Byron/Braidwood Units 1 & 2

Steam Generator

Eddy Current Analysis Guidelines

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1.0 PURPOSE

1.1 The purpose of this guideline is to provide general instructions and to define specific requirements for the analysis of eddy current data acquired for the ComEd Byron and Braidwood Units 1 & 2 steam generators.

1.2 Analysis guidelines provide a structure to ensure that data is (a) analyzed in accordance with the appropriate techniques and practices that reflect current industry experience, (b) in a consistent and repeatable manner and (c) in compliance with ComEd requirements.

1.3 Conditions encountered during the course of a steam generator examination not foreseen by this guideline are to be reported by data analysts to the Resolution or Lead Analyst of the job.

2.0 GENERAL CHARACTERISTICS OF STEAM GENERATORS

2.1 D-4 Steam Generators (Byron 1 & Braidwood 1)

2.1.1 Each plant operates at 1175 Megawatts.

2.1.2 Steam Generators are Westinghouse D-4 vertical U-Bend type tubes containing 4,578 mill-annealed Inconel 600 tubes per steam generator.

2.1.3 The tubes are mechanically rolled in the tubesheet.

2.1.4 The tube support plates are 0.750" drilled carbon steel.

2.2 D-5 Steam Generators (Byron 2 & Braidwood 2)

2.2.1 Each plant operates at 1175 Megawatts.

2.2.2 Steam Generators are Westinghouse D-5 vertical U-Bend type tubes containing 4,570 thermally treated Inconel 600 tubes per steam generator.

2.2.3 The tubes are hydraulically expanded in the tubesheet.

2.2.4 The tube support plates are 1.125" stainless steel with Quatrefoil holes.

2.3 Operating History of Steam Generators (D-4's)

2.3.1 Outer Diameter Stress Corrosion Cracking (ODSCC) at the support plates. This is the primary mode of degradation at Byron 1 and Braidwood 1. The majority of the indications are found on 3H, 5H, and 7H support plates. Most of the tubes plugged in the steam generators have been plugged as a result of this problem. These cracks are axially orientated.

2.3.2 Primary Water Stress Corrosion Cracking (PWSCC). This mode of degradation has been found at Byron only and it is considered the second highest mode of degradation. This type of degradation occurs within the confines of the hot leg tubesheet. These cracks are axial orientated and ID initiated.

2.3.3 Circumferential Cracking at the top of the tubesheet. This mode of degradation was found at Byron first during a limited inspection at the top of the tubesheet during refueling outage 6. These indications occur in the expansion transition of the tube above the tubesheet. These cracks are circumferentially orientated and OD initiated. Braidwood has also found circumferential cracking at the top of their tubesheet..

2.3.4 Pitting has also been a concern for Byron. Pitting usually occurs at the edge of support plates (above or below) and primarily on the hot leg side, however some tubes have been plugged due to cold leg pitting.

2.3.5 Low row U-Bend PWSCC has been a concern for Byron Station during earlier refueling outages. In fact Byron has had two leaker outages (April and June of 1988) as a result of cracks found in the U-Bend region. Since that time, U-Bend stress relief was performed to mitigate this problem.

2.3.6 Very limited amounts of Anti-Vibration Bar (AVB) Wear and preheater wear have been found in the Unit 1 steam generators. However, Unit 2 has seen a considerable amount of AVB wear.

2.4 Operating History of Steam Generators (D-5's)

2.4.1 AVB Wear has been the primary mode of degradation at Byron 2 and Braidwood 2. AVB wear occurs in the U-Bend region and it is caused as a result of the AVB's rubbing the tubing beyond the technical specification limit of 40% Through-Wall. Particular attention should be made in obtaining accurate % through wall for purposes of growth studies and projections.

2.4.2 Loose parts have been found in several areas in these steam generators. These parts have been found utilizing the 10 kHz channel. Tubes subject to loose part damage are either in the extreme peripheral areas or in the tube lane.

3.0 RESPONSIBILITIES

3.1 ComEd Representative

3.1.1 Responsible for interpreting, maintaining and implementing these guidelines, and determining plant specific Interim Plugging Criteria (IPC) eddy current data analysis applicability as well as dispositioning any unusual indications with the Lead Analyst of the job.

3.2.1 Responsible for selecting the Lead Analyst, Resolution Analyst and Data Analysts. The vendor may select the analysts as long as there is ComEd concurrence.

3.2 Lead Analyst

3.2.1 Analyzes eddy current data in accordance with this guideline.

3.2.2 Maintains supervision over all Shift Lead Analysts and Data Analysts during the job.

3.2.3 Responsible for communicating any problems that may arise during the inspection, i.e. "new modes of degradation" unfamiliar to the site or problems which could impact the schedule.

3.2.4 Identifies and processes required changes to the guideline during the course of the examination as circumstances may warrant. Changes are documented using the Analysis Guideline Change Form in Appendix B of this guideline and are subject to ComEd approval prior to usage.

3.2.5 Promptly informs all data Analysts of changes to this guideline as such changes occur. The Analysis Guideline Change Acknowledgment Form in Appendix B is used to document receipt and review of changes by all Analysts.

3.2.6 Perform duties of Lead Analyst or Resolution Analyst as required.

3.3 Resolution Analyst

3.3.1 Analyzes eddy current data in accordance with this guideline.

3.3.2 Resolves any discrepancies between primary and secondary analysts and resolves LAR (Lead Analyst Resolution) calls in accordance with the resolution criteria in Section 8 of this guideline.

3.3.3 Promptly informs the Lead Analyst of circumstances that arise during the course of data analysis that are not consistent with or not addressed by this guideline which may require changes to this guideline.

3.4 Data Analyst

3.4.1 Analyzes eddy current data in accordance with this guideline.

3.4.2 Prepares and submits a final report consistent with this guideline that is complete and free of errors for each calibration group.

4.0 PERSONNEL QUALIFICATIONS

4.1 Personnel analyzing data shall be qualified in accordance with SNT-TC-1A and certified to Level IIA or Level III.

4.2 In addition, the analyst shall have received training in the evaluation of eddy current data for nonferromagnetic tubing.

4.3 Data analysts will have successfully passed a ComEd eddy current data Analyst performance demonstration program consisting of site-specific training and testing prior to analyzing production data.

4.4 Per ComEd's response to Generic letter 95-03 "Circumferential Cracking of Steam Generator Tubes" all analsysts who review RPC results from the top of tubesheet RPC inspection will be Qualified Data Analsyts (QDA's) per EPRI Guidelines Appendix G.

5.0 GENERAL ANALYSIS REQUIREMENTS

5.1 All recorded indications shall be evaluated in accordance with this guideline. Guideline changes must be implemented using the change form given in Appendix B.

5.2 There is no minimum voltage threshold for reporting indications believed to be attributed to tube wall degradation.

5.3 Data analysis consists of reviewing Lissajous and strip chart displays to the extent that all indications of tube wall degradation and other signals as defined by this document are reported and dispositioned in accordance with the requirements of this document.

5.3.1 All recorded data shall be evaluated regardless of the extent tested.

5.3.2 Phase angle measurements shall be made utilizing VOLTS MAXRATE for signals which have a well-defined transition. For cases where no clear transition exists, a VOLTS PEAK-TO-PEAK approach shall be used. The use of guess angle shall be kept to a minimum

and only used when the latter two analysis functions do not give a good representation of the signal phase angle.

5.3.3 Indications for which there are no applicable reporting criteria or which the Analyst considers to be ambiguous or indeterminate should be reported as LAR. The Resolution Analyst must resolve such indications with the concurrence of the Lead Analyst.

5.4 All acquired data shall be subjected to two independent analyses. These are referred to as "primary" and "secondary" analyses.

5.4.1 The two individual analysis results shall be reviewed for discrepancies in accordance with Section 8.0 of this guideline.

5.4.2 If no discrepancies exist between the primary and secondary analyses, then the primary analysis results shall be considered as final.

5.5 All previous history must be addressed. If no indication is identified from the previous history at the location in question an INF or INR analysis code shall be reported (See Appendix C).

5.6 Axial locations in the hot leg shall be reported in a positive direction from supports, AVB's, tube sheet, and tube end up to but not including 11C.

5.7 Axial locations in the cold leg shall be reported in a positive direction from supports, tube sheet, and tube end up to 11C.

5.8 Probe speed (axial traverse speed and RPM as applicable) should be verified on the following occasions:

5.8.1 At each calibration run.

5.8.2 At any time probe speed is questionable.

5.9 Storing Analysis Setups are as follows:

5.9.1 The analysis setup established for each calibration group shall be stored to the data recording medium.

5.9.2 Each primary, secondary or resolution Analyst shall store results to primary, secondary, or resolution files respectively.

5.10 Reporting Criteria should be as follows:

5.10.1 The record of each tube analyzed shall include the Tube (Row, Column); VOLTS, DEG, % or three letter code, CH# and axial location corresponding to any reported indication(s); and the extent tested.

5.10.2 Acceptable three letter analysis codes for reported indications that are not assigned a percent through-wall are identified in Appendix C of this guideline.

5.10.3 Support structure (landmark) nomenclature and measurements are identified in Appendix D of this guideline.

5.11 Calibration Verification for the ASME Standard should be as follows:

5.11.1 Calibration verification shall be performed at the beginning and end of each calibration group. If the requirements are not met for bobbin probe data then the data Analyst will identify the affected data and determine which tubes, if any, require retest.

5.11.2 The ASME calibrations shall be compared within the following parameters using Channel 1:

(1) The phase angle of the 100% through-wall hole response should be at 40° +/- 1°.

(2) The phase angle of the 20% drill hole response should be between 50° and 130° clockwise from the 100% drill hole response.

(3) Responses from the calibration discontinuities should be clearly indicated and discernible from each other as well as probe motion.

5.12 IPC, F* and Circumferential cracking commitments with the NRC

5.12.1 Interim Plugging Criteria for TSP cracking will be implemented at both Byron and Braidwood Station's Unit 1. Plugging will be based on the upper voltage Repair Limit set forth by the site.

5.12.2 F* will be applied to both Byron and Braidwood Station. Particular detail should be placed on the location of the indications found within the tubesheet so that F* may be applied. The F* criteria includes indications which are found to be 1.7 inches or more below the top of the tubesheet.

5.12.3 Circumferential cracking has been found at both Bryon and Braidwood Station at the top of the tubesheet. NRC committments have been made to perform a representative sample (20%) of RPC inspections in low row U-bends and a 100% RPC inspection of the top of the tubesheet for all steam generators.

5.13 Probe pull speeds for implementation of IPC should not exceed 24 inches per second.

6.0 BOBBIN COIL EDDY CURRENT REQUIREMENTS

6.1 Analysis Set-up

6.1.1 Examination Frequencies (see Table 6-1)

Table 6-1 Tube Examination Frequencies

Frequency (kHz)	Differential Channel	Absolute Channel
550	1	2
300	3	4
130	5	6
10	7	8

6.1.2 Setting Mixes (see Table 6-2)

Table 6-2 Mix Set-up

Mix	Channel Sequence	Suppress on:	Save on:
Mix 1	1,5	Support Ring	N/A
Mix 2	4,6	Support Ring	N/A
Mix 3 (optional)	1,3,5	Support Ring & Clean TTS	ASME Cal Std Drill Holes & OD Groove
Mix 5	4,6	Support Ring	N/A

***Note:** Additional mixes may be established for screening and diagnostic applications at the discretion of the analyst. However, as a minimum, data screening and reporting shall be conducted using the applicable channels specified in Section 6.2.*

6.1.2.1 *Mix 1*: 550/130 kHz differential support mix; mix on ASME standard support ring. Set 3-point phase angle-depth calibration curve using ASME 100%, 60%, and 20% drill hole signals. Mix #1 is the primary channel for reporting indications at support structures (other than AVB's).

6.1.2.2 *Mix 2*: 300/130 kHz absolute; mix on ASME support ring signal. Set amplitude (voltage) 3-point calibration curve (VERTMAX) using the 0%, 20%, and 40% AVB wear scar signals. (Note: 50% wear scar may be substituted if 40% wear scar does not exist in standard). Mix 2 is used for reporting indications at AVB's.

6.1.2.3 *Mix 3 (optional)*: 550/300/130 kHz differential; suppress ASME support plate and normal in-generator roll expansion signal; save signals from ASME standard drill holes. Mix 3 is used to screen TTS expansion regions for indications and to aid in the confirmation of other indications.

6.1.2.4 *Mix 4*: Reserved for computer data screening (CDS)

6.1.2.5 *Mix 5*: 300/130 kHz absolute; mix on ASME support ring signal. Set amplitude (voltage) 3-point calibration curve (VERTMAX) using the 0%, 30%, and 50% AVB wear scar signals. (No transformation curve required). Mix 5 is used for reporting indications at cold-leg TSP's within the preheater section of the generator.

6.1.3 Setting Rotations

6.1.3.1 *Channels 1,3, and 5*: Adjust the rotation so that the phase angle of the signal from the 100% through-wall hole is 40 ° (+/- 1 °) with initial signal excursion down and to the right as the probe is pulled through the calibration standard.

6.1.3.2 *Channels 2, 4, 6, Mix 2, and Mix 5*: Adjust the rotation so that probe motion is horizontal with the through-wall hole signal starting upwards.

6.1.3.3 *Channel 6*: As an option, the signal response from the ASME 100% drill hole may be rotated to 32°(+/- 1°).

6.1.3.4 *Channels 7 and 8*: Adjust the rotation so that the initial excursion of the signal from the support ring is oriented vertically starting downwards.

6.1.3.5 *Mix 1 and Mix 3*: Set probe motion horizontal with the signal from the 100% drill hole starting downwards and to the right.

6.1.4 Setting Spans

6.1.4.1 *Channel 1 and Mix 1*: As a minimum, set span so that the magnitude of the ASME 20% drill hole response is approximately 25% of the full screen height (FSH) of the Lissajous display. Verify that the magnitude of the ASME 100% drill hole response is at least 50% of FSH.

6.1.4.2 *Mix 2*: Set span so that the magnitude of the AVB 20% wear scar response is approximately 25% of FSH.

6.1.4.3 *Locator Channels 7 and 8*: Set span so that the magnitude of the support plate response on Channels 7 and 8 are at least 50% and 25% of FSH, respectively.

6.1.5 Setting Volts

6.1.5.1 *Channel 1*: Set the ASME 20% Flat Bottom Hole(FBH) signal to 4 volts +/- 0.1 volts peak-to-peak in Channel 1 and save/store to all other channels and mixes.

6.1.5.2 *Mix 1*: If an IPC calibration standard is used to establish a voltage scale, then the voltage shall be set to the normalized value on the applicable transfer standard drawing. Save/store to Mix 1. If an ASME calibration standard is used, then set the 20% FBH signal to 2.75 volts +/- 0.1 volts peak-to-peak in Mix 1. Save/store to Mix 1.

6.1.5.3 *Mix 2*: Set the 40% wear scar signal (or 50% wear scar signal if applicable) to 5 volts (VERTMAX). Save/store to Mix 2.

6.1.5.4 *Mix 5*: Set the 50% wear scar signal to 5 volts (VERTMAX). Save/store to Mix 5.

6.1.6 Setting Curves

6.1.6.1 *Calibration Standard Hole Depths*:

(1) The actual depths corresponding to the nominal depths provided below shall be used in establishing calibration curves. "As built" hole dimensions shall be obtained from the applicable calibration standard drawings.

(2) Normalized calibration curves generated using phase angles based on a nominal wall thickness and a standard depth of penetration of 37% are permitted if the requirements of Section 6.1.6.1(1) cannot be satisfied.

6.1.6.2 *Use of Artificial Curves*: The use of artificial curves i.e. set 4.1, is prohibited.

Note: Use max rate for Channels 1,3,5, and Mix 1, and peak-to-peak for channels 4 and 6.

6.1.6.3 *Mix 1 and Channels 1,3, 4, 5, and 6*: Establish phase angle versus depth curves using the following nominal set points:

(1) Set Point 1: 100%
(2) Set Point 2: 60%
(3) Set Point 3: 20%

6.1.6.4 *Mix 2*: Establish a VERT MAX voltage versus depth curve using either of the following two cases of typical nominal set points, depending on the AVB calibration standard used:

	Case 1	Case 2
(1) Set Point 1:	0%	0%
(2) Set Point 2:	20%	30%
(3) Set Point 3:	40%	50%

6.1.6.5 *Mix 3 (Optional Turbo Mix)*: No calibration curve is required.

6.1.6.6 *Mix 5*: Establish a VERTMAX versus depth curve using the following nominal set points:

(1) Set Point 1: 0%
(2) Set Point 2: 30%
(3) Set Point 3: 50%

6.1.7 Data Display

6.1.7.1 As a minimum, set up the display configuration for initial data screening according to Table 6-3 using the span settings established in Section 6.1.4.

Table 6-3 Minimum Display Configuration Requirements

Display	Channel
Lissajous	CH 3
Left Strip Chart	CH 6 Vertical
Right Strip Chart	Mix 1 Vertical

6.1.8 Setting Scale and Axial Locations

6.1.8.1 Set the axial scale to the nearest one-hundredth (0.00) of an inch using Appendix D for dimensions and verify proper setting each time an indication is reported.

6.1.8.2 Scale should be set using the two support structures which bound the region of interest. For U-Bend indications, set scale using the two uppermost TSP's on either leg of the steam generator.

(1) Use the TSP centerline as the zero reference point when setting scale between TSP's.

(2) Use the top of the tubesheet and next TSP or baffle plate centerline when setting scale between the top of the tubesheet and the lowest TSP or baffle plate.

(3) Use the tube end and top of tubesheet when the region of interest is within the tubesheet.

6.1.8.3 Axial locations of indications are measured with a positive offset and physically upward in relation to the adjacent landmark.

(1) Locations of indications within the boundaries of support and baffle plates are referenced (+) or (-) as they occur above or below the support structure centerline.

(2) Indications within the expansion transition region near the secondary tubesheet face are referenced relative to the top of the tubesheet.

(3) U-bend indications are referenced (+) in relation to the adjacent AVB toward the hot-leg or upper hot-leg support plate as appropriate.

(4) AVB indications are referenced to (0.00) at the corresponding AVB.

6.1.8.4 Location landmarks are identified using the appropriate three-letter codes as specified in Appendix D.

6.2 Data Evaluation

Note: This section defines special augmented data screening and analysis requirements for various classes of indications. Particular attention should focus on analysis procedures for 1) free-span indications, and dings. Both of these types of indications have been associated with recent industry forced outages in preheater steam generators. In addition, evaluation requirements for screening support structures, e.g., support and baffle plates, AVB's, and the tubesheet secondary face, are described.

6.2.1 Support Plates and Baffle Plates:

6.2.1.1 Scroll support plates using Channel 3 and Mix 1. There is no minimum threshold voltage for reporting.

6.2.1.2 Channel 3 is usually a very useful channel for data screening and locating the initial position for phase angle measurement.

6.2.1.3 Mix 1 shall be used to determine the final phase angle measurement point.

Note: Interim Plugging Criteria (Applicable to Byron/Braidwood Unit 1 only)

6.2.1.4 Scroll support plates using Channel 3 and Mix 1. There is no minimum threshold voltage for reporting purposes.

6.2.1.5 Initial placement of the dots for identification of the flaw location may be performed using Channel 1 or 3, but the final peak-to-peak measurements must be performed using the Mix 1 Lissajous signal to include the full flaw segment of the signal. It may be necessary to iterate the positions of the measurement points between the identifying frequency and the Mix 1 channel to obtain proper placement.

6.2.1.6 The largest amplitude portion of the Lissajous signal (not necessarily the MAXRATE position) representing the indication should then be reported using Mix 1 to establish the voltage.

6.2.1.7 See Appendix A for additional information concerning ODSCC at the supports plates for Unit 1 only. Also, Figure 1 of Attachment 1 contains a flow diagram indicating the process for the Analyst to follow while reporting indications at the supports.

6.2.2 Tube-end through Top of Tubesheet+1.00" (Hot and Cold Legs)

Note: ***This section explains the requirements for identifying and calling any type of degradation that may occur in the tubesheet +1.00". The primary modes of degradation for Byron and Braidwood at these locations are Primary Water Stress Corrosion Cracking (PWSCC) within the tubesheet and Outer Diameter Stress Corrosion Cracking (ODSCC) at the top of the tubesheet._F* will be applied to tubes which contain tubeheet indications.***

6.2.2.1 Scroll all tubesheet secondary face expansion transitions using Channels 1, 3, 5, and Mix 1 at span settings such that the expansion signal (except for Mix 1) occupies the maximum extent of the Lissajous display without saturating.

6.2.2.2 As an option, Mix 3 (Turbo mix) may be used to carefully screen for degradation-like indications at the top of the tubesheet.

6.2.2.3 Distorted tube sheet entry signals or possible indications should be reported using the appropriate analysis code.

6.2.2.4 Figure 2 of Attachment 1 shows a flowchart illustrating data screening and reporting requirements.

6.2.3 U-Bend Region (11H through 11C)

6.2.3.1 Data Screening (Data Analysis) - Freespan regions

(1) The U-bend region between the uppermost support plates shall be scrolled in the Lissajous window using Channel 5 at a numerical span setting of 10 or less. Straight-leg sections shall be scrolled at normal span settings established during calibration.

(2) Possible indications observed in Channel 5 should be confirmed using Channel 3. It is emphasized that definitive indications may not always be observed in either of the two channels. Rather, the indications may assume a noise-like structure, with multiple discrete indications occurring in close proximity over a longer axial distance.

(3) Report all confirmed indications using a Free-Span Differential (FSD) analysis code. Subsequent disposition of all reported indications will be accomplished by a resolution analyst.

(4) Single indications may be reported using a discrete location while multiple indications in close proximity may be reported using a to-from location.

(5) Figure 3 of Attachment 1 shows a flowchart illustrating U-bend data screening and reporting requirements.

6.2.3.2 Disposition (Resolution Analysts)

(1) Previous history or rotating probe diagnostics shall be used to disposition FSD's .

(2) FSD's may be further reclassified as Free-Span Indications (FSI's) or Manufacturing Burnish Mark (MBM) etc., depending on the relative response of the absolute/differential bobbin coil modes.

(3) All FSI's will be RPC'd for confirmation.

6.2.3.3 Anti-vibration Bars:

(1) Scroll Anti-vibration bar locations using Mix 1 or Mix 2.

(2) Report indications using the Mix 2 VERTMAX analysis function. Signal amplitude, as measured on the conservative leg of the indication, shall be utilized for sizing indications at AVB's.

(3) Figure 4 of Attachment 1 shows a flowchart illustrating data screening and reporting requirements.

6.2.4 Freespan Region (Straight Sections of Tubing between support plates)

6.2.4.1 Ding signals or Freespan signals discovered during data screening shall be scroled in the Lissajous window using Channels 1, 3 and 5.

6.2.4.2 Possible Indications should be detected using Channel 3.

6.2.4.3 It should be noted that generally distorted indications are more apparent in Channels 3 and 5, and often are not evident in Channel 1 because of the overwhelming horizontal response caused by local tube indentation or deformation.

6.2.4.4 Channel 1 should be used to confirm % TW. If there is a +/- 10% TW difference between channels 4 and 6, the FSD code should be used, otherwise report as MBM.

6.2.4.5 The Resoultion Analyst should be involved to evaluate all FSD's with the use of previous history. Any FSD's that grow in voltage and phase angle should be reported by the Resoultion Analyst as a FSI so that the indication will be included on the RPC list.

6.2.4.6 Figure 5 of Attachment 1 shows a flowchart illustrating data screening and reporting requirements.

6.3 <u>Reporting Requirements</u>

6.3.1 All quantifiable indications of tube wall degradation shall be reported. For AVB indications, the reporting threshold is 15%.

6.3.2 All non-quantifiable indications (See Appendix C, Category II) shall be reported. As a general rule, Category II indications shall be considered a repairable condition unless proven otherwise using supplemental diagnostic techniques, e.g. RPC or equivalent, or historical review.

6.3.3 Dents or dings > 5.0 volts peak-to-peak (Mix 1). With the implementation of IPC a 20% sample of dents between 2.5 and 5.0 volts will be performed.

6.3.4 Distorted dents or dings having flaw-like characteristics shall be reported as FSI in the Free-Span only. Any dents or dings found at the support plates that contain an indication should by reported as DNI's (Dent with Indication)

6.3.5 Actual test extent shall be reported as the furthest landmark from the entry leg observed.

6.4 Recording Requirements

6.4.1 As a minimum, the following graphic printouts shall be generated for each reported quantifiable indication, "I" code indication, Free-Span Differential (FSD) and LAR indication:

6.4.1.1 Multiple-channel Lissajous graphics as specified in Tables 6-4 or Table 6-5.

6.4.2 The following information will be recorded in the FINAL REPORT section of the RECORDING MEDIUM:

6.4.2.1 For each tube evaluated, an entry must be made that, as a minimum, contains the S/G, ROW, COL, and EXTENT tested.

6.4.2.2 The evaluation of all indications to include the S/G, ROW, COL, VOLTS, DEG, %, CH#, LOCATION, and EXTENT tested.

6.4.2.3 Any RESTRICTED tubes and the location where probe passage is obstructed. Restricted locations must include elevation where restriction occurs.

