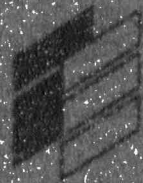Crystal River 3 8R/9R
Bobbin Voltage (S/N) Growth Rate Calculations

Submitted by

PACKER
ENGINEERING

E. D. Brown
Senior Consultant

May, 1995

Report No. 951906-H1

Prepared for:
Florida Power Corporation

Crystal River 3 8R/9R
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Summary

Voltage growth rates, scatter plots and distributions were calculated for the Crystal River 3 A & B steam generators using bobbin coil eddy current data acquired during 1992 (8R) and 1994 (9R). Calculations were made for free-span indications and indications at tube support structures. Approximately 442 A S/G indications and 1733 B S/G 9R indications were compared with 8R reported indications. Only those indications with less than a 5:1 signal-to-noise ratio reported during the 9R outage with 8R confirmation were used in the calculations.

Table 1 provides a summary of the average change and standard deviation for each steam generator and location of interest. The average values and standard deviations as determined from voltage change distributions are essentially the same for all cases considered with mean values and standard deviations of approximately zero and 0.15 respectively. It is concluded from the Table 1 data that there was no growth of eddy current indications in both steam generators at either the free-span or tube support plates from 1992 to 1994. This finding is consistent with previous growth rate studies performed in 1992 and 1994.

Regression analysis of the data show no strong dependency of voltage change on amplitude. The scatter in the support plate data as measured by the standard deviation is generally larger than the free-span data; this is attributed to support plate residual effects. All of the data are essentially distributed about a 45 degree line of zero growth which implies that changes in amplitude are most likely due to eddy current repeatability effects rather than real growth. Detailed results for individual steam generators and locations are presented in the following sections.

Table 1
CR-3 Growth Rate Summary

Steam Generator	Location	Number of Indications *	Average Value	Standard Deviation
A	Free-Span	62	+ 0.060	0.15
	Tube Support Plates	73	+ 0.042	0.18
B	Free-Span	232	+ 0.002	0.11
	Tube Support Plates	234	+ 0.002	0.16

Notes:
* 9R indications with 8R confirmation

<u>Steam Generator A</u>

- Free Span

Figure 1 presents a voltage scatter plot for the 1992/1994 outage S/G A free-span. The data are described by the regression equation Y = 0.88 * X + 0.01, with a correlation coefficient of R = 0.87 and a standard deviation of 0.19. The scatter plot shows a slight negative bias with increasing voltage. Figure 2 shows the voltage change distribution for the two outages with a Gaussian fit to the data. The mean change is + 0.060 volts with a standard deviation of 0.15 volts. The distribution of all free-span indication voltages reported during the 1994 outage is shown in Figure 3. The peak of the distribution occurs at approximately 0.5 volts.

- Tube Support Plates

Figure 4 presents a voltage scatter plot for S/G A 1992/1994 tube support plate indications. The data are described by the regression equation Y = 0.85 * X + 0.07, with a correlation coefficient of R = 0.63 and a standard deviation of 0.21. As with the previous free-span data, a slight negative bias with increasing voltage is exhibited. Figure 5 shows the voltage change distribution for the two outages for indications at tube support plates. The mean change is + 0.042 volts with a standard deviation of 0.18 volts. The distribution of voltages for all indications at tube support plates reported during the 1994 outage is shown in Figure 6. The peak of the distribution occurs at approximately 0.5 volts similar to the free-span data.

<u>Steam Generator B</u>

- Free-Span

Figure 7 presents a voltage scatter plot for the S/G B free-span data. The data are described by the regression equation Y = 0.92 * X + 0.03, with a correlation coefficient of R = 0.88 and a standard deviation of 0.14. For this case, the data are essentially randomly distributed about the no-growth line at 45 degrees. Figure 8 shows the voltage change distribution for the two outages. The mean change is + 0.002 volts with a standard deviation of approximately 0.11 volts. The distribution of free-span voltages reported during the 1994 outage is shown in Figure 9. The peak of the distribution occurs at approximately 0.3 volts.

