Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381-2000

NOV 0 2 2005

10 CFR 50.4

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

Gentlemen:

In the Matter of) Docket No. 50-390
Tennessee Valley authority)

WATTS BAR NUCLEAR PLANT (WBN) UNIT 1 - REQUEST FOR ADDITIONAL INFORMATION FOR END-OF-CYCLE 6 STEAM GENERATOR INSERVICE INSPECTION REPORTS (TAC NO. MC7485)

The purpose of this letter is to respond to NRC's request for additional information dated September 7, 2005, concerning the subject steam generator reports. The enclosure provides TVA's responses to NRC's questions as requested.

There are no regulatory commitments associated with this submittal. If you have any questions concerning this matter, please call me at (423) 365-1824.

Sincerely,

P. L. Pace
Manager, Site Licensing
and Industry Affairs

Enclosure
cc: See Page 2

A047

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Enclosure
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NRC QUESTION 1

Subsequent to your 2003 steam generator tube inspections (End-of-Cycle 5), you identified five tubes which were left in service despite having indications in the parent tube below the location where a sleeve was installed during the 2003 outage. Please confirm that these five tubes (row 18 column 35; row 19 column 32; row 22 column 31; row 22 column 37; row 42 column 55) were plugged during your 2005 outage (end-of-cycle 6). In addition, please confirm that no similar tubes were left in service following your 2005 steam generator tube inspection (i.e., confirm that F was not applied to a sleeved tube.)*

TVA RESPONSE

The steam generator tubes listed above were plugged during the End-of-Cycle (EOC)-6 outage. F* was not applied to tubes if sleeves were installed.

NRC QUESTION 2

In your June 28, 2005 letter, it was indicated that several of the tubes remaining in service contained indications located where the tube passes through the flow distribution baffle. Please confirm that your amendment request for implementing the voltage-based tube repair criteria discussed in Generic Letter (GL) 95-05 addressed the conditions in Section 2.a.3 of Attachment 1 to GL 95-05 (since specific U.S. Nuclear Regulatory Commission (NRC) approval is needed to apply the voltage-based limits to flow distribution baffle intersections).

a) *That is, confirm that your amendment request addressed the causal factors for high voltage growth at flow distribution baffle intersections and the applicability of these conditions at your plant. Also,*
b) *please discuss whether the average growth rates for the flow distribution baffle indications were less than that observed in steam generator 3 (although page 3-18 indicates that the average growth rates are less than that seen in steam generators 1 and 2, flow distribution baffle indications were found in steam generators 1, 2, and 3). If not, please discuss the implications.*

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TVA RESPONSE

a) TVA requested a change to Technical Specifications allowing the application of voltage based criteria at tube support plates and flow distribution baffle plates in a letter dated April 10, 2000, and provided additional information in letters dated September 18, 2000, August 22, 2001, November 8, 2001 and January 15, 2002. NRC approved the change to Technical Specifications in a letter dated February 26, 2002. The NRC safety evaluation attached to the February 26, 2002 letter approved the amendment as applicable to both tube support plates (TSPs) and flow distribution baffle (FDB) plates.

b) The indications detected at the FDB that were used in the growth analyses are shown below in a copy of Table 3-10 of TVA's June 28, 2005 letter:

SG	Row	Column	Support	Plugged	EOC6 Volts	EOC5 Volts	Change in Volts
1	8	75	H01	Yes	0.31	0.19	0.12
2	18	79	H01	Yes	0.46	0.29	0.17
2	27	85	H01		0.38	0.19	0.19
2	38	77	H01	Yes	0.27	0.22	0.05
3	14	86	H01		0.55	0.69	-0.14

Average change = growth / EOC-5 volts = 25 percent

The average growth rates (growth/EOC-5 volts) for each of the four steam generators is:

SG	Average Growth	Reference*
1	26%	Table 3-5
2	27%	Table 3-6
3	14%	Table 3-7
4	9%	Table 3-8

**Reference is found in TVA's letter to NRC dated June 28, 2005*

The statement that the average growth rate of the FDB indications is less than the average of Steam Generator 1 and Steam Generator 2 was made to indicate that the growth rate of the FDB indications is in the range of the rate observed for all indications in the steam generators with the highest rate and is therefore, not considerably

different from the growth rate of indications in the other TSPs.

In the predictive analysis the growth rates of individual steam generators was not used. Instead, the bounding growth rate curve shown in Figure 3-13, Figure 3-14, and Table 3-9 of TVA's June 28, 2005 letter is a result of the growth in Steam Generator 1 and Steam Generator 2. Thus, while the average growth rate observed in the FDBs exceed the growth in Steam Generator 3, the growth rate in Steam Generator 3 is bounded by the growth observed in Steam Generator 1 and Steam Generator 2, and therefore, there are no implications.

