

**DONALD C. COOK NUCLEAR PLANT, UNIT 2  
REACTOR VESSEL NOZZLE BORE  
DATA EVALUATION**

**FINAL REPORT  
SwRI Project 7804**

**Prepared for**

**American Electric Power Service Corporation  
1 Riverside Plaza  
Columbus, Ohio 43216-6631**

**Prepared by**

**Nondestructive Evaluation Science and Technology Division**

**August 1996**



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**Written by**



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Project Manager  
NDE Engineering Section  
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**Approved by**



**Bruce M. Jacobs  
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## I. INTRODUCTION AND SUMMARY

The 1996 reactor vessel examinations (April-May refueling outage) at Donald C. Cook Nuclear Plant, Unit 2 (Cook 2), were performed to satisfy the requirements for the second 10-year interval of plant operation per American Society of Mechanical Engineers (ASME) Section XI (1983 Edition) as well as the augmented examinations required by 10CFR50.55. The examinations were conducted by Southwest Research Institute (SwRI) using SwRI's Fast PaR device and Enhanced Data Acquisition System-II (EDAS-II<sup>TM</sup>). The reactor vessel shell welds were examined using procedures qualified under the Performance Demonstration Initiative (PDI) guidelines which implement ASME Appendix VIII requirements. Examinations of the nozzle-to-shell welds, nozzle inner radius sections, and the nozzle-to-safe end welds from the nozzle bore were performed using procedures (DCC-AUT14/1/0 and DCC-AUT15/1/0) written to ASME 1983 Edition of Section XI requirements.

The nozzle-to-shell weld examinations conducted from the nozzle bore were performed using an incorrect pulser preamp switch setting. This caused the actual examination sensitivity to be lower than the calibration sensitivity. This error was not discovered until after the completion of examinations, and at that time it was determined that a reexamination effort would have an adverse impact on the outage schedule. After conferencing with regulatory personnel, the plant staff decided to request relief for those examinations and investigate the opportunity to perform a meaningful analysis of the data as acquired.

After conducting a detailed and enhanced analysis of the existing data, it was determined that it was possible to identify those indications which exceeded the Code and Regulatory Guide equivalent evaluation thresholds. The existing data does not allow a complete sizing evaluation using Code or Regulatory Guide criteria. However, since a known flaw, detected from the bore and sized from the vessel outside surface during previous examinations, was also detected at the reduced sensitivity, it is possible to draw some inferences about the indications that were identified. Again this outage, the known flaw was sized independently from the outside surface of the vessel, and it displayed the same dimensions as it did in 1988 and 1990. All of the remaining indications identified during the enhanced analysis of the detection data were lower in amplitude than the known acceptable flaw, and after applying Code-style sizing calculations to the existing enhanced detection data, all of the measured dimensions were less than the similar measurements for the known flaw.

The existence of slag-type nozzle fabrication flaws is fairly well known within the nuclear industry with several documented cases of these flaws having been discovered through preservice and inservice inspection. The nozzle joint design is such that arc control is difficult and one of the most common outcomes is the accumulation of slag along the side walls of the joint. While it is difficult to precisely characterize ultrasonic indications with respect to the exact type of flaw, our experience in conducting these nozzle bore examinations is that such fabrication flaws are relatively common and that, in most cases, the indications have been documented for many years. In the case of the Cook 2 vessel, CB&I report "Investigation of Nozzle Weld Repairs On AMP Reactor Pressure Vessel", dated October 11, 1972, documents the existence of nozzle weld repairs made during vessel fabrication and also states that some fabrication flaws were accepted and left in the welds.

Six of the nozzle-to-shell welds at Cook 2 have been examined from the bore twice previously (once preservice and once inservice) using similar techniques and two of the nozzles have been examined three times previously (once preservice and twice inservice). Each of these examinations revealed some indications which required evaluation, but only one indication was determined to be unacceptable based on the initial evaluation results. This was the indication that was sized in 1988 (and again in 1990) using a tip-diffraction technique from the outside surface of the vessel and determined to be acceptable.

Based on SwRI's experience with nozzle bore examinations over the past 25 years, it is believed that, although the 1996 examinations were not performed at the proper gain setting, the enhanced analysis (as described in Section II) provided the opportunity to review the data in a manner that provided a high level of confidence. It is also felt that the results of these examinations are consistent with other examination experiences and that there is no reason to suspect that any new or unusual flaws exist in the Cook 2 nozzle welds.

## II. ENHANCED DATA ANALYSIS

While it was known that the examination data was not acquired at the required gain settings, it was felt that the characteristics of the EDAS-II system were such that an effective data review could be accomplished even at the lower gain setting. In order to perform an effective review of the data, SwRI performed the following tasks.

Upon return to SwRI, the entire examination system was reconstructed in the same configuration as used at Cook 2. The appropriate calibrations were downloaded to the system and verifications were performed to assure that the system was operating as it did at the plant. An empirical approach was used to determine "equivalent 50% and 20% thresholds" for each acquisition channel used during the examination. These thresholds were determined by (1) obtaining 50% and 20% reference signals through the entire examination system at calibration sensitivity, and then (2) recording the corresponding signal amplitude after the switch was changed to the incorrect setting used for examination.

Since EDAS-II digitizes and records the full video waveform at 10-bit resolution, it was possible to enhance the data display and then compare the recorded data to the derived thresholds to identify the indications that exceeded those thresholds. The enhanced data display provided improved amplitude resolution and allowed the analyst to view the data in a manner more consistent with normally acquired data sets. Although the data were acquired using detection scan increments which are larger than typical sizing increments, length and throughwall sizing calculations were made for each indication for evaluation purposes.

### III. ANALYSIS RESULTS

ASME Section XI and Regulatory Guide 1.150 require that all indications exceeding 50% DAC located in the outer 75% of the vessel shell be recorded and evaluated. Table A identifies 11 indications (including the known flaw) located in the outer 75% of the vessel shell which exceeded the equivalent 50% threshold. Information on indication location and correlation with previous examination data is also provided for each indication. See Figure 1 for azimuth locations.

Indications located in the inner 25% of the vessel shell are required to be recorded and evaluated if they exceed 20% DAC. No indications were observed in the inner 25% of the vessel shell that exceeded the equivalent 20% threshold.

Table B provides the amplitude-based throughwall and length sizing information that was calculated for each indication that exceeded the equivalent appropriate threshold. Although it is well known that throughwall measurements based upon amplitude are not typically accurate with respect to true flaw size, these calculations were made primarily for comparison purposes to the known flaw. Also, while the throughwall measurements may not be absolutely conservative, the length measurements are conservative because of the technique used for the calculations.

While the fact that the indications did not receive complete evaluation may be of some concern, it should be noted that 5 of the 11 were within 2 dB (normal Code calibration tolerance) of the 50% threshold (see Figure 2). Due to the normal variances that occur when applying Code procedures, it is quite possible that some of these would not have exceeded the evaluation threshold if the examinations had been performed at the proper gain setting. Also, due to the normal probability of false calls, had the indications been completely evaluated, it is likely that some, particularly those that could not be correlated with previous data, would have been determined to be nonrelevant (e.g., caused by transducer liftoff).

Based on the analysis performed, SwRI is confident that any recorded indication which would have exceeded 50% DAC (or 20% DAC for the inner 1/4T) has been identified. Although it is not possible to complete the required evaluation steps for the identified indications, it is felt that, based on SwRI's experience, the enhanced initial detection data presentation and results obtained are comparable to other nozzle examinations at Cook 2 and other plants.

Appendix A contains indication plots and Appendix B contains EDAS-II evaluation data for the 11 indications reported.

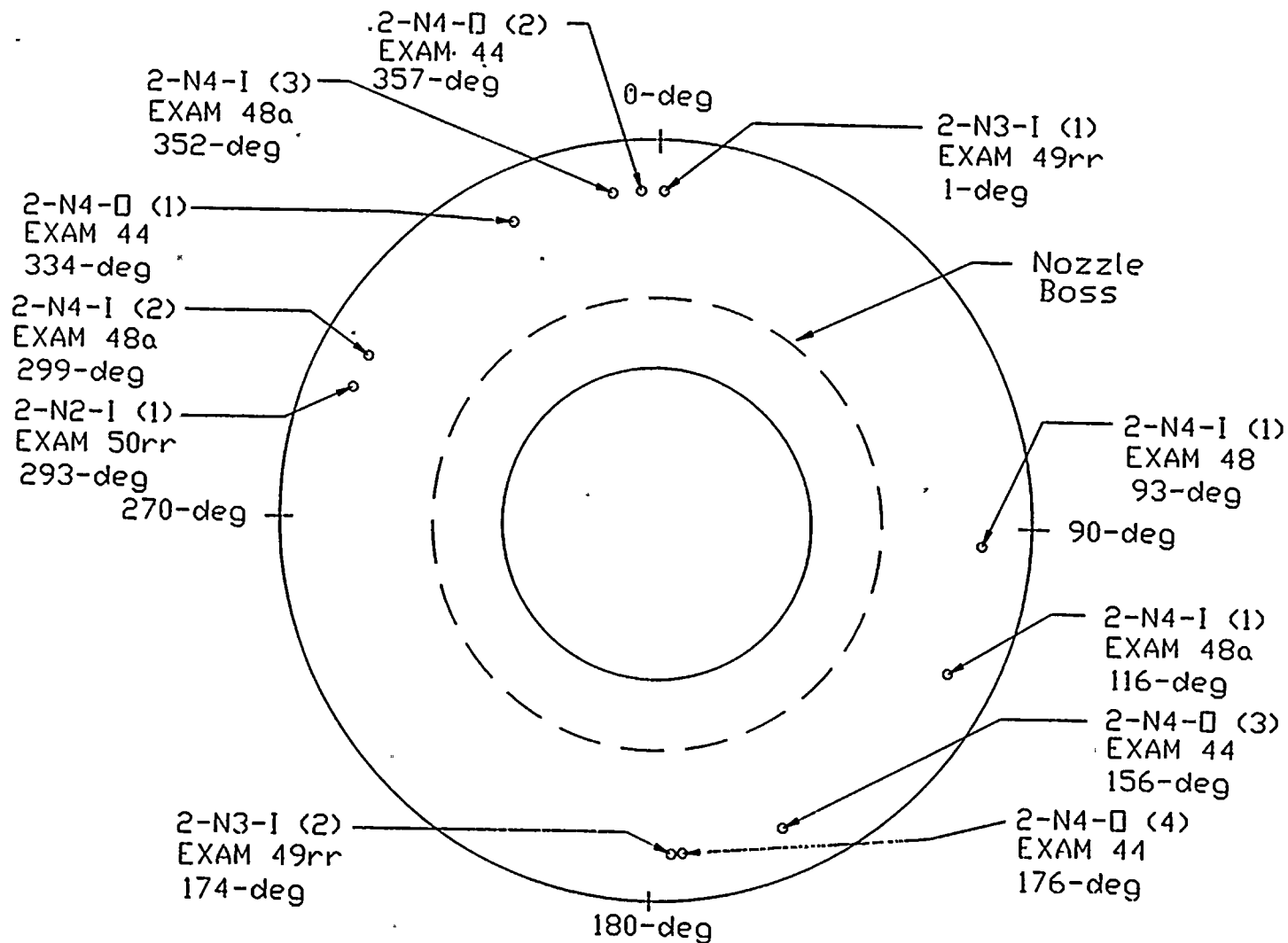


Figure 1. Donald C. Cook, Unit 2, Nozzle Bore Indications (Azimuth Locations)



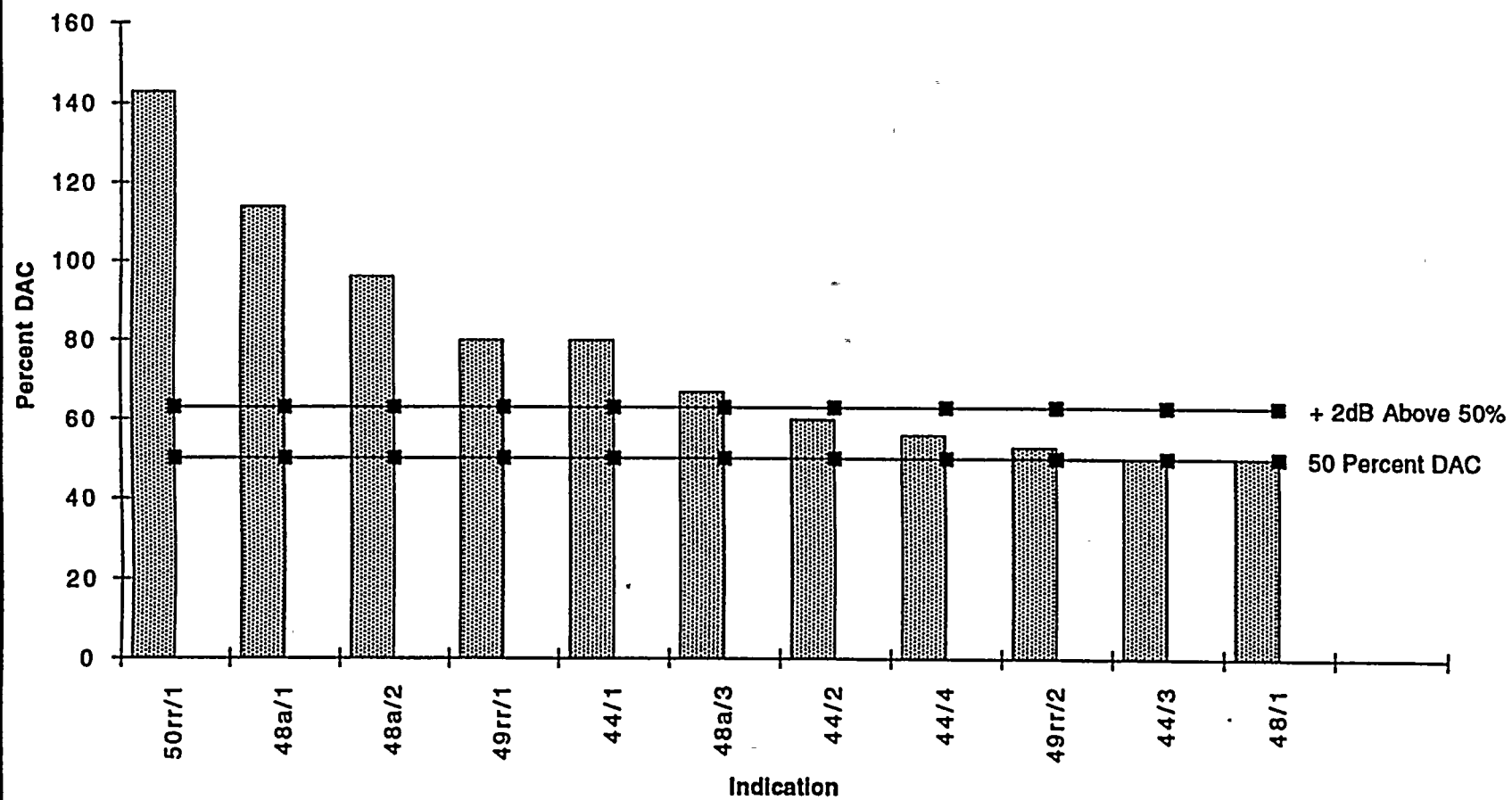


Figure 2. Indication Amplitude Chart

DONALD C. COOK UNIT 2

DETECTION EVALUATION / CORRELATION OF PREVIOUS DATA

Table A

Nozzle Identification	Exam No.	Ind. No.	Ind. Azm (Deg)	Ind. Amp. % DAC	Indication		1996	1988	1984	1977
					Inner	Outer	Transverse	Bore	Bore	Bore
					1/4 t	3/4 t	Confirmation	Confirmation	Confirmation	Confirmation
2-N4-O @ 22-Deg	44	1	334	80	N	Y	N	**	N	N
		2	357	60	N	Y	N	**	N	Y(1)
		3	156	50	N	Y	N	**	N	N
		4	176	56	N	Y	N	**	N	Y(1)
2-N4-I @ 67-Deg	48	1	93	50	N	Y	N	N	**	N
2-N4-I @ 67-Deg	48a	1	116	114	N	Y	N	N	**	N
		2	299	96	N	Y	N	N	**	N
		3	352	67	N	Y	N	N	**	N
2-N3-I @ 113-Deg	49rr	1	1	80	N	Y	N	Y(1)	**	Y(1)
		2	174	53	N	Y	N	Y(1)	**	N
2-N2-I @ 247-Deg	50rr	1	293	143	N	Y	N	Y(2)	**	Y(1)

