

**Indian Point Unit 2  
Low Row U-Bend Examinations**

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**Con Edison**

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# Technique Qualification for 1997 Row 2 and 3 U-Bend Examinations

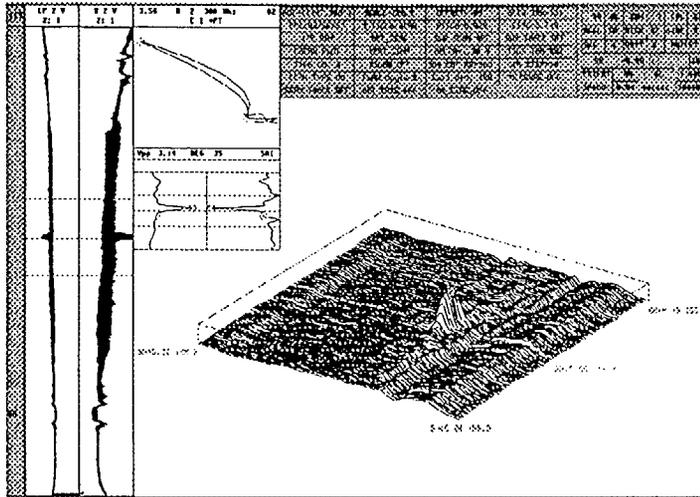
- Performed in accordance with the then current Rev. 4 of the EPRI PWR SG NDE Guidelines
- Midrange +Point probe
  - Qualification documentation ETSS 96511- 150, 300 & 400 kHz
  - Twenty-six sample data set
    - Two pulled tubes (~40% TW)
    - Twenty-four EDM samples (27% to 100% TW)
    - All 26 flaws detected
    - 91.5% POD at a 90% CL
- No requirement for site-specific technique qualification
- First utilization of midrange +Point at Indian Point Unit 2

## 1997 Row 2 and 3 U-Bend Examinations

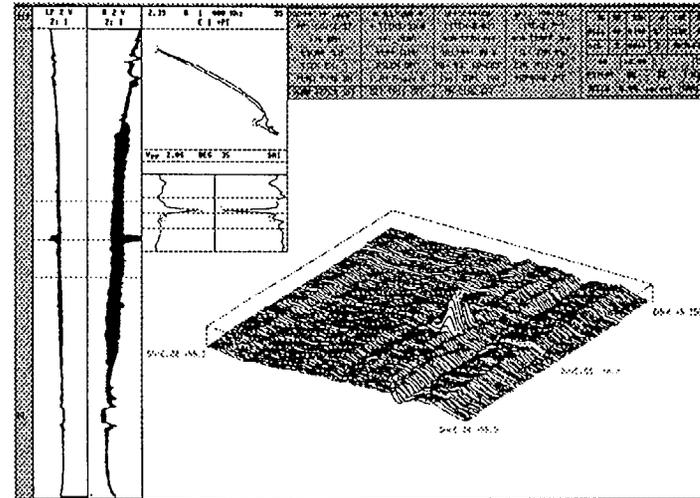
- Site Specific Performance Demonstration (SSPD) in accordance with EPRI PWR SG NDE Guidelines, Rev. 4
  - Practical examination utilized industry degraded U-bend +Point data
  - U-bend cracking not observed previously at Indian Point 2
- Calibration setup within industry variance
- Data quality requirements
  - No quantitative industry standards exist
  - Being incorporated into Rev. 6, EPRI Guidelines, March 2001
- +Point noise level similar to other MA Alloy 600 SGs
- PWSCC identified in the U-bend region of one tube; SG24, R2C67
  - Provided confidence in detection capability

