0.49	
2B	3	61	06H	0.61	
2B	3	62	03H	0.4	
2B	3	62	04H	0.18	
2B	3	63	02H	0.47	
2B	3	63	03H	0.45	
2B	3	72	03H	0.41	
2B	3	88	04H	0.43	
2B	3	89	04H	0.41	
2B	4	23	02H	0.29	
2B	4	23	06H	0.31	
2B	4	32	03H	0.22	
2B	4	36	04H	0.48	SAI
2B	4	41	04H	0.17	
2B	4	43	02H	0.12	
2B	4	44	02H	0.24	

SG	Row	Col	Locn	2R20 Volts	Comment
2B	4	48	03H	0.72	NDF
2B	4	52	03H	0.81	
2B	4	54	02H	0.81	
2B	4	56	04H	0.4	
2B	4	57	02H	0.28	
2B	4	57	04H	0.24	
2B	4	58	02H	0.47	
2B	4	59	02H	0.25	
2B	4	59	03H	0.23	
2B	4	62	03H	0.21	
2B	4	62	07H	0.32	
2B	4	63	04H	0.26	
2B	5	10	02H	0.41	
2B	5	12	03H	0.17	
2B	5	14	03H	0.45	
2B	5	20	03H	0.43	
2B	5	22	04H	0.72	
2B	5	28	02H	0.42	
2B	5	52	02H	0.94	
2B	5	54	02H	0.51	
2B	5	54	03H	0.27	
2B	5	54	07C	0.54	
2B	5	56	03H	0.95	
2B	5	58	02H	0.28	
2B	5	60	02H	0.42	
2B	5	62	03H	0.28	
2B	5	63	04H	0.17	
2B	5	64	02H	0.33	
2B	5	64	03H	0.18	
2B	5	68	02H	0.29	
2B	5	71	02H	0.47	
2B	5	71	06C	0.33	
2B	5	73	02H	0.32	
2B	5	73	04H	0.16	
2B	5	75	03H	0.21	
2B	5	75	04H	0.25	
2B	5	81	05H	0.13	
2B	5	92	02H	0.24	
2B	5	93	03H	0.31	

SG	Row	Col	Locn	2R20 Volts	Comment
2B	6	16	03H	0.18	
2B	6	23	04H	0.23	
2B	6	26	02H	0.18	
2B	6	27	03H	0.25	SAI
2B	6	52	02H	0.16	
2B	6	53	02H	0.52	
2B	6	53	03H	0.41	
2B	6	58	02H	0.56	
2B	6	58	03H	0.24	
2B	6	61	08H	0.13	
2B	6	63	02H	0.19	
2B	6	66	03H	0.72	
2B	6	70	05H	0.75	
2B	7	52	02H	0.66	
2B	7	54	02H	0.38	
2B	7	56	02H	1.21	NDF
2B	7	56	06C	0.55	
2B	7	63	07H	0.27	
2B	7	70	04H	0.45	
2B	7	70	05H	0.28	
2B	7	75	02H	0.16	
2B	8	2	03H	0.4	
2B	8	9	02H	0.21	
2B	8	9	03H	0.22	
2B	8	18	02H	0.24	
2B	8	18	03H	0.31	
2B	8	20	02H	0.35	
2B	8	22	02H	0.38	
2B	8	37	03H	0.27	
2B	8	53	02H	0.47	
2B	8	56	03H	0.49	
2B	8	57	08H	0.19	
2B	8	59	02H	0.16	
2B	8	59	05H	0.15	
2B	8	63	04H	0.34	
2B	9	4	03H	0.45	SAI
2B	9	5	03H	0.16	
2B	9	8	03H	0.2	
2B	9	11	02H	0.42	

SG	Row	Col	Locn	2R20 Volts	Comment
2B	9	11	03H	0.46	
2B	9	16	03H	0.1	
2B	9	17	02H	0.41	
2B	9	17	03H	0.31	
2B	9	18	02H	0.59	
2B	9	18	03H	0.53	
2B	9	26	02H	0.27	
2B	9	26	03H	0.62	
2B	9	52	02H	0.18	
2B	9	52	03H	0.3	
2B	9	59	03H	0.68	
2B	9	59	05H	0.32	
2B	9	61	07C	0.49	
2B	9	64	04H	0.41	SAI
2B	9	70	03H	0.15	
2B	9	70	05H	0.5	
2B	9	72	04H	0.32	
2B	9	77	04H	0.19	
2B	9	80	02H	0.95	
2B	9	85	02H	1.03	NDF
2B	9	92	02H	0.33	
2B	9	93	02H	0.48	
2B	10	6	02H	0.49	
2B	10	10	02H	0.02	
2B	10	14	02H	0.35	
2B	10	15	02H	0.35	
2B	10	17	02H	0.81	
2B	10	18	02H	0.24	
2B	10	26	02H	0.25	
2B	10	37	03H	0.25	
2B	10	41	07H	0.12	
2B	10	50	02H	0.28	
2B	10	50	03H	0.17	
2B	10	50	04H	0.17	
2B	10	52	02H	1.27	NDF
2B	10	52	04H	0.47	
2B	10	53	02H	0.43	
2B	10	54	02H	0.1	
2B	10	56	02H	0.39	

SG	Row	Col	Locn	2R20 Volts	Comment
2B	10	58	05H	0.13	
2B	10	63	02H	0.57	
2B	10	71	05H	0.68	
2B	10	76	03H	0.27	SAI
2B	10	78	04H	0.3	
2B	10	80	03H	0.2	
2B	10	82	03H	0.21	
2B	10	88	04C	0.12	
2B	10	89	02H	0.3	
2B	11	8	03H	0.22	
2B	11	8	04H	0.16	
2B	11	9	06H	0.08	
2B	11	9	07H	0.61	NDF
2B	11	18	02H	0.45	
2B	11	20	02H	0.56	
2B	11	21	03H	0.33	
2B	11	25	03H	0.33	SAI
2B	11	35	02H	0.04	
2B	11	42	03H	0.09	
2B	11	51	02H	0.08	
2B	11	53	02H	0.49	
2B	11	53	08C	0.41	
2B	11	57	03H	0.27	
2B	11	58	03H	0.24	
2B	11	58	04H	0.21	
2B	11	61	02H	0.92	
2B	11	61	03H	0.93	
2B	11	64	03H	0.37	
2B	11	75	02H	0.5	
2B	11	75	03H	0.17	
2B	11	83	03H	0.31	
2B	11	83	04H	0.24	
2B	12	10	02H	0.38	
2B	12	15	02H	0.4	
2B	12	15	03H	0.57	
2B	12	16	03H	0.26	
2B	12	22	02H	0.54	
2B	12	24	02H	0.5	
2B	12	24	04H	0.29	

SG	Row	Col	Locn	2R20 Volts	Comment
2B	12	51	02H	0.12	
2B	12	52	02H	0.55	
2B	12	52	03H	0.57	
2B	12	61	03H	0.66	
2B	13	37	03H	0.3	
2B	13	39	07H	0.12	
2B	13	47	02H	0.19	SAI
2B	13	53	02H	0.64	
2B	13	56	03H	0.23	
2B	13	56	03H	0.23	
2B	13	71	05C	0.24	
2B	13	73	02H	0.22	
2B	13	77	03H	0.38	
2B	13	78	02H	0.12	
2B	13	85	02H	0.33	
2B	13	86	02H	0.18	
2B	13	91	02H	0.45	
2B	14	13	02H	0.29	
2B	14	15	03H	0.35	
2B	14	18	02H	0.35	
2B	14	25	02H	0.47	
2B	14	27	03H	0.18	
2B	14	28	05H	0.14	
2B	14	32	02H	0.35	
2B	14	35	06H	0.19	
2B	14	36	03H	0.29	
2B	14	39	02H	0.04	
2B	14	54	02H	0.73	
2B	14	54	03H	0.43	
2B	14	57	02H	0.6	
2B	14	57	03H	0.36	
2B	14	61	02H	0.41	
2B	14	61	03H	0.56	
2B	14	61	05H	0.37	
2B	14	63	03H	0.3	
2B	14	70	02H	0.54	
2B	14	83	03C	0.24	
2B	14	84	04H	0.17	
2B	14	88	02H	0.16	

