Tennessee Valley Authority
1101 Market Street, LP 3R
Chattanooga, Tennessee 37402-2801

R. M. Krich
Vice President
Nuclear Licensing

July 16, 2010

10 CFR 50.4

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Sequoyah Nuclear Plant, Unit 2
Facility Operating License No. DPR-79
NRC Docket No. 50-328

Subject: **Response to Request for Additional Information Regarding the 90-Day and 180-Day Steam Generator Tube Inspection Reports for Cycle 16 Refueling Outage (TAC Nos. ME3400 and ME3971)**

References:

1. Letter from TVA to NRC, "Unit 2 Cycle 16 - 90 Day Steam Generator Report for Voltage-Based Alternate Repair Criteria and W* Alternate Repair Criteria," dated February 19, 2010

2. Letter from TVA to NRC, "Unit 2 Cycle 16 - 180-Day Steam Generator Inspection Report," dated May 19, 2010

3. Letter from NRC to TVA, "Sequoyah Nuclear Plant, Unit 2 - Request for Additional Information Regarding the 90-Day and 180-Day Steam Generator Tube Inspection Reports for Cycle 16 Refueling Outage (TAC Nos. ME3400 and ME3971)," dated June 7, 2010

This letter responds to NRC's request for additional information as contained in Reference 3. The enclosure provides TVA responses to the NRC questions associated with the steam generator tube inspection results from the Sequoyah Nuclear Plant, Unit 2 Cycle 16 Refueling Outage as documented in References 1 and 2.

D030
NRR

printed on recycled paper

There are no commitments contained in this letter. If you have any questions concerning this issue, please contact J. W. Proffitt at (423) 843-6651.

Respectfully,

R. M. Krich

Enclosure:
Response to Request for Additional Information

Enclosure
cc (Enclosure):

NRC Regional Administrator – Region II
NRC Senior Resident Inspector – Sequoyah Nuclear Plant

ENCLOSURE

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT, UNIT 2

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

NRC Question 1

Please discuss the scope and results of your secondary side steam drum inspections.

TVA Response

Upper internal visual inspections were performed in steam generator (SG) Nos. 2, 3, and 4. SG No. 1 was not inspected during the Sequoyah Nuclear Plant (SQN), Unit 2 Cycle 16 (U2C16) refueling outage. No unacceptable or abnormal conditions were discovered. The material condition of internal steam drum components were examined giving particular attention to structural integrity and corrosion and erosion damage. Structures visually examined included the following:

- Secondary side separator area and swirl vanes, paying special attention to the leading edge of the plates
- Steam dryers and drains
- Steam flow transmitter penetrations to ensure they were free of debris
- Level transmitter penetrations to ensure they were free of debris
- All accessible parts below deck plate, paying special attention to any drain cup debris and patches of corrosion
- Feed ring J-tubes, paying special attention to the wall thickness of the J-tube mouth and the J-tube to feed ring weld
- All accessible feedwater ring supports
- Conical-to-upper-shell girth weld on the inner shell of the SG looking for areas of patchy orange rust and pitting
- Riser barrel adjacent to J-tubes to evaluate areas looking for impingement induced erosion/corrosion
- Other areas as determined by engineering

In addition, ultrasonic testing thickness measurements of the feedwater inlet distribution tee were obtained to assess erosion for information.

The foreign material exclusion log was examined following the inspection to ensure no potential loose parts were left in the SG.

NRC Question 2

Prior to shutting down for your fall 2009 steam generator tube inspections, a small primary-to-secondary leak rate existed. Please discuss whether any leakage was observed after starting up from the fall 2009 refueling outage (RFO). If so, discuss the possible source of any leakage and any implications for your inspection and repair criteria.

TVA Response

There has been no detectable primary-to-secondary SG tube leakage identified since completion of the SQN, U2C16 refueling outage eddy current inspection and tube plugging.

NRC Question 3

On page E1-10 of your February 19, 2010, letter, it was indicated that the voltage growth was determined based on the historic review of 3743 distorted support indications. Please confirm this number since you detected 3747 indications at the supports, which included five indications that were only identified with a rotating probe. Please confirm that for every support indication identified during the fall 2009 RFO, you reviewed the historic data to determine if an indication was present; and, if an indication was present, you determined the growth rate of the indication and included it in your growth rate distribution.

TVA Response

The number of indications and the number of data pairs used for computing the growth rate are reported in SG-SGMP-10-2 (Reference 1) and shown in Table 3.1 for each SG.

Table 3.1: Number of Indications

End of cycle (EOC)-16	SG 1	SG 2	SG 3	SG 4	Total
Number of indications	655	711	876	1505	3747
Number of indications with lookbacks	655	707	876	1505	3743

In SG No. 2 there were 5 indications that were not detected by bobbin, but which were detected by +Point™. These indications were assigned an imputed bobbin voltage based on the relationship between the +Point™ voltage and bobbin voltage of other indications. Lookbacks to the previous outage data found that only one of these five indications had a detectable indication, as noted in Table 3.2.

Table 3.2: +Point™ Indications in SG 2

Row	Column	Location	Imputed Bobbin Voltage	Lookback Voltage	Growth, Volts (V) per cycle
13	92	H07	1.11	NDD	N/A
12	3	C07	1.12	NDD	N/A
33	77	H02	1.15	NDD	N/A
37	65	H03	1.22	NDD	N/A
41	30	H01	1.39	0.55	0.84

The indications detected by bobbin had lookback values and were included in the growth rate data. The indication at R41 C30 H01, with an imputed 2009 voltage, was also included in the growth rate data. Therefore, there were only four indications that had imputed voltages that did not have lookback values and, therefore, were excluded from the growth rate data. The tubes listed in Table 3.2 were plugged.