A better demonstration of the observation that the growth rates are not considerably different is a comparison with the bounding cumulative distribution of the growth rate in the four steam generators shown in Figure 1 below and in Figure 3-13 in the June 28, 2005 report. Also shown is the cumulative distribution of the FDB indications conservatively adjusted by Benard's approximation equation (Note 1) because of the small number of data points.

Note 1
Benard's approximation equation, i.e.,

$$\text{Median Rank Fraction} = \frac{\text{Actual Rank} - 0.3}{N_T + 0.4}$$

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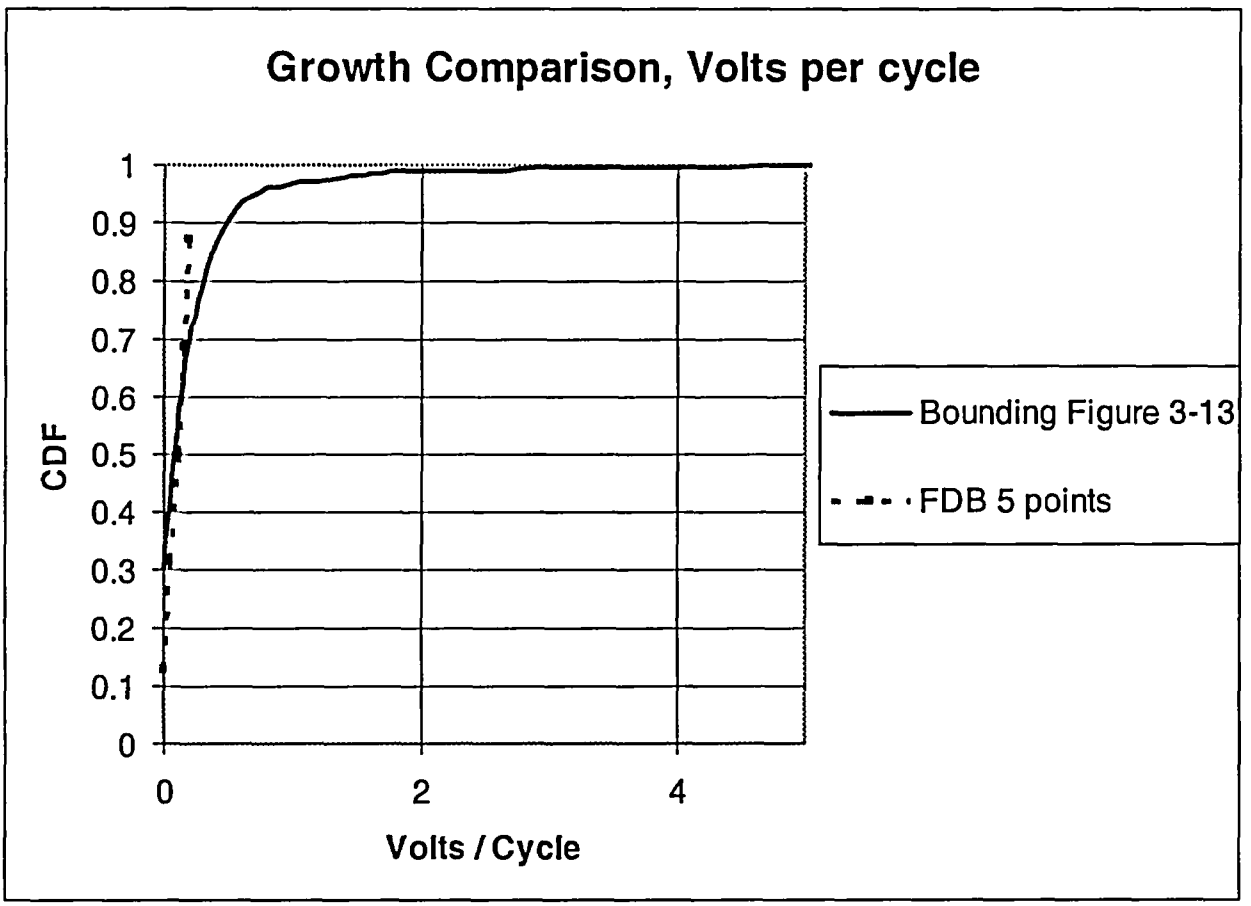
FIGURE 1



From the figure, it is clear that the growth rate of the FDB indications is not considerably different from the growth rate of the TSPs.