SG	Row	Col	Locn	2R20 Volts	Comment
2B	15	12	03H	0.28	
2B	15	26	03H	0.38	
2B	15	26	07H	0.11	
2B	15	27	02H	0.12	
2B	15	36	02H	0.23	
2B	15	52	02H	0.37	
2B	15	71	05H	0.18	
2B	15	75	02H	0.07	
2B	15	75	04H	0.18	
2B	15	80	04H	0.41	
2B	15	87	02H	0.11	
2B	15	89	02H	0.46	
2B	16	27	03H	0.32	
2B	16	29	02H	0.15	SAI
2B	16	31	02H	0.32	
2B	16	31	07H	0.22	
2B	16	36	04H	0.14	
2B	16	37	02H	0.22	
2B	16	37	04H	0.26	SAI
2B	16	44	02H	0.26	
2B	16	55	05H	0.26	
2B	16	61	02H	0.28	
2B	16	71	02H	0.17	
2B	17	35	03H	0.53	
2B	17	42	03H	0.61	
2B	17	42	04H	0.51	
2B	17	44	02H	0.28	SAI
2B	17	62	05H	0.45	
2B	17	64	02H	0.1	
2B	17	68	02H	0.32	
2B	17	68	03H	0.41	
2B	17	68	04H	1.07	SAI
2B	17	83	06C	0.19	
2B	18	12	03H	0.19	
2B	18	18	02H	0.25	
2B	18	28	04H	0.43	
2B	18	29	02H	0.48	
2B	18	30	04H	0.23	
2B	18	36	03H	0.89	

SG	Row	Col	Locn	2R20 Volts	Comment
2B	18	37	03H	0.2	
2B	18	38	03H	0.33	
2B	18	42	02H	0.36	
2B	18	53	03H	0.31	
2B	18	53	04H	0.33	
2B	18	54	02H	0.6	
2B	18	57	03H	0.12	
2B	18	58	02H	0.42	
2B	18	61	03H	0.17	
2B	18	64	03H	0.54	
2B	18	69	04H	0.1	
2B	18	69	05H	0.24	
2B	18	76	03H	0.27	
2B	19	15	02H	0.14	
2B	19	15	04H	0.13	
2B	19	29	02H	0.71	
2B	19	29	03H	0.98	
2B	19	36	02H	0.5	
2B	19	39	03H	0.55	
2B	19	39	04H	0.21	
2B	19	40	03H	0.44	
2B	19	45	02H	0.32	
2B	19	50	03H	0.45	
2B	19	51	02H	0.77	
2B	19	51	03H	0.46	
2B	19	69	02H	0.65	
2B	19	71	05H	0.24	
2B	19	74	02H	0.26	
2B	19	76	02H	0.18	
2B	19	78	02H	0.11	
2B	19	85	02H	0.19	
2B	20	11	02H	1.02	NDF
2B	20	16	03H	0.33	
2B	20	19	04H	0.09	
2B	20	20	04H	0.27	
2B	20	23	02H	0.19	SAI
2B	20	70	02H	0.16	
2B	20	81	02H	0.42	
2B	20	89	02H	0.43	

SG	Row	Col	Locn	2R20 Volts	Comment
2B	21	45	04H	0.22	
2B	21	53	03H	0.39	
2B	21	53	05H	0.22	
2B	21	54	02H	1.4	NDF
2B	21	75	02H	0.22	
2B	22	18	03H	0.96	SAI
2B	22	36	03H	0.18	
2B	22	52	02H	0.12	
2B	22	52	03H	0.23	
2B	22	53	02H	0.17	
2B	22	61	05H	0.19	
2B	22	62	03H	0.33	
2B	22	64	02H	0.26	
2B	23	33	03H	0.24	
2B	23	37	04H	0.68	SAI
2B	23	56	02H	0.32	
2B	23	61	02H	0.24	
2B	23	63	03H	0.2	
2B	23	63	05H	0.15	
2B	23	67	05H	0.28	
2B	23	86	02H	0.27	
2B	24	29	05H	0.21	
2B	24	30	03H	0.22	
2B	24	32	03H	0.18	
2B	24	42	02H	0.32	
2B	24	51	08H	0.12	
2B	24	52	02H	0.34	
2B	24	56	02H	0.16	
2B	24	58	03H	0.27	
2B	24	62	03H	0.51	
2B	24	63	03H	0.55	
2B	24	65	02H	0.1	
2B	24	68	08H	0.14	
2B	24	71	05H	0.21	
2B	24	84	05H	0.32	
2B	25	17	02H	0.1	
2B	25	24	03H	0.56	
2B	25	29	02H	0.18	
2B	25	64	06H	0.33	

SG	Row	Col	Locn	2R20 Volts	Comment
2B	25	79	08H	0.51	
2B	26	30	03H	0.56	
2B	26	39	03H	0.08	
2B	26	78	02H	0.17	
2B	27	17	05H	0.12	
2B	27	46	06H	0.17	
2B	27	52	04H	0.36	
2B	27	53	03H	0.22	
2B	27	68	02H	0.13	
2B	28	41	02H	0.18	
2B	28	59	04H	0.39	
2B	28	63	03H	0.23	
2B	28	67	03H	0.28	
2B	28	81	02H	0.13	
2B	29	20	03H	0.37	
2B	29	27	03H	0.46	
2B	29	31	05H	0.22	
2B	29	32	03H	0.12	
2B	29	32	05H	0.27	
2B	29	34	03H	0.33	
2B	29	35	04H	0.31	SAI
2B	29	37	03H	0.55	
2B	29	38	02H	0.49	MAI
2B	29	40	03H	0.73	
2B	29	41	02H	0.23	
2B	29	56	02H	1.19	NDF
2B	30	16	04H	0.15	
2B	30	16	07H	0.11	
2B	30	20	04H	0.21	
2B	30	27	02H	0.27	
2B	30	32	03H	0.23	
2B	30	50	04H	0.6	
2B	30	55	03H	0.44	
2B	30	56	04H	0.52	
2B	30	59	04H	0.17	
2B	30	78	02H	0.15	
2B	30	78	04H	0.22	
2B	30	79	02H	0.23	
2B	30	81	03H	0.21	

SG	Row	Col	Locn	2R20 Volts	Comment
2B	31	21	07H	0.58	
2B	31	23	02H	0.84	
2B	31	32	03H	0.56	
2B	31	32	05H	0.43	
2B	31	37	03H	0.35	
2B	31	39	02H	0.14	
2B	31	39	03H	0.42	
2B	31	48	02H	0.87	
2B	31	52	02H	0.58	
2B	31	64	02H	0.11	
2B	31	71	05H	0.15	
2B	31	75	04H	0.16	
2B	31	76	02H	0.31	
2B	31	78	02H	0.33	
2B	31	78	03H	1.04	NDF
2B	32	16	08H	0.17	
2B	32	29	05H	0.22	
2B	32	31	02H	0.16	SAI
2B	32	53	02H	0.61	
2B	32	55	02H	0.32	
2B	32	55	05H	0.19	
2B	32	61	02H	0.22	
2B	32	61	05H	0.41	
2B	32	77	02H	0.4	
2B	33	31	07H	0.24	
2B	33	32	02H	0.29	
2B	33	37	04H	0.28	
2B	33	44	02H	0.28	
2B	33	60	03H	0.1	
2B	33	62	02H	0.63	
2B	33	73	07H	0.43	
2B	34	18	08H	0.21	
2B	34	32	02H	0.3	
2B	34	35	03H	0.15	
2B	34	37	03H	0.27	
2B	34	48	02H	0.56	SAI
2B	34	48	03H	0.33	
2B	34	48	04H	0.18	
2B	34	51	02H	0.78	

SG	Row	Col	Locn	2R20 Volts	Comment
2B	34	51	03H	0.36	
2B	34	57	02H	0.26	
2B	35	40	02H	0.13	
2B	36	25	05H	0.15	
2B	36	42	03H	0.15	
2B	36	58	05H	0.19	
2B	36	64	02H	0.04	
2B	37	24	05H	0.21	
2B	37	32	03H	0.87	
2B	37	57	02H	0.24	
2B	37	57	05H	0.1	
2B	38	35	02H	0.17	
2B	38	63	03H	0.13	
2B	39	31	05H	0.12	
2B	39	33	03H	0.21	
2B	40	31	05H	0.12	
2B	40	42	02H	0.56	
2B	41	31	05H	0.3	
2B	41	52	08C	0.22	
2B	41	68	04H	0.35	
2B	42	51	04H	0.11	
2B	44	48	02H	0.33	

