UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

FACILITY: INDIAN POINT NUCLEAR GENERATING UNIT NO. 2

LICENSEE: CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

SUBJECT: SUMMARY OF JUNE 6, 2000, MEETING BETWEEN CONSOLIDATED EDISON COMPANY OF NEW YORK, INC AND NRC STAFF CONCERNING U-BEND INSPECTIONS (TAC NO. MA8219)

On June 6, 2000, a public meeting was held at the Westinghouse Offices, Waltz Mill Site, Pennsylvania, between Consolidated Edison (Con Ed), and the Nuclear Regulatory Commission (NRC) staff. The purpose of the meeting was to discuss matters related to the Indian Point Nuclear Generating Unit No. 2's (IP2) steam generators. Specifically, the probability of detection (POD) of flaws within the U-Bend region of the steam generators.

There were two presentations. The first of which focused on the eddy current inspection performance assessment. Discussions were in the areas of analyst training, the multiple eddy current inspection programs performed during the 2000 outage, analyst performance, alternate nondestructive examination methods, and structural integrity. The presentation discussing the analyst training provided a description of the differences between the 1997 and 2000 outage and what improvement occurred as a result of the change. The eddy current inspection program utilized multiple coil types. The base scope program employed cecco and bobbin in the sludge pile region and + point probe in the u-bend rows 2-4. The expansion program employed the use of + point from tube end through the sludge pile. The second presentation focused on the condition monitoring and operational assessment POD, and depth sizing of pressurized water stress corrosion cracking indications. Enclosure 1 is the list of attendees and Enclosure 2 are the handouts distributed during the meeting. Please direct any inquires concerning this meeting to me. I can be reached at (301) 415-1421 or JFH@NRC.GOV.

Jefferey F. Harold, Project Manager
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-247

Enclosures: As stated

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JUNE 6, 2000

MEETING CONCERNING U-BEND INSPECTIONS

Name	Organization
J. McCann	Consolidated Edison
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S. Coffin	NRC
C. Dodd	NRC
W. Schmidt	NRC
J. P. Lareau	Westinghouse
D. C. Adamonis	Westinghouse
T. A. Petterle	Westinghouse
D. Malinowski	Westinghouse
S. M. Ira	Westinghouse
L. Campagna	Westinghouse
G. Witeman	Westinghouse
A. Sagar	Westinghouse
G. Elder	Westinghouse

For PDR.

NRC Public Meeting With Con Edision
Steam Generator U-Bend Inspections

Westinghouse Waltz Mill Site
Madison, PA

June 6, 2000

Introduction

Purpose of Meeting

U-Bend POD Presentation

U-Bend POD Q&A

Other Topics

Copy For PDR

Indian Point-2 U-Bend CMOA
POD and Depth Sizing of PWSCC Indications

NRC/ConEd/Westinghouse Meeting
June 6, 2000

Westinghouse Waltz Mill Site

Prepared By:

T. A. Pitterle
Westinghouse Electric Company

Probability of Detection

Detection Enhanced with 800 kHz High Frequency Probe

- Reduced effects of deposits
- Reduced ovality effects apparently due to smaller coil shoe
- Permitted detection of indications in tubes found to have unacceptable signal to noise data with 400 kHz probe
  - Indications found in R2C4, R2C85 and R2C74
  - Additional indications detectable on R2C87
  - Indications found in R2C71 previously restricted for mid-range probe

Lower Bound +Point POD Distribution

- Low POD selected to bound high frequency probe detection (not applicable to mid-range coil detection)
- Maximum and average depth PODs