• Tube Support Plates

Figure 10 presents a voltage scatter plot for the S/G B tube support plate indications. The data are described by the regression equation Y = 0.79 * X + 0.16, with a correlation coefficient of R = 0.68 and a standard deviation of 0.21. A slight negative bias with increasing voltage is present. Figure 11 shows the voltage change distribution for the two outages. The mean change is + 0.002 volts with a standard deviation of 0.16 volts. The distribution of voltages for indications at tube support plates reported during the 1994 outage is shown in Figure 12. The peak of the distribution occurs at approximately 0.5 volts.
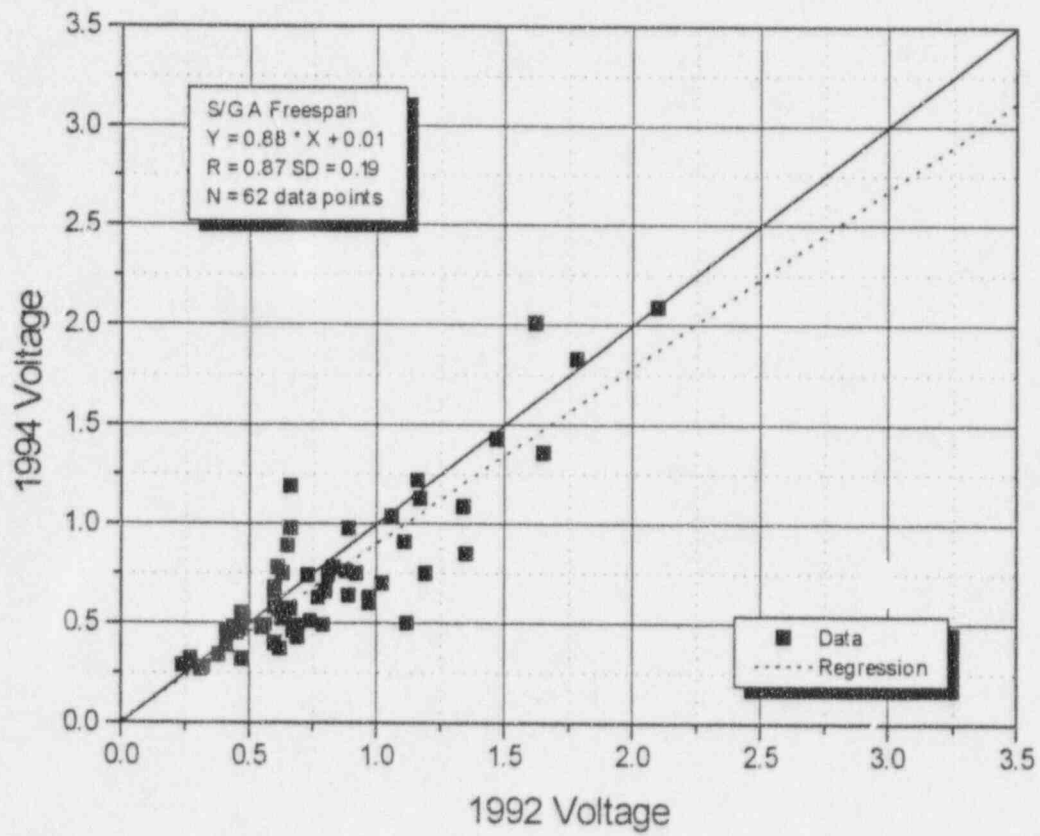
Figure 1. S/G A Voltage Scatter Plot - Free-Span Indications.
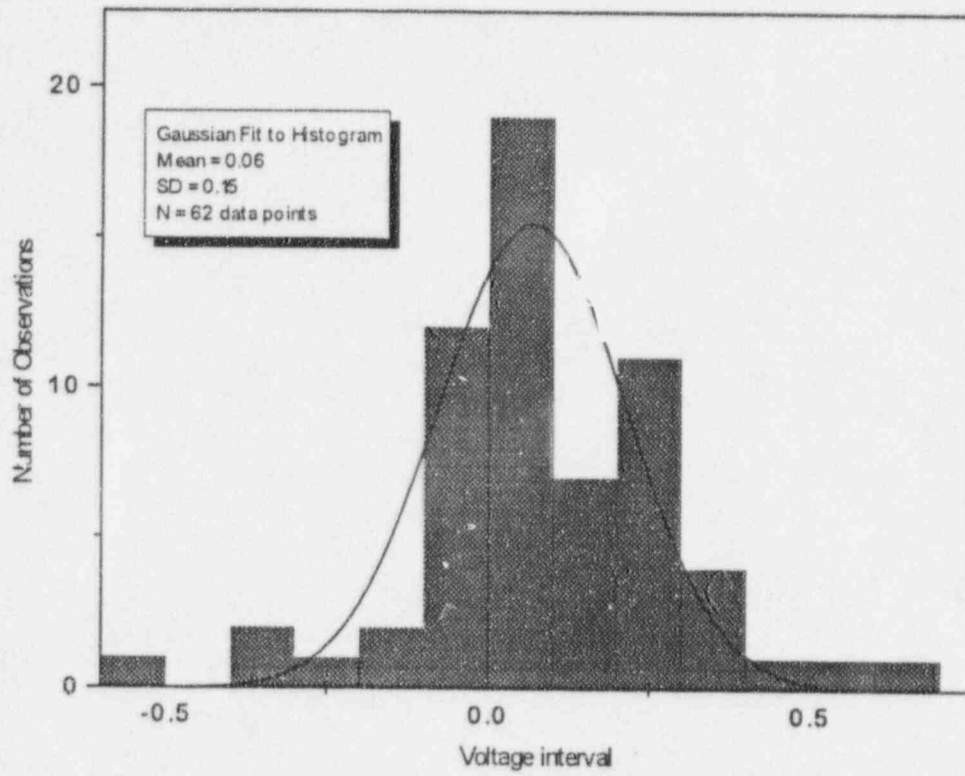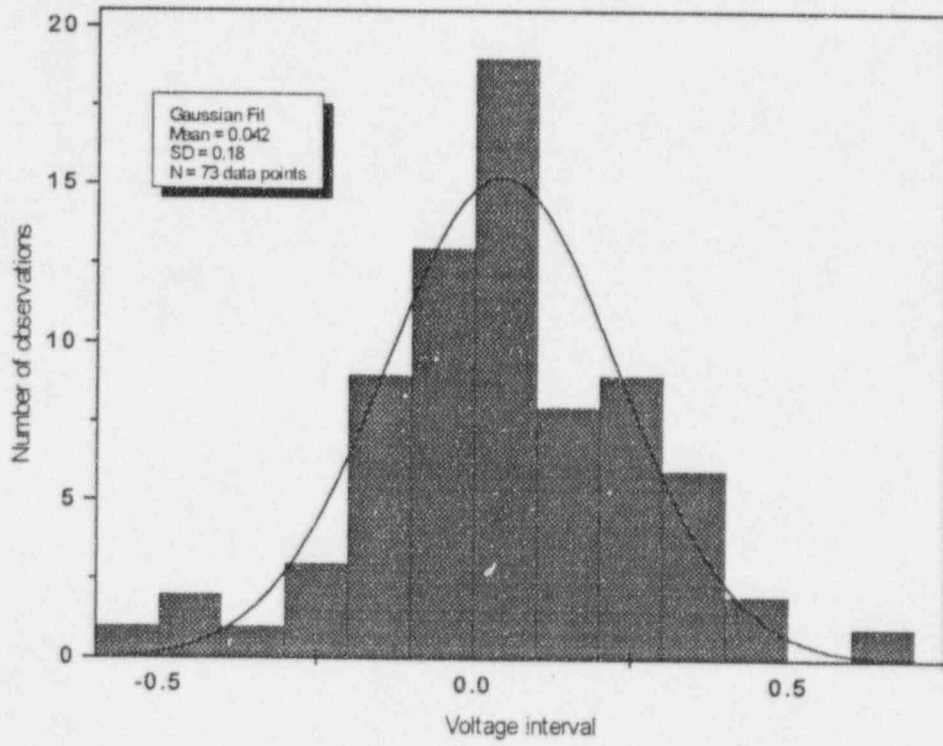
Figure 2. S/G A Voltage Change Distribution - Free-Span Indications.
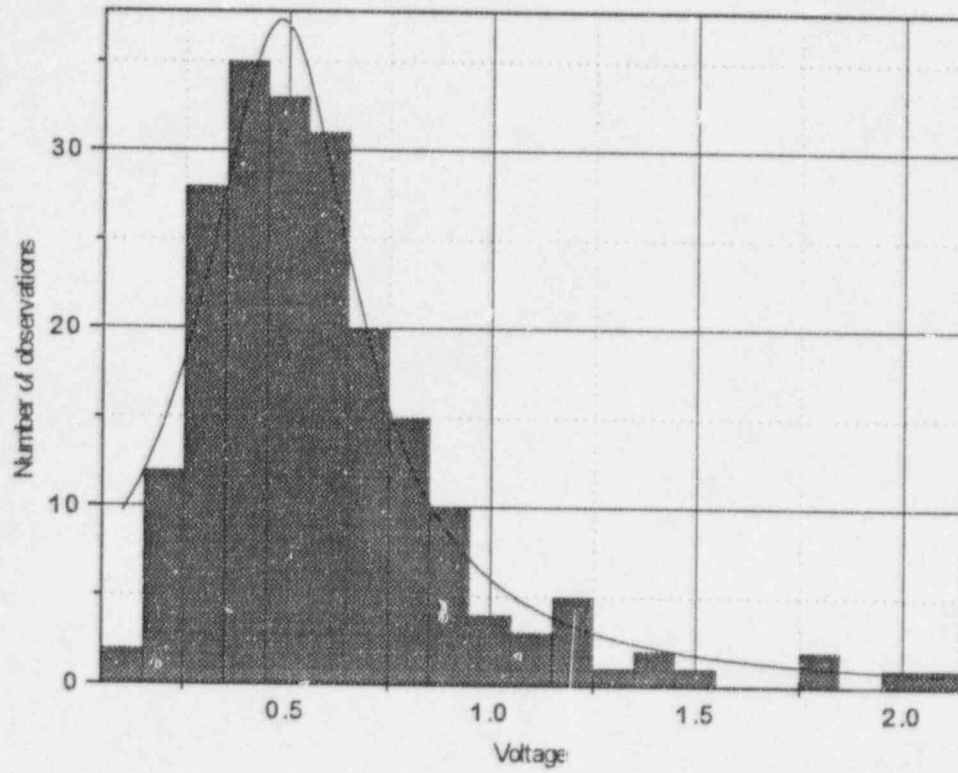
Figure 3. S/G A Voltage Histogram Fit With A Lorentz Distribution All 9R
Free-Span Indications.

