Florida
Power
CORPORATION
Crystal River Unit 3
Docket No. 50-302

April 8, 1996
3F0496-04

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

Subject: Technical Specification Change Request No. 203, Revision 2, Notifications Required Prior to MODE 4 and Responses to Request for Additional Information

Reference: A. FPC to NRC letter, 3F0396-19 dated March 21, 1996

Dear Sir:

Florida Power Corporation (FPC) submitted Technical Specification Change Request No. (TSCRN) 203, Revision 2 in Reference A. The revised TSCRN provided a proposed strategy for dispositioning small volume eddy current indications attributed to Intergranular Attack (IGA) in the first span of Crystal River Unit 3's Once-Through-Steam-Generators (OTSGs). The proposed dispositioning strategy (Reference A) included changes to the reporting requirements in Technical Specification 5.7.2.c. Accordingly, FPC is providing in Enclosure 1 the following notifications to the NRC prior to plant ascension into MODE 4:

1. Number of tubes plugged and sleeved,

2. Crack-like indications in the first span,

3. An assessment of growth for first span IGA indications, and

4. Results of in-situ pressure testing

The information provided in Enclosure 1 shows that a total of 44 tubes were plugged (26 in the A generator and 18 in the B generator) during the Refuel 10 inspections. No expansion into C-3 Category was required. No crack-like indications were observed in any free-span location throughout the OTSGs, including the first span. The results of the various assessments of growth support the previous assessment of no growth of the population of first span IGA indications. The results of in-situ pressure testing show no leakage was observed from any of the tube sections tested.

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During telephone conversations with the Staff regarding Reference A, FPC was requested to provide information which is summarized below.

- **Provide the basis for target test pressure, sample selection, and results of in-situ pressure testing. Provide a discussion about why this test is bounding.** This information is provided in Enclosure 1. Attachment 3 presents the Refuel 10 first span voltage versus occurrence distribution.

- **Perform a review of the historic NDE database to identify any free-span indications which were assigned a bobbin coil percent through-wall call in previous outages.** The results of the review are contained in Enclosure 1.

- **Provide a Voltage-to-Volume correlation with wear indications removed from the correlation. The Staff requested a basis for the inclusion of multiple indications in this correlation.** Information about the development of the Voltage-to-Volume correlation is provided in Enclosure 1. The information in Enclosure 1 includes the bases for using combined defect volumes as part of the Voltage-to-Volume correlation. Attachment 4 provides the Voltage-to-Volume correlation and the supporting data. Attachment 5 provides data acquisition parameters and variables used in various datasets relevant to this item and to the next item below.

- **Provide a growth rate assessment including the use of both length and voltage arguments of indications from the 1994 OTSG tube inspections and indications from the 1996 OTSG tube inspections.** The growth rate studies are provided in Attachment 1. Several exhibits and their purpose are presented within the attachment. As mentioned previously, these exhibits conclude there is no growth in the population of first span IGA indications.

FPC believes the above information provides the necessary data to finalize your review of our proposed one-time license amendment. However, please contact Blair Wunderly at (352) 563-4545 or Phyllis Dixon at (352) 563-4787 if we can provide further assistance. We sincerely appreciate the effort the NRC staff has given to support the timely issuance of this license amendment necessary for restart from our current refueling outage.

Sincerely,

Gary Boldt

G. L. Boldt,
Vice President
Nuclear Production

GLB/LVC

Attachments
xc: Regional Administrator, Region II
Senior Resident Inspector
NRR Project Manager

ITS MODE 4 REPORTING REQUIREMENTS (PROPOSED)

1) Number of tubes plugged and sleeved: A total of forty four (44) tubes were plugged during the Refuel 10 Outage (10R). Twenty six (26) of this total were in the 'A' OTSG while the remaining eighteen (18) were in 'B.' No tubes were sleeved in either OTSG during 10R.

2) Crack-like indications in the first span: Based upon MRPC three coil examination, there were no crack-like indications observed in the first span of either OTSG during 10R. No crack-like indications were found in any free-span location throughout the OTSG.

3) In order to provide an assessment of growth of the first span indications, the following exhibits are included as Attachment 1.

- 1994 voltage versus 1996 voltage for first span indications - 10R general inspection results

- 1994 MIZ-18 voltage versus 1996 MIZ-18 voltage for first span indications - 10R MIZ-18/30 Comparison Study results

- 1994 MIZ-18 phase angle versus 1996 MIZ-18 phase angle for first span indications - 10R MIZ-18/30 Comparison Study results

- 1994 versus 1996 length and width comparison for those first span indications which underwent motorized rotating pancake coil (MRPC) inspection during both outages

- 10R first span indications not identified in previous outages

The attached exhibits are rather self-evident, but a few items of explanation are necessary. Prior to beginning the 10R CR-3 OTSG eddy current examination, FPC ran a comparison study between the ZETEC MIZ-18A and MIZ-30-8 eddy current instruments and setup. The purpose of this study was to assure comparability of previous outage results with those obtained using the newer inspection hardware setup. Eighty five (85) first-span indications were included within the scope of this study. Each of these indications was initially inspected with the MIZ-18A setup. This data was obtained using the same essential variables for acquisition and analysis as used during the 1994 CR-3 outage. The 1996 MIZ-18A to 1994 MIZ-18A data comparison shows essentially no growth. The scatter of the data about the zero growth line is easily bounded by the acquisition variability observed for new probes (previously provided to the Staff in Reference 1). The general 1996 to 1994 voltage comparison was based on data obtained with both MIZ-30-8 and MIZ-18A set-ups. Based upon the results of the comparison study performed prior to the outage, the MIZ-30-8 set-up produces slightly higher voltages than does the MIZ-18A. This difference essentially envelopes the scatter in the 1994 to 1996 general comparison.

The length and width study included all first-span indications which received MRPC inspection during the last two outages. The data is scattered rather evenly about the line of zero growth. The larger degree of scatter in this data is attributed to the analysis variability associated with the clip plot sizing technique, particularly for smaller indications. It is noted that the indications which experienced the largest increase in magnitude from 1994 to 1996 were the smaller indications observed during the 1994 examination. The largest 1994 indications consistently exhibited a lower extent measurement during the 1996 outage. In comparison with previous outages, the scatter in this years' data is less than in the past. This is attributed to the special attention to detail paid to the sizing of indications during 10R (Only the Level III analysts performed this function during 10R and they were qualified with a practical performance demonstration test which included clip plot demonstration).

The results of the various plots all support FPC's previous assessment of 'no growth' for the population of first-span IGA indications.

4) Results of in-situ pressure testing, if performed:

During 10R, in-situ pressure testing was performed on 19 indications of interest within 13 tubes. This information was previously provided to the Staff in Reference 1. The CR-3 10R in-situ testing employed a local test method, whereby the pressurized test volume was limited to an approximate 9 inch section of the tube. Given the closely-spaced nature of the CR-3 first span IGA, an additional 58 indications were also tested, by virtue of their location relative to the indication of interest. This information is based upon 1996, pre-insitu bobbin coil eddy current testing of the first span of each candidate tube. Information on the additional indications is provided in Attachment 2.

The results of the testing indicate no leakage was observed from any of the tested tube sections. These results are consistent with, and supportive of the technical approach FPC has chosen to address leakage integrity within the proposed amendment request. Post-insitu bobbin coil eddy current testing was performed on each tube section. This testing determined there was no significant change in the original bobbin coil signal and no diametric variations noted as a result of the pressure testing.

OTHER VERBAL NRC REQUESTS FOR ADDITIONAL INFORMATION

Basis for target test pressure used during in-situ pressure testing

The target test pressure used during in-situ testing was developed based upon the following considerations. NRC Generic Letter 95-05 "Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking", Section 2 provides guidance for the pressure at which to evaluate tube leakage integrity. The maximum pressure stipulated in the Generic Letter is the "assumed differential pressure across the tube walls equal to the pressurizer safety valve setpoint plus 3 percent for valve accumulation, less atmospheric pressure in the faulted SGs." This equates to a value of 2575 psig for CR-3. This pressure is conservative; well in excess of the maximum main steam line break (MSLB) differential pressure calculated as part of the CR-3 safety analysis.