NRC QUESTION 3

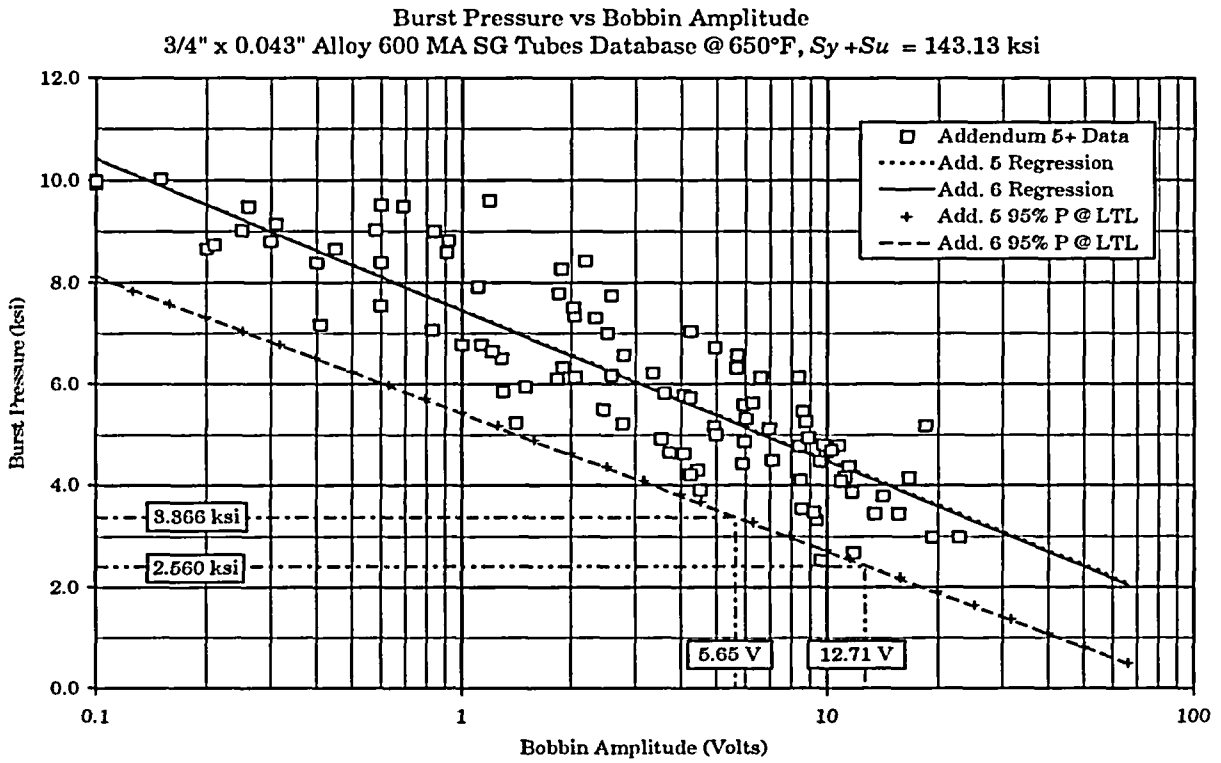
One tube was identified with a 6.32 volt indication. Please discuss what actions, if any, were taken to ensure that this tube had adequate structural integrity since the voltage exceeded the structural limit of 5.65 volts.

RESPONSE

There is no requirement to do single-tube structural integrity calculations. The requirement in GL 95-05 is for a probability of burst for the bundle. This indication was included in the bundle analysis, and the steam generator met structural

performance criteria. Therefore, no additional actions were taken. If a single tube is of interest, according to Figure 6-2 of Addendum 6 of EPRI Report NP-7480-L shown below, an indication greater than 12 volts would be expected to meet the steam line break pressure with 95 percent probability using 95/95 lower tolerance limit material properties. The 5.65 limit in the Addendum is used as an upper bound repair limit. Above this limit, rotating coil examination cannot be used to keep the indication in service. Below this limit, if rotating pancake coil (RPC) does not confirm the indication, the tube can be left in service.

FIGURE 6-2
¾-INCH BURST PRESSURE CORRELATION



NRC QUESTION 4

On page 5-7 of your June 28, 2005, letter, you indicated that the end-of-cycle 6 predicted values of the probability of burst and leakage were conservative because they were based on a very conservative industry voltage growth rate. However, your January 15, 2004, letter (ML040220171) indicates that Table 3-9 was used

for the End-of-Cycle 6 projections. Table 3-9 provided a bounding growth rate from all four steam generators at Watts Bar. Please confirm whether an industry voltage growth rate or a plant-specific growth rate was used in the calculations.

