VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

April 7, 1980

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
Attn: Mr. O. D. Parr, Chief
Light Water Reactors Branch No. 3
Division of Project Management
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Serial No. 315
LQA/ESG:rab

Docket No. 50-339

Dear Mr. Denton:

REACTOR VESSEL NOZZLE INSPECTION REPORT
NORTH ANNA UNIT NO. 2

Enclosed for your use is a report entitled "Assessment of Reheat Cracks in the North Anna No. 2 Reactor Vessel Nozzle Regions." The report includes the results of the recent ultrasonic inspection of the nozzles, and the Westinghouse evaluation of the inspection findings. The report concludes that the reheat cracks found in the vessel nozzles are well within the ASME Code Section XI acceptance limits and do not impair the integrity of the vessel.

Very truly yours,

B. R. Sylvia
Manager-Nuclear Operations
and Maintenance

Enclosure

8004100410

ASSESSMENT OF REHEAT CRACKS IN THE NORTH ANNA NO. 2 REACTOR VESSEL NOZZLE REGIONS

SUMMARY

The ultrasonic test indications observed during the inspection of the North Anna #2 reactor vessel nozzle are characteristic of reheat cracking. This reheat cracking condition has been addressed in the three Westinghouse reports sent to the NRC in 1971 (References 1, 2, 3). These reports include a metallurgical investigation of reheat cracking as well as a fracture mechanics assessment. The reheat cracking was characterized (References 1, 2, 3) as grain boundary separations in the base metal, restricted in depth to the grain coarsened part of the weld heat affected zone (HAZ) beneath the weld bead overlap. The maximum depth of cracking observed in this zone was 0.100 inch. The maximum depth of the HAZ in this overlap area was less than 0.125 inch. (note Section A).

Analyses of the reheat cracks have been made per the method defined in ASME Code Section XI, IWB 3512.1 and are well within the acceptance limits (note Section B).

The assessment of the metallurgical characterization and the ultrasonic test results concludes that the structural integrity of the vessel has not been impaired.

SECTION A - Reheat Cracking - Metallurgical Characterization

Reheat cracking as found in the North Anna nozzles was a subject of an extensive international cooperative research effort around 1970 to 1974. The characteristics of reheat cracking were well-defined and agreed to by the metallurgical and welding groups working on this subject. The results of these programs were documented in the Welding Research Council Bulletin #197 dated August 1974. These results were considered and were concurrently implemented by Regulatory Guide 1.43. The cracking occurred in a region of the coarse grained structure resulting from the first bead which was subsequently reheated to a temperature in the range of 1100° to 1300° F from a second bead applied adjacent to the first bead. During the subsequent post weld heat treatment, this reheated coarse grained region at the overlap area underwent creep at the grain boundaries resulting in intergranular cracking (reheat cracking). The reheat cracking was characterized (References 1, 2, 3) as grain boundary separations in the base metal restricted in depth to the grain coarsened part of the HAZ beneath the weld bead overlap. The maximum depth of cracking observed in this zone was 0.100 inch. In addition reheat cracking has been characterized as multiple cracking, essentially rows of grain boundary separations, which are located in the base material at the overlap of the weld clad bead, Figures 3.1 or 3.4 of Reference 2. The extent of the numbers of these cracks can be seen in Figure 3.2 of Reference 1. This characteristic appearance of a multitude of cracks was observed on all the nozzles in North Anna No. II, note Section B Ultrasonic Test Results. The maximum depth of the HAZ in this overlap area was less than 0.125 in. Reheat cracking occurs in SA508 Class 2 materials after post weld treatment (PWHT) of one layer cladding where high heat input weld overlay cladding procedures were applied (Ref. 1, 2, 3). The weld overlay cladding procedure for the one layer cladding for the North Anna No. 2 nozzle was the automatic gas metal arc process (details in Appendix A). Ultrasonic indications in the nozzle protrusion (note Section B) are not considered to be significant since these indications are located within the 0.65 to 0.74 inch austenitic stainless steel

cladding and the welding procedure used was a low heat input, multilayer, shielded metal arc weld process. The fabricator was Sulzer Brother Limited who was a subcontractor to Rotterdam Dockyard Company (Reference 2, Table Q.1-1).

A review was made to determine whether underclad cracking (cold cracks) could be present; the weld cladding procedure used (Appendix A) precluded the potential for underclad cracking. Underclad cracking has been observed only when a second layer of cladding has been deposited without the use of preheat. There have been no reportable instances of under clad cracking where one layer cladding has been deposited with a cladding procedure requiring preheat and postheat temperatures equivalent to that used for the cladding of the North Anna #2 nozzles.

SECTION B - Ultrasonic Test Results

Description of Ultrasonic Testing Technique

The examinations were conducted from the clad nozzle bore surfaces using 70 longitudinal wave, dual element, transmit-Receive search units manufactured by Krautramer/RTD/BAM. The time. The time base of the instrument was calibrated on 2mm diameter side-drilled holes at depths of 3mm, 7mm, and 11mm. Test sensitivity was established on the flat bottom of a 2mm diameter hole drilled just below the clad/base metal interface in a representative calibration block.

After the test system was calibrated, instrument sensitivity was increased by 6db for scanning. Scanning was conducted on the clad nozzle bore surfaces in both circumferential directions. When an indication was detected, instrument sensitivity was returned to the primary reference level and the maximum amplitude obtained. If the amplitude was equal to or greater than 50% of primary reference, the indication was recorded per the criteria defined in the procedure.

The calibration sensitivity of this examination technique is at least 5 times that required by conventional ASME Section XI examination methods (3/32 side drilled hole). This fact was demonstrated by making a direct comparison between the instrument gain required to set the amplitude of the 2mm diameter flat bottom reference reflector to 80% of full screen height versus that required to obtain the same signal amplitude from a side drilled hole of the same diameter and depth. Calibration on the flat bottom hole resulted in an instrument gain setting 14-16dB greater than that for the side drilled hole.

Areas where reportable indications were detected with the 7 search unit were evaluated with a KBI, Gamma Series, 5.0MHz, 0 , transmit-receive search unit. Calibration for this examination was established on the flat bottom of a 2mm diameter flat bottom hole drilled to the clad/base metal interface in a representative calibration block. Any indication detected by the 70 longitudinal wave inspection and also detectable by the 0 straight beam inspection was considered acceptable by the criteria defined in the test procedure. A copy of the detailed test procedure is attached as Appendix B.

The nozzle bore examinations were conducted by qualified ultrasonic test operators from Sonic Systems International, Houston, Texas under the direct supervision of Westinghouse personnel. Personnel and equipment certification records are on file.

INSPECTION RESULTS

Ultrasonic test results of all six reactor vessel nozzle bores revealed a distinct pattern of individual indications in circumferential rows. (1-1/2" to 2" apart in the axial direction) around the nozzle bore which is characteristic of reheat cracking.

This pattern of reheat tracking can be seen by referring to Figure 3.2 of Reference 2. This figure illustrates that reheat cracks occur in a distance pattern consisting of a multitude on individual cracks aligned to parallel and in discrete rows.

The multitude and repetitive nature of the reflectors noted in the North Anna Unit II nozzles precluded complete recording. Therefore, reflectors were mapped in random sections to demonstrate the repetitive nature of the condition. The reflectors had typical lengths of 3/8" and fell in discrete rows of bands around the nozzles.

Calibration and row data sheets, and ultrasonic reflector plots of all six nozzles are included as Appendix C.

The ultrasonci reflector plots show recordable reflectors which were marked during the ultrasonic examination. All recordable reflectors were not marked and subsequently were not mapped, but these reflectors, fell within the pattern characteristic of reheat cracking. Recording of all indications would have resulted in mapping of rows of reflectors around the entire circumference of the nozzle. Only a sampling of recordable reflectors were marked and plotted to demonstrate the repetitive nature of the indications. The individual reflectors that are plotted are from a row of recordable indications.

Evaluation of Test Results

From the recorded indications and from observations made by Westinghouse personnel during the ultrasonic testing, the reflector characteristics conform quite well with the criteria defined for reheat cracking. Reflector lengths are typically 3/8", lie in discrete bands around the nozzle which are separated by 1 1/2 to 2 inches, and occur in clusters.

Reflector lengths were measured using a 12dB drop method. The longest reflector was found to be 0.5". The inherent conservatism of this sizing method when applied to small reflectors has been demonstrated by the fact that the 2mm diameter flat bottom hole in the nozzle bore calibration block yields an ultrasonically measured length of 7.5mm.