NRC Question 4

From Table 4-7 of your February 19, 2010, letter, the number of tubes examined on the cold-leg was calculated to be 3189. This is two tubes less than the number of tubes in service. Please

™ : +Point™ is a trademark of Zetec, Inc.

discuss whether the cold-leg portion of each tube was examined with a bobbin coil probe. If not, discuss how this was accounted for in your operational assessment.

TVA Response

The cold-leg portion of each tube was examined with a bobbin coil probe. A total of 3191 cold-leg tubes were examined. It appears that there was a counting error in the number of tubes tested with a worn probe on the cold leg only. A recount was conducted based on the Cal Board Lists that indicated which calibration groups were in or out of calibration. The correct number is 79 tubes tested with a worn probe on the cold leg only. In addition, a typographical error was noted and corrected on the line of new indications equal to or greater than 0.5 volts (V) in tubes with good probe. The percent was correct, but the ratio was in error. The table below shows the corrected values in bold lettering.

Table 4-7 Corrected: Summary of SG 2 Indications Found in the Current Inspection that were Tested with a Worn Probe in the Previous Inspection

Steam Generator 2		
Number of new indications in EOC-16		122
Worn Probe in EOC-15	Number of new indications tested with worn probe in EOC-15	77
	Number of these equal to or greater than 0.5 V in EOC-16	42
	Number of tubes tested with worn probe hot leg (HL) and cold leg (CL)	1074
	Number of tubes tested with worn probe CL only	**79** (one new)
	Number of tubes tested with worn probe HL only	505
Good Probe in EOC-15	Number of new indications tested with good probe in EOC-15	45
	Number of these equal to or greater than 0.5 V in EOC-16	29
	Number of tubes tested with good probe HL	1612
	Number of tubes tested with good probe CL	2038
Ratio of new indications in tubes tested with worn probe to number of tubes tested with a worn probe (HL only)		76/1579 = 0.048
Ratio of new indications in tubes tested with good probe to number of tubes tested with a good probe (HL only)		45/1612 = 0.028
Percentage of new indications equal to or greater than 0.5 V in tubes tested with worn probe		42/77 = 54.5%
Percentage of new indications equal to or greater than 0.5 V in tubes tested with good probe		**29/45** = 64.4%
Steam Generator 2		
Number of previous indications in EOC-16		589
Worn Probe in EOC-15	Number of previous indications tested with worn probe in EOC-15	322
	Number of these exceeding 2.0 V in EOC-16	0
	Highest voltage indication of these in EOC-16	1.79 V

NRC Question 5

In steam generators 2 and 3 (Tables 4-7 and 4-8 of your February 19, 2010, letter, respectively) the ratio of new indications in tubes tested with worn probes is higher than the ratio of new indications in tubes tested with good probes. This possibly indicates that the worn probes are missing indications (although the overall average from all four steam generators indicates that the ratios of these two quantities are comparable). Please discuss any corrective action taken in response to these results or discuss why no corrective action was needed.

TVA Response

The appropriate information from Tables 4-6 through 4-10 is summarized in Table 5.1.

Table 5.1: Ratios taken from Tables 4-6 through 4-10

	SG 1	SG 2	SG 3	SG 4	Total
Ratio of new indications in tubes tested with worn probe to number of tubes tested with a worn probe (HL only)	0.028	0.048	0.068	0.046	0.048
Ratio of new indications in tubes tested with good probe to number of tubes tested with a good probe (HL only)	0.042	0.028	0.046	0.060	0.044

The ratios of new indications previously tested with a worn probe are higher for SG Nos. 2 and 3, but lower for SG Nos. 1 and 4.

In addition to the information in Table 5.1, the percentage of new indications greater than 0.5 V will help assess if the population of new indications is significantly different.

Table 5.2: Percentages taken from Tables 4-6 through 4-10

	SG 1	SG 2	SG 3	SG 4	Total
Percentage of new indications equal to or greater than 0.5 V in tubes tested with worn probe	60.0	54.5	64.4	52.4	57.6
Percentage of new indications equal to or greater than 0.5 V in tubes tested with good probe	52.0	64.4	64.0	45.5	54.9

Table 5.1 shows a variation from SG to SG. In some cases the ratio of new indications in tubes previously tested with a worn probe is greater than the ratio of new indications in tubes previously tested with a good probe, and in some cases it is smaller. Since the SGs experience essentially the same conditions, there is no known cause for a greater ratio in one SG than another. The ratios for the SGs combined are almost the same. Therefore, the differences are suspected to be a result of random variations in the detectability of these indications.

Table 5.2 shows the variation of the percent of new indications equal to or greater than 0.5 V. These percentages also show some variation but do not show a trend that would indicate that there is a difference in the nature of the population of indications. It is reasonable to presume based on these ratios and percentages that the new indications detected that were previously

NRC Question 6

The largest indication of outside diameter stress corrosion cracking (ODSCC) at the tube support elevations grew from approximately 0.4 volts in 2008 to 6.6 volts in 2009. The 0.4 volt indication in 2008 had been inspected with a worn probe. Please discuss any insights on the reason for such a high growth rate. For example, is the growth rate of indications in tubes inspected with a worn probe significantly higher than the growth rate of indications in tubes inspected with "good" probes (i.e., probes that passed the probe wear criterion)?