RESPONSE

The statement "The predicted values of the probability of burst and leakage were conservative because they were based on a very conservative industry voltage growth rate in Reference 5." is incorrect. This is an editorial error. A plant specific growth rate was used in the calculations. Table 3-9 of the Cycle 5 90-day Report provided a bounding growth rate of all four steam generators at Watts Bar as NRC indicated.

NRC QUESTION 5

The largest voltage indication observed at the End-of-Cycle 6 (2005) was not predicted. This resulted in exceeding the limiting projection on probability of burst. In addition, the most limiting accident induced leak rate (0.175 gallons per minute (gpm)) was exactly predicted (although for a different steam generator). Given that the maximum voltage indication was not predicted and that your probability of burst projections for End-of-Cycle 7 (8.65×10^{-3}) are near the limits (10^{-2}), discuss what corrective actions were taken to ensure such an under-prediction in the maximum observed voltage (and probability of burst) does not occur for the End-of-Cycle 7. The NRC recognizes that tube inspections will not be performed at the End-of-Cycle 7 due to the planned replacement of the Watts Bar steam generators.

RESPONSE

TVA has followed industry guidance at Sequoyah for preventing large growth for outside diameter stress corrosion cracking (ODSCC) at support plates. This guidance suggests that an indication between 1 volt and 2 volts may experience large growth and recommends plus point inspections of indications greater than 1 volt instead of the required 2 volts for Model 51 steam generators with preventive plugging.

The requirement for plus point examination for Model D steam generators at Watts Bar is already 1 volt and the repair limit is 1 volt, therefore, no additional examinations were performed. All indications except for the one 6.32 volt indication were

under the predicted maximum voltage. The one 6.32 volt indication significantly affected the predictions for Unit 1 Cycle 7. Since performance criteria were met and predicted to be met for the entire cycle, no additional actions were taken for indications less than 1 volt.

NRC QUESTION 6

Figure 3-17 indicates that several of the larger voltage indications exhibited negative growth. Although the staff is aware that this does occur at other plants, the large number of negative growths (resulting in a decreasing trend in growth rate as a function of beginning-of-cycle voltage) does not appear to be consistent with that observed at other plants. Please discuss any insights on this trend including a discussion of whether these results draw into question the non-destructive examination uncertainty models applied at Watts Bar.

RESPONSE

The trend of decreasing growth with increasing beginning-of-cycle (BOC) voltage has been observed and reported in other plants, including Sequoyah Unit 1 EOC 11. This is not unexpected when the average growth rate is small. This phenomenon is likely caused by small indications with larger non-destructive examination (NDE) error in one cycle growing to an easier to characterize size in the next inspection, thus less NDE error, giving the appearance of negative growth.

NRC QUESTION 7

In section 4.6, the upper voltage repair limit was calculated. Please discuss the purpose for the "(518/482)" adjustment in calculating this limit.

RESPONSE

The upper voltage repair limit is based on the structural limit in Table 4-1 of 5.65 volts for accident pressure of 2405 pounds per square inch (psi). It must be reduced by considering the projected voltage growth during the next cycle and NDE uncertainty. The maximum average percentage growth rate for any steam generator is seen from Table 3-6 (SG 2) to be 27 percent per 482 day Cycle 6. According to Reference 1 in TVA's June 28,

2005 letter, the minimum growth adjustment is 30 percent per effective full power year (EFPY)(42.5 percent per cycle for the anticipated 518 effective full power days (EFPD)Cycle 7). Therefore, the specific maximum value of 42.5 percent and 20 percent for NDE uncertainty will be used to estimate the voltage repair limit. This results in an upper voltage repair limit of 5.65 / (1 + 0.425 + 0.20) = 3.47 volts. No indications equal to or greater than this voltage were left in service.