Table A-3 SG-C 2R20 DSI Indications

SG	Row	Col	Locn	2R20 Volts	Comment
2C	1	23	07C	0.34	
2C	2	78	03H	0.41	
2C	2	80	03H	0.19	
2C	2	85	03H	0.39	
2C	3	8	04H	0.41	
2C	3	9	04H	0.1	
2C	3	9	06H	0.12	
2C	3	12	07H	0.26	
2C	3	18	03H	0.24	
2C	3	35	05H	0.24	
2C	3	39	04H	0.18	
2C	3	39	07H	0.45	
2C	3	45	02H	0.38	
2C	3	58	02H	0.51	
2C	3	60	02H	0.4	
2C	3	60	03H	0.48	
2C	3	64	02H	0.21	
2C	3	64	03H	0.67	
2C	3	80	02H	0.31	
2C	3	90	06H	0.33	
2C	3	93	04H	0.36	
2C	3	94	04H	0.25	
2C	4	3	04H	0.13	
2C	4	11	02H	0.21	
2C	4	26	03H	0.75	
2C	4	28	06H	0.4	
2C	4	33	02H	0.44	
2C	4	33	04H	0.35	
2C	4	39	07H	0.51	SAI
2C	4	48	02H	0.22	
2C	4	49	03H	0.43	
2C	4	69	03H	0.29	
2C	4	76	03H	0.44	
2C	5	6	03H	0.3	
2C	5	6	04H	0.11	
2C	5	7	02H	0.23	
2C	5	7	03H	0.9	

SG	Row	Col	Locn	2R20 Volts	Comment
2C	5	15	03H	0.27	
2C	5	18	02H	0.28	
2C	5	19	02H	0.44	
2C	5	19	03H	0.23	
2C	5	29	03H	0.27	
2C	5	61	02H	0.43	
2C	5	62	02H	0.24	
2C	5	66	03H	0.35	
2C	5	70	05C	0.51	
2C	5	71	02H	0.44	
2C	5	76	03H	0.38	
2C	5	86	08H	0.85	
2C	5	89	02H	0.58	
2C	6	23	02H	0.14	
2C	6	30	02H	0.3	
2C	6	30	03H	0.31	
2C	6	54	03H	0.69	
2C	6	55	02H	0.42	
2C	6	63	02H	0.67	
2C	6	78	03H	1.03	NDF
2C	6	84	03H	0.46	
2C	6	92	04H	0.23	
2C	7	12	08C	0.43	SAI
2C	7	40	03H	0.4	
2C	7	40	04H	0.37	
2C	7	49	02H	0.38	
2C	7	49	03H	0.23	
2C	7	58	02H	0.5	
2C	7	67	02H	0.33	
2C	7	80	03H	0.18	
2C	8	2	08H	0.28	
2C	8	23	02H	0.71	
2C	8	24	02H	0.41	
2C	8	43	03H	0.29	
2C	8	63	06H	0.21	
2C	8	72	03H	0.3	
2C	8	84	03H	0.28	
2C	9	13	03H	0.09	
2C	9	20	04H	0.49	

SG	Row	Col	Locn	2R20 Volts	Comment
2C	9	26	03H	0.3	NDF
2C	9	30	02H	0.38	
2C	9	32	02H	0.69	
2C	9	35	02H	0.53	
2C	9	37	02H	0.44	
2C	9	38	03H	0.29	
2C	9	39	05H	0.27	
2C	9	41	02H	0.45	
2C	9	44	03H	0.17	
2C	9	45	05H	0.39	
2C	9	45	06H	0.26	
2C	9	47	02H	0.42	
2C	9	54	02H	0.96	
2C	9	54	04H	0.35	
2C	9	65	06H	0.29	
2C	9	74	04H	0.2	
2C	10	8	02H	0.76	
2C	10	9	03H	0.28	
2C	10	10	02H	0.48	
2C	10	10	03H	0.19	
2C	10	18	04H	0.14	
2C	10	24	03H	0.24	
2C	10	36	02H	0.36	
2C	10	37	02H	0.54	
2C	10	38	07H	0.44	
2C	10	43	02H	0.17	
2C	10	44	02H	0.33	
2C	10	51	02H	0.66	
2C	10	51	05H	0.23	
2C	10	54	02H	0.67	NDF
2C	10	54	03H	0.44	NDF
2C	10	72	02H	0.47	
2C	10	72	03H	0.51	
2C	10	76	04H	0.2	
2C	10	78	03H	0.13	
2C	11	7	02H	0.32	
2C	11	9	03H	0.61	
2C	11	17	02H	0.31	
2C	11	36	02H	0.46	

SG	Row	Col	Locn	2R20 Volts	Comment
2C	11	49	02H	0.5	
2C	11	62	03H	0.45	
2C	11	70	03H	0.35	
2C	11	72	03H	0.38	
2C	11	88	05H	0.51	
2C	12	9	02H	0.22	
2C	12	30	02H	0.57	
2C	12	35	04H	0.2	
2C	12	55	02H	0.43	
2C	12	70	02H	0.44	
2C	12	70	03H	0.22	
2C	12	83	03H	0.17	
2C	13	7	03H	0.31	
2C	13	32	02H	0.09	
2C	13	35	02H	0.85	SAI
2C	13	35	05H	0.33	SAI
2C	13	43	02H	0.19	
2C	13	43	03H	0.42	
2C	13	59	03H	0.4	
2C	13	62	04H	0.21	
2C	13	63	02H	0.12	
2C	13	64	02H	0.38	
2C	14	29	04H	0.16	SAI
2C	14	38	02H	0.27	
2C	14	39	05H	0.22	
2C	14	50	02H	0.6	
2C	14	54	02H	0.43	
2C	14	59	03H	0.11	
2C	14	59	04H	0.2	
2C	14	59	06H	0.1	
2C	14	70	08H	0.19	
2C	15	5	04H	1.44	NDF
2C	15	14	03H	0.23	
2C	15	35	02H	0.16	
2C	15	35	03H	0.35	
2C	15	38	04H	0.32	SAI
2C	15	39	02H	0.69	
2C	15	39	03H	0.48	
2C	15	61	02H	0.1	

SG	Row	Col	Locn	2R20 Volts	Comment
2C	15	62	02H	0.4	
2C	15	80	03H	0.15	
2C	15	87	03H	0.31	
2C	16	15	03H	0.61	
2C	16	17	02H	0.31	
2C	16	46	02H	0.61	
2C	16	46	04H	0.2	
2C	16	55	06H	0.38	
2C	16	57	03H	0.59	
2C	16	63	02H	0.1	
2C	16	73	02H	0.27	
2C	17	9	04H	0.24	SAI
2C	17	14	04H	0.22	
2C	17	17	02H	0.12	
2C	17	18	02H	0.32	
2C	17	24	04H	0.1	
2C	17	26	03H	0.21	
2C	17	35	03H	0.7	SAI
2C	17	38	02H	0.32	
2C	17	48	02H	1	NDF
2C	17	49	02H	0.4	
2C	17	50	03H	0.59	SAI
2C	17	61	02H	0.68	
2C	17	61	03H	0.32	
2C	17	63	02H	0.38	
2C	17	66	02H	0.18	
2C	17	67	02H	0.43	
2C	17	68	02H	0.39	
2C	18	15	06H	0.15	
2C	18	47	03H	0.73	
2C	18	47	04H	0.44	
2C	18	48	02H	0.6	NDF
2C	18	48	03H	0.64	NDF
2C	18	48	04H	0.47	NDF
2C	18	50	02H	0.36	
2C	18	51	02H	0.35	
2C	18	53	02H	0.61	
2C	18	54	02H	0.49	
2C	18	54	03H	0.3	