# SG 24, R2C67 - 1997 Midrange +Point Data

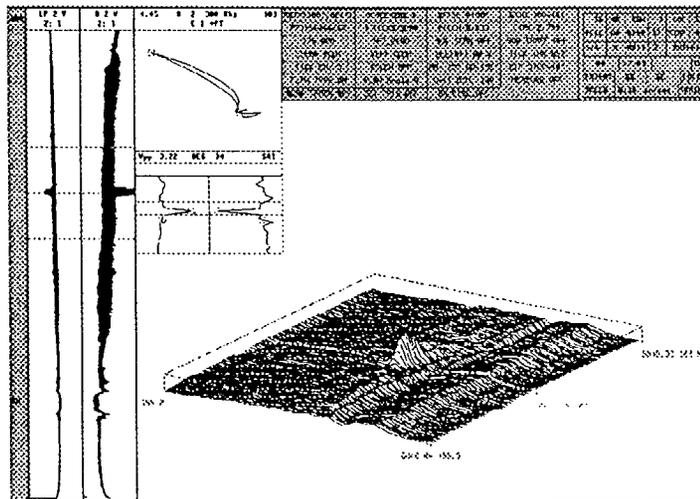
300 kHz 1997 Setup



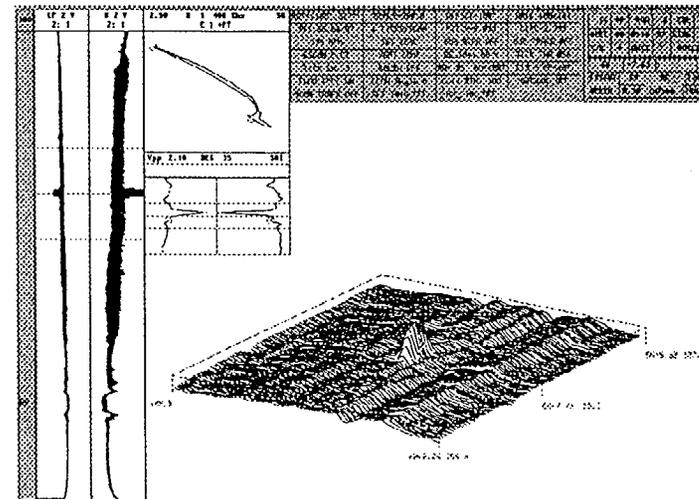
400 kHz 1997 Setup



300 kHz 2000 Setup



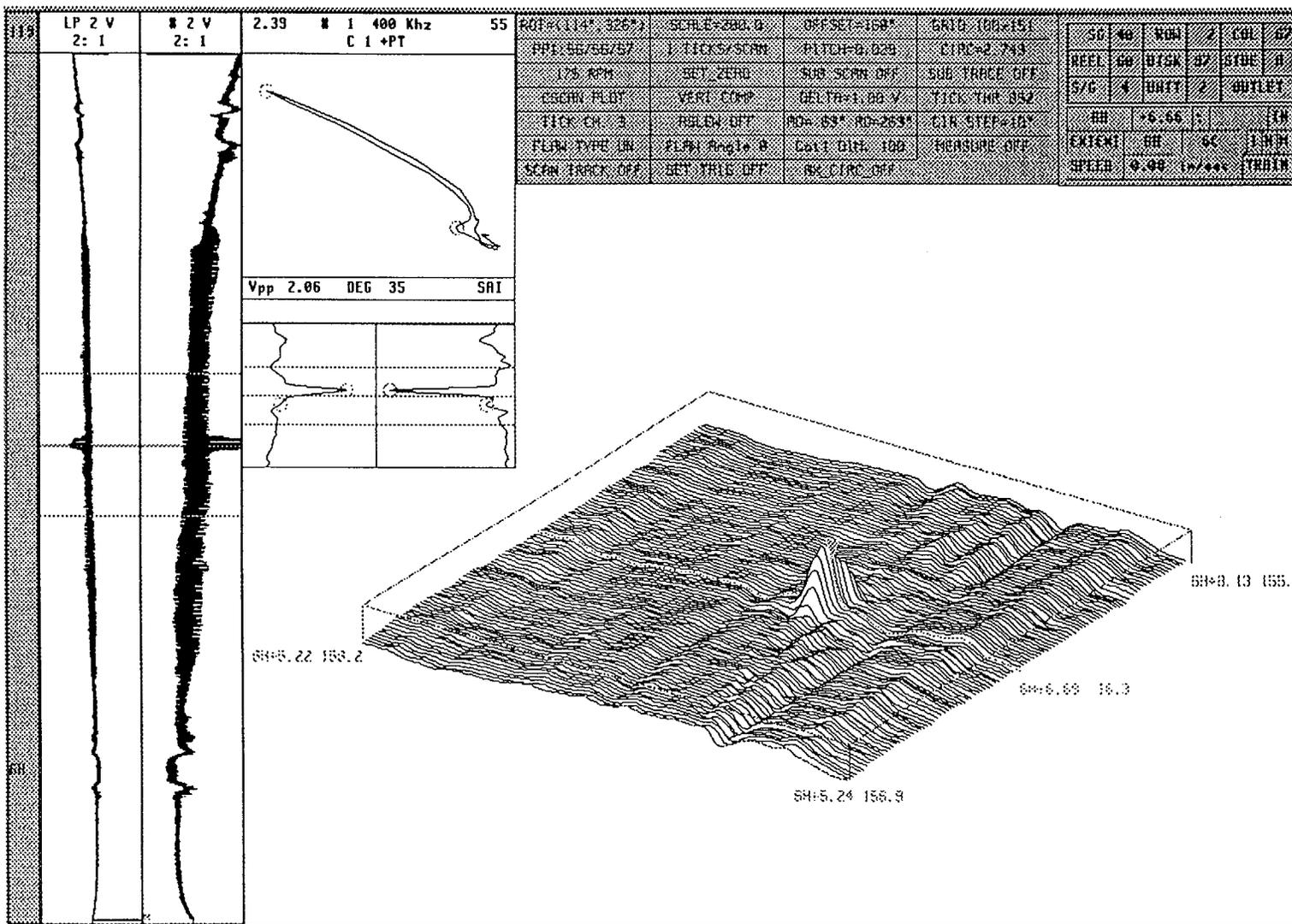
400 kHz 2000 Setup





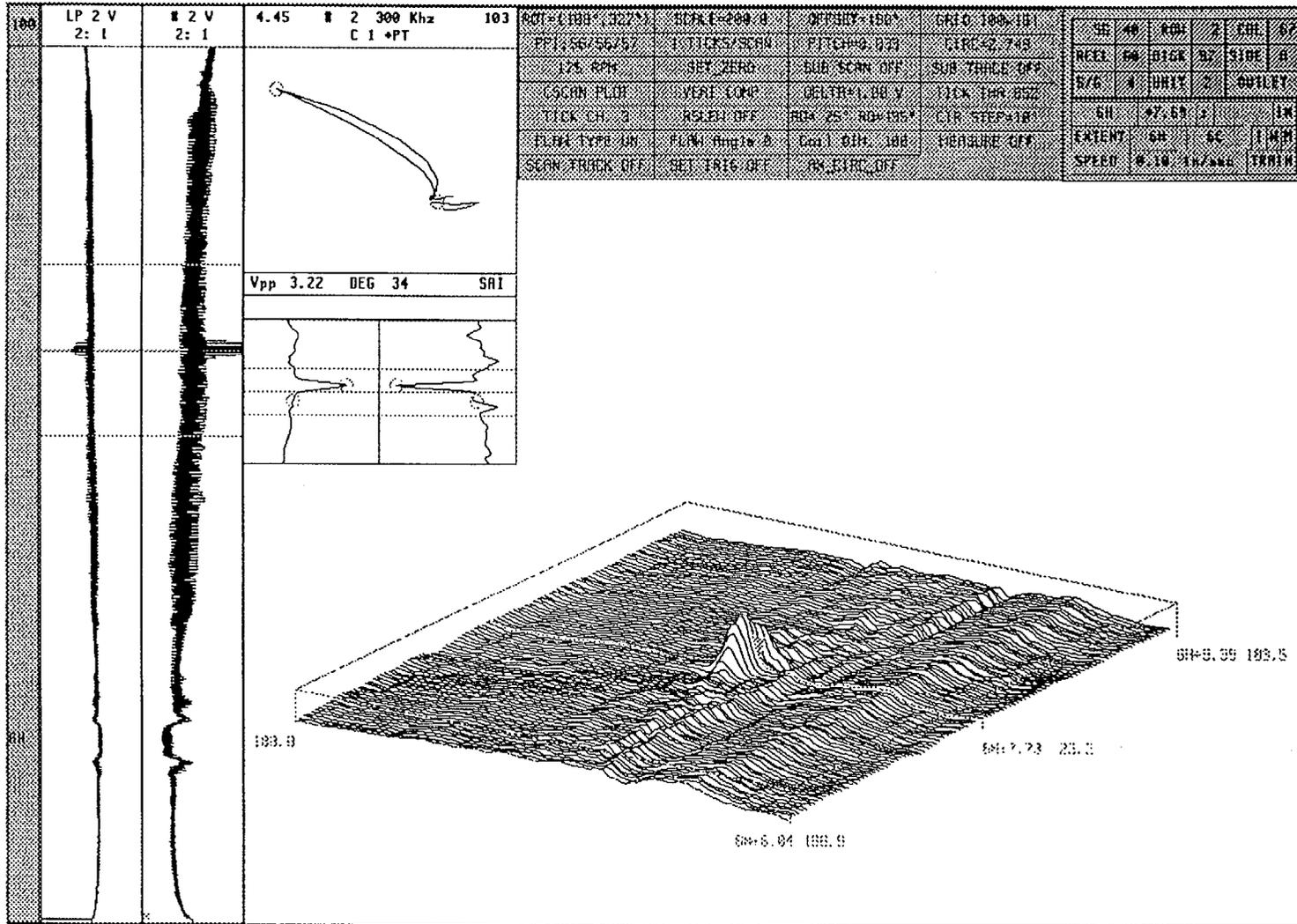
# SG 24, R2C67 - 1997

## 400 kHz Midrange +Point 1997 Setup



# SG 24, R2C67 - 1997

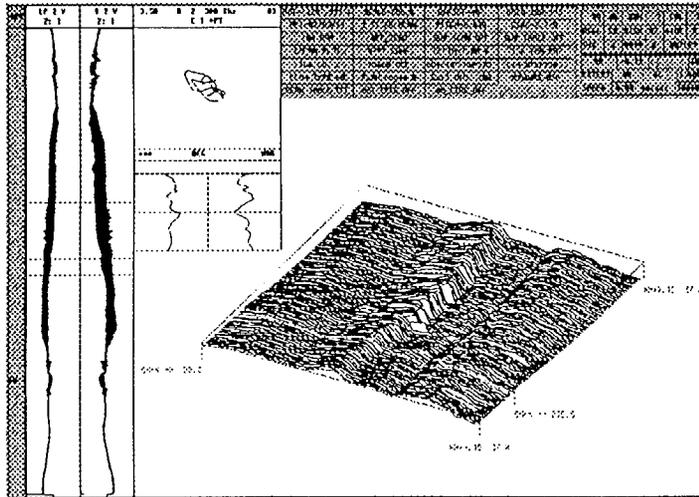