TVA Response

The growth rates for indications previously tested with a worn probe and those previously tested with a good probe can be compared for each SG. This is shown in Figures 6.1 through 6.4.

Figure 6.1

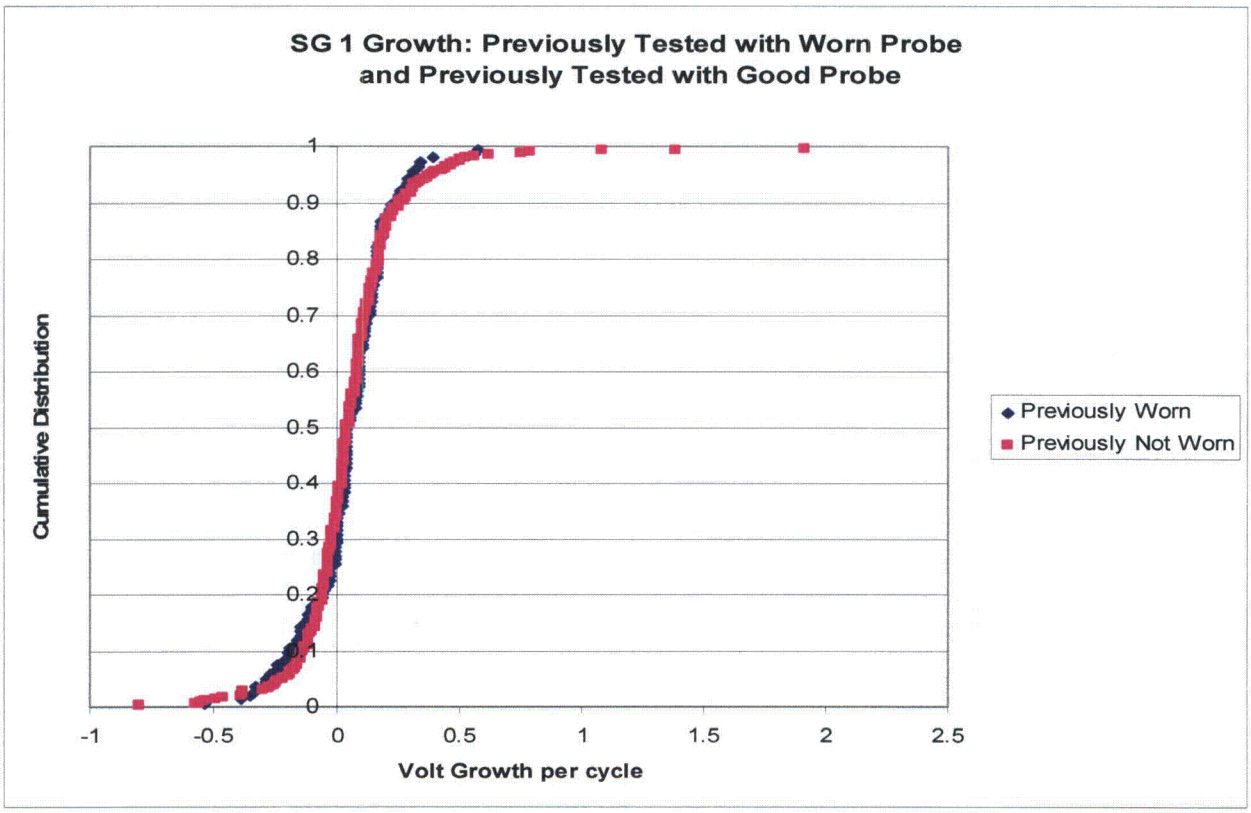


Figure 6.2

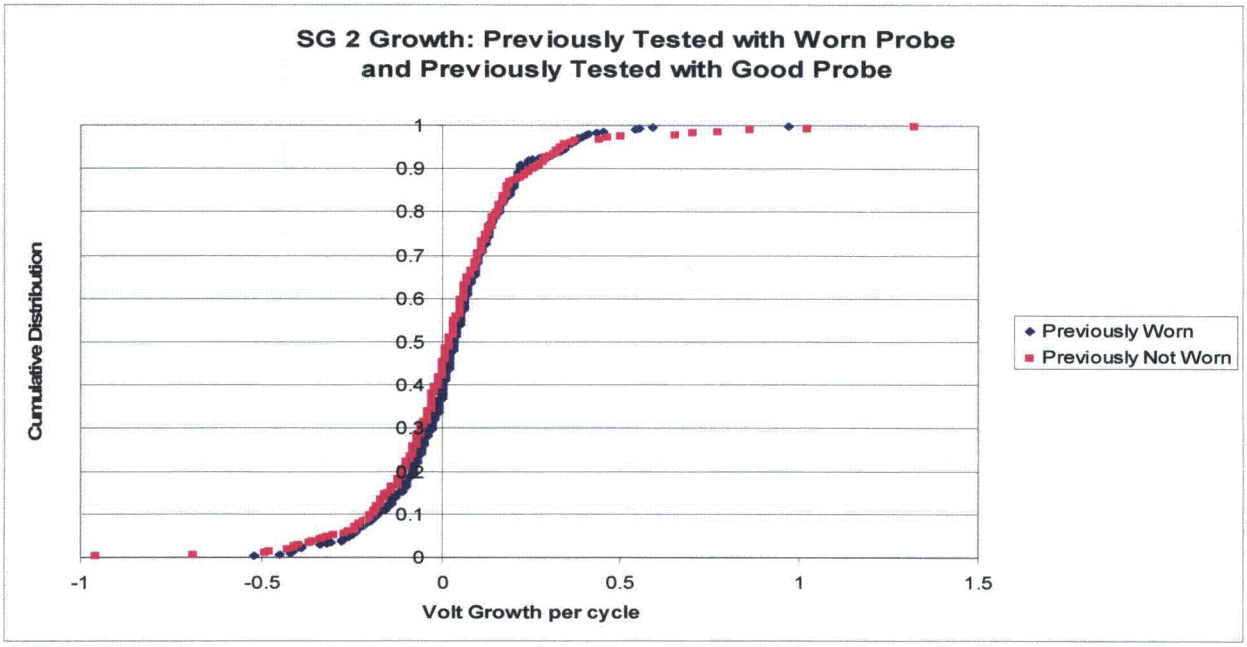


Figure 6.3

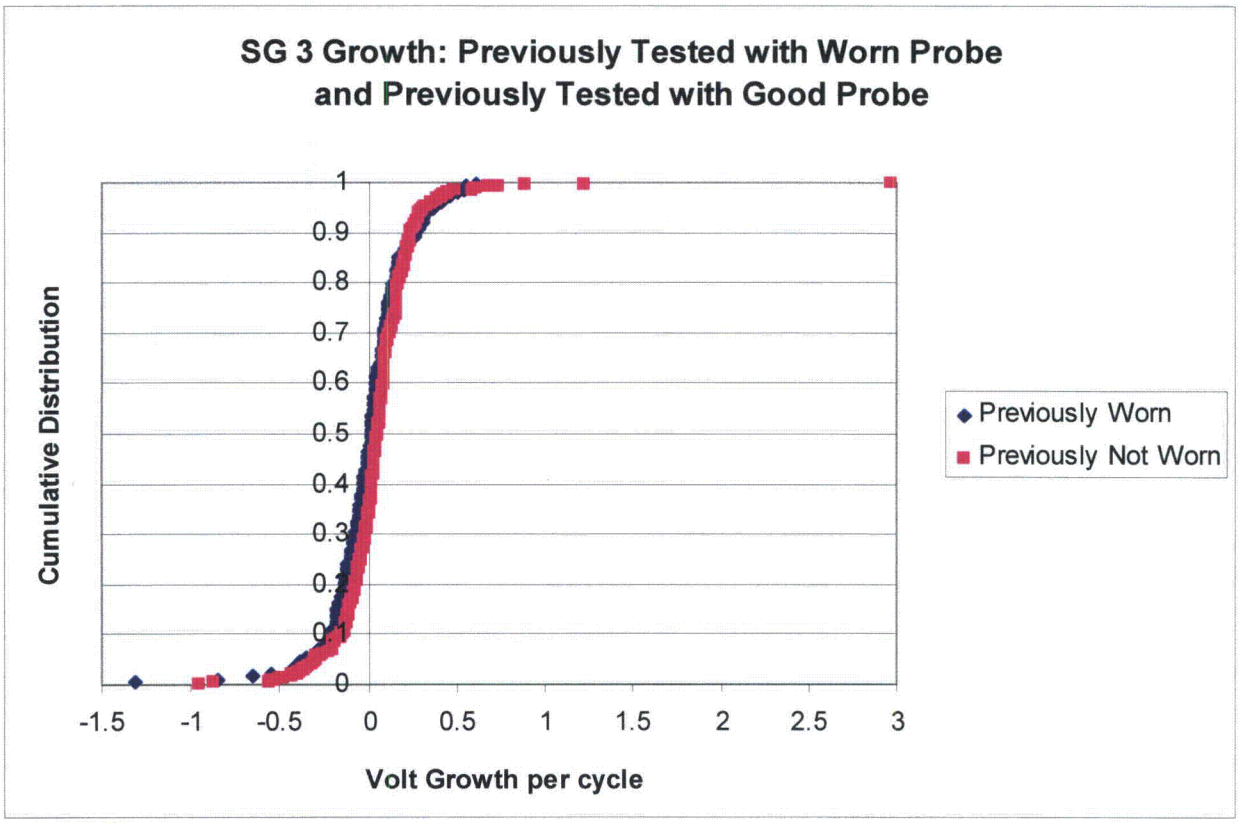
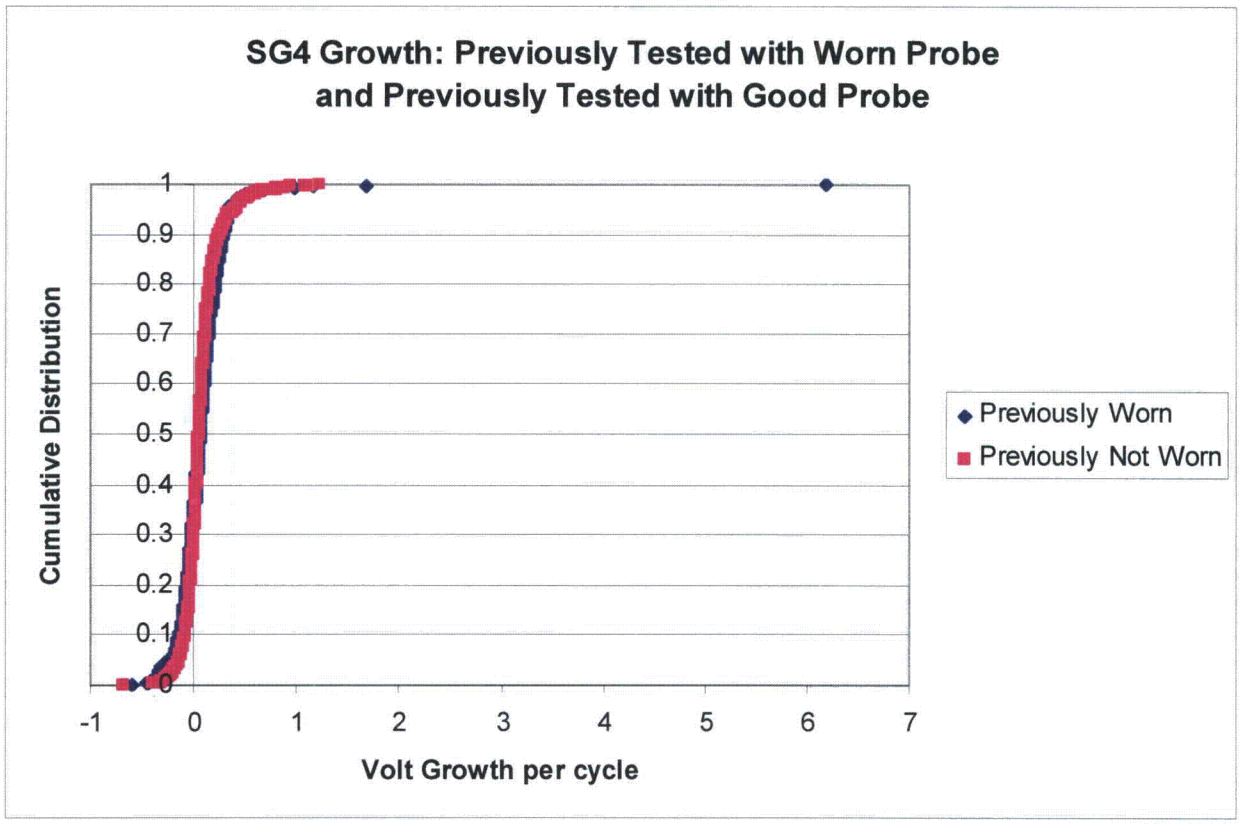