The pressure calculated above is then adjusted for the temperature difference between ambient test conditions and those postulated for the accident. The primary basis for the magnitude of this adjustment is consideration of the change to the material modulus of elasticity for inconel alloy 600 tubing. Section III of the ASME Boiler and Pressure Vessel Code, Appendix 1, indicates an adjustment of 10% is appropriate for NO6600 (tube material). Draft EPRI guidelines for in-situ pressure testing (currently under development) also specify an adjustment of 10% to test pressure to account for ambient test conditions and accident temperatures of interest. Based upon these source documents, test pressure was calculated to be 2833 psig.

In response to Staff concerns about uncertainties associated with test pressure, FPC selected a target test pressure of 3125 psig (nominal) for the 10R in-situ testing campaign. This is the system hydrostatic test pressure for the OTSG. To account for potential instrument inaccuracies, the initial gauge pressure in the field was established at 3100 psig. During the 10 minute hold initiated at this pressure, there was a gradual decay in test pressure with time as the air in the test volume was compressed into solution. However, to more fully understand the pressure decay and to provide additional assurance in the adequacy of the testing, the time at the maximum pressure range for each tube section was doubled from that stipulated in the procedure and required by the ASME Code for hydrostatic testing (10 minutes). In all testing, a final pressure of 2900 psig or greater was achieved at the end of the final 10 minute hold.

Basis for In-situ Pressure Test Sample Selection

All 10R inspected tubes containing eddy current indications with a signal amplitude of one (1) volt and greater during either the 1994 or the 1996 eddy current test (ECT) inspection outage were included within the proposed test sample. Since the primary purpose of this testing is to provide additional confidence in the proposed leakage integrity disposition criteria, using the leakage-based ECT parameter of voltage as a primary consideration for selection is logical. Based upon the CR-3 pulled tube results presented in Reference 1, there is a proportional relationship between signal voltage and defect depth.

Signal voltage and defect volume are further shown to be directly proportional in Reference 1. Thus, this relationship was also considered and used during the selection process for in-situ test candidates. This provided a second "diverse" means of identifying the deepest indications for testing. In this approach, the signal voltage of individual indications was divided by the product of the signals length and width. For a given voltage, those indications with the lowest length and width product should be indicative of the deepest penetration.

The proposed CR-3 criteria for addressing leakage integrity is a value of 1.25 volts. Thus, testing all 10R indications greater than this value and all those down to a value of 1.0 volts (based upon the largest voltage noted during the last two inservice inspections) provides a good distribution of test population about the proposed limit. Utilizing the two methods of selecting test candidates as well as extending the testing to 1.0V (based upon either of the last two outage results) provides high confidence that the test population bounds the remaining population of inservice CR-3 OTSG indications. The difference between the lower limit of testing and the proposed disposition criteria (0.25 volts or 20% of the proposed limit) is consistent with the uncertainty calculated for the proposed voltage-depth correlation.

Attachment 3 is the 10R first-span voltage versus occurrence distribution. This distribution, even assuming an additional 20% uncertainty applied to all the data, shows there is a low probability of having any indication left in service which would exceed the proposed 1.25V criteria. Growth rate information presented previously within this response indicates the same conclusion would apply at the end of the upcoming operating cycle.

Review of the Historic NDE Database

During 10R, the NRC Staff presented the position that assigning a percent through-wall estimate to free-span indications could not be technically justified and was therefore not allowed. 10 CFR 50, Appendix B which requires "qualified techniques" was cited as the basis for this position, with the further clarification that the Staff considers only support plate wear, pitting, and impingement damage mechanisms to have associated qualified techniques for throughwall sizing. In lieu of a qualified technique, the Staff maintained that bobbin coil indications, confirmed by motorized rotating pancake coil (MRPC) technique, must be considered defective and repaired. This is necessary in their view as the only manner in which the plant can assure legal compliance with the through-wall criteria specified in the Technical Specifications. Based upon further discussions, the Staff has acknowledged that manufacturing burnish marks, or MBMs, are acceptable to remain in service provided a thorough evaluation of the indication has been performed and it is concluded the indication is indeed, an MBM.

During the 10R outage inspection, there were two (2) free-span indications which were assigned a bobbin coil percent through-wall call. Both of these indications were confirmed by a MRPC inspection to be MBMs. However, both tubes were plugged prior to receiving the subsequent clarification from the NRC Staff regarding MBMs.

In response to Staff inquiries, FPC reviewed the historic CR-3 ECT data base for similar calls made in previous outages. Based upon this review, four (4) active (tubes which were not previously plugged or subsequently plugged during

10R), inservice bobbin coil indications were found in the 'A' OTSG and three (3) in the 'B' OTSG. Each of these indications was examined with MRPC. All seven of the indications were either identified as MBMs (4) or failed to confirm with the MRPC technique (3). From the historic database, the deepest percent throughwall value for the indications confirmed to be MBMs was 11%. These tubes were allowed to remain in service.

FPC considers this issue to be a generic regulatory issue and a new NRC position. Industry practice for the past 15 years has been to assign a percent throughwall value to indications which exhibit a strong, correlatable eddy current signal. In this regard, FPC was simply following industry accepted practice in dispositioning these indications. This practice has been communicated to the Staff over the years in the content of the Technical Specification required 12 month post-outage OTSG inspection report.

Voltage to Volume Correlation

Attachment 4 contains the voltage to volume correlation from Reference 1 with the exception that the data points attributable to wear have been removed. The action to remove the wear data is necessary in order to maintain consistency with the decision to limit the scope of this proposed license amendment to address just first-span, pit-like IGA. The results of the regression analysis of the IGA-only data set support the validity of the 1.25 volt criteria.

Two additional changes to the previous Reference 1 correlation curve data set were necessary as a result of the decision to include only first-span, IGA indications. Firstly, the voltages used in the previous correlation and presented in Reference 2 were based upon a re-analysis of CR-3 pulled tube data normalized using the P1 channel. This was necessary in order to provide comparability of the voltage values for IGA and those associated with wear and justify combining both data sets. The CR-3 P1 channel is a mixed frequency channel which utilizes 600 and 200 kilohertz frequencies. It is utilized in the analysis of tube support plate (TSP) indications where the elimination of the TSP residuals allows better identification and quantification of indication signals. For the same reasons that all previous data was normalized on the P1 channel, it is now necessary to modify the values of signal amplitude (voltages) for each of the IGA indications. In order to provide the most defensible values for voltage, FPC has used the signal amplitude data obtained for those indications from Reference 1 which were detected in the field as part of the pre-tube pull bobbin coil eddy current examination. The decision to utilize pre-pull field ECT data meant that two of the data points were not utilized in the revised correlation. One of the defects was not detected in the field. The other was run twice (initial examination and then later as a 'PID' "Positive Identification") with widely varying results, causing the data point to be suspect. A statistical analysis of the data point also indicated it to be questionable. Thus, this data point was excluded from the final correlation.

The details of the acquisition techniques used during the 1992 outage, and hence used in the development of the voltage-to-volume correlation, are also provided as Attachment 5.

The Staff has also asked FPC to provide the basis for using combined defect volumes as part of the voltage-to-volume correlation. This explanation includes a discussion of the rationale for selecting the points within the data set. Essentially, points in the data set were selected based upon expert analysis of all CR-3 pulled tube bobbin coil data. Based upon this review, a judgement was made by the analyst whether metallographic data for a particular defect could be related to field eddy current data with a high degree of confidence. Raw data was reviewed to ensure the indication of interest appeared as a single bobbin coil indication. The visual presence of multiple indications located in close axial proximity to one another was basis for rejecting this data point since the signal contribution due to nearby indications could potentially introduce error. ECT lissajous and c-scan plots were carefully reviewed for the appearance of multiple indications within the data. Metallographic data for those indications which appeared to be unique was further reviewed to ensure there were no other defects located within an axial distance of 0.3 inches or less (the approximate field of view of the 510 bobbin coil) which could influence the bobbin coil signal from the indication of interest.