## 300 kHz Midrange +Point 2000 Setup



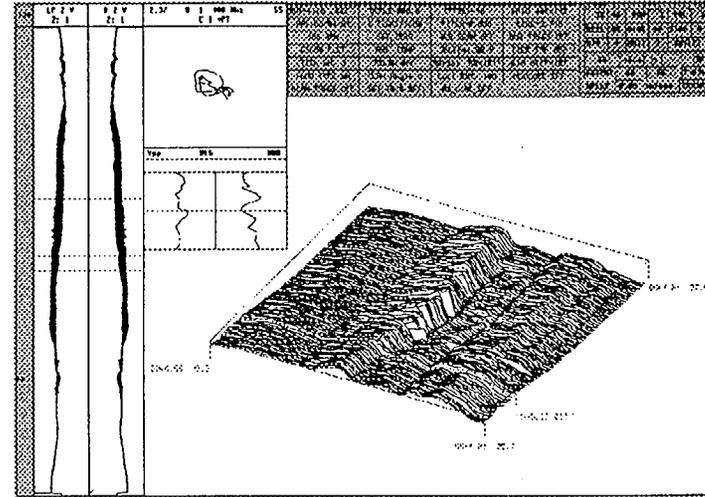


# SG 24, R2C5 - 1997 Midrange +Point Data

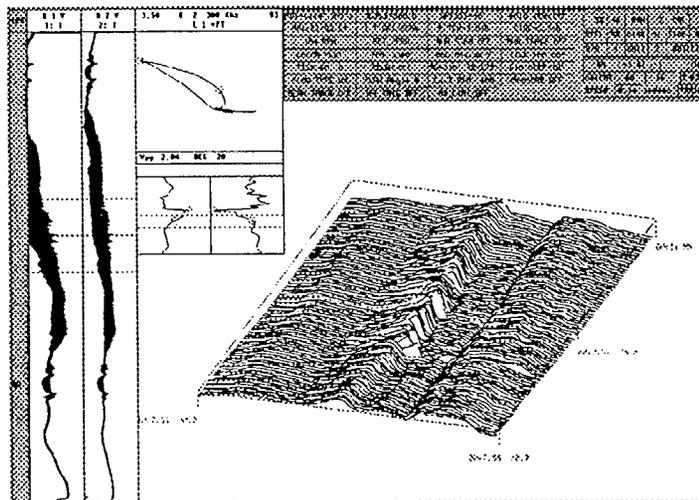
300 kHz 1997 Setup



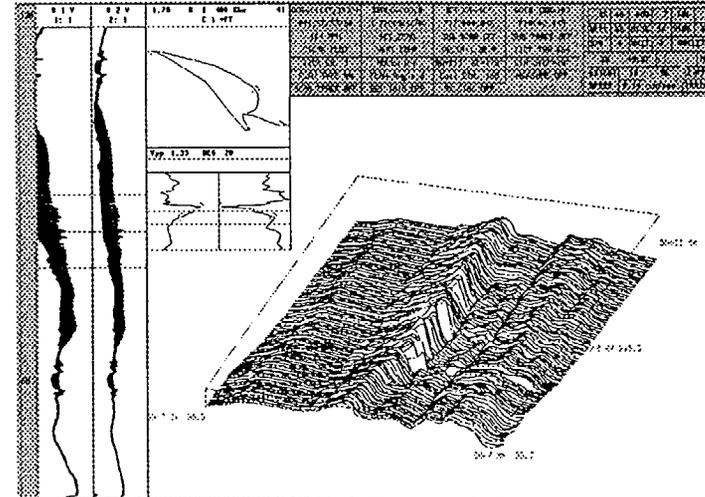
400 kHz 1997 Setup



300 kHz 2000 Setup

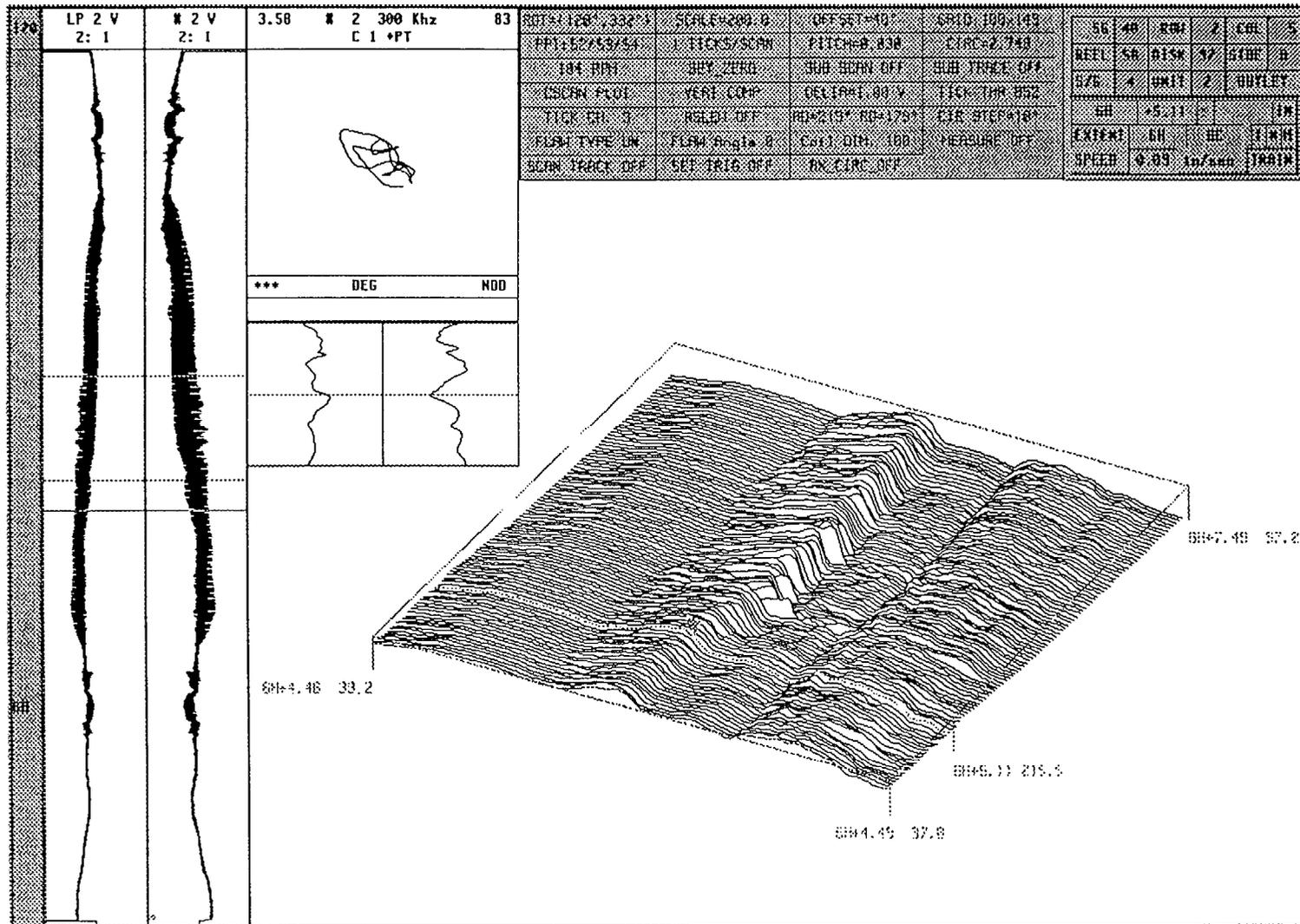


400 kHz 2000 Setup



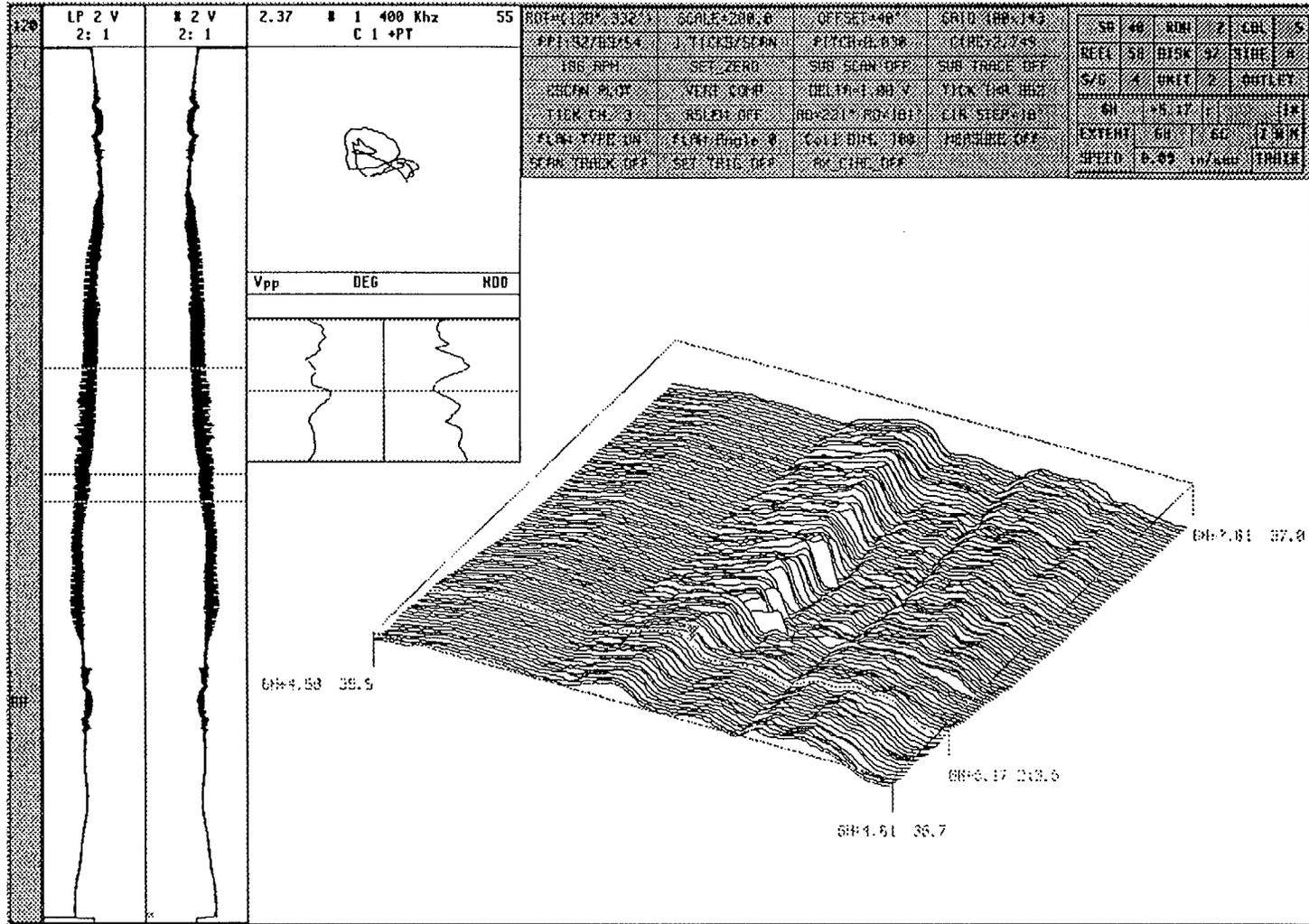
# SG 24, R2C5 - 1997

## 300 kHz Midrange +Point 1997 Setup



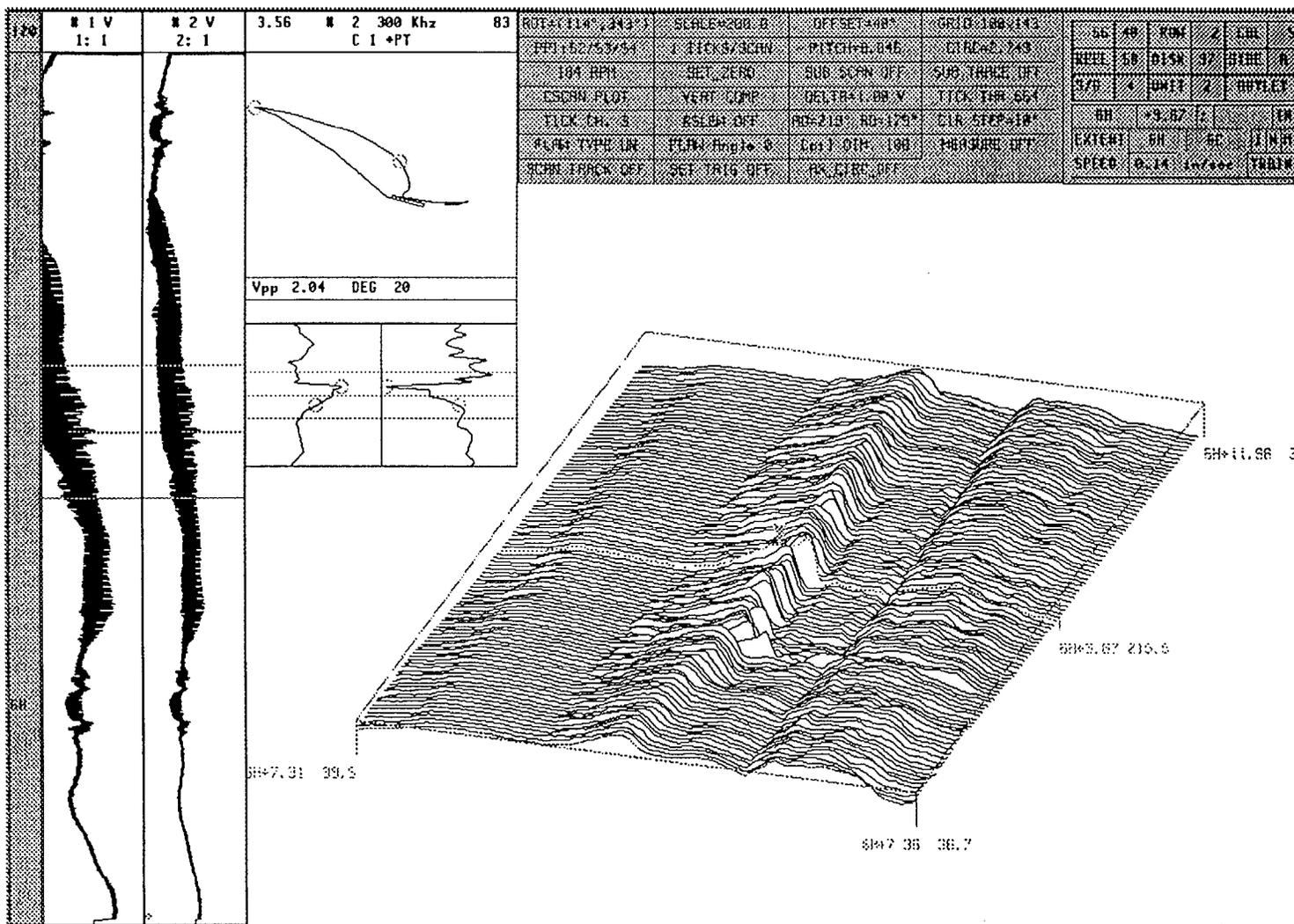