SG	Row	Col	Locn	2R20 Volts	Comment
2C	18	55	02H	0.39	
2C	18	56	03H	0.42	NDF
2C	18	59	03H	0.33	
2C	18	62	02H	0.44	
2C	18	62	03H	0.59	
2C	18	62	04H	0.16	
2C	18	66	03H	0.46	
2C	18	67	02H	0.36	
2C	18	67	03H	0.6	
2C	18	73	03H	0.28	
2C	19	26	03H	0.3	
2C	19	29	02H	0.42	
2C	19	48	02H	0.7	
2C	19	48	03H	0.69	NDF
2C	19	54	02H	0.21	
2C	19	57	04H	0.36	
2C	19	57	05H	0.45	
2C	19	79	02H	0.88	
2C	20	75	02H	0.51	
2C	20	76	02H	0.7	SAI
2C	20	76	03H	1.17	NDF
2C	20	78	04H	0.33	SAI
2C	20	85	03H	0.26	
2C	21	18	02H	0.51	
2C	21	18	03H	0.46	
2C	21	25	04H	0.09	
2C	21	62	02H	0.34	
2C	21	67	07H	0.28	
2C	22	18	02H	0.51	
2C	22	18	05H	0.21	
2C	22	20	02H	0.69	
2C	22	24	03H	0.22	
2C	22	33	02H	0.27	
2C	22	61	03H	0.3	
2C	22	64	03H	0.25	
2C	22	75	04H	0.3	SAI
2C	22	77	03H	0.19	
2C	23	10	02H	0.2	
2C	23	28	03H	0.54	

SG	Row	Col	Locn	2R20 Volts	Comment
2C	23	37	02H	0.7	
2C	23	39	02H	0.23	
2C	23	39	05H	0.22	
2C	23	42	02H	0.27	
2C	23	42	03H	0.41	
2C	23	69	03H	0.18	
2C	23	77	02H	0.28	
2C	24	11	03H	0.26	
2C	24	34	08H	0.46	
2C	24	48	03H	1.22	NDF
2C	24	50	02H	0.17	
2C	24	56	03H	0.2	
2C	24	57	02H	0.25	
2C	24	61	02H	0.42	
2C	24	63	04H	0.21	
2C	24	79	02H	0.7	
2C	25	17	03H	0.2	
2C	25	26	04H	0.11	
2C	25	31	02H	0.59	
2C	25	33	08H	0.2	
2C	25	34	02H	0.76	
2C	25	34	03H	0.33	
2C	25	34	05H	0.54	
2C	25	47	03H	0.45	
2C	25	47	08H	0.16	
2C	25	54	02H	0.2	
2C	25	60	02H	0.51	
2C	25	61	02H	0.23	
2C	25	61	05H	0.38	
2C	25	62	04H	0.5	NDF
2C	25	65	02H	0.38	
2C	25	65	07H	0.31	SAI
2C	25	71	06H	0.35	
2C	25	74	02H	0.2	SAI
2C	25	76	02H	0.61	
2C	25	76	05H	0.41	
2C	25	79	02H	0.2	
2C	26	24	06H	0.05	
2C	26	38	05H	0.14	

SG	Row	Col	Locn	2R20 Volts	Comment
2C	26	39	05H	0.25	
2C	26	42	02H	0.51	
2C	26	44	06H	0.2	
2C	26	65	03H	0.3	
2C	26	70	03H	1.21	NDF
2C	26	72	08H	0.18	
2C	27	20	02H	0.63	
2C	27	22	02H	0.16	
2C	27	24	04H	0.13	
2C	27	31	02H	0.69	
2C	27	60	02H	0.58	
2C	27	69	02H	0.3	
2C	27	76	03H	0.44	
2C	28	27	05H	0.26	
2C	28	35	02H	0.6	
2C	28	42	02H	0.27	
2C	28	42	04H	0.12	
2C	28	44	02H	0.28	
2C	28	50	03H	0.26	
2C	28	73	03H	0.13	
2C	28	85	02H	0.48	
2C	29	11	05H	0.38	
2C	29	26	05H	0.2	
2C	29	29	03H	0.95	
2C	29	37	02H	0.35	
2C	29	38	05H	0.18	
2C	29	43	03H	0.41	
2C	29	47	02H	0.19	
2C	29	48	05H	0.27	
2C	29	57	05H	0.17	
2C	29	63	05H	0.21	
2C	30	12	03H	0.21	
2C	30	24	02H	0.36	
2C	30	25	04H	0.1	
2C	30	31	03H	0.29	
2C	30	31	04H	0.29	
2C	30	41	02H	0.18	
2C	30	60	02H	0.37	
2C	30	61	02H	0.71	

SG	Row	Col	Locn	2R20 Volts	Comment
2C	30	61	04H	0.43	SAI
2C	30	64	04H	0.47	SAI
2C	31	14	05H	0.09	
2C	31	17	04H	0.12	
2C	31	22	02H	0.21	
2C	31	29	04H	0.67	
2C	31	49	02H	0.19	
2C	31	60	02H	0.38	
2C	31	61	03H	0.24	
2C	31	61	04H	0.21	
2C	31	62	03H	0.5	
2C	31	64	04H	0.54	SAI
2C	31	66	02H	0.48	
2C	31	66	05H	0.28	
2C	31	75	02H	0.3	SAI
2C	31	77	06H	0.15	
2C	31	81	02H	1.3	NDF
2C	31	81	03H	0.45	
2C	32	19	05H	0.25	
2C	32	25	03H	0.23	
2C	32	63	03H	0.3	SAI
2C	32	67	06H	0.23	SAI
2C	33	34	06H	0.23	
2C	33	60	07H	0.29	
2C	34	24	07H	0.11	
2C	34	39	05H	0.18	
2C	34	55	03H	0.38	
2C	34	58	02H	0.52	
2C	34	58	04H	0.33	
2C	34	58	05H	0.27	
2C	34	59	02H	0.53	
2C	35	22	02H	0.15	
2C	35	26	05H	0.77	
2C	35	34	03H	0.17	
2C	35	34	04H	0.19	
2C	35	38	07H	0.12	
2C	35	53	06H	0.2	
2C	36	20	03H	0.6	
2C	36	26	05H	0.64	

SG	Row	Col	Locn	2R20 Volts	Comment
2C	36	27	05H	0.26	
2C	36	53	02H	1.33	SAI
2C	37	26	05H	0.12	
2C	37	35	03H	0.1	
2C	37	52	06H	0.21	
2C	38	42	05H	0.17	
2C	39	27	04H	0.29	
2C	40	25	03H	0.12	
2C	40	39	03H	0.09	
2C	40	53	04H	0.43	
2C	41	27	04H	0.25	
2C	41	44	04H	0.4	
2C	41	50	08H	0.21	
2C	42	32	04H	0.12	
2C	46	41	07H	0.2	

Enclosure B
L-19-034

Unit #2 – 2R20 Steam Generator F* (F Star) Report

(11 Pages Follow)

FIRST ENERGY NUCLEAR OPERATING COMPANY

Technical Services Engineering Department
Nuclear Engineering Programs Section
Beaver Valley Power Station

Subject: Unit #2 - 2R20 Steam Generator F* (F Star) Report

Prepared by: Gary Alberti
Steam Generator Examination Program Owner
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Reviewed by: Sean Padgett
Supervisor, Nuclear Engineering Programs
Date: 1-8-2019

Approved by: Steve Hovanec
Manager, Technical Services Engineering
Date: 1/08/2019

UNIT #2 - 2R20 STEAM GENERATOR F* (F STAR) REPORT

Technical Specification 5.6.6.2.4 requires that a report be submitted to the Nuclear Regulatory Commission (NRC) within 90 days after the initial entry into MODE 4 following an outage in which the F* (F Star) methodology was utilized during steam generator (SG) inspections. For the fall 2018 refueling outage (2R20), the initial entry into MODE 4 occurred on November 12, 2018.

Per Technical Specification 5.6.6.2.4, the following information is to be submitted to the NRC:

(a) Total number of indications, location of each indication, orientation of each indication, severity of each indication, and whether the indications initiated from the inside or outside surface. This information can be found in Tables 2RCS-SG21A, 2RCS-SG21B and 2RCS-SG21C.

(b) The cumulative number of indications detected in the tubesheet region as a function of elevation within the tubesheet. This information can be found in Attachment A: "Unit 2 - Cumulative Listing of Tubesheet Indications (All Outages)".

(c) The projected end-of-cycle accident-induced leakage from tubesheet indications. This information can be found in the right-hand column of Tables 2RCS-SG21A, 2RCS-SG21B and 2RCS-SG21C. It is also explained in Item 4 under Information for All Tables on Page 3.

Discussion:

During 2R20, the Plus Point probe was utilized to inspect the top of tubesheet region in both the hot and cold legs. The 2R20 inspection scope included 100 percent of the inservice hot leg tubes in all three SGs plus a twenty percent random sample of the inservice cold leg tubes in 2RCS-SG21B. The inspection distance for either leg was from 6.0 inches above the top of tubesheet to 3.0 inches below the top of tubesheet. This inspection distance bounds the required F* examination distance (that is, the expanded portion of the tube below the bottom of roll expansion transition) of 2.22 inches below the bottom of the roll expansion transition.