\*\*No exam performed

☒ 1988 Code Allowable Flaw - Confirmed Sizing In 1990 and 1996

Y(1) - Below Code Recording Threshold

Y(2) - At or Above Code Recording Threshold

Y - Yes

N - No

ccclaf10

**DONALD C. COOK UNIT 2**

**1996 ISI - SIZING EVALUATION**

**Table B**

Nozzle Identification	Exam No.	Ind. No.	Ind. Azm (Deg)	ASME Length Meas. (inch)	2a	a	a/l	a/t (%)	a/t Allow. (%)	s
2-N4-O @ 22-Deg	44	1	334	2.38	1.26	0.65	0.27	6.2	3.8	2.66
		2	357	1.22	0.37	0.20	0.16	1.9	3.0	4.70
		3*	156	1.29	0.14	0.16	0.12	1.5	2.7	0.00
		4	176	1.29	0.36	0.20	0.16	1.9	3.0	4.10
2-N4-I @ 67-Deg	48	1	93	1.24	Spot	-	-	-	-	-
2-N4-I @ 67-Deg	48a	1*	116	1.88	1.36	1.55	0.50	14.8	3.5	0.18
		2	299	1.90	1.05	0.55	0.29	5.2	4.0	0.75
		3	352	2.51	1.38	0.70	0.28	6.7	3.8	0.72
2-N3-I @ 113-Deg	49rr	1	1	2.45	1.34	0.65	0.27	6.2	3.8	2.73
		2	174	1.28	Spot	-	-	-	-	-
2-N2-I @ 247-Deg	50rr	1*	293	3.75	1.53	1.7	0.45	16.2	3.5	0.16

 1988 Code allowable flaw- Confirmed sizing in 1990 and 1996

Length measurements are considered conservative

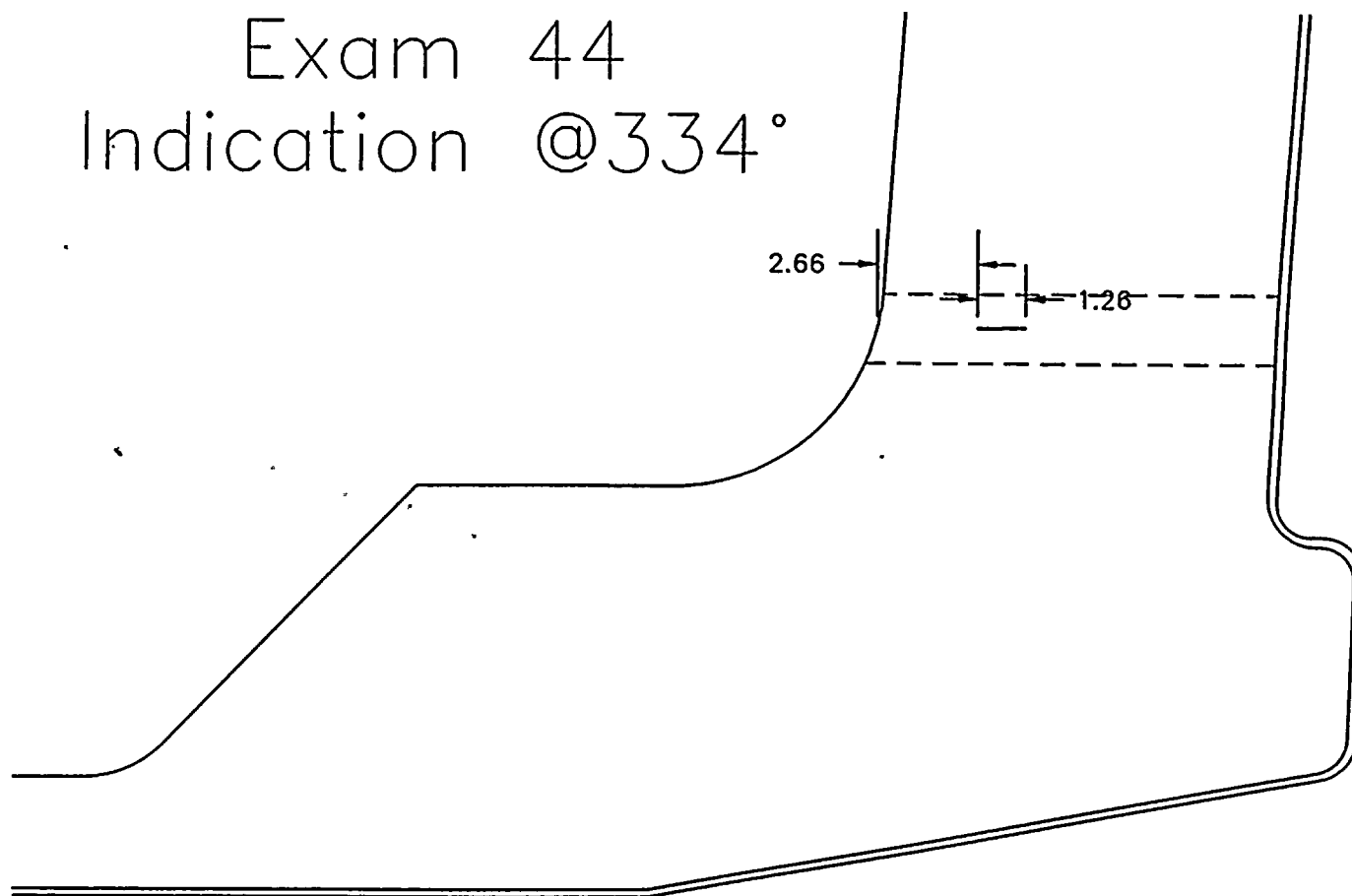
t = 10.5 inches, sizing was performed in accordance with the 1983 Edition of Section XI, Tables IWB 3510 and IWB 3512

\* Surface indications

cooklv11

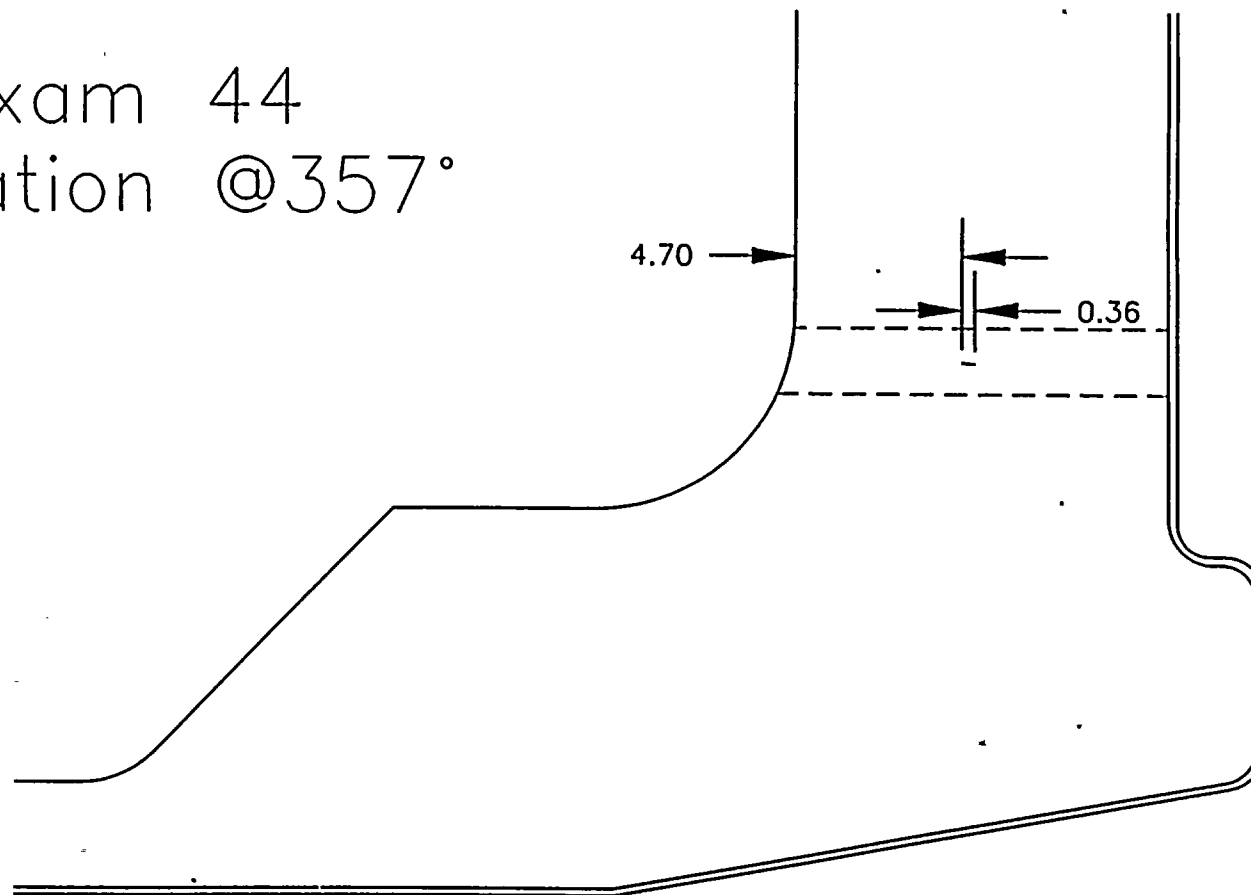
**APPENDIX A**  
**INDICATION LOCATION PLOTS**