Figure 6.4



As seen in Figures 6.1 through 6.4, the largest growth occurred with an indication that had been previously tested with a good probe in the SGs except for SG No. 4. The one outlier in SG No. 3 that resulted in the indication slightly exceeding the predicted maximum voltage was previously tested with a good probe. The indications with the two largest growth values in SG No. 4 were previously tested with a worn probe and the outlier resulted in the 6.6 V indication that exceeded the predicted maximum voltage. The cumulative distribution curves lie on top of each other except for the outliers. This indicates that the populations are essentially the same.

Figures 6.5 and 6.6 are the same as Figures 4-1 and 4-3 of the 90-day report (Reference 1). These figures show the relationship between the worn probe voltage, called RPW (Repeat test due to Probe Wear), and the voltage of the same indication when subsequently tested with a good probe. The voltage pairs scatter about the 1-1 line indicating that it is just as likely for the worn probe to give a smaller voltage reading as a larger one compared to the good probe value. The greatest undercall by a worn probe of the 101 data pairs is 0.89 V, and the greatest overcall is 1.05 V.

Based on the comparison of the growth rates in SG Nos. 3 and 4, one with the outlier previously tested with an unworn probe and one with the outlier previously tested with a worn probe, and the observation from Figures 6.5 and 6.6 that the difference between worn probe and good probe is scattered about the 1-1 line with a maximum variation of around 1 V, there is no reason to suspect that indications previously tested with a worn probe would generally experience more apparent growth than indications previously tested with a good probe.

Figure 6.5: Figure 4-1 of SG-SGMP-10-2 - Retest DSI [distorted support indication] Voltage vs. First Test Voltage RPW of Indications Originally Measured with Worn Probe