There are ten tubes located on the hot leg side of the SGs that have roll expansion transitions at lower than nominal elevations. The ten hot leg tubes with the deeper roll transition locations were inspected to a depth of 5.0 inches below the top of tubesheet to ensure the F* distance was adequately examined. On the cold leg side of 2RCS-SG21B, there are seven tubes with a lower than nominal roll transition location. These tubes were not included in the 2R20 twenty percent random sample inspection of the cold leg tubesheet. However, these seven tubes were included with the 2R20 special interest sample plan for cold leg tubesheet bulges and over-expansions. No indications were reported from the cold leg tubesheet examinations performed in 2RCS-SG21B.

The morphology for the majority of the indications being reported from the hot leg top of tubesheet region is believed to be outside diameter stress corrosion cracking (ODSCC). This is based on signal recognition and the location of the reported indications. Both axial and circumferentially orientated indications were observed. Circumferential indications located above the top of tubesheet remain bounded by the expansion transition.

None of the indications that were reported during the 2R20 SG examinations represented a (Cycle 20) leakage potential at postulated main steam line break (MSLB) conditions nor did the 2R20 indications challenge the structural integrity performance criteria.

The projected accident induced leakage from all combined sources (sleeves, plugs, indications left in-service under Generic Letter 95-05 and other degradation within the tube bundle) remains well below the 2.2 gallons per minute (gpm) per SG allowed by the Technical Specifications.

The information provided on the following pages summarizes the degradation observed during the 2R20 top of tubesheet region examinations.

UNIT #2 - 2R20 STEAM GENERATOR F* (F STAR) REPORT

Information for all Tables:

1) Elevation column: TSH - Top of tubesheet (Hot Leg). 0.00" is located at the secondary side tubesheet face. A negative measurement is the distance into the tubesheet from the secondary side face. All other elevations (> 0.00") are considered to be above secondary side tubesheet face.
2) Orientation column: SAI - Single axial indication; SCI/MCI - Single or multiple circumferential indications.
3) Severity columns: This data has been re-analyzed utilizing the Plus Point probe 300 kHz channel. The 300 kHz channel provides the most accurate sizing technique and is used for assessing the severity of the indications. The reported arc lengths are taken from the data resolution process. Profile analysis shows these measurements to be generally conservative.
4) Projected EOC Leakage column: Indications reported within the 3.0" (5.0" for particular tube locations) inspection distance below the top-of-tubesheet were either removed from service via plugging or repaired with the Alloy 800 sleeve during 2R20. The projected end of cycle (EOC) accident induced leakage from indications that were removed from service via plugging is considered zero. See Note 1 after each table for the projected leakage information for tubes with sleeves installed.

2RCS-SG21A Hot Leg Tubesheet:

There were ninety-three indications in ninety-one tubes. Eighty-six indications were located at or slightly below the top of tubesheet (Sixty-nine were single circumferential ODSCC indications, ten were multiple circumferential ODSCC indications and seven were single axial indications). The remaining seven indications were located above the top of tubesheet (Six were single circumferential ODSCC indications and one was a single axial indications).

Table 2RCS-SG21A

Indication Location				Orientation	Severity			Initiation Surface/ Degradation	Projected EOC Leakage
SG	Row	Column	Elevation (Inches)		Volts	Axial Length (Inches)	Arc Length (Degrees)		
A	1	78	TSH -0.09	SCI	0.16		120.00	OD	Zero
A	2	37	TSH 0.00	SCI	0.09		136.90	OD	Zero
A	2	59	TSH -0.07	SCI	0.07		73.10	OD	Zero
A	3	58	TSH -0.08	SCI	0.17		66.20	OD	See Note 1
A	3	59	TSH -0.07	SCI	0.12		70.80	OD	See Note 1
A	3	60	TSH -0.10	SCI	0.13		52.30	OD	See Note 1
A	4	40	TSH -0.04	SCI	0.08		110.80	OD	See Note 1
A	4	56	TSH -0.07	SCI	0.08		58.50	OD	See Note 1
A	4	59	TSH -0.11	SCI	0.14		29.20	OD	See Note 1
A	4	60	TSH -0.06	SCI	0.14		100.00	OD	See Note 1
A	4	61	TSH -0.12	SCI	0.07		29.20	OD	See Note 1
A	4	64	TSH -0.06	SCI	0.12		35.40	OD	See Note 1
A	5	28	TSH 0.11	SCI	0.12		69.00	OD	See Note 1
A	5	56	TSH 0.00	MCI	0.17		80.00	OD	See Note 1
A	5	59	TSH -0.01	SCI	0.17		80.00	OD	See Note 1
A	5	72	TSH -0.11	SCI	0.12		104.60	OD	See Note 1
A	6	10	TSH -0.11	SCI	0.20		170.80	OD	See Note 1
A	6	33	TSH 0.00	SCI	0.17		110.80	OD	See Note 1

UNIT #2 - 2R20 STEAM GENERATOR F* (F STAR) REPORT

Table 2RCS-SG21A (Cont.)

Indication Location				Orientation	Severity			Initiation Surface/ Degradation	Projected EOC Leakage
SG	Row	Column	Elevation (Inches)		Volts	Axial Length (Inches)	Arc Length (Degrees)		
A	6	35	TSH 0.00	SCI	0.06		66.20	OD	See Note 1
A	6	41	TSH 1.03	SAI	0.10	0.24		OD	See Note 1
A	6	59	TSH -0.08	SCI	0.19		130.80	OD	See Note 1
A	7	22	TSH -0.19	SCI	0.09		110.80	OD	See Note 1
A	7	33	TSH -0.13	SCI	0.11		30.80	OD	See Note 1
A	7	40	TSH -0.13	MCI	0.06		100.00	OD	See Note 1
A	7	68	TSH -0.17	SCI	0.11		109.20	OD	See Note 1
A	7	79	TSH -0.04	SCI	0.22		275.40	OD	See Note 1
A	8	40	TSH -0.08	MCI	0.05		152.30	OD	See Note 1
A	8	50	TSH -0.06	MCI	0.08		40.00	OD	See Note 1
A	8	52	TSH -0.05	SCI	0.11		93.80	OD	See Note 1
A	8	54	TSH 0.01	SCI	0.08		135.40	OD	See Note 1
A	8	55	TSH 0.00	SCI	0.09		192.20	OD	See Note 1
A	8	61	TSH 0.15	SCI	0.04		90.80	OD	See Note 1
A	9	35	TSH 0.00	SCI	0.12		116.90	OD	See Note 1
A	9	58	TSH 0.00	SCI	0.22		81.50	OD	See Note 1
A	9	68	TSH -0.09	SCI	0.26		120.60	OD	See Note 1
A	9	75	TSH -0.15	SCI	0.16		130.80	OD	See Note 1
A	10	40	TSH 0.02	SCI	0.07		33.80	OD	See Note 1
A	10	63	TSH -0.10	SCI	0.10		144.60	OD	See Note 1
A	11	37	TSH -0.13	MCI	0.14		181.50	OD	See Note 1
A	11	48	TSH -0.04	SCI	0.07		156.90	OD	See Note 1
A	11	52	TSH 0.00	MCI	0.13		193.80	OD	See Note 1
A	11	58	TSH -0.06	MCI	0.12		185.30	OD	See Note 1
A	11	59	TSH -0.10	SCI	0.16		100.00	OD	See Note 1
A	11	60	TSH -0.09	SCI	0.23		129.20	OD	Zero
A	11	62	TSH -0.11	SCI	0.16		118.50	OD	See Note 1
A	12	39	TSH -0.05	SCI	0.16		124.60	OD	See Note 1
A	12	44	TSH -0.10	MCI	0.07		133.80	OD	See Note 1
A	12	53	TSH -0.04	MCI	0.10		38.50	OD	See Note 1
A	12	60	TSH -0.10	SCI	0.05		16.90	OD	See Note 1
A	13	55	TSH 0.00	SCI	0.07		72.30	OD	See Note 1
A	13	56	TSH -0.03	SCI	0.07		46.20	OD	See Note 1
A	13	58	TSH -0.09	SCI	0.09		49.20	OD	See Note 1
A	13	64	TSH -0.02	SCI	0.06		56.90	OD	See Note 1
A	13	76	TSH -0.03	SCI	0.18		127.70	OD	See Note 1
A	14	56	TSH -0.11	SCI	0.17		106.20	OD	See Note 1
A	15	22	TSH -0.15	SCI	0.10		16.50	OD	See Note 1
A	15	51	TSH -0.06	SCI	0.10		38.50	OD	See Note 1
A	15	62	TSH 0.00	SCI	0.11		101.50	OD	See Note 1
A	16	48	TSH 0.00	SCI	0.09		78.50	OD	See Note 1
A	17	33	TSH -0.17	SCI	0.30		156.90	OD	See Note 1

UNIT #2 - 2R20 STEAM GENERATOR F* (F STAR) REPORT

Table 2RCS-SG21A (Cont.)