The basis for combining multiple defect volumes within the eddy current correlation for voltage-to-volume is the design of the ECT probe and basic eddy current theory. As mentioned above, the field of view of a 510 bobbin coil eddy current probe is approximately 0.3 inches. At separation distances less than this value, the bobbin coil cannot distinguish unique indications. The coil essentially "sees" the resultant signal from the contribution of all indications within this expanse. Bobbin coil eddy current signal amplitude is proportional to the total volume of removed material within the coil field of view. Defect depths and dimensions are not additive, but volume is. This is shown in Figure 13 of the APTECH report for the CR-3 wear data (Reference 1). It has also been shown in numerous EPRI reports including NP-2299 "Field Experience with Multifrequency-Multiparameter Eddy Current Technology", dated March 1982. Pertinent data from this report is attached. The graphics show the effect on the bobbin coil signal amplitude of adding additional flat-bottom holes around the circumference of a section of tubing. For flat-bottom hole volumes ranging from 1 Volume to 4 Volumes, the bobbin coil voltage ranges from '1x' volt to '4x' volts.

Use of the EPRI NDE Center Data for developing the uncertainty for the CR-3 Best Estimate Curve

The voltages presented in the EPRI NDE Study are based upon re-analysis of 1992 CR-3 pulled tube eddy current test (ECT) data. Thus, the essential variables of acquisition for the CR-3 1992 field ECT data, used to develop the voltage-to-volume correlation, and the EPRI Study are the same. See Attachment 5. The difference between the two data sets is in the analysis of the data.

The eddy current voltage component utilized in the EPRI evaluation is the vertical maximum component of the signal or "vert max". Vert max voltage values are generally smaller than peak-to-peak voltage values since the analysis software is basically only reading a portion of the vector component of the signal. In fact, unless the phase angle of the defect is oriented at a 90 degree angle with respect to the flaw plane, peak-to-peak voltage will always be larger than the vert max component. Thus, developing the CR-3 best estimate correlation based upon peak-to-peak voltages produces a correlation which is conservative in terms of predicted voltage for a given defect depth to one developed using vert max. This is illustrated in Figure 8 of the APTECH report (Reference 1) showing the comparison between the CR-3 best estimate (Vpp) versus the EPRI best estimate (Vmax).

Again, from basic vector analysis, use of the vert max signal in lieu of the Vpp in this correlation should not affect the slope of the regression line fit of the data set even if the data from the two was combined (and it was not). The only impact of using this data directly would be in the offset or the y-intercept calculated for the best estimate regression. This can also be seen in Figure 8 of the APTECH report. This is one reason this data cannot be directly combined with the field data.

The EPRI Study data was also normalized differently than CR-3 field data. However, normalization is arbitrary and affects only the magnitude of the absolute value of the parameter. The magnitude of the data uncertainty, expressed in percentage terms, is independent of normalization.

Having said all this above, use of the EPRI data set is limited in application to the development of the uncertainties for application to the CR-3 best estimate correlation. B&W Owners Group IGA uncertainty data was provided within the APTECH report for a comparison to the EPRI data since this voltage is based on peak-to-peak voltage. Indeed, the report shows it is statistically justified to utilize either data set. The report shows, in a number of ways, that the uncertainties from the two data sets are very similar. Because the uncertainty is presented in terms of a percentage, it can be directly applied to the CR-3 best estimate line.

References

1) FPC to NRC, letter 3F0396-19, "Technical Specification Change Request No. 203, Revision 2", dated March 21, 1996.

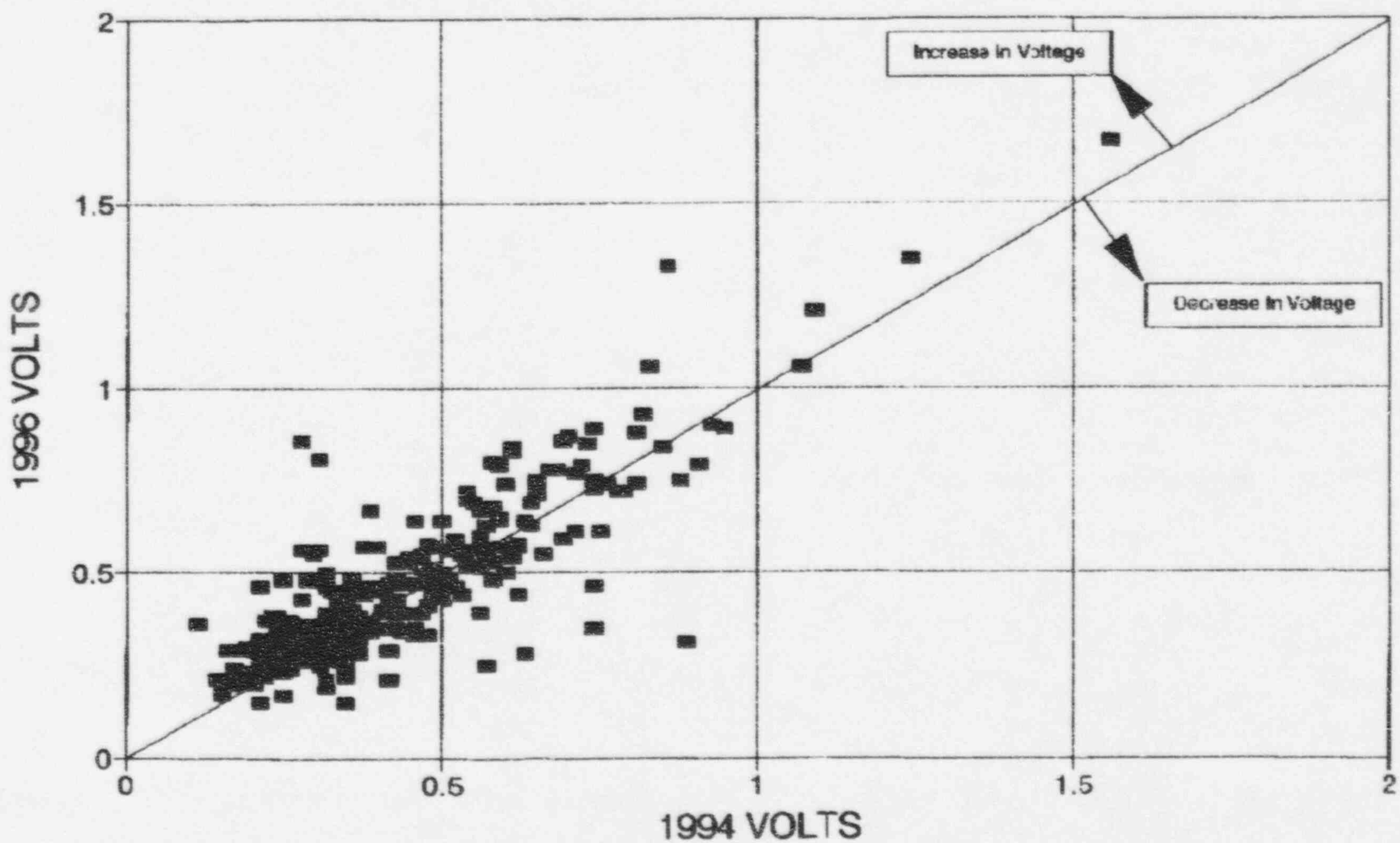
2) FPC to NRC, letter 3F1295-03, "Technical Specification Change Request No. 203, Revision 0, Small Volume Eddy Current Indication Disposition", dated December 5, 1995.