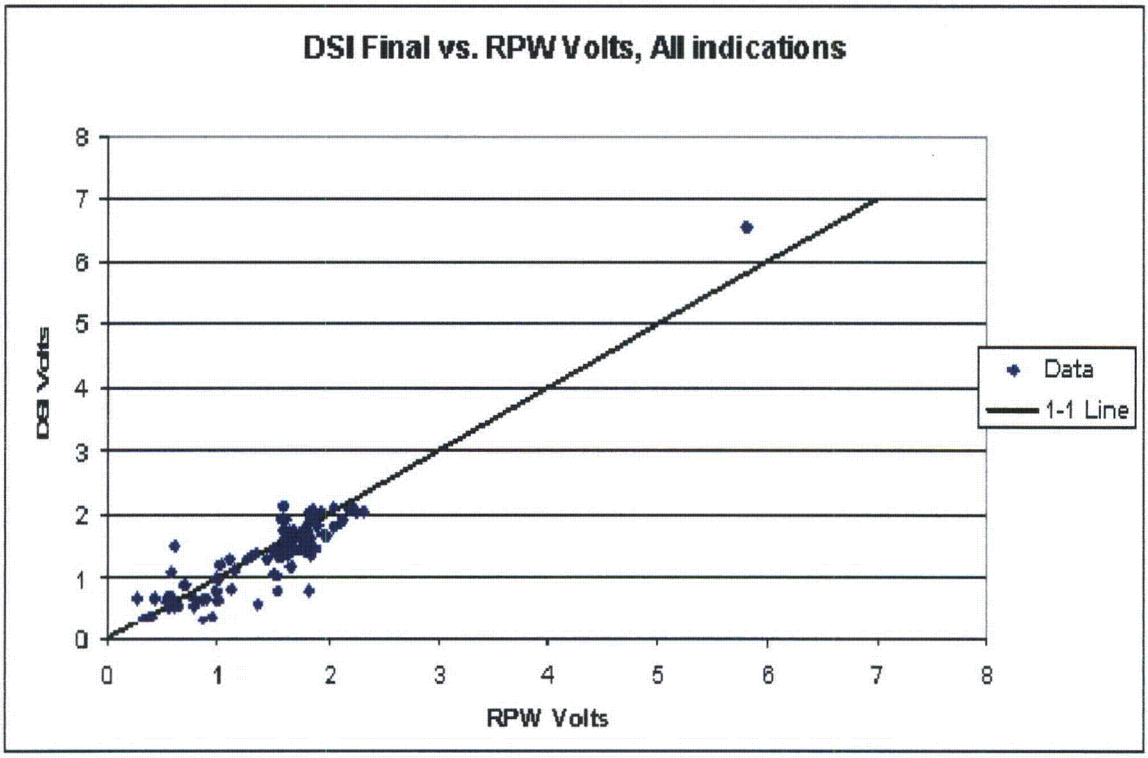
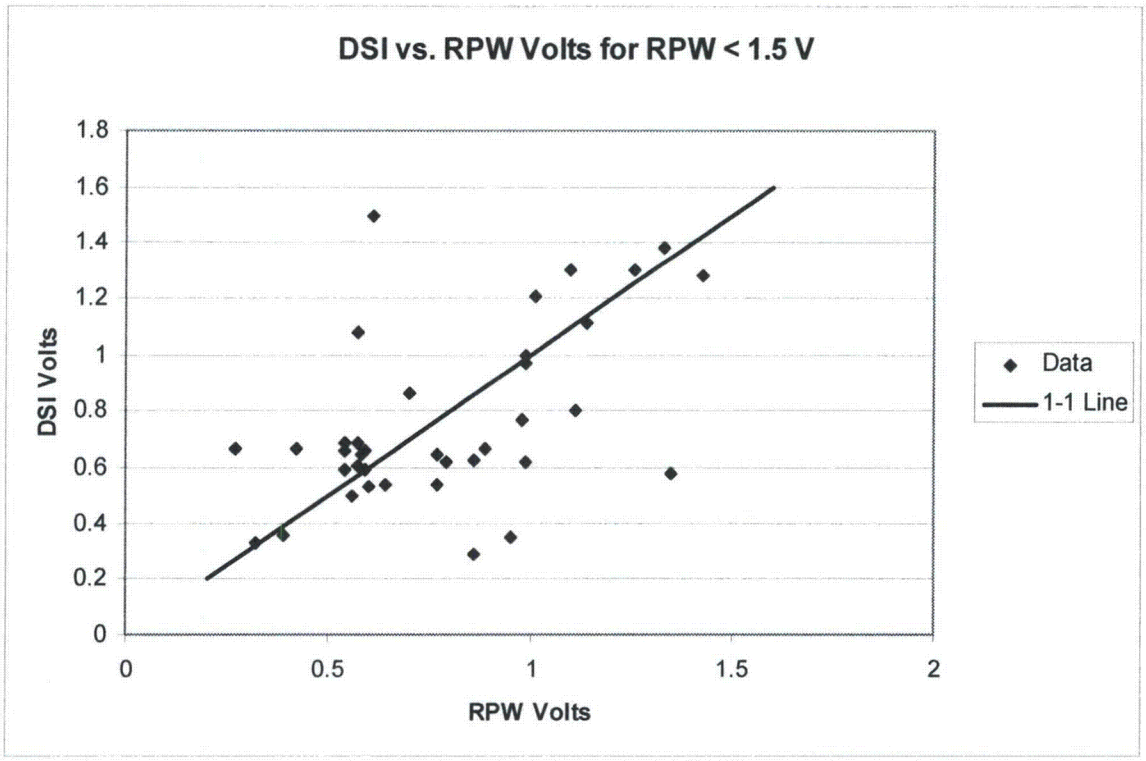


Figure 6.6: Figure 4-3 of SG-SGMP-10-2 - Retest DSI Voltage vs. RPW Voltage of Indications Originally Measured with Worn Probe (RPW < 1.5 V)



NRC Question 7

During the fall 2009 RFO, the voltages of two of the indications of outside diameter stress corrosion cracking at the tube support plates exceeded your projections. The methodology for projecting the end-of-cycle voltage distribution for such indications was intended to be conservative in terms of projecting the number and severity of the flaws (and therefore conservative in estimating the accident induced leakage and burst probability). This under prediction in the severity of the indications led to under predicting the burst probability in steam generator 4. Although no performance criteria were exceeded, the results appear to question the conservatisms of the methodology and may become a safety concern if your projections become closer to the performance criteria. Given these results, please discuss whether any changes to your assessment methodology are needed to ensure your projections will be conservative.

TVA Response

The history of the largest measured indication and the maximum prediction for the previous several cycles is shown in Table 7.1.