Current NDE technology does not permit a direct measurement of through-wall dimensions. However, many reheat cracks have been destructively examined in earlier investigations (Ref. 1, 2, 3). From these data and from extensive knowledge of the reheat cracking phenomenon a reliable estimate of the through-wall dimensions can b made. These flaws are restricted to the coarse-grained region directly beneath weld bead overlaps and have been found to be less than 0.100" in depth. Since the maximum measured depth of the coarse grained area near the overlap area was 0.125, a conservative assumption of individual crack through-wall dimensions is 0.125." These individual flaws, 0.125" (a) and 0.5 (1), distributed throughout the nozzles in a pattern described in the "Inspection Results" section of this report were characterized according to the rules of IWA-3000, ASME XE, 1972 Edition.

Review of IWA-3000 indicated it was not necessary to apply the criteria of IWA-3330 for multiple planar flaws or IWA-3350 for parallel planar flaws during the characterization process. In the first case, distances between adjacent rows of indications were 1-1/2" to 2", much greater than $2a_1$ (1/4"); refer to ASME XI, 1977 Edition, Figure IWA-3330-1, Surface Flaw #1. In the second case, although the primary planes of individual flaws in a row were less than 1/2" apart, they were not displaced axially so as to significantly increase the effective length of the flaw (1/2"); refer to ASME XI, 1977 Edition, Figure IWA-3350, Semi-Elliptical Surface Flaws.

Thus all indications were characterized as individual planar surface flaws with through-wall dimensions equal to 0.125" and lengths of 0.5" for ASME XI preservice acceptance calculations.

For the North Anna Unit 2 inlet nozzle bores, the nozzle thickness is 13.0" calculated per the method defined in ASME XI, Table IWB-3512.1, note 2, where $t=(t_{n1} + t_{n2}) +2$.

Dimensions t_{n1} and t_{n2} were obtained from nozzle fabrication drawings. For an aspect ratio (a/l) equal to 0.25, the allowable surface defect size is 3.1% of the nozzle thickness (a/t) per Table IWB-3512.1. Given a reheat crack where a=0.125", the actual a/t value is equal to 0.96%, well within acceptable limits. (See Figure 1)

For the North Anna Unit 2 outlet nozzle bores the nozzle thickness is 10.65" per note 2, Table IWB-3512.1. For an aspect ratio (a/l) equal to 0.25, the allowable surface defect size is 3.1% of the nozzle thickness (a/t) per Table IWB-3512.1. The reheat crack through wall dimension of 0.125" translates into an actual a/t value of 1.17%. Again, this value is well within ASME XI acceptance limits for the nozzle bore. (See Figure 2)

Indications in inlet and outlet nozzles in the vicinity of the nozzle safe end welds were evaluated per the 1977 Edition of ASME XI, Table IWB-3514.2. Considering a reheat crack where a=0.125" and l=0.5", the allowable flaw size in percent of the component thickness is 9.5%. The actual flaw size in percent of thickness is 5.0% for the inlet nozzles and 4.7% for the outlet nozzles, acceptable per ASME XI. (See Figure 3)

References

1. Mager, T. R. et al, "Reactor Vessels Weld Cladding - Base Metal Interaction". Westinghouse Report WCAP 7673-L, April 1979.

2. Mager, T. R. et al, "Reactor Vessels Weld Cladding - Base Metal Interaction". Westinghouse Report WCAP 7673-L Addendum 1, August 1971.

3. Mager, T. R. et al, "Reactor Vessels Weld Cladding - Base Metal Interaction". Westinghouse Report WCAP 7733, July 1971.