Indication Location				Orientation	Severity			Initiation Surface/ Degradation	Projected EOC Leakage
SG	Row	Column	Elevation (Inches)		Volts	Axial Length (Inches)	Arc Length (Degrees)		
A	17	46	TSH 0.00	SAI	0.13	0.12		OD	See Note 1
A	17	73	TSH 0.00	SCI	0.13		110.80	OD	See Note 1
A	18	27	TSH 0.00	SAI	0.12	0.14		OD	See Note 1
A	19	45	TSH -0.03	SCI	0.16		53.80	OD	See Note 1
A	22	46	TSH 0.00	SCI	0.08		118.50	OD	See Note 1
A	23	18	TSH -0.16	MCI	0.17		140.00	OD	See Note 1
A	23	22	TSH -0.14	SCI	0.11		27.70	OD	See Note 1
			TSH -0.14	SAI	0.11	0.31		OD	
A	23	27	TSH -0.06	SCI	0.15		66.20	OD	See Note 1
A	24	27	TSH 0.00	SAI	0.13	0.13		OD	See Note 1
A	24	70	TSH -0.13	SCI	0.07		24.60	OD	See Note 1
A	25	46	TSH -0.14	SCI	0.14		229.20	OD	See Note 1
A	26	28	TSH 0.00	SCI	0.13		26.20	OD	See Note 1
A	28	21	TSH -0.14	SAI	0.11	0.18		OD	Zero
A	28	27	TSH -0.10	SCI	0.17		101.50	OD	See Note 1
A	28	64	TSH -0.01	SCI	0.08		16.90	OD	See Note 1
			TSH 0.04	SCI	0.10		16.90		
A	28	67	TSH -0.02	SCI	0.11		204.60	OD	See Note 1
A	28	70	TSH 0.00	SAI	0.15	0.11		OD	See Note 1
A	28	77	TSH 0.02	SCI	0.14		146.20	OD	Zero
A	29	69	TSH 0.00	SCI	0.11		58.50	OD	See Note 1
A	30	25	TSH -0.20	SCI	0.10		140.00	OD	See Note 1
A	30	40	TSH -0.10	SCI	0.14		155.40	OD	See Note 1
A	30	44	TSH -0.07	SCI	0.11		36.90	OD	See Note 1
A	31	66	TSH -0.04	SCI	0.13		193.00	OD	See Note 1
A	33	27	TSH -0.06	SAI	0.08	0.16		OD	See Note 1
A	33	73	TSH 0.00	SCI	0.17		110.80	OD	Zero
A	34	66	TSH 0.00	SCI	0.11		100.00	OD	See Note 1
A	37	66	TSH 0.00	SCI	0.13		32.30	OD	Zero
A	39	61	TSH 0.00	SCI	0.10		61.50	OD	Zero
A	39	62	TSH -0.06	SCI	0.13		149.20	OD	Zero
A	42	48	TSH 0.00	SCI	0.19		120.00	OD	Zero
A	42	49	TSH -0.04	SCI	0.11		146.20	OD	Zero

Note 1 - Per WCAP 15919 (R2), "SG Tube Repair for Westinghouse Designed Plants with 7/8" Inconel 600 Tubes Using Leak Limiting Alloy 800 Sleeves", the per sleeve leak rate at normal operating conditions is 0.000543 gallons per hour (gph) and at main steam line or feedwater line break conditions is 0.000863 gph. For 2RCS-SG21A which currently has 247 Alloy 800 tubesheet sleeves installed, this equates to 2.2354×10^{-3} gpm and 3.5527×10^{-3} gpm, respectively.

UNIT #2 - 2R20 STEAM GENERATOR F* (F STAR) REPORT

2RCS-SG21B Hot Leg Tubesheet:

There were ninety-nine indications in ninety-nine tubes. Eighty-six indications were located at or slightly below the top of tubesheet (Eighty-one were single circumferential ODSCC indications, two were multiple circumferential ODSCC indications and three were single axial ODSCC indications). The remaining Thirteen indications were located above the top of tubesheet (Nine were single circumferential ODSCC indications, one was a multiple circumferential ODSCC indication and three were single axial ODSCC indications).

Table 2RCS-SG21B

Indication Location				Orientation	Severity			Initiation Surface/ Degradation	Projected EOC Leakage
SG	Row	Column	Elevation (Inches)		Volts	Axial Length (Inches)	Arc Length (Degrees)		
B	1	72	TSH -0.07	SCI	0.11		61.50	OD	Zero
B	2	71	TSH 0.00	SCI	0.07		92.30	OD	Zero
B	3	33	TSH -0.05	SCI	0.15		93.80	OD	See Note 1
B	3	68	TSH -0.09	SCI	0.19		146.20	OD	See Note 1
B	4	59	TSH 0.57	SCI	0.11		30.80	OD	See Note 1
B	5	31	TSH -0.22	SCI	0.10		35.40	OD	See Note 1
B	6	64	TSH 0.00	SCI	0.04		147.70	OD	See Note 1
B	7	27	TSH 0.00	SCI	0.05		36.90	OD	See Note 1
B	7	42	TSH 0.00	SAI	0.08	0.14		OD	See Note 1
B	7	50	TSH 0.00	SCI	0.07		113.80	OD	See Note 1
B	8	37	TSH 0.06	SCI	0.18		67.70	OD	See Note 1
B	8	56	TSH 0.04	SCI	0.14		76.90	OD	See Note 1
B	8	59	TSH -0.16	SCI	0.08		35.40	OD	See Note 1
B	8	60	TSH -0.08	SCI	0.08		38.50	OD	See Note 1
B	9	26	TSH -0.10	SCI	0.11		46.20	OD	See Note 1
B	9	39	TSH -0.04	SCI	0.09		36.90	OD	See Note 1
B	9	70	TSH -0.07	SCI	0.07		27.70	OD	See Note 1
B	9	72	TSH 0.00	SCI	0.11		83.10	OD	See Note 1
B	10	12	TSH -0.01	SCI	0.08		123.10	OD	See Note 1
B	10	14	TSH 0.00	SCI	0.16		135.40	OD	See Note 1
B	10	16	TSH 0.00	SCI	0.12		193.80	OD	See Note 1
B	10	54	TSH -0.01	SCI	0.08		27.70	OD	See Note 1
B	10	56	TSH 0.00	SCI	0.15		115.40	OD	See Note 1
B	11	41	TSH -0.02	MCI	0.11		120.00	OD	See Note 1
B	11	43	TSH 0.04	MCI	0.12		206.20	OD	See Note 1
B	11	44	TSH -0.08	SCI	0.13		297.00	OD	See Note 1
B	11	51	TSH -0.06	SCI	0.16		213.50	OD	See Note 1
B	11	52	TSH 0.00	SCI	0.10		129.20	OD	See Note 1
B	12	33	TSH 0.00	SCI	0.17		276.90	OD	See Note 1
B	12	52	TSH 0.00	SCI	0.13		78.50	OD	See Note 1
B	12	55	TSH -0.03	SCI	0.09		35.40	OD	See Note 1
B	12	56	TSH 0.00	SCI	0.08		96.90	OD	See Note 1
B	12	59	TSH 0.00	SCI	0.08		76.90	OD	See Note 1
B	13	36	TSH -0.15	SAI	0.35	0.16		OD	See Note 1
B	13	41	TSH -0.05	SCI	0.11		33.80	OD	See Note 1
B	13	45	TSH -0.04	SCI	0.13		63.10	OD	See Note 1
B	13	50	TSH -0.07	SCI	0.16		237.20	OD	See Note 1

UNIT #2 - 2R20 STEAM GENERATOR F* (F STAR) REPORT

Table 2RCS-SG21B (Cont.)