Recommended POD consistent with Indication Sizes Found in the Inspection

Figure A.3-5. Year 2000, SG 4, U-Bend Tube R2C4 – 400 kHz Mid-Range

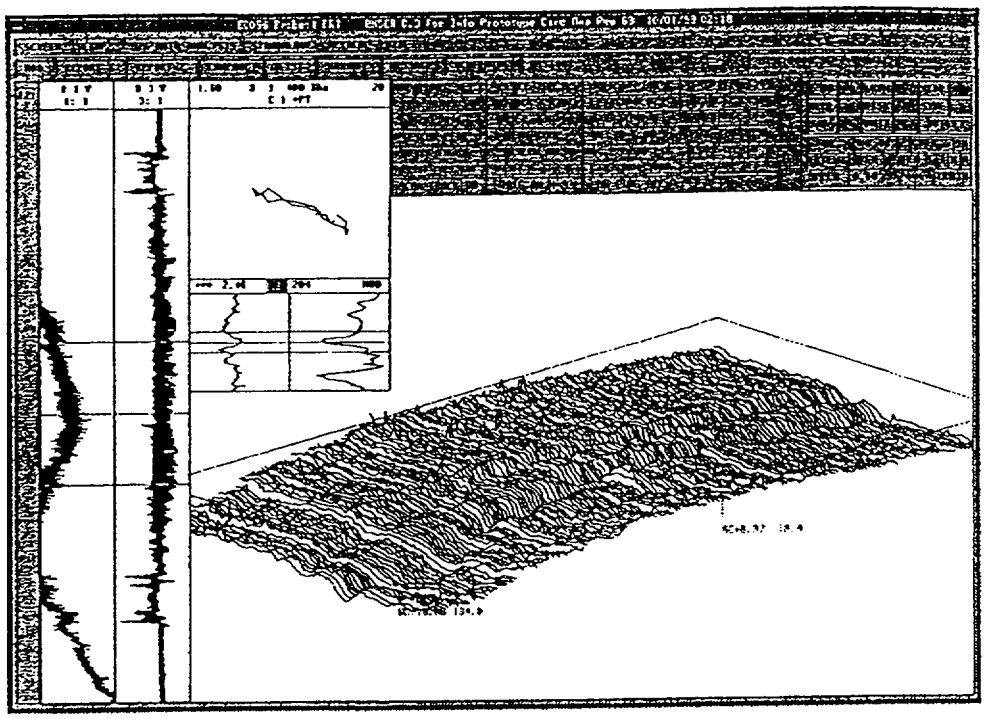


Figure A.3-6. Year 2000, SG 4, U-Bend Tube R2C4 – 400 kHz High Frequency

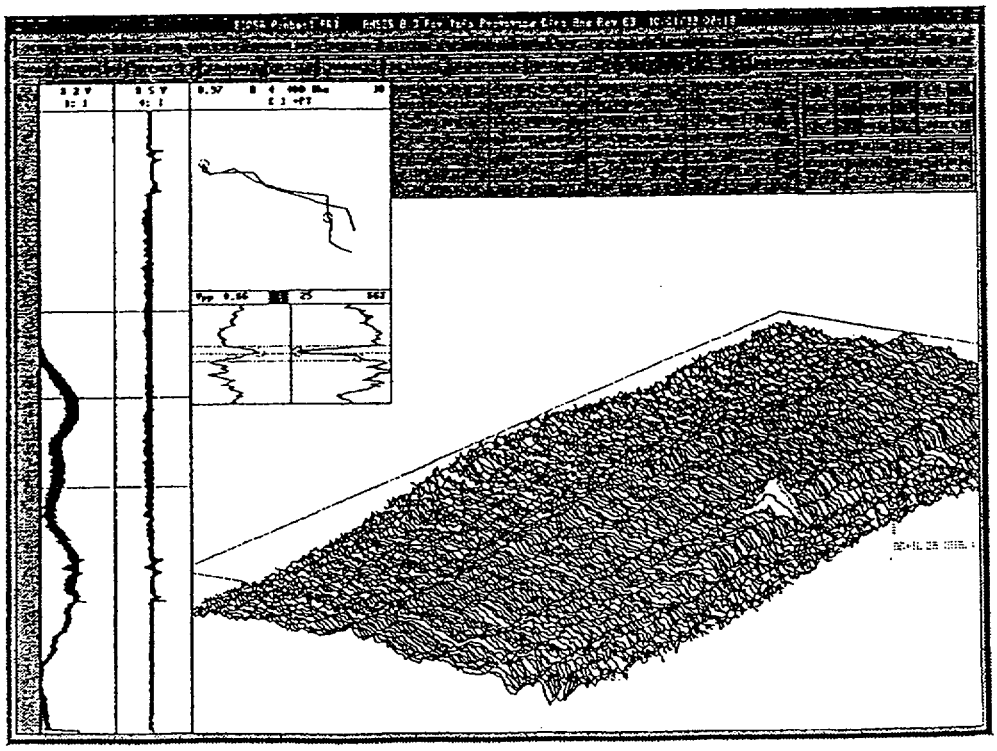


Figure A.1-5. Year 2000, SG 4, U-Bend Tube R2C4 – 400 kHz Mid-Range

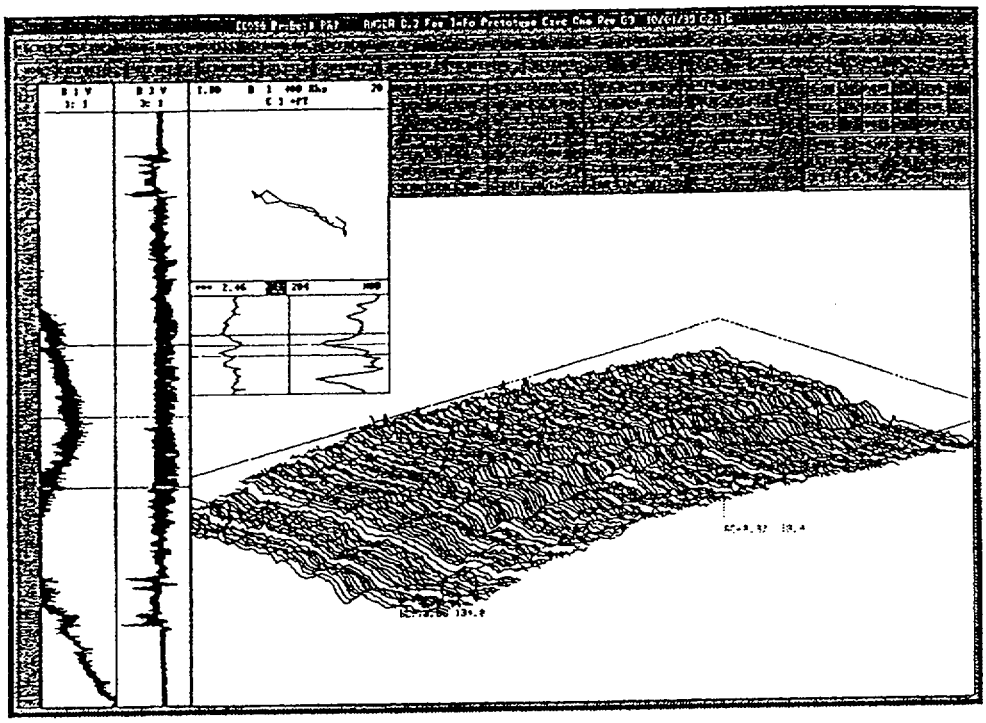


Figure A.1-6. Year 2000, SG 4, U-Bend Tube R2C4 – 800 kHz High Frequency

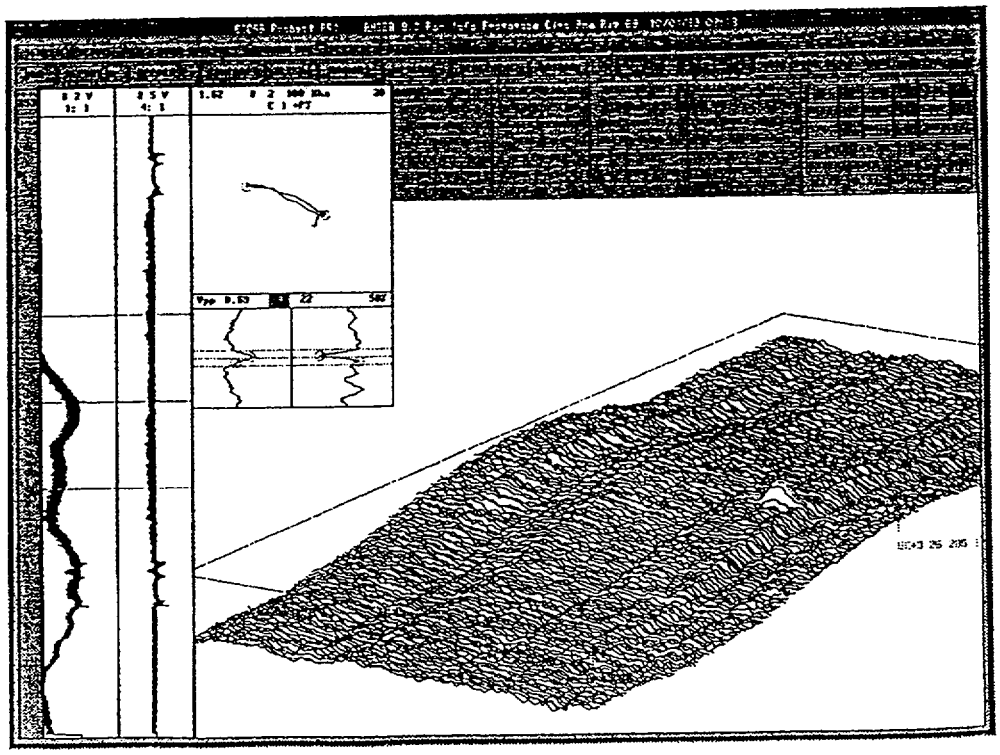


Figure A.1-13. Year 2000, SG 4, U-Bend Tube R2C74 – 400 kHz Mid-Range

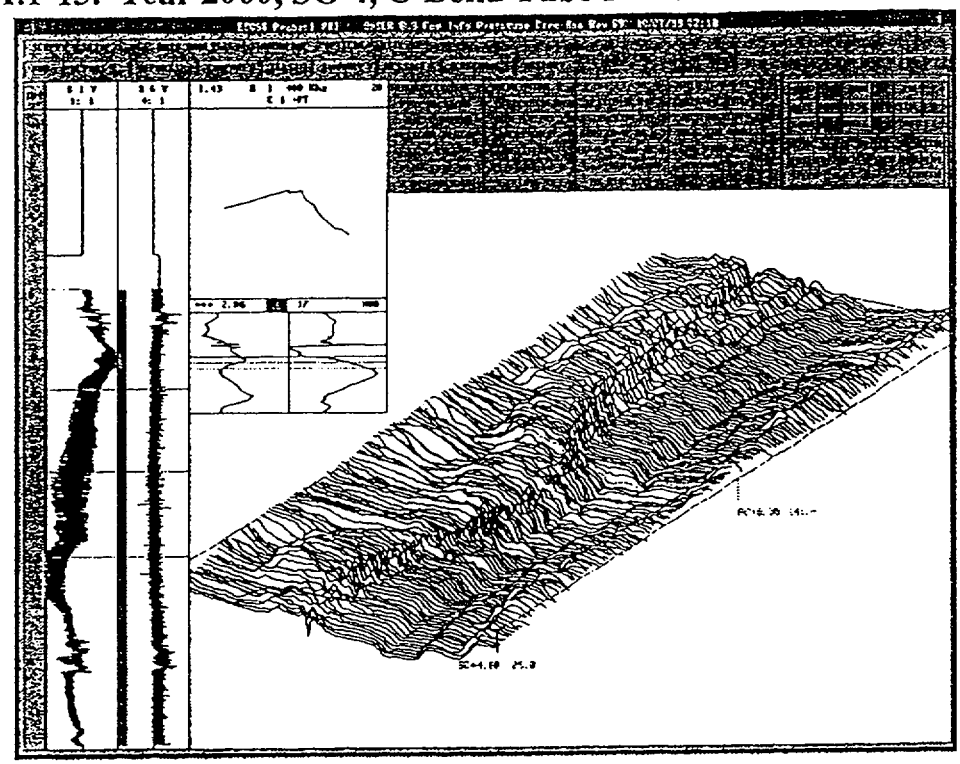


Figure A.1-14. Year 2000, SG 4, U-Bend Tube R2C74 – 800 kHz High Frequency

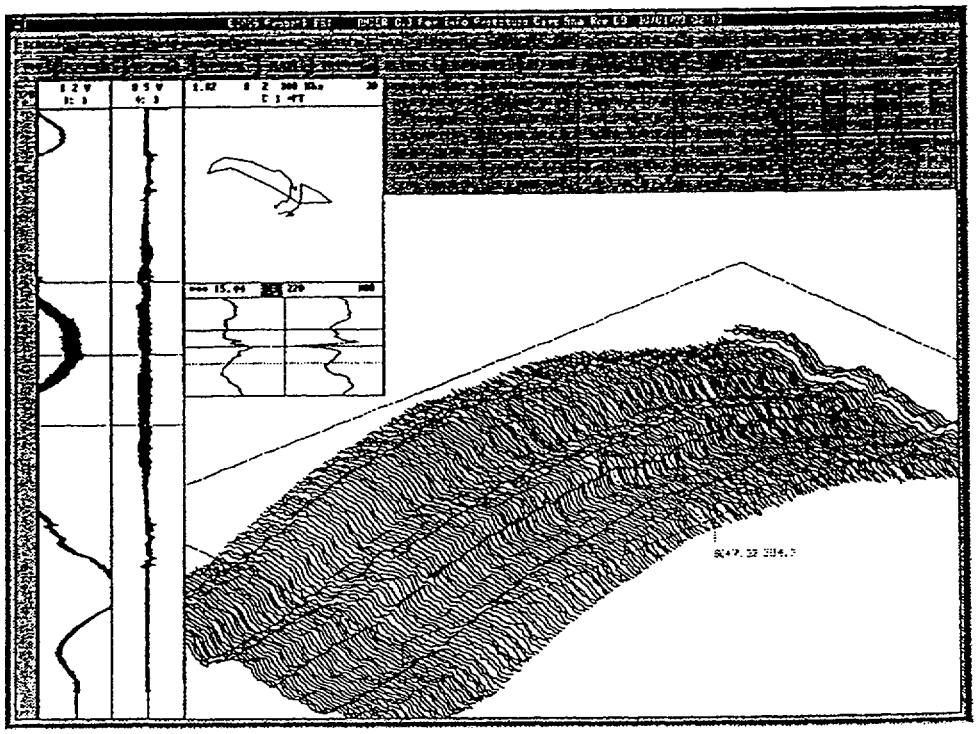


Figure 5-1. Comparisons of +Point Average Depth PODs

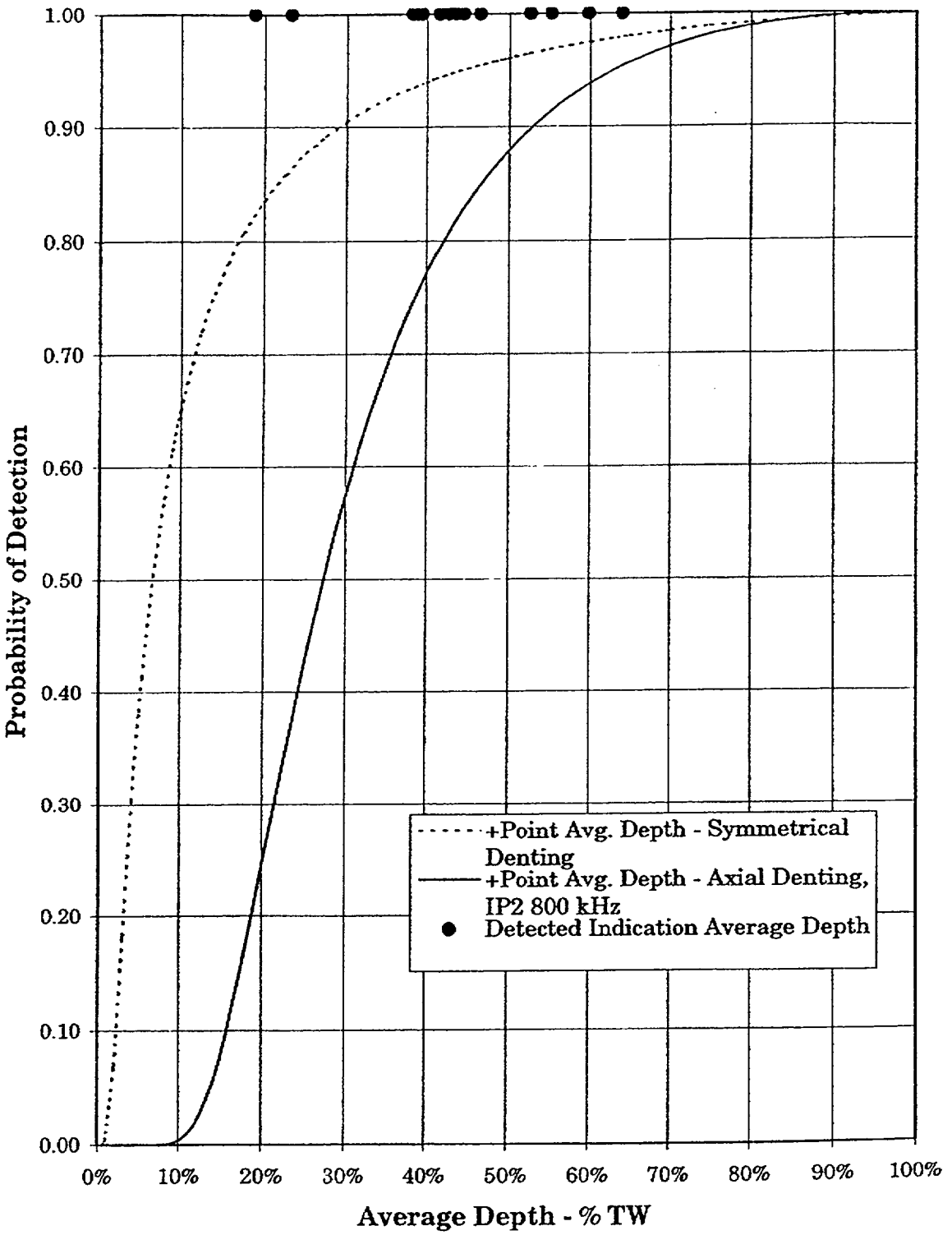
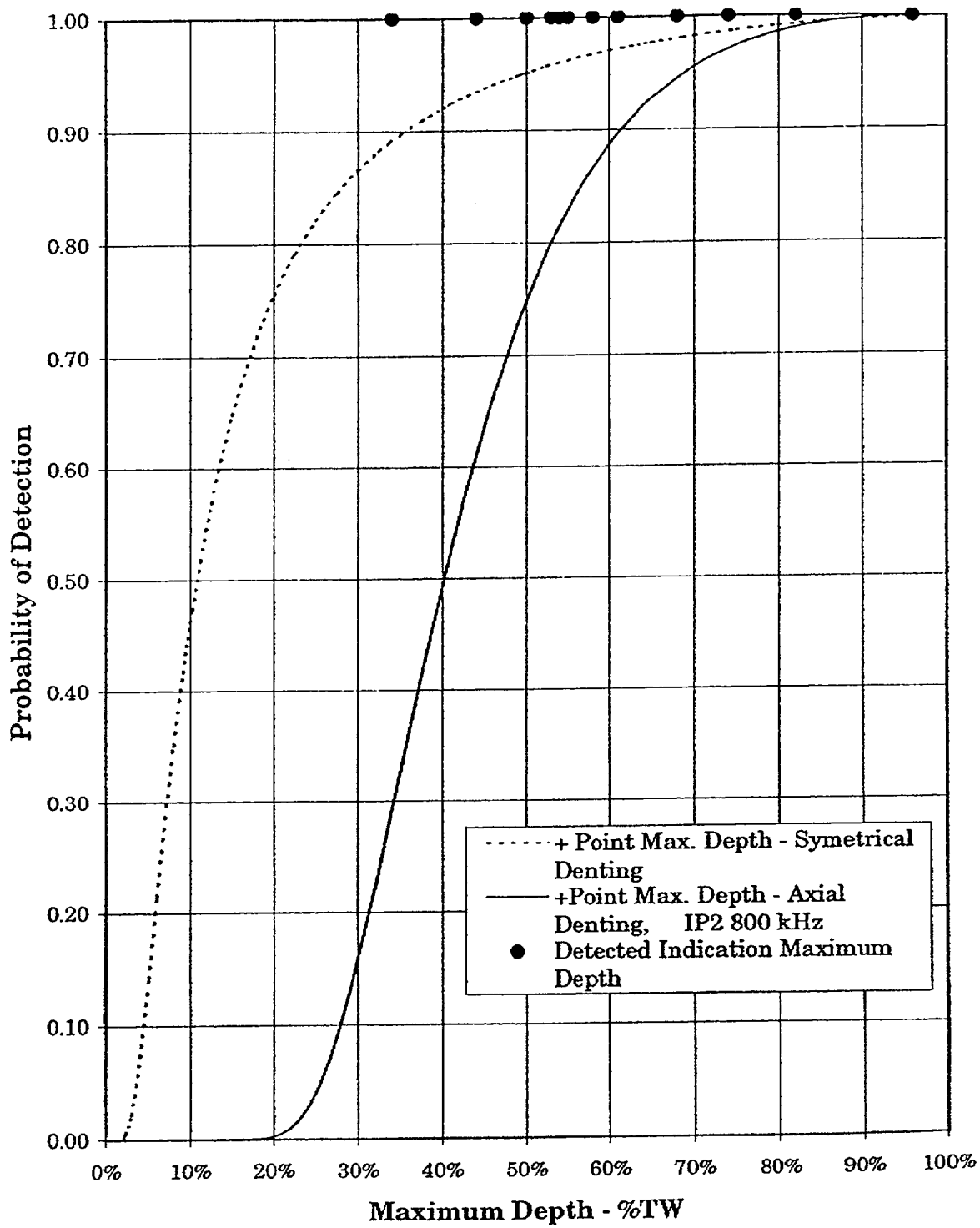