Exam 44  
Indication @334°



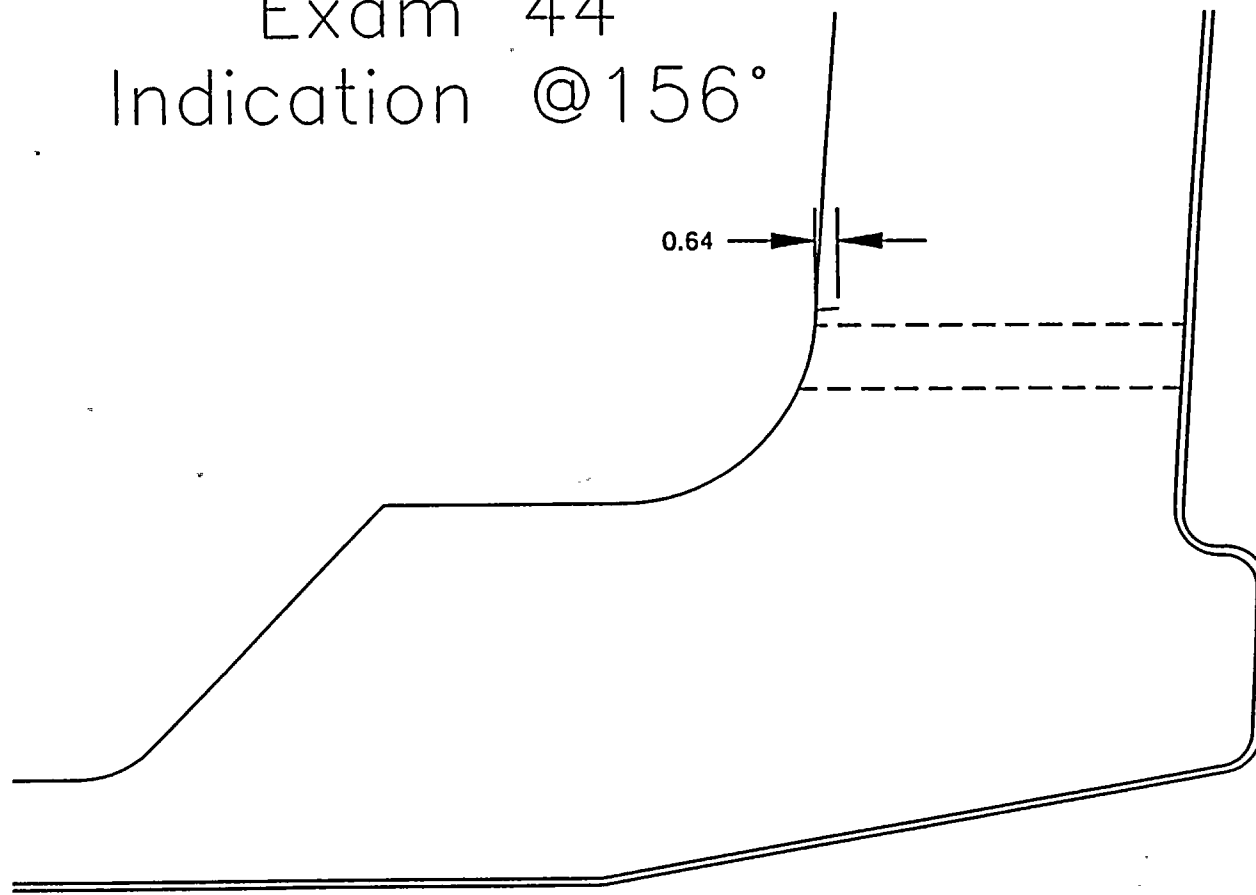
Indication #1

Exam 44  
Indication @357°



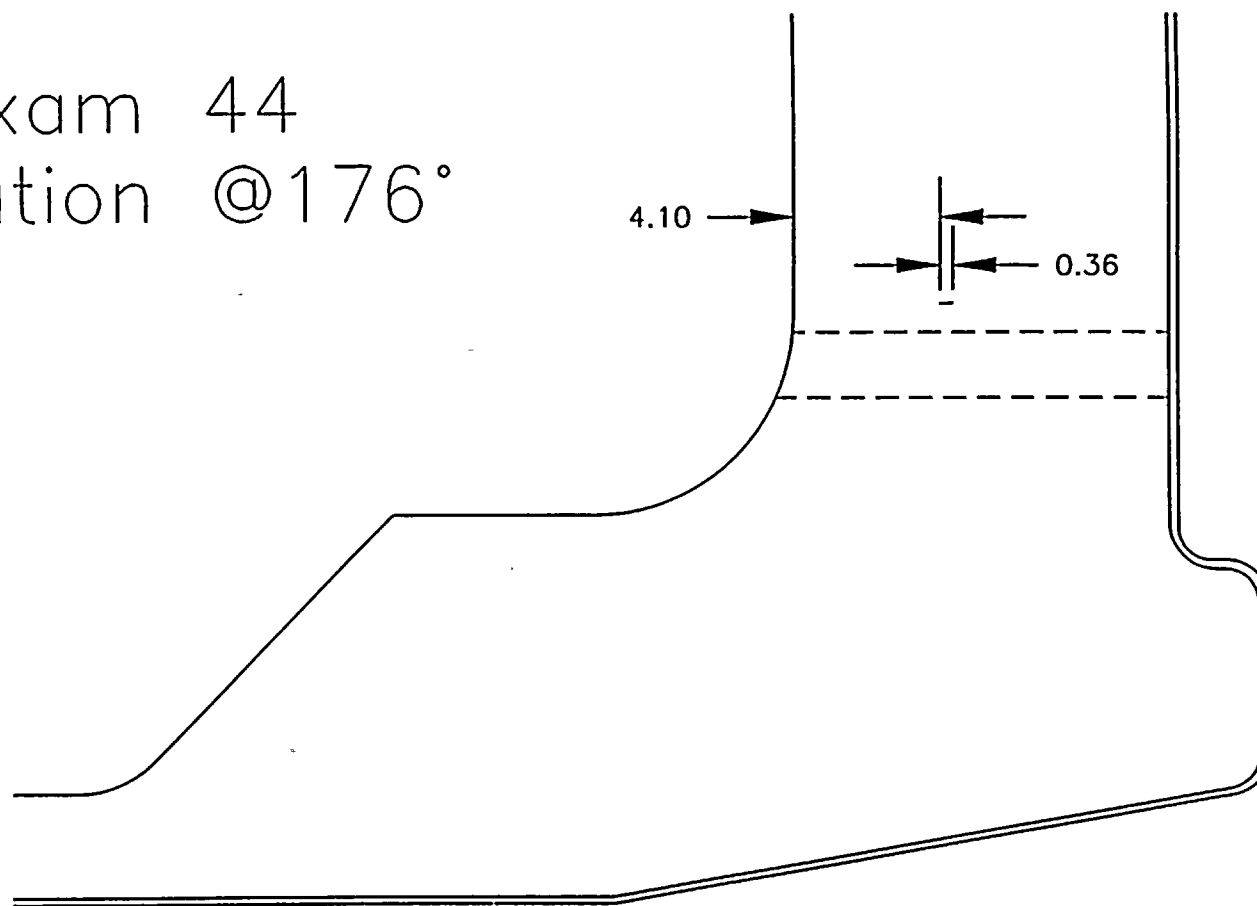
Indication #2

Exam 44  
Indication @156°



Indication #3

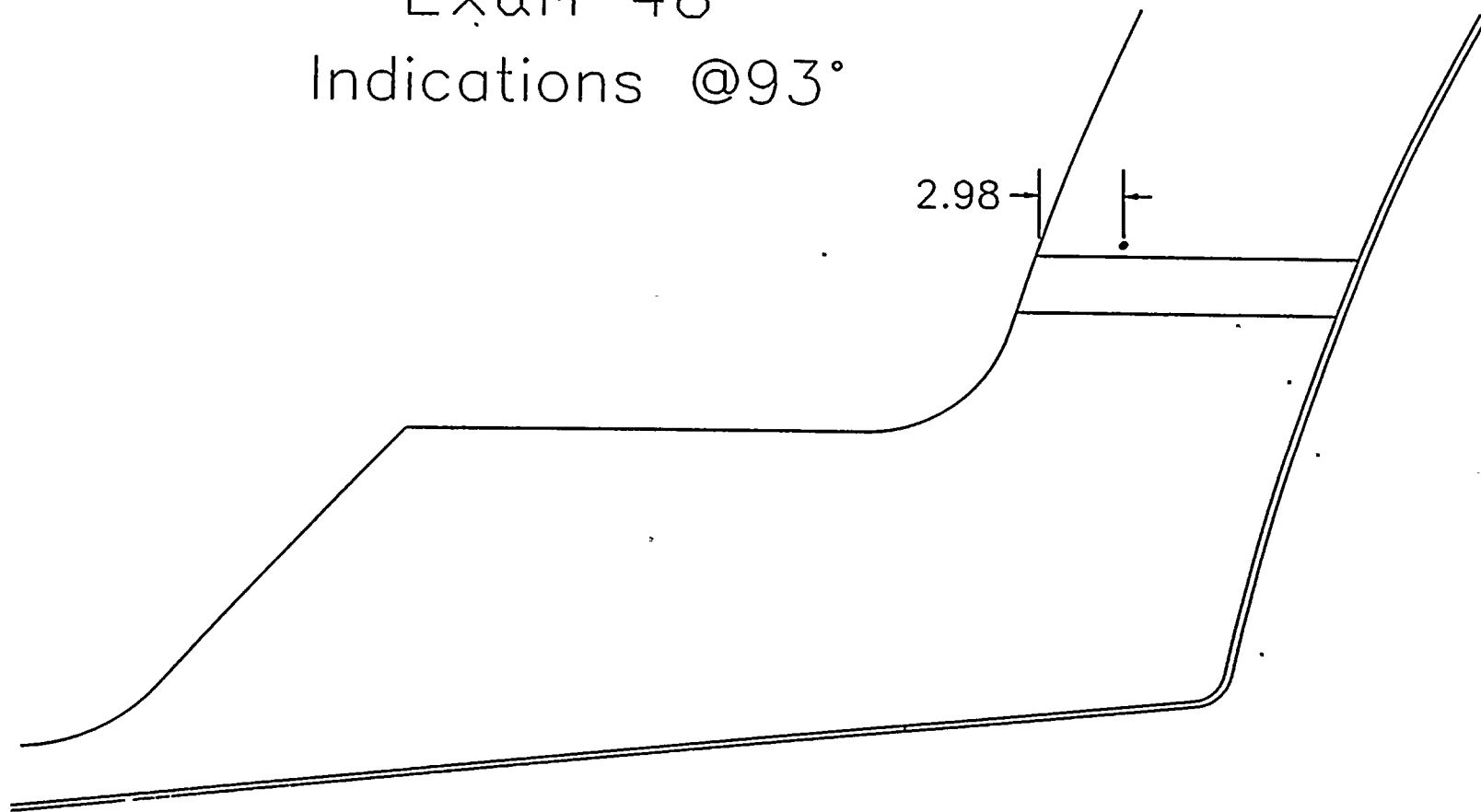
Exam 44  
Indication @176°



Indication #4

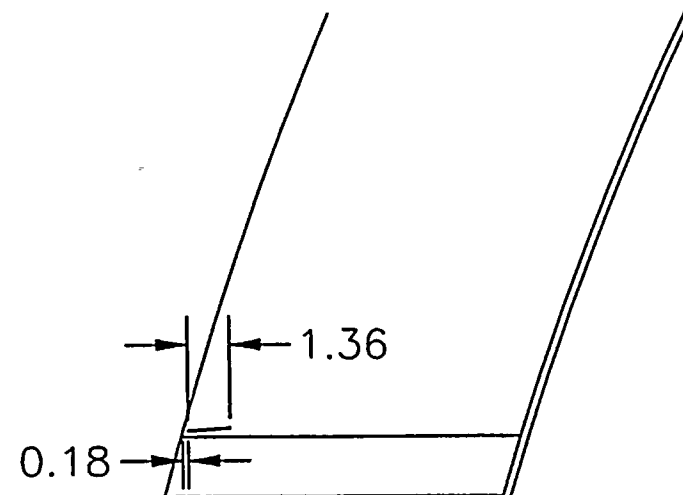


Exam 48  
Indications @93°



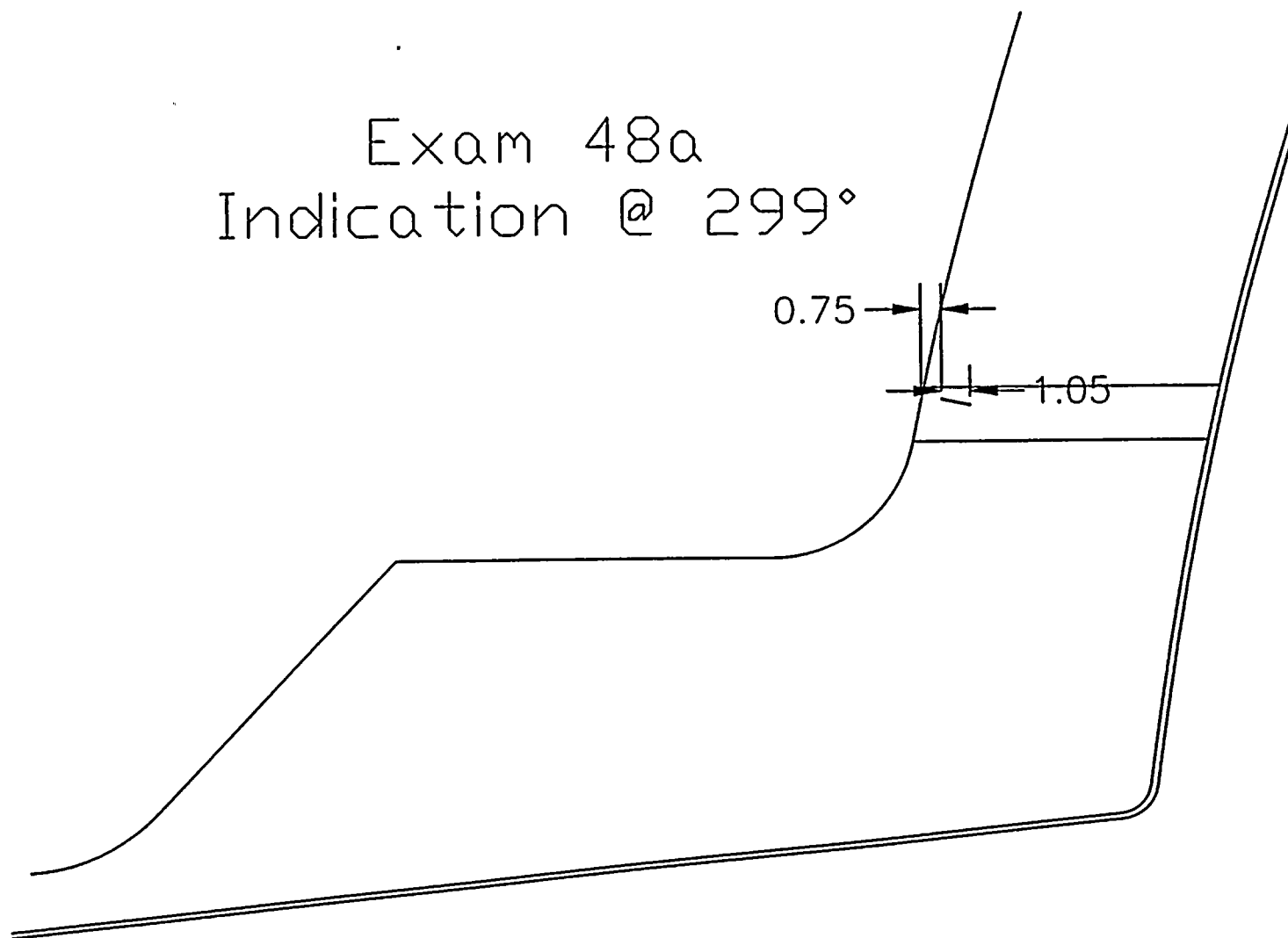
Indication #1

Exam 48a  
Indication @116°



Indication #1

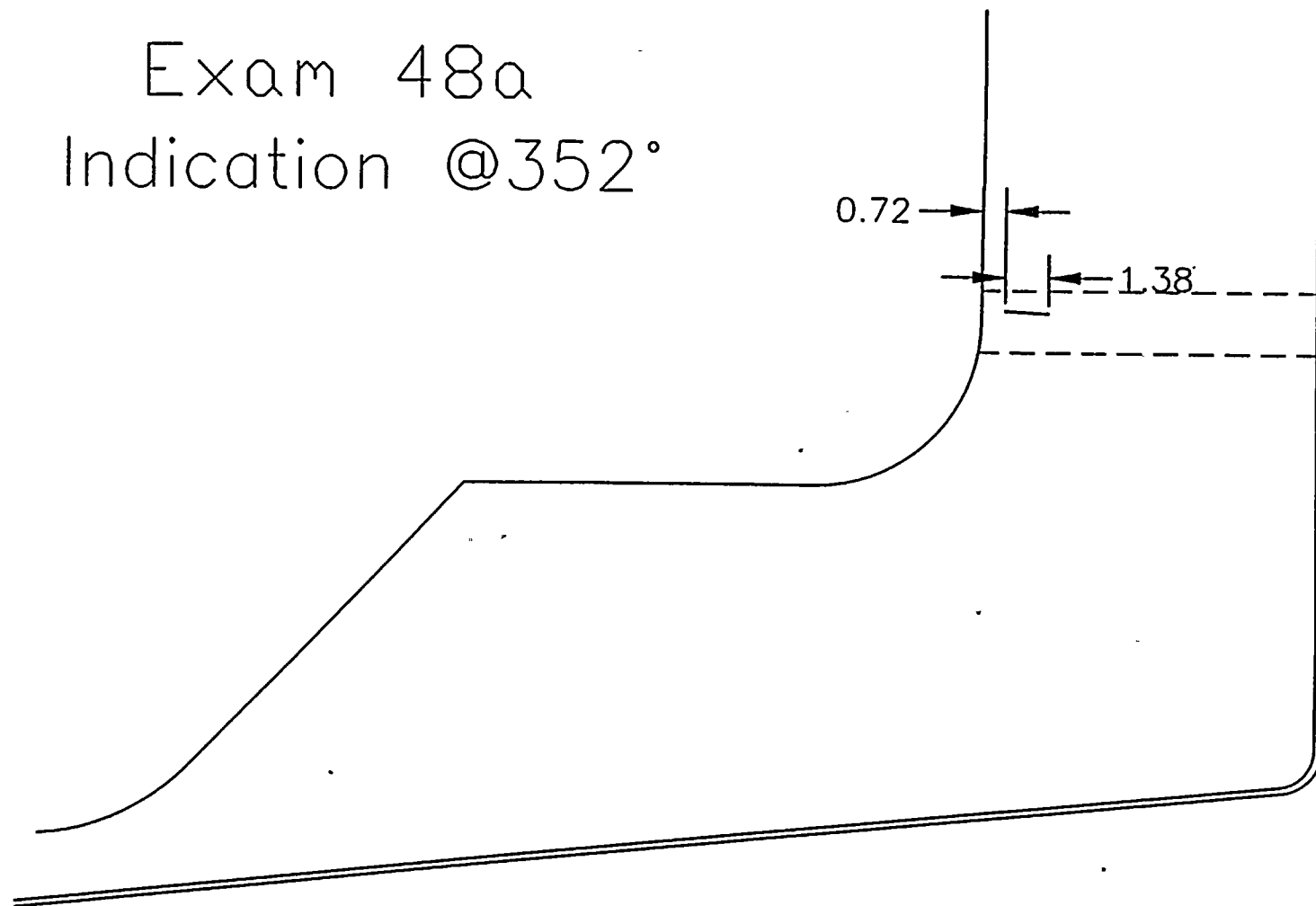
Exam 48a  
Indication @ 299°



Indication #2



Exam 48a  
Indication @352°



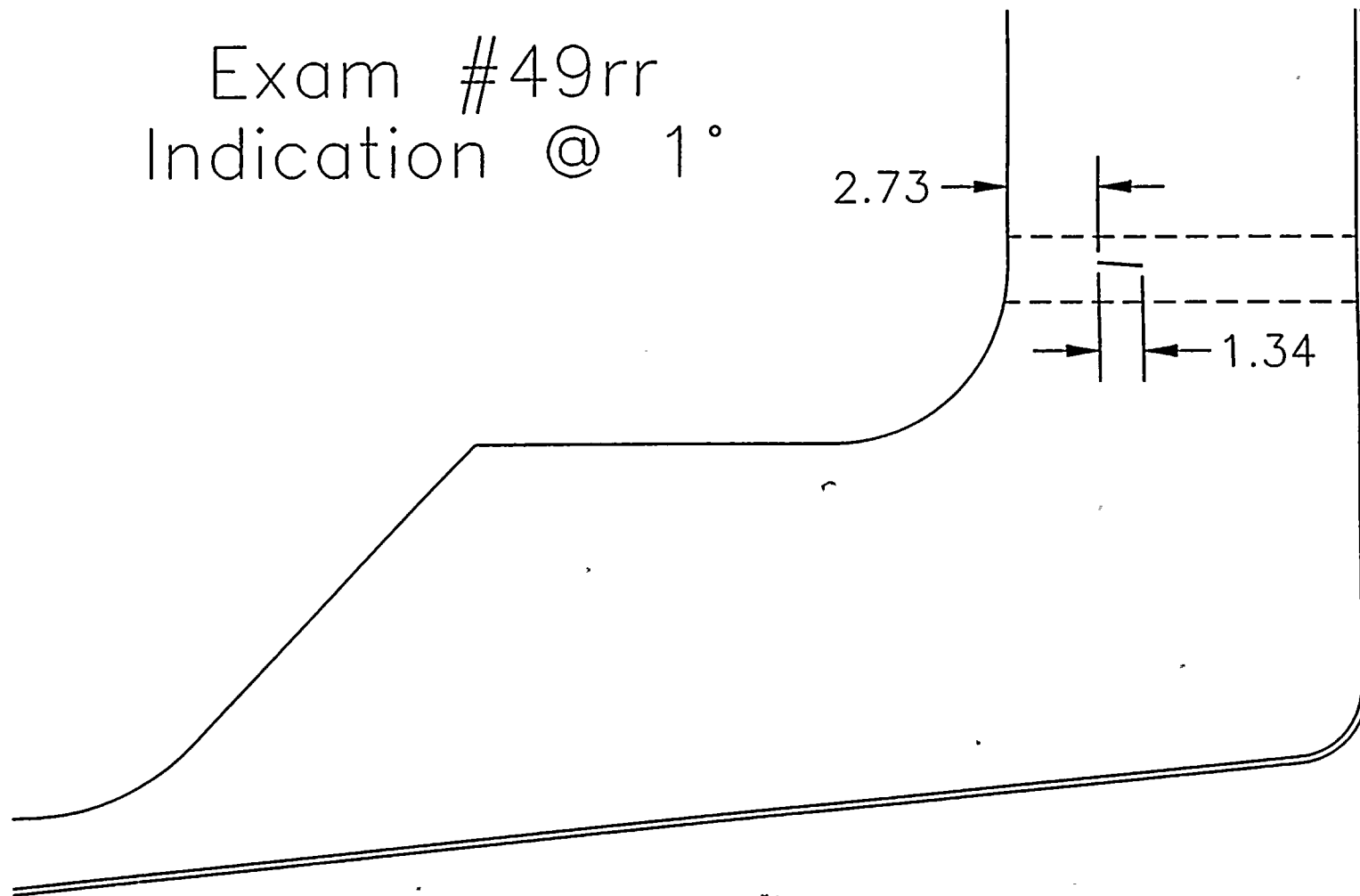
Indication #3

Exam #49rr  
Indication @ 1°

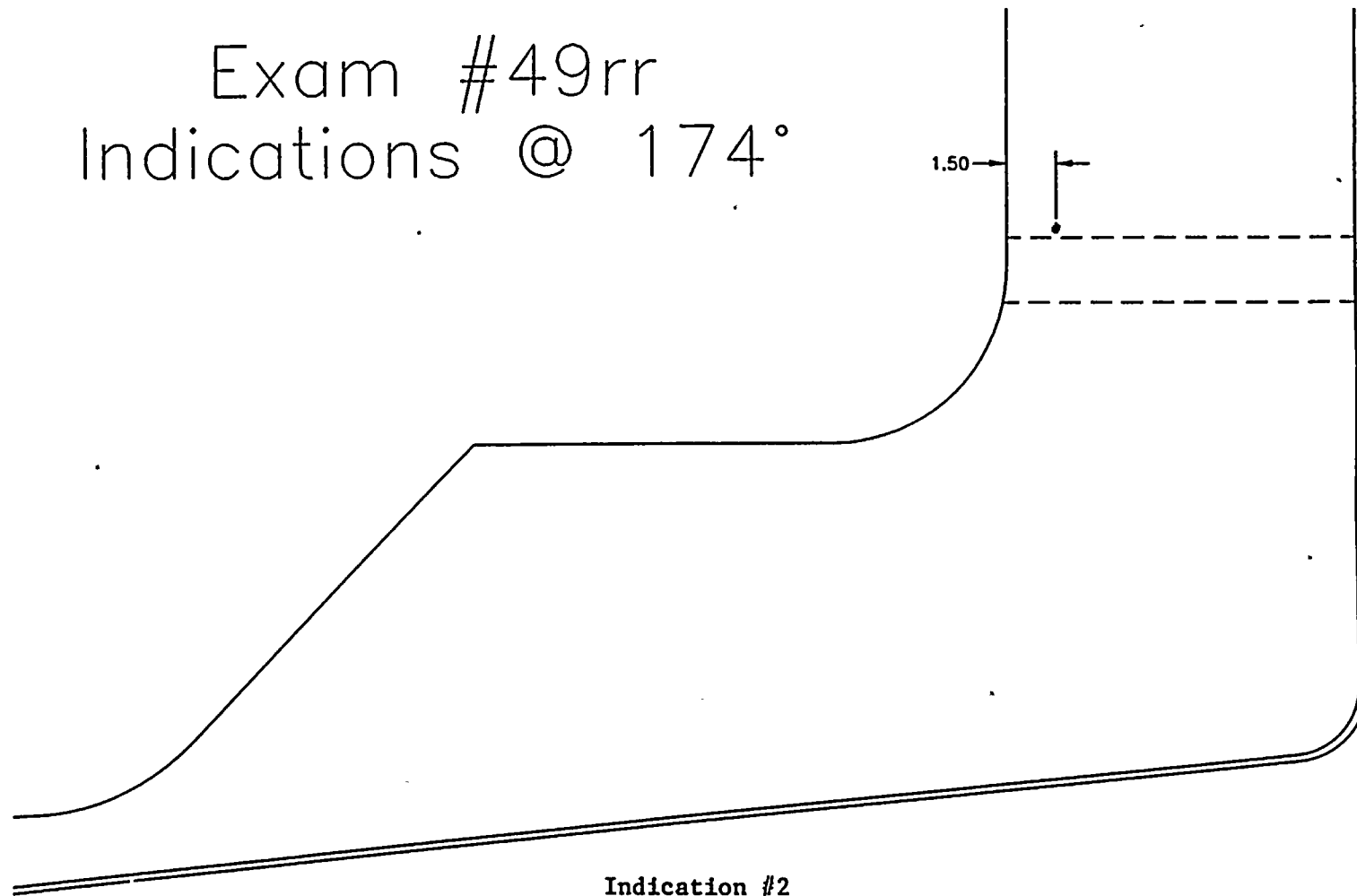
2.73

1.34

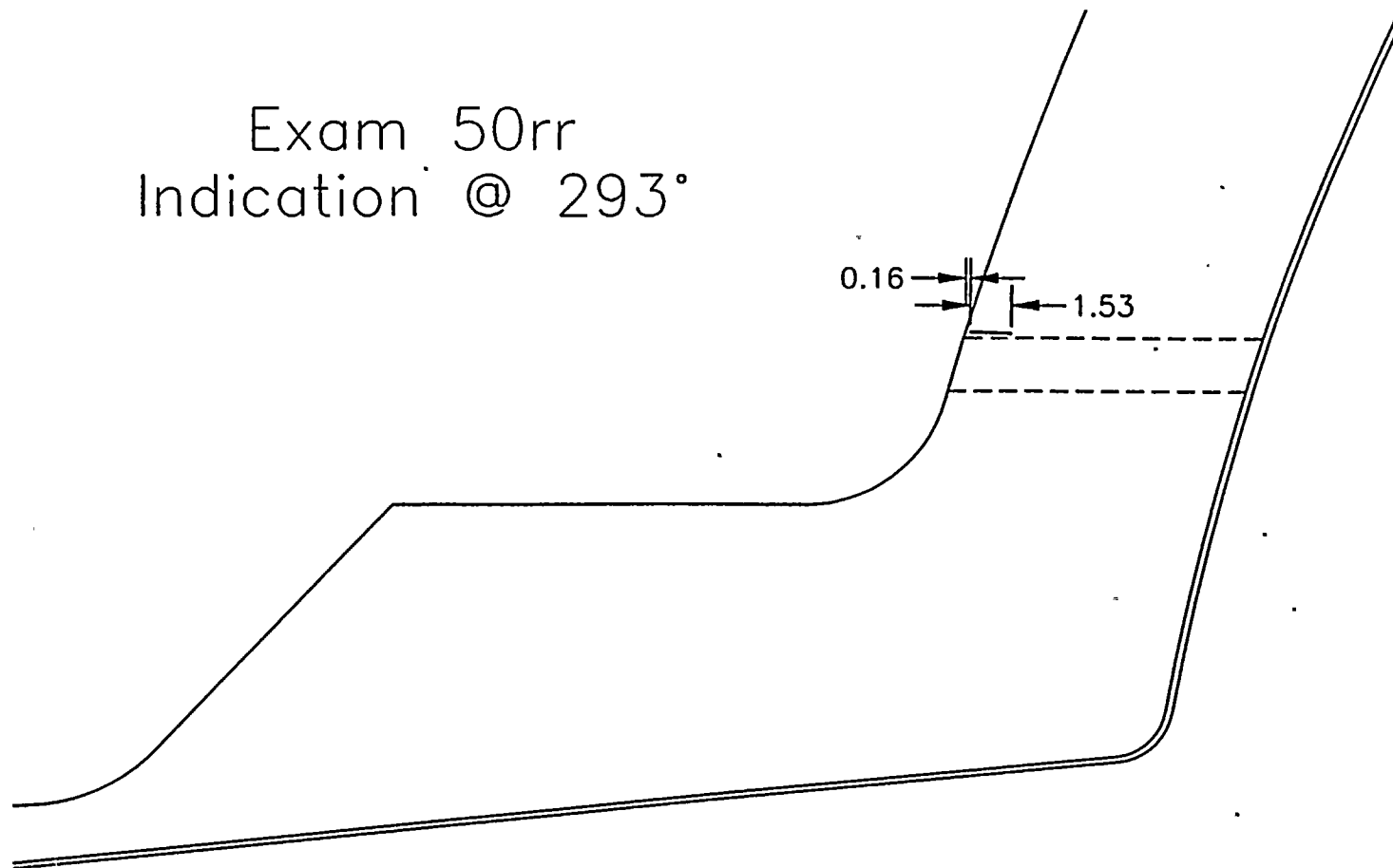
Indication #1



Exam #49rr  
Indications @ 174°



Exam 50rr  
Indication @ 293°



Indication #1



**APPENDIX B**  
**EDAS-II EVALUATION DATA**

DC Cook Unit 2

2-N4-O

Outlet Noz. Bore @ 22 deg. Looking TWD

Cursor Box 1 of 5

Scan Axis

16.45 - 17.69

Inc. Axis

211.67 - 222.47

Depth In Material

3.93 - 5.02

## Channel 1

Module Coordinates

Inc. Axis

23.57 - 24.81

Scan Axis

## Channel 2

Module Coordinates

Inc. Axis

20.33 - 21.57

Scan Axis

## Channel 3

Module Coordinates

Inc. Axis

33.73 - 44.62

Scan Axis

23.57 - 24.81

## Channel 4

Module Coordinates

Inc. Axis

28.92 - 39.82

Scan Axis

20.33 - 21.57

## Channel 4

Feature Analysis

Summary

Comments

Enhanced Analysis

## Cursor Box 2 of 5

Scan Axis

20.45 - 22.29

Inc. Axis

329.27 - 340.07

Depth In Material

12.81 - 13.41

## Channel 1

Module Coordinates

Inc. Axis

-

Scan Axis

36.45 - 38.29

## Channel 2

Module Coordinates

Inc. Axis

-

Scan Axis

25.89 - 27.73

## Channel 3

Module Coordinates

Inc. Axis

151.33 - 162.13

Scan Axis

36.45 - 38.29

## Channel 4

Module Coordinates

Inc. Axis

146.61 - 157.34

Scan Axis

25.89 - 27.73

## Channel 4

Planar

Feature Analysis

Reference Points

Inc. Axis Location

335.21

334.00

Surface Location

23.29

24.57

Scan Axis Location

21.01

22.25

Depth In Material

12.99

13.20

Metal Path

13.19

13.40

Time

118.4

120.3

% DAC

38

39

Separation

1.26

Inc. Axis Values

Scan No. Limits

122

126

Inc. Axis Limits

332.91

337.58

Depth

13.17

Length

2.38

Maximum Point

% DAC

66

Inc. Axis Location

334.00

Surface Location

24.33

Scan Axis Location

22.01

Depth In Material

13.17

Metal Path

13.37

Time

120.0

Comments

:

Ind # 1 with Enhanced Evaluation

:

Cursor Box 3 of 5  
 Scan Axis  
 Inc. Axis  
 Depth In Material

20.13 - 21.93  
 168.48 - 179.28  
 14.50 - 14.95

Module Coordinates  
 Inc. Axis  
 Scan Axis

## Channel 1

170.53 - 181.33  
 37.81 - 39.61

Module Coordinates  
 Inc. Axis  
 Scan Axis

## Channel 2

165.72 - 176.52  
 25.89 - 27.69

Feature Analysis  