ATTACHMENT 1
(FIVE PAGES)

GROWTH RATE INFORMATION

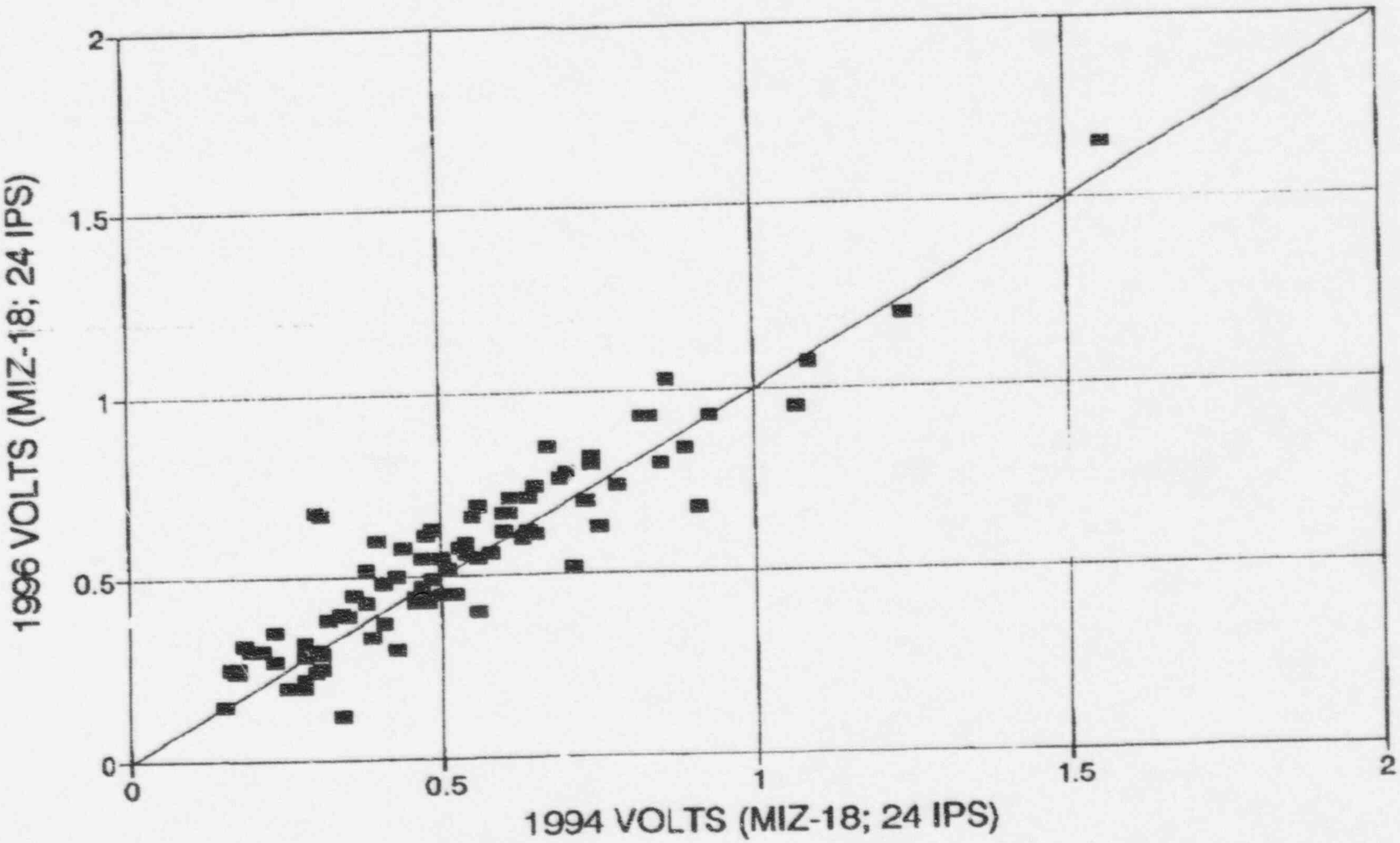
GROWTH OF INDICATIONS - 1st SPAN

CRYSTAL RIVER-3 03/96 RFO10



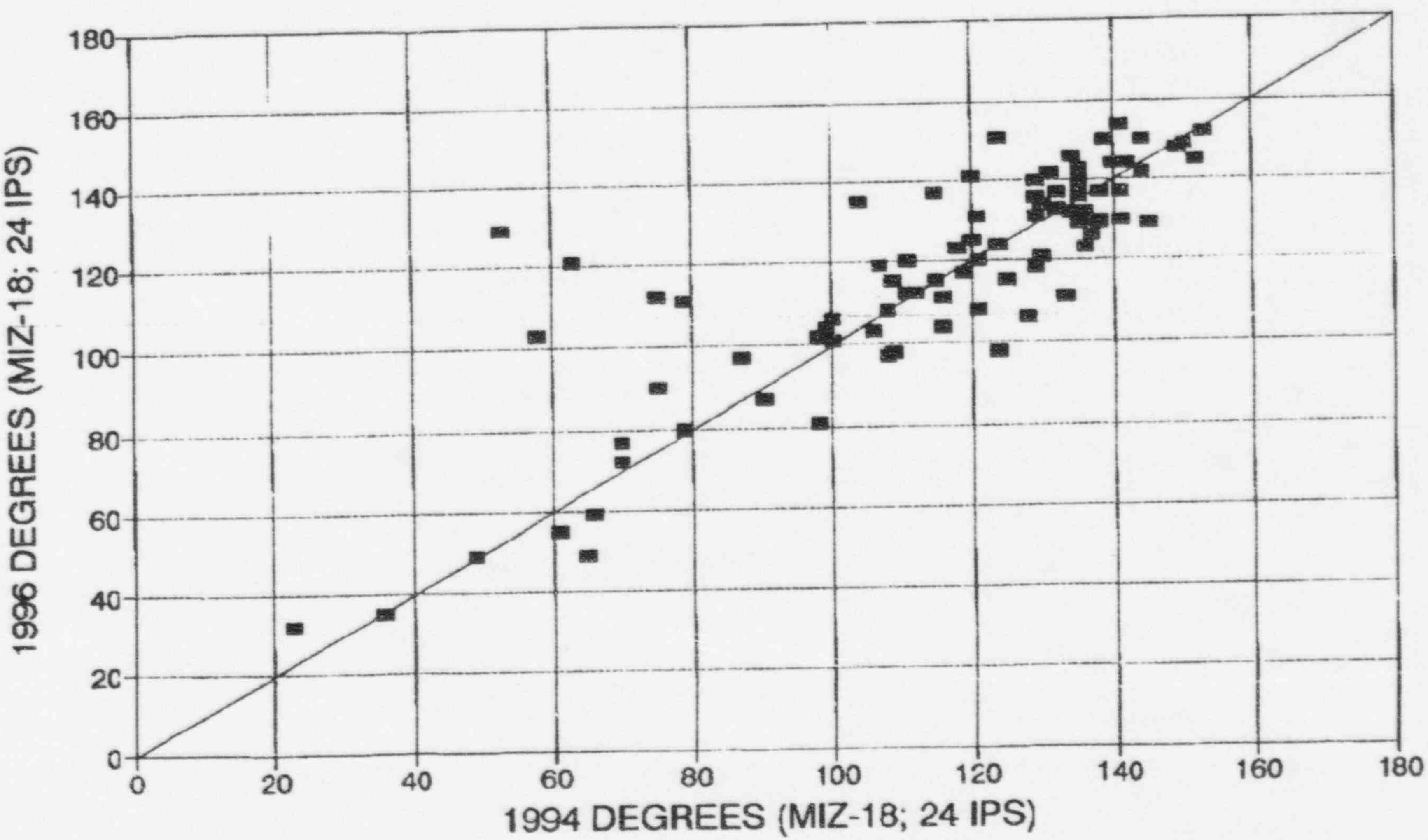
1994 TO 1996 1st SPAN GROWTH - MIZ18

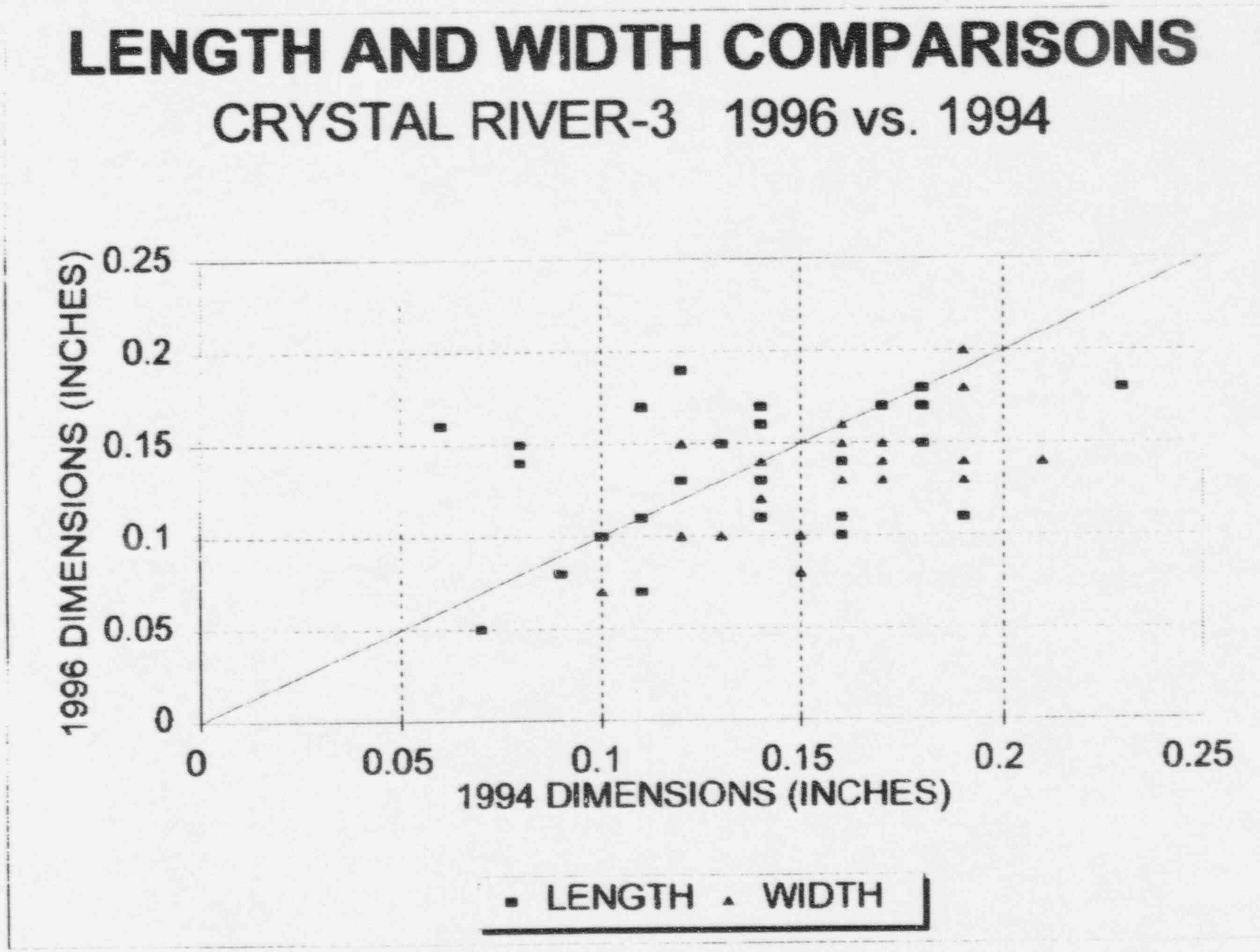
CRYSTAL RIVER-3



1994 TO 1996 1st SPAN GROWTH - MIZ18

CRYSTAL RIVER-3




LENGTH AND WIDTH COMPARISONS
CRYSTAL RIVER-3 1996 vs. 1994
1996 DIMENSIONS (INCHES)
0.25
0.2
0.15
0.1
0.05
0
0
0.05
0.1
0.15
0.2
0.25
1994 DIMENSIONS (INCHES)
LENGTH
WIDTH

MRPC-Confirmed 10R First Span Bobbin Coil Indications Not Identified During A Previous Outage

TUBE #	LOCATION	VOLTAGE
31-37	LTS+22.53	0.49
36-39	LTS+6.36	0.43
36-40	LTS+25.13	0.42
37-93	LTS+6.36	0.68
51-34	LTS+5.49	0.54
51-80	LTS+8.68	0.29
81-96	LTS+12.26	0.65
81-98	LTS+11.74	0.41
86-24	LTS+12.77	0.42
91-43	LTS+5.88	0.28
91-97	LTS+9.95	0.4
96-30	LTS+7.66	0.23
	LTS+11.97	0.36
	LTS+8.12	0.53
96-39	LTS+16.29	0.29
	LTS+7.67	0.29
	LTS+14.84	0.44
	LTS+26.04	0.46
	LTS+6.73	0.37
101-48	LTS+11.42	0.26
106-35	LTS+10.79	0.34
	LTS+8.81	0.4
	LTS+11.35	0.27
106-42	LTS+16.5	0.47
106-87	LTS+6.11	0.39
111-33	LTS+9.24	0.38

All tubes are from RCSG-1B. No new indications were noted in RCSG-1A.

ATTACHMENT 2
(THREE PAGES)

IN-SITU PRESSURE TEST INFORMATION

Attachment 2

10R CR-3 INSITU PRESSURE TEST TUBE SAMPLE AND RESULTS

COUNT	ROW	TUBE	94 LOC (LTSF+)	94 VOLTS	96 VOLTS	LENGTH (inches)	WIDTH (Inches)	NOTES	In-Situ Results
1	90	43	6.32	1	1.01	0.11	0.11		No Leakage
2	105	32	8.22	1	0.9	0.16	0.15	3 closely spaced	No Leakage
3	49	50	10.71	1.02	0.81	0.11	0.15		No Leakage
4	48	47	7.53	1.04	0.83	0.16	0.15		No Leakage