Figure 5-2. Comparisons of + Point Max. Depth PODs



+Point Sizing of U-Bend Indications

+Point Sizing Methods for PWSCC at Dented TSP Intersections Applied

- Refinements applied to distinguish noise from flaw signal, particularly for R2C5
  - Noise characterized away from flaw
  - Flaw signal extends beyond noise in phase response

400 kHz Data Used for Sizing

- Correlations of destructive exam ("truth") to NDE developed for 300-400 kHz data
  - NDE sizing uncertainty standard deviation increased by 25% to reflect application of dented TSP data to U-bend indications
- Higher frequencies yield larger depths and correlation to destructive data not available
- 11 indications in 2000 sized at 400 kHz out of 14 detected/sized at 800 kHz
- Growth rates developed from 1997 and 2000 400 kHz data (9 indications)

Figure 1
Indian Point-2
R2C5 Noise Level of About 0.9 Volts Away from Flow

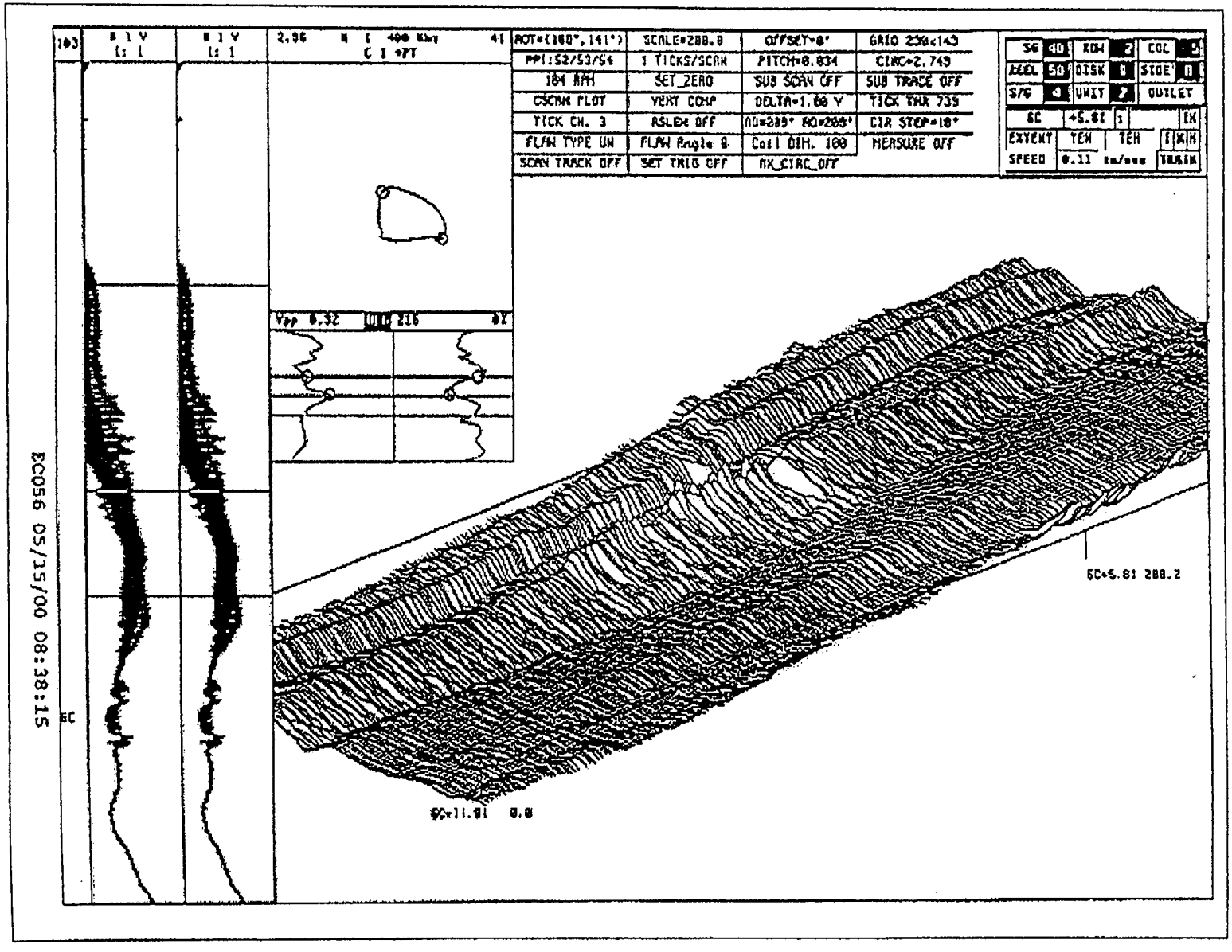


Figure 2
Indian Point-2
R2C5 Combined Noise Plus Flaw Peak Voltage of 2.46 Volt

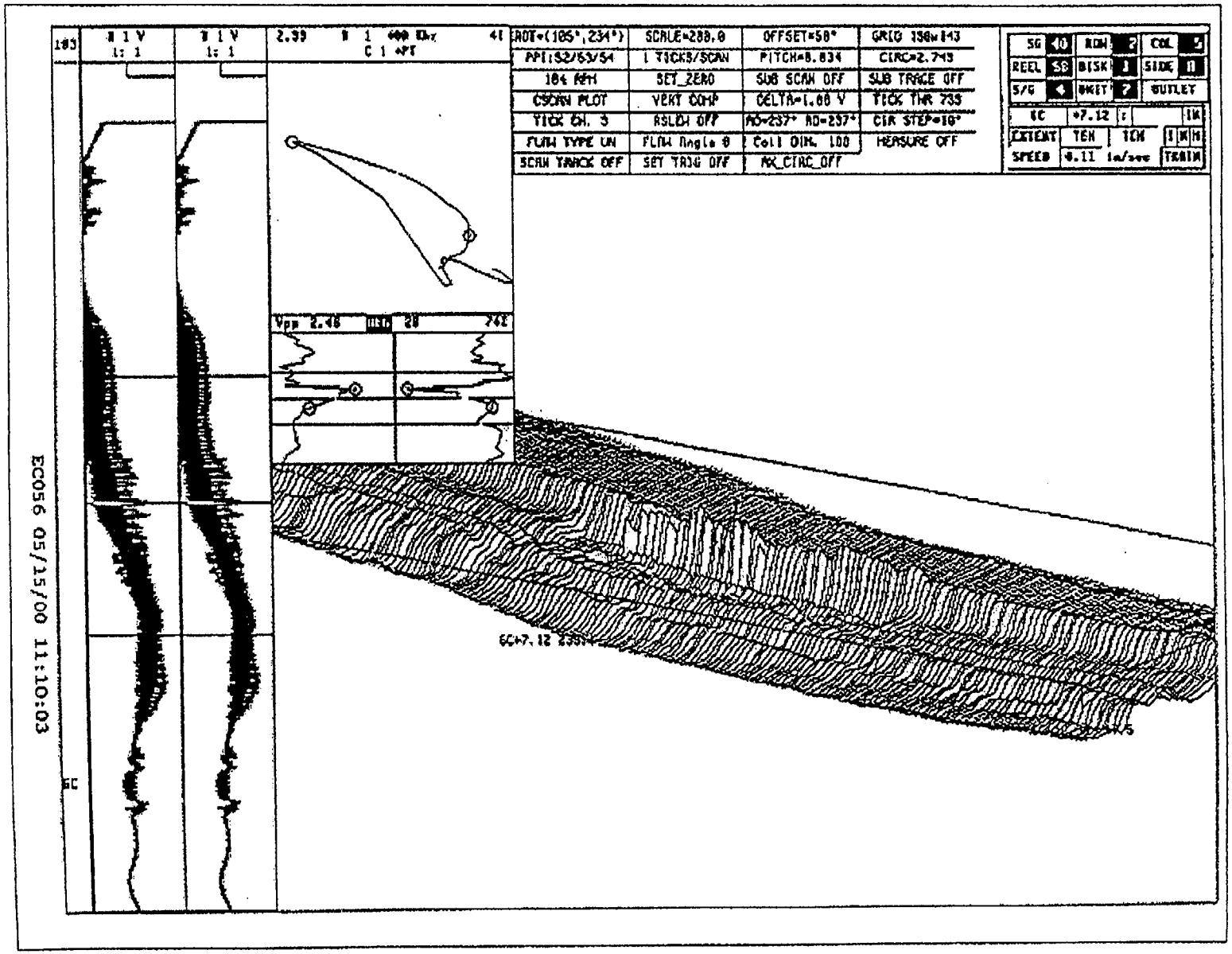


Figure 3
Indian Point-2
R2C5 Peak Flaw Voltage of 1.38 Volt

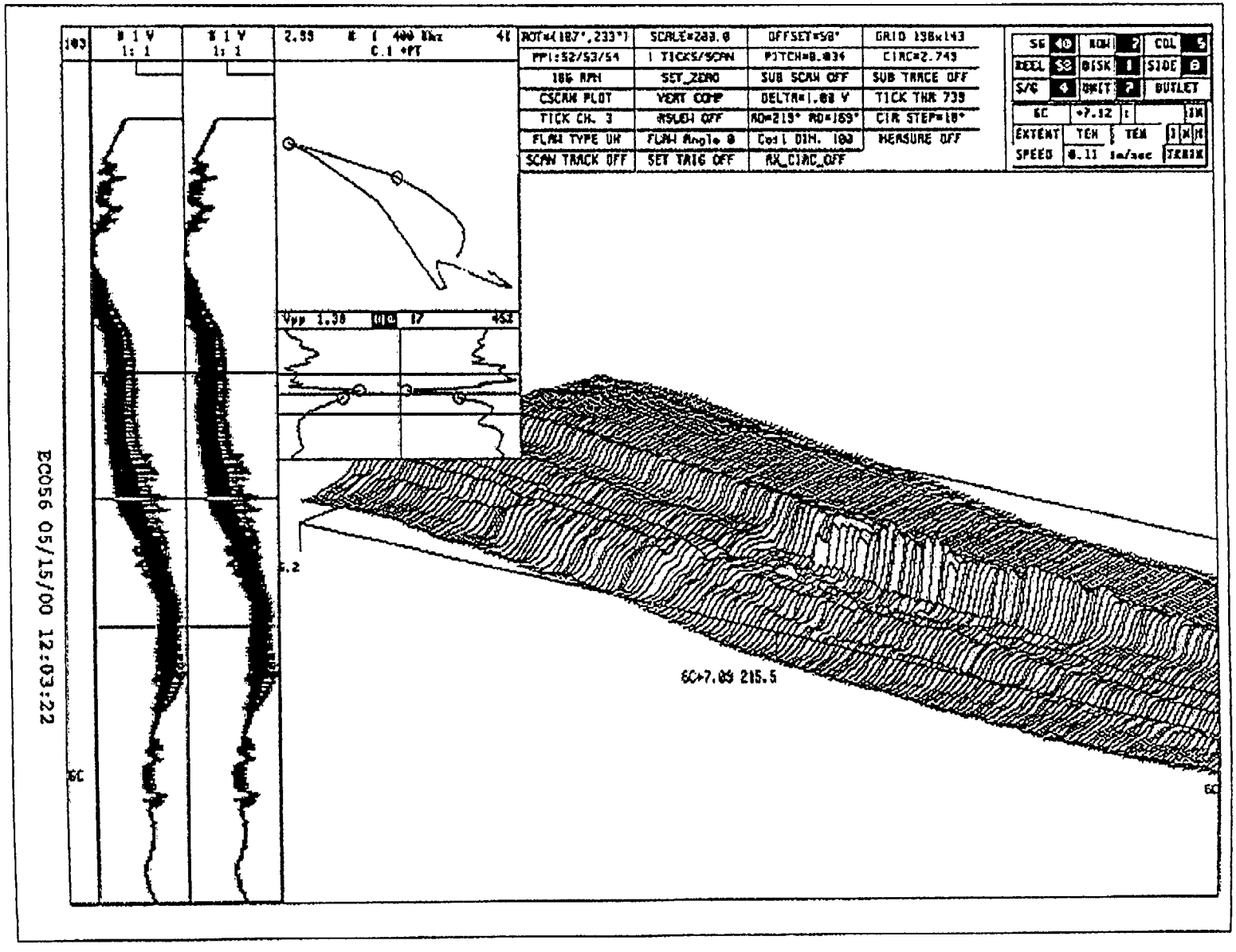


Fig 4c

INDIAN POINT 2__ 03/24/00 OUTLET UNIT: 2 SG: 4 REEL: 218 PRI

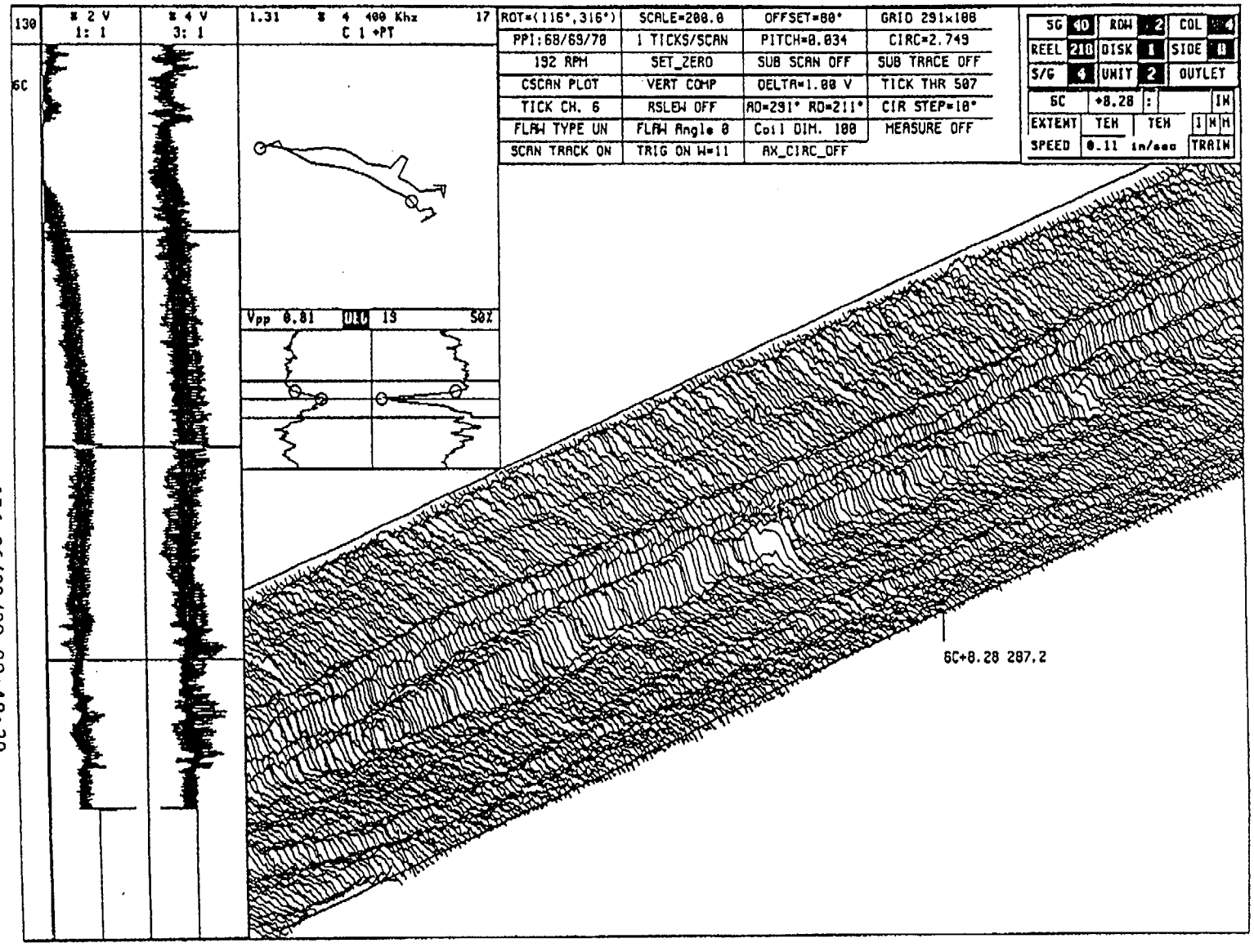


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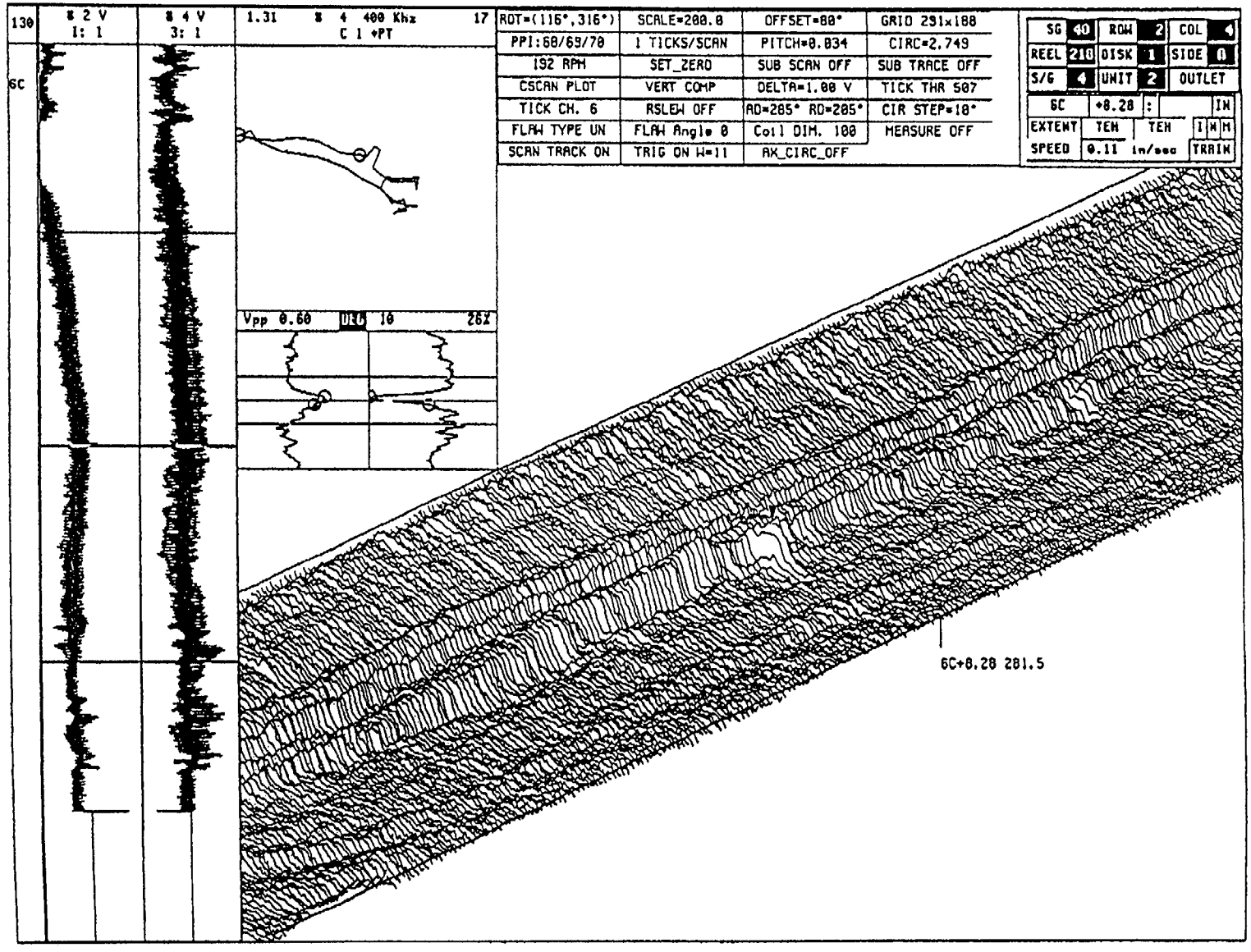
Fig. 4d