 Reference Points  
 Inc. Axis Location  
 Surface Location  
 Scan Axis Location  
 Depth In Material  
 Metal Path  
 Time  
 % DAC  
 Separation  
 Inc. Axis Values  
 Scan No. Limits  
 Inc. Axis Limits  
 Depth  
 Length

Channel 2  
Planar

175.60	175.60
23.73	24.09
21.13	21.49
14.74	14.78
14.97	15.01
134.4	134.7
39	43
	0.36
140	142
174.41	176.80
	14.78
	1.29

Maximum Point  
 % DAC  
 Inc. Axis Location  
 Surface Location  
 Scan Axis Location  
 Depth In Material  
 Metal Path  
 Time  
 Comments

46  
 175.60  
 23.85  
 21.25  
 14.78  
 15.01  
 134.7

## Ind # 4 Enhanced Analysis

## Module Coordinates

Inc. Axis

Scan Axis

## Channel 3

37.81 - 39.61

## Module Coordinates

Inc. Axis

Scan Axis

## Channel 4

25.89 - 27.69

## Cursor Box 4 of 5

Scan Axis

Inc. Axis

Depth In Material

24.65 - 26.53

155.28 - 158.88

14.88 - 15.44

## Module Coordinates

Inc. Axis

Scan Axis

## Channel 1

157.34 - 160.92

42.73 - 44.61

## Module Coordinates

Inc. Axis

Scan Axis

## Channel 2

152.54 - 156.12

30.49 - 32.37

## Feature Analysis

## Reference Points

Inc. Axis Location

Surface Location

Scan Axis Location

Depth In Material

Metal Path

Time

% DAC

Separation

## Channel 2

## Planar

156.40

156.40

28.13

28.29

25.45

25.61

15.13

15.17

15.36

15.40

137.9

138.2

41

41

0.16

Inc. Axis Values		
Scan No. Limits	124	126
Inc. Axis Limits	155.22	157.59
Depth	15.13	
Length	1.29	
Maximum Point		
% DAC	41	
Inc. Axis Location	156.40	
Surface Location	28.13	
Scan Axis Location	25.45	
Depth In Material	15.13	
Metal Path	15.36	
Time	137.9	
Comments		

Ind # 3 Enhanced Analysis

Module Coordinates	Channel 3
Inc. Axis	-
Scan Axis	42.73 - 44.61

Module Coordinates	Channel 4
Inc. Axis	-
Scan Axis	30.49 - 32.37

-----

Cursor Box 5 of 5	
Scan Axis	20.09 - 21.77
Inc. Axis	350.87 - 1.67
Depth In Material	12.46 - 13.34

Module Coordinates	Channel 1
Inc. Axis	-
Scan Axis	35.77 - 37.45

Module Coordinates	Channel 2
--------------------	-----------



Inc. Axis  
Scan Axis

-  
25.49 - 27.17

## Channel 3

## Module Coordinates

Inc. Axis  
Scan Axis

172.92 - 183.71  
35.77 - 37.45

## Channel 4

## Module Coordinates

Inc. Axis  
Scan Axis

168.12 - 178.92  
25.49 - 27.17

Channel 4  
PlanarFeature Analysis  
Reference Points

Inc. Axis Location  
Surface Location  
Scan Axis Location  
Depth In Material  
Metal Path  
Time  
% DAC  
Separation

356.79	356.79
23.13	23.49
20.85	21.21
12.85	12.95
13.05	13.15
117.1	118.1
41	41
	0.37

## Inc. Axis Values

Scan No. Limits  
Inc. Axis Limits  
Depth  
Length

141	143
355.59	358.00
	12.92
	1.22

## Maximum Point

% DAC  
Inc. Axis Location  
Surface Location  
Scan Axis Location  
Depth In Material  
Metal Path  
Time

49
356.79
23.41
21.13
12.92
13.12
117.8

## Comments

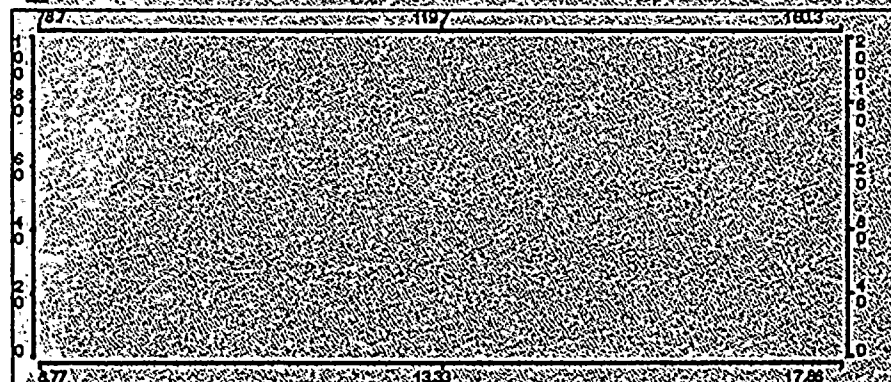
:  
:  
:  
:

Ind # 2 Enhanced Evaluation

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Reviewed By W. Lloyd SNT Level III Date 8/3/94



123 SCAN NO  
334.00 INC. AXIS  
SCAN AXIS  
TIME  
METAL PATH  
MATERIAL DEPTH  
% SCREEN HEIGHT  
% DAC

## B-SCAN CONTROL OPTIONS

Next B-Scan  
Previous B-Scan

## A-SCAN CONTROL OPTIONS

Compressed Display

Replay ☐ OffDirection ☐ ForwardSpeed ☐

Select Scan Axis

Lower 11.97

Upper 40.09

## GEOMETRY OPTIONS

Mode ☐ Off

## FEATURE ANALYSIS OPTIONS

Analyze Cursor Box

## Planar Analysis

Select Reference Point

Point 1 Point 2

335.21 334.00 Inc. Axis Location

23.29 24.57 Surface Location

21.01 22.25 Scan Axis Location

13.19 13.40 Metal Path

118.4 120.3 Time

38 39 % DAC

12.99 13.20 Depth In Material  
1.26 Separation

Lower Upper

122 126 Scan No. Limits

332.91 337.58 Inc. Axis Limits

13.17 Depth  
2.38 Length

Select Maximum Point

66 % DAC

334.00 Inc. Axis Location

24.33 Surface Location

22.01 Scan Axis Location

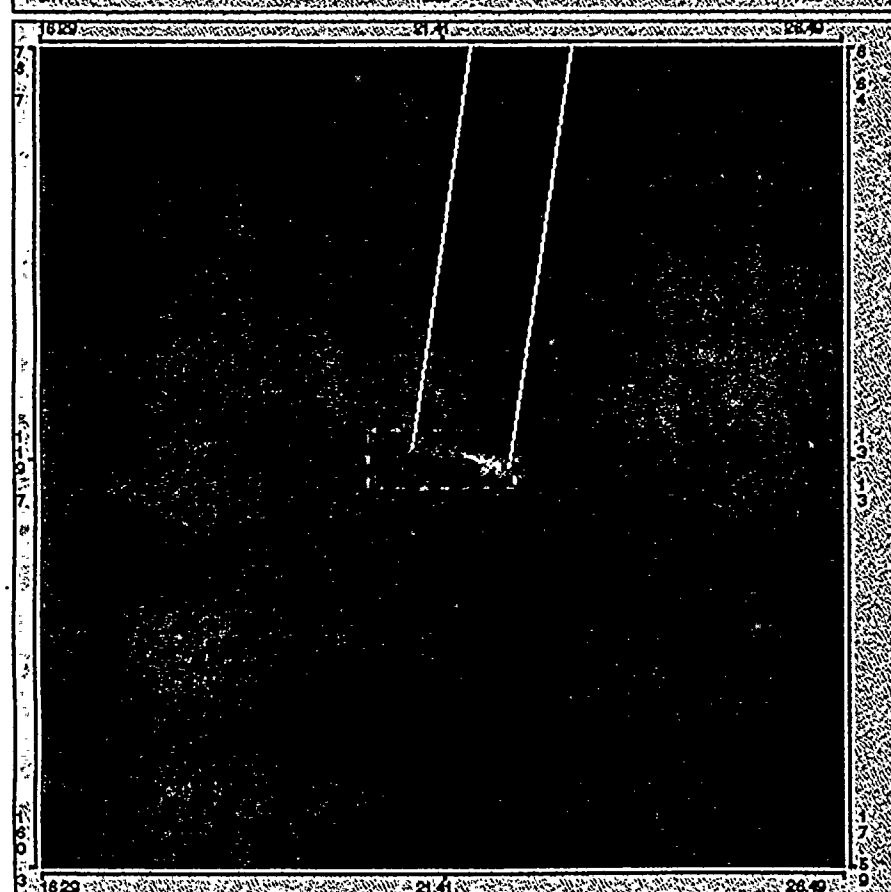
13.37 Metal Path

120.0 Time

13.17 Depth In Material

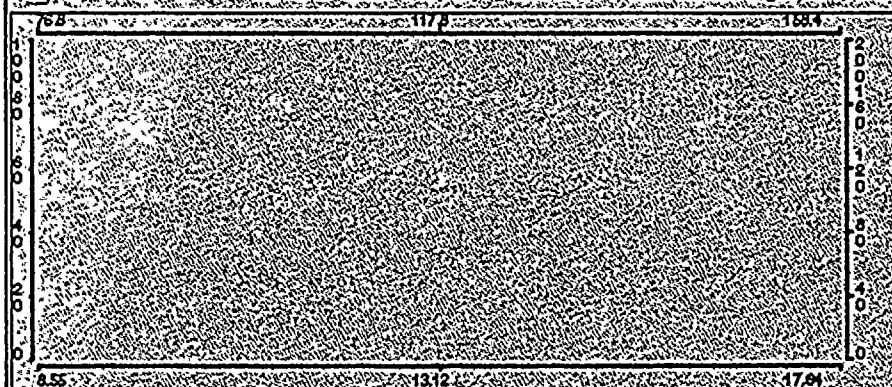
Comments

Ind H-1 with Enhanced Evaluation



Inc. 334.00  
Scan 16.29  
Depth 8.64





142 SCAN NO  
356.79 INC AXIS  
23.49 SCAN AXIS  
116.6 TIME  
12.97 METAL PATH  
12.77 MATERIAL DEPTH  
4 % SCREEN HEIGHT  
9 % DAC

## B-SCAN CONTROL OPTIONS

Next B-Scan

Previous B-Scan

## A-SCAN CONTROL OPTIONS

Compressed Display

Replay ☐ OffDirection ☒ ForwardSpeed ☐

Select Scan Axis

Lower 11.97

Upper 40.09

## GEOMETRY OPTIONS

Mode ☒ Off

## FEATURE ANALYSIS OPTIONS

Analyze Cursor Box

## Planar Analysis

Select Reference Point

Point 1

Point 2

356.79	356.79	Inc. Axis Location
23.13	23.49	Surface Location
20.85	21.21	Scan Axis Location
13.05	13.15	Metal Path
117.1	118.1	Time
41	41	% DAC
12.85	12.95	Depth In Material
0.37		Separation

Lower Upper

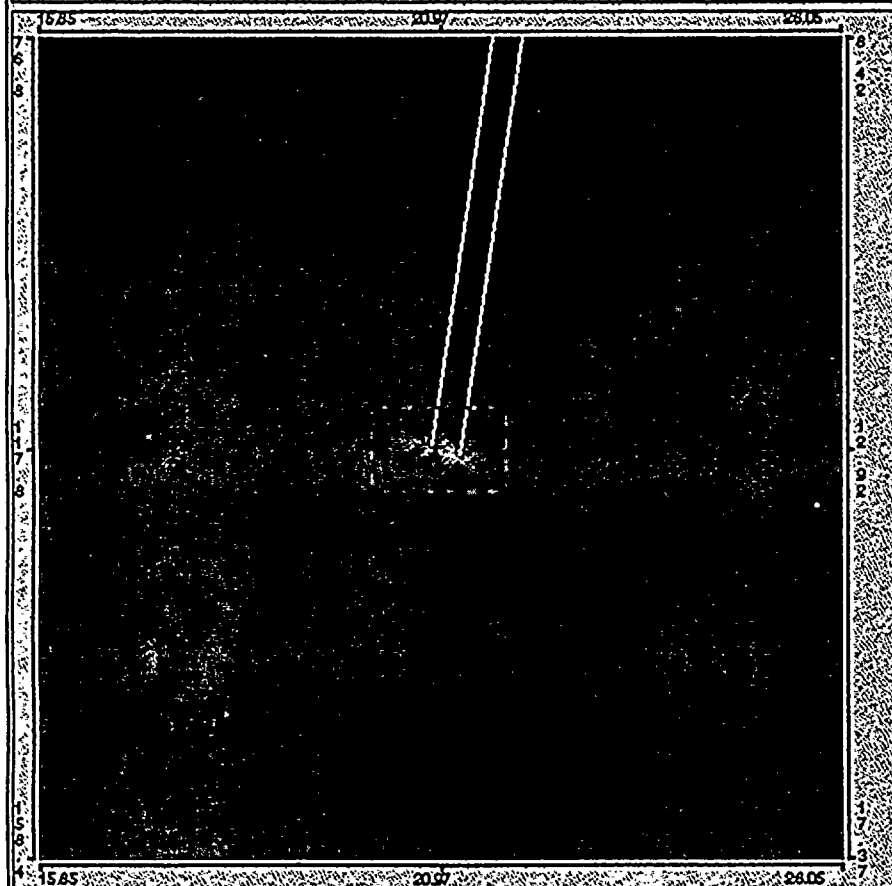
141	143	Scan No. Limits
355.59	358.00	Inc. Axis Limits
12.92		Depth
11.22		Length

Select Maximum Point

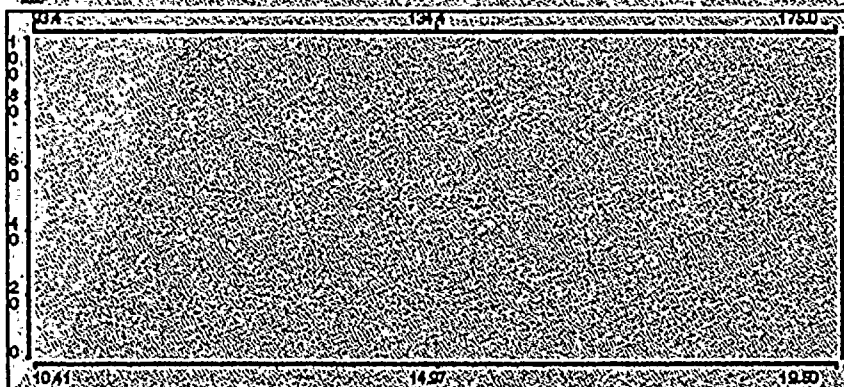
49	% DAC
356.79	Inc. Axis Location
23.41	Surface Location
21.13	Scan Axis Location
13.12	Metal Path
117.8	Time
12.92	Depth In Material

Comments

Ind. # 2: Enhanced Evaluation



Inc. 356.79  
Scan 15.85  
Depth 8.42



141 SCAN NO  
175.60 INC. AXIS  
SCAN AXIS  
TIME  
METAL PATH  
MATERIAL DEPTH  
% SCREEN HEIGHT  
% DAC

## B-SCAN CONTROL OPTIONS

Next B-Scan

Previous B-Scan

## A-SCAN CONTROL OPTIONS

Compressed Display

Replay ☐ OffDirection ☒ ForwardSpeed ☐

Select Scan Axis

Lower 11.97

Upper 40.09

## GEOMETRY OPTIONS

Mode ☒ Off

## FEATURE ANALYSIS OPTIONS

Analyze Cursor Box

## Planar Analysis

(Select Reference Point)

Point 1

Point 2

175.60	175.60	Inc. Axis Location
23.73	24.09	Surface Location
21.13	21.49	Scan Axis Location
14.97	15.01	Metal Path
134.4	134.7	Time
39	43	% DAC
14.74	14.78	Depth In Material
0.36		Separation

Lower

Upper

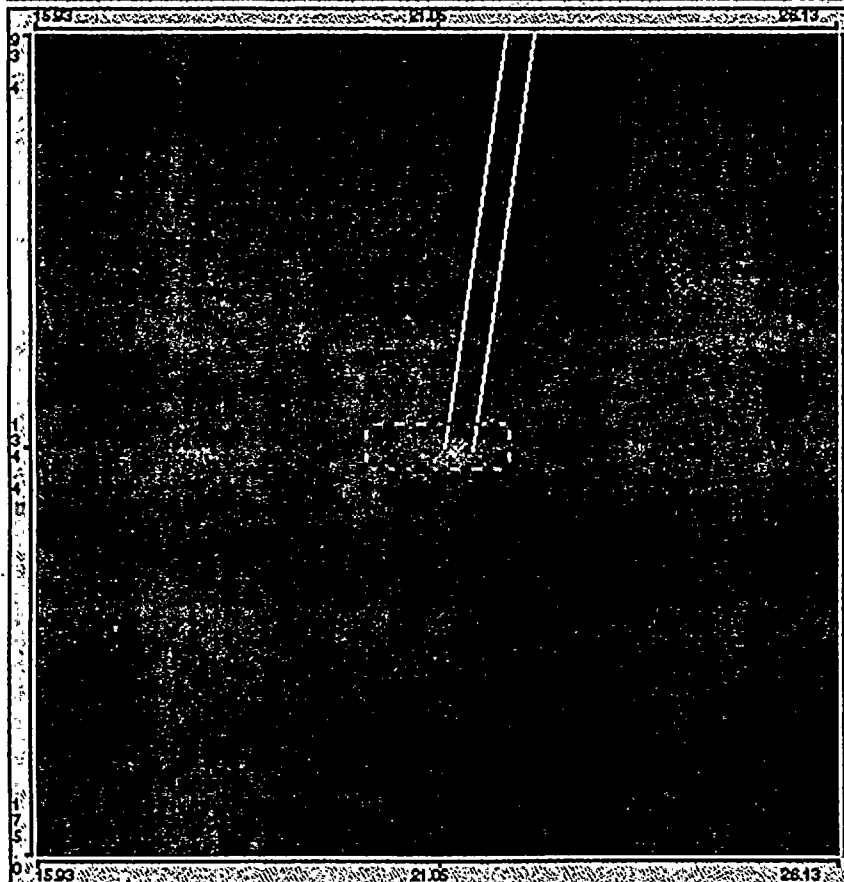
140	142	Scan No. Limits
174.41	176.80	Inc. Axis Limits
14.78		Depth
1.29		Length

(Select Maximum Point)

46	% DAC
175.60	Inc. Axis Location
23.85	Surface Location
21.25	Scan Axis Location
15.01	Metal Path
134.7	Time
14.78	Depth In Material

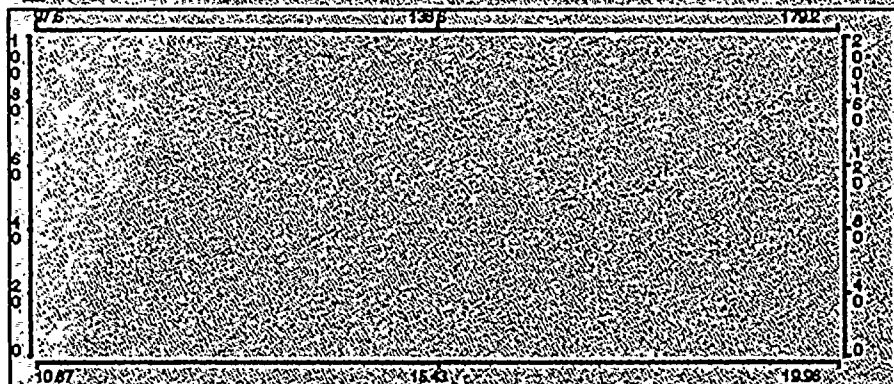
Comments

Ind. H. 4: Enhanced Analysis



Inc. 175.60  
Scan 15.93  
Depth 10.25





125 SCAN NO  
16840 INC. AXIS  
SCAN AXIS  
TIME  
METAL PATH  
MATERIAL DEPTH  
% SCREEN HEIGHT  
% DAC

## B-SCAN CONTROL OPTIONS

Next B-Scan  
Previous B-Scan

## A-SCAN CONTROL OPTIONS

Compressed Display

Replay ☐ Off  
Direction ☐ Forward  
Speed ☐

## Select Scan Axis

Lower 11.97  
Upper 40.09

## GEOMETRY OPTIONS

Mode ☐ Off

## FEATURE ANALYSIS OPTIONS

Analyze Cursor Box

## Planar Analysis

## Select Reference Point

Point 1 Point 2

156.40	156.40	Inc. Axis Location
28.13	28.29	Surface Location
25.45	25.61	Scan Axis Location
15.36	15.40	Metal Path
137.9	138.2	Time
41	41	% DAC
15.13	15.17	Depth In Material
0.16		Separation