S/G A TSP
Y = 0.85 * X + 0.07
R = 0.63 SD = 0.21
N = 73 data points
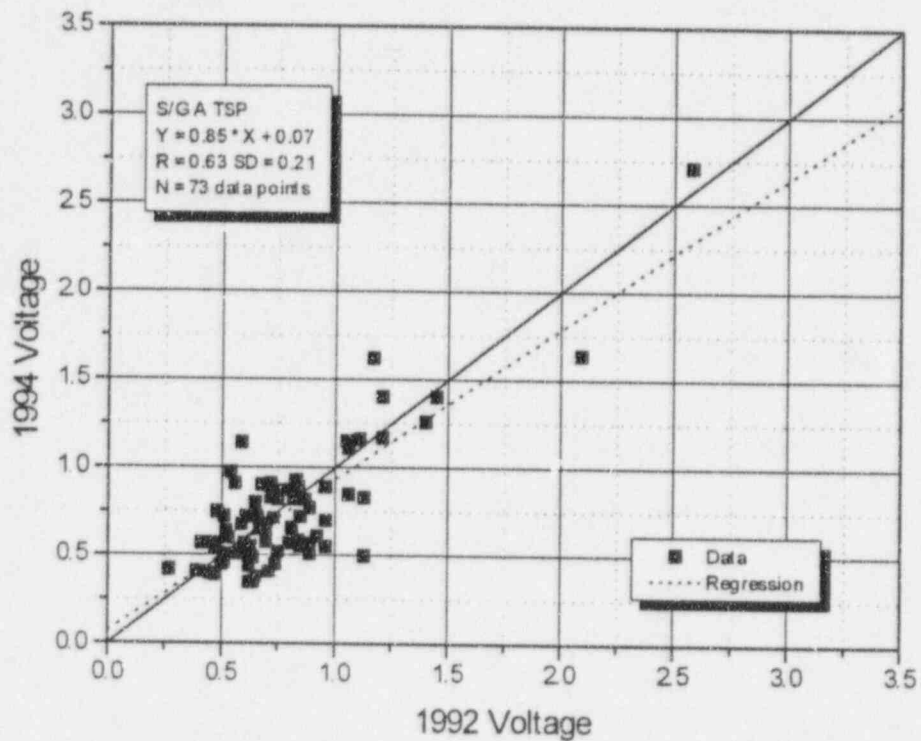
Figure 4. S/G A Voltage Scatter Plot - Indications at Tube Support Plates.