The limiting free span burst pressure is three times normal operating differential pressure (NODP). Reference 2 in TVA's June 28, 2005 letter, notes a reactor coolant system (RCS) pressure of 2235 pounds per square inch gauge (psig) and steam pressure of 934 psig, making 3NODP = 3903 psi. The upper voltage repair limit for FDB intersections is based on the structural limit from Figure 6-2 of Reference 6 in TVA's June 28, 2005 letter, of 3.29 volts for a free span burst pressure of 3903 psi. It must be reduced by considering the projected voltage growth during the next cycle and NDE uncertainty. The average percentage growth rate for the FDBs, from Table 3-10, is 25 percent during the 482 day Cycle 6. According to Reference 1 in TVA's June 28, 2005 letter, the minimum growth adjustment is 30 percent per EFPY (42.5 percent per cycle for the anticipated 518 EFPD Cycle 7). Therefore, the specific maximum value of 42.5 percent and 20 percent for NDE uncertainty will be used to estimate the voltage repair limit. This results in an upper voltage repair limit of 3.29 / (1 + 0.425 + 0.20) = 2.02 volts. No FDB indications equal to or greater than this voltage were left in service.

The small difference in the upper voltage repair limit is conservative and does not change the results.

NRC QUESTION 8

Section 5.0 describes the condition monitoring assessment. Figures 5-1 through 5-4 depict the distribution of end-of-cycle voltages adjusted by the non-destructive examination uncertainty distribution. Please discuss whether the discrete distributions in these figures (which may have been truncated/adjusted for fractional indications) were used in the condition monitoring assessment or whether the condition monitoring assessment utilized a non-truncated/adjusted distribution of indications.

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Condition monitoring assessments use the as-found-distribution with size adjusted for NDE uncertainties. These distributions are not truncated or adjusted otherwise. The fractional indications are a result of the 0.6 probability of detection and are used in operational assessments.

The Monte Carlo analysis for the condition monitoring assessment calculation predicts some indication trial voltages in excess of 8.2 volts in the case of Steam Generator 2, where the values are truncated in Figure 5-2 at 6.9 volts. The values are truncated for graphical display only by integrating the upper tail of the Monte Carlo trial results to 0.3 and 0.7 of an indication.

NRC QUESTION 9

Section 4.7 provides an assessment of the probe wear criteria used at Watts Bar. In a portion of this assessment, the ratio of the current number of indications greater than 1 volt to the total number of these indications that were inspected with a worn probe in the previous inspection was compared to the ratio of the number of indications greater than 1 volt to the total number of indications in the current inspection. Based on similar ratios, a conclusion was drawn that there was no significant effect of probe wear on the population of indications. The staff notes that such a comparison is only valid if the number of tubes inspected with both a worn and good probe is comparable. That is, if the number of tubes inspected with worn probes is significantly different from the number of tubes inspected with a good probe, an erroneous conclusion may be made with respect to the adequacy of the probe wear criteria. As a result, please compare the percentage of new indications at the end-of-cycle (EOC) 6 that were inspected with a worn probe during the EOC-5 inspection to the percentage of new indications that were inspected with a good probe during the EOC-5 inspection. In addition, please compare the percentage of new indications greater than or equal to 0.5 volts during the EOC-6 inspection that were inspected with a worn probe during the EOC-5 inspection to the percentage of new indications greater than or equal to 0.5 volts during the EOC-6 inspection that were inspection with a good probe during the EOC-5 inspection. If there are significant differences, please provide an assessment of the adequacy of the probe wear criteria and its impact on your operational assessment for EOC-7. Calculation of the above percentages requires the

total number of tubes inspected with a good and worn probe during the EOC-5 inspections. A value of 0.5 volts was chosen to be consistent with the NRC staff's approval of the alternate probe wear criterion (refer to NRC letter to Nuclear Energy Institute dated February 9, 1996).

RESPONSE

A review of the data from the 2003 EOC-5 inspection was conducted to identify the tubes that were inspected with a worn probe and not reinspected with a good probe. The list of calibration groups that failed calibration was identified. The following information was developed by interrogating the data:

TABLE 1
Identification of Tubes Tested with Worn Probe in 2003 EOC-5 and Categorization of New Indications

SG	Original tubes	Plug prior to 2003	Tested with Worn probe (HL)	Tested with Good Probe (Difference)	Number of indications in 2005 EOC-6 (HL and CL)	Number of new indications in 2005 EOC-6	Number of new (2005) indications in tubes with worn probe in 2003	Number of new (2005) indications in tubes tested with good probe in 2003
SG1	4674	49	1974	2651	330	122	59	63
SG2	4674	57	2727	1890	193	85	38	47
SG3	4674	48	1776	2850	201	76	23	53
SG4	4674	98	1883	2693	216	94	17	77
Total			8360	10084	940	377	137	240

NOTE: *The number of new indications in tubes tested with a worn probe in 2003 of 137 is higher than the number of 106 reported in the 90 Day Report. This is a consequence of a more thorough search for such indications. This small difference does not impact the conclusions.*

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TABLE 2
Ratio of New Indications in Tubes with Worn/Good Probe to Number of Tubes Tested with Worn/Good Probe. (Data from Table 1.)