Lower Upper

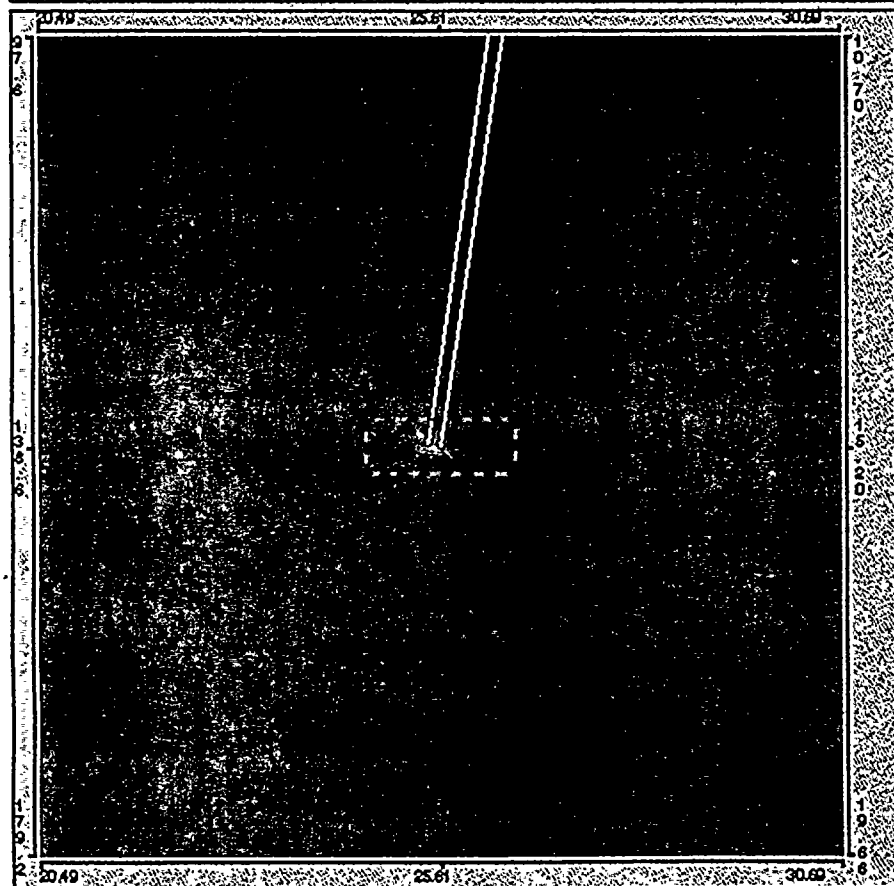
124	126	Scan No. Limits
155.22	157.59	Inc. Axis Limits
15.13		Depth
1.29		Length

## Select Maximum Point

41	% DAC
156.40	Inc. Axis Location
28.13	Surface Location
25.45	Scan Axis Location
15.36	Metal Path
137.9	Time
15.13	Depth In Material

## Comments

Ind. # 3 Enhanced Analysis



Inc. 156.40  
Scan 20.49  
Depth 10.70

DC Cook Unit 2  
2-N4-I  
Inlet Noz. Bore @ 67 deg. Looking TWD

---

Cursor Box 1 of 2  
Scan Axis  
Inc. Axis  
Depth In Material

20.87 - 22.11  
209.90 - 219.89  
4.01 - 5.12

Module Coordinates  
Inc. Axis  
Scan Axis

Channel 1  
-  
28.07 - 29.31

Module Coordinates  
Inc. Axis  
Scan Axis

Channel 2  
-  
24.51 - 25.75

Module Coordinates  
Inc. Axis  
Scan Axis

Channel 3  
32.71 - 42.72  
28.07 - 29.31

Module Coordinates  
Inc. Axis  
Scan Axis

Channel 4  
27.12 - 37.11  
24.51 - 25.75

Feature Analysis  
Comments

Channel 4  
Summary

Enhanced Analysis 7/23/96

---

## Cursor Box 2 of 2

Scan Axis	17.11 - 18.19
Inc. Axis	87.50 - 97.49
Depth In Material	15.62 - 16.05

## Channel 1

## Module Coordinates

Inc. Axis	90.42 - 100.43
Scan Axis	35.91 - 36.99

## Channel 2

## Module Coordinates

Inc. Axis	84.92 - 94.91
Scan Axis	21.95 - 23.03

## Channel 2

## Planar

## Feature Analysis

## Inc. Axis Values

Scan No. Limits	77	79
Inc. Axis Limits	91.91	94.09
Depth		15.83
Length		1.24

## Maximum Point

% DAC	44
Inc. Axis Location	93.00
Surface Location	19.23
Scan Axis Location	17.55
Depth In Material	15.83
Metal Path	15.92
Time	141.4

## Comments

:  
:  
:  
:Indication #1  
Spot

## Channel 3

## Module Coordinates

Inc. Axis	-
Scan Axis	35.91 - 36.99

## Channel 4

## Module Coordinates

Inc. Axis	-
Scan Axis	21.95 - 23.03





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Reviewed By

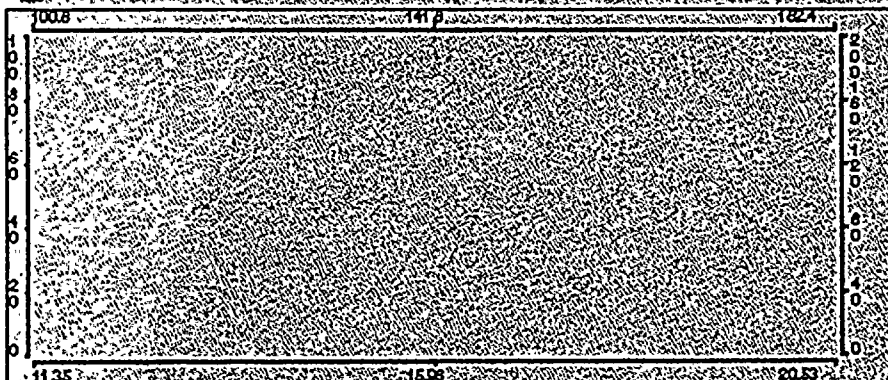
W. Clay

SNT Level

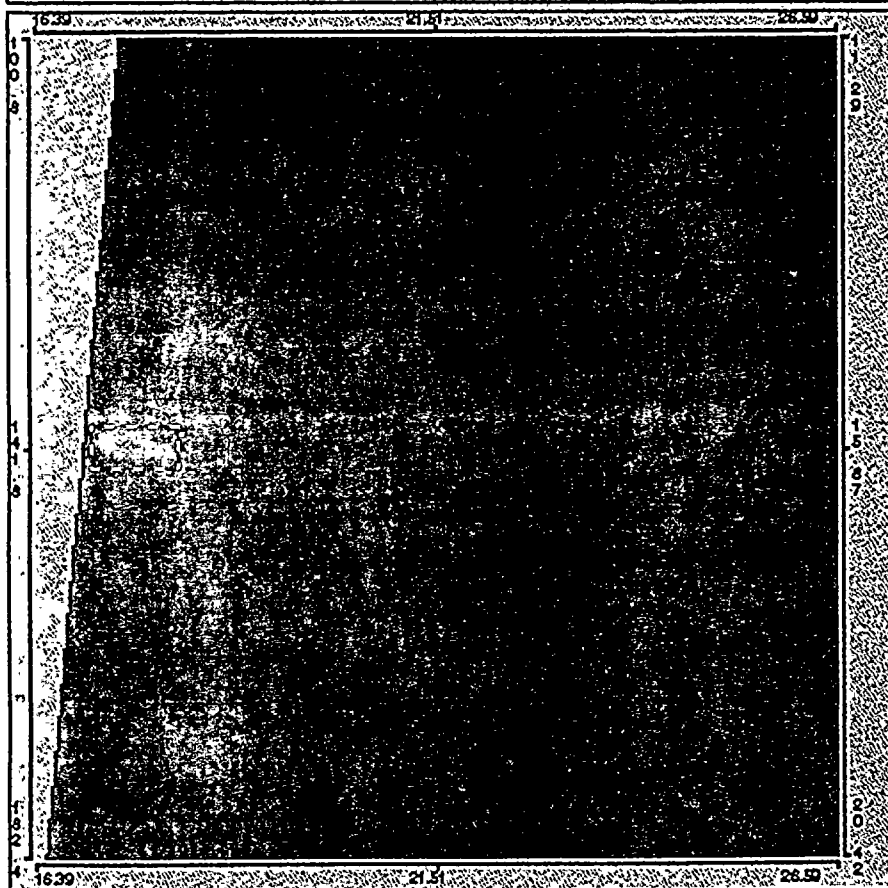
III

Date

8/5/16



78 SCAN NO.  
93.00 INC. AXIS  
26.47 SCAN AXIS  
108.2 TIME  
12.16 METAL PATH  
12.11 MATERIAL DEPTH  
8 % SCREEN HEIGHT  
17 % DAC



## B-SCAN CONTROL OPTIONS

(Next B-Scan)

(Previous B-Scan)

## A-SCAN CONTROL OPTIONS

(Compressed Display)

Replay ☐ OffDirection ☒ ForwardSpeed ☐

(Select Scan Axis)

Lower 16.39

Upper 41.23

## GEOMETRY OPTIONS

Mode ☐ Off

## FEATURE ANALYSIS OPTIONS

(Analyze Cursor Box)

## Planar Analysis

(Select Reference Point)

(Point 1)

(Point 2)

Inc. Axis Location

Surface Location

Scan Axis Location

Metal Path

Time

% DAC

Depth In Material

Separation

(Lower)

(Upper)

77

79

Scan No. Limits

91.91

94.09

Inc. Axis Limits

15.83

(Depth)

1.24

Length

(Select Maximum Point)

44

% DAC

93.00

Inc. Axis Location

19.23

Surface Location

17.55

Scan Axis Location

15.92

Metal Path

141.4

Time

15.83

Depth In Material

Comments

Indication #1

Spot 1

Inc. 93.00  
Scan 16.39  
Depth 11.29

DC Cook Unit 2  
2-N4-I  
Inlet Noz. Bore @ 67 deg. Looking TWD

---

Cursor Box 1 of 4  
Scan Axis  
Inc. Axis  
Depth In Material

20.87 - 22.11  
315.35 - 325.34  
4.01 - 5.12

Module Coordinates  
Inc. Axis  
Scan Axis

## Channel 1

-  
28.07 - 29.31

Module Coordinates  
Inc. Axis  
Scan Axis

## Channel 2

-  
24.51 - 25.75

Module Coordinates  
Inc. Axis  
Scan Axis

## Channel 3

138.22 - 148.14  
28.07 - 29.31

Module Coordinates  
Inc. Axis  
Scan Axis

## Channel 4

132.62 - 142.62  
24.51 - 25.75

Feature Analysis  
Comments

Channel 4  
Summary

:  
:  
:  
:

Analysis performed after enhancement

---

Cursor Box 2 of 4  
 Scan Axis  
 Inc. Axis  
 Depth In Material

21.43 - 23.11  
 294.26 - 304.25  
 15.23 - 15.73

## Channel 1

Module Coordinates  
 Inc. Axis  
 Scan Axis

-  
 39.87 - 41.55

## Channel 2

Module Coordinates  
 Inc. Axis  
 Scan Axis

-  
 26.23 - 27.91

## Channel 3

Module Coordinates  
 Inc. Axis  
 Scan Axis

117.13 - 127.11  
 39.87 - 41.55

## Channel 4

Module Coordinates  
 Inc. Axis  
 Scan Axis

111.52 - 121.53  
 26.23 - 27.91

Channel 4  
Planar

Feature Analysis  
 Reference Points

Inc. Axis Location  
 Surface Location  
 Scan Axis Location  
 Depth In Material  
 Metal Path  
 Time  
 % DAC

299.83	298.72
23.39	24.43
21.75	22.79
15.44	15.58
15.53	15.67
137.9	139.2
41	41

Separation

1.05

Inc. Axis Values

Scan No. Limits  
 Inc. Axis Limits  
 Depth  
 Length

100	103
297.52	300.92
15.44	
1.90	

Maximum Point

% DAC

73

Inc. Axis Location  
 Surface Location  
 Scan Axis Location  
 Depth In Material  
 Metal Path  
 Time

299.83  
 23.87  
 22.23  
 15.44  
 15.53  
 137.9

Comments

:  
 :

Ind. # 2 Enhanced Analysis

Cursor Box 3 of 4  
 Scan Axis  
 Inc. Axis  
 Depth In Material

18.27 - 20.43  
 113.03 - 123.02  
 15.66 - 16.23

Module Coordinates  
 Inc. Axis  
 Scan Axis

## Channel 1

116.02 - 125.92  
 37.11 - 39.27

Module Coordinates  
 Inc. Axis  
 Scan Axis

## Channel 2

110.41 - 120.41  
 23.11 - 25.27

Feature Analysis  
 Reference Points  
 Inc. Axis Location  
 Surface Location  
 Scan Axis Location  
 Depth In Material  
 Metal Path  
 Time  
 % DAC

Channel 2  
Planar

116.30	116.30
20.35	21.71
18.67	20.03
15.90	15.94
15.99	16.03
142.1	142.4
51	49

Separation  
 Inc. Axis Values

1.36

Scan No. Limits  
 Inc. Axis Limits  
 Depth  
 Length

97	100
114.10	117.40
	15.94
	1.88

Maximum Point  
 % DAC

101

Inc. Axis Location  
 Surface Location  
 Scan Axis Location  
 Depth In Material  
 Metal Path  
 Time

116.30  
 21.31  
 19.63  
 15.94  
 16.03  
 142.4

Comments

Ind #1 with Enhanced Analysis  
Depth sized @ 1/2 max

Module Coordinates  
Inc. Axis  
Scan Axis

## Channel 3

-  
37.11 - 39.27

Module Coordinates  
Inc. Axis  
Scan Axis

## Channel 4

-  
23.11 - 25.27

Cursor Box 4 of 4  
Scan Axis  
Inc. Axis  
Depth In Material

24.03 - 26.07  
350.87 - 355.31  
15.19 - 15.76

Module Coordinates  
Inc. Axis  
Scan Axis

## Channel 1

-  
42.43 - 44.47

Module Coordinates  
Inc. Axis  
Scan Axis

## Channel 2

-  
28.83 - 30.87

Module Coordinates  
Inc. Axis  
Scan Axis

## Channel 3

173.71 - 178.12  
42.43 - 44.47

Module Coordinates  
Inc. Axis  
Scan Axis

## Channel 4

168.14 - 172.62  
28.83 - 30.87



Feature Analysis  
Reference PointsChannel 4  
Planar

Inc. Axis Location	353.03	351.92
Surface Location	25.95	27.31
Scan Axis Location	24.31	25.67
Depth In Material	15.44	15.65
Metal Path	15.53	15.74
Time	137.9	139.8
% DAC	38	38
Separation		1.38
Inc. Axis Values		
Scan No. Limits	148	152
Inc. Axis Limits	350.84	355.32
Depth		15.51
Length		2.51
Maximum Point		
% DAC		51
Inc. Axis Location		353.03
Surface Location		26.51
Scan Axis Location		24.87
Depth In Material		15.51
Metal Path		15.60
Time		138.6

## Comments

Ind # 3 Enhanced Analysis

:  
:  
:  
:

Reviewed By

W. Chy

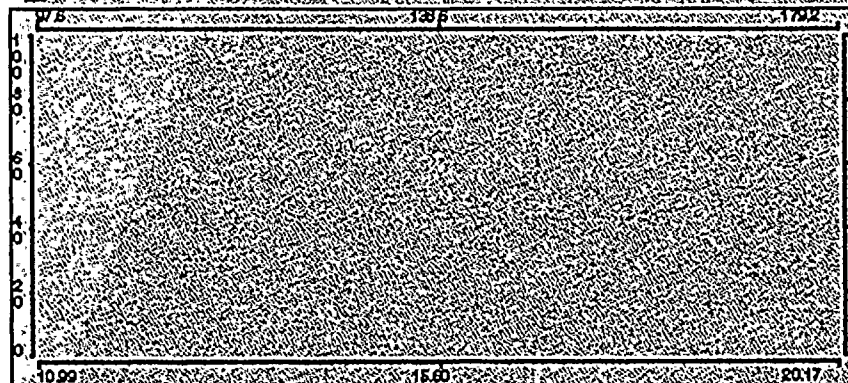
SNT Level

III

Date

8/5/96





149 SCAN NO  
 351.92 INC AXIS  
 SCAN AXIS  
 TIME  
 METAL PATH  
 MATERIAL DEPTH  
 % SCREEN HEIGHT  
 % DAC

## B-SCAN CONTROL OPTIONS

Next B-Scan  
 Previous B-Scan

## A-SCAN CONTROL OPTIONS

Compressed Display  
 Replay ☒ Off  
 Direction ☒ Forward  
 Speed ☒

## Select Scan Axis

Lower 16.39  
 Upper 41.23

## GEOMETRY OPTIONS

Mode ☒ Off

## FEATURE ANALYSIS OPTIONS

Analyze Cursor Box

## Planar Analysis

Select Reference Point

Point 1 Point 2

353.03	351.92	Inc Axis Location
25.95	27.31	Surface Location
24.31	25.67	Scan Axis Location
15.53	15.74	Metal Path
137.9	139.8	Time
38	38	% DAC
15.44	15.65	Depth In Material
	1.38	Separation

Lower Upper

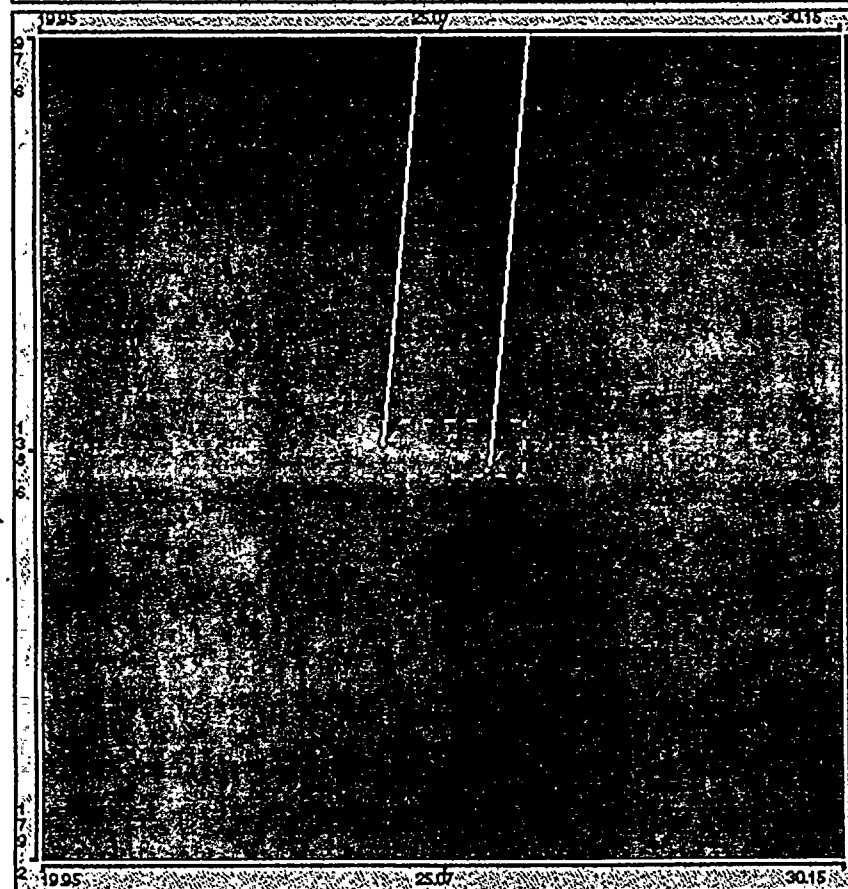
148	152	Scan No. Limits
350.84	355.32	Inc Axis Limits
15.51		Depth
2.51		Length

Select Maximum Point

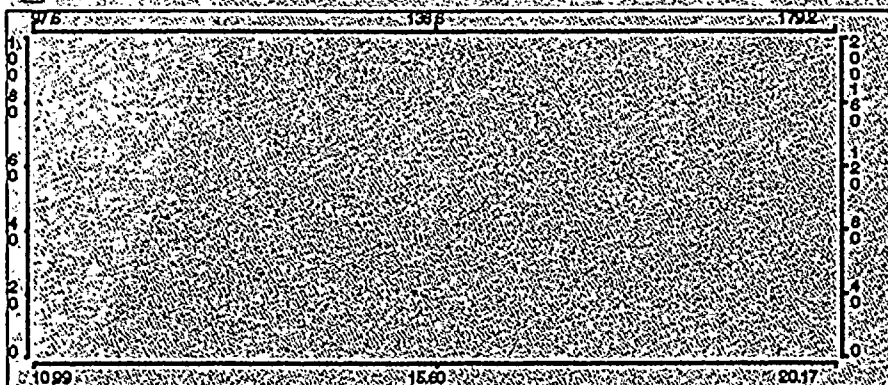
51	% DAC
353.03	Inc Axis Location
26.51	Surface Location
24.87	Scan Axis Location
15.60	Metal Path
138.6	Time
15.51	Depth In Material

Comments

Ind # 3 Enhanced Analysis



Inc. 351.92  
 Scan 19.95  
 Depth 10.93



102 SCAN NO.  
299.83 INC. AXIS  
SCAN AXIS  
TIME  
METAL PATH  
MATERIAL DEPTH  
% SCREEN HEIGHT  
% DAC

## B-SCAN CONTROL OPTIONS

Next B-Scan  
Previous B-Scan

## A-SCAN CONTROL OPTIONS

Compressed Display

Replay ☐ OffDirection ☐ ForwardSpeed ☐

Select Scan Axis

Lower 16.39

Upper 41.23

## GEOMETRY OPTIONS

Mode ☐ Off

## FEATURE ANALYSIS OPTIONS

Analyze Cursor Box

## Planar Analysis

Select Reference Point

Point 1

Point 2

299.83	298.72	Inc. Axis Location
23.39	24.43	Surface Location
21.75	22.79	Scan Axis Location
15.53	15.67	Metal Path
137.9	139.2	Time
41	41	% DAC
15.44	15.58	Depth In Material
	1.05	Separation

Lower Upper

100 103 Scan No. Limits

297.52 300.92 Inc. Axis Limits

15.44 Depth

1.90 Length

Select Maximum Point

73 % DAC

299.83 Inc. Axis Location

23.87 Surface Location

22.23 Scan Axis Location

15.53 Metal Path

137.9 Time

15.44 Depth In Material

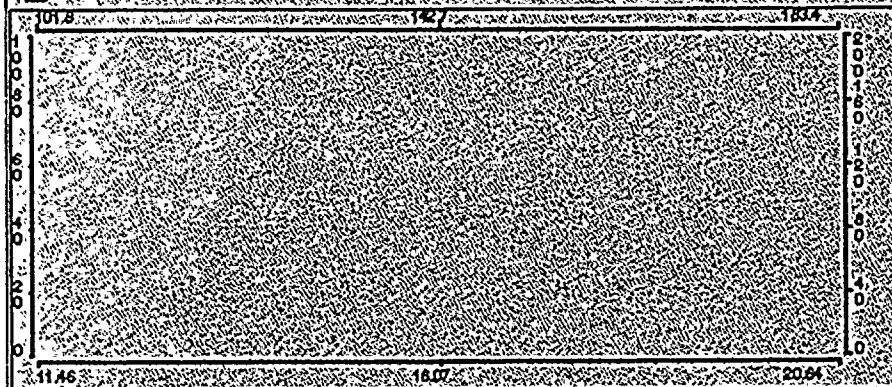
Comments

Ind. H. 2 Enhanced Analysis

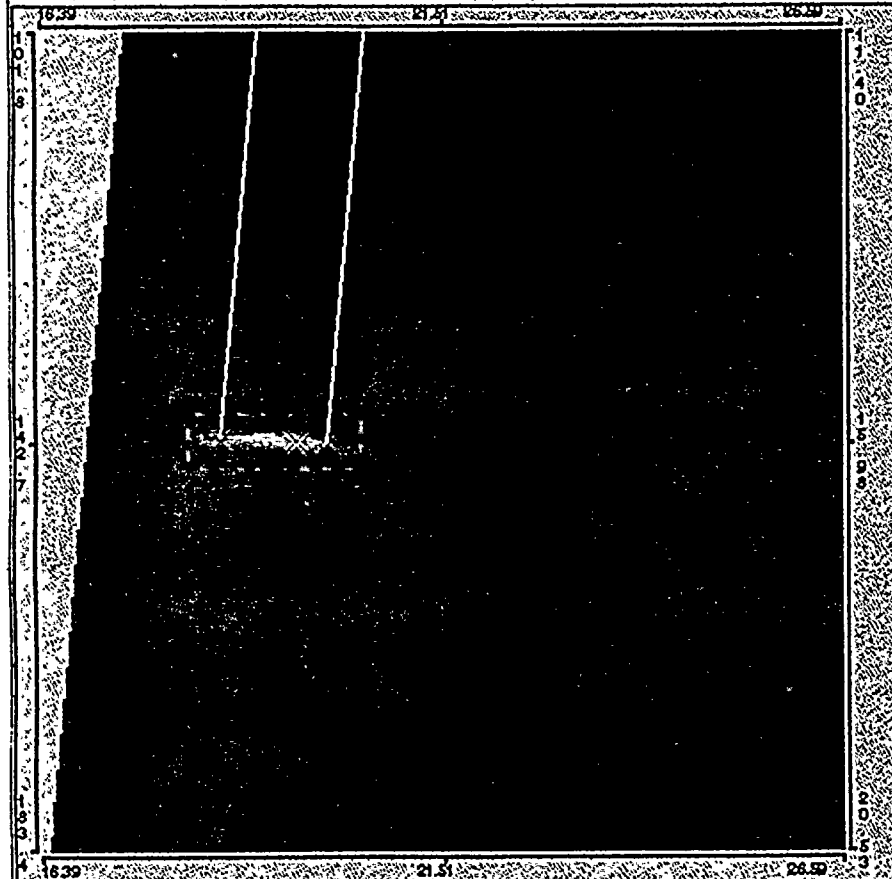
Inc. 299.83  
Scan 17.19  
Depth 10.93



# EDAS B-Scan Display - Channel 2, Refracted Angle 06, Exam Number Exam48a



99 SCAN NO  
116.30 INC. AXIS  
24.65 SCAN AXIS  
112.3 TIME  
12.75 METAL PATH  
12.68 MATERIAL DEPTH  
3 % SCREEN HEIGHT  
7 % DAO



B-SCAN CONTROL OPTIONS  
(Next B-Scan)  
(Previous B-Scan)

A-SCAN CONTROL OPTIONS  
(Compressed Display)  
Replay ☒ Off  
Direction ☒ Forward  
Speed ☐  
(Select Scan Axis)

(Lower) 16.39  
(Upper) 41.23

GEOMETRY OPTIONS  
Mode ☒ Off

FEATURE ANALYSIS OPTIONS  
(Analyze Cursor Box)

Inc. 116.30  
Scan 16.39  
Depth 11.40

## EDAS Feature Analysis - Channel 2

### Planar Analysis

(Select Reference Point)  
(Point 1) (Point 2)  
116.30 116.30 Inc. Axis Location  
20.35 21.71 Surface Location  
18.67 20.03 Scan Axis Location  
15.99 16.03 Metal Path  
142.1 142.4 Time  
51 49 % DAC  
15.90 15.94 Depth in Material  
1.35 Separation

(Lower) (Upper)  
97 100 Scan No. Limits  
114.10 117.40 Inc. Axis Limits  
15.94 (Depth)  
1.88 Length

(Select Maximum Point)  
101 % DAC  
116.30 Inc. Axis Location  
21.31 Surface Location  
19.63 Scan Axis Location  
16.03 Metal Path  
142.4 Time  
15.94 Depth in Material

Comments  
Ind. #1 with Enhanced Analysis  
Depth sized @ 1/2 max

DC Cook Unit 2  
2-N3-I  
Inlet Noz. Bore @ 113 deg. Looking TWD

---

Cursor Box 1 of 3  
Scan Axis  
Inc. Axis  
Depth In Material

20.87 - 22.11  
209.90 - 219.89  
4.01 - 5.12

Module Coordinates  
Inc. Axis  
Scan Axis

## Channel 1

-  
28.07 - 29.31

Module Coordinates  
Inc. Axis  
Scan Axis

## Channel 2

-  
24.51 - 25.75

Module Coordinates  
Inc. Axis  
Scan Axis

## Channel 3

32.71 - 42.71  
28.07 - 29.31

Module Coordinates  
Inc. Axis  
Scan Axis

## Channel 4

27.13 - 37.14  
24.51 - 25.75

Feature Analysis  
Comments

Channel 4  
Summary

:  
:  
:  
:

Analysis performed with  
enhancement

---

## Cursor Box 2 of 3

Scan Axis

24.27 - 26.11

Inc. Axis

169.64 - 179.63

Depth In Material

16.48 - 16.95

## Channel 1

## Module Coordinates

Inc. Axis

172.62 - 182.62

Scan Axis

43.95 - 45.79

## Channel 2

## Module Coordinates

Inc. Axis

167.02 - 177.03

Scan Axis

29.19 - 31.03

## Channel 2

Planar

## Feature Analysis

Inc. Axis Values

Scan No. Limits

151  
174.09153  
176.29

Inc. Axis Limits

Depth

16.66

Length

1.28

Maximum Point

% DAC

44

Inc. Axis Location

175.20

Surface Location

26.63

Scan Axis Location

24.87

Depth In Material

16.66

Metal Path

16.75

Time

148.8

Comments

Ind #2 - Spot

:  
:  
:  
:

## Channel 3

## Module Coordinates

Inc. Axis

-

Scan Axis

43.95 - 45.79

## Channel 4

## Module Coordinates

Inc. Axis

-

Scan Axis

29.19 - 31.03



## Cursor Box 3 of 3

Scan Axis	22.19 - 24.11
Inc. Axis	354.20 - 4.19
Depth In Material	15.05 - 15.48

## Channel 1

## Module Coordinates

Inc. Axis	-
Scan Axis	40.43 - 42.35

## Channel 2

## Module Coordinates

Inc. Axis	-
Scan Axis	26.99 - 28.91

## Channel 3

## Module Coordinates

Inc. Axis	177.03 -
Scan Axis	40.43 - 42.35

## Channel 4

## Module Coordinates

Inc. Axis	171.51 - 181.42
Scan Axis	26.99 - 28.91

Channel 4  
Planar

## Feature Analysis

## Reference Points

Inc. Axis Location	0.81	359.73
Surface Location	24.07	25.39
Scan Axis Location	22.47	23.79
Depth In Material	15.12	15.34
Metal Path	15.20	15.42
Time	135.0	137.0
% DAC	46	44

## Separation

1.34

## Inc. Axis Values

Scan No. Limits	155	159
Inc. Axis Limits	358.61	3.02
Depth	15.19	
Length	2.45	

## Maximum Point

% DAC	70
Inc. Axis Location	0.81
Surface Location	24.83
Scan Axis Location	23.23
Depth In Material	15.19