$t = \frac{tn_1 + tn_2}{2} = 13.0''$

l (LONGEST REFLECTOR) = 0.5" VIA 12dB DROP

$a = 0.125''$

$a/l = .25$

a/t allowable = 3.1%

a/t actual = 0.96%

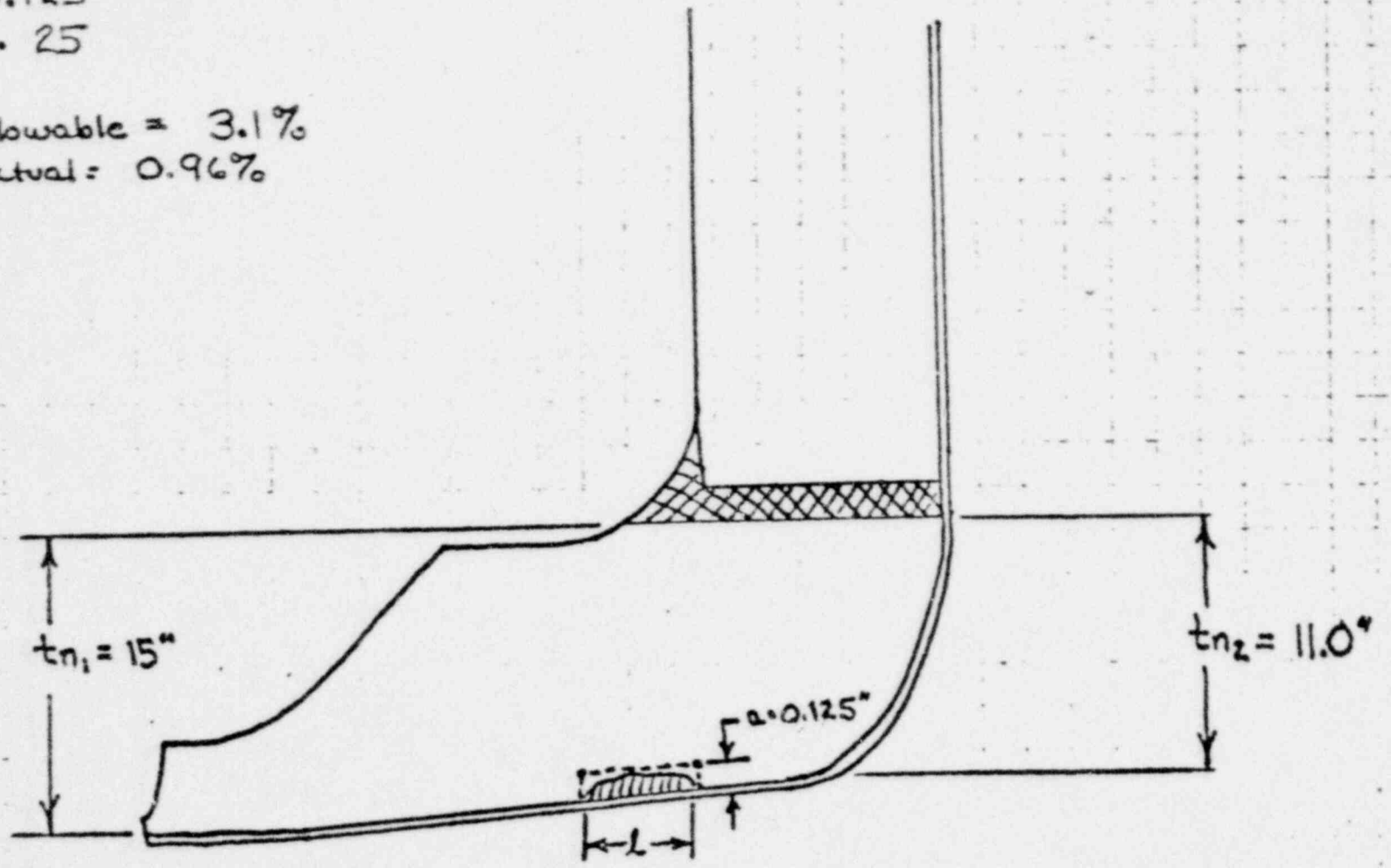


FIGURE 1 : NORTH ANNA UNIT 2 INLET NOZZLE
IWB-3512-1 EVALUATION

$t = \frac{tn_1 + tn_2}{2} = 10.65''$

l (LONGEST REFLECTOR) = 0.5" w/ 12dB DROP

$a = 0.125''$

$a/l = 0.25$

a/t allowable = 3.1%

a/t actual = 1.17%

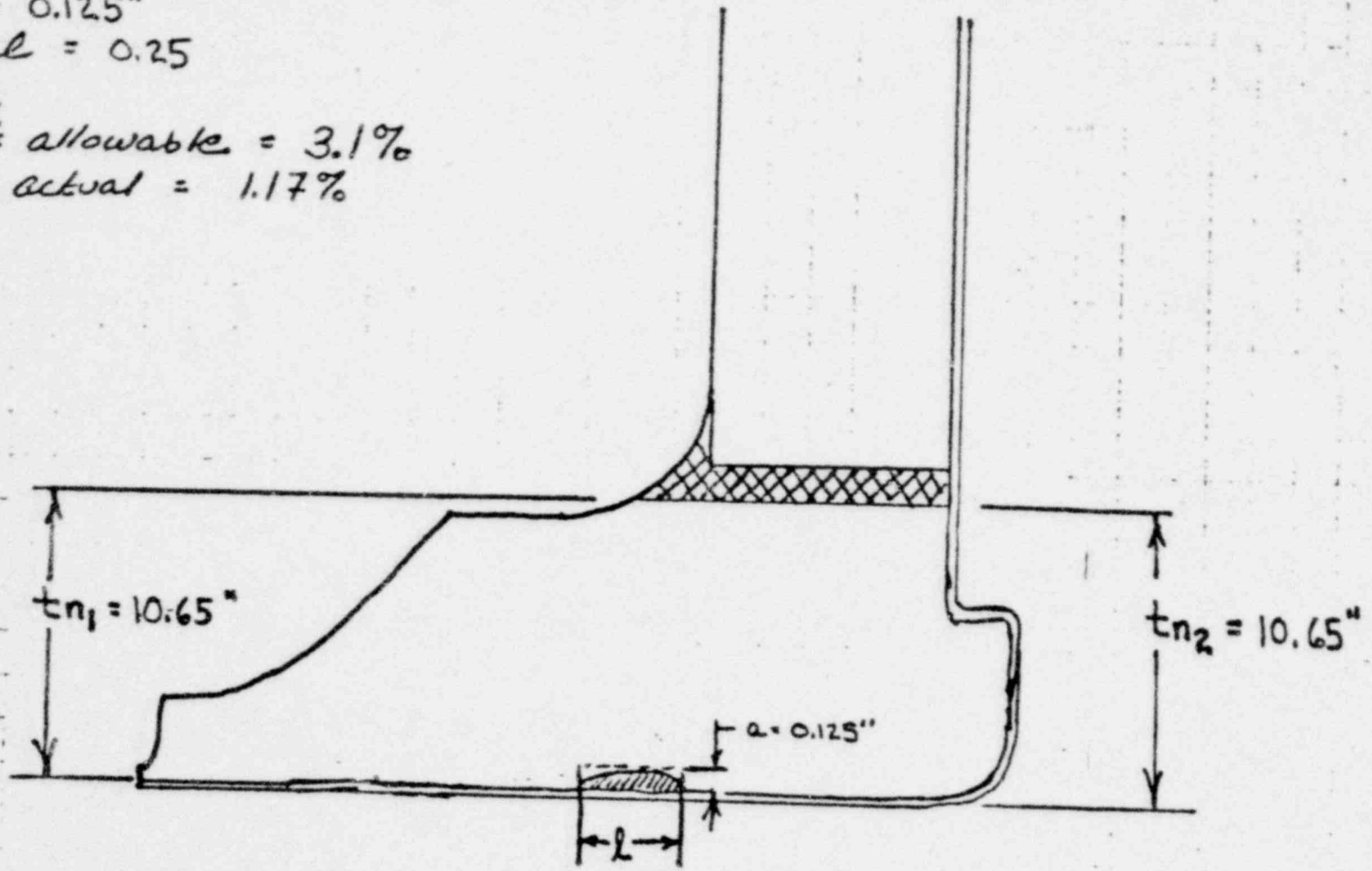
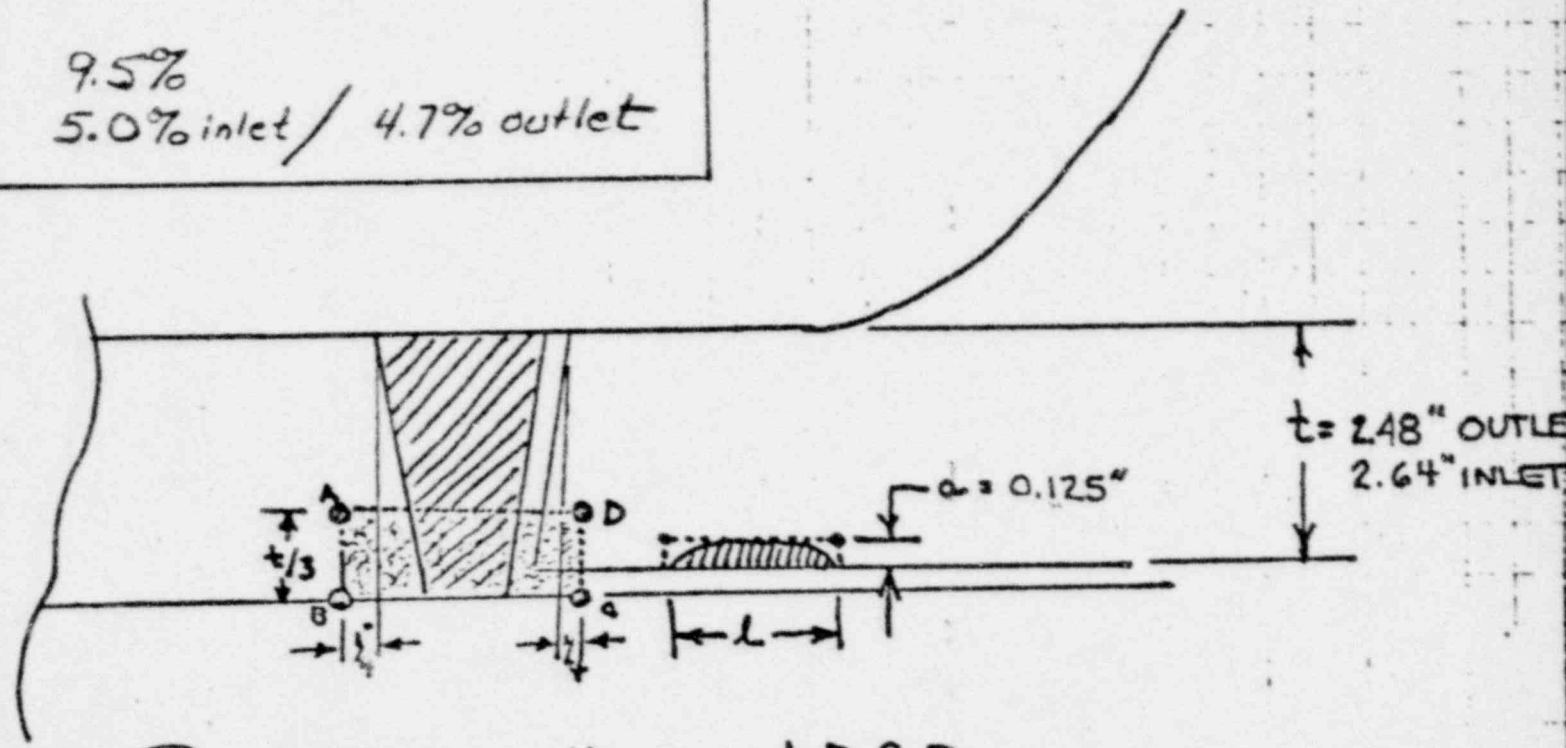


FIGURE 2: NORTH ANNA UNIT 2 OUTLET NOZZLE
IWB-3512-1 EVALUATION

t = 2.48" outlet / 2.64" inlet
l (LONGEST REFLECTOR) = 0.5" r/n 12dB DROP
a = 0.125"
a/l = .25

a/t allowable = 9.5%
a/t actual = 5.0% inlet / 4.7% outlet



NOTE: REQUIRED EXAMINATION VOLUME IS A-B-C-D

FIGURE 3: NORTHANNA UNIT 2 VESSEL NOZZLE IN VICINITY OF SAFE END

IWB-3514.2 EVALUATION (ASME XI 1977)

APPENDIX A

NORTH ANNA NO. 2 NOZZLE
CLADDING PROCEDURE

1) Base material specification grade and type.

The base material of all nozzles in the North Anna No. 2 reactor vessel is ASTM A-508, cl. 2.

2) Process type, electrode sizes

Single layer clad using automatic gas metal arc with cold wire addition and oscillation, 2 wire process using 1/16" diameter wire

3) Heat input for each layer (Amps, volts, speed)

Amps = 230 - 290; Volts = 34 ± 2; Speed = 4 inches/minute

4) Pre-heat, post-heat, interpass temperature

Pre-heat temperature = 120°C (250°F) minimum. Post-heat temperature = raise pre-heat temperature to 205°C (400°F), hold for 2 hours, cool to ambient (soaking heat treatment.) Interpass temperature = 200°C (392°F) maximum.

5) Post weld heat treatment (PWHT)

Intermediate PWHT = 1100°F - 1175°F held for 15 minutes
Final PWHT = 1100°F - 1175°F held for 1 hour/in weld thickness.

6) Stress relief heat treatment

Stress relief heat treatment is the same as shown in Item 5 above.

7) Manufacturer and sub-contractors

The reactor vessel was manufactured by Rotterdam Dockyard Company, Rotterdam The Netherlands. The nozzles were clad by Sulzer Brothers Limited, Winterthur, Switzerland as a sub-contractor to Rotterdam.