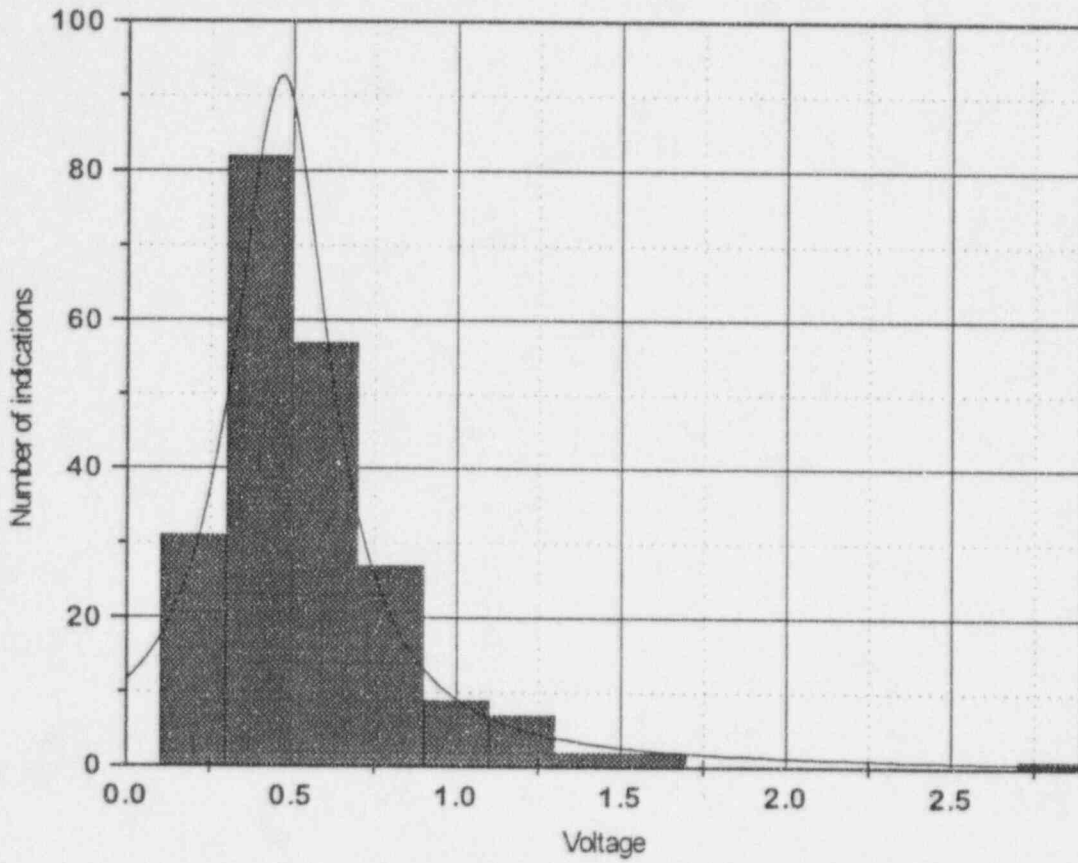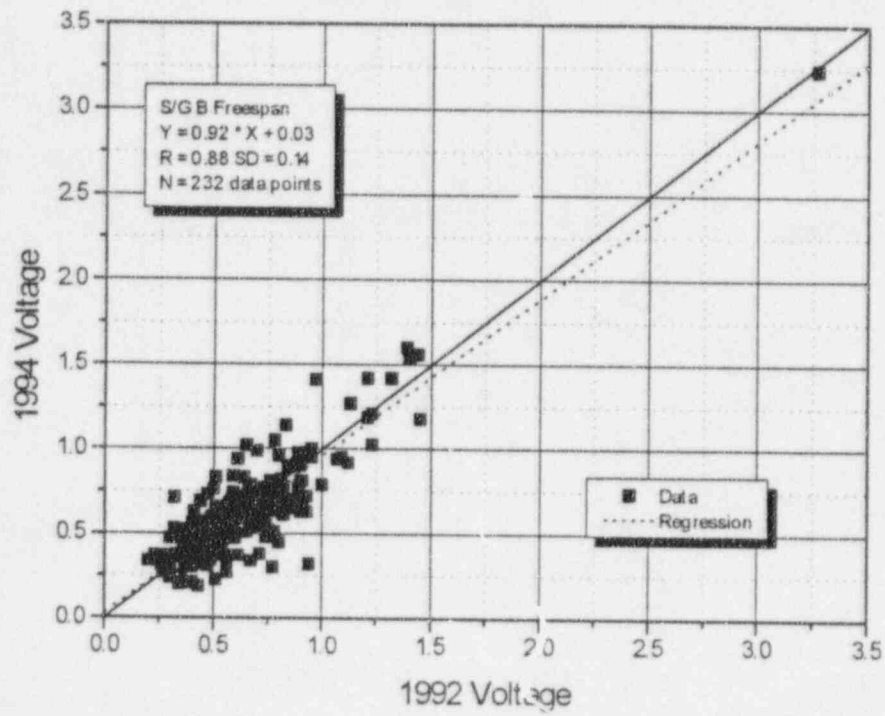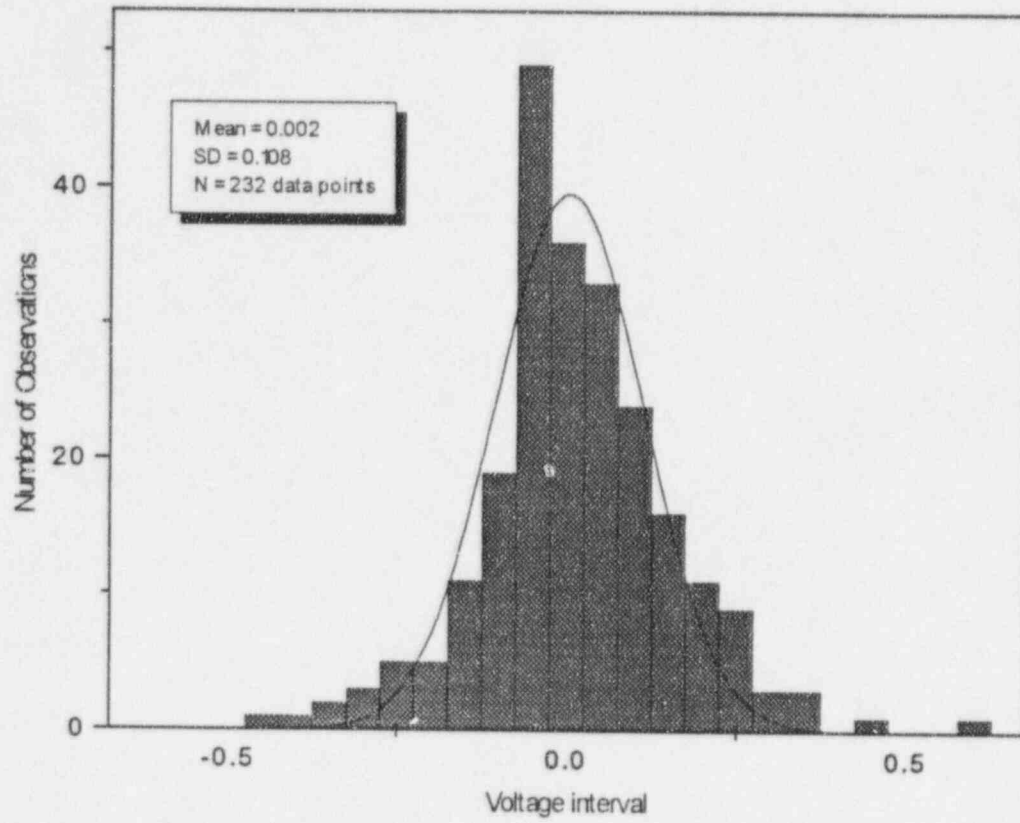Figure 5. S/G A Voltage Change Distribution - Indications at Tube Support
Plates.