6.4.3 The SUMMARY portion of the RECORDING MEDIUM shall include:

6.4.3.1 All information recorded on the RECORDING MEDIUM.

Table 6-4 Eight-Channel Graphics

Location	Lissajous	Charts
Supports	1,3,5, Mix 1, 2,4,6, Mix 2	Mix 1
AVB's	1,3,5, Mix 1, 2,4,6, Mix 2	Mix 2
Free Span	1,3,5, Mix 1, 2,4,6, Mix 2	5
Top of Tubesheet	1,3,5, Mix 1, 2,4,6, Mix 2 or Mix 3	Mix 1

Table 6-5 Four-Channel Graphics

Location	Lissajous	Charts
Supports	1,3,5, Mix 1	6, Mix 1
AVB's	1,3, 6, Mix 2	6, Mix 2
Free Span	1,3,5,6	1, 5
Top of Tubesheet	1,3,5, Mix 1	5, Mix 1

7.0 ROTATING PANCAKE COIL (RPC) REQUIREMENTS

7.1 Analysis Setup

7.1.1 Examination Frequencies (see Table 7-1)

Table 7-1 Three-Coil Rotating Probe

Channel	Frequency (kHz)	Coil	Coil Type	Function
1	300	1	Pancake	General Detection
2	300	5	Circ Wound	Axial Detection
3	300	7	Axial Wound	Circumferential Detection
4	200	1	Pancake	General Confirmation
5	200	5	Circ Wound	Axial Confirmation
6	200	7	Axial Wound	Circumferential Confirmation
7	100	1	Pancake	General Confirmation
8	100	4	Pancake	Trigger
9	100	5	Circ Wound	Axial Confirmation
10	100	7	Axial Wound	Circumferential Confirmation
11	10	1	Pancake	Locator

7.1.2 Setting Mixes (Optional)

7.1.2.1 At the option of the data analysts or at the direction of the Lead Analyst, mixes may be established for information only.

7.1.3 Setting Rotations

7.1.3.1 Detection/Confirmation Channels: Set probe motion to within +/- 5° of horizontal with flaw excursions directed upwards.

7.1.3.2 Channel 8: Set the trigger pulse vertically upwards at 90°-120°.

7.1.3.3 Channel 11: Set the response of the support plate vertically downward at approximately 270°.

7.1.4 Setting Spans

7.1.4.1 Channels 1,2,4,5,& 9: Set spans such that the peak-to-peak response of the axially oriented 40% EDM notch is at least 25% FSH.

7.1.4.2 Channels 3,6 & 10: Set spans to same nominal numerical values as Channels 2,5, and 9 respectively.

7.1.4.3 Channel 8: Set span so that the trigger pulse occupies approximately 50% FSH.

7.1.4.4 Channel 11: Set span so that the support plate occupies 25%-50% FSH.

7.1.5 Setting Volts

7.1.5.1 Pancake Coil

(1) Set the voltage for Channel 1 to 20.00 +/- 0.3 volts on the largest peak-to-peak response of the 100% EDM notch.

(2) Normalize the voltage for other pancake coil channels (CH 4 and CH 7) in reference to Channel 1. Store to all other channels for that coil.

7.1.5.2 Circumferential Wound Coil

(1) Set the voltage for Channel 2 to 20.00 +/- 0.3 volts on the largest peak-to-peak response of the 100% EDM notch.

(2) Normalize the voltage for all other pancake coil channels (CH 5 and CH 9) in reference to Channel 2. Store to all other channels for that coil.

7.1.5.3 Axial Wound Coil

(1) Set the voltage for Channel 3 to 20.00 +/- 0.3 volts on the largest peak-to-peak response of the 100% EDM notch.

(2) Normalize the voltage for all other pancake coil channels (CH 6 and CH 10) in reference to Channel 3. Store to all other channels for that coil.

7.1.6 Setting Curves

7.1.6.1 Depth calibration curves are not required. Phase angle or amplitude curves may be established at the Analysts' option for information only.

7.1.7 Data Display

7.1.7.1 Setup the display configuration for initial data screening according to Table 7-2 using span settings established above.

Table 7-2 Display Configuration

Display	Channel
Lissajous	CH 1 (300 kHz)
Left Chart	CH 1 or CH P1 Vertical
Right Chart	CH 2 or CH 3 Vertical

7.1.8 Setting Scale and Axial Locations

7.1.8.1 Using Channel 1, set scale using the as built length of the calibration standard.

7.1.8.2 Verify proper scale setting when reporting each indication.

7.1.8.3 For support plate indications, axial locations should be referenced positively (+) upward or negatively (-) downward from the centerline (0.00) of the nearest support plate.

7.1.8.4 For top of tubesheet indications, axial locations should be referenced positively (+) upward or negatively (-)downward from the top of the tubesheet zero (0.00) reference.

7.1.9 C-Scan

7.1.9.1 C-scan features shall be adjusted consistent with the software suppliers recommended practice.

7.1.10 Indication Length Measurements

7.1.10.1 Software features for measuring indication lengths will be invoked consistent with the software supplier's recommended practice.

7.1.10.2 Setup of measurement features should be done using the nominal tube Inside Diameter (ID) and the as-built dimensions of the EDM notch standard discontinuities.

7.1.11 Filters (Optional)

7.1.11.1 At the option of the data analysts or at the direction of the Lead Analyst, bandpass filters on process channels P1, P2 and P3 using Channels 1,2 and 3 (300 KHz), respectively, may be established using the nominal settings of Table 7-3. Settings may be adjusted slightly to improve signal-to-noise.

Table 7-3 Bandpass Filter Setup

Parameter	Value
Sharpness	23 coefficients
Low cutoff frequency	10 Hz
High cutoff frequency	100 Hz

7.2 Data Evaluation

7.2.1 Screening

.2.1.1 Review strip chart data while scrolling all acquired data using Channel 1 to establish the presence of an indication. Other analysis channels may be used for additional confirmation.

7.2.1.2 Decrease initial span settings (higher gain) as required such that proper detailed analysis is conducted on all data.

7.2.1.3 Indications which are flaw-like on any of the degradation channels shall be reported regardless of the extent to which the channels correlate.

7.2.2 Analysis

7.2.2.1 Graphic displays and relative three-coil amplitude response shall be used to determine flaw orientation and dimensionally using the basic logic summarized in Figure 7 of Attachment 1.

7.2.2.2 Three-coil relative signal response as shown in Table 7-4 may be used to assist in determining flaw dimensionally and orientation.

Table 7-4 Three-coil Relative Amplitude Response

Coil	Flaw Dimensionality/Orientation		
	Vol	Axial	Circ
Pancake	+	+	+
Axial	+	+	-
Circ	+	-	+

7.2.2.3 Three-dimensional discontinuities in general will have a comparable response from the pancake and axial/circ coils. Linear or two-dimensional discontinuities will typically show a preferred response to either the axial or circ coils (or both) dependent on flaw orientation. The pancake coil is equally sensitive to linear discontinuities independent of their orientation.

7.2.2.4 Indications with a preferred amplitude response from either the axial or circ coil shall be analyzed using a three-letter analysis code indicative of the orientation (axial or circumferential) and frequency of occurrence in a given plane. Indications with comparable amplitude responses from all three coils shall be analyzed as three-dimensional (volumetric) using an appropriate analysis code.

7.2.2.5 Locations with both axial and circumferential indications present concurrently shall be analyzed as mixed-mode.

7.3 Reporting Requirements

7.3.1 The voltage of an indication will be measured at the peak signal for each indication. This will generally be at the center most "hit" of the indication using the detection channel (CH 1 typically). Peak-to-peak voltage should be used for the voltage reading, adjusting the window width to minimize noise in the signal.

7.3.2 Indication location will be derived from the center most "hit" point of the calling channel.

7.3.3 Indications will not be reported as a percent depth, but assigned an analysis code indicative of the Dimensionality, orientation and frequency of occurrence of the flaw in a given plane. Permissible analysis codes are listed in Appendix C.

7.4 Recording Requirements

7.4.1 The following graphic printouts should be generated for each reported indication:

7.4.1.1 Main display screen typically with the Lissajous of the calling channel (CH 1), left strip chart of a low frequency channel adequate to display the bounding or nearest support and right strip chart with the vertical component of a confirmatory channel (e.g., CH P1 or CH 2).

7.4.1.2 C-scan of indication with the low frequency channel displayed on the strip chart and either the calling channel or corresponding filtered channel for the C-scan plot.

8.0 RESOLUTION CRITERIA

8.1 Primary and secondary analyses results will be compared and referred to the Lead and/or Resolution analysts for resolution and disposition.

8.2 Conditions requiring resolution include:

8.2.1 All quantifiable indications > 40% through-wall, and Category 2 Indications listed in Appendix C where primary and secondary analysis results do not match.

8.2.2 Quantifiable indications between 20% and 39% reported by one Analyst but not the other.

8.2.3 Indications in which the depth estimate differs by more than 10% through-wall

8.2.4 Indications for which location measurements differ by more than;

8.2.4.1 +/- 1" for free-span.

8.2.4.2 +/- 0.5" at support structures.

8.2.5 Indications at tube support plates for plants implementing IPC for which;

8.2.5.1 Bobbin coil indications are greater than the repair limit voltage where primary and secondary analysis results do not match.

8.2.5.2 The reported location extends beyond either support plate edge.

8.2.5.3 Indications are diagnosed as circumferential cracking by RPC.

8.2.5.4 The bobbin coil voltage values called by primary and secondary analysts deviate by more than 20% and one or both calls exceeds 1 volt.

8.2.5.5 All large mix residuals that could mask a 1.0 volt indication found at TSP's.

8.2.6 Reporting errors or discrepancies in such items as steam generator, tube or reel ID, probe type, extent tested, analysis code assignment, etc.

8.2.7 One analyst reports a tube not reported by another.

8.3 Any tube with an initially reported repairable condition - by either the primary or secondary analyst, or both - that is subsequently resolved to a non-repairable condition during resolution - shall be reported to a ComEd representative for information.

APPENDIX A
DATA ACQUISITION AND ANALYSIS REQUIREMENTS FOR TSP ODSCC

A.1.0 INTRODUCTION

A.1.1 This appendix documents techniques for the inspection of Byron and Braidwood Unit 1 steam generator tubes related to the identification of ODSCC or IGA/SCC at tube support plate (TSP) regions.

A.1.2 This appendix contains guidelines which provide direction in applying the ODSCC Interim Plugging Criteria (IPC) described in this report. The procedures for eddy current testing using bobbin coil (BC) and rotating pancake coil (RPC) techniques are summarized. The procedures given apply to the bobbin coil inspection, except as explicitly noted for RPC inspection. The methods and techniques detailed in this appendix are requisite for implementation of TSP IPC.

Note: ***The following sections define specific acquisition and analysis parameters and methods to be used for the inspection of steam generator tubing.***

A.2.0 DATA ACQUISITION

Note: ***Byron and Braidwood Unit 1 steam generators utilize 3/4" OD x 0.043" wall, Alloy 600 mill-annealed tubing. The carbon steel support plates and baffle plates are designed with drilled holes.***

A.2.1 **Instrumentation** utilized shall be the Zetec MIZ-18 (For the acquisition of Eddy current data) equipment, the Echoram ERDAU or other equipment with similar specifications.

A.2.2 **Probes** which will be used are the following:

A.2.2.1 Bobbin Coil Probes - To maximize consistency with laboratory IPC data, differential probes with the following parameters shall be used for examination of IPC tube support plate intersections:

(a) 0.610 outer diameter

(b) Two bobbin coils, each 60 mils long, with 60 mils between coils (coil centers separated by 120 mils)

(c) In addition, the probe design must incorporate centering features that provide for minimum probe wobble and offset; the centering features must maintain constant probe center to tube ID offset for nominal diameter tubing. For locations which must be inspected with smaller than nominal diameter probes, it is essential that the reduced diameter probe be calibrated to the reference normalization (Section A.2.6.1 and Section A.2.6.2) and that the centering features permit constant probe center to tube ID offset. Probes must have centering adjustment that collapse to the reference probe diameter.

(d) Once probe has been calibrated on the 20% TW holes, the voltages response for new bobbin coil probes for the 40% TW to 100% TW holes should not differ from the nominal voltage by more than 10%.

A.2.2.2 Rotating Pancake Coil Probes - Pancake coil designs (vertical dipole moment) with a coil diameter d, where d is 0.060" $< d <$ 0.125", shall be used. While other multi-coil (i.e., 1,2 or 3-coil) probes can be utilized, it is recommended that if a 3-coil probe is used, any voltage measurements should be made with the probe's pancake coil rather than its circumferential or axial coil.

(a) The maximum probe pulling speed shall be 0.2 in./sec for the 1-coil or 3-coil probe, or 0.4 in/sec. for the 2-coil probe. The maximum rotation shall be 300 rpm. This would result in a pitch of 40 mils for the 3-coil probe.

A.2.3 Calibration Standards to be utilized for IPC

A.2.3.1 Bobbin Coil Standards - These standards will meet the following criteria:

A.2.3.1.1 Voltage Normalization Standard

Note: ***All holes shall be machined using a mechanical drilling technique. This calibration standard will need to be calibrated against the reference standard used for the IPC laboratory work by direct testing or through the use of a transfer standard.***

(a) One 0.052" diameter 100% thr ugh wall hole

(b) Four 0.028" diameter through wall holes, 90 degrees apart in a single plane around the tube circumference; the hole diameter tolerance shall be +/- 0.001" (optional).

(c) One 0.109" diameter flat bottom hole, 60% through from OD

(d) One 0.187" diameter flat bottom hole, 40% through from the OD

(e) Four 0.187" diameter flat bottom holes, 20% through from the OD, spaced 90 apart in a single plane around the tube circumference. The tolerance on hole diameter and depth shall be +/-0.001".

(f) A simulated support ring, 0.75" long, comprised of SA-285 Grade C carbon steel or equivalent.

A.2.3.1.2 Probe Wear Standard

Note: ***A probe wear standard is used for monitoring the degradation of probe centering devices leading to off-center coil positioning and potential variations in flaw amplitude responses.***

(a) Contains four 0.052" +/- 0.001 inch diameter through-wall holes, spaced 90 degrees apart around the tube circumference.

(b) Has axial spacing such that signals can be clearly distinguished from one another. See Figure A-1.

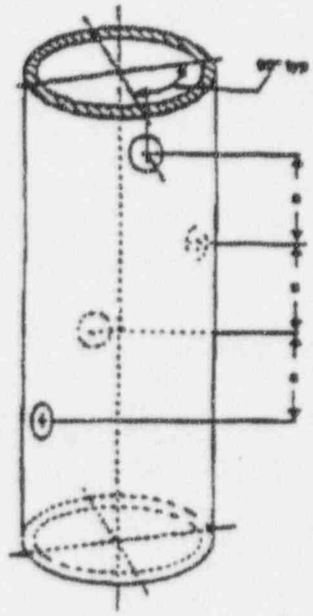


Figure A-1: Probe Wear Standard Schematic

A.2.3.2 Rotating Probe Standard - This standard may contain the following:

(a) Two axial EDM notches, located at the same axial position but 180 degrees apart circumferential, each 0.006" wide and 0.5" long, one 80% and one 100% through wall from the OD.

(b) Two axial EDM notches, located at the same axial position but 180 degrees apart circumferentially, each 0.006" wide and 0.5" long, one 60% and one 40% through-wall from the OD.

(c) Two circumfermtial EDM notches, one 50% through wall from the OD with a 75 degree (0.49" arc length), and one 100% through wall with a 26 degree (0.20") arc length, with both notches 0.006" wide.

(d) A simulated support segment 270 degrees in circumferential extent, 0.75" thick, comprised of SA-285 Grade C carbon steel or equivalent.

(e) The center to center distance between the support plate simulation and the nearest slot shall be at least 1.25". The center to center distance between the EDM notches shall be at least 1.0". The tolerance for the widths and depths of the notches shall be 0.001". The tolerance for slot lengths shall be 0.010".

A.2.4 Application of Bobbin Coil Wear Standard

A.2.4.1 A calibration standard has been designed to monitor bobbin coil probe wear. During steam generator examination, the bobbin probe is inserted into the wear monitoring standard; the initial (new probe) amplitude response from each of the four holes is determined and compared on an individual basis with subsequent measurements. Signal amplitudes or voltages from the individual holes - compared with their initial amplitudes - must remain within 15% of their initial amplitude (i.e., {(worn-new)/new} for an acceptable probe wear condition. If this condition is not satisfied, then the probe

must be replaced. All tubes since the last acceptable probe wear measurement must be re-inspectected with the new probe.

A.2.4.2 Bobbin Coil Wear Standard Placement Under ideal circumstances, the incorporation of a wear standard in line with the conduit and guide tube configuration would provide continuous monitoring of the behavior of bobbin probe wear. However, the curvature of the channel head places restrictions on the length on in line tubing inserts which can be accommodated. The spacing of the ASME Section XI holes and the wear standard results in a length of tubing which cannot be freely positioned within the restricted space available. The flexible conduit sections inside the channel head, together with the guide tube, limit the space available for additional in line components. Voltage responses for the wear standard are sensitive to bending of the leads, and mock up tests have shown sensitivity to the robot end effector position in the tubesheet, even when the wear standard is placed on the bottom of the channel head. Wear standard measurements must permit some optimization of positions for the measurement and this should be a periodic measurement for inspection efficiency. The preexisting requirement to check calibration using the ASME tubing standard is satisfied by periodic probing at the beginning and end of each probe's use as well as at four hour intervals. This frequency is adequate for wear standard purposes as well. Evaluating the probe wear under uncontrollable circumstances would present variability in response due to channel head orientations rather than changes in the probe itself.

A.2.5 Acquisition Parameters

Note: The following pa.ameters apply to bobbin coil data acquisition and should be incorporated in the applicable inspection procedures to supplement (not necessarily replace) the parameters normally used.

A.2.5.1 Test Frequencies

A.2.5.1.1 This technique requires the use of bobbin coil 550 kHz and 130 kHz test frequencies in the differential mode. It is recommended that the absolute mode also be used, at test frequencies of 130 kHz and 10 - 35 kHz. The low frequency (10-35 kHz) channel should be recorded to provide a means of verifying tube support plate edge detection for flaw location purposes. The 550/130 kHz mix or the 550 kHz differential channel is used to access changes in signal amplitude for the probe wear standard as well as for flaw detection.

A.2.5.1.2 RPC frequencies should include channels adequate for detection of OD degradation in the range of 100 kHz to 550 kHz, as well as a low frequency channel to support location of the TSP edges.

A.2.5.2 Digitizing Rate

A.2.5.2.1 A minimum digitizing rate of 30 samples per inch should be used. Combinations of probe speeds and instrument sample rates should be chosen such that:

$$\frac{\text{Sample Rate (samples/sec.)}}{\text{Probe Speed (in/sec)}} \geq 30 \text{ (samples/in.)}$$

A.2.6 Analysis Parameters

Note: ***This section discusses 1) the methodology for establishing bobbin coil data analysis variables such as spans, rotations, mixes, voltage scales, and calibration curves. Although indicated depth measurement may not be required to support an alternative repair limit, the methodology for establishing the calibration curves is presented. The use of these curves is recommended for consistency in reporting and to provide compatibility of results with subsequent inspections of the same steam generator and for comparison with other steam generators and/or plants.***

A.2.6.1 Bobbin Coil 550 kHz Differential Channel

Note: ***(1) For all new probes the analyst must minimize mix residuals on the calibration standard as applicable***
(2) Probes exceeding the 15% sensitivity voltage for wear shall be disposed and all tubes since the last sucessful measurement for probe wear shall be re-inspected with the new probe.

A.2.6.1.1 Spans and Rotations: Spans and rotations can be set at the discretion of the user and/or in accordance with applicable procedures, but all TSP intersections must be viewed at a span setting one-half or less than that which provides 3/4 full screen amplitude for 4x20% holes with bobbin probes and 1/10 or less the corresponding span for 0.5" long through-wall slot (EDM notch) with RPC probes.

A.2.6.1.2 Voltage Scale: The peak-to-peak signal amplitude of the signal from the four 20% through-wall holes should be set to produce a voltage equivalent to that obtained from the IPC lab standard. The laboratory standard normalization voltages are 4.0 volts at 550 kHz and 2.75 volts for the 550/130 kHz mix.

Note: ***The transfer/field standard will be calibrated against the laboratory standard using a reference laboratory probe to establish voltages for the field standard that are equivalent to the above laboratory standard. These equivalent voltages are then set on the field standard to establish calibration voltages for any other standard.***

(a) Voltage normalization to the standard calibration voltages at 550 kHz is the preferred normalization to minimize analyst sensitivity in establishing the mix. However, if the bobbin probes used result in a 550/130 kHz mix to 550 kHz voltage ratios differing from the laboratory standard ratio of 0.69 by more than 5% (0.66 to 0.72), the 550/130 kHz mix calibration voltage should be used for voltage normalization.

A.2.6.1.3 Calibration Curve: Establish a phase versus depth calibration curve using measured signal phase angles in combination with the "as-built" flaw depths for the 100%, 60%, and 20% holes.

A.2.6.2 Bobbin Coil 550/130 kHz Differential Mix Channel

A.2.6.2.1 Spans and Rotations: Spans and rotations can be set at the discretion of the user and/or in accordance with applicable procedures.

A.2.6.2.2 Voltage scale: See Section A.2.6.1

A.2.6.2.3 Calibration Curve: Mix 1 is a 550/130 kHz differential support mix; mix on ASME standard support ring. Set 3-point phase angle-depth calibration curve using ASME 100%, 60%, and 20% drill hole signals. Mix 1 is the primary channel for reporting indications at support structures.

A.2.6.3 Rotating Pancake Coil Channel

A.2.6.3.1 Voltage Scale: The RPC amplitude will be referenced to 20 volts for a 0.5 inch long 100% through wall notch at 300 kHz. Each channel shall be set individually to the desired amplitude for the EDM notches on the plant standards; cross calibration will be achieved by comparison of the RPC responses from the 100% drilled hole.

A.2.7 <u>Analysis Methodology</u>

A.2.7.1 Bobbin coil indications at support plates attributable to ODSCC are quantified using the Mix 1 (550 kHz/130 kHz) data channel. This is illustrated with the example shown in Figure A-2. The 500/130 kHz mix channel or other channels appropriate for flaw detection (550 kHz, 300 kHz, or 130 kHz) may be used to locate the indications of interest within the support plate signal. The largest amplitude portion of the Lissajous signal representing the flaw should then be measured using the 550/130 kHz Mix 1 channel to establish the peak-to-peak voltage as shown in Figure A-2. Initial placement of the dots for identification of the flaw location may be performed as shown in Figures A-3 and A-4, but the final peak-to-peak measurements must be performed on the Mix 1 Lissajous signal to include the full flaw segment of the signal. It may be necessary to iterate the positions of the dots between the identifying frequency and the 550/130 kHz mix to obtain proper placement. As can be seen in Figure A-4, failure to do so can reduce the voltage measurement of Mix 1 by as much as 65% to 70% due to the interference of the support plate signal in the raw frequencies. The voltage as measured from Mix 1 is then entered as the analysis of record for comparison with the repair limit voltage.

A.2.7.2 To support the uncertainty allowances maintained in the IPC, the difference in amplitude measurements for each indication will be limited to 20%. If the voltage values called by the independent analysts deviate by more than 20% and one or both of the calls exceeds 1.0 volts, analysis by the resolution analyst will be performed. These triplicate analyses result in assurance that the voltage reported departs from the correct call by no more than 20%.

A.2.8 <u>Reporting Guidelines</u>

Note:	***The reporting requirements identified below, are in addition to any other reporting requirements specified by the user***

A.2.8.1 Minimum Requirements

A.2.8.1.1 All bobbin coil flaw indications in the 550/130 kHz mix channel at the tube support plate intersections regardless of the peak-to-peak signal amplitude must be reported. All TSP locations with indications exceeding the repair limit must be examined with RPC probes.

A.2.8.2 Additional Requirements

A.2.8.2.1 For each reported indication, the following information should also be recorded:

(a) Tube identification (row, column)
(b) Signal amplitude (volts)
(c) Signal phase angle (degrees)
(d) Indication (3 letter code)
(e) Test Channel (ch#)
(f) Axial position of tube (location)
(g) Extent of test (extent)
(h) Pobe size
(I) Tape #

2.8.2.2 RPC reporting requirements should include as a minimum: type of degradation (axial, circumferential or other), maximum voltage, phase angle, crack lengths, and location of the center of the crack within the TSP. The crack axial center to edge need not coincide with the position of maximum amplitude. Locations which do not exhibit flaw-like indications in the RPC isometric plots may continue in service, except that all intersections exhibiting flaw-like bobbin behavior and bobbin amplitudes in excess of the repair limit voltage must be repaired, notwithstanding the RPC analyses. RPC isometrics should be interpreted by the analyst to characterize the signals observed; only featureless isometrics are to be reported as NDD. Signals not interpreted as flaws include dents, liftoff, deposits, copper, magnetite, etc.

A.3.0 DATA EVALUATION

A.3.1 Use of 550/130 Differential Mix for Extracting the Bobbin Flaw Signal

A.3.1.1 In order to identify a discontinuity in the composite signal as an indication of a flaw in the tube wall, a simple signal processing procedure of mixing the data from the two test frequencies is used which reduces the interference from the support plate signal by approximately one order of magnitude. The test frequencies most often used for this signal processing are 550 kHz and 130 kHz for 43 mil wall Alloy 600 tubing. Any of the differential data channels including the mix channel may be used for flaw detection (though the 130 kHz is often subject to the influence from many different effects), but the final evaluation of signal detection, amplitude and phase angle will be made from the 550/130 kHz differential mix channel. Upon detection of a flaw signal in the differential mix channel, confirmation from other raw channels is not required; all such signals must be reported as indications of possible ODSCC. The voltage scale for the 550/130 kHz differential channel should be normalized as described in Section A.2.1.6.1 and A.2.1.6.2.