# SG 24, R2C5 - 1997

## 400 kHz Midrange +Point 1997 Setup



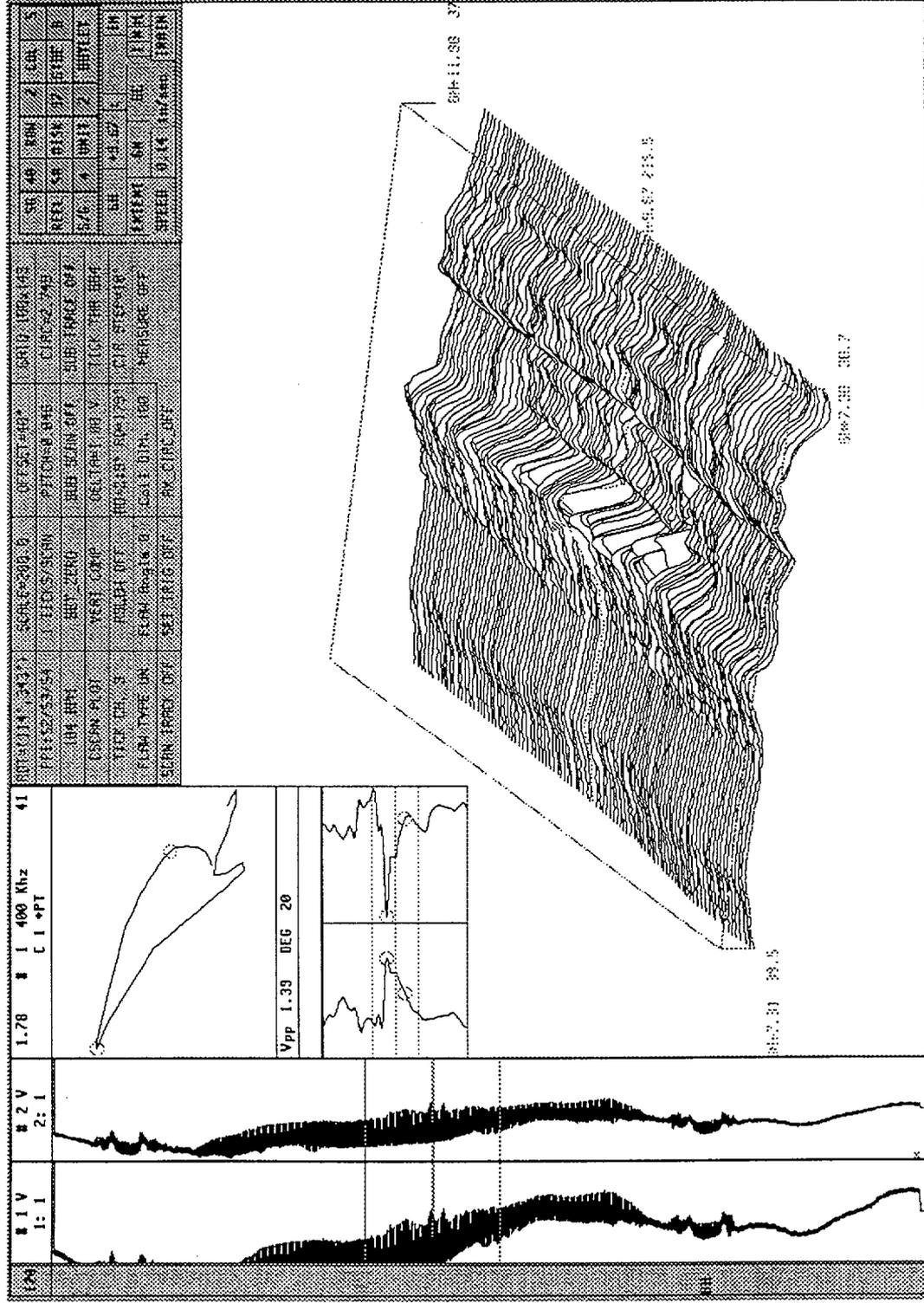
# SG 24, R2C5 - 1997

## 300 kHz Midrange +Point 2000 Setup



# SG 24, R2C5 - 1997

## 400 kHz Midrange +Point 2000 Setup



# 2000 Row 2, 3, and 4 U-Bend Examinations Midrange +Point

- SSPD in accordance with Rev. 5 of the EPRI NDE Guidelines
  - Written training supplement developed
    - “IP2 Spring 2000 Outage U-bend +Point Analysis Training”
    - Setup with 20% ID EDM notch visible at 6 to 10°
    - Requirements for data quality
- All row 2, 3 and 4 U-bends inspected with midrange +Point
  - PWSCC identified in three U-bends
    - SG 21; R2C87
    - SG 24; R2C69 and R2C72
- Data quality criteria evolved as inspections progressed
- Independent review of all low row U-bend data (Tertiary review)
  - Senior analysts performed primary, secondary and resolution
  - Specific training administered
  - Revealed no new indications
  - 457 of 863 U-bends classified as BDA due to low S/N ratios

# Assessment of High Frequency +Point Options

- Site test of midrange +Point at 750 kHz and 800 kHz high frequency +Point
  - Prototype 800 kHz +Point probe manufactured
  - Retested two tubes with PWSCC identified by midrange +Point
    - SG 24; R2C69 and R2C72
  - High frequency probe showed better S/N ratios
- Decision to reinspect with the 800 kHz high frequency probe