Table 7.1: History of Maximum Actual and Predicted Indication Voltages

Cycle	Largest Indication, V	Largest Prediction, V	Growth used in prediction
EOC-11	3.35	2.7	Max of Cycle 9 or 10, SG specific
EOC-12	9.76	3.7	Bound of Cycle 10 and 11
EOC-13	2.36	10.4	Cycle 12
EOC-14	4.74	9.8	Cycle 12
EOC-15	2.77	5.3	Cycle 14
EOC-16	6.55	4.1	Cycle 14

From Table 7.1 it is seen that outliers happen once every several cycles. After the large indication was detected at end of cycle (EOC)-12 the growth rate used for the predictions for EOC-13 and EOC-14 considered the large growth and, therefore, greatly over-predicted the actual maximum voltage value. Since the guidelines require that the growth rate used bound the previous two cycles, subsequent predictions were made based on the growth in Cycle 14.

There is clearly no trend of largest indication versus operation time.

Tables 7.2 and 7.3 are the same as Tables 5-1 and 5-2 of SG-SGMP-10-2 (Reference 1). The outliers have a noticeable effect on the predicted probability of burst, especially when the probability is small. The probability of burst for SG 4 with the 6.55 V indication was 7.041×10^{-4} compared to the predicted value of 5.11×10^{-4}. This is a change from 5.1 percent of the allowable to 7 percent of the allowable. Viewed in this light, since the probability of burst is well below the acceptance criteria, the change is not very significant.

The leakage is more characteristic of the population of indications and it is conservatively predicted. Even in the case of the 9.76 V indication at EOC-12, as seen in Tables 7.4 and 7.5, the calculated leakage was essentially in line with the prediction.

Table 7.2: Table 5-1 of SG-SGMP-10-2 - Analysis Results for EOC-16 Voltage Distributions with NDE [nondestructive examination] Uncertainty

SG	Number of Monte Carlo Trials	Number of Indications	Maximum Volts Measured	Burst Probability 95% conf.	95/95 Steam Line Break (SLB) Leak Rate, gpm
1	250,000	655	2.81	1.115×10^{-4}	0.191
2	250,000	711	2.71	1.210×10^{-4}	0.213
3	250,000	876	4.17	1.628×10^{-4}	0.377
4	250,000	1505	6.55	7.041×10^{-4}	0.667

Table 7.3: Table 5-2 of SG-SGMP-10-2 - Predicted Results

SG	Number of Monte Carlo Trials	Number of Indications	Maximum Volts Predicted	Burst Probability 95% conf.	95/95 SLB Leak Rate, gpm
1	250,000	890	3.8	2.22×10^{-4}	0.535
2	250,000	994.33	3.8	2.04×10^{-4}	0.603
3	250,000	1191	4.1	4.90×10^{-4}	1.030
4	250,000	2231.33	4.1	5.11×10^{-4}	1.410

Table 7.4: Table 6.2 of SG-SGDA-03-55 - Monte Carlo Analysis Results for Measured EOC-12 Voltage Distributions

SG	Number of Trials	Number of Indications	Max Volts Measured	Burst Probability 95% Conf.	95/95 SLB Leak Rate, gpm
1	250,000	247	1.88	6.2×10^{-5}	0.209
2	250,000	252	1.81	5.3×10^{-5}	0.236
3	250,000	307	9.76	3.6×10^{-3}	1.08
4	250,000	739	3.55	1.4×10^{-4}	0.965

Table 7.5: Table 6.1 of SG-SGDA-03-55 - Predicted Results for EOC-12

SG	Number of Trials	Number of Indications	Max Volts	Burst Probability 95% conf.	95/95 SLB Leak Rate, gpm
1	250,000	216.67	2.4	1.2×10^{-5}	0.519
2	250,000	227.00	2.7	4.2×10^{-5}	0.634
3	250,000	259.00	2.9	5.8×10^{-5}	1.05
4	250,000	1024.00	3.7	7.3×10^{-5}	3.40

It is apparent from Table 7.1 that if a previous outlier is considered in the growth rate then a more conservative prediction is made. The present guidelines require the consideration of the growth rate of the previous two inspections. Since the occurrence of outliers appears to be less frequent than every two inspections, the history of a past outlier can be lost. However, since the outlier has just occurred at EOC-16, the next predictions will consider the growth rate that includes the outlier. As seen in Table 7.6, the prediction for EOC-17 considers the Cycle 16 growth rate.

The predictions for probability of burst and leakage for EOC-17 consider the growth rate of Cycle 16 and are well below the acceptance criteria. The maximum voltage predicted is not required by Generic Letter (GL) 95-05 to be reported but has been reported for SQN, Unit 2, historically to facilitate understanding of the predictions with respect to the measured indication data. The predicted maximum voltage is defined somewhat arbitrarily by the

voltage where the upper tail of the Monte Carlo results of number of indications versus voltage integrates to 0.3 indications.

Table 7.6: Table 6-3 of SG-SGMP-10-2 - EOC-17 Predicted Results

SG	Number of Monte Carlo Trials	Number of Indications	Maximum Volts*	Burst Probability 95% Confidence	95/95 SLB Leak Rate (gpm)
1	250,000	1081.7	7.3	6.529×10^{-4}	0.654
2	250,000	1172.0	7.3	7.254×10^{-4}	0.694
3	250,000	1445.0	7.5	1.009×10^{-3}	1.07
4	250,000	2455.3	7.7	1.796×10^{-3}	1.67

* Voltage where tail is accumulated to 0.3 indications

NRC Question 8

On page E2-2 of your February 19, 2010, letter, you reported the operational assessment leakage for "GL [Generic letter] 95-05" flaws as 1.760 gallons per minute. This value does not match the most limiting value reported on page E1-82 of that letter. Please clarify.