APPENDIX B

ULTRASONIC TEST PROCEDURE

ULTRASONIC TEST PROCEDURE FOR DETECTION OF SUB-CLADDING CRACKS IN REACTOR VESSEL NOZZLE BORES

1.0 SCOPE

1.1 This document describes the ultrasonic testing technique and evaluation criteria to establish the existence of cracks beneath cladding on reactor vessel nozzle bores.

2.0 EQUIPMENT

2.1 Pulse-echo ultrasonic equipment shall be used. The instrument shall be equipped with dB calibrated gain or attenuation controls.

2.2 A dual-element, transmit-receive, 2.0 MHz, 70° longitudinal wave search unit shall be used for the primary examination. This search unit shall be of the type Krautkramer-RTD-BAM SE-70-L2-150-F18, or equivalent.

2.3 A dual-element, transmit-receive, 2.0 - 5.0 MHz, miniature 0° longitudinal wave search unit shall be used to aid in evaluation of reflectors. This search unit shall be of the type Krautkramer SEB-4-KF-8, or equivalent.

2.4 Glycerine or an equivalent shall be used in sufficient quantity to maintain continuous coupling of the search unit to the part being examined.

2.5 A reference block shall be provided for calibration of the ultrasonic test system. The block shall be clad using a process and material representative of that used on the production part. The contour of the block shall be representative of the ID of the nozzle bore. The block shall contain 2mm diameter side drilled holes at locations specified in Figure 1.

3.0 SURFACE FINISH, CLAD THICKNESS, AND PREPARATION

3.1 All examinations will be conducted from the clad surface of the nozzle bore. The clad surface shall be free from dirt, weld spatter, or any other foreign material that might interfere with free movement or contact of the search unit.

3.2 The clad surface finish of the reference block shall be no better than that of the part being tested.

3.3 The defects of concern are located in the heat-affected-zone of the nozzle material, just below the clad/base metal interface. To aid in evaluation of reflectors it is important to have as much information as possible concerning the nominal clad thickness.

3.4 Divide the nozzle bore into four equal sections to aid in scanning and recording of reflectors. Measure the circumference of the nozzle bore at the vessel and piping ends to establish the locations of the 0°, 90°, 180°, and 270° axes. Mark these axes along the entire length of the nozzle bore with an approved, semi-permanent marking pen.

4.0 SWEEP RANGE CALIBRATION

4.1 Establish a linear sweep presentation for the 70° examination system by adjusting the instrument delay and range controls to set the maximum responses from the side drilled holes whose axes are perpendicular to the clad bead direction such that each screen division represents 2mm of depth.

See Figure 1, reference holes "A", "B", and "C".

4.2 Establish a linear sweep presentation for the 0° T-R examination system by adjusting the instrument delay and range controls to set the maximum responses from the side drilled holes whose axes are perpendicular to the clad direction such that each screen division represents 2mm of depth.

See Figure 1, reference holes "A", "B", and "C".

5.0 TEST SENSITIVITY

5.1 Establish the test sensitivity for the 70° examination system by adjusting the instrument gain controls to obtain an 80% of full screen height indication from the flat bottom of the 2mm diameter hole drilled just below the clad/base metal interface and parallel to the clad bead direction. This is the primary reference level.

See Figure 1, reference hole "D".

5.2 Establish the test sensitivity for the 0° transmit-receive examination system by adjusting the instrument gain controls to obtain an 80% of full screen height indication from the flat bottom of the 2mm diameter hole drilled through carbon steel to the clad/base metal interface. This is the primary reference level.

See Figure 1, reference hole "E".

6.0 SCANNING - 70° EXAMINATION

6.1 Scanning with the 70° search unit shall be performed from the clad surface in both circumferential directions, i.e., parallel to the welding direction. The entire nozzle bore shall be examined in this fashion.

6.2 The scanning speed shall not exceed 6 inches per second.

6.3 Each scan shall overlap the previous scan by at least 25% of the search unit width to assure complete examination coverage.

6.4 Scanning shall be performed using a minimum gain setting of two times the primary reference level (+ 6 dB). All indications shall be evaluated at the primary reference level.

7.0 RECORDING OF REFLECTORS - 70° EXAMINATION

7.1 Indications equal to or greater than 50% of the primary reference level defined in paragraph 5.1 shall be recorded and their locations marked on the nozzle bore for further evaluation with the 0° transmit-receive examination system.

7.2 The specific sequence for data recording is provided below.

7.2.1 Record the maximum amplitude of the reflector, a) in percent of the primary reference level when reflector amplitude is less than the primary reference level, or b) by number of dB required to reduce the maximum amplitude to the primary reference level when the reflector amplitude is greater than the primary reference level; i.e., "100% + 6" when reflector maximum amplitude is 200% of reference.

7.2.2 Record the search unit location where the maximum amplitude is observed. Axial location shall be measured from the safe-end, circumferential location shall be measured from the nearest longitudinal axis of the bore; 0°, 90°, 180° or 270°.

7.2.3 Record the scanning direction, clockwise or counter-clockwise as viewed from the large diameter end of the nozzle (vessel side).

7.2.4 Record the depth of the reflector at the location of maximum amplitude as read from the instrument sweep.

7.2.5 Record the length of the reflector as determined by the "12 dB drop" method. Move the search unit to the left of the point of maximum amplitude until the reflector amplitude drops to 25% of maximum. Mark this point. Then move the search unit to the right of the point of maximum amplitude until the reflector again drops to 25% of maximum. The distance between these two points is the reflector length.

7.2.6 Mark the reflector location on the nozzle bore surface with an approved, semi-permanent marking pen.

7.2.7 Rotate the search unit 180° and scan the area of interest to establish whether the reflector can be detected when scanning in the opposite circumferential direction. Record any indication, regardless of amplitude, per paragraphs 7.2.1 through 7.2.5.

8.0 EVALUATION OF REFLECTORS WITH THE 0° TRANSMIT-RECEIVE EXAMINATION SYSTEM

8.1 Only areas where indications are detected with the 70° search unit shall be scanned with the 0° transmit-receive examination system. Any indication detected with the 0° transmit-receive search unit, regardless of amplitude, shall be recorded.

8.1.1 Record the maximum amplitude of the reflector, a) in percent of the primary reference level when reflector amplitude is less than the primary reference level, or b) by number of dB required to reduce the maximum amplitude to the primary reference level when the reflector amplitude is greater than the primary reference level; i.e., "100% + 6" when reflector maximum amplitude is 200% of reference.

8.2.1 Record the depth of the reflector at the location of maximum amplitude as read from the instrument sweep.

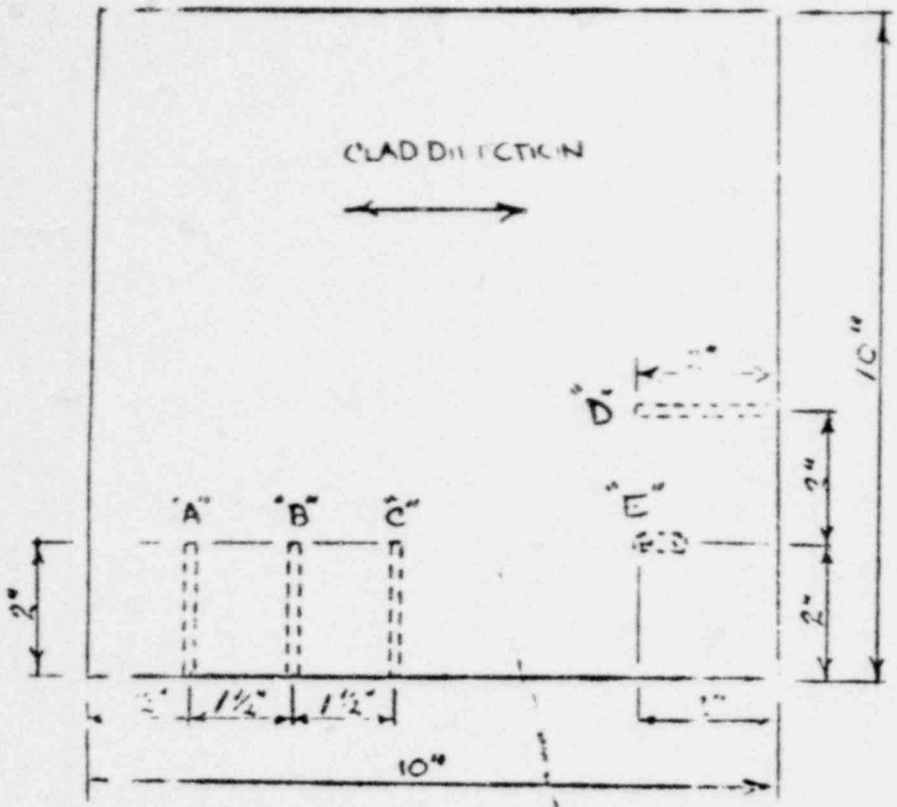
9.0 REFLECTOR CHARACTERIZATION

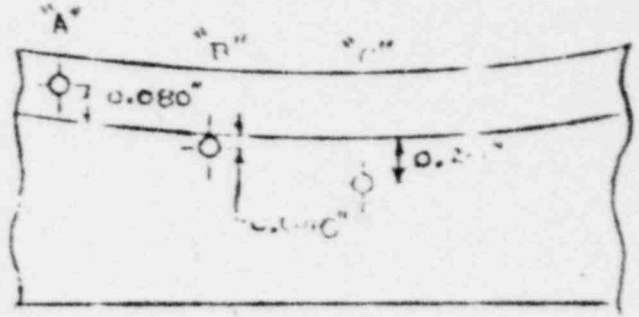
9.1 Reflectors which meet the following criteria are considered indicative of inclusions, porosity, or lack of bonding between the cladding and base material. They are, therefore, considered innocuous.