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INDIAN POINT 2 03/24/00 OUTLET UNIT: 2 SG: 4 REEL: 218 PRI

Table 3-5. Indian Point-2 U-Bend Indication +Point Sizing Results for 800 and 400 kHz Data

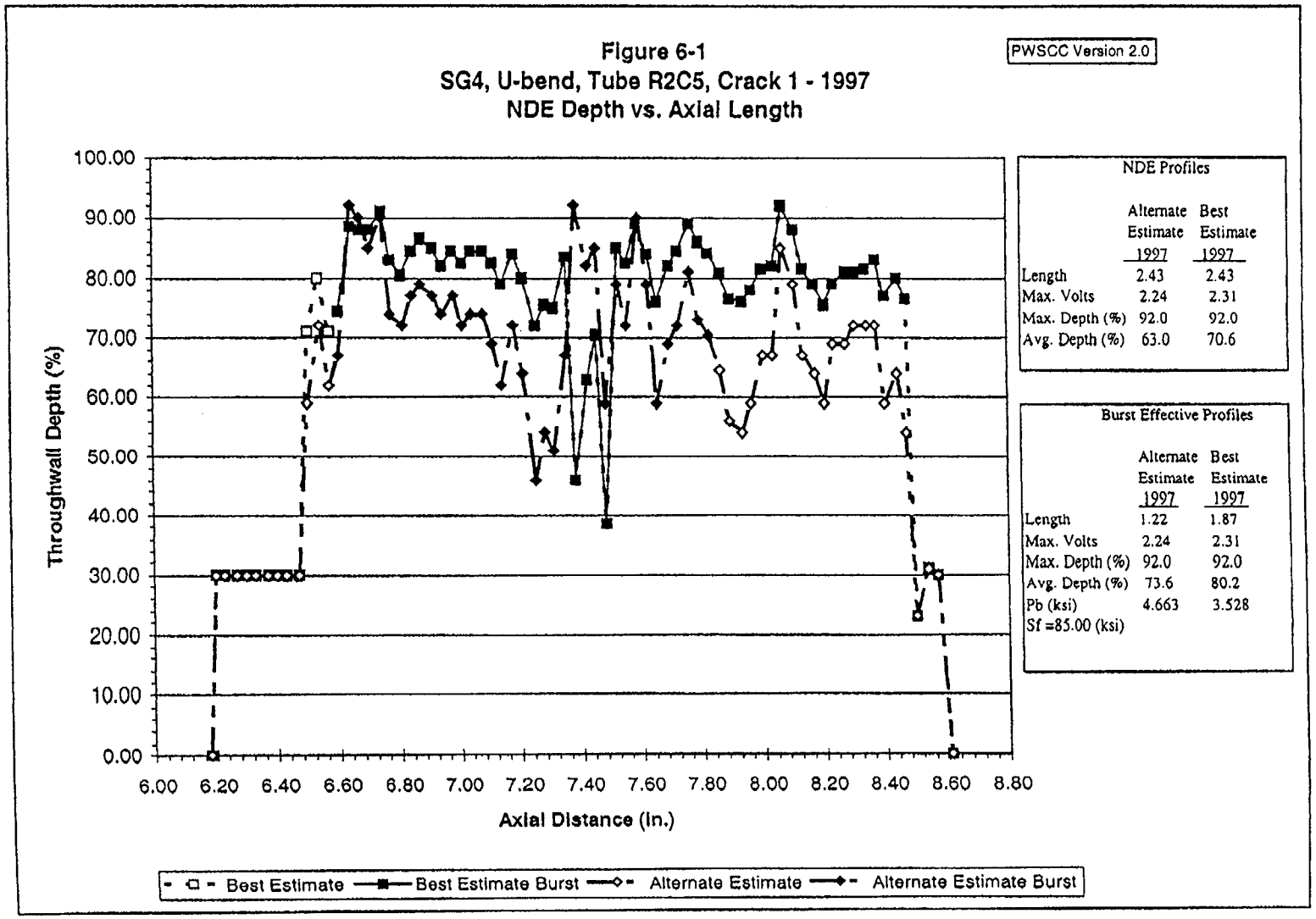
SG	Tube	Crack No.	+Point Sizing Results					
			Max. Volts	Max. Depth (%)	Avg. Depth (%)	Length (inch)	Burst Avg. Depth	Burst Length (inch)
	Leaking Indication		**400 kHz – 1997 Data**					
4	R2C5	1	2.24	92	63.0	2.43	73.6	1.26
		1	2.31	92	70.6	2.43	80.2	1.87
	New Indications		**400 kHz – 2000 Data**					
4	R2C69	1	2.71	74	55.2	0.91	58.3	0.79
		2	1.03	74	44.5	0.11	44.5	0.11
		3	0.94	54	38.2	0.23	42.0	0.20
4	R2C72	1	3.17	82	59.8	0.54	66.6	0.44
4	R2C71(1)	1	2.43	96	64.0	0.57	69.0	0.48
1	R2C87	1	1.68	55	42.8	0.30	48.0	0.25
		2	2.25	61	43.6	0.29	48.0	0.25
		3	2.28	53	41.6	0.35	44.3	0.31
3	R2C85(2)	1	1.20	50	38.9	0.25	46.0	0.18
4	R2C4(2)	1	0.86	44	23.2	0.17	32.3	0.10
4	R2C74(2)	1	0.97	38	14.4	0.19	19.4	0.11
	New Indications		**800 kHz – 2000 Data**					
4	R2C69	1	4.12	89	64.6	0.97	68.5	0.86
		2	1.03	68	48.8	0.27	48.8	0.27
		3	0.92	84	61.1	0.23	61.1	0.23
4	R2C72	1	3.60	82	62.8	0.56	69.9	0.47
4	R2C4	1	0.89	50	33.0	0.12	33.0	0.12
4	R2C71	1	1.77	95	75.6	0.58	75.6	0.58
		2	0.95	34	18.8	0.09	18.8	0.09
4	R2C74	1	1.42	53	39.4	0.16	39.4	0.16
1	R2C87	1	2.79	84	60.7	0.28	60.7	0.28
		2	2.91	79	65.1	0.35	65.1	0.35
		3	2.82	68	51.8	0.43	59.3	0.32
		4	1.81	58	46.5	0.23	48.2	0.21
		5	0.70	68	52.6	0.11	52.6	0.11
3	R2C85	1	1.41	68	44.5	0.28	47.9	0.25