A.3.1.2 The present evaluation procedure requires that there is no minimum voltage for flaw detection purposes and that all flaw signals, however small, be identified. The intersections with flaw signals > the repair limit will be inspected with RPC. Although the signal voltage is not a measure of flaw depth, it is an indicator of the tube burst pressure when the flaw is identified as axial ODSCC with or without minor IGA.

A.3.2 Amplitude Variability

A.3.2.1 It has been observed that voltage measurements taken from the same data by different analysts may vary, even when using identical analysis guidelines. This is largely due to differences in analyst interpretation of where to place the dots on the lissajous figure for the peak-to-peak amplitude measurement. Figures A-5 and A-6 show the correct placement of the dots on the Mix 1 Lissajous figures for the peak-to-peak voltage amplitude measurements for two tubes from Plant S. In Figure A-5, the placement is quite obvious. In Figure A-6, the placement requires slightly more of a judgment call. Figures A-7 and A-8 show these same two tubes with peak-to-peak measurements being made, but in both cases the dots have been placed at locations where the normal max-rate dots would be located. The reduction in the voltage amplitude measurement is 19.3% in Figure A-7 and 16.3% in Figure A-8. While this is an accepted method of analysis for phase-angle measurements, it is not appropriate for the voltage amplitude measurements required.

A.3.2.2 In Figures A-5 and A-6, the locations of the dots for the peak-to-peak measurements being performed from Mix 1 show the corresponding dots on the 550 kHz raw frequencies as also being located at the peak or maximum points of the flaw portion of the Lissajous figure. In no case should the dots to measure the voltage amplitude be at locations less than the maximum points of the flaw portion of the 550 kHz raw frequency.

A.3.2.3 Figure A-9 is an example of where the dots have been placed on the transition region of the 550 kHz raw frequency data Lissajous figure. It is clear from the Mix 1 Lissajous figure that this does not correspond to the maximum voltage measurement. The correct placement on the Mix 1 Lissajous figure is shown in Figure A-10. This placement also corresponds to the maximum voltage measurement on the 550 kHz raw frequency data channel.

A.3.2.4 In some cases, it will be found that little if any definitive help is available from the use of the raw frequencies. Such as the example shown in Figure A-11, where there are no significantly sharp transitions in any of the raw frequencies. Consequently, the placement of the measurement dots must be made completely on the basis of the Mix 1 channel Lissajous figure as shown in the upper left of the graphic. An even more difficult example is shown in Figure A-12. The logic behind the placement of the dots in Mix 1 is that sharp transitions in the residual support plate signals can be observed at the locations of both dots. In the following graphic, Figure A-13, somewhat the same logic could be applied in determining the flaw-like portion of the signal from the Mix 1 Lissajous pattern. However, inasmuch as there is no sharp, clearly defined transition, coupled with the fact that the entry lobe into the support plate is distorted on all of the raw frequencies, the dots should be placed as shown in Figure A-14. This is a conservative approach and should be taken whenever a degree of doubt as to the dot placement exists.

A.3.2.5 It is noted that by employing these techniques, identification of flaws is improved and that conservative amplitude measurements are promoted. The Mix 1 traces which result from this approach confirm to the model of TSP ODSCC which represents the degradation as a series of microcrack segments axially integrated by the bobbin coil; i.e., short segments of changing phase angle direction represent changes in average depth with changing axial position. This procedure may not yield the maximum bobbin depth call. If maximum depth is desired for information purposes, shorter segments of the overall crack may have to be evaluated to obtain the maximum depth estimate.

However, the peak to peak voltages as described herein must be reported, even if a different segment is used for the depth call.

A.3.3 Alloy Property Changes

> *Note:* ***Only thoseAll mix residuals located at tube supports that could mask a 1.0 volt indication shall be reported as MRI (Mix Residual Indication) and these indications will be included on the RPC list. Large mix residuals are those that could cause a 1.0 volt indication to be missed or misread. Any indications found at such intersections with RPC shall be repaired.***

A.3.3.1 This signal manifests itself as part of the support plate "mix residual" in both the differential and absolute mix channels. It has often been confused with copper deposits as the cause. Such signals are often found at support plate intersections of operating plants, as well as in some model boiler test samples, and are not necessarily indicative of tube wall degradation. Six support plate intersections from Plant A, judged as free of tube wall degradation on the basis of the mixed differential channel using the guidelines given in Section A.2.7 of this document, were pulled in 1989. Examples of the bobbin coil field data are shown in Figure A-15. (inspection data from a plant with 7/8 inch diameter tubing.) The mix residual for this example is approximately 3 volts in the differential mix channel and no discontinuity suggestive of a flaw can be found in this channel. An offset in the absolute mix channel which could be confused as a possible indication is also present. These signals persisted without any significant change even after chemically cleaning the OD and the ID of the tubes. The destructive examination of these intersections showed very minor or no tube wall degradation. Thus, the overall "residuals" of both the differential and absolute mix channels were not indications of tube wall degradation. One needs to examine the detailed structure of the "mix residual" (as outlined in Section A.2.7) in order to assess the possibility that a flaw signal is present in the residual composite. Verification of the integrity of TSP intersections exhibiting alloy property or artifact signals is accomplished by RPC testing of a representative sample of such signals.

A.3.4 Copper and Denting Interference's

A.3.4.1 Copper Interference

> *Note:* ***All intersections with interferring copper deposits shall be inspected with RPC. All indications found at such intersections with RPC shall be repaired.***

(a) In situations where significant copper interference in the eddy current data is noted, the eddy current technique basically becomes unreliable. This results from the unpredictability of the amount and morphology of copper deposit on the tubes which may be found in operating steam generators. The above observation is true both for bobbin and RPC or any other eddy current probe. Fortunately, significant copper interference has not occurred in the support plate crevice regions at Byron or Braidwood. Copper is not expected to become a problem since both Byron and Braidwood contain copper free secondary plants.

(b) Inspections with RPC and bobbin probes have shown good correlation for flaw amplitudes exceeding 1.0 volt; i.e., more than 50% of the bobbin signals identified have been confirmed to exhibit flaws to the RPC probe. This suggests that spurious signals from conductive deposits do not result in excessively high false call rates. Furthermore, signals judged as NDD with the bobbin guidelines have

been confirmed to be free of RPC detectable flaws. Copper is a concern for NDE only when plated directly on the tube surface in elemental form. Copper particles with the sludge in the crevice do not significantly influence the eddy current response. To Westinghouse's knowledge, no pulled tubes have been identified with copper deposits on the tube at the TSP intersections - in contrast with free span tubing. Copper deposits have not been identified at TSP intersections in the Byron or Braidwood steam generators and no copper alloys are used in the secondary system. Thus, it is not expected that copper influence will significantly influence the TSP signals in the Byron or Braidwood steam generators.

A.3.4.2 Dent Interference

Note: All interesections with dent signals greater than or equal to 2.5 volts shall be reported by the analyst. All dents > 5.0 volts will be inspected using RPC and 20% of dents at supports between 2.5 and 5.0 volts will be inspected using RPC. All dents > 5.0 volts that contain an indication per RPC shall be repaired.

(a) The 550/130 kHz (differential) support plate suppression mix reduces or eliminates the support plate and the magnetite which may be present with the support plate, but the resulting processed signal will still be a composite flaw, other artifacts and a dent, if present. These composite signals represent vectorial combinations of the constituent effects, and as such they may not conform to the behavior expected from simple flaw simulations as a function of test frequencies.

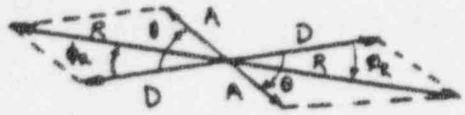
(b) The effect of the dent on the detection and evaluation of a flaw signal depends on both the relative amplitudes of the flaw and dent signals and the relative spatial relationship between them, If the flaw is located near the center of the dent signal, interference with flaw detection may become insignificant, even for relatively large dent to flaw ratios. The flaws signal in a typical support plate dent in this event occurs at mid-plane, away from the support plate edges where the dent signal exhibits maximum voltage; thus the flaw in the middle section of the support plate appears as a discontinuity in the middle of the composite signal. It can be observed in Figures A-20 through A-25, from Plant A, that one can often extract a flaw signal even when the flaw signal-to-noise ratio (S/N) is less than unity. The question of S/N ratio requirements necessary for flaw detection is not a number that can be readily determined; but as can be seen from these figures, even with ratios as low as 0.184/1.0, the flaw signal can be detected and evaluated.

(c) The greatest challenge to flaw detection due to dent interference occurs when the flaw occurs at the peak of the dent signal. Detection of flaw signals of amplitudes equal to or greater than 1.0 volts (flaws greater that 1 .0 volts require RPC testing) in the presence of peak dent voltages can be understood by vectorial combination of a 1.0 volt flaw signal across the range of phase angles associated with 40% (110 degrees) to 100% (40 degrees) through wall penetrations with dent signals of various amplitudes. It is easily shown that 1.0 volt flaw signals combined with dent signals up to approximately 5.0 volts peak to peak will yield resultant signals with phase angles that fall within the flaw reporting range, and in all cases will exceed 1.0 volts. All such dent signals with a flaw indication signal will be subjected to RPC testing. To demonstrate this, one-half the dent peak-to-peak voltage (entrance of exit lobe) can be combined with the 1.0 volt flaw signal at the desired phase angle.

(d) The Plant A inspection data is shown in Figures A-20 through A-25 to permit flaw detection and evaluation for flaws situated away from the peak dent voltages.

The vector combination analysis shows that for moderate dent voltages where flaws occur coincident with dent entrance or exit locations, flaw detection at the 1.5 volts amplitude level is successful via phase discrimination of combined flaw/dent signals from dent only signals.

(e) The vector addition model for axial cracks coincident with denting at the TSP edge is illustrated as follows:



where R = Resultant Signal Amplitude
A = Flaw Signal Amplitude
D = TSP Dent Amplitude - one edge (Peak-to-Peak = 2D)
0 = Flaw Signal Phase Angle
(100% = 40°; 40% ~110°)
ϕ_R = Phase Angle of Resultant Signal
and
$R^2 = (D + A\cos\theta)^2 + (A\sin\theta)^2$
$\theta_R = \arctan^{-1} (A\sin/D + A\cos\theta)$

Note:	***For dents without flaws, a nominal phase angle of 180° is expected. The presence of a flaw results in rotation of the phase angle to < 180° and into the flaw plane. A phase angle of 170 (10°) away from nominal dent signal) provides a sufficient change to identify a flaw. For dents with peak-to-peak amplitude of 5.0 volts, D = 2.5 v and the minimum phase angle rotation (OR) for a 1.0 volt ODSCC flaw signal greater than 40% through-wall is predicted to be at least 11°, sufficiently distinguishable from the 180° (0°) phase angle associated with a simple dent.***

(f) Supplement information to reinforce this phase discrimination basis for flaw identification can be obtained by examination of a 300/130 kHz mix channel; dent response would be lessened while the OD originating flaw response is increased relative to the 550/130 kHz mix. RPC testing of indications identified in this fashion will confirm the dependability of flaw signal detection. Intersections with dent voltages exceeding 5.0 volts for which 1.0 volt flaws may not be detectable, are candidates for RPC inspection of dented TSP intersections.

A.3.5 TSP Noise Criteria

Note:	***Data which contain quantitaive noise criteria (resulting from electrical noise, tube noise, calibration standard noise shall be re-inspected***

A.3.5.1 Eddy current data acquired from active tubes and calibration standards shall be reviewed for the presence of electrical and tube noise with the following criteria:

(a) *ID Chatter or Pilgering Noise*-Tubes identified with noise associated with ID chatter or pilgering at TSP locations in excess of 5 volts peak-to-peak shall be inspected with RPC. If a flaw is confirmed with RPC, the tube shall be repaired.

(b) *Probe Noise*-Electrical noise due to a failing or intermittent probe is readily recognizable as the noise signal often assumes the shape of a random square wave modulating the eddy current signal. General eddy current data quality must be monitored to ensure that a minimum 3:1 signal to noise (S/N) is maintained.

(c) *Noise Spiking*-Electrical or noise spikes at TSP's in excess of 0.3 volts peak-to-peak on the vertical channel will be rejected by the analyst and the tube will be reexamined.

Note: ***Data failing to meet the above requirements should be rejected and the tube should be re-inspected.***

A.3.5.2 The data analysts must continuously verify probe acceptability for each tube examined by reviewing the overall quality of the data and determining if the probe is causing undesirable and interfering signal responses.

A.3.5.3 EPRI is currently developing a quantified noise criteria for industry use. The above criteria will be employed at Byron and Braidwood until the EPRI noise criteria is employed.

A.3.6 RPC Flaw Characterization

3.6.1 The RPC inspection of some support plate intersections with bobbin coil indications > 1.0 volts is recommended in order to verify the applicability of the alternate repair limit. This is based on establishing the presence of ODSCC with minor IGA as the cause of the bobbin indications.

Note: ***The signal voltage for RPC data evaluation will be based on 20 volts for the 100% through-wall 0.5" long EDM notch at all frequencies.***

3.6.2 The nature of the degradation and its orientation (axial or circumferential) will be determined from careful examination of the isometric plots of the RPC data. The presence of axial ODSCC at the support plates has been well documented, but the presence of circumferential indications related to ODSCC at support plate intersections has also been established by tube pulls at two plants. Figures A-16 to A-18 show examples of single and multiple axial ODSCC from Plant S.

3.6.3 Figure A-19 is an example of a circumferential indication related to ODSCC at a tube support plate location from another plant. If circumferential involvement results from circumferential cracks as opposed to multiple axial cracks, discrimination between axial and circumferentially oriented cracking can be generally established for affected arc lengths of about 45 degrees to 60 degrees or larger. Axial cracking has been found by pulled tube exams for RPC arcs of 150 degrees when the axial extent is significant, such as > 0.2 inch.

Note: ***Pancake coil resolution is considered adequate for separation between circumferential and axial cracks. This can be supplemented by careful interpretation of 3-coil results. Since denting has not occurred at the Byron or Braidwood units, circumferential cracking is not expected to happen at the support plates.***

3.6.4 The presence of IGA as a local effect directly adjacent to crack faces is expected to be indistinguishable from the crack responses and as such of no structural consequence. When IGA exists as a general phenomenon, the eddy current response is proportional to the volume of affected tube material, with phase angle corresponding to depth of penetration and amplitude relatively larger than that expected for small cracks. The presence of distributed cracking, e.g., cellular SCC, may produce responses from microcracks of sufficient individual dimensions to be detected but not resolved by the RPC, resulting in volumetric responses similar to three-dimensional degradation.

Note: ***For hot leg TSP locations, there is little industry experience on the basis of tube pulls for volumetric degradation, i.e., actual wall loss or general IGA. For cold leg TSP locations, considerable experience is available for volumetric degradation in the form of thinning of peripheral tubes, favoring the lower TSP elevations. Therefore, in the absence of confirmed pulled tube experience to the contrary, volumetric OD indications at hot-leg tube support plates should be considered to represent ODSCC.***

A.3.7 Confinement of ODSCC/IGA Within the Support Plate Region

A.3.7.1 The measurement of axial crack lengths from RPC isometrics can be determined using the following analysis practices. For the location of interest, the low frequency channel (e.g. 10 kHz) is used to set a local scale for measurement. By establishing the midpoint of the support plate response, a reference point for indication location is established. Calibration of the distance scale is accomplished by setting the displacement between the 10 kHz absolute, upper and lower support plate transitions equal to 0.75 inch.

A.3.7.2 In order to establish that a bobbin indication is within the support plate, the displacement of each end of the signal is measured relative to the support plate center. The field measurement is then corrected for field spread (look-ahead) to determine the true distance from the TSP center to the crack tip. If this distance exceeds one-half the support plate axial length (0.375"), the crack will be considered to have progressed outside the support plate. This condition requires LAR and will be reported to the site representative. Dispositioning of the conditions may include further inspection with RPC. Per the repair criteria, indications, extending outside the support plate require tube repair.

A.3.8 Length Determination with RPC Probes

A.3.8.1 At the analysis frequency, either 300 kHz or 400 kHz, the ends of the crack are located using the slope-intercept method; i.e., the leading and trailing edges of the signal pattern are extrapolated to cross the null baseline (see Figure A-26). The difference between these two positions is the crack length estimate. Alternately, the number of scan lines indicating the presence of flaw behavior times the pitch of the RPC provides an estimate of the crack length which must be corrected for EC field spread.

A.3.9 RPC Inspection Plan

A.3.9.1 The RPC inspection plan will include the following upon implementation of the IPC repair limits:

(a) Bobbin voltage indications > than 1 volt

(b) All intersections with interferring signals from copper deposits.

(c) All intersections with dent signals greater than 5.0 volts and a 20% sample of dent signals between 2.5 and 5.0 volts.

(d) All intersections with large mix residuals that could mask a 1.0 volt indication.

(e) All intersections which may exhibit PWSCC or circumferentially initiated cracks at the supports.

Note: ***It is ComEd's standard practice to use 3-coil RPC probes, incorporating a pancake coil, an axial preference coil, and a circumferential preference coil. Comparisons for ODSCC with bobbin amplitudes exceeding 1.0 volts have shown that the pancake coil fulfills the need for discrimination between axial and circumferential indications, when compared against the outputs of the preferred direction coils. Pancake coils have been the basis for reporting RPC voltages for model boiler and pulled tube indications in the IPC database; these data permit semi-quantitative judgments on the potential significance of RPC indications. The requirements for a pancake coil is satisfied by the single coil, 2-coil, and 3-coil probes in common use for RPC inspections.***

Figure A-2: Bobbin Coil Amplitude Analysis of ODSCC at TSP.

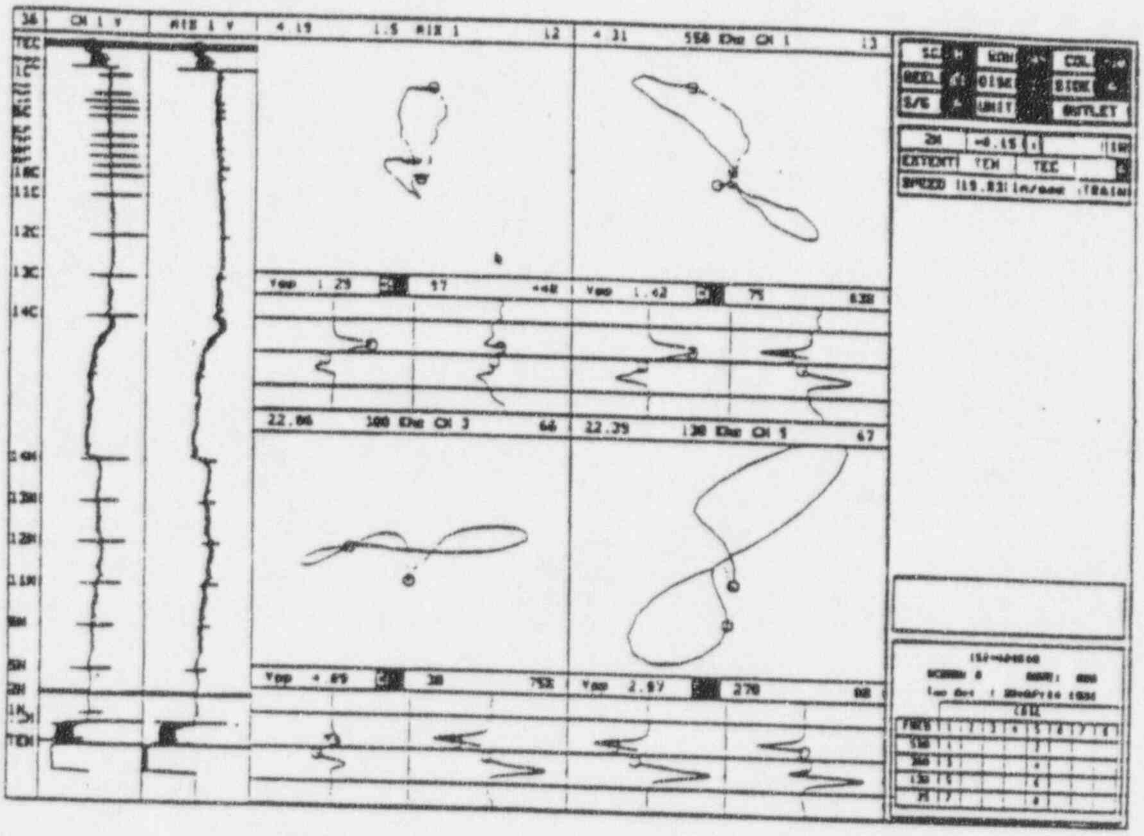


Figure A-3: Bobbin Coil Amplitude Analysis of ODSCC Indication at TSP - Improper Identification of Full Flaw Segment Resulting in Reduced Voltage Measurement When Compared with Figure A-2.

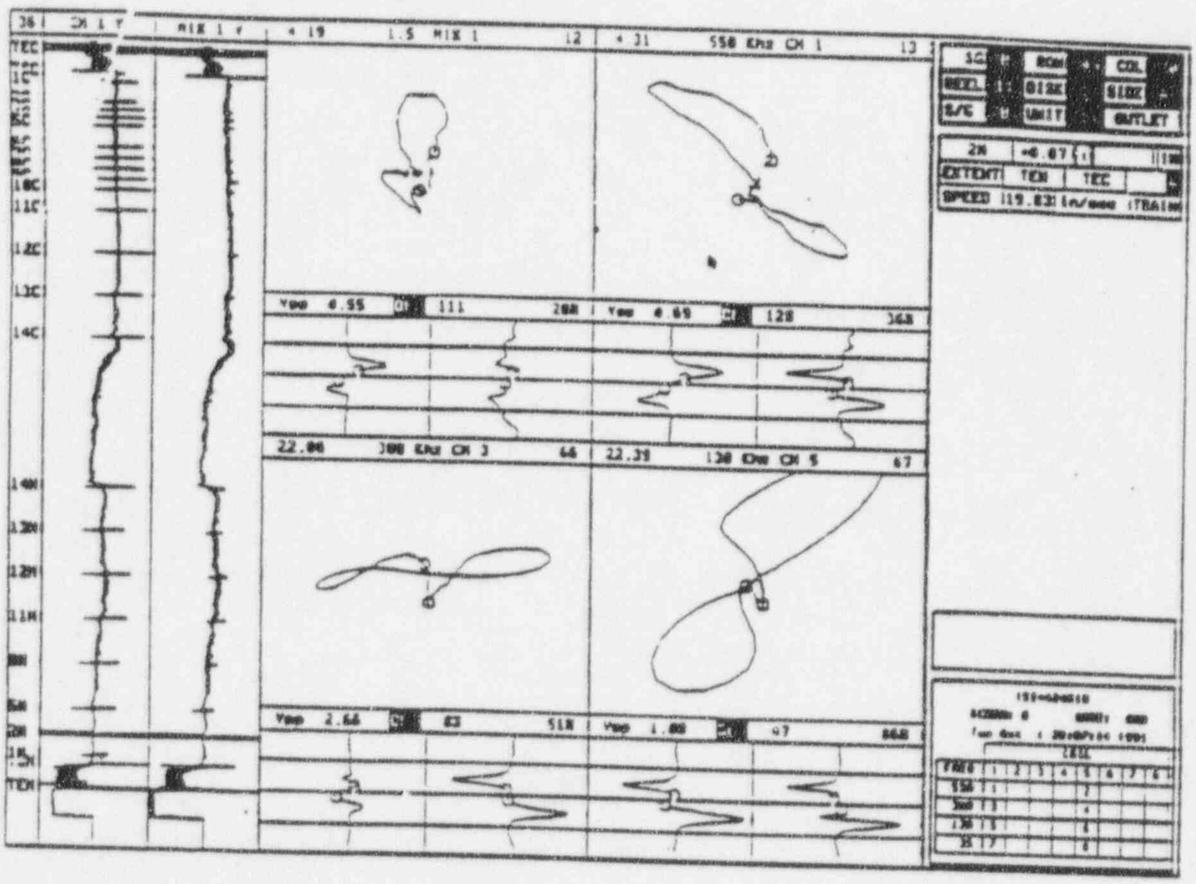


Figure A-4: Bobbin Coil Amplitude Analysis of ODSCC Indication at TSP - Improper Identification of Full Flaw Segment Resulting in Reduced Voltage Measurement When Compared to Figure A-2.