5	103	90	8.14	1.05	0.87	0.16	0.15		No Leakage
6	46	37	10.54	1.07	1.06	0.15	0.14		No Leakage
7	58	38	12.34	1.09	1.21	0.11	0.11		No Leakage
			9.59	1.24	1.35	0.17	0.15		No Leakage
			7.51	1.56	1.67	0.17	0.15		No Leakage
8	89	34	5.78	1.13	0.96	0.12	0.15		No Leakage
			15.15	1.29	1.12	0.11	0.11		No Leakage
9	57	38	12.17	1.14	1.11	0.14	0.24	2 nearly connected	No Leakage
10	93	27	7.76	1.26	1.24	0.18	0.14		No Leakage
11	39	41	9.62	1.27	1.21	0.13	0.16		No Leakage
12	46	44	10.12	0.83	1.06	0.13	0.11		No Leakage
13	50	35	9.15	0.86	1.33	0.18	0.18		No Leakage

ADDITIONAL INDICATIONS UNDERGOING INSITU DURING 10R		
Tube	Location	Voltage
39-41	LTSF+ 6.43	0.69
39-41	LTSF+ 8.32	0.65
39-41	LTSF+ 10.22	0.6
39-41	LTSF+ 10.96	0.58
39-41	LTSF+ 11.29	0.57
39-41	LTSF+ 11.98	0.21
39-41	LTSF+ 12.58	0.46
39-41	LTSF+ 12.93	0.16
39-41	LTSF+ 13.75	0.36
46-37	LTSF+ 6.52	0.89
46-37	LTSF+ 8.04	0.84
46-37	LTSF+ 8.74	0.55
46-37	LTSF+ 11.06	0.74
46-44	LTSF+ 6.5	0.84
46-44	LTSF+ 7.29	0.55
46-44	LTSF+ 8.45	0.81
46-44	LTSF+ 11.31	0.4
46-44	LTSF+ 13.09	0.53
48-47	LTSF+ 7.24	0.68
48-47	LTSF+ 9.49	0.19
48-47	LTSF+ 11.17	0.42
49-50	LTSF+ 6.11	0.37
49-50	LTSF+ 8.33	0.58
49-50	LTSF+ 9.19	0.52
49-50	LTSF+ 11.67	0.91
50-35	LTSF+ 9.55	0.32
50-35	LTSF+ 10.51	0.29
50-35	LTSF+ 10.99	0.57
50-35	LTSF+ 12.15	0.38
50-35	LTSF+ 12.66	0.35
50-35	LTSF+ 13.65	0.19
57-38	LTSF+ 12.52	0.47
57-38	LTSF+ 13.63	0.48
58-38	LTSF+ 5.68	0.64
58-38	LTSF+ 10.02	0.85
58-38	LTSF+ 11.17	0.6
58-38	LTSF+ 13.38	0.53
89-34	LTSF+ 9.04	0.95
89-34 *	LTSF+ 12.21	1.78
89-34	LTSF+ 12.5	0.47
89-34	LTSF+ 13.28	0.71
89-34	LTSF+ 15.36	0.56
89-34	LTSF+ 16.51	0.9
90-43	LTSF+ 7.95	0.67
90-43	LTSF+ 10.54	0.64