1. Midrange probe was restricted and +Point inspection was not performed with midrange probe. Data at 400 kHz obtained by evaluating high frequency probe data at 400 kHz.
2. Bad data was obtained with midrange probe and U-bend region of flaw was not inspectable in region of flaw. Data at 400 kHz obtained by evaluating high frequency probe data at 400 kHz based on flaw detected at 800 kHz.

Table 5-1. Indian Point-2 U-Bend Axial PWSCC Growth Rates (400 kHz Data)

			+Point - 2000 inspection Midrange Coil						+Point - 1997 Inspection Midrange Coil						Growth per EFPY 2000-1997 = 1.48 EFPY					
S G	Tube	Crack No.	Max. Volts	Max. Depth	Avg. Depth	Length	Burst Avg. Depth	Burst Length	Max. Volts	Max. Depth	Avg. Depth	Length	Burst Avg. Depth	Burst Length	Max. Volts	Max. Depth	Avg. Depth	Length	Burst Avg. Depth	Burst Length
	R2C5 Note 1	1		100			90		2.24 2.31	92 92	63.0 70.6	2.43 2.43	73.6 80.2	1.22 1.87		8.00	11.1		11.1	
4	R2C69	1	2.71	74	55.2	0.91	58.3	0.79	1.33	84	57.0	0.9	62.8	0.7	0.93	-6.76	-1.22	0.01	-3.04	0.06
			1.03	74	44.5	0.11	44.5	0.11	0.54	50	31.5	0.25	39.0	0.16	0.33	16.22	8.78	-0.09	3.72	-0.03
			0.94	54	38.2	0.23	42.0	0.20	0.61	50	33.8	0.16	37.7	0.13	0.22	2.70	2.97	0.05	2.91	0.05
4	R2C72	11	3.17	82	59.8	0.54	66.6	0.44	1.3	79	61.8	0.39	66.4	0.35	1.26	2.03	-1.35	0.10	0.14	0.06
4	R2C71	1	2.43	96	64.0	0.57	69.0	0.48	1.87	87	57.5	0.68	63.1	0.57	0.38	6.08	4.39	-0.07	3.99	-0.06
1	R2C87	1	1.68	55	42.8	0.30	48.0	0.25	1.05	63	40.8	0.15	40.8	0.15	0.43	-5.41	1.35	0.10	4.86	0.07
		1	2.25	61	43.6	0.29	48.0	0.25	0.76	53	36.4	0.19	40.8	0.16	1.01	5.41	4.86	0.07	4.86	0.06
		1	2.28	53	41.6	0.35	44.3	0.31	0.95	63	36.5	0.27	45.2	0.19	0.90	-6.76	3.45	0.05	-0.61	0.08
														Avg.	0.68	2.39	3.80	0.03	3.09	0.04
														Max.	1.26	16.22	11.1	0.10	11.1	0.08

Note 1. R2C5 not sizeable in 2000 by NDE after crack opening resulting in leakage. Maximum depth in 2000 is assumed to be throughwall. For ligament tearing, which is the expected cause for opening the R2C5 crack, the average depth to tear the ligament of a 2.2 to 2.4 inch flaw would be about 90%. The 90% depth value is applied with the smaller burst effective depth estimate for R2C5 in 1997 to assign a conservative growth value to R2C5.



NDE Profiles

	Alternate Estimate 1997	Best Estimate 1997
Length	2.43	2.43
Max. Volts	2.24	2.31
Max. Depth (%)	92.0	92.0
Avg. Depth (%)	63.0	70.6

Burst Effective Profiles

	Alternate Estimate 1997	Best Estimate 1997
Length	1.22	1.87
Max. Volts	2.24	2.31
Max. Depth (%)	92.0	92.0
Avg. Depth (%)	73.6	80.2
Pb (ksi)	4.663	3.528
Sf =85.00 (ksi)		

Figure 3-5. Indian Point-2: Comparison of SG 4 R2C71 400 and 800 kHz Depth Profiles

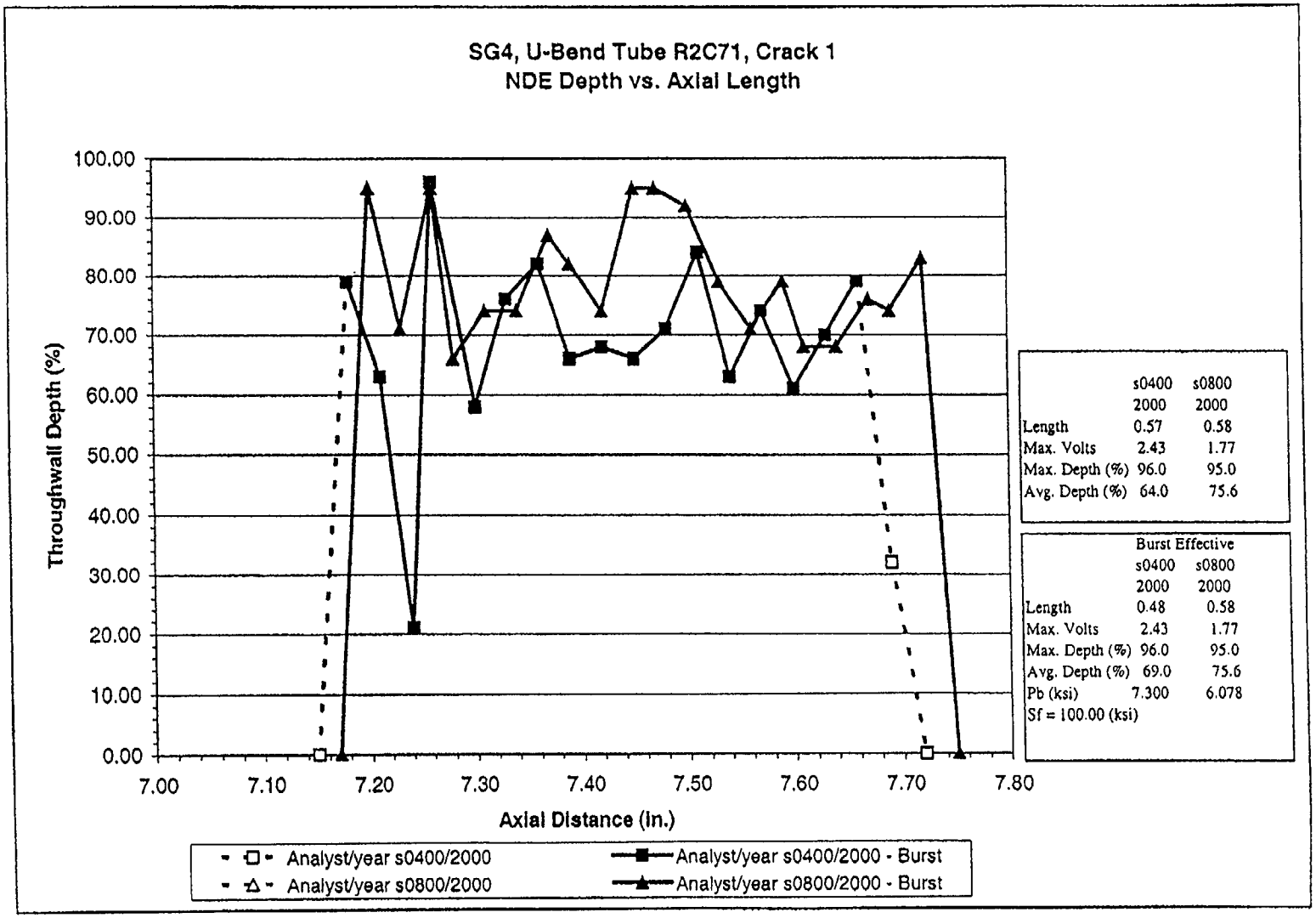


Figure 8-3
SG 4, U-Bend Tube R2C71, Crack Depth Profiles
Comparison of Pre and Post In Situ
NDE Depth vs. Axial Length

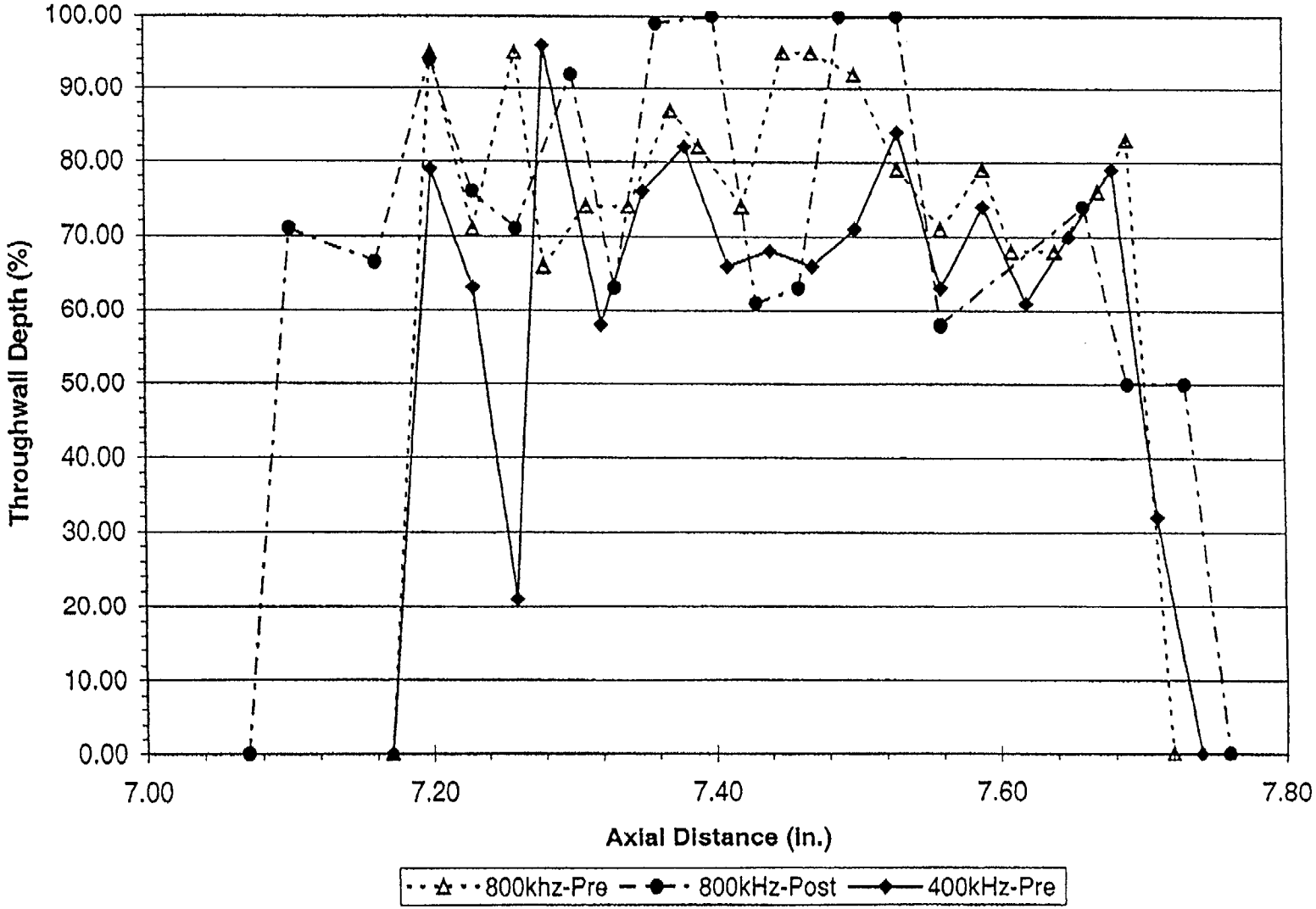


Figure 3-4. Indian Point-2: Comparison of SG 4 R2C69 400 and 800 kHz Depth Profiles