Figure 6. S/G A Voltage Histogram Fit with A Lorentz Distribution - All 9R Indications at Tube Support Plates.

Figure 7. S/G B Voltage Scatter Plot - Free-Span Indications.

Figure 8. S/G B Voltage Change Distribution - Free-Span Indications.
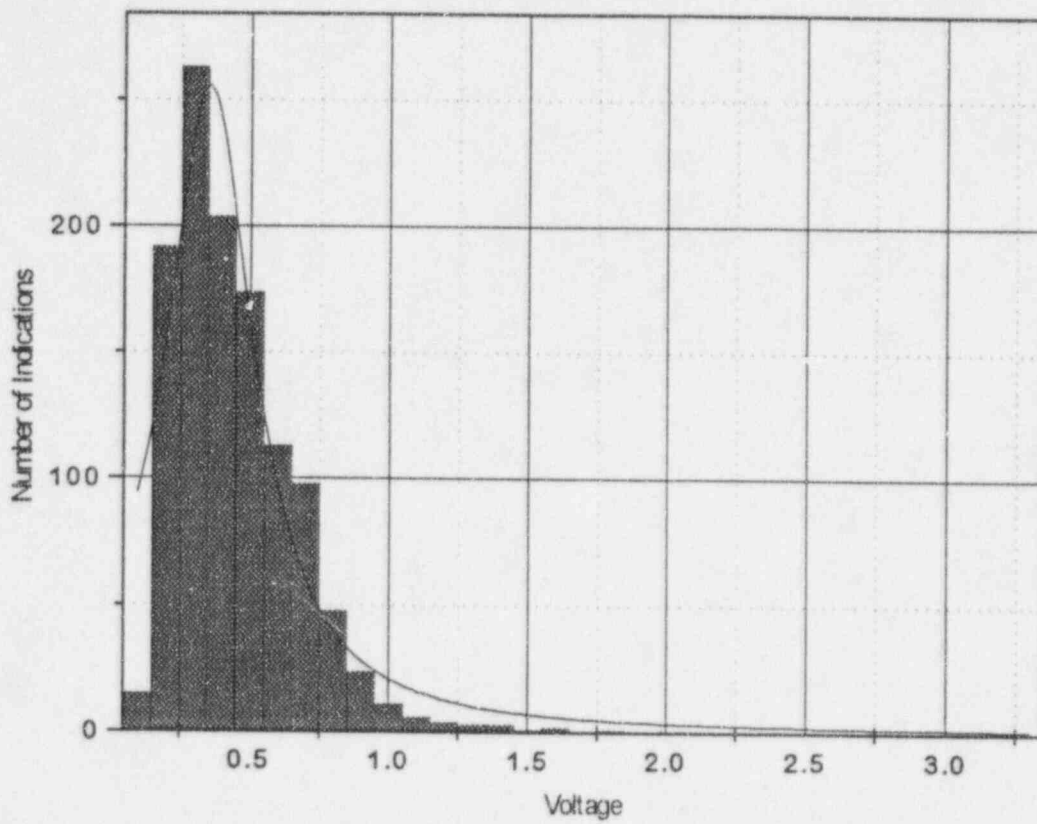