ADDITIONAL INDICATIONS UNDERGOING INSITU DURING 10R						
93-27			LTSF+ 9.2			0.66
93-27			LTSF+ 10.34			0.38
93-27			LTSF+ 10.83			0.26
103-90			LTSF+ 5.21			0.62
103-90			LTSF+ 6.92			0.76
103-90			LTSF+ 7.59			0.27
103-90			LTSF+ 8.78			0.28
103-90			LTSF+ 9.48			0.76
105-32			LTSF+ 7.67			0.72
105-32			LTSF+ 8.06			0.75
105-32			LTSF+ 9.17			0.72
105-32			LTSF+ 9.75			0.32
105-32			LTSF+ 11.15			0.49

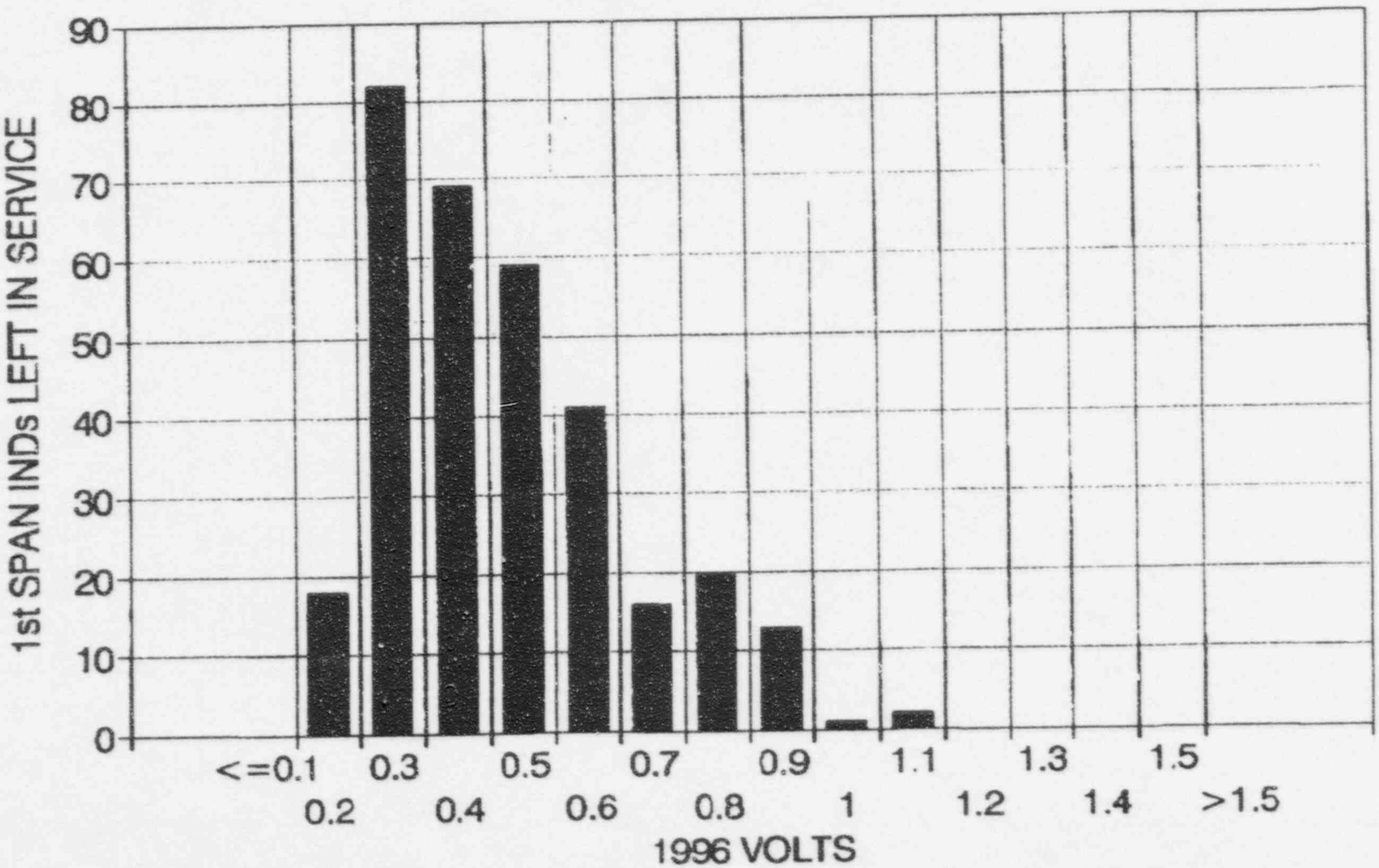
*** Tube plugged based upon this indication (Voltage).**

ATTACHMENT 3
(ONE PAGE)