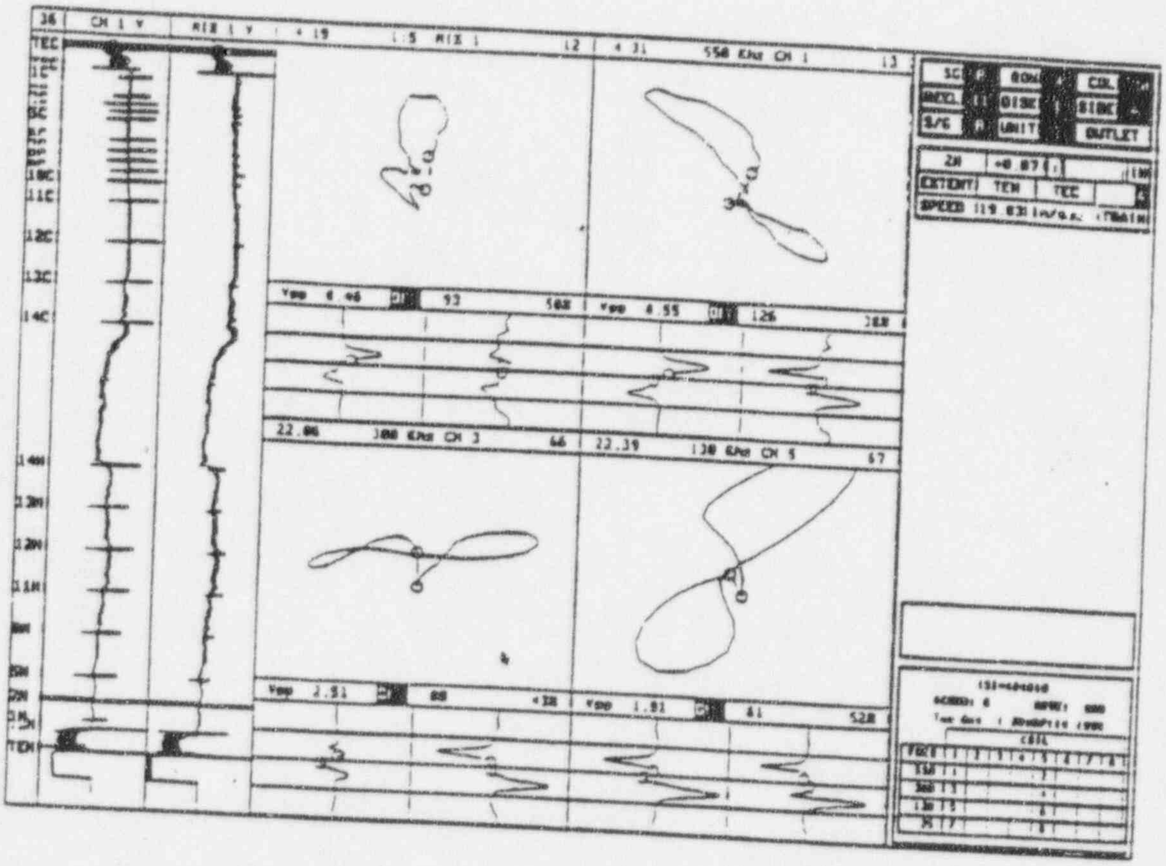


Figure A-5: Correct Placement of Voltage Set Points on Mix 1 Lissajous Traces for R18C103.

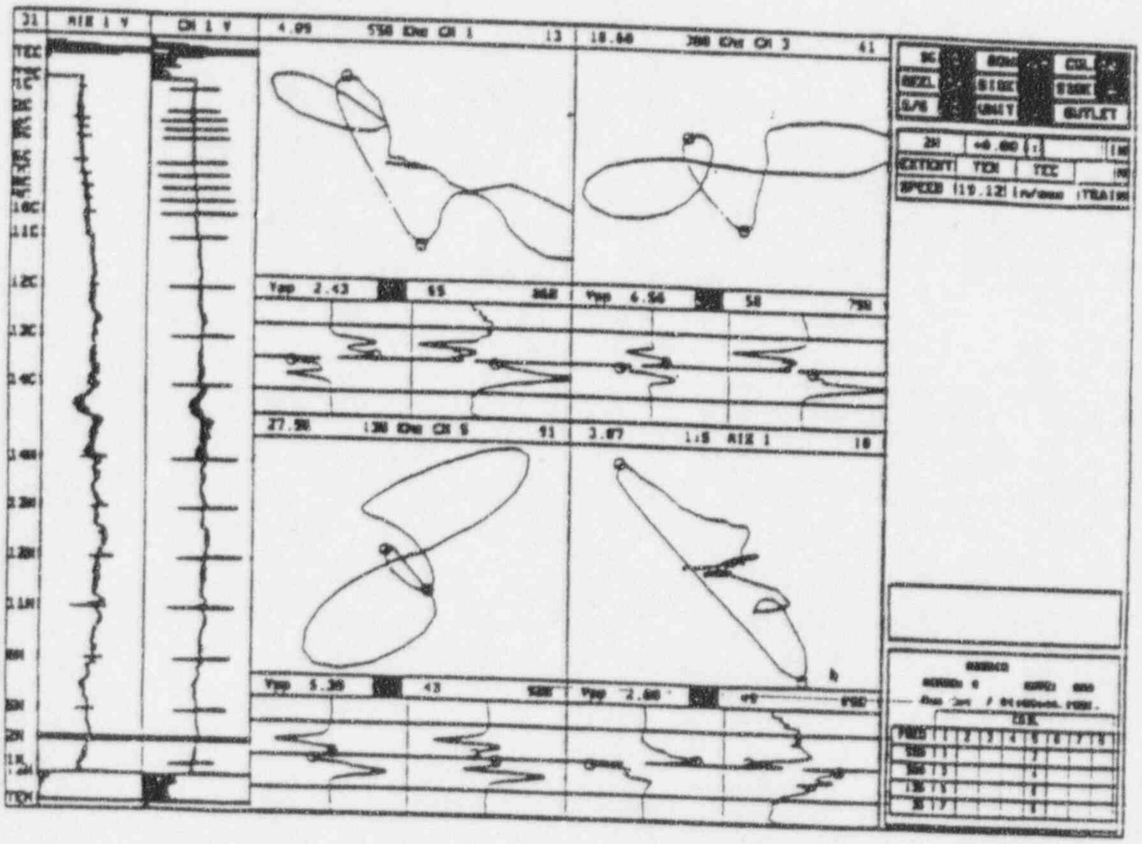


Figure A-6: Correct Placement of Vector Dots on Mix 1 Lissajous Traces for R22C40.

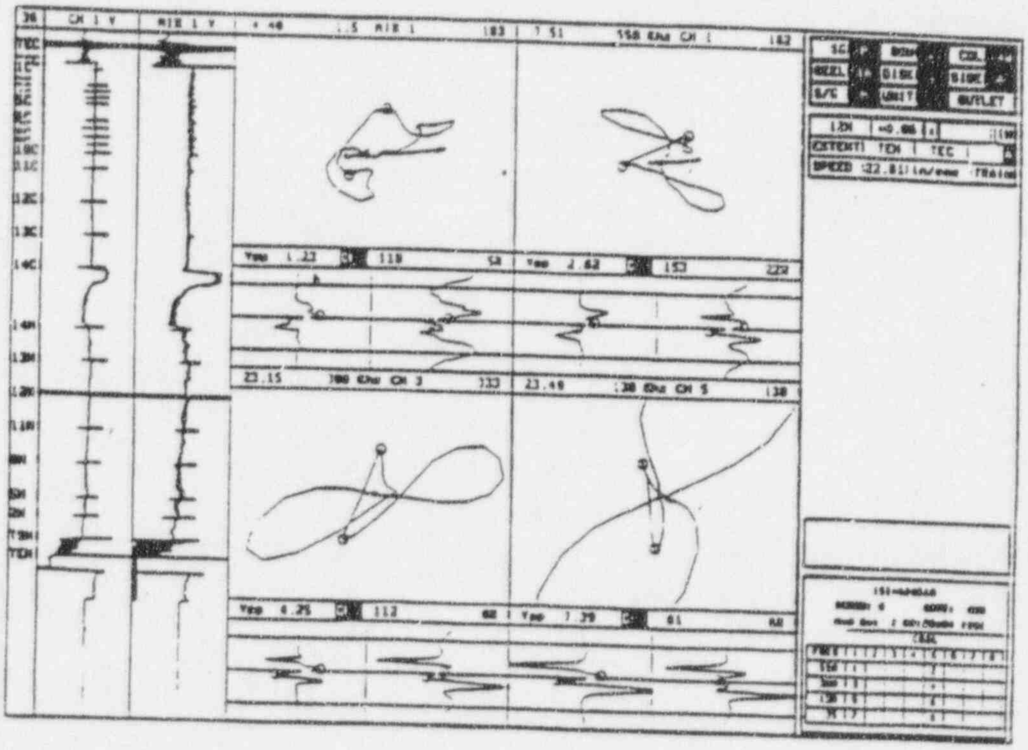


Figure A-7: Incorrect Placement of Vector Dots on Mix 1 Lissajous Traces for R18C103.

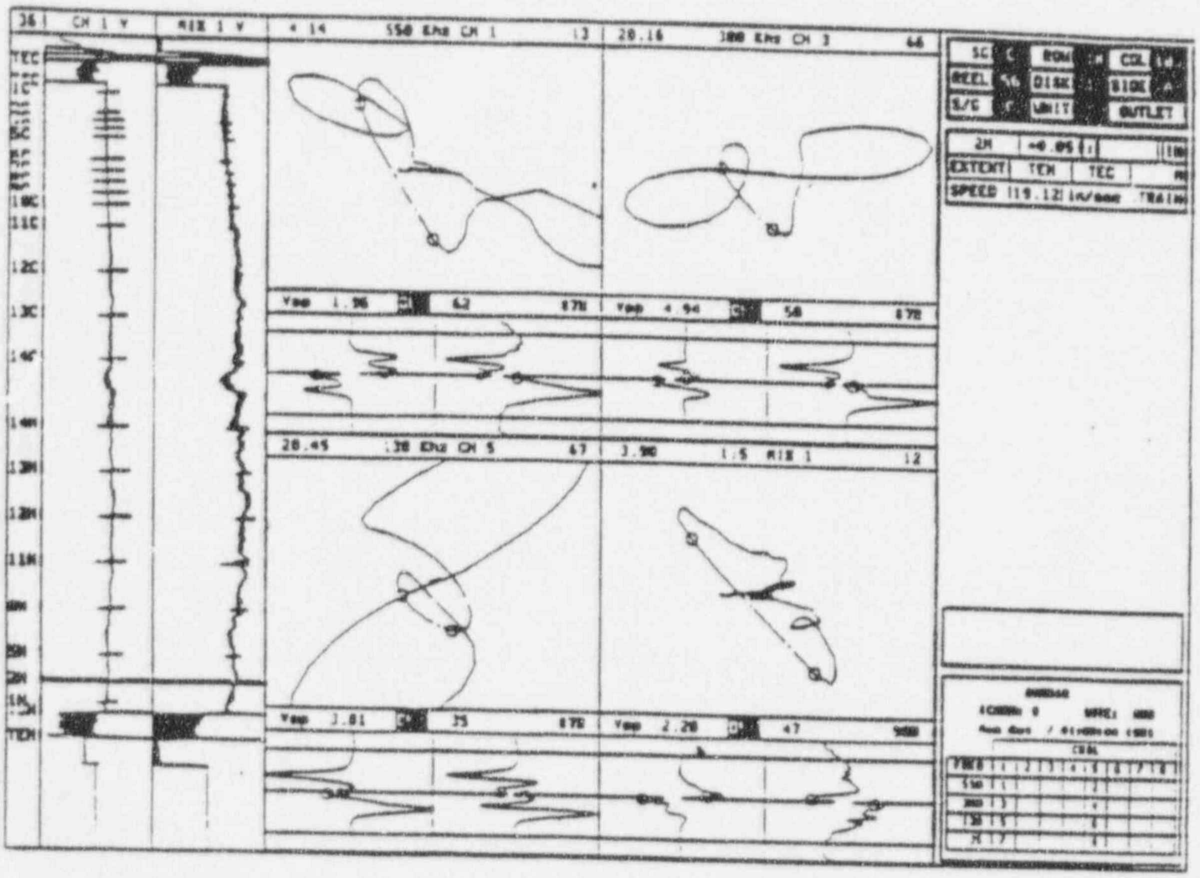


Figure A-8: Incorrect Placement of Vector Dots on Mix 1 Lissajous Traces for R22C40.

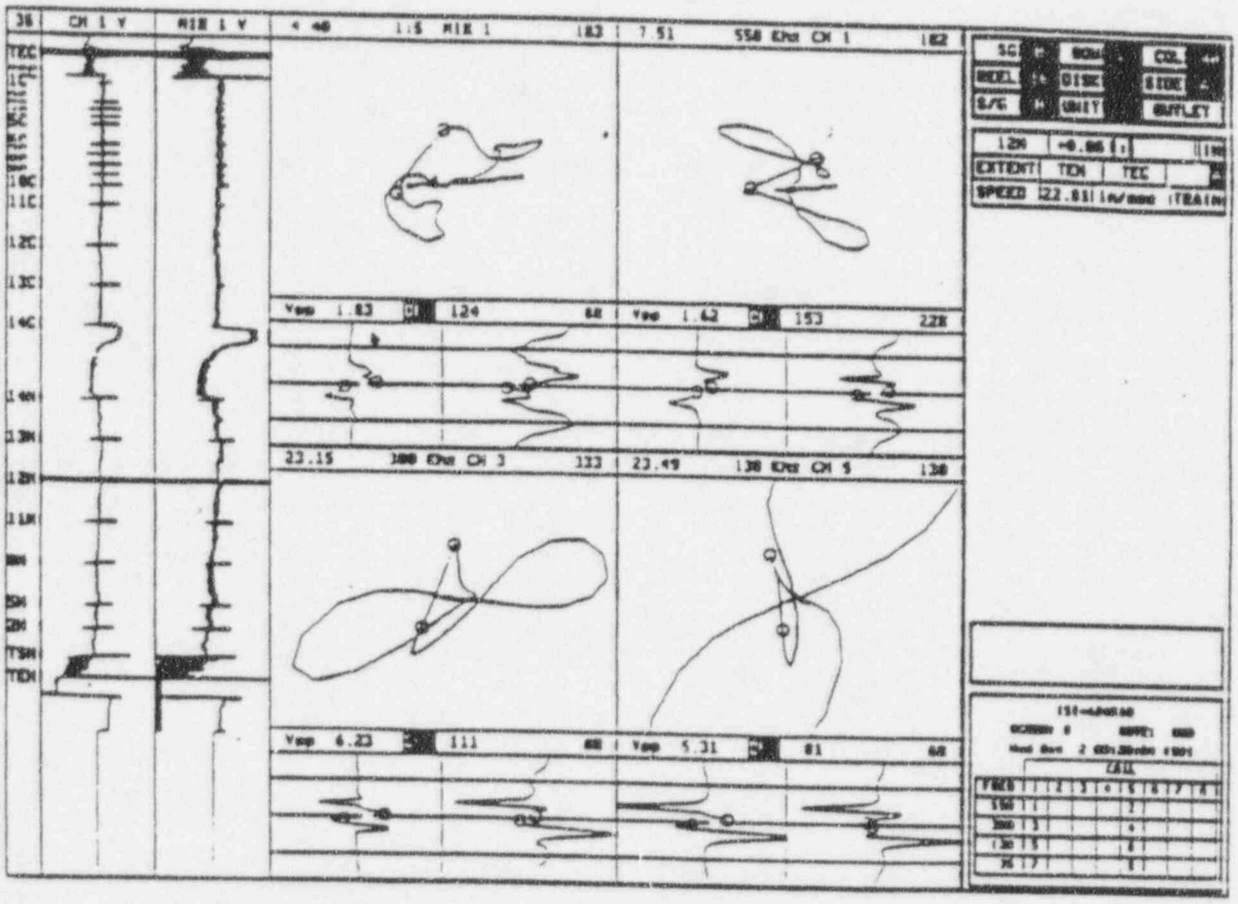


Figure A-9.: Incorrect Maximum Voltage Derived from Placement of Vector Dots on Transition Region of 550 kHz Raw Frequency Data Lissajous Trace for R42C44.

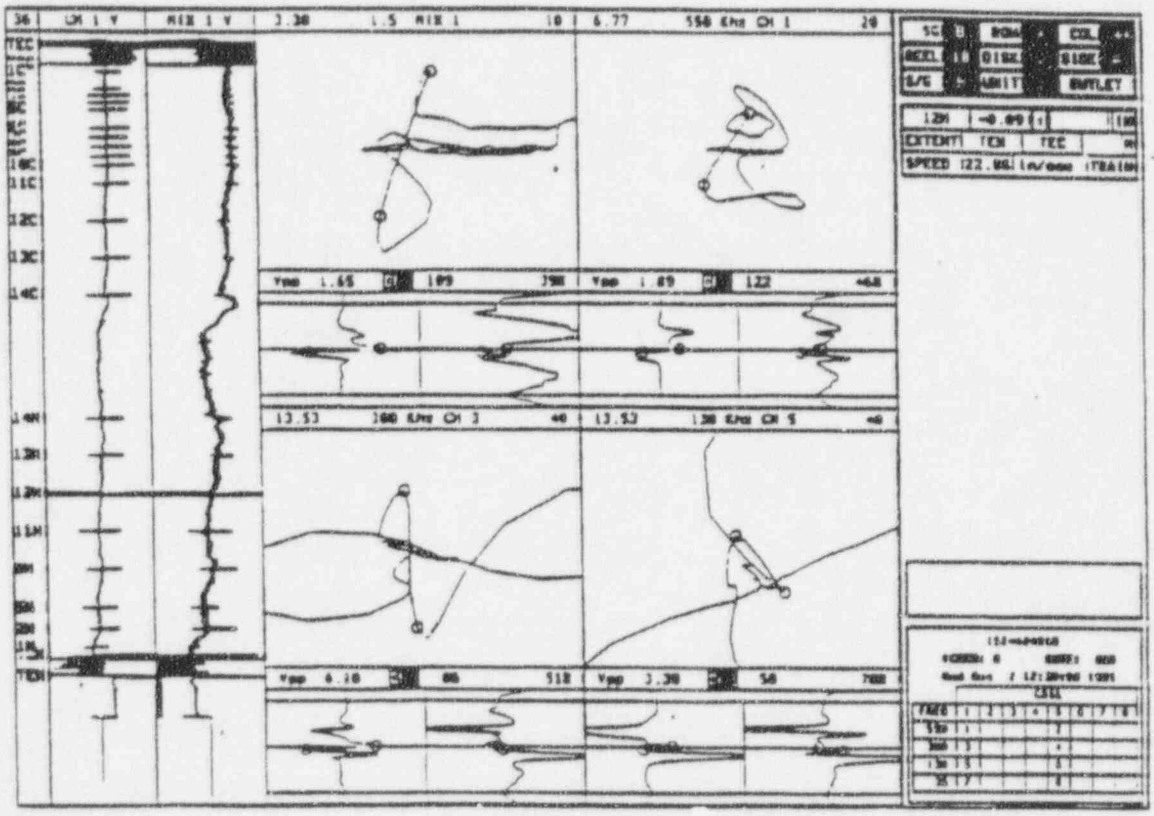


Figure A-10: Correct Placement of Vector Dots on Mix 1 Lissajous Figure for R42C44.

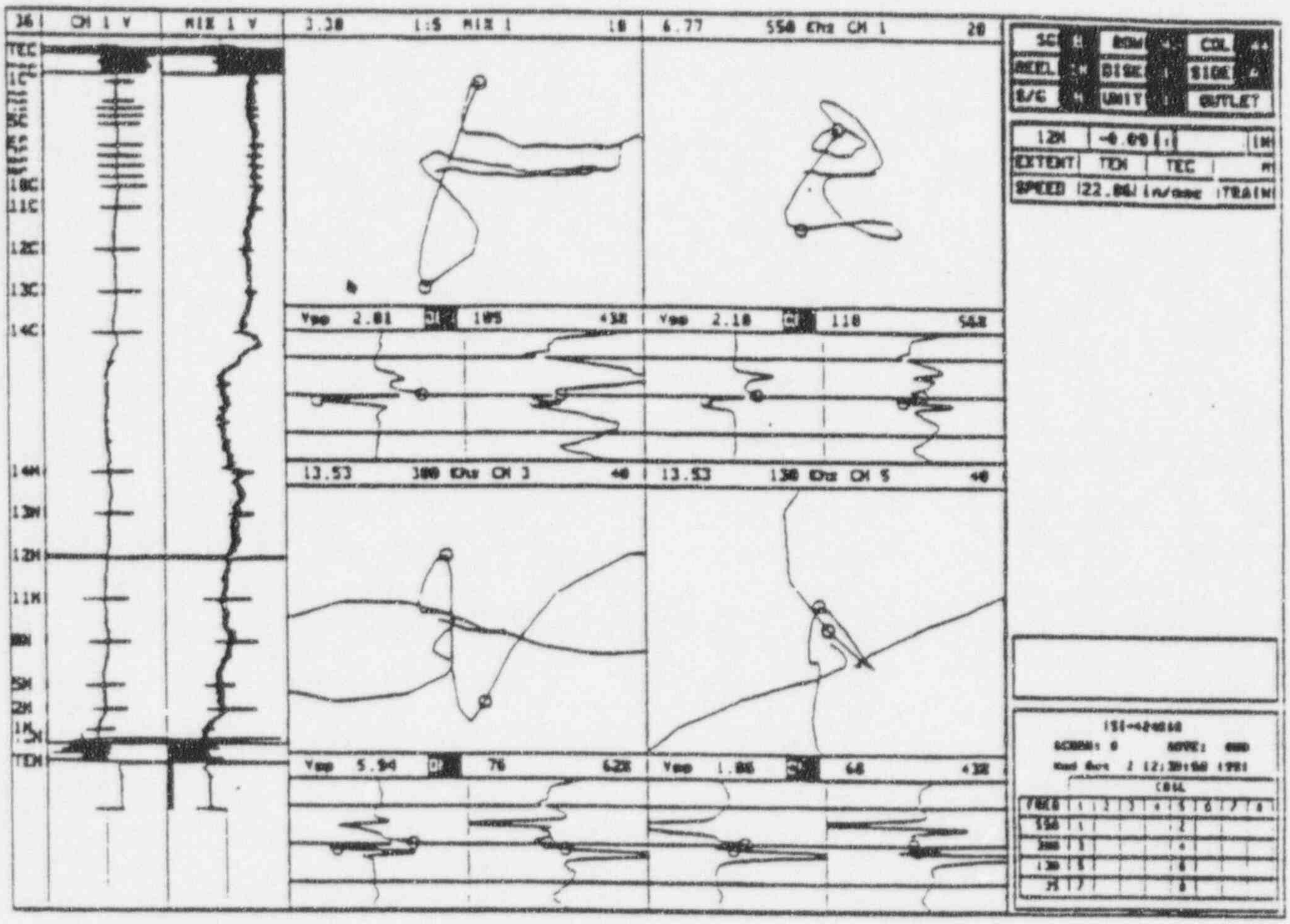


Figure A-11: Placement of Vector Dots Based Solely on Mix 1 Lissajous Figure (no significantly sharp transitions in any of the raw frequencies) - R10C44.

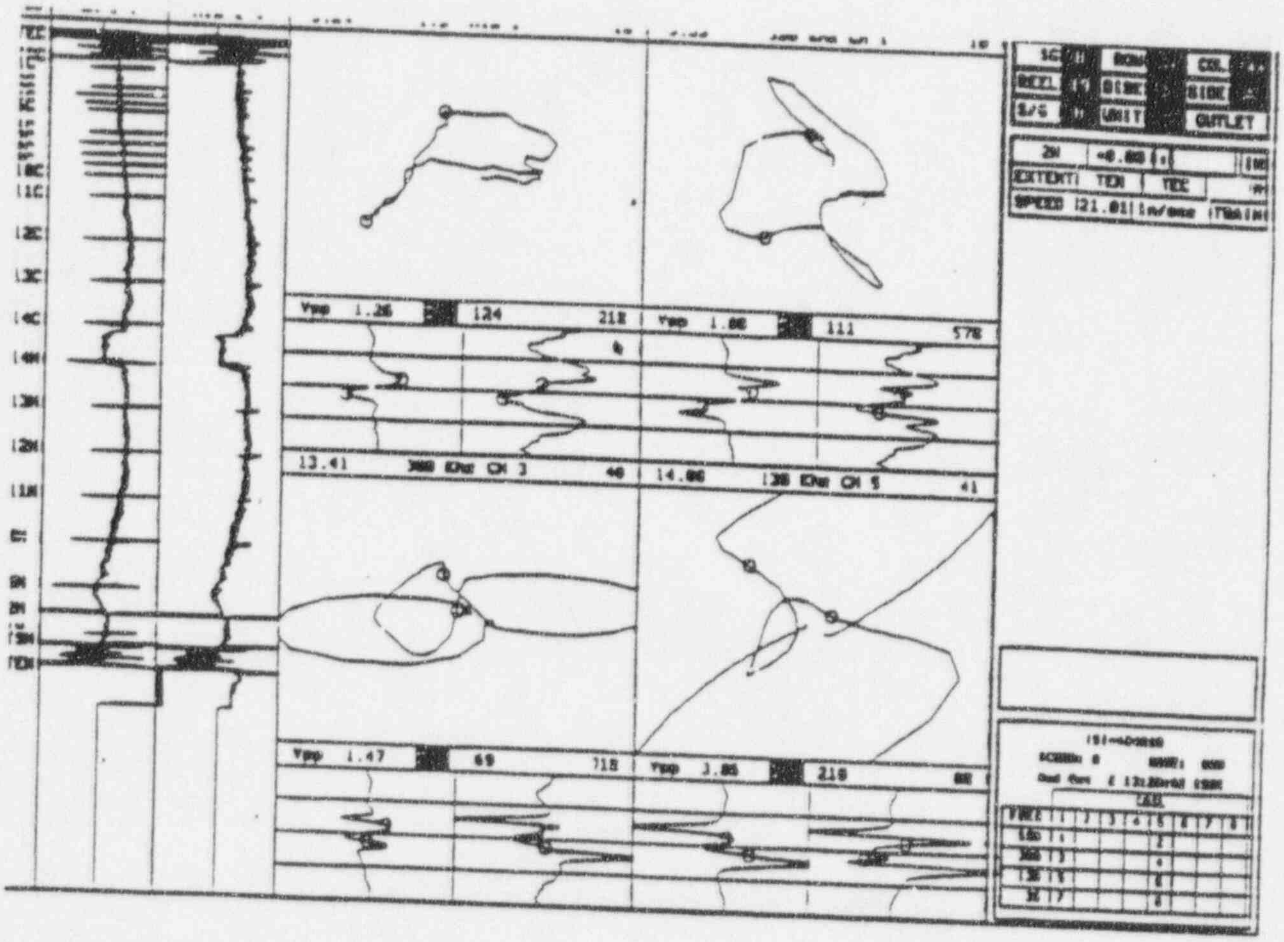


Figure A-12: Placement of Dots Marking Mix 1 Lissajous Figure for R16C26.