Figure 9. S/G B Voltage Histogram Fit With A Lorentz Distribution - All 9R
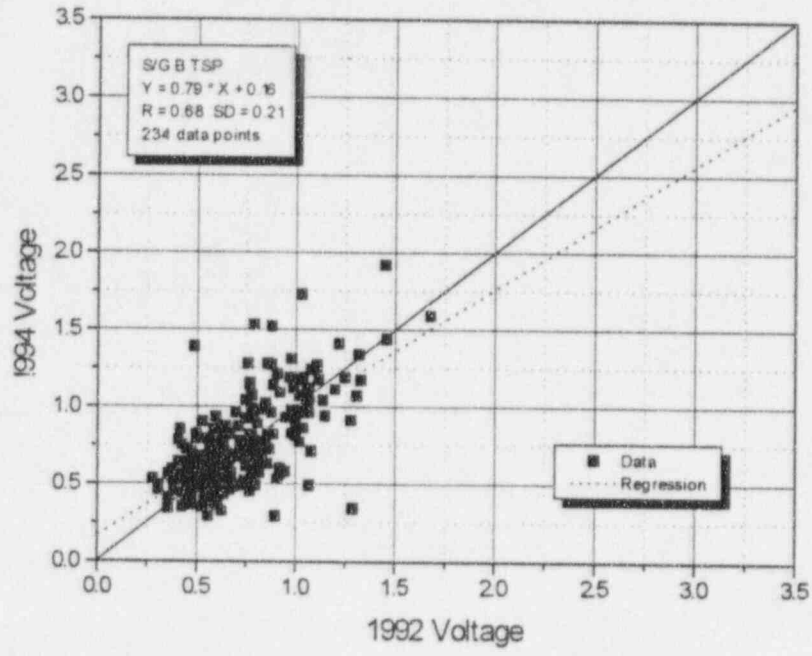Free-Span Indications.

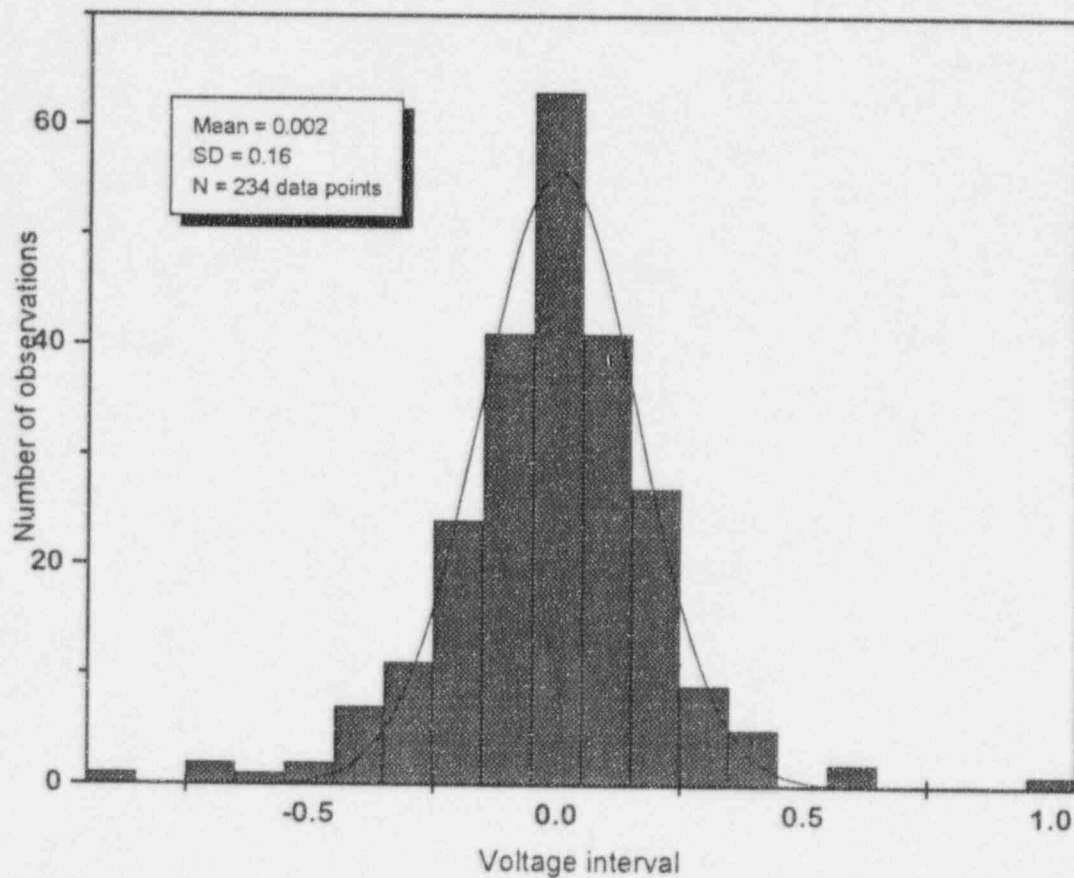Figure 10. S/G B Voltage Scatter Plot - Indications at Tube Support Plates.