TVA Response

The 1.760 gallons per minute (gpm) value is a typographical error. The operational assessment leakage for GL 95-05 flaws should be 1.670 gpm. The numbers "6" and "7" were transposed when transferring to the subject table. The total leakage from the automatic calculation for the subject table should now be 2.809 gpm instead of 2.899 gpm.

NRC Question 9

Please clarify the first sentence of the second paragraph on page E2-2 of your February 19, 2010, letter. In particular, confirm that you assessed the leakage contribution from all primary water and outside diameter stress corrosion cracking indications at or below the top of the tubesheet in your condition monitoring and operational assessment.

TVA Response

Condition monitoring and operational assessment calculations include all instances of primary water and outside diameter stress corrosion cracking with respect to W* alternate repair criteria leakage contribution regardless of location in the tubesheet.

NRC Question 10

Please discuss whether any of the tubes had the bottom of the WEXTEX transition located more than 2.88-inches below the top of the tubesheet. If so, discuss how many tubes had this condition.

TVA Response

There were no instances where the bottom of the WEXTEX transition was located greater than 2.88 inches below the top of the tubesheet in either the hot leg or cold leg.

NRC Question 11

Please clarify the indication and location columns in Table 2 on page E2-5 of your February 19, 2010, letter. In particular address why there are two indication columns, two "location 1" columns, and two "location 2" columns.

TVA Response

The first set of indication/location columns is the flaw (single axial indication (SAI), single circumferential indication (SCI), or single volumetric indication (SVI)) with the location relative to the top-of-tubesheet and the second set of indication/location columns is the corresponding bottom of WEXTEX transition with the location relative to the top of tubesheet for the tubes listed.

NRC Question 12

Several ODSCC indications were reported in the tubesheet region. Please discuss whether these indications were below the bottom of the expansion transition. If so, discuss how a corrosive environment was achieved below the bottom of the WEXTEX transition (e.g., did the tube lose contact with the tubesheet). If the tube is not in contact with the tubesheet, discuss any implications to W.*

TVA Response

There were no instances where outer diameter stress corrosion cracking was detected below the bottom of the WEXTEX transition.

NRC Question 13

Two indications were attributed to wear from a loose part in steam generator 4. A possible loose part signal was not evident in the eddy current data. Please discuss whether a visual inspection was performed to confirm the absence of a loose part at these locations. Since a loose part may not be conductive or may be a small distance away from the tube and therefore not detected during the eddy current examination, discuss whether an assessment was performed for the continued wear of these tubes. If not, discuss why not.

TVA Response

The two loose part wear indication locations in question are near the bundle periphery and were examined visually during the SG foreign object search and retrieval activities associated with SG No. 4. No foreign material was evident at either location; thus, no further evaluation was warranted.

NRC Question 14

On page 6 of 101 in the May 19, 2010, letter, it was indicated that twelve indications of axial ODSCC was detected in the free span region in three tubes. This appears to contradict the information on page 4 of 101 where four tubes are identified as being plugged for this degradation mechanism. Is this difference a result of counting the one tube that was plugged for axial ODSCC in the sludge pile region as an axial ODSCC indication in the free span? If not, please explain the difference.

TVA Response

The one sludge pile axial ODSCC in the free span of the tube is included in the subject table reflecting the total number for free span axial ODSCC.

NRC Question 15

On page 8 of 101 in the May 19, 2010, letter, it was indicated that the U2C15 operational assessment predicted the limiting accident leakage to be 1.34 gallons per minute and the limiting burst pressure as 4.55E-4. These values do not appear to match those reported on page 5-6 of your February 19, 2010, letter. Please clarify.

TVA Response

The February 19, 2010, letter (Reference 1)values on page 5-6 are SQN, U2C16 predicted limiting accident leakage and limiting burst pressure and not SQN, Unit 2, Cycle 15 (U2C15) being referenced for comparison in the May 19, 2010, letter (Reference 2), page 8 of 101.

NRC Question 16

Please clarify the nature of the geometry affect at the first tube support plate intersection in the tube that was preventively plugged.

TVA Response

The geometry effects identified in U2C15 by the +Point™ inspection were identified to resolve a bobbin indication. This indication is one of several indications that are approximately 0.5-V by bobbin in amplitude that begin approximately 4 inches below the first support and go up to 2 inches above the support. They are discrete singular geometry signals indicating small ding-like signals that are most probably a result of the tube manufacturing process or the result of tube installation during SG manufacture. The indication identified by +Point™ was characterized correctly as geometry. The small amplitude of these indications has negligible effect on the analysis process. The support plate has had a small indication tracked for many outages with little change. During this cycle, SQN U2C16, we experienced large growth in one of our support plate indications. We were unable to determine the cause of the large growth. Since the tube in question had these ding-like indications, we elected to conservatively plug this tube to eliminate the possibility of a high growth indication.

References:

1. Letter from TVA to NRC, "Unit 2 Cycle 16 - 90 Day Steam Generator Report for Voltage-Based Alternate Repair Criteria and W* Alternate Repair Criteria," dated February 19, 2010

2. Letter from TVA to NRC, "Unit 2 Cycle 16 - 180-Day Steam Generator Inspection Report," dated May 19, 2010