Indication Location				Orientation	Severity			Initiation Surface/ Degradation	Projected EOC Leakage
SG	Row	Column	Elevation (Inches)		Volts	Axial Length (Inches)	Arc Length (Degrees)		
B	13	52	TSH 0.07	SCI	0.11		15.40	OD	See Note 1
B	13	53	TSH 0.00	SCI	0.10		106.20	OD	See Note 1
B	14	27	TSH -0.06	SCI	0.15		132.30	OD	See Note 1
B	14	44	TSH -0.05	SCI	0.06		27.70	OD	See Note 1
B	14	57	TSH 0.00	SCI	0.12		129.20	OD	See Note 1
B	14	61	TSH -0.10	SCI	0.14		24.60	OD	See Note 1
B	14	70	TSH 0.00	SCI	0.16		178.50	OD	See Note 1
B	15	11	TSH 0.00	SCI	0.10		83.10	OD	See Note 1
B	15	12	TSH -0.01	SCI	0.10		47.70	OD	See Note 1
B	15	43	TSH -0.04	SCI	0.11		21.50	OD	See Note 1
B	15	71	TSH -0.06	SCI	0.27		135.40	OD	See Note 1
B	16	16	TSH -0.12	SCI	0.11		40.00	OD	See Note 1
B	16	19	TSH -0.07	SCI	0.12		146.20	OD	See Note 1
B	16	20	TSH -0.26	SCI	0.12		86.20	OD	See Note 1
B	16	28	TSH 0.00	SCI	0.16		226.00	OD	See Note 1
B	16	35	TSH 0.01	SCI	0.12		101.50	OD	See Note 1
B	17	16	TSH 0.00	SCI	0.13		147.70	OD	See Note 1
B	17	19	TSH -0.08	SCI	0.10		75.40	OD	See Note 1
B	17	20	TSH -0.04	SCI	0.17		42.00	OD	See Note 1
B	17	23	TSH -0.05	SCI	0.15		32.30	OD	See Note 1
B	17	68	TSH -0.11	SCI	0.18		170.20	OD	See Note 1
B	18	24	TSH 0.00	SCI	0.26		93.80	OD	See Note 1
B	18	35	TSH -0.07	SCI	0.08		304.60	OD	See Note 1
B	18	51	TSH 0.00	SCI	0.07		47.00	OD	See Note 1
B	19	22	TSH 0.08	SAI	0.38	0.18		OD	See Note 1
B	19	69	TSH 0.08	SCI	0.18		147.70	OD	See Note 1
B	20	21	TSH 0.11	SAI	0.13	0.08		OD	See Note 1
B	20	23	TSH 0.00	SAI	0.24	0.16		OD	See Note 1
B	20	29	TSH -0.10	SCI	0.10		60.00	OD	See Note 1
B	20	40	TSH 0.03	SCI	0.12		50.80	OD	See Note 1
B	20	50	TSH 0.00	SCI	0.10		29.20	OD	See Note 1
B	20	76	TSH -0.02	SCI	0.21		201.50	OD	See Note 1
B	21	32	TSH -0.02	SCI	0.13		83.10	OD	See Note 1
B	22	51	TSH 0.00	SCI	0.13		27.70	OD	See Note 1
B	23	28	TSH 0.19	SAI	0.17	0.23		OD	See Note 1
B	24	51	TSH -0.13	SCI	0.09		121.50	OD	See Note 1
B	24	60	TSH -0.08	SCI	0.14		30.80	OD	See Note 1
B	25	31	TSH -0.07	SCI	0.22		106.20	OD	See Note 1
B	27	27	TSH -0.15	SCI	0.14		160.00	OD	See Note 1
B	27	30	TSH -0.05	SCI	0.12		20.00	OD	See Note 1
B	27	63	TSH -0.12	SCI	0.11		181.50	OD	See Note 1

UNIT #2 - 2R20 STEAM GENERATOR F* (F STAR) REPORT

Table 2RCS-SG21B (Cont.)

Indication Location				Orientation	Severity			Initiation Surface/ Degradation	Projected EOC Leakage
SG	Row	Column	Elevation (Inches)		Volts	Axial Length (Inches)	Arc Length (Degrees)		
B	28	38	TSH -0.04	SCI	0.10		30.80	OD	See Note 1
B	28	67	TSH 0.04	SCI	0.17		96.90	OD	See Note 1
B	29	29	TSH -0.48	SCI	0.08		30.00	OD	See Note 1
B	30	31	TSH -0.05	SCI	0.15		195.40	OD	See Note 1
B	30	32	TSH -0.03	SCI	0.11		190.80	OD	See Note 1
B	30	58	TSH -0.11	SCI	0.10		161.50	OD	See Note 1
B	31	48	TSH -0.03	SCI	0.10		81.50	OD	See Note 1
B	31	67	TSH 0.00	SCI	0.12		216.90	OD	See Note 1
B	32	47	TSH -0.04	SCI	0.12		124.60	OD	See Note 1
B	32	49	TSH -0.10	MCI	0.07		207.30	OD	See Note 1
B	32	57	TSH 0.10	SCI	0.11		43.10	OD	See Note 1
B	33	57	TSH 0.12	SCI	0.14		104.60	OD	See Note 1
B	35	41	TSH 0.00	SCI	0.06		27.70	OD	See Note 1
B	35	59	TSH -0.06	SCI	0.23		141.50	OD	See Note 1
B	35	60	TSH -0.04	SCI	0.10		10.80	OD	See Note 1
B	36	32	TSH -0.11	SCI	0.12		121.50	OD	Zero
B	36	33	TSH -0.10	SCI	0.15		210.30	OD	Zero
B	36	36	TSH -0.03	SCI	0.08		210.30	OD	See Note 1
B	36	47	TSH -0.05	SCI	0.17		241.50	OD	Zero
B	36	51	TSH -0.04	SCI	0.10		33.80	OD	See Note 1
B	36	65	TSH 0.09	SCI	0.20		127.70	OD	See Note 1

Note 1 - Per WCAP 15919 (R2), "SG Tube Repair for Westinghouse Designed Plants with 7/8" Inconel 600 Tubes Using Leak Limiting Alloy 800 Sleeves", the per sleeve leak rate at normal operating conditions is 0.000543 gallons per hour (gph) and at main steam line or feedwater line break conditions is 0.000863 gph. For 2RCS-SG21B which currently has 169 Alloy 800 tubesheet sleeves installed, this equates to 1.5295×10^{-3} gpm and 2.4308×10^{-3} gpm, respectively.

2RCS-SG21B Cold Leg Tubesheet:

A twenty percent random sample of the inservice cold leg tubes in 2RCS-SG21B was performed from 6 inches above to 3 inches below TTS. No tubes with roll expansions greater than 0.75 inches below the top of tubesheet were included in the random sample, therefore no tubes were required to be inspected to a depth of greater than 3.0 inches. No indications were detected during the cold leg inspection in 2RCS-SG21B.

UNIT #2 - 2R20 STEAM GENERATOR F* (F STAR) REPORT

2RCS-SG21C Hot Leg Tubesheet:

There were fifty-one indications in fifty-one tubes. Forty-seven indications were located at or slightly below the top of tubesheet (Forty-seven were single circumferential ODSCC indications). The remaining four indications were located above the top of tubesheet (Four were single circumferential ODSCC indications).