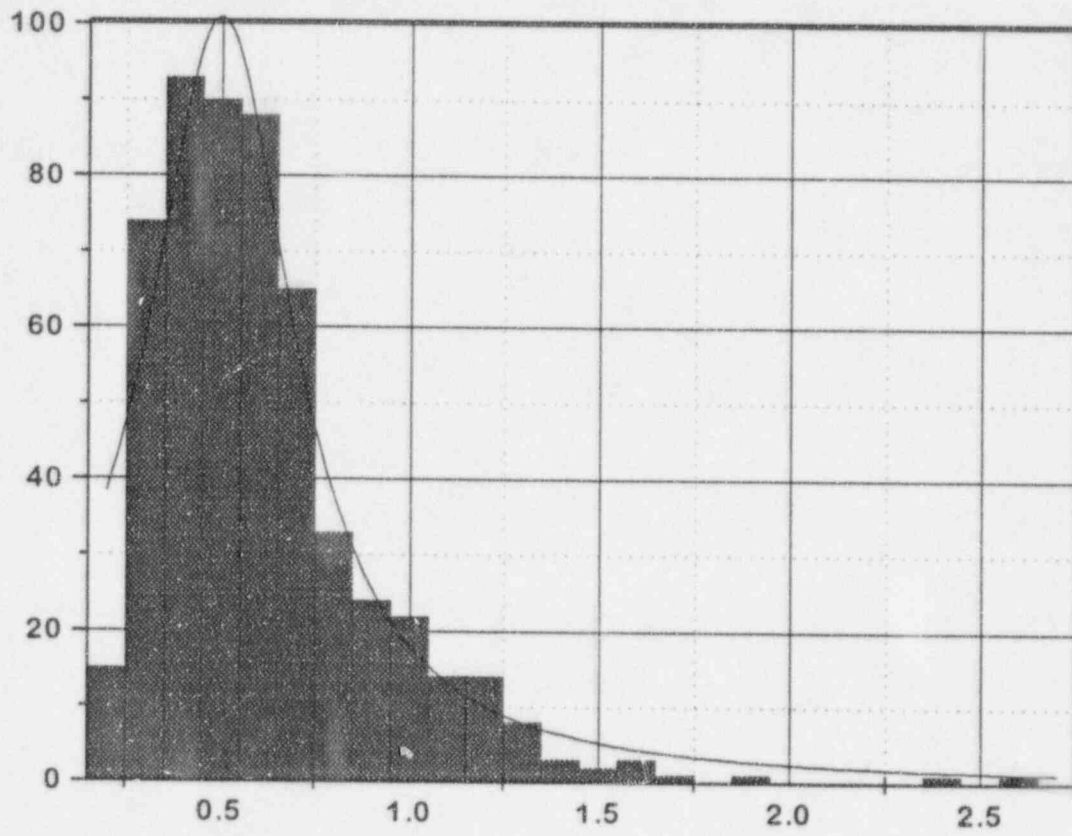Figure 11. S/G B Voltage Change Distribution - Indications at Tube Support Plates.

Figure 12. S/G B Voltage Histogram Fit With a Lorentz Distribution - All 9R
Indications at Tube Support Plates.