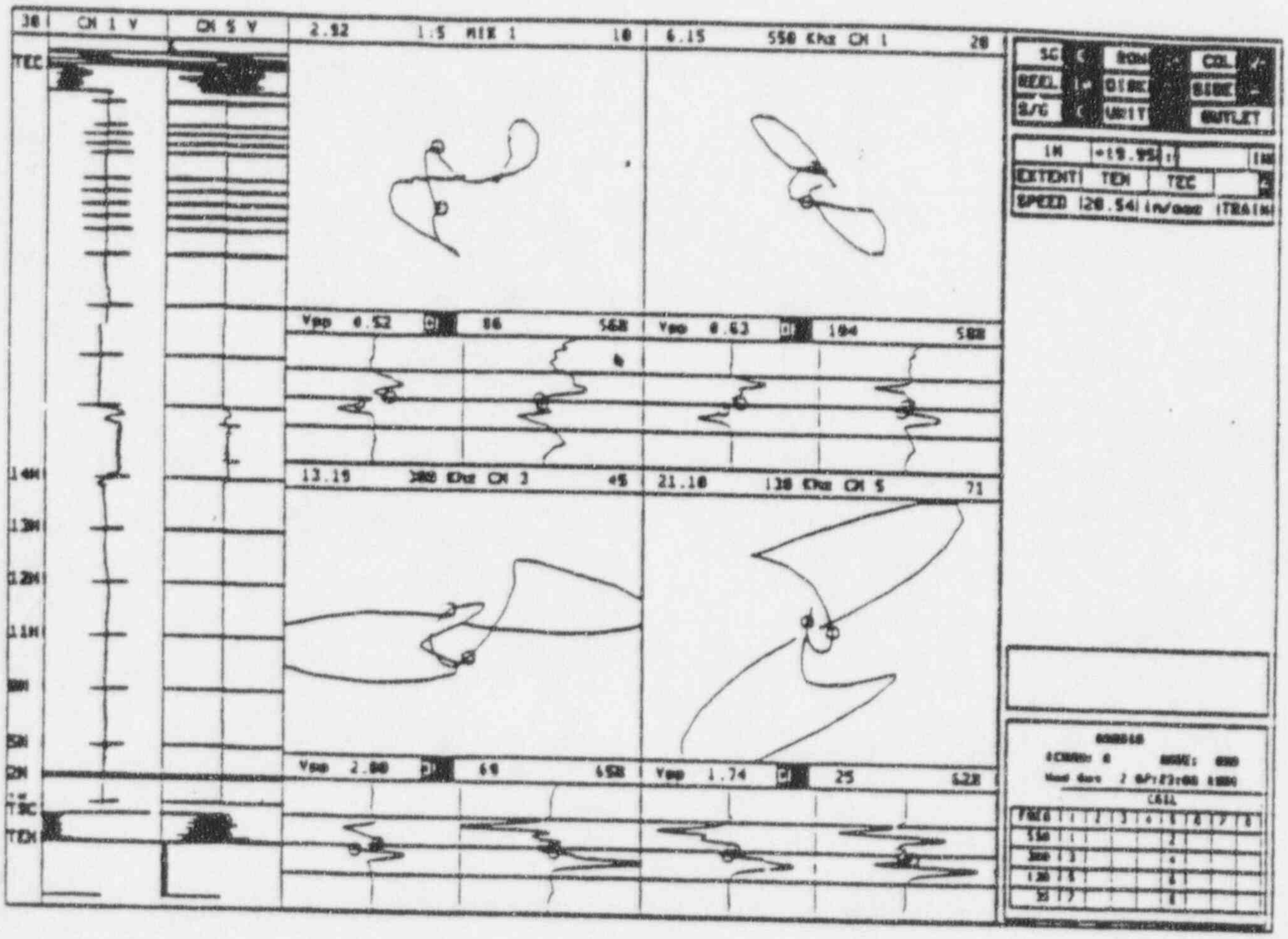


Figure A-13: Incorrect Placement of Vector Dots Marking Mix 1 Lissajous Figure for R30C74.

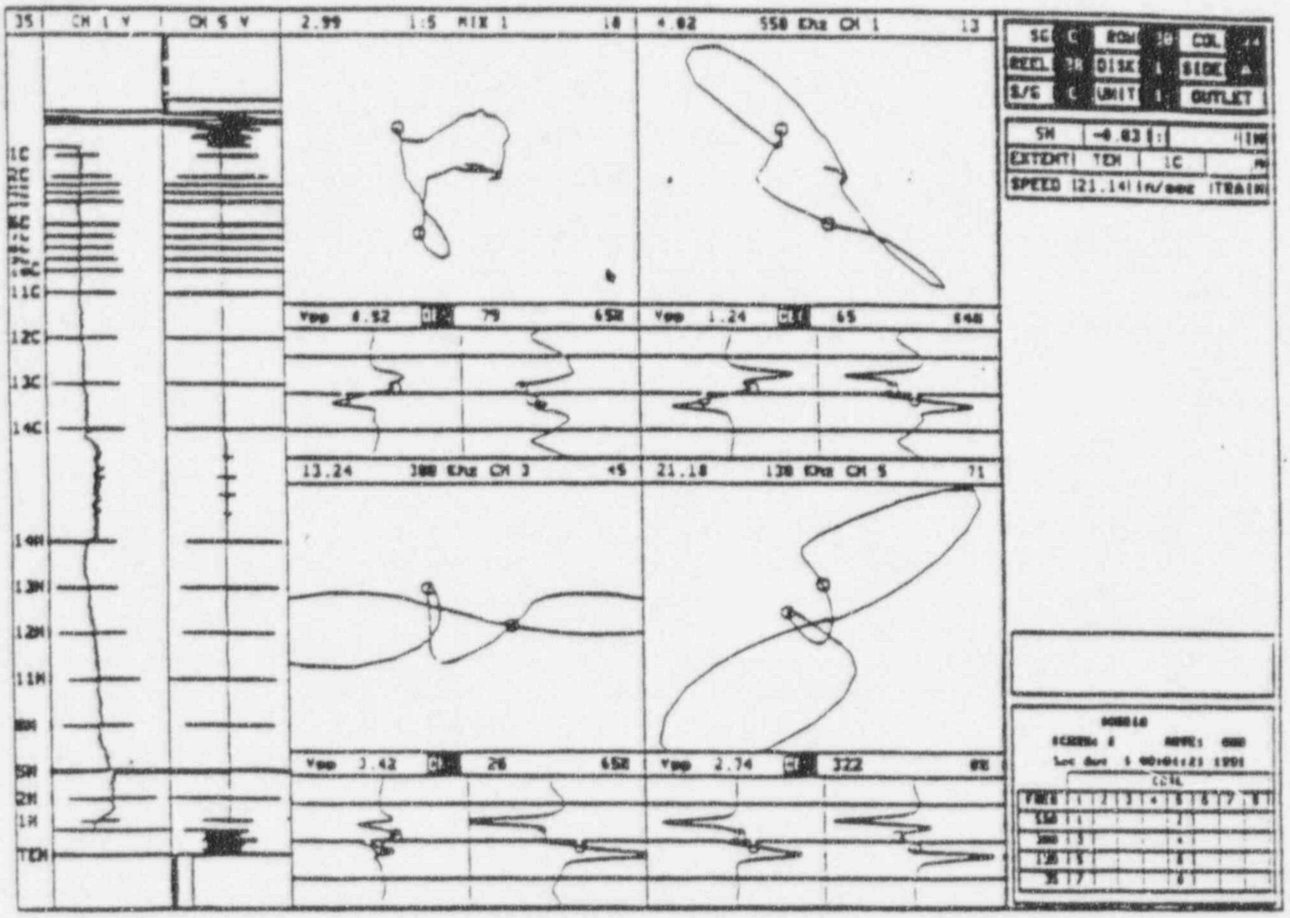


Figure A-14: Correct Placement of Dots to Effect Maximum Voltage - R30C74.

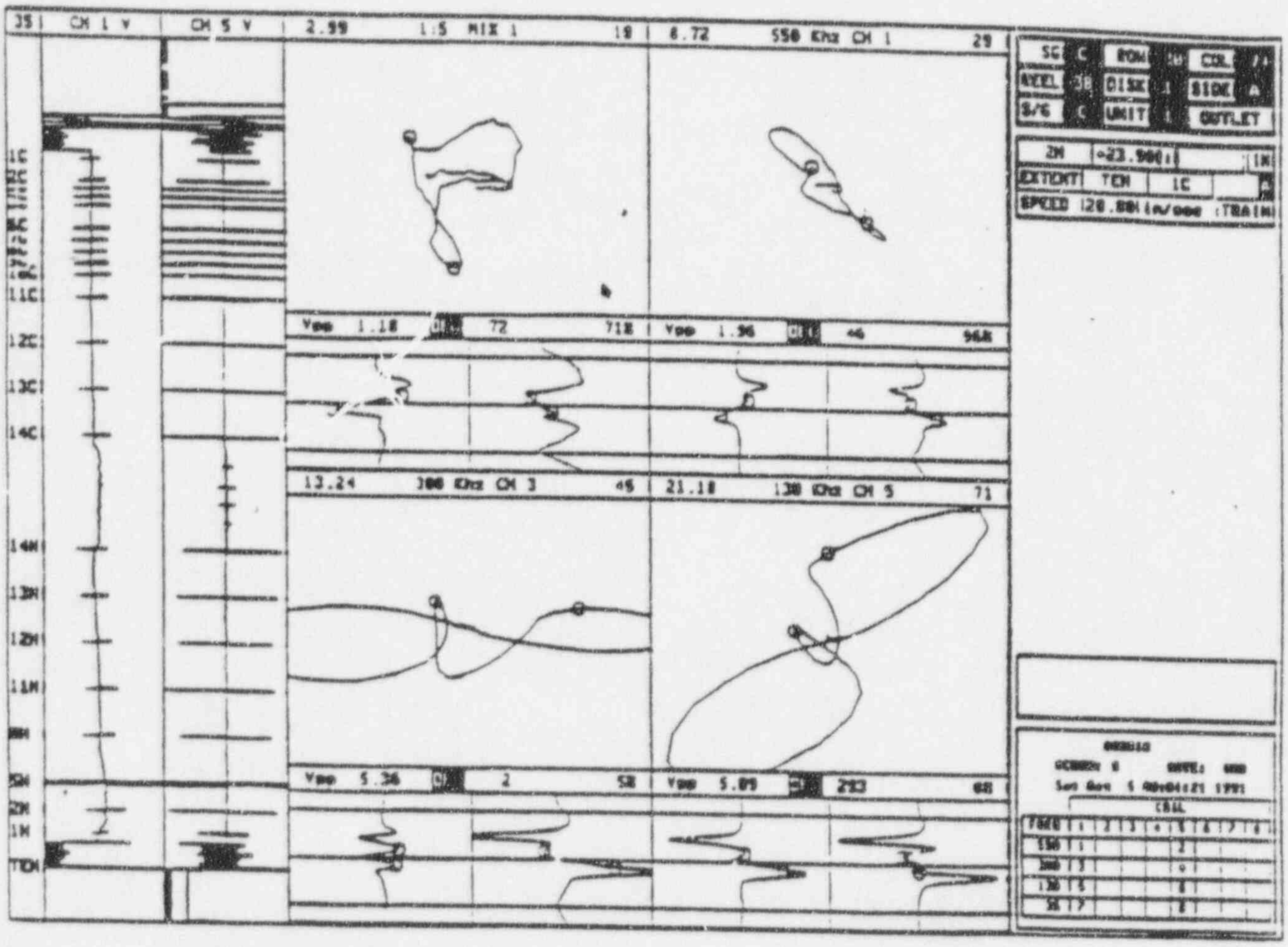


Figure A-15: Example of Bobbin Coil Field Data - Mix Residual Due to Alloy Change.

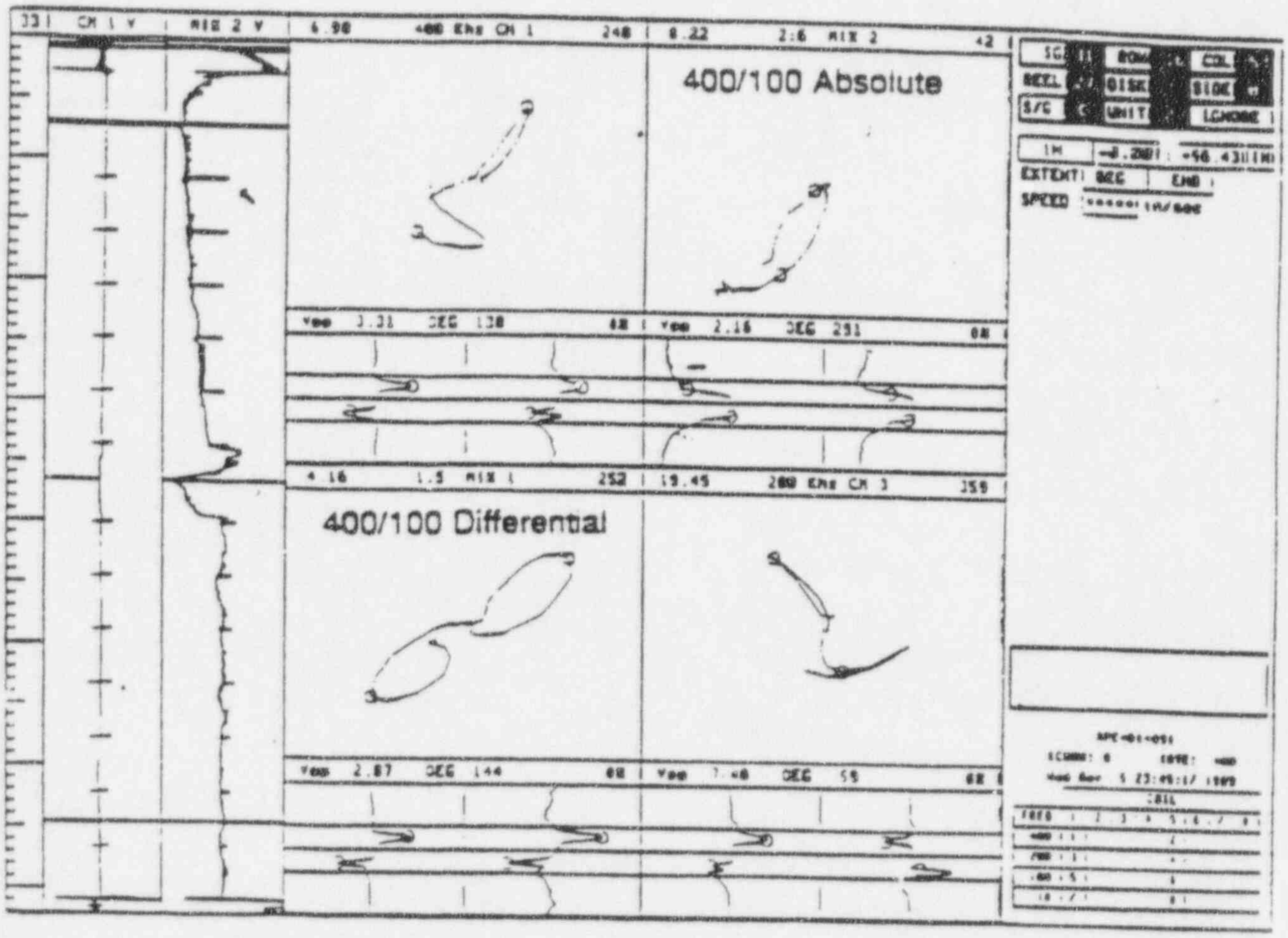


Figure A-16: Example of RPC Data for Single Axial Indication (SAI) Attributed to ODSCC - Plant S.

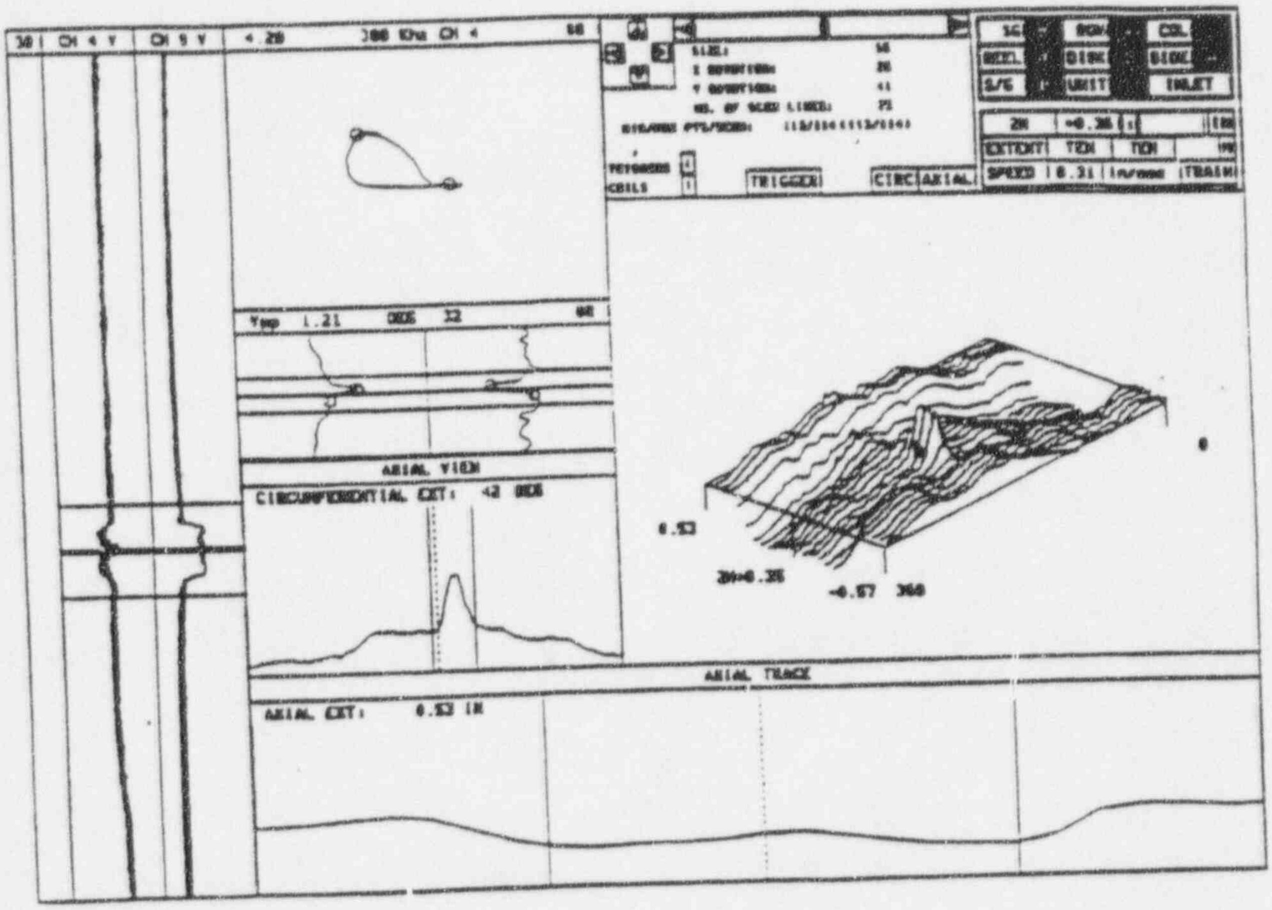


Figure A-17: RPC Data for Single Axial ODSCC Indication(SAI) - Plant S.

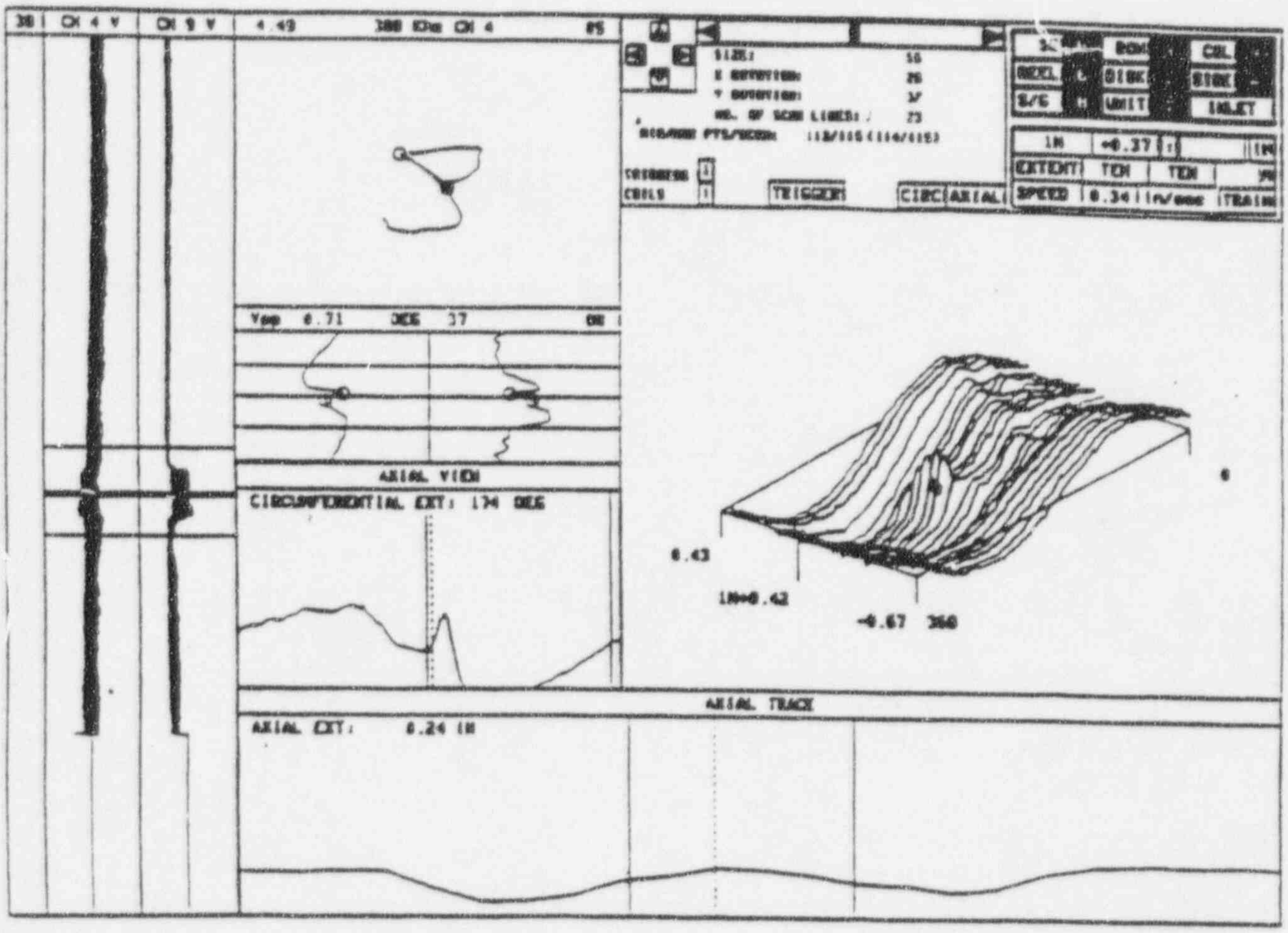


Figure A-18: RPC Data for Multiple Axial ODSCC Indications (MAI) - Plant S.

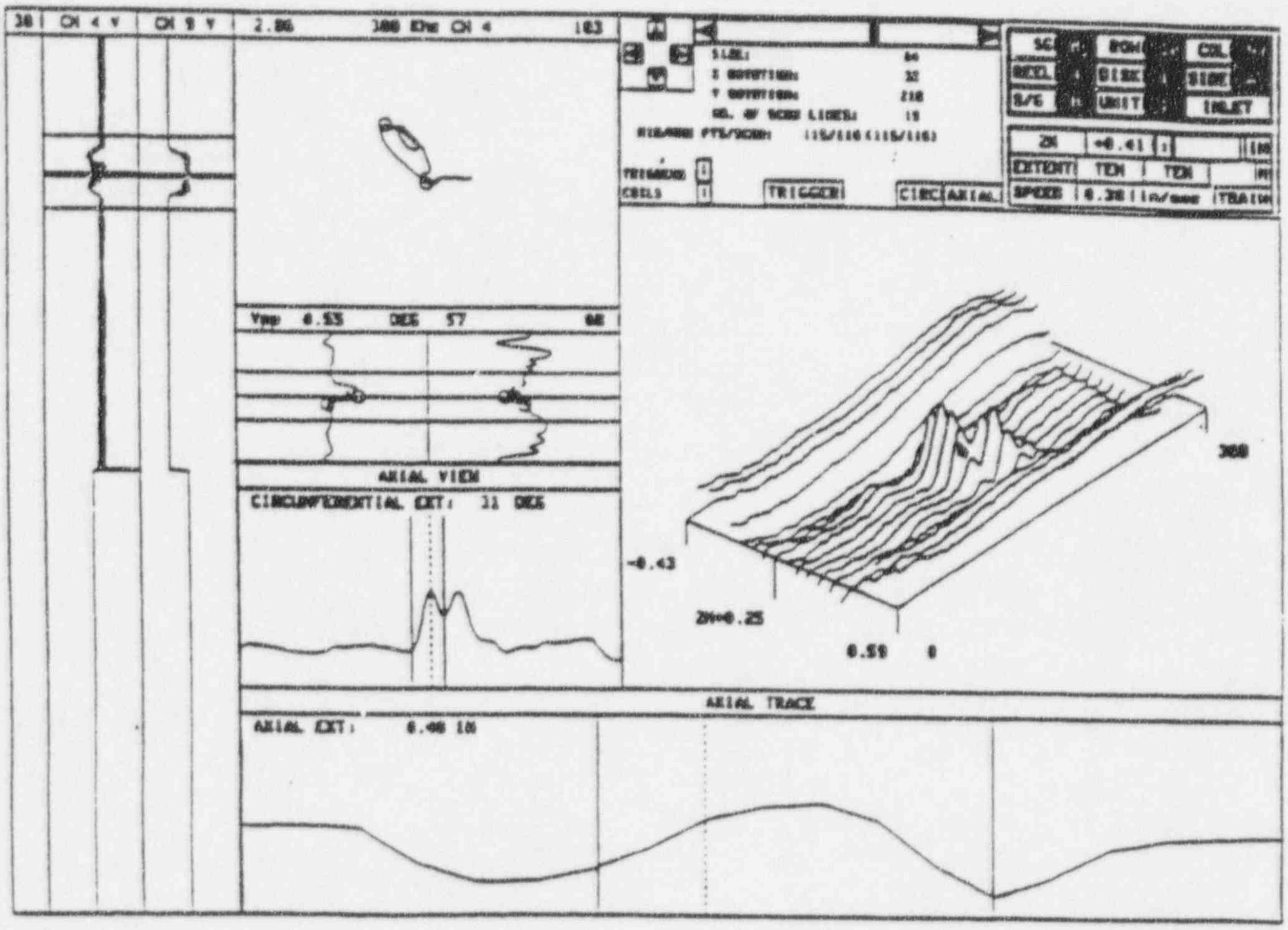


Figure A-19: RPC Data for Circumferential ODSCC Indications at Dented Upper and Lower TSP Edges.