1OR FIRST SPAN VOLTAGE DISTRIBUTION

VOLTAGE DISTRIBUTION - 1st SPAN

CRYSTAL RIVER-3 03/96 RFO10



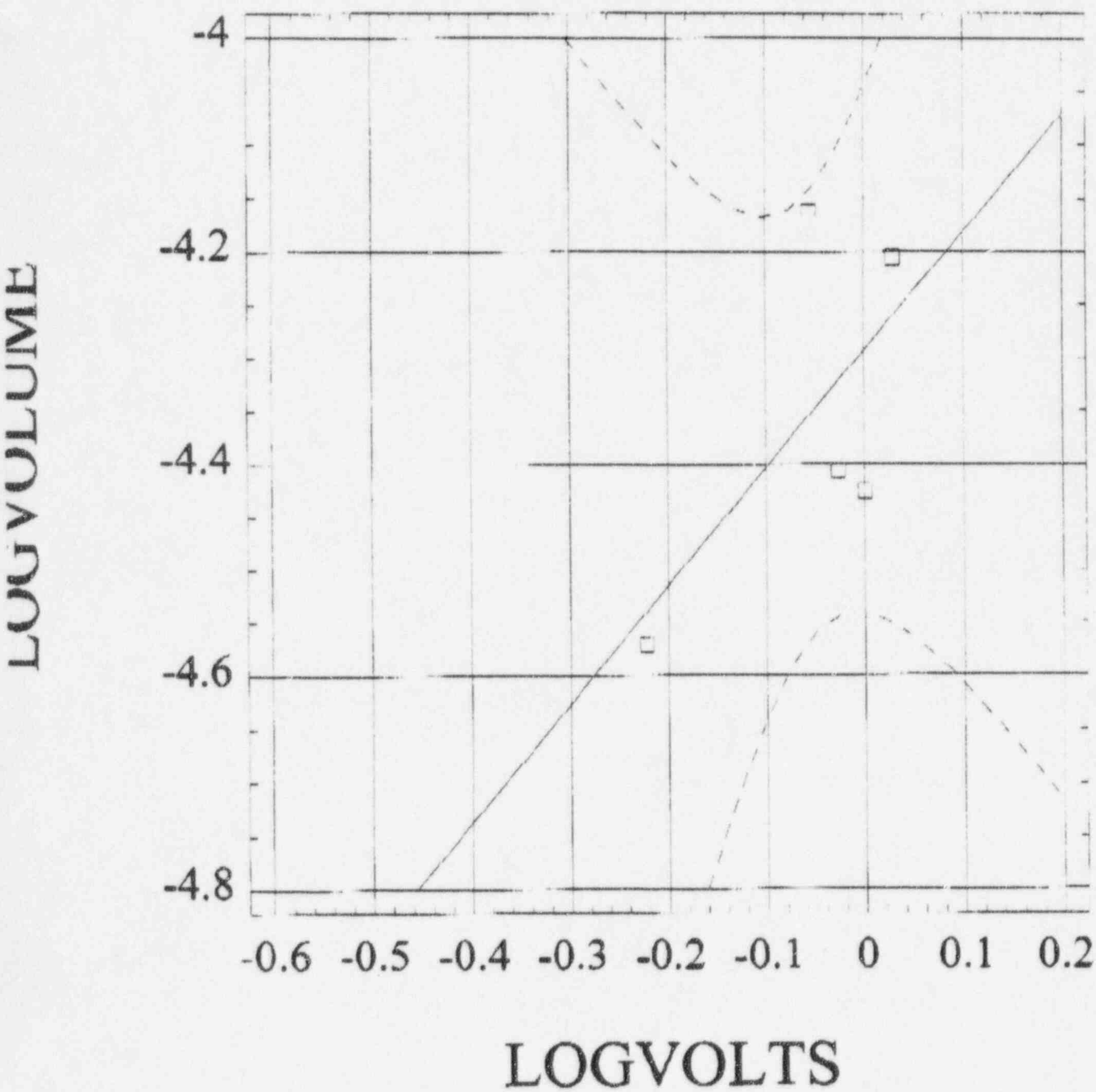
Average Volts = 0.43

ATTACHMENT 4
(10 PAGES)

VOLTAGE-TO-VOLUME CORRELATION

AND SUPPORTING DATA

Plot of Fitted Model



Data Used To Establish the Voltage-Volume Correlation for IGA Defects					
Tube ID	Defect ID(s)	Location LTSF+"" inches	Volume, E-6 cubic inches	Voltage	Circumferential Location (Degrees)
90-28	O/N/M	6.38	37.5	1	340/100/290
90-28	I/H/G	7.88	62.3	1.07	200/10/330
97-91	P/O	8.28	68.8	0.88	90/15
109-30	B	7.99	39.2	0.94	275
109-30	D	9.78	26.9	0.6	285

The source for this data in EPRI Report TR-103756, "Examination of Crystal River Unit 3 Steam Generator Tube Sections", dated April 1994. Table 2-8, Table 3-1, and Appendix A, Table 4. All are attached.

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Projects S413-06, -07, -08
Final Report
April 1994

Examination of Crystal River Unit 3 Steam Generator Tube Sections

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(continued on back cover)

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specimens were stored in clearly labeled clean plastic bags to prevent loss and/or confusion of the samples. Sectioning diagrams were maintained for each tube section and defect area examined.

All of the defect specimens from the first freespan region identified in Tables 2-6 and 2-7 were utilized for metallography, except specimens 52-51-2F and 90-28-2N, which were analyzed by SEM/EDS and SAM/XPS. In addition, two (2) specimens were isolated on 109-30-2 based on the laboratory slow-pull bobbin coil ECT data; these defect specimens correlated with the field reported bobbin coil indications at LTSF + 8 inches (27% TW; 0.94 V; Specimen B) and LTSF + 9.2 inches (S/N; 0.54 V; Specimen D) for metallographic examination by incremental grinding. Detailed sectioning diagrams for tube sections 52-51-2, 109-30-2, 90-28-2, 97-91-2 and 106-32-2 are shown in Figures 2-36 through 2-38. Additional ring sections were taken from tube sections 52-51-4, 133-33-3 and 133-33-9 for characterization of the OD deposits by metallography and SEM/EDS.

2.2.9 Metallography

Selected samples were mounted in Epomet (a thermoset resin), and prepared for metallographic examination using standard techniques. Deionized water was utilized as the grinding and polishing lubricant for preservation of corrosion product chemistry within defect regions on tube specimens subsequently used for microchemical analyses. The specimens were examined as-polished on the metallograph at magnifications up to 1,000X to characterize defects and deposit morphology. Selected grinding planes on specimens 109-30-2D and 109-30-2B were etched electrolytically in 5% nital solution to reveal the grain structure, then re-examined to establish the defect path relative to the grain boundaries.

Step Grinding Results (109-30-2D & 109-30-2B)

IGA patches were identified on both of these specimens (see Figure 2-39). The IGA exhibited a classic thumbnail shape. The IGA had maximum depths of 40% and 50% throughwall for 109-30-2D and 109-30-2B, respectively.

A summary of the metallography results for these specimens is provided in Table 2-8.

Table 2-8
SUMMARY OF INCREMENTAL GRIND & POLISH DATA

Grind No.	Axial Position	Remarks	Defect Extent			Grind No.	Axial Position	Remarks	Defect Extent		
			Circ. Extent	Depth (%TW)	Vol. (10^{-4} in³)				Circ. Extent	Depth (%TW)	Vol. (10^{-4} in³)
Specimen 109-30-2D:						Specimen 109-30-2B:					
8	10.00	IGA Patch at 285°	9°	24%	6.3	10	8.38	IGA Patch at 275°	5	38%	4.0
9	10.02	IGA Patch at 285°	9°	40%	8.5	11	8.39	IGA Patch at 275°	11	46%	11.7
10	10.03	IGA Patch at 285°	6°	32%	3.5	12	8.41	IGA Patch at 275°	12	50%	13.8
11	10.04	IGA Patch at 285°	6°	40%	5.9	13	8.42	IGA Patch at 275°	9	35%	9.1
12	10.06	IGA Patch at 285°	3°	40%	2.7	14	8.44	IGA Patch at 275°	2	10%	0.6
						15	8.46	IGA Patch at 275°	2	3%	0.1
				Total:	26.9					Total:	39.2

TABLE 3-1

SUMMARY OF EDDY CURRENT DISTINGUISHABLE DEFECTS

Tube Section No.	Defect No.	Position		Defect Extent				Eddy Current Results			
								Bobbin Coil		MRPC	
		Axial (inches)	Circ. (°)	Axial (mils)	Circ. (°)	Depth (%TW)	Vol. (10^{6} in^{3})	Field	Lab	Field	Lab
90-28-2	AF	17.2	150°	28.9	2.0	51%	3.0		S/N		
	AD2/1	16.1	180°/315°	52.4	3.5	37%	6.9				S/N
	AB	15.5	340°	54.4	8.3	30%	13.8				
	Z	15.1	325°	38.2	1.3	30%	1.5		S/N		
	X2/1	14.6	340°/110°	45.6	2.7	43%	5.4		S/N		S/N
	V2/1	14.0	270°/350°	53.7	7.5	48%	19.9				
	T2/1	13.2	110°/330°	36.3	7.8	50%	14.5				
	S2/1	12.9	350°/110°	33.9	3.2	26%	2.9		S/N		
	Q	12.3	340°	59.2	3.1	45%	8.5		S/N		
	O/N/M	11.5	340°/100°/290°	58.5	14.5	43%	37.5		S/N		S/N
	K	10.8	290°	31.8	3.6	18%	2.1		S/N		
	I/H/G	10.2	200°/10°/330°	71.5	17.3	49%	62.3	S/N	S/N	S/N	S/N
	AFC*	9.2								S/N	
	E	7.8	340°	70.9	7.9	50%	28.8	46%	36%	S/N	S/N
	C/B	6.1	20°/315°	56.5	6.1	41%	14.5	S/N	S/N	S/N	S/N
	AFC*	1.0							S/N		
52-51-2	X	16.5	315°	40.3	2.0	32%	2.6				S/N
	U	15.3	315°	32.7	4.8	26%	4.2				
	S	14.7	315°	63.7	8.3	33%	17.9				
	R	14.1	250°	38.9	3.7	18%	2.7		S/N		S/N
	P	13.1	200°	43.9	5.3	33%	7.9				
	N2/1	12.4	180°/260°	33.6	4.6	30%	4.8				
	L	11.4	180°	33.5	1.4	13%	0.6				S/N
	K2/1	11.0	250°/180°	42.7	7.8	45%	15.4				
	I2/1	10.0	350°/270°	49.7	15.2	42%	32.9	S/N		S/N	S/N
	G/F	8.9	315°/350°	69.9	5.7	47%	19.3	S/N	S/N	S/N	
	AFC*	7.9						S/N	S/N	S/N	S/N
	D	6.5	265°	60.9	8.4	34%	17.9	S/N	S/N	S/N	S/N
	B	-1.0	20°	38.6	2.0	38%	3.0				
97-91-2	W	14.1	105°	60.6	9.6	54%	32.0	67%	S/N	S/N	S/N
	AFC*	12.3									S/N
	U/T/S	11.5	245°/90°/95°	58.2	26.0	46%	70.9		S/N	S/N	S/N
	R1	9.3	350°	11.0	6.1	4%	0.3			S/N	S/N
	AFC*	8.6						S/N	S/N	S/N	S/N
	P/O	8.3	90°/15°	74.4	18.0	50%	68.8	67%	S/N		