SG	Ratio of new indications in tubes with worn probe to number of tubes tested with worn probe	Ratio of new indications in tubes with good probe to number of tubes tested with good probe
SG1	0.0299	0.0238
SG2	0.0139	0.0249
SG3	0.0130	0.0186
SG4	0.00903	0.0286
SUM	0.0658	0.0958
Average	0.0165	0.0240

TABLE 3
Number of New Indications Equal to or Greater than 0.5 Volts

SG	Number of new indications in 2005 greater or equal to 0.5 volts	Number of new (2005) indications greater or equal to 0.5 volts in tubes with worn probe in 2003	Number of new (2005) indications greater or equal to 0.5 volts in tubes tested with good probe in 2003
SG1	82	44	38
SG2	45	19	26
SG3	51	15	36
SG4	63	10	53
Total	241	88	153

TABLE 4
Ratio of New Indications in Tubes with Worn/Good Probe to Number of Tubes Tested with Worn/Good Probe
(indications equal to or greater than 0.5 volts)

SG	Ratio of new indications in tubes with worn probe to number of tubes with worn probe	Ratio of new indications in tubes with good probe to number of tubes with good probe
SG1	0.0223	0.0143
SG2	0.00697	0.0138
SG3	0.00845	0.0126
SG4	0.00531	0.0197
SUM	0.0430	0.0604
Average	0.0108	0.0151

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The voltage distributions of the new indications are shown in Figures 1 through 4 for Steam Generators 1 through 4 respectively.