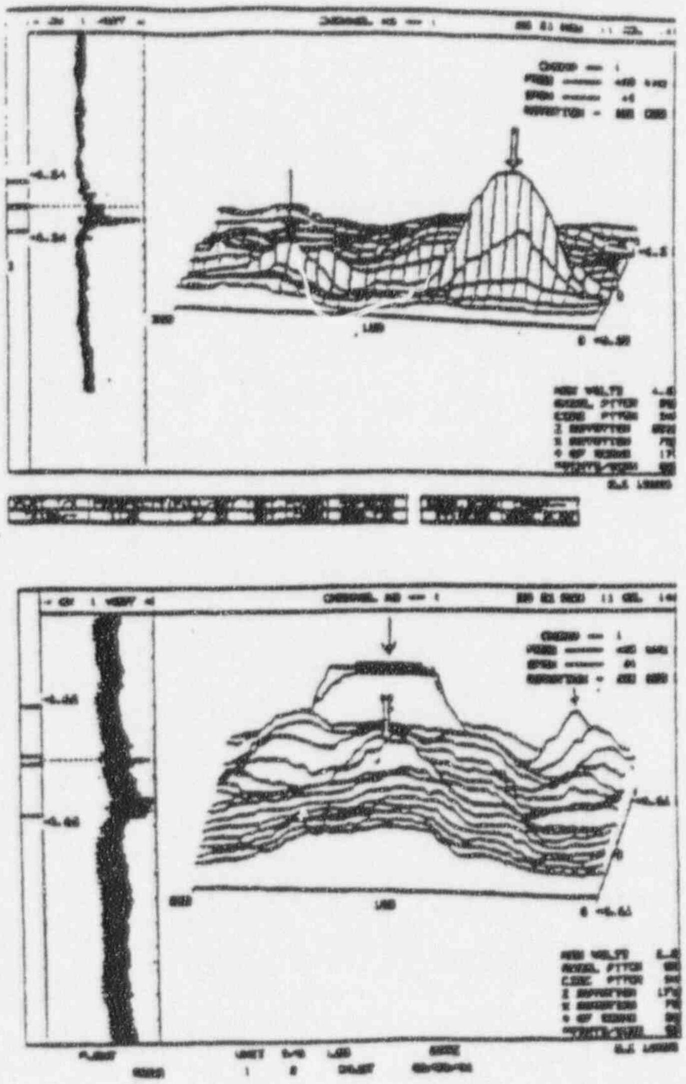


Figure A-20: Example of Bobbin Coil Field Data - Flaw Signals for ODSCC at Dented TSP Intersection from Plant A.

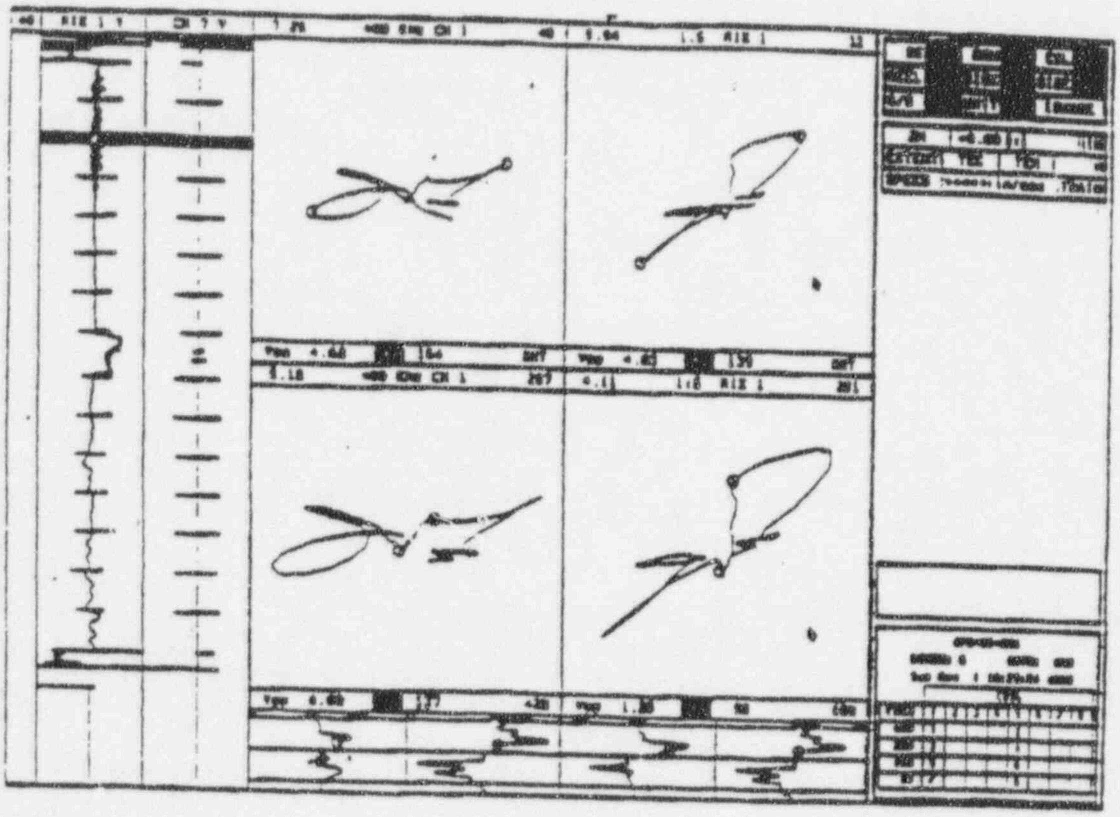


Figure A-21: Example of Bobbin Coil Field Data - Flaw Signals for ODSCC at Dented TSP Intersection from Plant A.

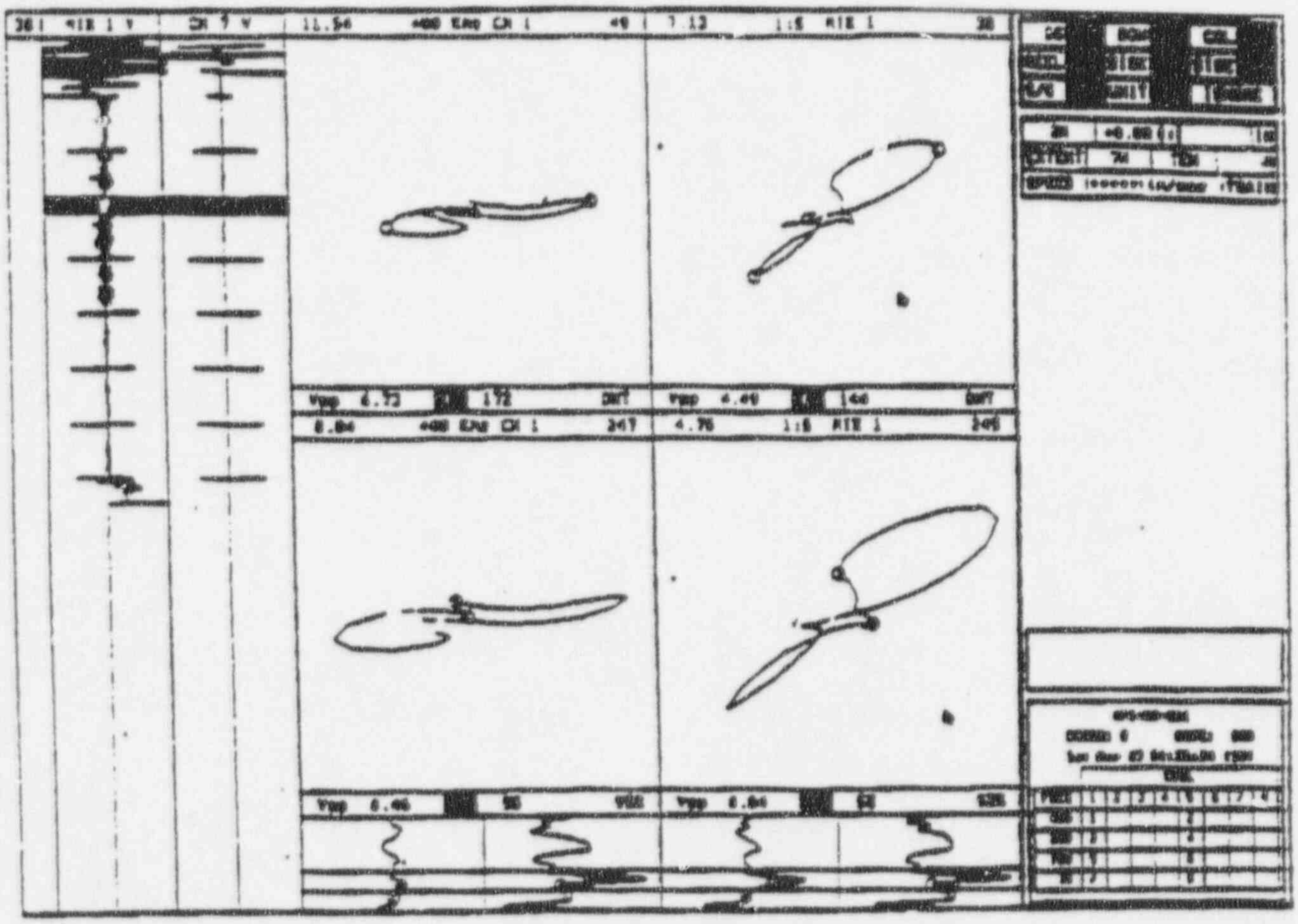


Figure A-22: Example of Bobbin Coil Field Data - Flaw Signals for ODSCC at Dented TSP Intersection from Plant A.

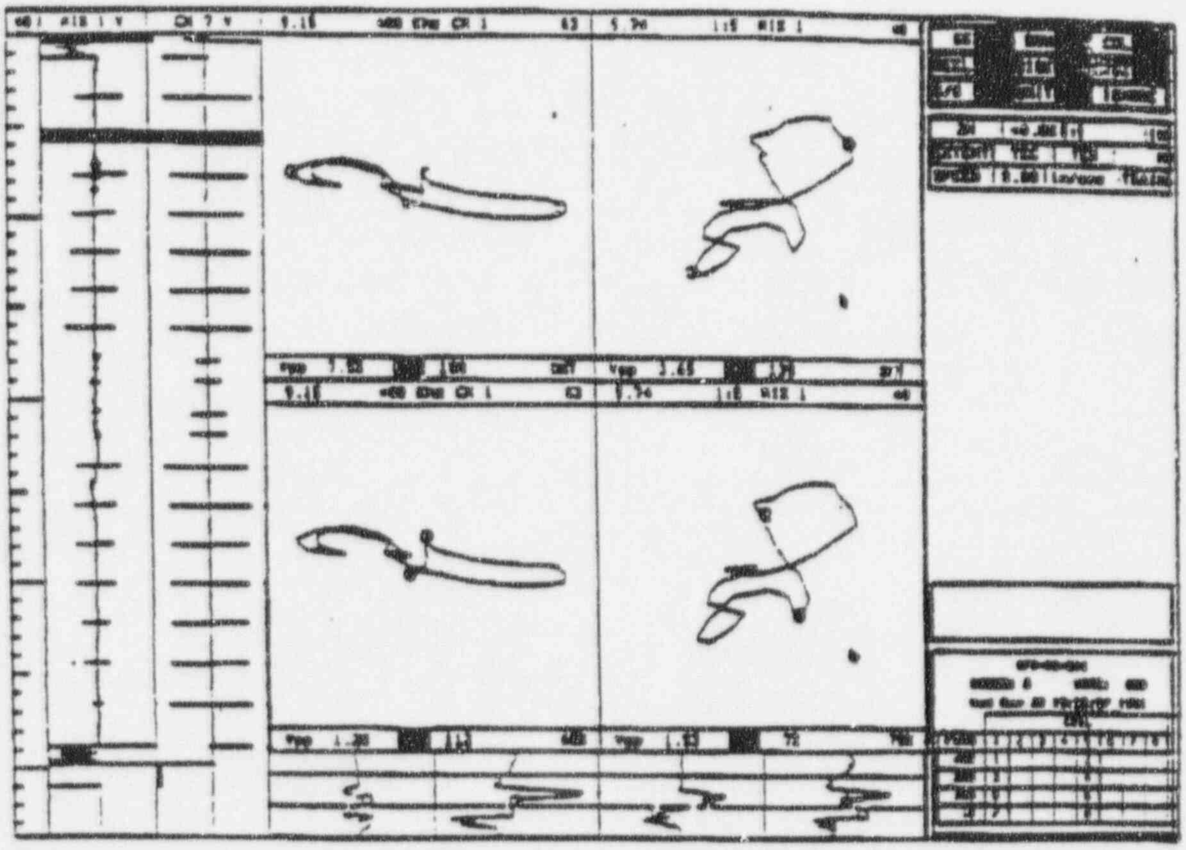


Figure A-23: Example of Bobbin Coil Field Data - Flaw Signals for ODSCC at Dented TSP Intersection from Plant A.

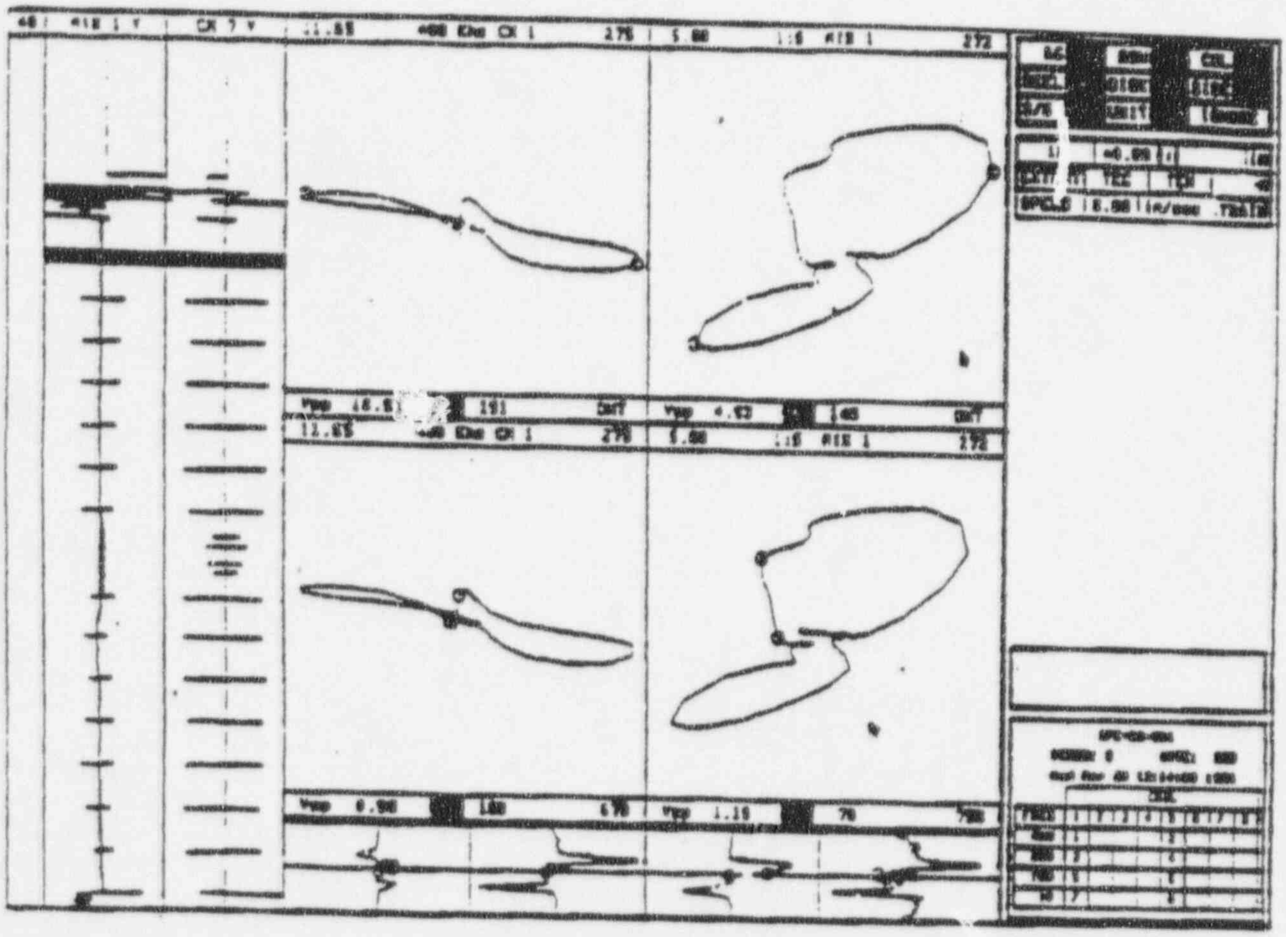


Figure A-24: Example of Bobbin Coil Field Data - Flaw Signals for ODSCC at Dented TSP Intersection from Plant A.

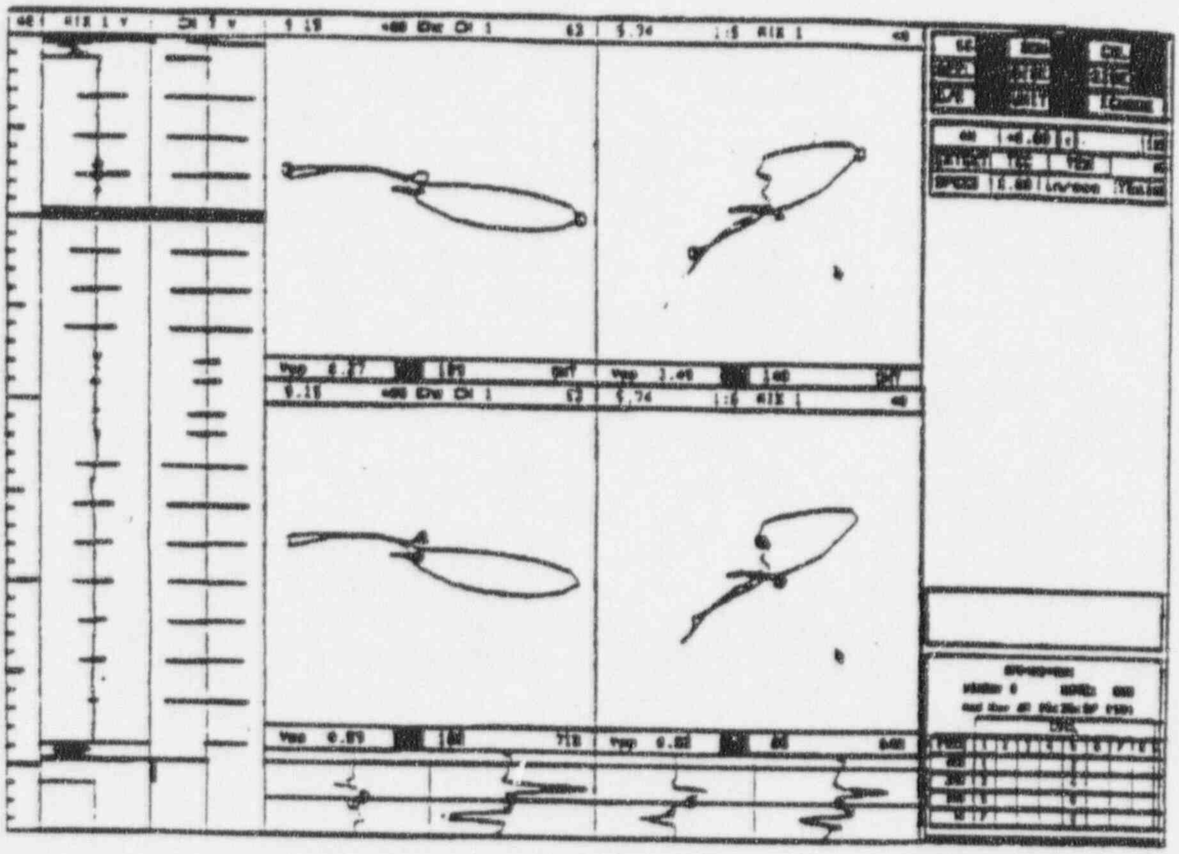


Figure A-25: Example of Bobbin Coil Field Data - Flaw Signals for ODSCC at Dented TSP Intersection from Plant A.

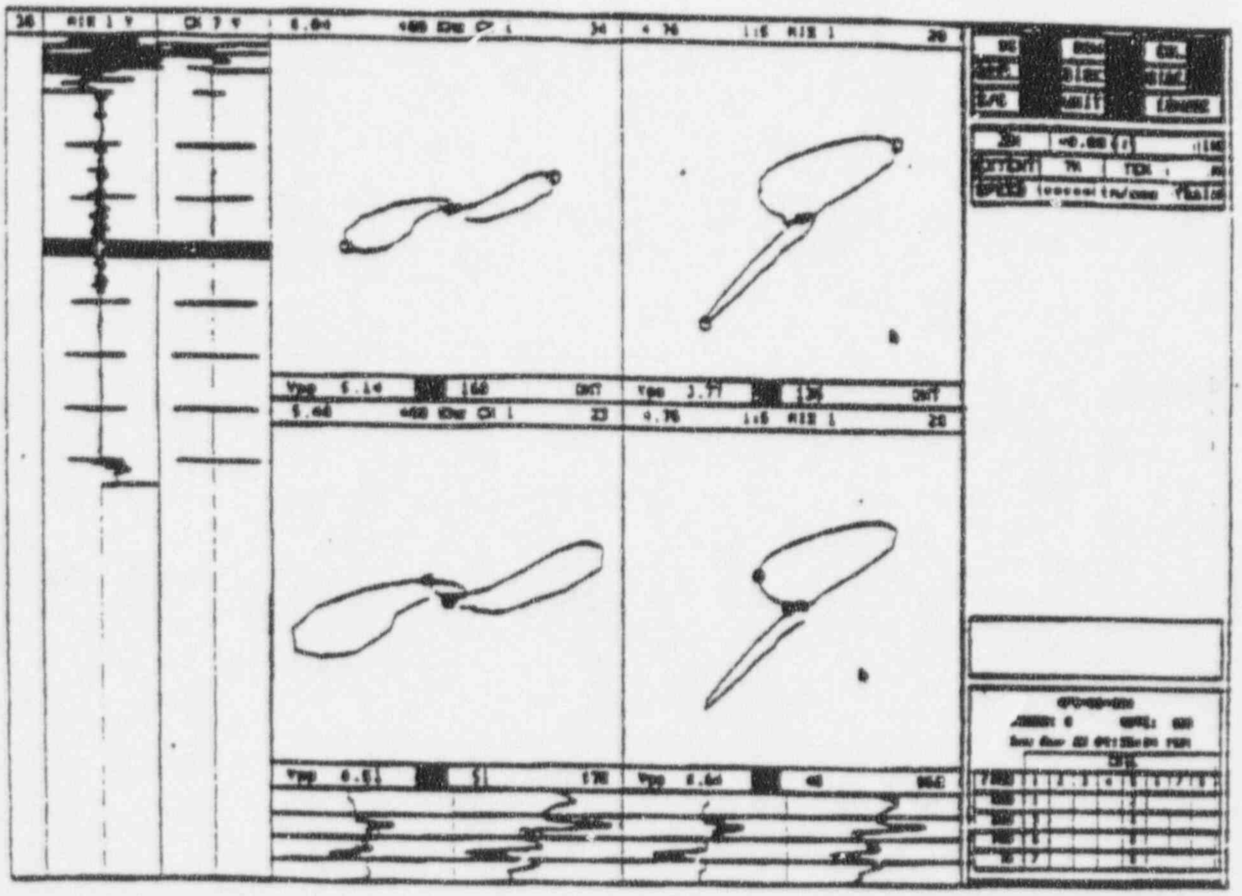
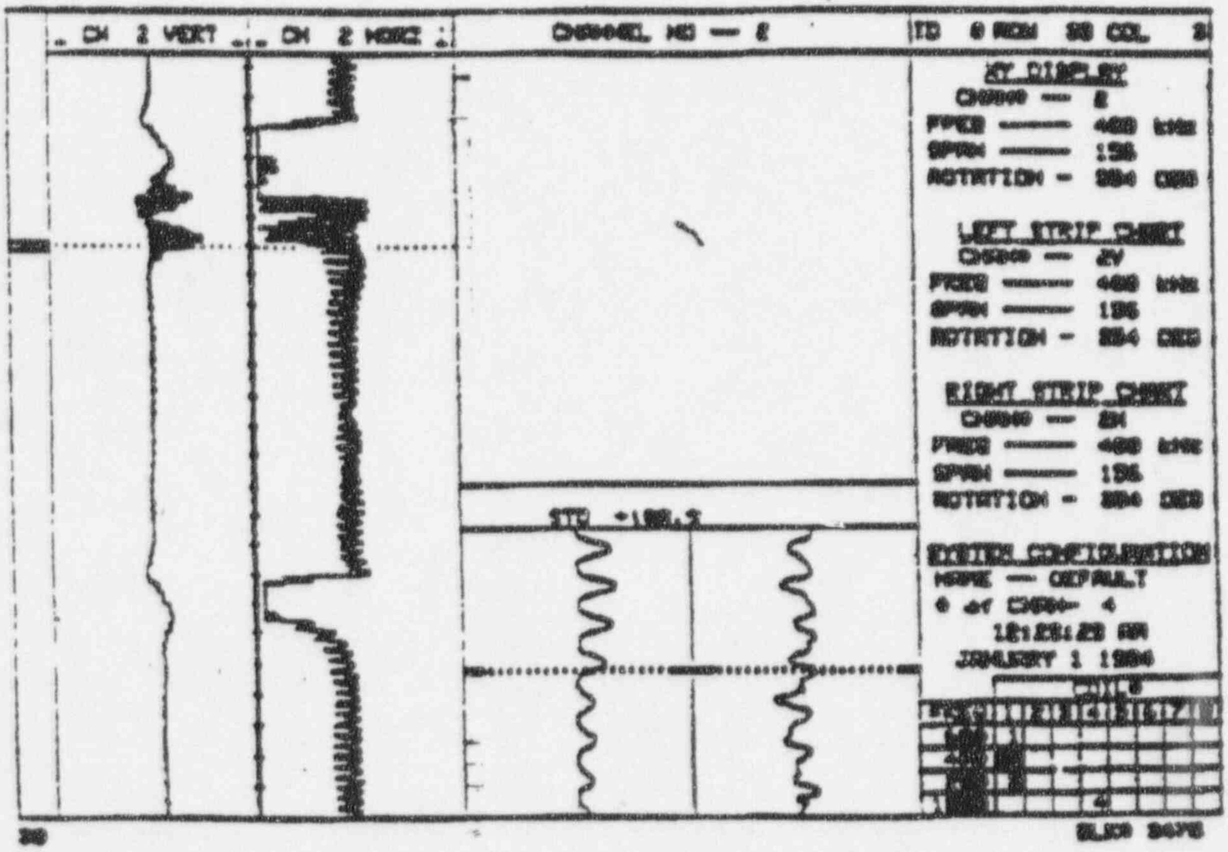


Figure A-26: Location of One End of an Indication Using an RPC Probe.