# High Frequency Probe Qualification

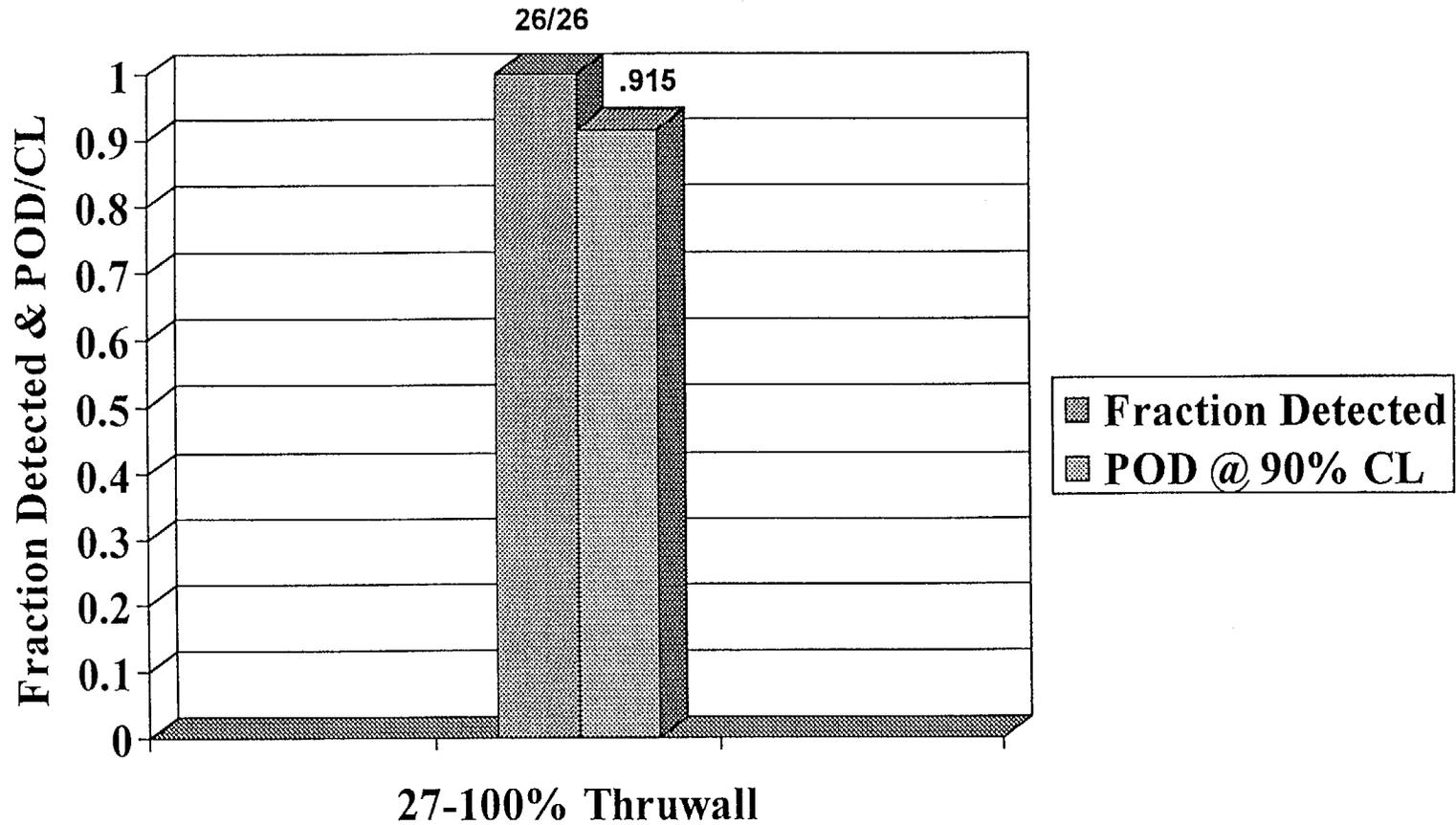
- 800 kHz high frequency +Point qualified per EPRI Rev. 5
- Qualification documentation
  - EPRI ETSSs 99997.1 (800 kHz) and 99997.2 (1000 kHz)
  - Twenty-six sample data set
    - Two pulled tubes with service-related degradation (~40% TW)
    - Twenty-four EDM samples (27% to 100% TW)
    - All 26 ID flaws detected
    - 91.5% POD at a 90% CL
    - Deposit simulation with Cu foil had no effect on detectability
- High frequency probe was site qualified

# High Frequency +Point ETSS 99997.1 Qualification Data Set for U-Bend PWSCC

Type	Depth (% Thruwall)
Pulled Tube	40
Pulled Tube	40
Lab EDM	62
Lab EDM	62
Lab EDM	42
Lab EDM	42
Lab EDM	40
Lab EDM	100
Lab EDM	100
Lab EDM	44
Lab EDM	60
Lab EDM	60
Lab EDM	50

Type	Depth (% Thruwall)
Lab EDM	54
Lab EDM	40
Lab EDM	58
Lab EDM	55
Lab EDM	44
Lab EDM	44
Lab EDM	45
Lab EDM	32
Lab EDM	27
Lab EDM	41

# High Frequency +Point ETSS 99997.1 Technique Performance



# 2000 U-Bend Examinations

## 800 kHz High Frequency +Point

- First industry application of the 800 kHz high frequency +Point
  - All row 2 and 3 U-bends
  - Row 4 U-bends classified as BDA with midrange +Point
- Applied data quality requirements developed for midrange +Point
- High frequency +Point identified PWSCC in four U-bends classified as BDA or RST with the midrange +Point:
  - SG 23; R2C85
  - SG 24; R2C4, R2C71 and R2C74
- Five tubes remained classified as BDA with 800 kHz +Point
  - All BDA tubes plugged