9.1.1 Any indication detected by the 70° examination, regardless of amplitude, at a depth with in the weld-deposited, stainless steel cladding.

9.1.2 Any indication detected by the 70° examination, regardless of amplitude, also detected by the 0° transmit-receive examination at a corresponding location and at a depth within ± 2mm of that predicted by the 70° test.

9.2 Reflectors who exhibit characteristics other than those described above are considered suspect and will be subject to evaluation on an individual basis.

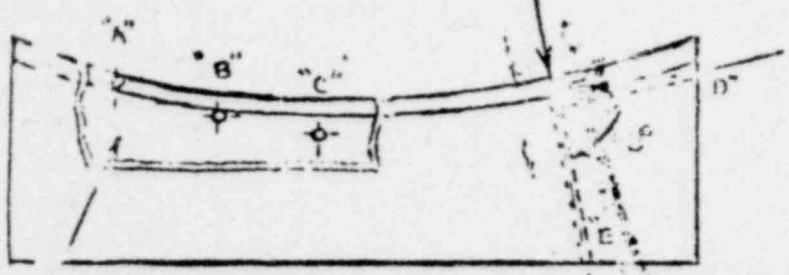




VIEW A

NOTES:

1. ALL DRILLED HOLES ARE 2mm ϕ (5/64") WITH FLAT BOTTOMS.
2. THE FLAT BOTTOM OF HOLE "D" SHOULD BE PARALLEL TO THE BLOCK RADIUS
3. THE FLAT BOTTOM OF HOLE "E" SHOULD BE PERPENDICULAR TO THE BLOCK RADIUS.
4. CLAD SURFACE FINISH SHALL BE REPRESENTATIVE OF THE NOZZLE BEING EXAMINED.



~16" RADIUS

SEE ENLARGED "VIEW A" FOR HOLE LOCATIONS.

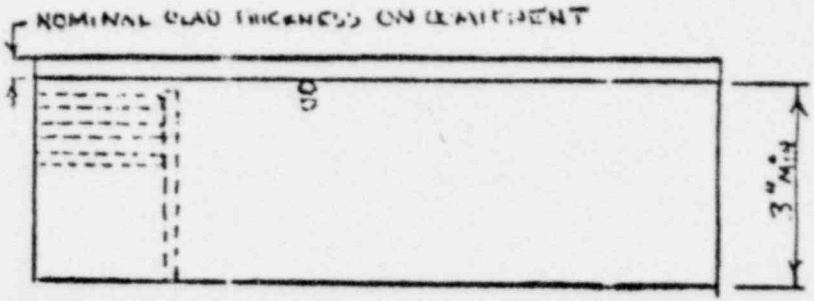
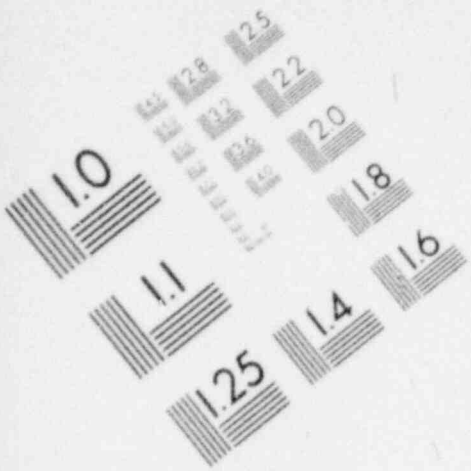


FIGURE 1: CALIBRATION BLOCK FOR EXAMINATION OF NOZZLE WELDS FOR DETECTION OF CRACKING BENEATH THE CLADDING, RECOMMENDED DESIGN.

POOR ORIGINAL



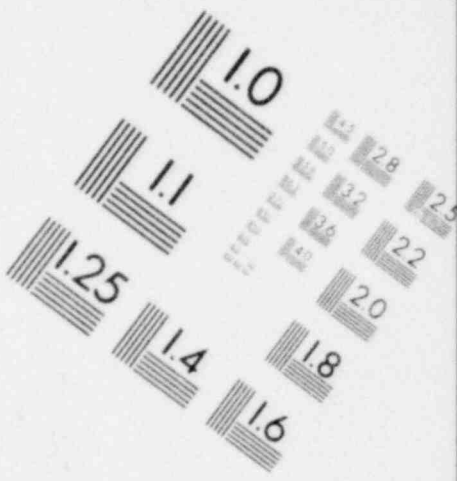
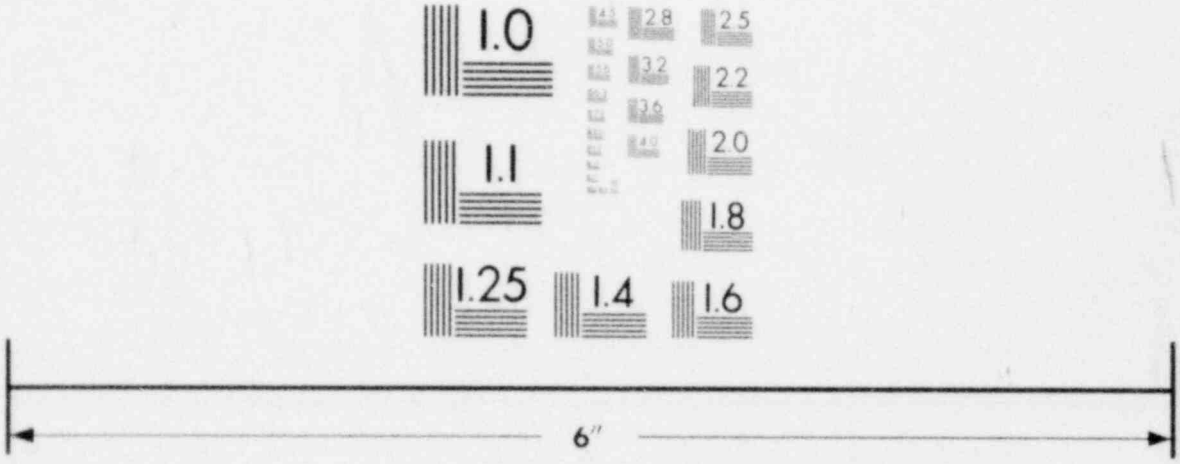
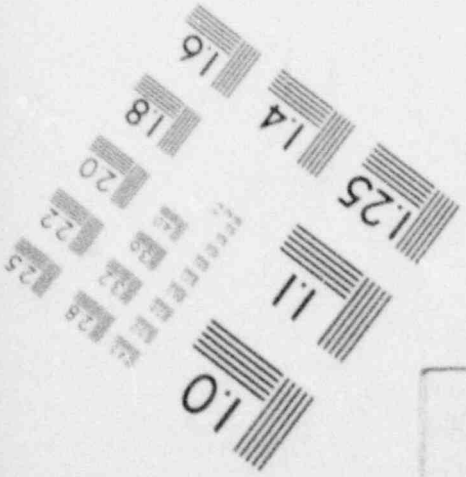
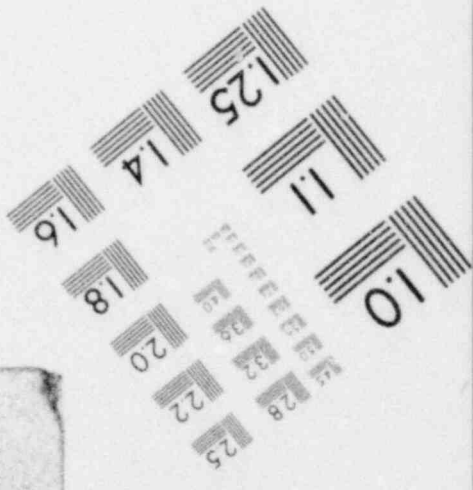


IMAGE EVALUATION
TEST TARGET (MT-3)



MICROCOPY RESOLUTION TEST CHART





Plant/Unit _____
Comp/System _____

CALIBRATION DATA SHEET

#

Data Sheet No. _____
Procedure No. _____
Subject _____
Rev/Change No. _____
Calibration Block No. _____
Surface _____