APPENDIX B
ANALYSIS GUIDELINE CHANGE FORM

ANALYSIS GUIDELINES CHANGE FORM

CHANGE FORM #:______________

SUBJECT:

DESCRIPTION OF CHANGE:

REASON FOR CHANGE:

TECHNICAL BASIS:

EXAMINATION IMPACT:

AUTHORIZATIONS:

Lead Analyst________________________________ Date: ____/____/____

ComEd Acknowledgment__________________________ Date ____/____/____

ANALYSIS GUIDELINES CHANGE ACKNOWLEDGMENT FORM
(Continued)

CHANGE FORM #:______________

EFFECTIVE DATE OF CHANGE ___/___/___ TIME ___/___ am/pm

Analyst Signature	Date	Time
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APPENDIX C
ANALYSIS AND RETEST CODES

Analysis & Retest Codes

Category 1 - No Further Action:	Analysis	Retest
No Detectable Degradation	NDD	RND
Plugged	PLG	-----
Sleeved	SLV	RSV
Positive Indentification	PID	-----

Category 2 - Possible Flaw, Further Action Required:	Analysis	Retest
Non-Quantifiable Indication	NQI	RNQ
Absolute Drift Indication	ADI	RAD
Distorted Support Indication	DSI	RDI
Distorted Tubesheet Indication	DTI	RTI
Dent with Possible Indication	DNI	RNI
Distorted Roll Indication	DRI	RTI
Single Axial Indication	SAI	RSA
Multiple Axial Indications	MAI	RMA
Single Circumferential Indication	SCI	RSC
Multiple Circumferential Indications	MCI	RMC
Mixed Residual Indications	MRI	RMI
Free-Span Indication	FSI	RSI
Lead Analyst Resolution	LAR	RAR

Category 3 - Possible Loose Part, Further Action Required:	Analysis	Retest
Possible Loose Part	PLP	RLP

Category 4 - Further Action Required, Retest Condition:	Analysis	Retest
Bad Data	RBD	RBD
Incomplete Test	INC	RIC
Obstructed	OBS	ROB
Template Plug	TMP	RTP
Tube No Test	TNT	RNT
To Be Retested	TBR	-----
Fixture	FIX	RFX
Tube Number Check	TNC	RNC

Category 5 - No Further Action Required:	Analysis	Retest
Bulge	BLG	RBL
Copper Deposit	CUD	RCD
Dent	DNT	RDN
Deposit	DEP	RDP
Ding	DNG	RDG
Distorted Roll Transition Signal	DRT	RRT
Distorted Support Plate Signal	DSS	RDS
Distorted Tubesheet Signal	DTS	RDT
Expansion	EXP	REX
Free-span Signal	FSS	RFS
Indication Not Reportable	INR	RNR

Category 5 - No Further Action Required (Con't)	Analysis	Retest
Indication Not Found	INF	RNF
Manufacturing Burnish Mark	MBM	RBM
Manufacturing Anomaly Mark	MAM	RAM
Noisy Tube	NSY	RSY
Over Roll	OVR	RVR
Overexpansion	OXP	RXP
Partial Tubesheet Expansion	PTE	RTE
Permeability Variation	PVN	RPV
Skipped Roll	SKR	RSR
Sludge	SLG	RSG
Top Main Roll	TMR	RTM
Volumetic Indication (s)	VOL	RVL
Free-Span Differential	FSD	RSD
Shot Peening Anamoly	SPA	RPA

APPENDIX D
SUPPORT STRUCTURES
NOMENCLATURE & MEASUREMENTS

Support Structures Nomenclature and Measurements

Westinghouse Model D4 S/G
Support Structures Measurements

Level	Elevation Spacing (Inches)	
	Hot Leg	Cold Leg
Tube End	0	0
Top of Tubesheet	21.2	21.2
Center of 1st support	6.4	6.4
Center of 2nd support	n/a	12
Center of 3rd support	30	18
Center of 4th support	n/a	18
Center of 5th support	36	18
Center of 6th support	n/a	18
Center of 7th support	36	18
Center of 8th support	43	43
Center of 9th support	43	43
Center of 10th support	43	43
Center of 11th support	43	43

Support Structures Nomenclature and Measurements

Westinghouse Model D5 S/G
Support Structures Measurements

Level	Elevation Spacing (Inches)	
	Hot Leg	Cold Leg
Tube End	0	0
Top of Tubesheet	21.2	21.2
Center of 1st support	8.4	8.4
Center of 2nd support	n/a	12
Center of 3rd support	28	18
Center of 4th support	n/a	18
Center of 5th support	36	18
Center of 6th support	n/a	18
Center of 7th support	36	18
Center of 8th support	43	43
Center of 9th support	43	43
Center of 10th support	43	43
Center of 11th support	43	43

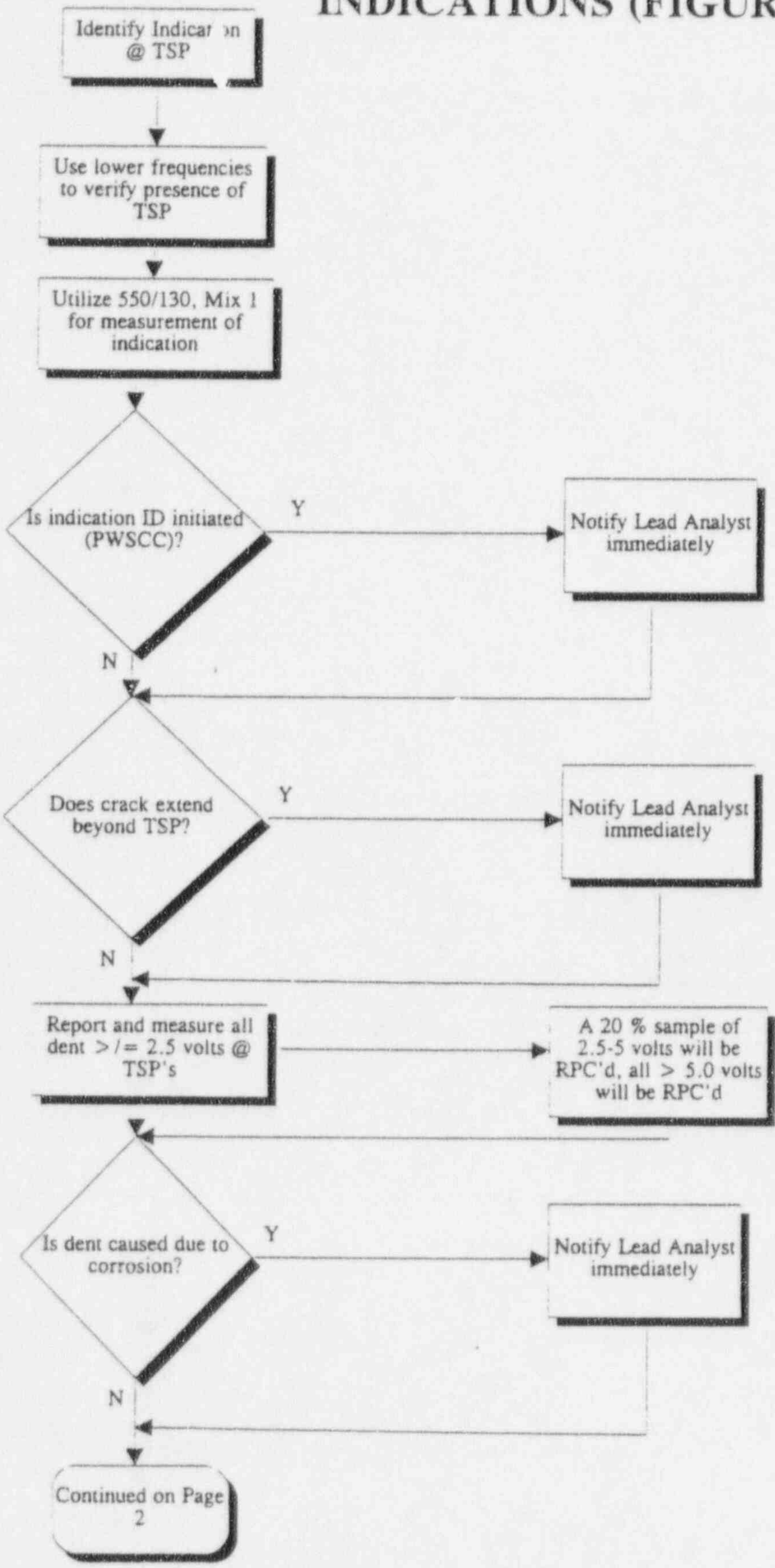
Support Structures Nomenclature and Measurements

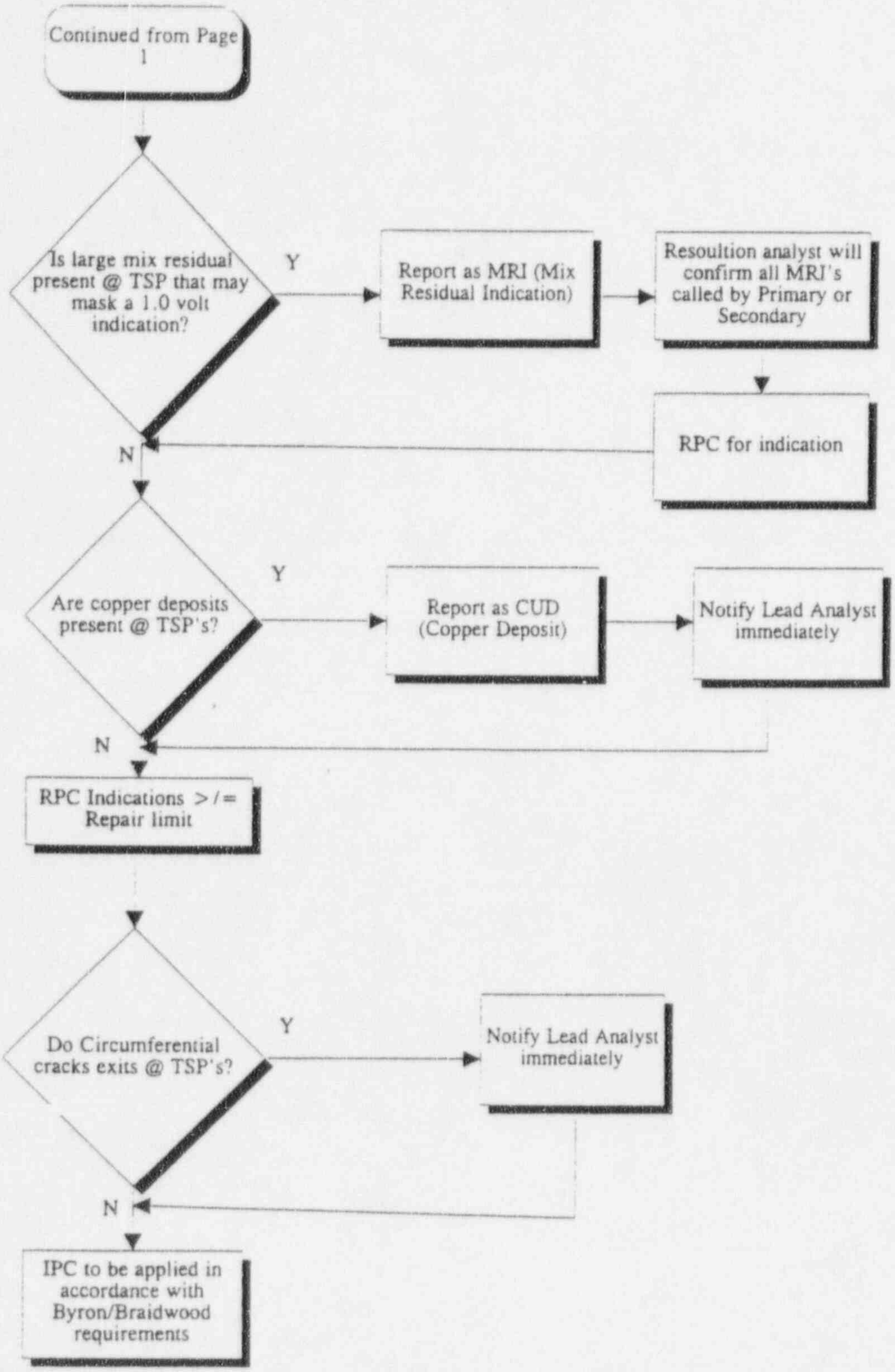
Structures Nomenclature

Notation	Description
TEH	Tube end hot
TSH	Top of tubesheet - hot leg
01H	1st support plate - hot leg
03H	3rd support plate - hot leg
05H	5th support plate - hot leg
07H	7th support plate - hot leg
08H	8th support plate - hot leg
09H	9th support plate - hot leg
10H	10th support plate - hot leg
11H	11th support plate - hot leg
AV1	1st anti-vibration bar
AV2	2nd anti-vibration bar
AV3	3rd anti-vibration bar
AV4	4th anti-vibration bar
11C	11th support plate - cold leg
10C	10th support plate - cold leg
09C	09th support plate - cold leg
08C	08th support plate - cold leg
07C	07th support plate - cold leg
06C	06th support plate - cold leg
05C	05th support plate - cold leg
04C	04th support plate - cold leg
03C	03th support plate - cold leg
02C	02th support plate - cold leg
01C	01st support plate - cold leg
TSC	Top of tubesheet - cold leg
TEC	Tube end cold

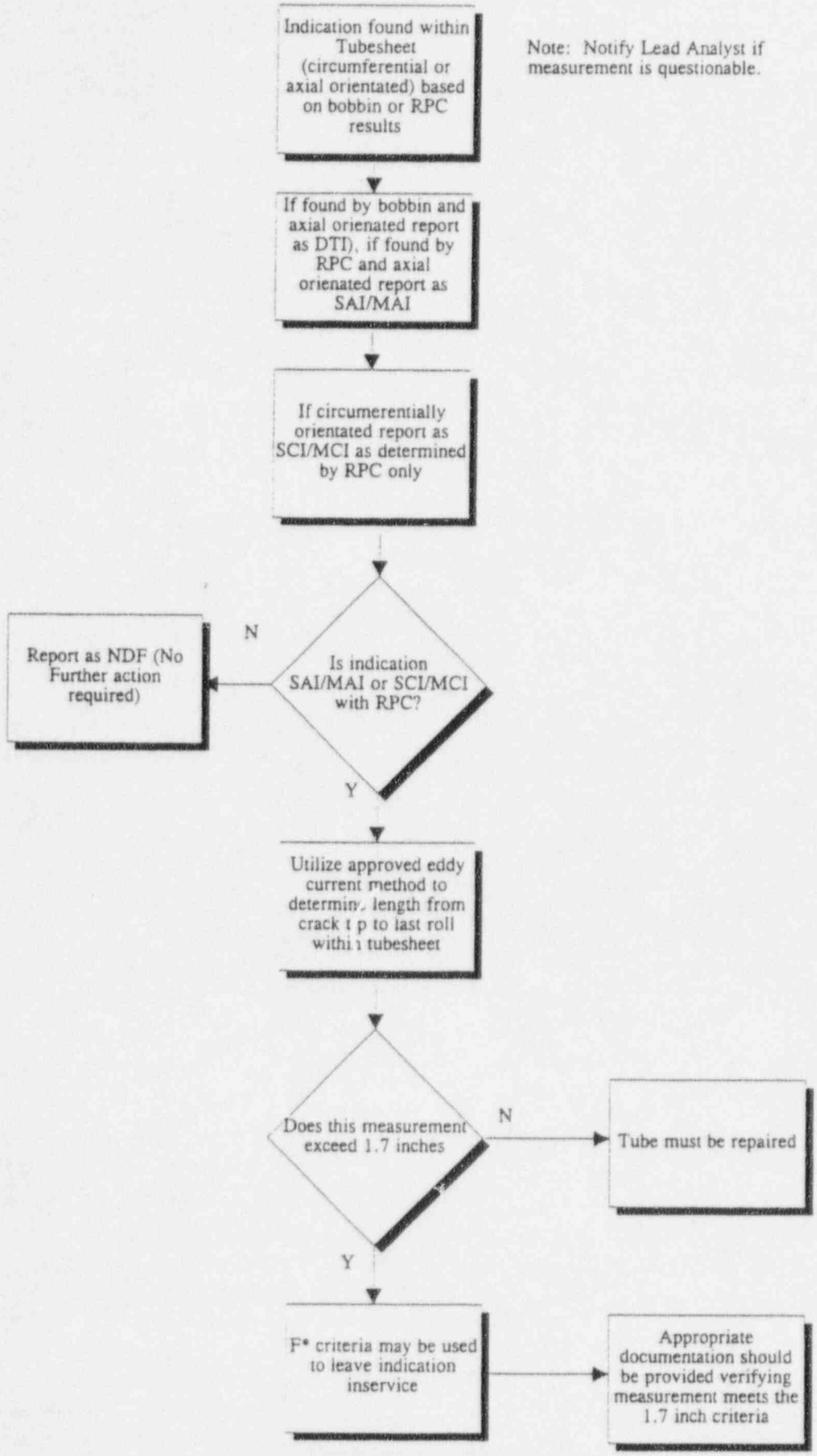
ATTACHMENT 1
(FIGURE 1, 2, 3, 4, 5 & 6)

FLOW DIAGRAM FOR TUBE SUPPORT PLATE INDICATIONS (FIGURE 1)

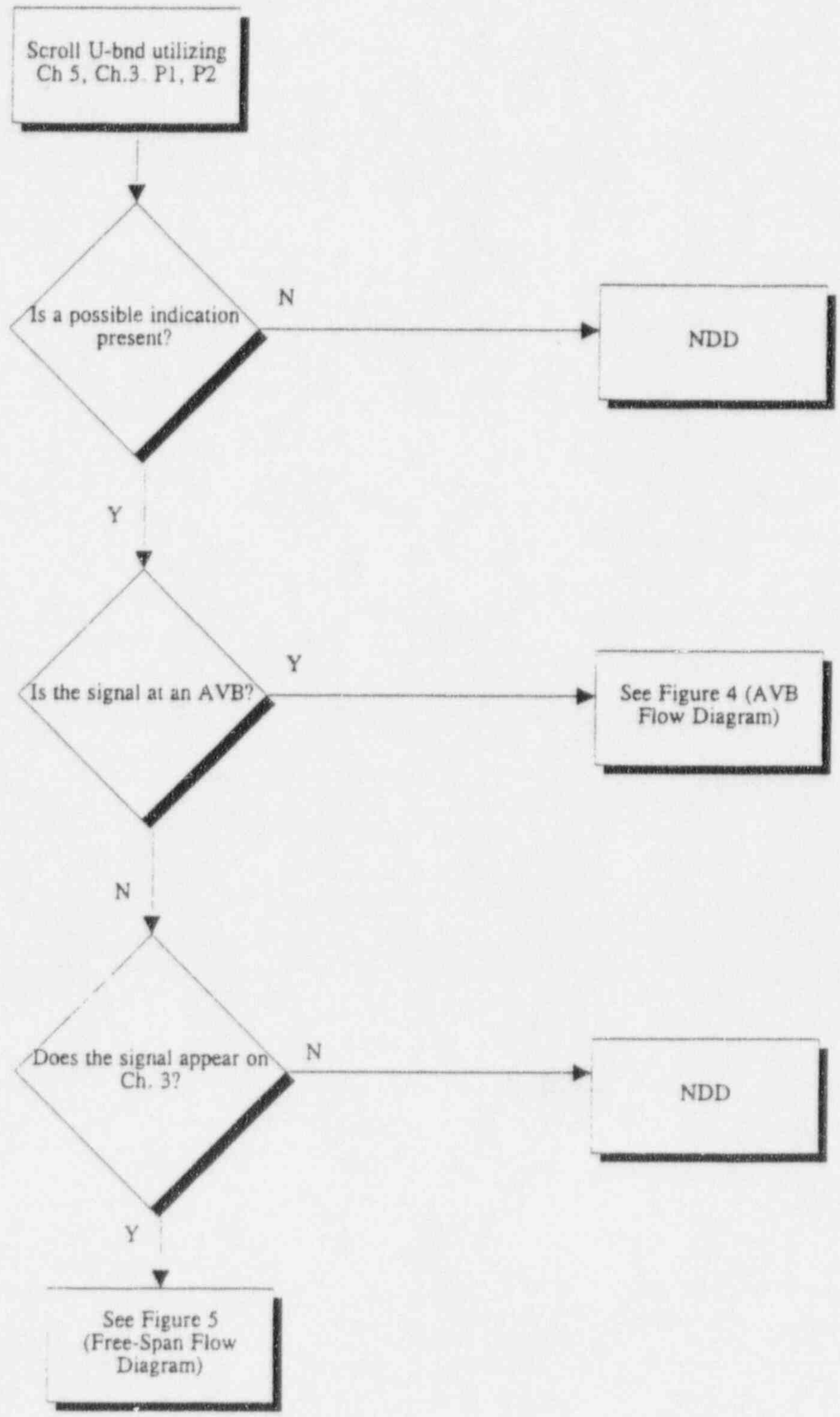



Continued from Page 1
Is large mix residual present @ TSP that may mask a 1.0 volt indication?
Y
Report as MRI (Mix Residual Indication)
Resoultion analyst will confirm all MRI's called by Primary or Secondary
RPC for indication
N
Are copper deposits present @ TSP's?
Y
Report as CUD (Copper Deposit)
Notify Lead Analyst immediately
N
RPC Indications >/= Repair limit
Do Circumferential cracks exits @ TSP's?
Y
Notify Lead Analyst immediately
N
IPC to be applied in accordance with Byron/Braidwood requirements