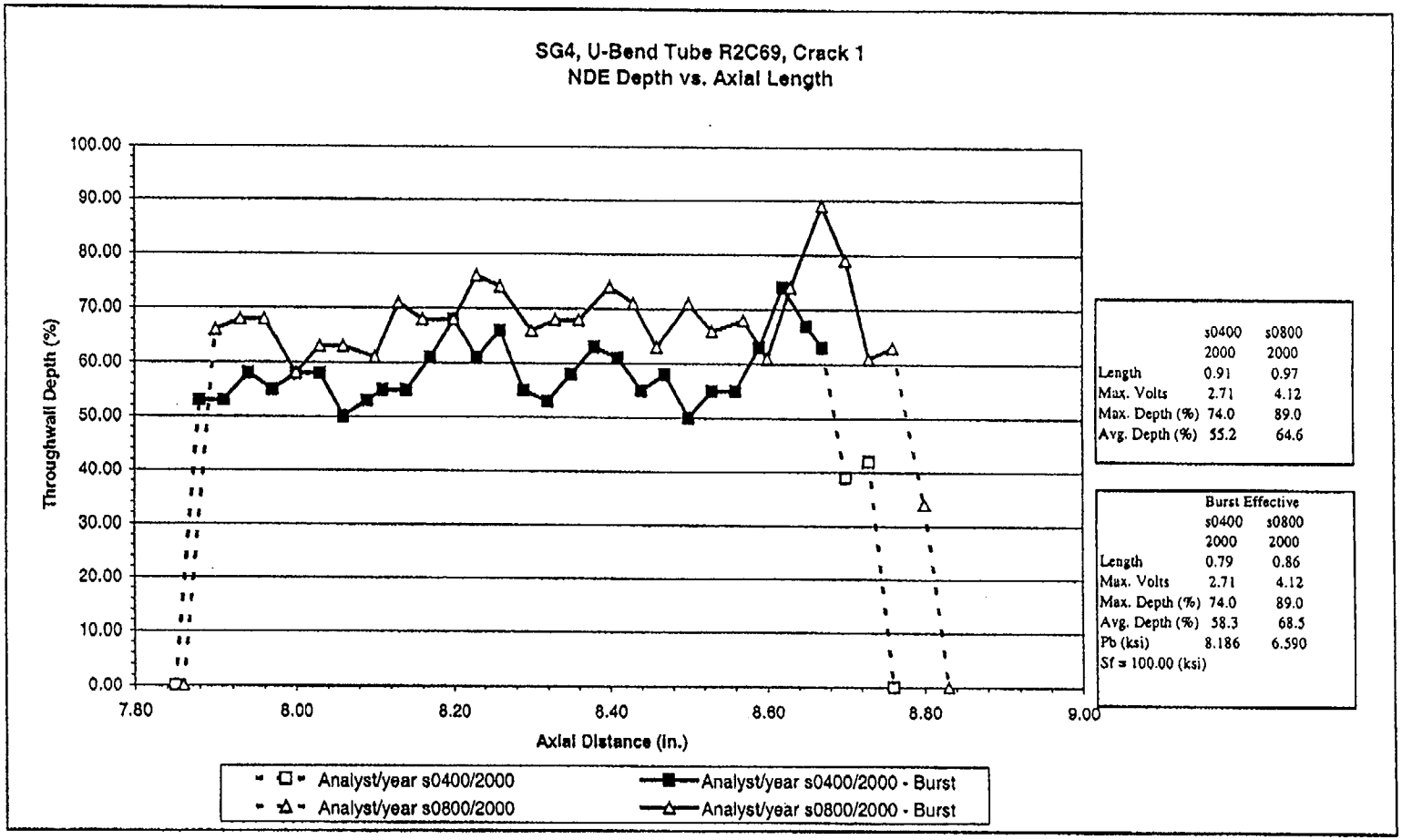


Figure 8-2
SG 4, U-Bend Tube, R2C69 Crack Depth Profiles
Comparison of Pre and Post In Situ
NDE Depth vs. Axial Length

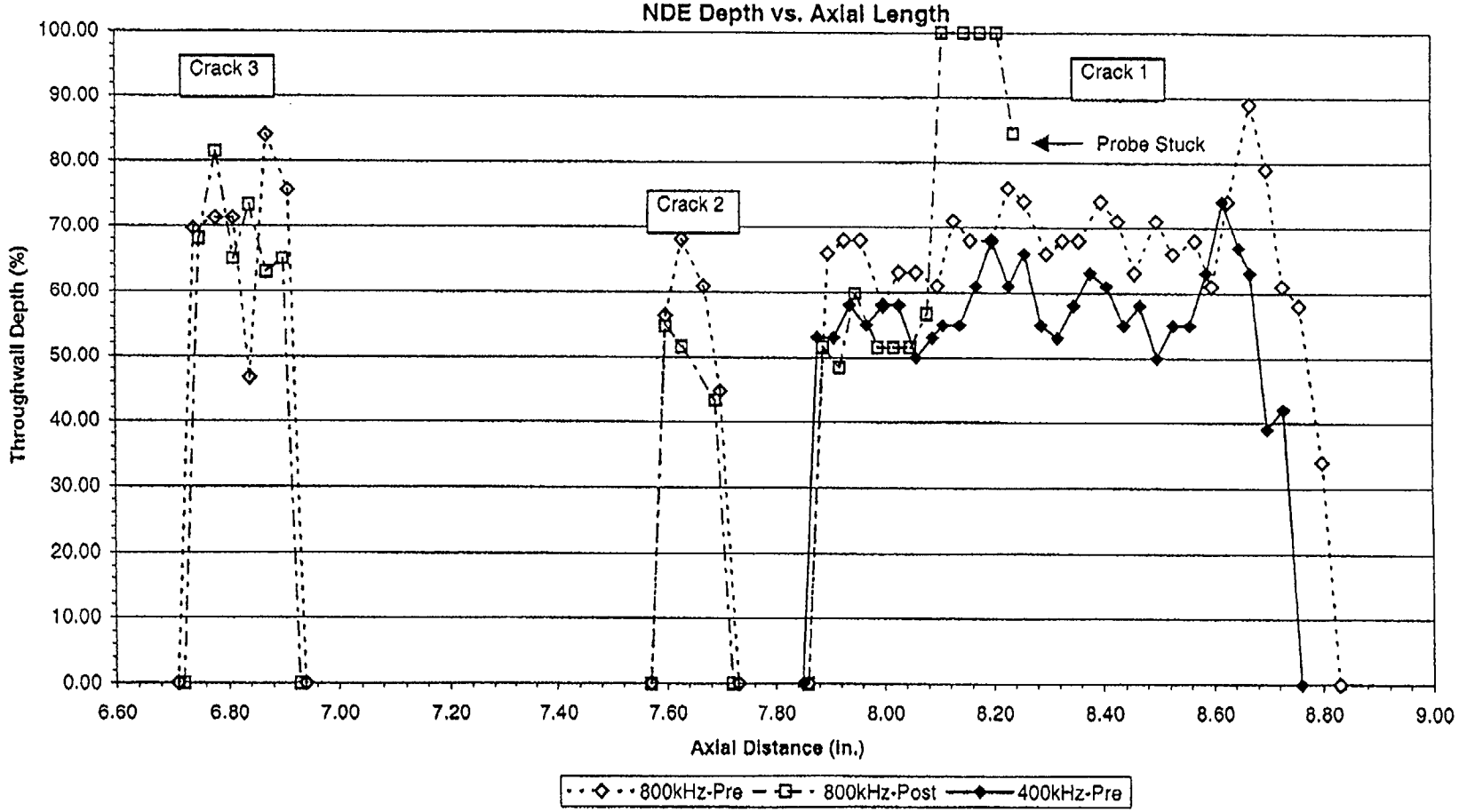


Figure 5-10.
Indian Point-2 New Indication Average Depth Distribution

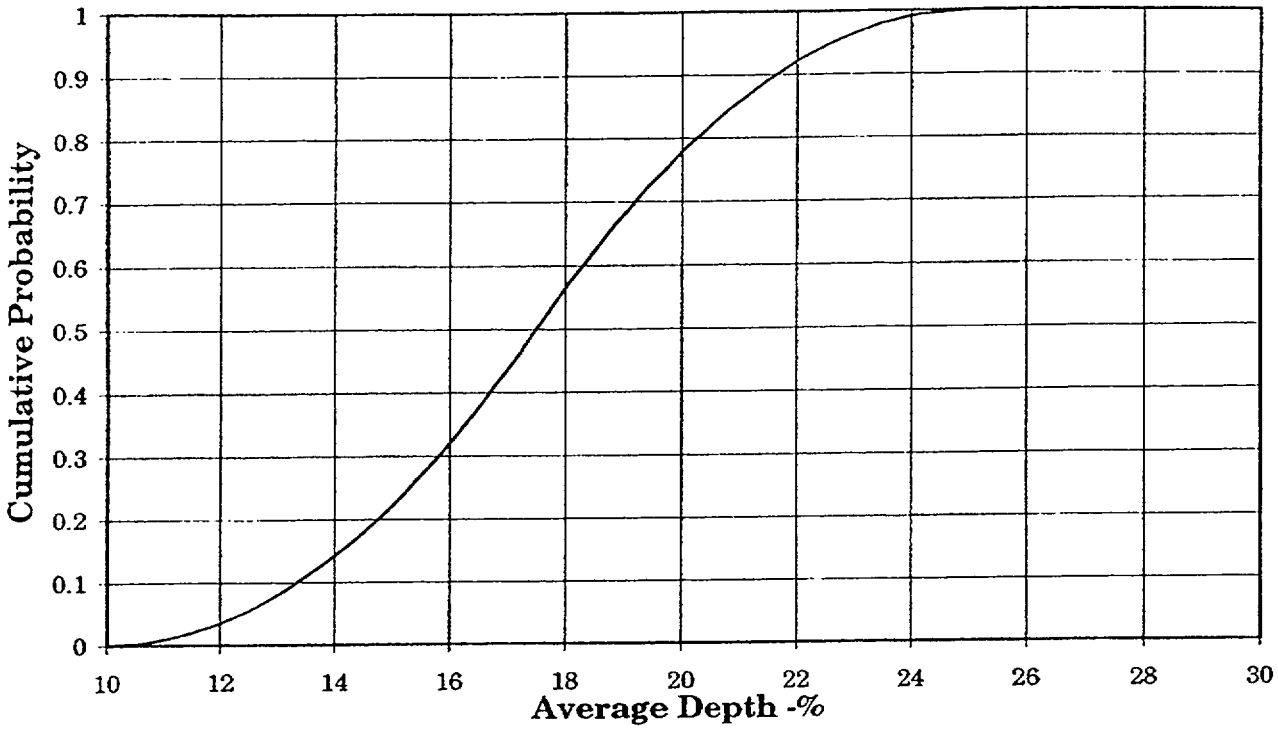
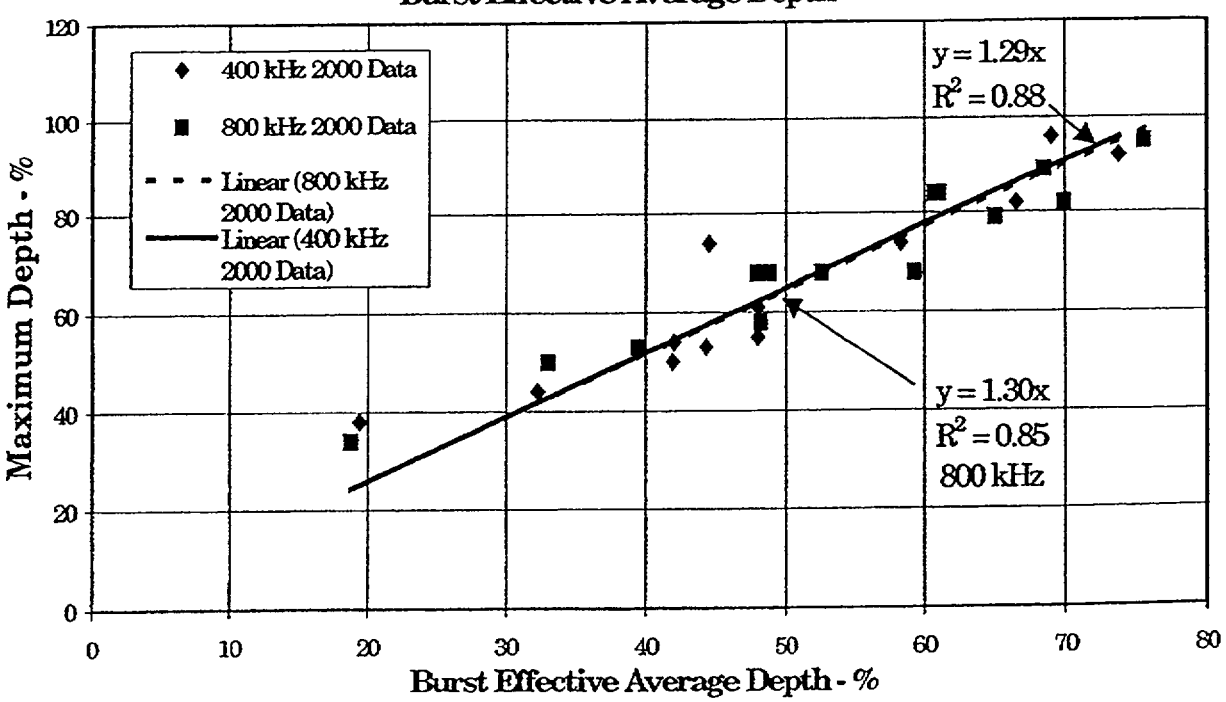