TABLE 3-1 (Continued)

Tube Section No.	Defect No.	Position		Defect Extent				Eddy Current Results			
		Axial (inches)	Circ. (°)	Axial (mils)	Circ. (°)	Depth (%TW)	Vol. (10^{-6} in³)	Bobbin Coil		MRPC	
								Field	Lab	Field	Lab
97-91-2 (cont.)	M	7.1	320°	19.7	3.3	16%	1.1				
	K	6.6	225°	49.8	3.8	29%	5.7				
	I	5.6	355°	6.7	2.4	4%	0.1				
	G	3.3	20°	13.1	0.7	5%	0.0				
	E2/1/D	2.8	20°/285°/350°	13.5	5.7	6%	0.5				
	B	1.1	285°	16.3	2.5	6%	0.2				
	AFC*	-1.7							S/N		
106-32-2	BG/BF	16.6	90°/30°	55.1	7.6	15%	6.2				
	BD/BC	15.6	50°/30°	63.5	12.8	31%	25.5				
	BB/BA/AZ	14.9	90°/35°/45°	35.3	12.9	20%	9.4				
	AY	14.6	220°	55.3	16.1	36%	32.9	S/N	S/N		
	AX	14.3	30°	39.9	9.6	32%	12.6				
	AT/AU/AV	13.2	135°/45°/60°	46.8	42.3	34%	69.2	S/N	S/N	S/N	
	AR	12.3	90°	44.9	12.8	19%	11.2			S/N	
	AQ2/1	11.7	180°/90°	38.1	16.0	35%	21.9			S/N	
	AP/AO	11.2	20°/90°	48.0	14.4	27%	19.2	S/N			
	AN/AM 3/2/1	10.8	240°/0°/50°/45° 125°/180°/170°	26.5	31.9	27%	23.5	S/N	S/N	S/N	
	AL2/1	10.5	25°/80°/75°	27.7	10.2	11%	3.2			S/N	
	AJ/AK	9.9	190°/25°	61.3	22.8	39%	56.0	S/N	S/N	S/N	
	AG2/AH	8.8	100°/60°	59.1	13.0	35%	27.6		S/N	S/N	S/N
	AFC*	8.2								S/N	
	AE/AD/AC2	7.7	225°/60° 220°	62.5	27.5	24%	42.4	S/N	S/N		
	AC1/AB	7.4	60°/70°	53.5	11.5	18%	11.4				
	Z/AA	7.0	180°/200°	46.2	18.6	34%	30.0				
	X2/Y/X1	6.4	65°/85°/50°	33.7	20.4	28%	19.8	S/N	S/N	S/N	S/N
	V2	5.3	125°	40.8	2.1	14%	1.2			S/N	S/N
	Q	-0.6	190°	17.1	3.2	7%	0.4				
	N	-1.8	270°	5.4	1.0	15%	0.1				
	L/K/J I/H	-2.3	280°/310°/105° 40°/120°	17.3	31.3	14%	7.8				
	F	-3.4	160°	12.0	9.3	9%	1.0				
	E	-3.9	145°	18.2	3.4	23%	1.5				
	C	-5.4	350°	6.7	4.9	7%	0.2				

* AFC = Apparent False Call

TABLE 4

BOBBIN

FIELD VS. LABORATORY EDDY CURRENT

SPECIMEN		FIELD RESULTS				LABORATORY RESULTS			
ROW-TUBE-PIECE	AREA OF INTEREST	LOCATION	VOLTS	PHASE	1992 %TW	AXIAL LOCATION**	VOLTS	PHASE	1992 %TW
41-44-2	26.3" TO 45.3"	LTSF + 6.86"	0.89	118	S/N	BIM +11.92"	0.75	120	S/N
		LTSF +12.12"	0.62	117	S/N	BIM +16.76"	0.80	120	S/N
		LTSF +15.53"	0.85	126	S/N	BIM +20.64"	0.72	120	S/N
						BIM + 9.70"*	0.45	124	S/N
						BIM +10.63"*	0.48	118	S/N
						BIM +13.86"*	0.26	119	S/N
						BIM +22.81"*	0.59	140	S/N
52-51-2	25.3" TO 42.3"	LTSF + 5.79"	0.98	148	S/N	BIM + 8.64"	0.97	154	S/N
		LTSF + 8.03"	0.52	78	S/N	BIM +10.91"	0.79	87	S/N
		LTSF + 9.22"	0.95	149	S/N	BIM +12.21"	1.02	130	S/N
		LTSF +10.12"	0.47	75	S/N	BIM +16.97"	0.35	107	S/N
90-28-2	21.3" TO 42.3"	LTSF + 6.38"	1.00	107	S/N	BIM +13.32"	0.91	97	S/N
		LTSF + 7.88"	1.73	121	46	BIM +14.78"	1.66	122	36
		LTSF +10.35"	1.07	119	S/N	BIM +17.21"	1.06	126	S/N
						BIM + 7.98"*	0.44	144	S/N
						BIM +17.65"*	0.46	100	S/N
						BIM +18.61"*	0.46	116	S/N
						BIM +18.99"*	1.07	132	S/N
						BIM +19.72"*	0.66	143	S/N
						BIM +21.39"*	1.12	130	S/N
						BIM +21.92"*	0.65	91	S/N
						BIM +23.66"*	1.08	164	S/N
97-91-2	28.3" TO 43.3"	LTSF + 8.28"	0.88	90	76	BIM +15.54"	0.75	113	44
		LTSF + 8.56"	0.65	110	S/N	BIM +15.82"	0.79	124	S/N
		LTSF +14.28"	0.71	106	63	BIM +19.19"	0.64	91	62
						BIM +21.89"*	0.93	103	52
						BIM + 5.58"*	0.51	161	S/N
106-32-2	25.3" TO 42.3"	LTSF + 5.76"	0.84	135	S/N	BIM + 9.13"	0.50	135	S/N
		LTSF + 8.22"	0.34	138	S/N	BIM +12.89"	0.70	167	S/N
		LTSF + 9.48"	0.55	156	S/N	BIM +14.19"	0.74	144	S/N
		LTSF +10.91"	0.48	147	S/N	BIM +10.80"	0.56	155	S/N
		LTSF +11.24"	0.34	131	S/N	BIM + 8.76"	0.71	122	S/N
		LTSF +12.82"	0.57	162	S/N	BIM + 7.27"	0.67	153	S/N
		LTSF +14.34"	0.30	110	S/N	BIM + 5.90"	0.73	160	S/N
109-30-2	25.3" TO 33.3"	LTSF + 5.66"	0.79	150	S/N	BIM +13.11"	0.80	159	S/N
		LTSF + 7.99"	0.94	133	30	BIM +15.39"	0.94	131	27
		LTSF + 9.22"	0.31	132	S/N	BIM +16.62"	0.35	138	S/N
		LTSF + 9.78"	0.60	150	S/N	BIM +17.17"	0.54	148	S/N
						BIM +25.45"*	0.33	131	S/N

*ADDITIONAL LOCATIONS REPORTED DURING LAB ANALYSIS

**AXIAL LOCATION IS MEASURED FROM THE BOTTOM TUBE END

NOTE: ALL PIECE 4'S FOR EACH TUBE EXHIBITED NO DETECTABLE DEGRADATION (NDD)