FIGURE 1

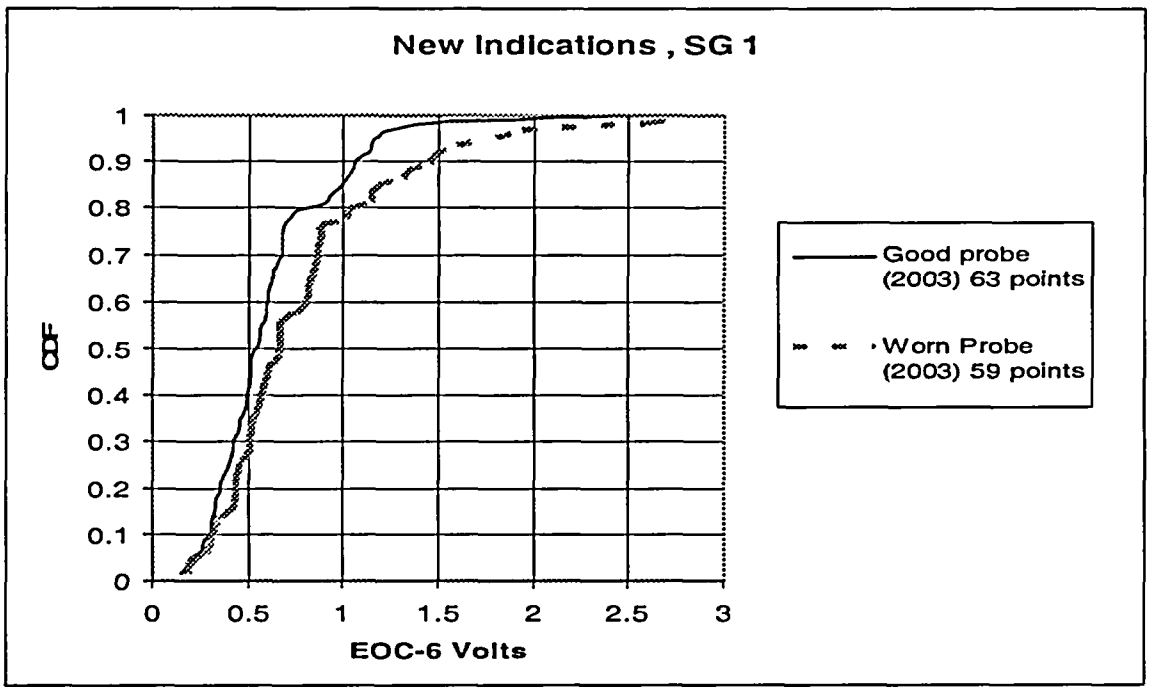

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FIGURE 2

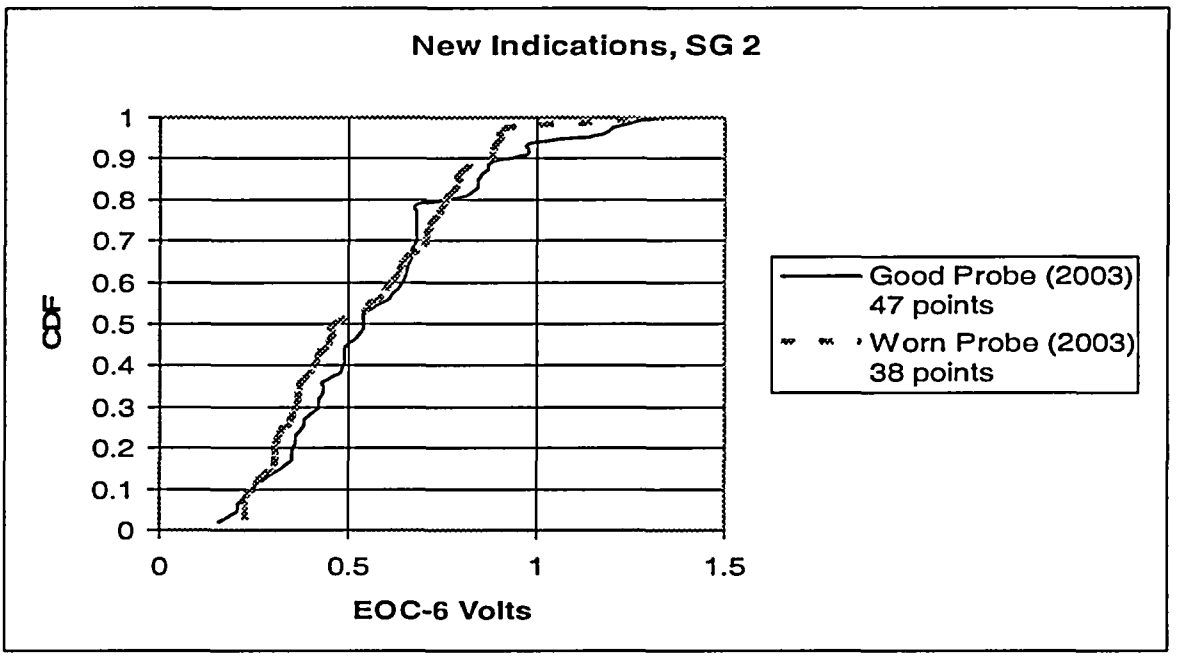

FIGURE 3

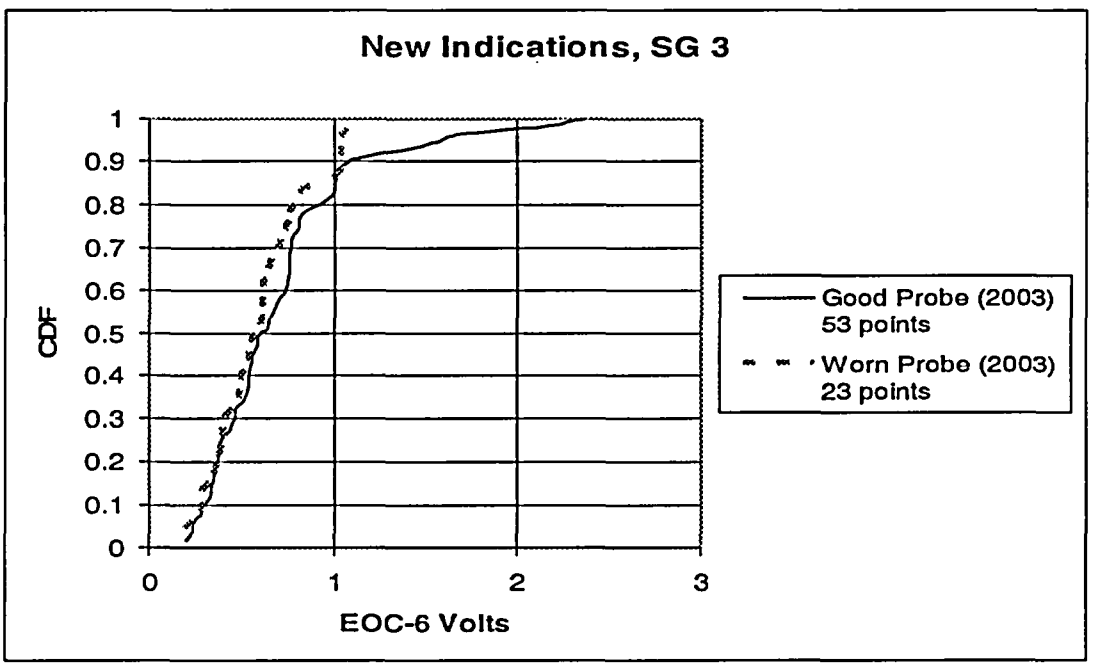

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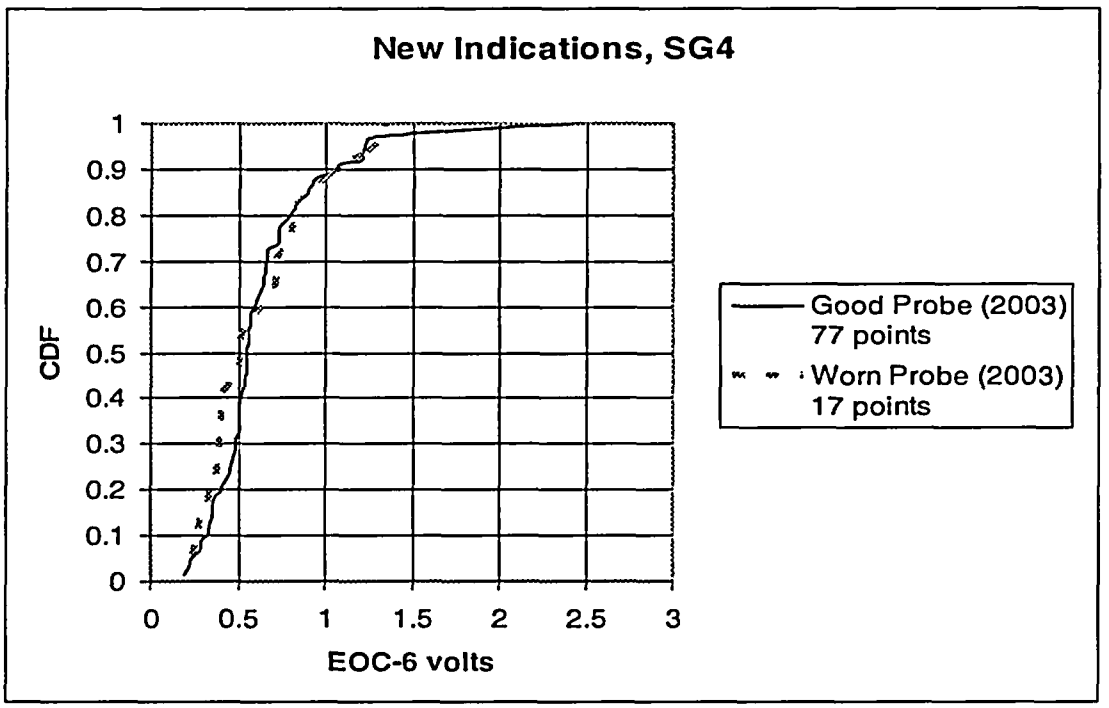
FIGURE 4



Discussion

From Table 1 it is seen that the number of new indications found in tubes that had previously been tested with a good probe is slightly greater than the number found in tubes that had been previously tested with a worn probe. Table 1 also shows that the number of tubes tested with a worn probe is only slightly less than the number of tubes tested with a good probe. From the new indication totals in Table 1, 36.3 percent of the new indications were in tubes previously tested with a worn probe and 63.7 percent were in tubes previously tested with a good probe. From Table 3, the corresponding percentages for new indications equal to or greater than 0.5 volts are essentially the same, 36.5 percent and 63.5 percent respectively.

The ratio of new indications to the number of tubes tested is given in Table 2. There is some variation among the different steam generators as would be expected from random events. The totals, however, show that the ratio of new indications in tubes previously tested with worn probes to the total number of tubes tested with worn probe is 0.0165, or 1.7 percent. The ratio of new indications in tubes previously tested with good probes to the total number of tubes tested with good

probes is 0.0240, or 2.4 percent. For new indications equal to or greater than 0.5 volts, the corresponding totals from Table 4 show that the ratio of new indications in tubes previously tested with worn probes to the total number of tubes tested with worn probe is 0.0108, or 1.1 percent. The corresponding ratio of new indications in tubes previously tested with good probes to the total number of tubes tested with good probes is 0.0151, or 1.5 percent.

These observations indicate that there is not a significant difference in the rate of detection of new indications in tubes previously tested with worn probes or good probes.

The voltage magnitude of the new indications in tubes previously tested with worn probes and good probes is essentially the same as seen in Figures 1 through 4. This further supports the position that significant differences in results are not occurring due to previous testing.