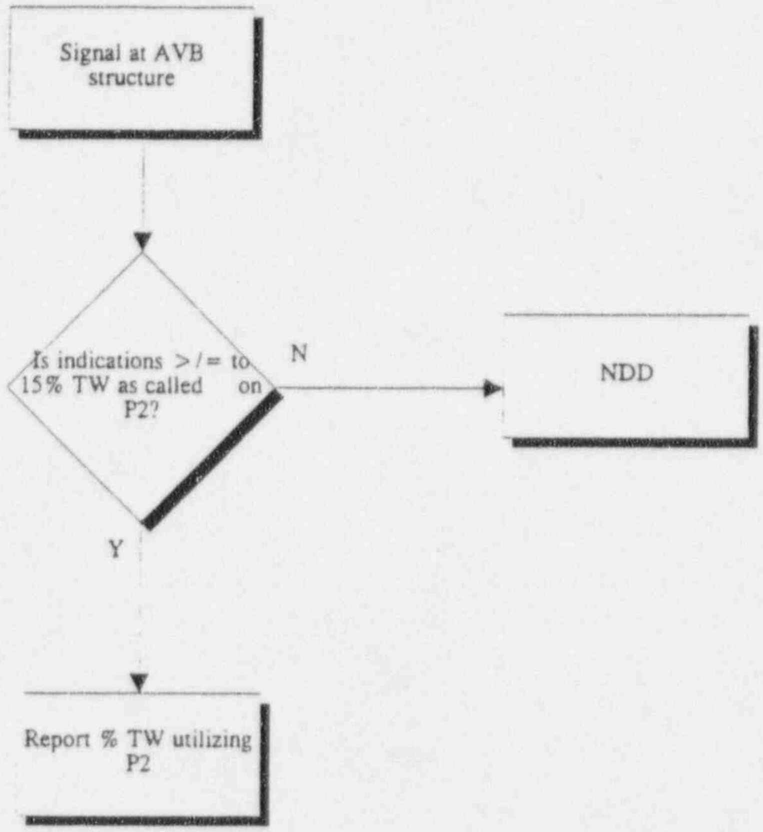
FLOW DIAGRAM FOR TUBESHEET INDICATIONS (F*)
(FIGURE 2)



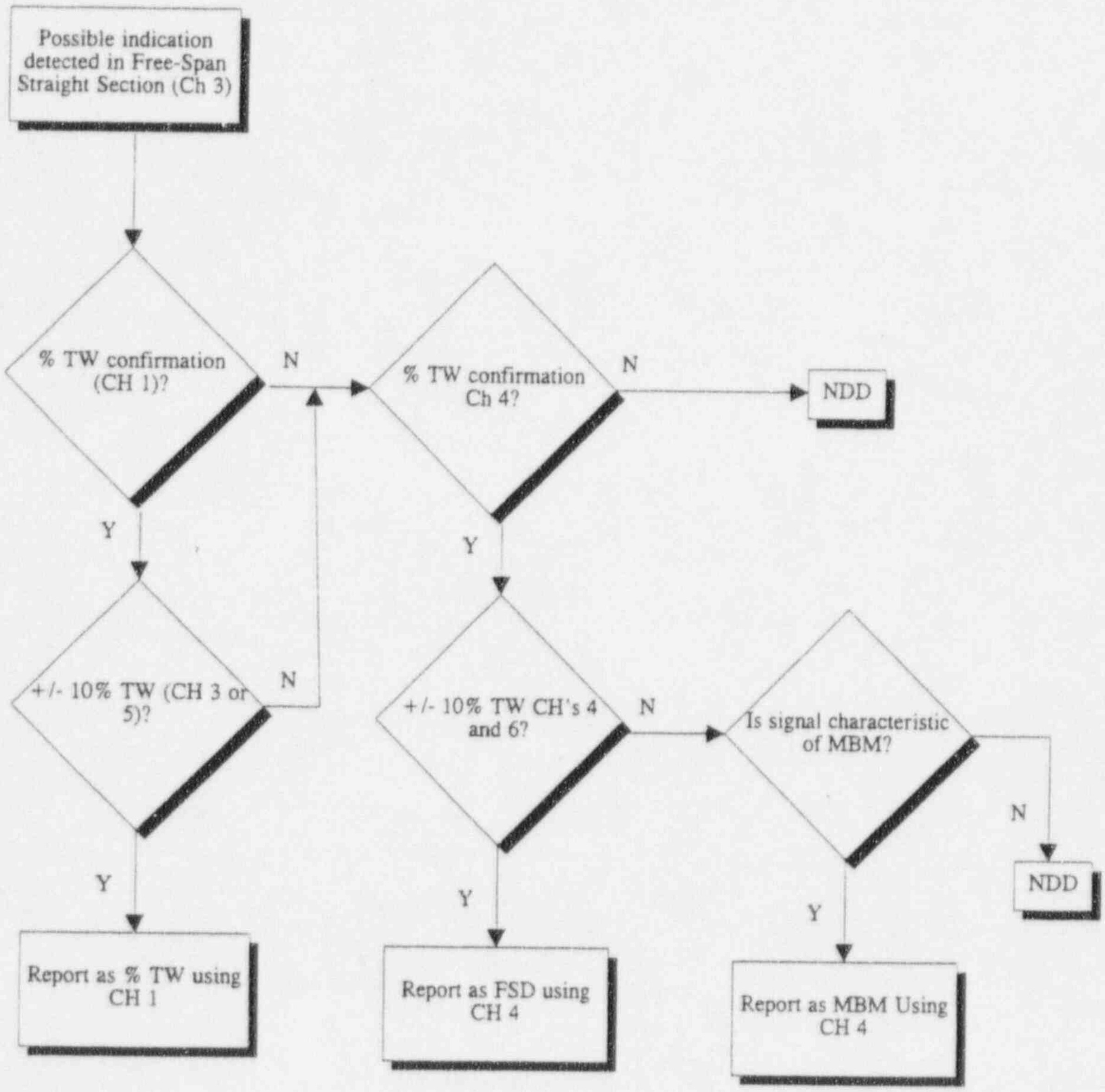
FLOW DIAGRAM FOR U-BEND REGION 11H THROUGH 11C (FIGURE 3)



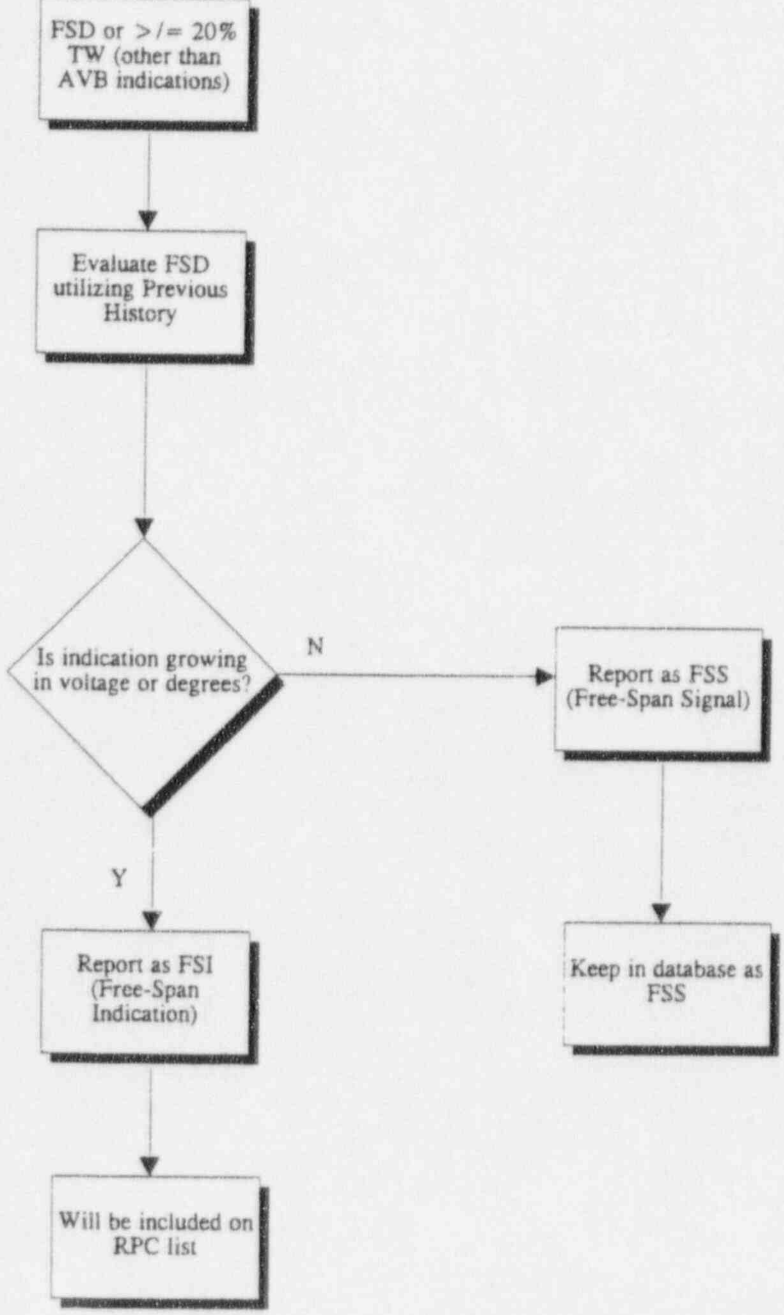
FLOW DIAGRAM FOR INDICATIONS AT AVB'S (FIGURE 4)



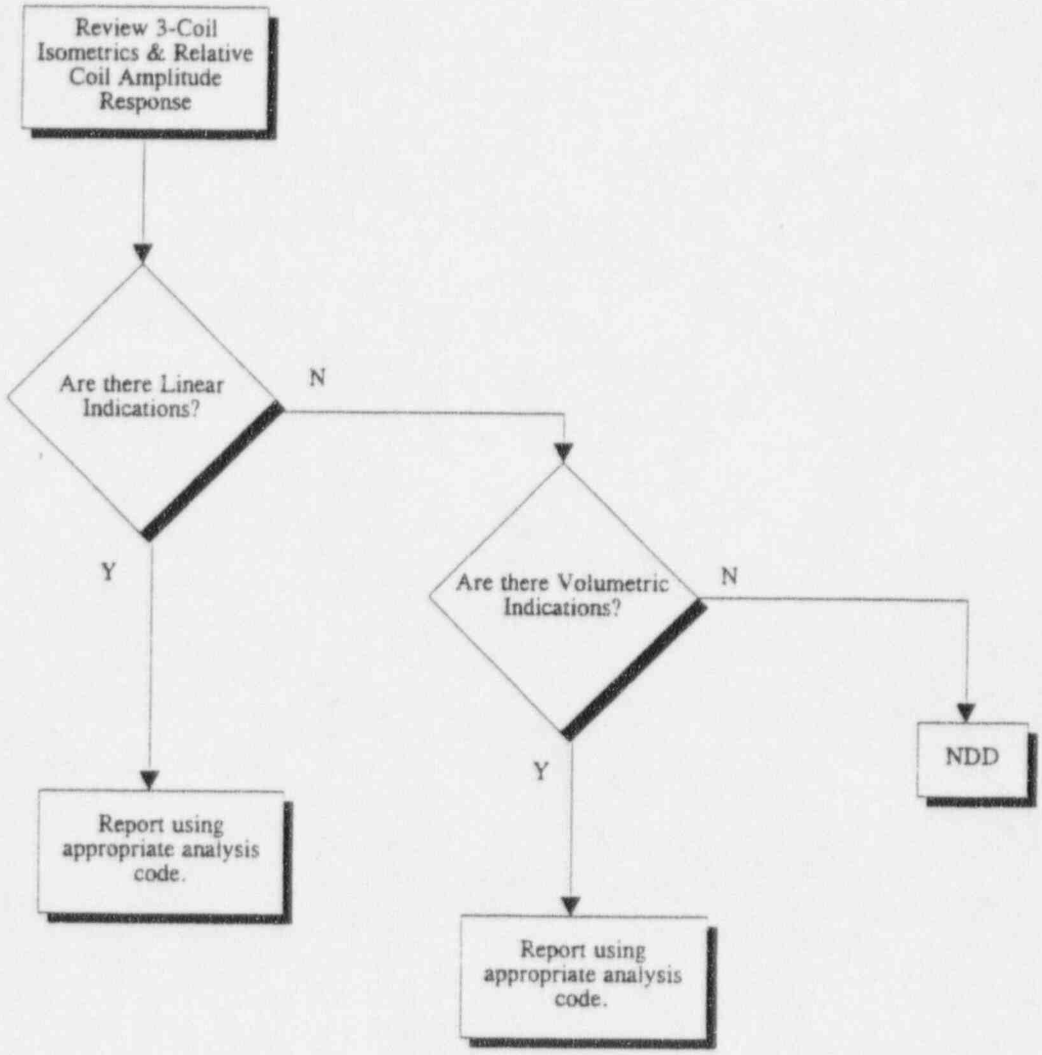
FLOW DIAGRAM FOR FREESPAN STRAIGHT SECTIONS (FIGURE 5)



FLOW DIAGRAM FOR RESOLUTION OF FREESPAN INDICATIONS (FIGURE 6)



FLOW DIAGRAM FOR ROTATING PROBE ANALYSIS (FIGURE 7)



ANALYSIS GUIDELINES CHANGE FORM

CHANGE FORM #: 1

SUBJECT:
Editonal changes to guidelines in section 6.3.3, A.3.9.1(a), Figure 1 and Figure 5 of Attachment 1 and note under A.3.3 "Alloy Property Changes"

DESCRIPTION OF CHANGE:

1) 6.3.3: "Dents or dings > *5.0* volts peak to peak.." This should read "> *2.5 volts*"
2) A.3.9.1: "Bobbin voltage indications > *1.0 volt*". This should read ">***lower repair limit***"
3) Figure 1: See attachment to this page for changes. All changes are generic and do not require any additional input from the analysts.
4) Figure 5: See attachment to this change form. All changes are generic and involve the anlayst making an FSI call rather than a % TW call.
5) Note under A.3.3: Remove the word "All" in the first sentence.

REASON FOR CHANGE:
To provide the analysts with additional information for reporting damage mechanisms.

TECHNICAL BASIS:
These changes are editorial in nature and they do not challenge the technical basis since the analsyts will already be addressing these types of damage mechanisms.

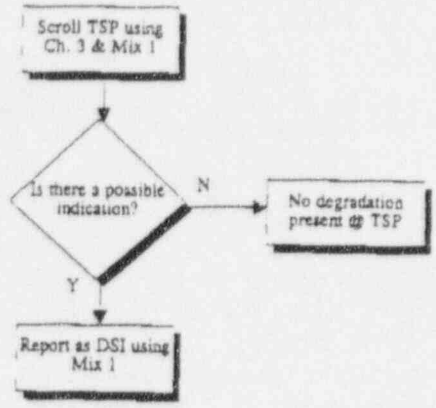
EXAMINATION IMPACT:
None

AUTHORIZATIONS:

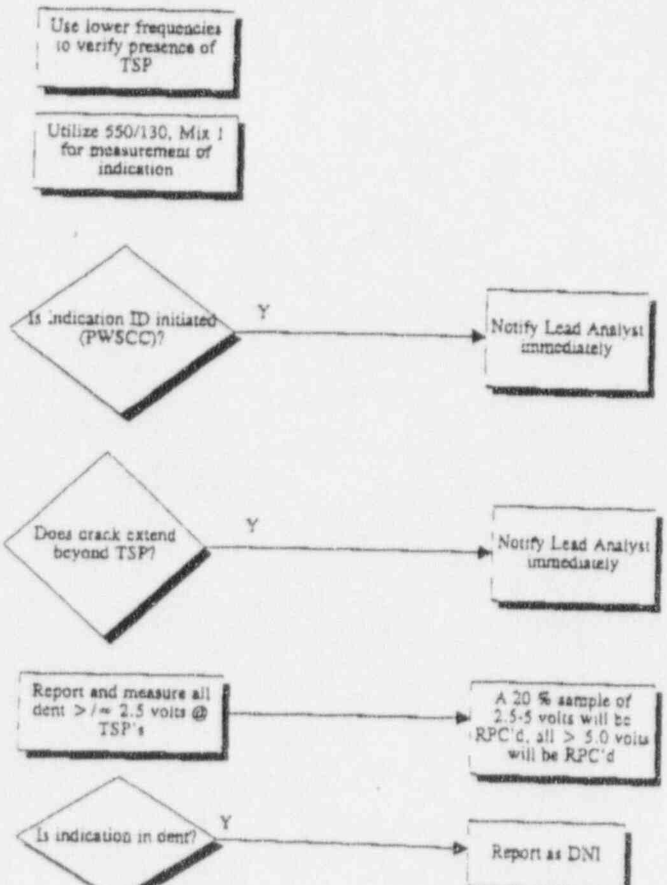
Lead Analyst [signature] Date: 10 / 3 / 95

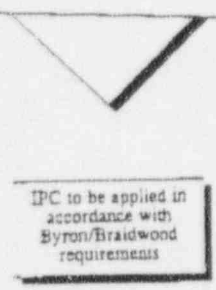
ComEd Acknowledgment [signature] Date 10 / 3 / 95

FLOW DIAGRAM FOR TUBE SUPPORT PLATE INDICATIONS (FIGURE 1)

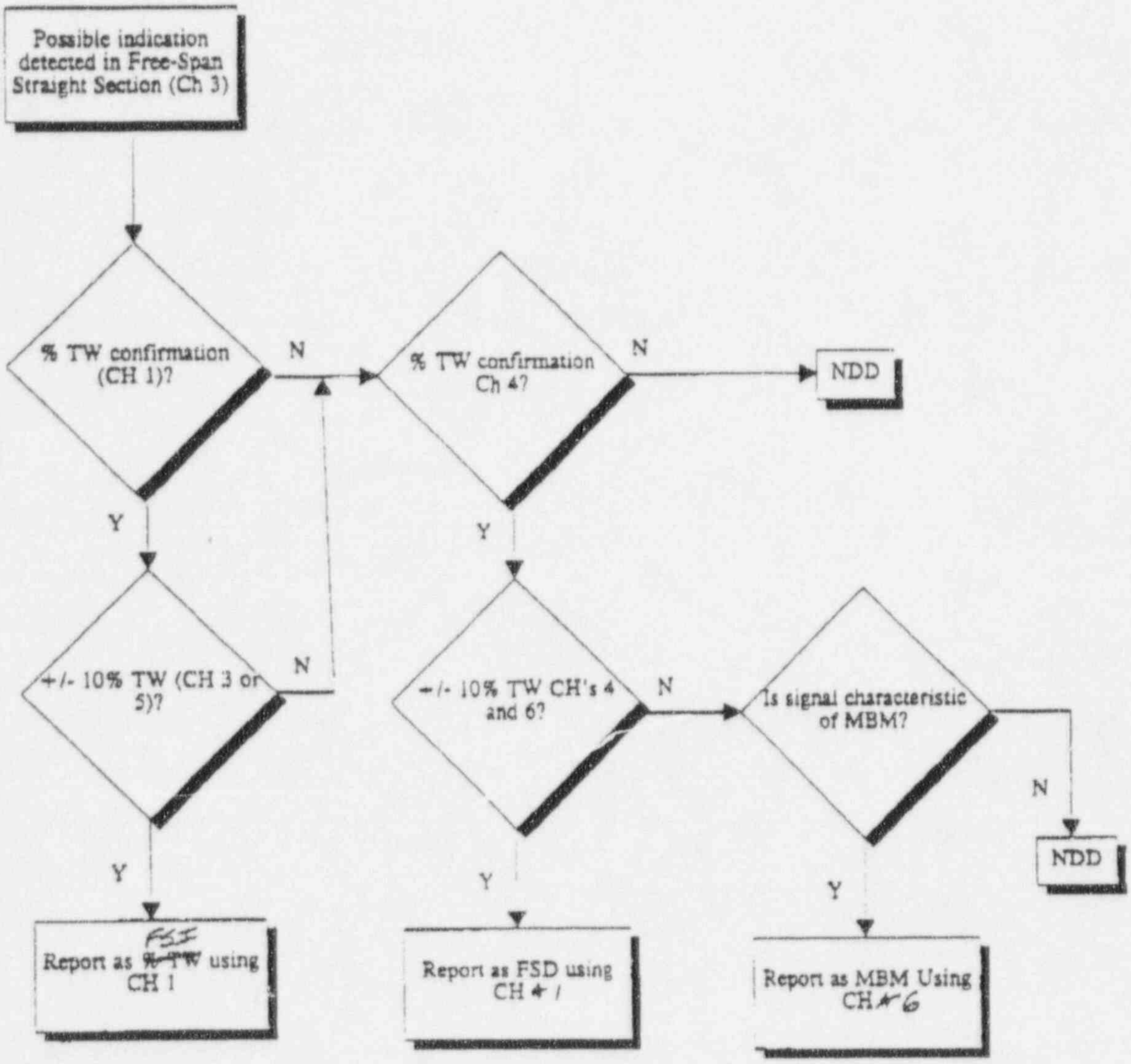


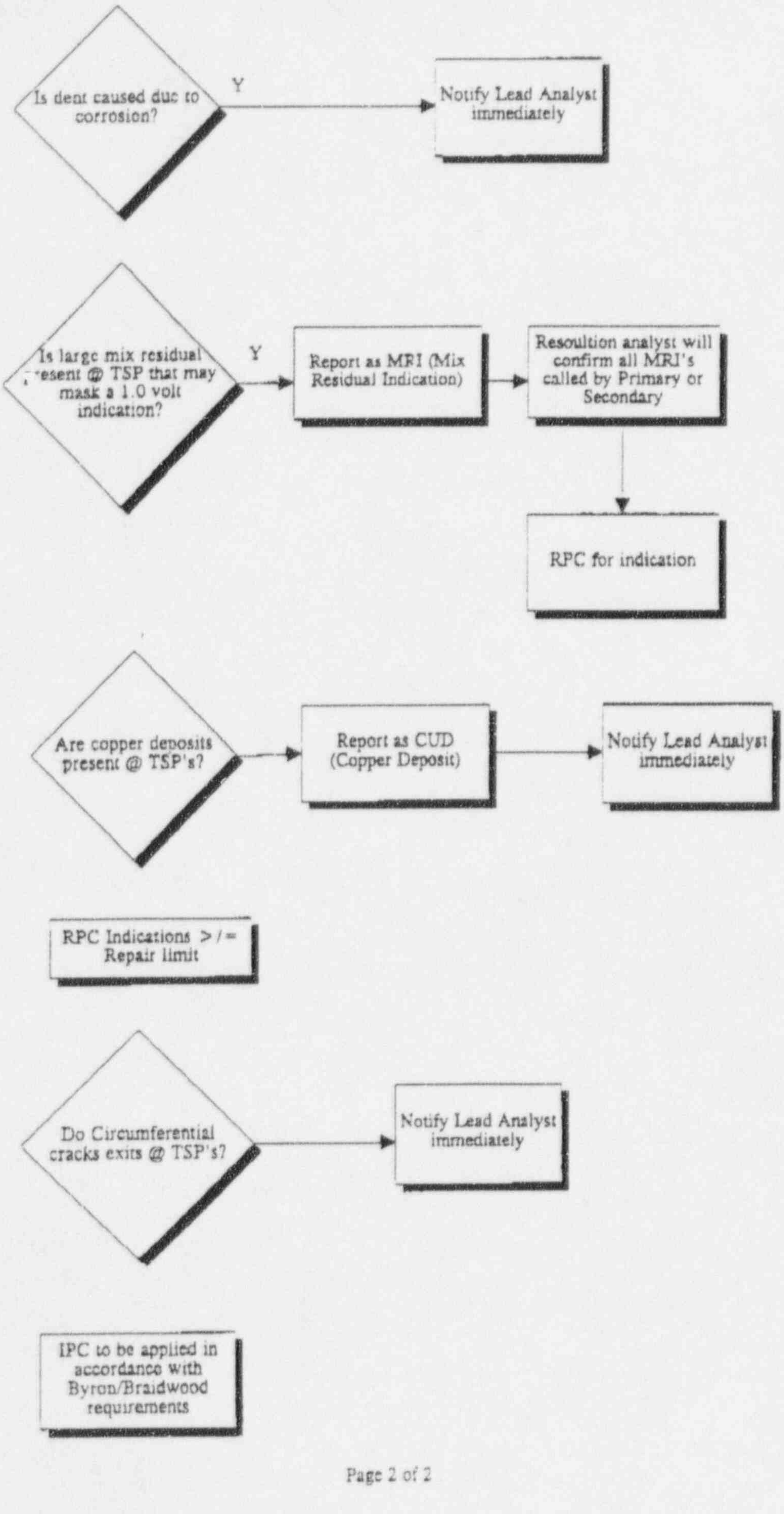
JOB FLOW DIAGRAM





FLOW DIAGRAM FOR FREESPAN STRAIGHT SECTIONS (FIGURE 5)




Is dent caused due to corrosion?
Y
Notify Lead Analyst immediately
Is large mix residual present @ TSP that may mask a 1.0 volt indication?
Y
Report as MRI (Mix Residual Indication)
Resoultion analyst will confirm all MRI's called by Primary or Secondary
RPC for indication
Are copper deposits present @ TSP's?
Report as CUD (Copper Deposit)
Notify Lead Analyst immediately
RPC Indications >/= Repair limit
Do Circumferential cracks exits @ TSP's?
Notify Lead Analyst immediately
IPC to be applied in accordance with Byron/Braidwood requirements

ANALYSIS GUIDELINES CHANGE ACKNOWLEDGMENT FORM

(Continued)

CHANGE FORM #: ____

EFFECTIVE DATE OF CHANGE 10/3/95 TIME __/__ am/pm

Analyst Signature	Date	Time
KIM, SEON GON	10/04/95	10:00
KWON, KYUNG JOO	10/04/95	10:00
OH, CHANG HA	10/04/95	10:00
KO, JONG IN	10/04/95	10:00
KIM, SEOK GON	10/04/95	10:00
YOO, BYEONG YONG	10/04/95	10:00
[signature]	10/05/95	8:55
[signature]	10/5/95	15:10
[signature]	10/5/95	15:15
[signature]	10/5/95	15:20
[signature]	10/5/95	15:25
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