# Data Quality Results

## Midrange Vs High Frequency +Point

Row	Midrange Independent Review Results (Number of Tubes)		High Frequency Results (Number of Tubes)	
	Acceptable Data	Low S/N Data	Acceptable Data	Low S/N Data
<b>SG 21</b>				
2	40	32	71	1
3	32	57	88	1
4	41	46	46	0
Totals	113	135	205	2
<b>SG 22</b>				
2	16	19	35	0
3	31	43	74	0
4	38	36	36	0
Totals	85	98	145	0
<b>SG 23</b>				
2	7	38	44	1
3	23	49	72	0
4	30	60	60	0
Totals	60	147	176	1
<b>SG 24</b>				
2	28	28	54	2
3	37	48	85	0
4	83	1	1	0
Totals	148	77	140	2
<b>Overall Totals</b>	406	457	666	5
<b>Percent Bad Data</b>		(53%)		(0.8%)

## 2000 U-Bend Examination Results Midrange Vs High Frequency

Steam Generator	Tube	Midrange Coil	High Frequency Coil
21	R2C87	SAI	SAI
23	R2C85	BDA	SAI
24	R2C4	BDA	SAI
24	R2C69	SAI	SAI
24	R2C71	RST*	SAI
24	R2C72	SAI	SAI
24	R2C74	BDA	SAI

\* Reported restricted at 6H and UB

# Conclusions

## Low Row U-Bend Examination Programs

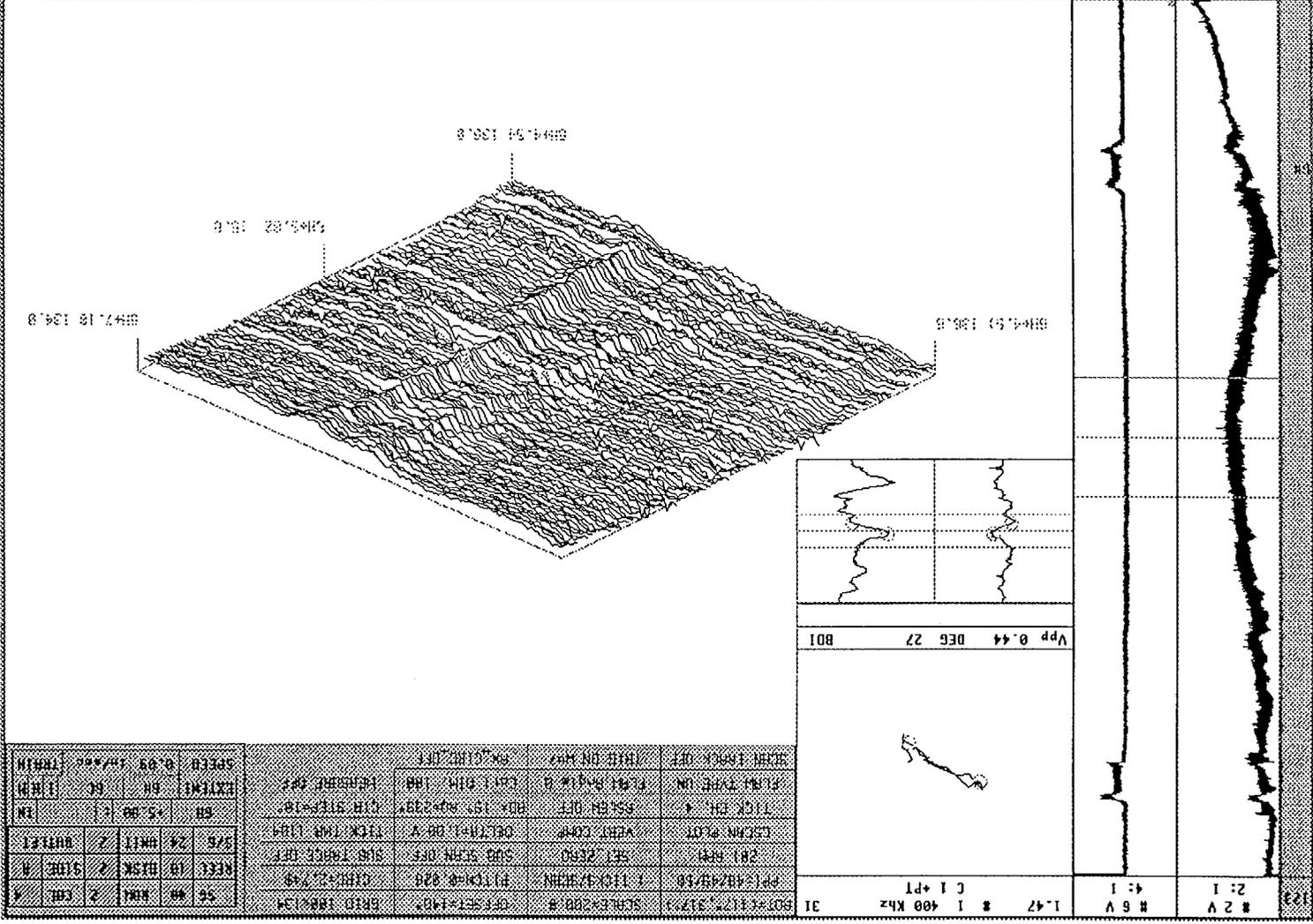
- 1997, 2R13 examination program met industry guidelines
  - Revision 4 of the EPRI PWR Steam Generator NDE Guidelines
    - Industry qualified technique
    - Site-specific performance demonstration
    - Calibration setups within industry variance
    - U-bend +Point data quality similar to industry (Alloy 600 MA)
- 2000, 2R14 examination program met industry requirements
  - Revision 5 of the EPRI PWR Steam Generator NDE Guidelines
    - Site qualified technique
    - Site-specific performance demonstration
    - Calibration setups within industry variance
    - New data quality requirements

## **Conclusions (Cont'd)**

### **Low Row U-Bend Examination Programs**

- When lessons-learned are considered, use of high frequency +Point provided the most significant improvement to POD
  - Setup rotations and 300 kHz versus 400 kHz midrange data provided minimal improvement
- The high frequency probe is site validated for use at Indian Point Unit 2
- Technology being transferred to other utilities and vendors

# SG 24, R2C4 - 2000 400 KHZ Midrange +Point



# SG 24, R2C4 - 2000

## 800 kHz High Frequency +Point