INSTRUMENT SETTINGS
Mfg/Model No.:
Serial No. :
Sweep Length :
Sweep Delay :
Pulse Length/Damping:
Freq.: Rep. Rate:
Filter: Video: Jack:
DEC/Gate Switch: Range:
Mode Select: Reject:
Gain (coarse): (fine):

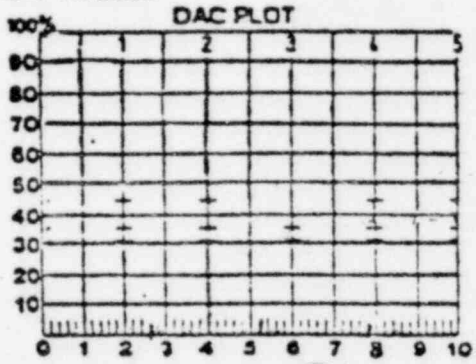
SEARCH UNIT
Scan Angle: Mode:
Fixturing (if any):
Style or Type No. :
Size & Shape :
Frequency :
Serial No/Brand:
Measured Angle :
Couplant Brand:
Couplant Batch:

IDENT	DEPTH	AMPL. %	ATTEN. dB

INSTR. LINEARITY CAL.					
Amplitude					
	High	Low		High	Low
1			5		
2			6		
3			7		
4			8		

SCAN AREA	

DAC PLOT



AMPL. CONTROL LINEARITY		
Initial	Δ dB	Result
80	-6	
80	-12	
40	+6	
20	+12	

EXAMINATION WELD/AREA	RECORDABLE INDICATION		COMMENTS/REASON FOR INCOMPLETED SCAN(S)
	Yes	No	

CALIBRATION CHECKS	TIME
Initial Cal.	
Intermediate	
Intermediate	
Intermediate	
Final Cal.	

ADDITIONAL SHEETS? (CHECK BOX)			
Continuation			
Supplements		None	

EXAMINERS 1 _____ Date _____ Level _____

2 _____ Date _____ Level _____

REVIEWER _____ Date _____

POOR ORIGINAL

Plant/Unit _____ Calibration Data Sheet # _____

Comp/System _____

Examiners 1. _____ Level _____

2. _____ Level _____

Date _____

Reviewer _____ Date _____

POOR ORIGINAL

Indication #	Between axes	70° Longitudinal Data			Location			0°T-2 Data	
		Amplitude	Depth	Length	Nearest Axis	Distance from N.A.	Distance from Seta End	Ampl.	Depth
		CW							
		CCW							
		CW							
		CCW							
		CW							
		CCW							
		CW							
		CCW							
		CW							
		CCW							
		CW							
		CCW							
		CW							
		CCW							
		CW							
		CCW							
		CW							
		CCW							
		CW							
		CCW							
		CW							
		CCW							
		CW							
		CCW							
		CW							
		CCW							
		CW							
		CCW							

Addendum #1
12/21/79

POOR ORIGINAL

ULTRASONIC TEST PROCEDURE FOR DETECTION OF SUB-CLADDING CRACKS IN REACTOR VESSEL NOZZLE BORES

1.0 SCOPE

1.1 This document provides supplementary calibration requirements and additional scanning requirements for outlet nozzles.

5.0 TEST SENSITIVITY

Add the following paragraph

5.3 "Calibration shall be checked at four hour intervals during the examination. If, during any calibration check it is determined that the primary reference amplitude has decreased by 20% of its amplitude, all data sheets since the last calibration check shall be marked void, a new calibration sheet made, and the voided examination areas reexamined.

If the primary reference amplitude has increased by 20% of its amplitude, all recorded indications since the last valid calibration check shall be reevaluated with the corrected calibration and their values shall be changed on the data sheets".

6.0 SCANNING - 70° EXAMINATION

5.1 Add the following sentence

"The end face of all outlet nozzle projections shall be scanned in two circumferential and two radial directions".

APPENDIX C

UT CALIBRATION SHEETS AND UT REFLECTOR MAPS

Plant/Unit NORTH ANNA II
Comp/System REACTOR NOZZLE LOOP A INLET

CALIBRATION DATA SHEET
4

Data Sheet No. UT Procs for
Procedure No. Detection of
Subject Sub-Cladding Cracks
Rev/Change No. in RV Nozzle
Calibration Block No. Bosa
Surface

INSTRUMENT SETTINGS	
Mfg/Model No.:	SONIC MARK I
Serial No. :	01057E
Sweep Length :	1-1.36
Sweep Delay :	2-0.05
Pulse Length/Damping:	MIN
Freq.: 2 MHz	Rep. Rate: 3K
Filter: Hi	Video: N/A Jack: T
DEC/Gate Switch: OFF	Range: 1"
Mode Select: N/A	Reject: OFF
Gain (coarse): 80	(fine): 4

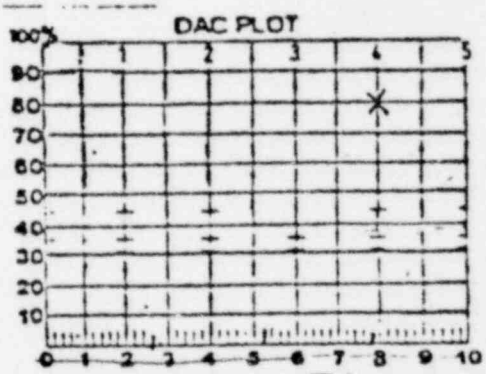
SEARCH UNIT	
Scan Angle: 70°	Mode: RL
Fixturing (if any):	
Style or Type No. :	RTD-BAM
Size & Shape :	18 MM Ø
Frequency :	2.0 MHz
Serial No/Brand :	KRAUTKRAMER 591-135
Measured Angle :	70°
Couplant Brand:	SONOTRACE 40
Couplant Batch:	79284

IDENT	DEPTH	AMPL. %	ATTEN. dB
A	3 MM	—	—
B	7 MM	—	—
C	11 MM	—	—
D	8 MM	80%	84

INSTR. LINEARITY CAL.					
Amplitude					
	High	Low		High	Low
1			5		
2			6		
3			7		
4			8		

SCAN AREA	

DAC PLOT



AMPL. CONTROL LINEARITY		
Initial	Δ dB	Result
80	-6	40%
80	-12	19%
40	+6	82%
20	+12	80%

EXAMINATION WELD/AREA	RECORDABLE INDICATION Yes	No	COMMENTS/REASON FOR INCOMPLETED SCAN(S)
REACTOR NOZZLE			SEE ATTACHED SHEET
LOOP A INLET	✓		

CALIBRATION CHECKS	TIME
Initial Cal.	9:25
Intermediate	11:45
Intermediate	13:40
Intermediate	
Final Cal.	14:00

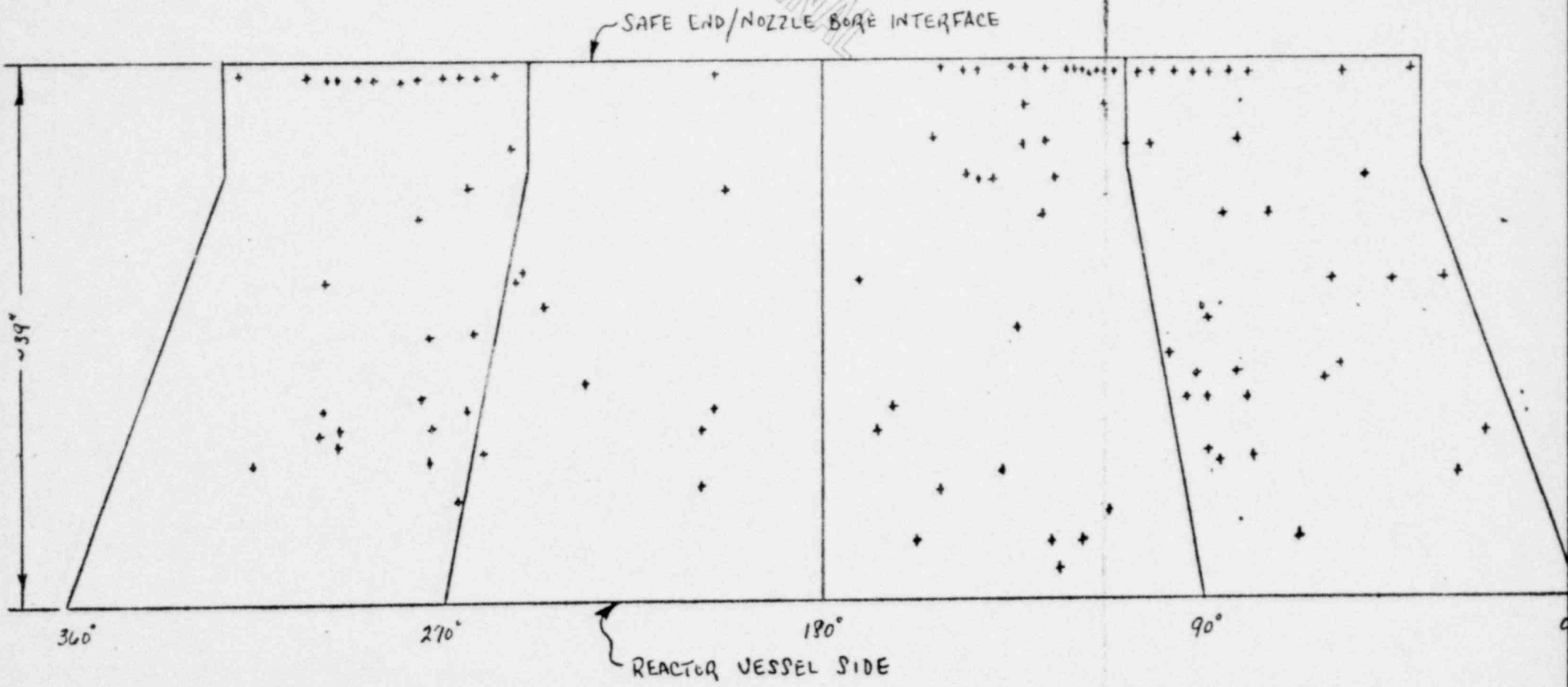
ADDITIONAL SHEETS? (CHECK BOX)			
Continuation			
Supplements	✓	None	