Table 2RCS-SG21C

Indication Location				Orientation	Severity			Initiation Surface/ Degradation	Projected EOC Leakage
SG	Row	Column	Elevation (Inches)		Volts	Axial Length (Inches)	Arc Length (Degrees)		
C	1	53	TSH 0.00	SCI	0.06		47.70	OD	Zero
C	1	56	TSH -0.11	SCI	0.14		178.50	OD	Zero
C	1	65	TSH 0.00	SCI	0.14		167.70	OD	Zero
C	1	67	TSH -0.09	SCI	0.11		222.30	OD	Zero
C	1	69	TSH -0.06	SCI	0.13		170.80	OD	Zero
C	1	82	TSH -0.06	SCI	0.12		93.80	OD	Zero
C	3	56	TSH 0.00	SCI	0.13		40.00	OD	See Note 1
C	4	33	TSH 0.11	SCI	0.34		183.00	OD	See Note 1
C	5	22	TSH -0.13	SCI	0.26		143.10	OD	See Note 1
C	5	46	TSH -0.04	SCI	0.08		15.40	OD	See Note 1
C	5	50	TSH -0.10	SCI	0.11		41.00	OD	See Note 1
C	5	54	TSH 0.02	SCI	0.17		50.50	OD	See Note 1
C	6	46	TSH -0.04	SCI	0.20		218.50	OD	See Note 1
C	7	29	TSH -0.01	SCI	0.11		120.00	OD	See Note 1
C	7	50	TSH -0.04	SCI	0.10		30.50	OD	See Note 1
C	7	68	TSH -0.10	SCI	0.14		35.40	OD	See Note 1
C	9	50	TSH -0.01	SCI	0.14		30.00	OD	See Note 1
C	9	58	TSH -0.06	SCI	0.09		86.20	OD	See Note 1
C	10	78	TSH -0.08	SCI	0.15		72.30	OD	See Note 1
C	11	17	TSH -0.05	SCI	0.15		106.20	OD	See Note 1
C	11	18	TSH -0.03	SCI	0.14		130.80	OD	See Note 1
C	11	32	TSH -0.06	SCI	0.09		76.90	OD	See Note 1
C	12	73	TSH -0.10	SCI	0.08		69.20	OD	See Note 1
C	13	13	TSH 0.00	SCI	0.07		29.20	OD	See Note 1
C	15	72	TSH 0.00	SCI	0.17		141.50	OD	See Note 1
C	18	64	TSH -0.06	SCI	0.05		38.50	OD	See Note 1
C	18	69	TSH -0.06	SCI	0.14		146.20	OD	See Note 1
C	22	34	TSH -0.05	SCI	0.20		56.90	OD	See Note 1
C	23	37	TSH 0.00	SCI	0.34		133.80	OD	See Note 1
C	25	31	TSH -0.05	SCI	0.20		144.50	OD	See Note 1
C	25	69	TSH -0.07	SCI	0.16		140.00	OD	See Note 1
C	25	72	TSH -0.08	SCI	0.15		153.80	OD	See Note 1
C	25	74	TSH 0.00	SCI	0.15		166.20	OD	See Note 1
C	26	25	TSH 0.00	SCI	0.13		75.40	OD	See Note 1

UNIT #2 - 2R20 STEAM GENERATOR F* (F STAR) REPORT

Table 2RCS-SG21C (Cont.)

Indication Location				Orientation	Severity			Initiation Surface/ Degradation	Projected EOC Leakage
SG	Row	Column	Elevation (Inches)		Volts	Axial Length (Inches)	Arc Length (Degrees)		
C	26	38	TSH 0.09	SCI	0.18		58.50	OD	See Note 1
C	26	66	TSH -0.10	SCI	0.08		47.70	OD	See Note 1
C	27	35	TSH 0.00	SCI	0.15		256.00	OD	See Note 1
C	27	37	TSH 0.00	SCI	0.15		181.50	OD	See Note 1
C	27	40	TSH -0.07	SCI	0.11		72.30	OD	See Note 1
C	28	58	TSH -0.01	SCI	0.09		156.30	OD	See Note 1
C	30	55	TSH -0.04	SCI	0.16		101.50	OD	See Note 1
C	30	57	TSH 0.04	SCI	0.15		38.50	OD	See Note 1
C	30	62	TSH -0.09	SCI	0.13		72.30	OD	See Note 1
C	30	64	TSH -0.07	SCI	0.10		132.30	OD	See Note 1
C	31	38	TSH 0.00	SCI	0.11		52.30	OD	See Note 1
C	35	35	TSH -0.09	SCI	0.18		41.50	OD	See Note 1
C	35	50	TSH 0.00	SCI	0.11		181.50	OD	See Note 1
C	36	53	TSH -0.12	SCI	0.14		229.00	OD	See Note 1
C	37	59	TSH -0.04	SCI	0.14		72.30	OD	See Note 1
C	37	62	TSH -0.16	SCI	0.11		41.50	OD	Zero
C	37	66	TSH -0.11	SCI	0.11		47.30	OD	Zero

Note 1 - Per WCAP 15919 (R2), "SG Tube Repair for Westinghouse Designed Plants with 7/8" Inconel 600 Tubes Using Leak Limiting Alloy 800 Sleeves", the per sleeve leak rate at normal operating conditions is 0.000543 gallons per hour (gph) and at main steam line or feedwater line break conditions is 0.000863 gph. For 2RCS-SG21C which currently has 65 Alloy 800 tubesheet sleeves installed, this equates to 5.8825×10^{-4} gpm and 9.3492×10^{-4} gpm, respectively.

Attachment A
Unit 2 - Cumulative Listing of Tubesheet Indications (All Outages)
(Updated through 2R20)

2RCS-SG21A Hot Leg Tubesheet	
INCH	COUNT
0.00"	83
- 0.01"	20
- 0.02"	19
- 0.03"	29
- 0.04"	28
- 0.05"	24
- 0.06"	30
- 0.07"	28
- 0.08"	23
- 0.09"	24
- 0.10"	20
- 0.11"	30
- 0.12"	7
- 0.13"	20
- 0.14"	12
- 0.15"	6
- 0.16"	7
- 0.17"	6
- 0.18"	
- 0.19"	2
- 0.20"	2
- 0.21"	
- 0.22"	
- 0.23"	1
TOTAL	421

2RCS-SG21A Cold Leg Tubesheet	
INCH	COUNT
0.00"	
- 0.01"	
- 0.02"	
- 0.03"	
- 0.04"	
- 0.05"	1
- 0.06"	
- 0.07"	
- 0.08"	
- 0.09"	
- 0.10"	
- 0.11"	
- 0.12"	
- 0.13"	
- 0.14"	
- 0.15"	
- 0.16"	1
- 0.17"	
- 0.18"	
- 0.19"	
- 0.20"	
TOTAL	2

2RCS-SG21B Hot Leg Tubesheet	
INCH	COUNT
0.00"	49
- 0.01"	13
- 0.02"	9
- 0.03"	19
- 0.04"	20
- 0.05"	22
- 0.06"	18
- 0.07"	21
- 0.08"	33
- 0.09"	27
- 0.10"	20
- 0.11"	19
- 0.12"	11
- 0.13"	3
- 0.14"	2
- 0.15"	8
- 0.16"	3
- 0.17"	3
- 0.18"	4
- 0.19"	
- 0.20"	2
- 0.21"	3
- 0.22"	2
- 0.26"	1
- 0.27"	1
- 0.31"	1
- 0.48"	1
TOTAL	315

2RCS-SG21B Cold Leg Tubesheet	
INCH	COUNT
0.00"	
- 0.01"	
- 0.02"	
- 0.03"	
- 0.04"	
- 0.05"	
- 0.06"	
- 0.07"	
- 0.08"	
- 0.09"	
- 0.10"	
- 0.11"	
- 0.12"	
- 0.13"	
- 0.14"	
- 0.15"	
- 0.16"	
- 0.17"	
- 0.18"	
- 0.19"	
- 0.20"	
- 16.39"	1
TOTAL	1

2RCS-SG21C Hot Leg Tubesheet	
INCH	COUNT
0.00"	22
- 0.01"	3
- 0.02"	3
- 0.03"	5
- 0.04"	12
- 0.05"	17
- 0.06"	16
- 0.07"	13
- 0.08"	20
- 0.09"	16
- 0.10"	16
- 0.11"	13
- 0.12"	9
- 0.13"	5
- 0.14"	6
- 0.15"	1
- 0.16"	4
- 0.17"	1
- 0.18"	2
- 0.19"	1
- 0.20"	
- 0.22"	1
- 0.36"	1
- 0.40"	1
- 0.41"	1
- 0.50"	1
- 1.22"	1
- 1.49"	1
- 3.16"	1
- 18.36"	1
TOTAL	194

2RCS-SG21C Cold Leg Tubesheet	
INCH	COUNT
0.00"	
- 0.01"	
- 0.02"	
- 0.03"	
- 0.04"	
- 0.05"	
- 0.06"	
- 0.07"	
- 0.08"	
- 0.09"	
- 0.10"	
- 0.11"	
- 0.12"	
- 0.13"	
- 0.14"	
- 0.15"	
- 0.16"	
- 0.17"	
- 0.18"	
- 0.19"	
- 0.20"	
- 5.29"	1
TOTAL	1

The five shaded tube locations were reported as a distorted tubesheet signal from the bobbin coil probe. Rotating pancake coil examinations did not confirm any of these signal as real indications.