Figure 5-11
Indian Point-2 U-Bend PWSCC Ratio of Maximum to Burst Effective Average Depth



Benchmark Analyses

Benchmark Analyses for Integral Check of Sizing and Analysis Methods

- Projections of 1997 data to compare with R2C5 leakage and in situ results in 2000
  - Test of Monte Carlo techniques applying profiles, growth distributions, burst correlation and ligament tearing correlation
  - Projections at 95/95 should provide lower bound to in situ results
  - Operational assessment benchmark analyses must be performed at high probability to reflect growth rate distribution (nominal growth would be expected to underestimate large indications)
- Comparisons of burst and ligament tearing pressures using 2000 profiles with in situ test results
  - Analysis results at 95/50 should provide lower bound
  - Best estimate analyses are test of profiles and burst/tear profiles

Benchmark Results

- Best estimate R2C5 profile yields better agreement with leakage than alternate profile
- 400 kHz profiles are preferred data as 800 kHz profiles introduce unnecessary conservatism
- Analyses correctly predict indications with more limiting in situ test results
  - Burst pressures and ligament tearing predicted at pressures below test results at required confidence levels for R2C69, R2C71 and R2C69
  - Only low level leakage of R2C74 initiating at 4486 psi not bounded by analyses

Table 6-1. Summary of Predictions for R2C5 Leakage Event Based on 1997 Data

+Point Profile	Burst Pressure (psi)		SLB Leakage (gpm)		Ligament Tearing & Leakage at ΔP_{NO}[1] (gpm)		Estimated Event Leakage at ΔP_{NO} (gpm)
	95/95	50/50	95/95	50/50	95/95	50/50	
Reference Growth Rates							
Best estimate	1349	3100	166	3.89	12	0.0	140-160
Alternate estimate	1724	4070	118	0.0	12	0.0	
Growth Rates x 1.25							
Best Estimate	1295		195	6.31			
Alternate estimate	1535		145	0.0			

Notes:
1. Ligament tearing computed at ΔP_{NO} = 1569 psi for EOC-14. Leak rates adjusted from SLB leak rate correlation assuming a SLB to normal operating leak rate ratio of 5.0.

Table 6-2. Indian Point-2 U-Bend Indications: Comparison of Burst Pressures and Leakage for Projected and Actual EOC-14 Indications

Analyses & In Situ Results at Operating Temperatures - Requirements: $3\Delta P_{NO}$ = 4617 psi, SLB Leak Rate = 1 gpm

Indication			Calculation Parameters		Burst Pressure Predictions - psi				SLB Leak Rate gpm				In Situ Test Results	
					1997 NDE Projection		2000 NDE Data		1997 NDE Projection		2000 NDE Data		Burst Pressure psi	SLB Leak Rate gpm
SG	Tube	Crack No.	NDE Profile	Year Profile	95/95	50/50	95/50	50/50	95/95	50/50	95/50	50/50		
4	R2C69	1	400 kHz	1997	3313	5600	4851	6970	2.818	0.0	0.0	0.0	>4834	0.00
		2			6949	9750	8447	10000	0.0	0.0	0.0	0.0		
		3			7350	10000	7657	10000	0.0	0.0	0.0	0.0		
		1	800 kHz	2000	-		3749	5770	-	-	1.51	0.0		
		2			-	-	6589	9090	-	-	0.0	0.0		
		3			-	-	6099	8800	-	-	0.0	0.0		
4	R2C71	1	400 kHz	1997	3703	5860	4486	6430	1.047	0.0	0.04	0.0	>4206	0.024
		1	800 kHz	2000	-	-	3823	5570	-	-	0.60	0.0		
4	R2C72	1	400 kHz	1997	4283	6400	4888	6800	0.316	0.0	0.0	0.0	>5140	0.00
		1	800 kHz	2000	-	-	4432	6420	-	-	0.10	0.0		
1	R2C87	1	400 kHz	1997	6955	9580	6888	9380	0.0	0.0	0.0	0.0	>5140	0.00
		2			6888	9570	6968	9330	0.0	0.0	0.0	0.0		
		3			6391	8910	7048	9420	0.0	0.0	0.0	0.0		
		1	800 kHz	2000	-	-	5680	8240	0.0	0.0	0.0	0.0		
		2			-	-	5130	7490	0.0	0.0	0.0	0.0		
		3			-	-	5778	7900	0.0	0.0	0.0	0.0		

Table 6-3. Indian Point-2 U-Bend Indications: Comparison of Condition Monitoring Burst and Ligament Tearing Pressures with In Situ Test Results

Indication			NDE Profile Frequency	Burst Pressure Predictions psi		Ligament Tearing Pressure psi		In Situ Test Results	
SG	Tube	Crack No.		95/50	Best Estimate	95/50	Best Estimate	Burst Pressure psi	Initial Leakage Pressure psi
4	R2C69	1	400 kHz	4851	6503	2877	5796	>4834	4834
		1	800 kHz	3749	5235	0.0	4580		>2 gpm
4	R2C71	1	400 kHz	4486	5799	0.0	5480	>4206	Steady
		1	800 kHz	3823	4828	0.0	4096		Increase
4	R2C72	1	400 kHz	4888	6219	2570	6022	>5140	>5140
		1	800 kHz	4432	5728	0.0	5466		
1	R2C87	1	400 kHz	6888	8838	6498	8835	>5140	>5140
		2		6968	8837	6553	8840		
		1	800 kHz	5680	7828	0.0	7665		
		2		5130	6834	2658	6688		
4	R2C4	1	400 kHz	9017	11314	9078	10664	>5140	>5140
			800 kHz	8879	11059	9041	10650		
4	R2C74	1	400 kHz	9850	12150	9470	11035	>5140	4486
			800 kHz	8035	10202	8487	10202		
3	R2C85	1	400 kHz	7456	9578	7580	9422	>5140	>5140
			800 kHz	6827	8846	6945	8862		

Indian Point 2
2R14 Steam Generator Inspection

June 6, 2000

Con Edison

Westinghouse

For PDR.

Inspection Performance Assessment

- Analyst training
- Multiple eddy current inspection programs
- Analyst statistics and performance
- Alternate NDE method
- Structural integrity
- Conclusions

Analyst Training

- Primary, secondary and resolution analysts QDAs
- Site specific written examination
  - ANSER software orientation
  - Indian Point 2 specific degradation mechanisms
- Site specific practical examination
  - Included 1997 Indian Point 2 data
    - Crevice, sludge pile, low row U-bend and support plates
  - All Cecco tests graded to meet 80% POD @ 90% CL
- U-bend training supplements
  - First upon initial investigation
  - Second for "tertiary review" of midrange +Point data and used for analysis of high frequency +Point
- +Point training for expanded sludge pile program

1997 Versus 2000 Outage

1997 Outage	2000 Outage	Why This Is An Improvement
General Rev.4 of the EPRI Guidelines in force for the outage. NEI 97-06 not in force.	**General** Intent of Rev.5 of the EPRI Guidelines met for the outage. NEI 97-06 intent met as well.	Rev. 5 defines additional rigors for analyst training and testing. NEI 97-06 provides industry commitment to how steam generators are to be examined.
Analyst Training Based on sample and 1995 data analysis results.	**Analyst Training** Based on sample and 1997 data analysis results.	1997 data included first reported axial indications in crevice, sludge pile and low row U-bends. These were not part of the experience base for the 1997 outage.
Analyst Testing Not done on a statistical basis for Cecco probe data – point basis only. Not done on Indian Point 2 data confirmed by RPC.	**Analyst Testing** Cecco test was based on statistical requirements per Rev. 5 of the EPRI Guidelines. Reduced data set for bobbin and RPC per EPRI Guidelines. Data based on 1997 inspection and included all identified damage mechanisms.	Majority of the Cecco calls used had also been confirmed by RPC (expansion, crevice, sludge pile and support plate). All data used in the testing and grading was Indian Point 2 data; data from other sites or samples were not part of the grading set. All Cecco tests (PWSCC and ODSCC) were graded to meet the 80% POD @ 90% CL per EPRI Guidelines because Cecco is not part of the QDA practical examination.
Analysis Process All Cecco/Bobbin probe data was analyzed for both bobbin and Cecco results concurrently by the same analyst. I.e. the primary analyst had to analyze for both Cecco and bobbin.	**Analysis Process** All Cecco/Bobbin probe data was analyzed for bobbin and Cecco results separately by different analyst teams.	As a lesson learned in debriefing the analysts following the 1997 outage, it was determined that the analysis was slowed due to analyzing both types of data concurrently. It was felt that this might lead to some level of distraction and fatigue for the analyst which might increase the potential for missed calls. The separate analyses allow the analyst to concentrate on one type of analysis, thereby improving that analysis. Also, it affords four looks at the data rather than two in the primary and secondary analyses.