EXAMINERS 1 [signature] Date 3-22-80 Level II
2 Robert W. Curl Date 3-22-80 Level I
REVIEWER [signature] Date 3/25/80

POOR ORIGINAL

POOR ORIGINAL

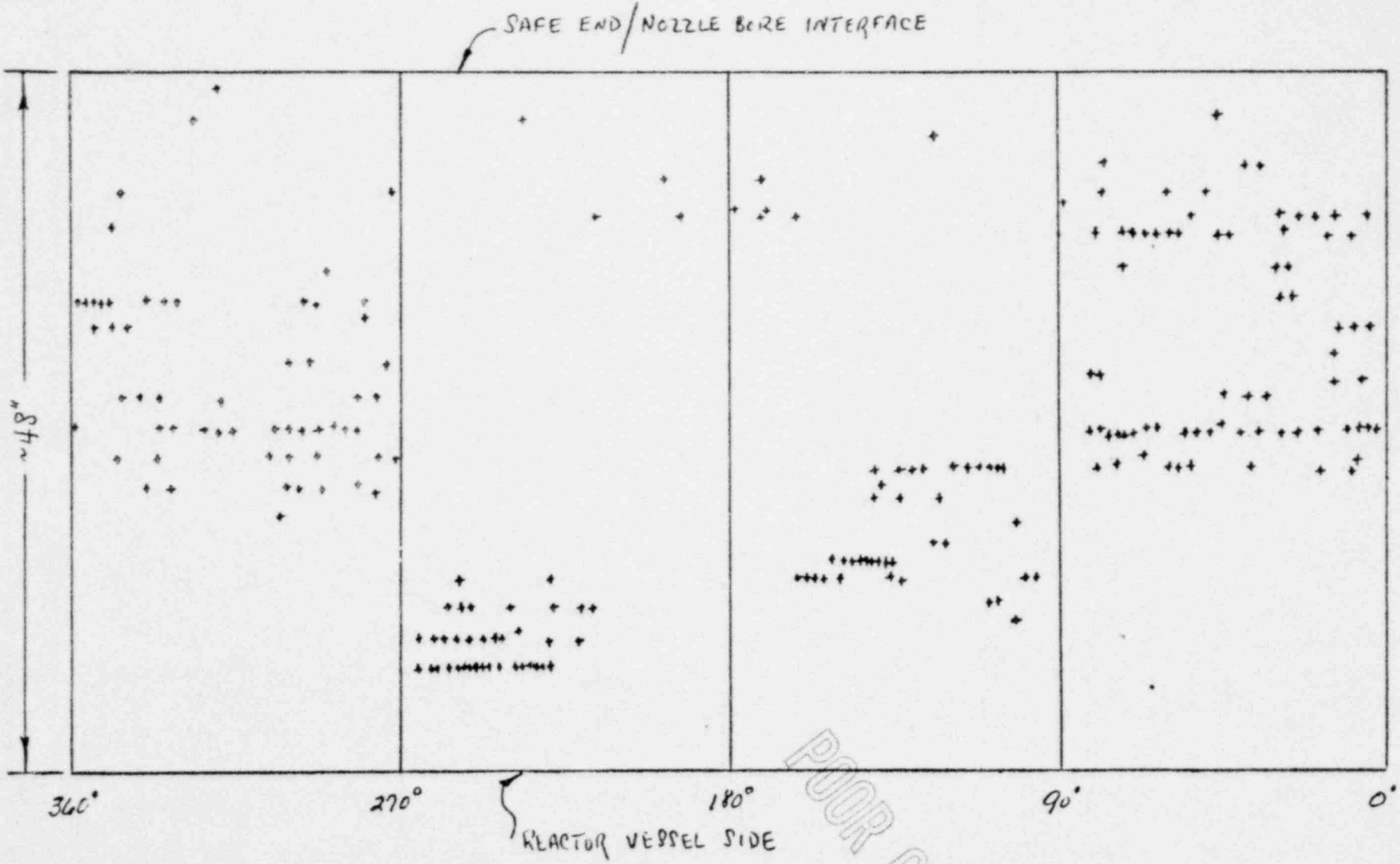
SMALL DIAMETER (INNER) - ~28"
LARGE DIAMETER (INNER) - ~35"



NORTH ANNA UNIT II LOOP A INLET NOZZLE

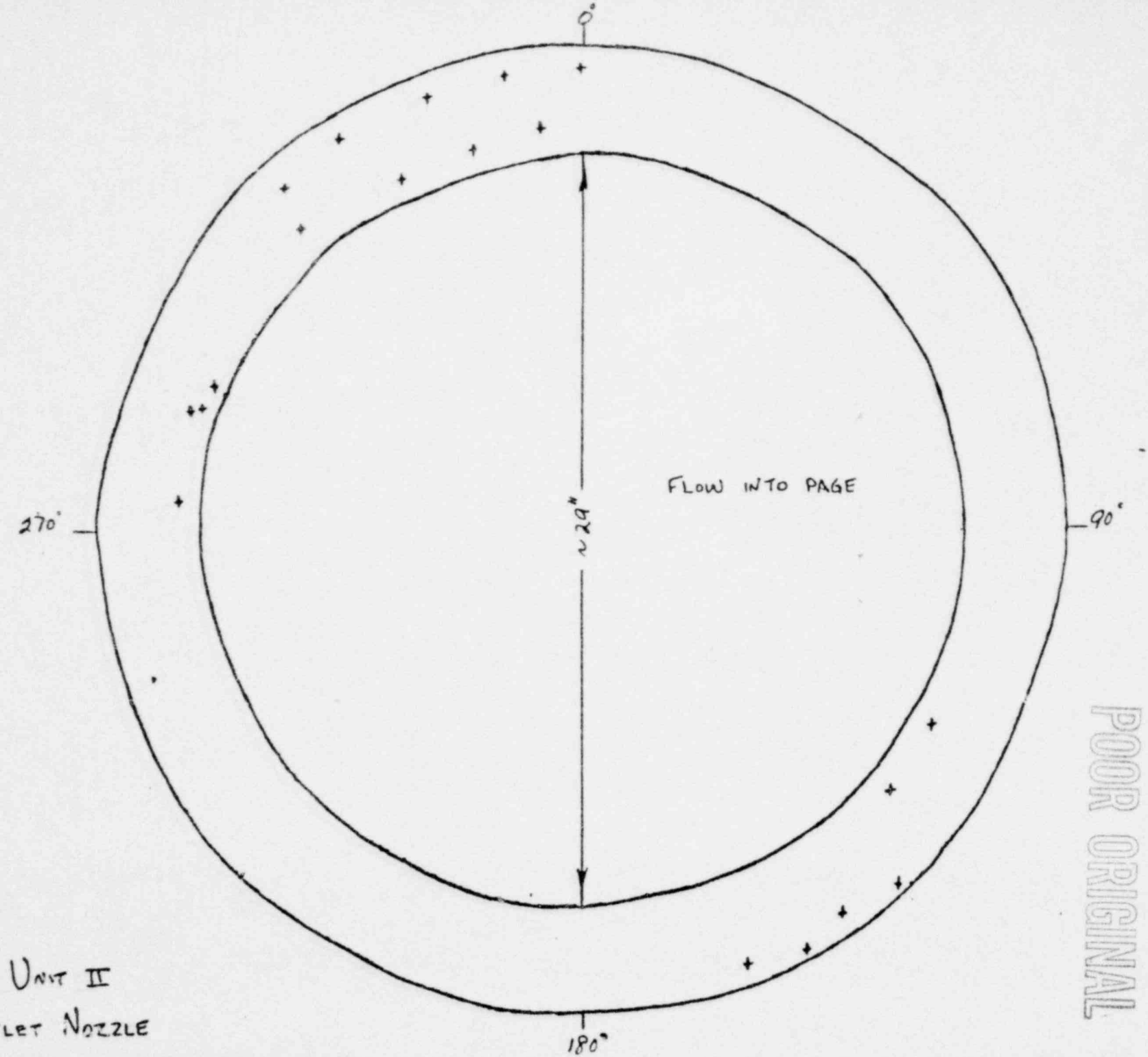
note: only sections taken to demonstrate repetition of indications