Metal Path  
Time  
Comments

15.27  
135.7

Ind #1

:  
:  
:  
:

iewed By

W. Clay to

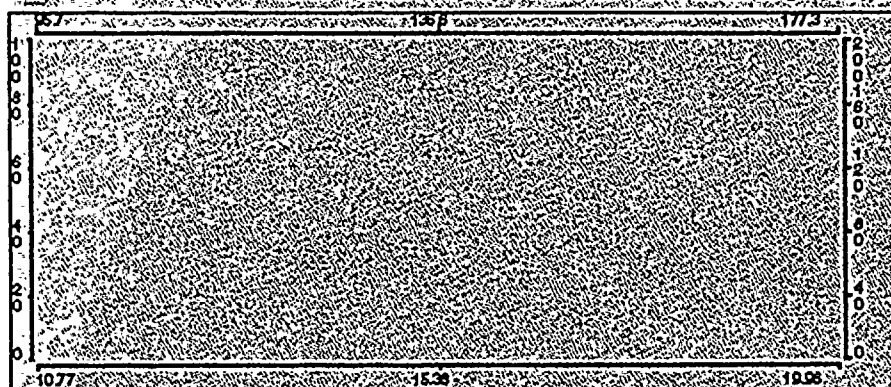
SNT Level

III

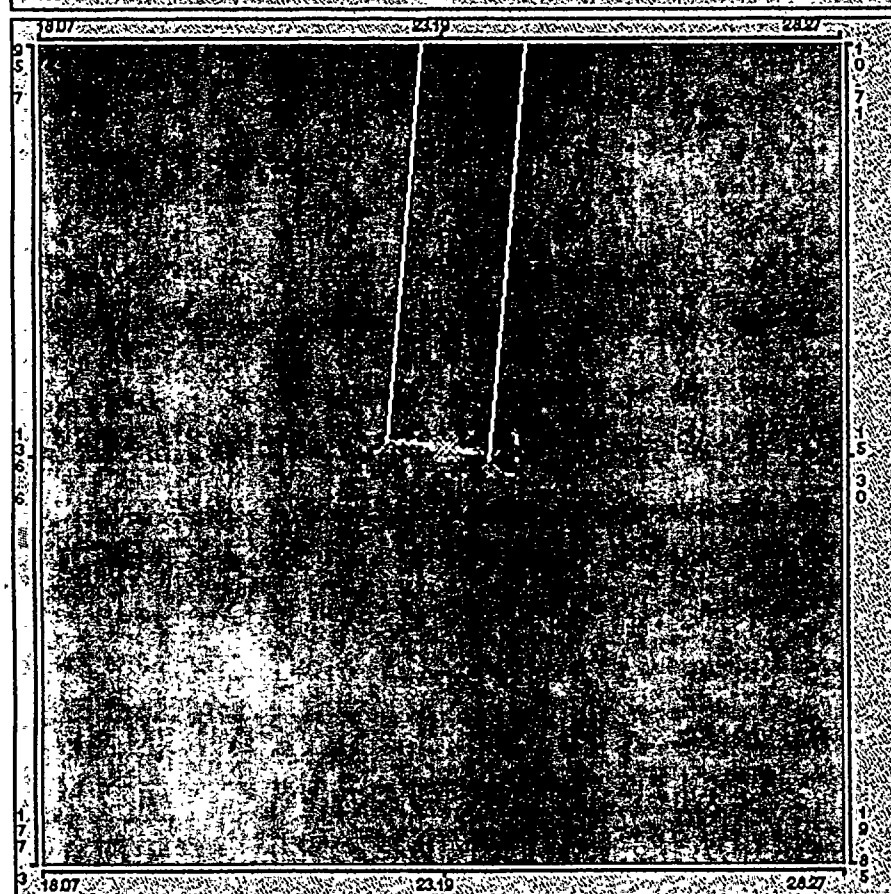
Date

8/5/96





(67) SCAN NO.  
 0.81 INC. AXIS  
 SCAN AXIS  
 TIME  
 METAL PATH  
 MATERIAL DEPTH  
 % SCREEN HEIGHT  
 % DAC



## B-SCAN CONTROL OPTIONS

(Next B-Scan)

(Previous B-Scan)

## A-SCAN CONTROL OPTIONS

Compressed Display

Replay ☐ OffDirection ☐ ForwardSpeed ☐

Select Scan Axis

Lower 16.39

Upper 41.23

## GEOMETRY OPTIONS

Mode ☐ Off

## FEATURE ANALYSIS OPTIONS

Analyze Cursor Box

## Planar Analysis

Select Reference Point

Point 1

Point 2

0.81	359.73	Inc. Axis Location
24.07	25.39	Surface Location
22.47	23.79	Scan Axis Location
15.20	15.42	Metal Path
135.0	137.0	Time
46	44	% DAC
15.12	15.34	Depth In Material
1.34		Separation

Lower

Upper

155 159 Scan No. Limits

358.61 3.02 Inc. Axis Limits

15.19

Depth

2.45

Length

Select Maximum Point

70

% DAC

0.81

Inc. Axis Location

24.83

Surface Location

23.23

Scan Axis Location

15.27

Metal Path

135.7

Time

15.19

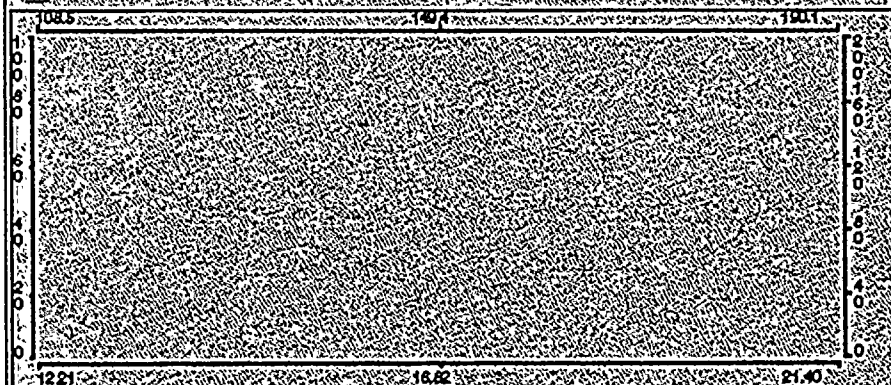
Depth In Material

Comments

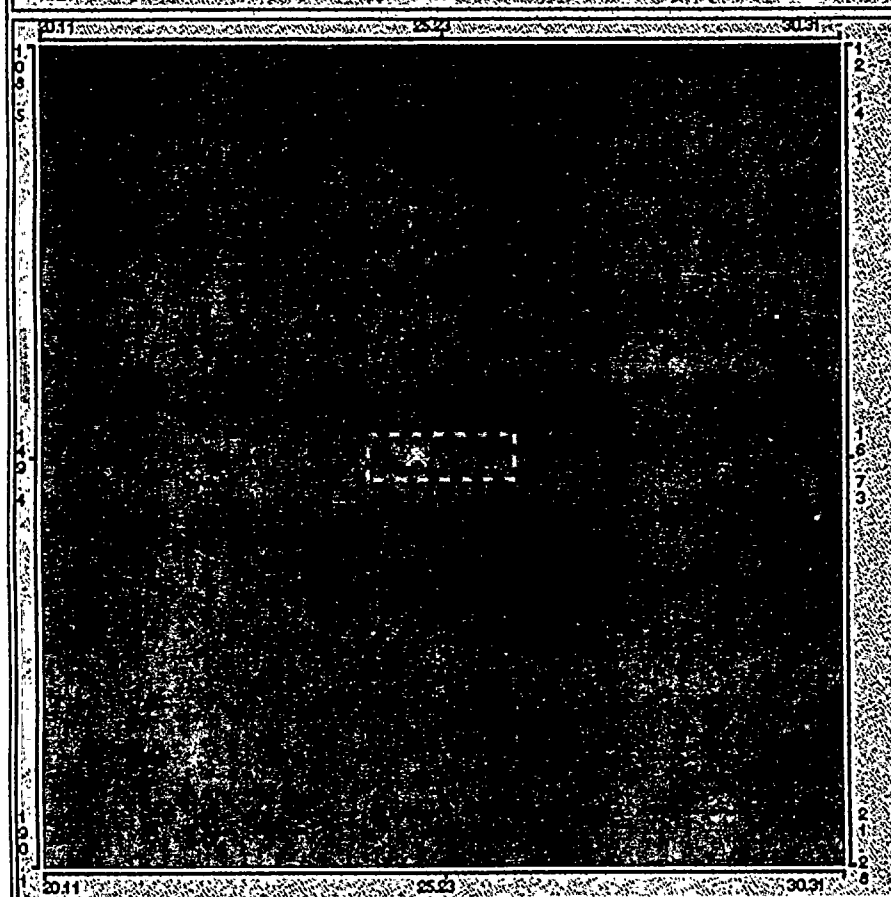
Ind. #1

Inc. 0.81  
 Scan 18.07  
 Depth 10.71





152 SCAN NO.  
175.20 INC. AXIS  
SCAN AXIS  
TIME  
METAL PATH  
MATERIAL DEPTH  
% SCREEN HEIGHT  
% DAC



## B-SCAN CONTROL OPTIONS

Next B-Scan  
Previous B-Scan

## A-SCAN CONTROL OPTIONS

Compressed Display

Replay ☐ OffDirection ☐ ForwardSpeed ☐

Select Scan Axis

Lower 16.39

Upper 41.23

## GEOMETRY OPTIONS

Mode ☐ Off

## FEATURE ANALYSIS OPTIONS

Analyze Cursor Box

## Planar Analysis

Select Reference Point

Point 1

Point 2

Inc. Axis Location

Surface Location

Scan Axis Location

Metal Path

Time

% DAC

Depth In Material

Separation

Lower

Upper

151

153

Scan No. Limits

174.09

176.29

Inc. Axis Limits

16.66

Depth

1.28

Length

Select Maximum Point

44

% DAC

175.20

Inc. Axis Location

26.63

Surface Location

24.87

Scan Axis Location

16.75

Metal Path

148.8

Time

16.66

Depth In Material

Comments

Ind: #2 - Spot

Inc. 175.20  
Scan 20.11  
Depth 12.14



DC Cook Unit 2

2-N2-I

Inlet Noz. Bore @ 247 deg. Looking TWD

-----  
Cursor Box 1 of 1

Scan Axis

19.47 - 21.67

Inc. Axis

290.93 - 295.37

Depth In Material

15.66 - 16.26

Module Coordinates

Channel 1

Inc. Axis

-

Scan Axis

38.31 - 40.51

Module Coordinates

Channel 2

Inc. Axis

-

Scan Axis

24.31 - 26.51

Module Coordinates

Channel 3

Inc. Axis

113.72 - 118.22

Scan Axis

38.31 - 40.51

Module Coordinates

Channel 4

Inc. Axis

108.23 - 112.63

Scan Axis

24.31 - 26.51

Feature Analysis

Channel 4

Reference Points

Planar

Inc. Axis Location

293.13

293.13

Surface Location

21.39

22.91

Scan Axis Location

19.71

21.23

Depth In Material

15.87

16.08

Metal Path

15.96

16.17

Time

141.8

143.7

% DAC

56

55

Separation

1.53

Inc. Axis Values

Scan No. Limits

93

99

Inc. Axis Limits

289.82

296.42

Depth

15.94

Length

3.75

Maximum Point

% DAC

109

Inc. Axis Location

293.13

Surface Location 21.99  
Scan Axis Location 20.31  
Depth In Material 15.94  
Metal Path 16.03  
Time 142.4

## Comments

:  
:  
:  
:

Ind # 1 Enhanced Evaluation 7/26/96  
Length = 50% DAC Depth = 1/2 max

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Reviewed By

W. Clay

SNT Level

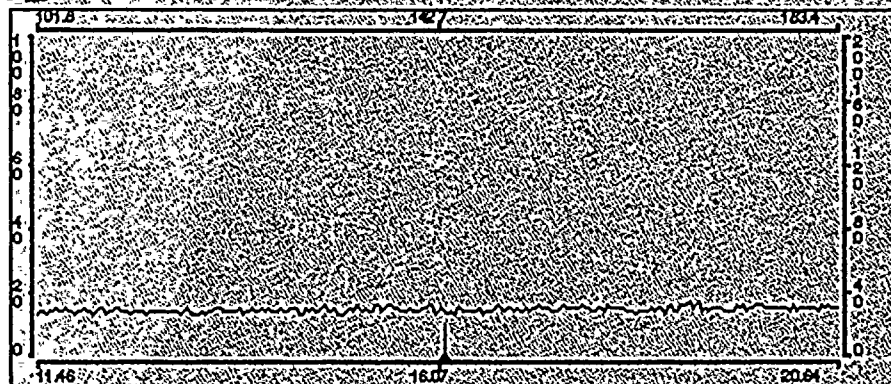
III

Date

8/5/96







98 SCAN NO  
 293.13 INC AXIS  
 26.69 SCAN AXIS  
 143.4 TIME  
 16.14 METAL PATH  
 16.06 MATERIAL DEPTH  
 14 % SCREEN HEIGHT  
 29 % DAC

## B-SCAN CONTROL OPTIONS

Next B-Scan

Previous B-Scan

## A-SCAN CONTROL OPTIONS

Compressed Display

Replay ☒ OffDirection ☒ Forward

Speed

Select Scan Axis

Lower 16.39

Upper 41.23

## GEOMETRY OPTIONS

Mode ☒ Off

## FEATURE ANALYSIS OPTIONS

Analyze Cursor Box

## Planar Analysis

Select Reference Point

Point 1

Point 2

293.13	293.13	Inc Axis Location
21.39	22.91	Surface Location
19.71	21.23	Scan Axis Location
15.96	16.17	Metal Path
141.8	143.7	Time
56	55	% DAC
15.87	16.08	Depth in Material
	1.53	Separation

Lower

Upper

93 99 Scan No. Limits

289.82 296.42 Inc Axis Limits

15.94 Depth

3.75 Length

Select Maximum Point

109 % DAC

293.13 Inc Axis Location

21.99 Surface Location

20.31 Scan Axis Location

16.03 Metal Path

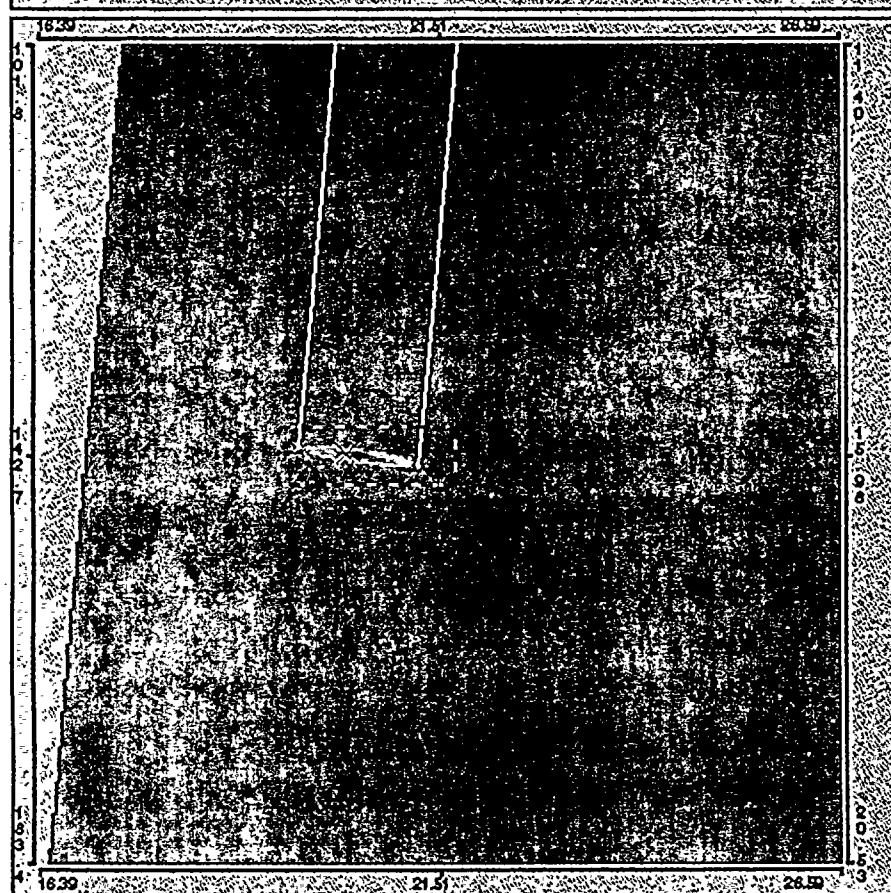
142.4 Time

15.94 Depth in Material

## Comments

Ind # 1, Enhanced Evaluation, 7/26/96

Length = 50% DAC Depth = 1/2 max



Inc. 293.13  
 Scan 16.39  
 Depth 11.40