•Standards used in 2000 meet new industry guidelines

Multiple Eddy Current Inspection Programs

- Multiple coil types
  - Cecco, bobbin, MR pancake, HF pancake, MR +Point, HF +Point
- Base scope program
  - 100% Cecco/bobbin, 100% U-bend +Point rows 2-4, re-roll RPC and bobbin
  - Identified areas for improvement in crevice and sludge pile
- Expansion program
  - +Point from tube end through sludge pile
    - Examination of record for crevice and sludge pile
  - Analysts reviewed data prior to expansion program
    - Sludge pile, crevice, tube end and roll transitions

Base Scope Cecco and Bobbin Sludge Pile Examination Program

- SSPD in accordance with Rev. 5 of the EPRI NDE Guidelines
  - Indian Point 2 data used for training and testing
  - Cecco tests graded to meet 80% POD @ 90% CL
    - 19 sample size
- All hot and cold leg tubes examined from 20" above TTS to TE
  - Eight hot leg axial ODSCC indications confirmed by +Point
    - SG 22; R33C51, R34C51, R35C51
    - SG 23; R31C47, R30C46, R31C46 and R29C46
    - SG 24; R42C43
- Question about "blind zone" in sludge pile region

Base Scope Sludge Pile Insitu Tests

- All sludge pile axial indications insitu tested
- R34C51 exhibited leakage
  - Post insitu eddy current inspection
    - Previously unreported crevice cracking
  - R34C51, R35C51 and R29C46 called by one analyst
    - Same primary and secondary analysts on R34C51 and R35C51
      - Same analysts made calls on R33C51
- Options assessed
  - Re-analysis of crevice Cecco data
  - +Point inspection of crevice
  - UT sample
- +Point expansion selected
  - Including sludge pile and UT sample
- +Point training administered to analysts

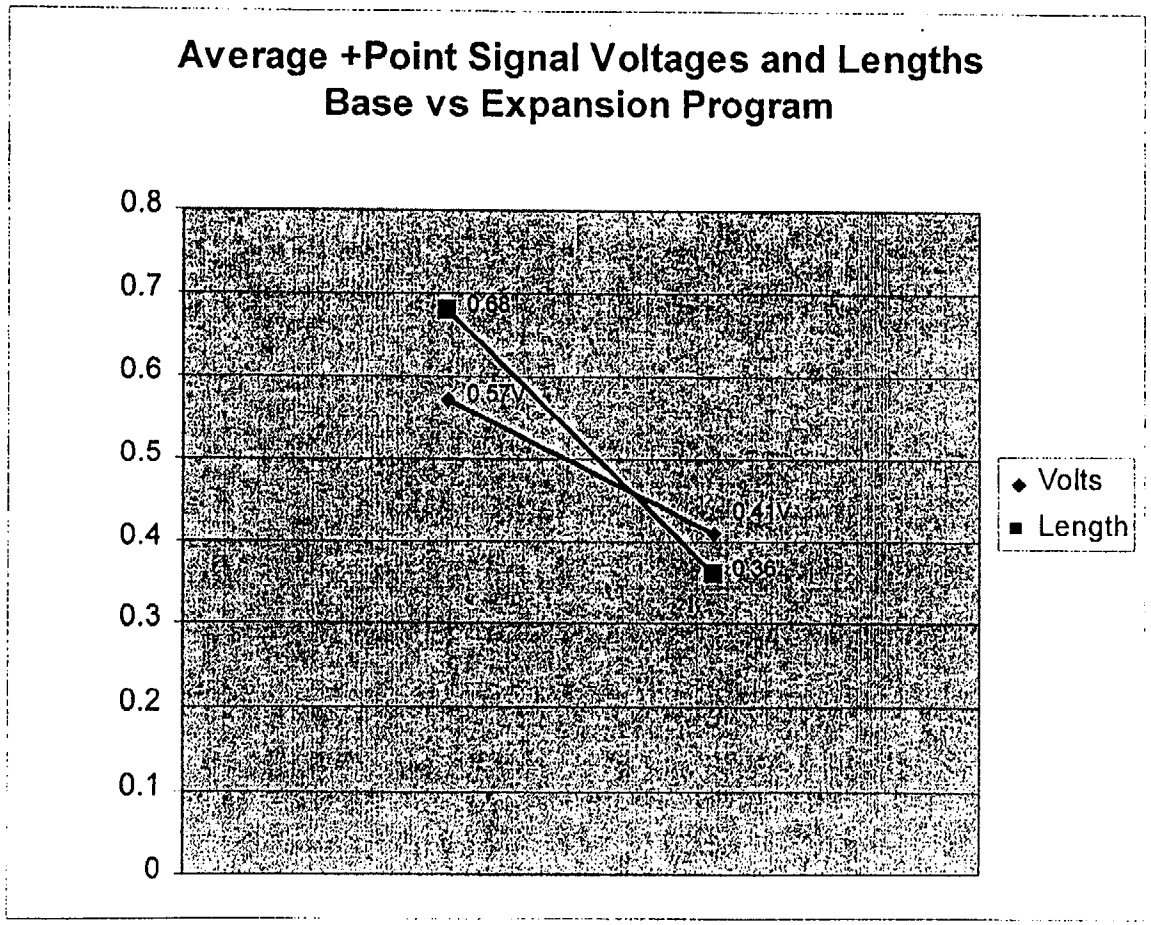
Hot Leg Sludge Pile Expansion Program

- 20% of the tubes in steam generators 21, 22, 23 and 24 inspected from TEH to below TSP1 (~48" above TTS)
  - concentrated in kidney region
- Results analyzed to determine
  - maximum elevation above the tubesheet at which axial indications were found
  - height of the sludge pile
  - upper boundary for +Point inspections of the remaining tubes in each steam generator
- The remaining 80% of the hot leg tubes in all steam generators were examined from TEH to a height of 24" above the top of tubesheet (20" plus a 20% buffer)

Cold Leg Sludge Pile Expansion Program

- 20% of the tubes in steam generator 23 inspected from TEC to just below TSP1
- Results analyzed to establish
  - maximum elevation above the tubesheet at which indications were found
  - height of the sludge pile
- 20% of tubes in steam generators 21, 22 and 24 were inspected from TEC to 24" above TTS
  - expansion to another 20% sample necessary in steam generators 23 and 24 due to pits exceeding the 28% repair criterion
  - no cracks detected
  - pitting was detected

Base Program Versus +Point Expansion Program Sludge Pile Results



Sludge Pile Indications
Expanded Scope

S/G	Row	Col	Probe	Cal	Indication	Primary	Secondary	Comments
21	34	41	PPT	531	SAI	Yes	No	real flaw; modest amplitude increase post in-situ
22	33	49	PPT	331	SAI	Yes	Yes	real flaw; modest amplitude increase post in-situ
	33	54	PPT	473	MAI	Yes	Yes	real flaw; no noticeable amplitude increase post in-situ; small shallow indication
	34	54	PPT	315	MAI	Yes	Yes	real flaw; modest amplitude increase post in situ

+Point Expansion Program Indications by Analysts

Indications	Primary Only	Secondary Only	Both Analysts	Total
Number	243	341	803	1387
Percent	17.5%	24.6%	57.9%	100%

- No industry database on detection by single/both analysts
- Recent sludge pile data from PLANT X:
  - 11 of 19 indications reported by both - 57.9%

+Point Expansion Program Hits and Misses for Axial Crevice and Sludge Pile Indications

- Crack-like indications detected in the hot leg +Point expansion program were identified in the zone from 3" above tube end hot to maximum height examined (24" or 48" above TTS)
- Coverage included crevice and sludge pile
  - 24" above TTS for 80%
  - 48" above TTS for 20%
- These indications were assessed in terms of analyst statistics for HITS and MISSES by primary and secondary analysts.
- A total of 210 indications

Analyst Performance for Axial Crevice and Sludge Pile Indications

SG	HIT		MISS		TOTAL	
	PRI	SEC	PRI	SEC	PRI	SEC
21	8	8	2	2	10	10
22	87	77	8	16	95	93*
23	45	42	10	12	55	54*
24	40	48	10	2	50	50
TOTAL	180	175	30	32	210	207*
AVG	85.7%	84.5%	14.3%	15.5%		

* Three tubes were reported as BDA by secondary analysts

Analyst Performance +Point Expansion Program Axial Indications in Crevice and Sludge Pile

- No tubes identified with significant sludge pile indications missed by a single (primary or secondary) analyst
- Analyst conservatism demonstrated by overcalls
  - Overcalls on the order of 7.7%
- Statistics for individual analysts in the expansion program were evaluated where a statistically significant population of indications was evaluated
  - Two analysts identified with "HITS" less than 80%
  - Study expanded to include entire +Point program
  - Both analysts achieved "HITS" 80% or greater
- Indications detected in the +Point expansion program were smaller in terms of voltage, length and depth as compared to those in the base scope program

Alternate NDE Method
Ultrasonic Sampling in Sludge Pile Region

- Westinghouse UTEC system used to sample tubes steam generator 22
- Two inspection phases
  - inspection of localized areas of sixteen tubes where Cecco and/or bobbin eddy current examinations had identified indications and +Point examinations were used for confirmation
  - inspections of twenty-three tubes from just above the first support plate to the top of tubesheet
    - seven contained known eddy current indications
    - sixteen "NDD"
    - three tubes subject to full-length insitu pressure testing were included

Phase 1 Ultrasonic Sampling Results

Cecco				+Point	UTEC
Tube	Volts	Location	Code		
R18C83	13.92	TSH +1.40	PI	NDD	NDD
R19C83	2.52	TSH + 0.85	PI	NDD	NDD
R21C83	16.79	TSH + 0.74	PI	NDD	NDD
R27C26	1.98	TSH + 12.97	PI	NDD	NDD
R30C43	8.68	TSH + 3.2	PI	PIT	PIT
R33C51	7.98	TSH + 0.61	PI	MAI	MAI
R33C51	6.31	TSH + 0.68	PI	SAI	MAI
R34C28	55.29	TSH + 1.19	PI	PIT	NDD/DEPOSIT
R34C28	30.12	TSH + 0.63	PI	PIT	NDD/DEPOSIT
R34C28	14.22	TSH + 17.71	PI	NDD	NDD
R34C51	24.35	TSH + 0.17	PI	MAI	MAI
R34C51	13.19	TSH + 0.62	PI	MAI	MAI
R35C27	118.4	TSH + 1.41	PI	PIT	NDD/DEPOSIT
R35C40	11.55	TSH + 4.37	PI	VOL	NDD/DEPOSIT
R35C50	17.32	TSH + 0.27	PI	VOL	PIT
R35C50	0.67	TSH - 0.19	PI	NDD	NDD
R35C51	10.61	TSH + 0.60	PI	MAI	MAI
R35C51	13.66	TSH + 0.93	PI	MAI	MAI
R38C64	122.3	TSH + 16.63	PI	VOL	NDD/DEPOSIT
R39C43	8.09	TSH + 9.96	PI	NDD	NDD
R39C43	6.02	TSH + 9.69	PI	NDD	NDD
R39C59	13.87	TSH + 8.68	PI	VOL	NDD/DEPOSIT
R43C53	16.29	TSH + 1.26	PI	VOL	PIT/WEAR
R43C53	14.88	TSH + 1.29	PI	NDD	PIT/WEAR

Phase 2 Ultrasonic Sampling Results

Tube	Post Insitu	+Point	Location	UTEC
R3C24	YES	NDD	NA	NDD
R7C66	NO	NDD	NA	NDD
R9C18	NO	NDD	NA	NDD
R11C81	NO	NDD	NA	NDD
R15C32	NO	NDD	NA	NDD
R15C77	NO	NDD	NA	NDD
R15C80	NO	NDD	NA	NDD
R17C72	NO	NDD	NA	NDD
R18C76	NO	NDD	NA	NDD
R22C75	NO	NDD	NA	NDD
R22C78	NO	NDD	NA	NDD
R25C37	NO	NDD	NA	NDD
R25C49	NO	PIT	TSH +6.48	PIT
R26C76	NO	NDD	NA	NDD
R29C63	NO	NDD	NA	NDD
R31C41	NO	NDD	NA	NDD
R32C48	NO	SAI	TSH + 0.73	WEAR
R33C51	YES	MAI	TSH + 1.07	MAI
R34C54	NO	MAI	TSH + 0.57	MAI
R35C50	NO	VOL	TSH + 0.38	PIT
R35C51	YES	MAI	TSH + 0.65	MAI
R35C52	NO	MAI	TSH +0.75	MAI
R35C56	NO	NDD	NA	NDD

Ultrasonic Sampling in Sludge Pile Region

- All OD axial indications (SAI and MAI) confirmed by +Point were confirmed by UTEC.
- No additional axial indications were found by ultrasonic inspection in areas where +Point did not confirm the Cecco and/or bobbin calls as OD axial degradation.
- Cecco and/or bobbin indications not confirmed by +Point were also reported as NDD by UTEC.
- There was general agreement between +Point and UTEC on volumetrics (VOL) and pits (PIT).
- No evidence of "new" indications in tubes subject to insitu testing
- Validates eddy current results in sludge pile

Structural Integrity

- Insitu pressure testing
- 44 tubes tested excluding row 2 U-bends
  - 40 with crevice or sludge pile indications
  - 4 with no detectable degradation
- No leakage from any indications in expanded program
- No additional indications identified post-insitu above TTS
- 43 of 44 exhibited no leakage
  - R34C51 in the base scope program was the exception

Conclusions

- Multiple eddy current examinations provide reasonable assurance of detection
- No tubes with significant indications identified by only one analyst in the +Point expansion program
- Expansion program analyst performance exceeds 80% POD @ 90% confidence level
- Ultrasonic testing identified no new indications
- Insitu pressure test results
  - No new sludge pile indications
  - No leakage for expansion program indications
- Insitu and ultrasonic data provide independent assessment of sludge pile results
  - Independent tests of 70 tubes with no detectable or additional degradation support statistics for 95% POD @ 95% confidence level
- Multiple sources of data provide confidence in the inspection program
- No additional data analysis is necessary