INNER DIAMETER – ~29"



POOR ORIGINAL

NORTH ANNA UNIT II LOOP A OUTLET NOZZLE



North Anna Unit II
Loop A Outlet Nozzle
End Projection

POOR ORIGINAL

Plant/Unit NORTH ANNA
Comp/System REACTOR NOZZLE BORE

CALIBRATION DATA SHEET # 1

Data Sheet No.
Procedure No.
Subject
Rev/Change No.
Calibration Block No.
Surface

INSTRUMENT SETTINGS	
Mfg/Model No.:	SONIC MK I
Serial No. :	00869E
Sweep Length :	078
Sweep Delay :	2 28
Pulse Length/Damping:	MIN.
Freq.: 2 MHz Rep. Rate:	3K
Filter: Hi Video: Jack:	N/A
DEC/Gate Switch: OFF Range:	1"
Mode Select: N/A Reject:	OFF
Gain (coarse): 80 (fine):	4

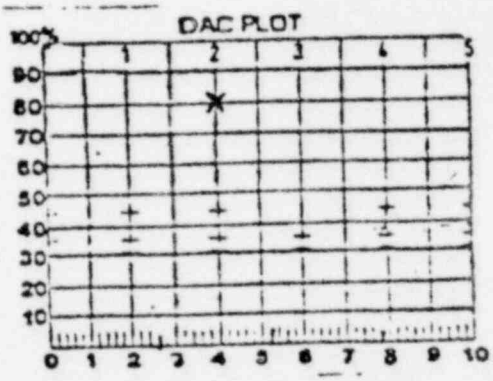
SEARCH UNIT	
Scan Angle: 70° Mode:	R-L
Fixturing (if any):	
Style or Type No. :	RTD-BAM
Size & Shape:	18mm
Frequency :	2 MHz.
Serial No/Brand:	591-172
Measured Angle :	70°
Couplant Brand:	SONOTRACE 40
Couplant Batch:	79284

IDENT	DEPTH	AMPL.	ATTEN.
A	3mm		
B	7mm		
C	11mm		usual
D	8mm	80%	AT 84db

INSTR. LINEARITY CAL.					
Amplitude					
	High	Low		High	Low
1			5		
2			6		
3			7		
4			8		

SCAN AREA	

DAC PLOT



AMPL. CONTROL LINEARITY		
Initial	Δ dB	Result
80	-6	38
80	-12	19
40	+6	80
20	+12	80

EXAMINATION WELD/AREA	RECORDABLE INDICATION Yes	No	COMMENTS/REASON FOR INCOMPLETED SCAN(S)
Loop 'B' INLET	✓		SEE ATTACHED SHEET

CALIBRATION CHECKS	TIME
Initial Cal.	11:00
Intermediate	13:40
Intermediate	
Intermediate	
Final Cal.	17:35

ADDITIONAL SHEETS? (CHECK BOX)			
Continuation			
Supplements		None	

EXAMINERS 1 [signature] Date 3-19-80 Level II
2 [signature] Date 3-19-80 Level II
REVIEWER [signature] Date 3/24/80

POOR ORIGINAL

Plant/Unit North Anna II
Comp/System Reactor Nozzle Bore

CALIBRATION DATA SHEET
2

Data Sheet No.
Procedure No.
Subject
Rev/Change No.
Calibration Block No.
Surface

INSTRUMENT SETTINGS	
Mfg/Model No.:	Sonic Mk I
Serial No. :	00869E
Sweep Length :	0.78
Sweep Delay :	2.28
Pulse Length/Damping:	MIN
Freq.: 2 MHz Rep. Rate:	3K
Filter: HI Video: Jack:	N/A
DEC/Gate Switch: OFF Range:	"
Mode Select: N/A Reject:	OFF
Gain (coarse): 80 (fine):	4

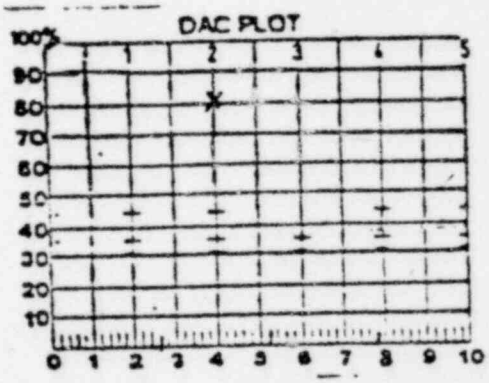
SEARCH UNIT	
Scan Angle: 70° Mode:	P-L
Fixturing (if any):	
Style or Type No. :	RTD-BAM
Size & Shape :	18 mm
Frequency :	2 MHz.
Serial No/Brand:	591-172
Measured Angle :	70°
Couplant Brand:	Sonotrace 40
Couplant Batch:	79284

IDENT	DEPTH	AMPL. %	ATTEN. dB
A	3mm		
B	7mm		
C	11mm		WMP
D	8mm	80%	9+
			84 db

INSTR. LINEARITY CAL.					
Amplitude					
	High	Low		High	Low
1			5		
2			6		
3			7		
4			8		

SCAN AREA	

DAC PLOT



AMPL. CONTROL LINEARITY		
Initial	Δ dB	Result
80	-6	38
80	-12	19
40	+6	80
20	+12	80

EXAMINATION WELD/AREA	RECORDABLE INDICATION Yes	No	COMMENTS/REASON FOR INCOMPLETED SCAN(S)
Loop "B" Inlet	✓		SEE ATTACHED SHEET

CALIBRATION CHECKS	TIME
Initial Cal.	8:45
Intermediate	11:45
Intermediate	13:50
Intermediate	
Final Cal.	15:05

ADDITIONAL SHEETS? (CHECK BOX)			
Continuation			
Supplements		None	

EXAMINERS 1 Wm Roberts Date 3-20-80 Level II
2 [illegible] Date 3-20-80 Level II
REVIEWER [illegible] Date 3/24/80

POOR ORIGINAL

Plant/Unit NORTH ANNA II

Calibration Data Sheet # 11

Comp/System REACTOR NOZZLE LOOP B INLET

Examiners 1. Michael Roberts Level II

2. Stephen W. Stapel Level I

Date 3-19-80 & 3-20-80

Reviewed D. C. Adamson Date 3/24/80

POOR ORIGINAL

Indication #	Between Axis	70° Longitudinal Data			Location			0° T-R Data	
		Amplitude	Depth	Length	Nearest Axis	Distance from N.A.	Distance from Seal Ext	Ampl.	Dep
1	90°-180°	CW 80%	8 mm	1/4"	180°	1"	20"	—	—
		CCW 100%+6db	8 mm	3/16"	180°	1"	20"		
2	180°-270°	CW 100%+5db	8 mm	5/16"	180°	5 5/8"	17 1/8"	—	
		CCW 100%+4db	7 mm	1/2"	180°	5 5/8"	17 1/8"		
3	180°-270°	CW 100%+1db	9 mm	3/16"	180°	7/16"	17 1/8"	—	—
		CCW 100%	9 mm	3/16"	180°	7/16"	17 1/8"		
4	270°-0°	CW 100%+2db	8 mm	3/16"	270°	7 1/4"	26 1/2"	—	—
		CCW 50%	8 mm	1/8"	270°	7 1/4"	26 1/2"		
5	270°-0°	CW 80%	8 mm	3/8"	270°	7 3/4"	29"	—	—
		CCW 40%	8 mm	3/8"	270°	7 3/4"	29"		
6	270°-0°	CW 100%+3db	8 mm	3/16"	270°	11"	32"	—	—
		CCW 100%	8 mm	3/16"	270°	11"	32"		
7	270°-0°	CW 100%	8 mm	5/16"	270°	9 1/2"	32"	—	—
		CCW 100%+3db	8 mm	5/16"	270°	9 1/2"	32"		
8	270°-0°	CW 100%+1db	8 mm	3/8"	270°	6 3/4"	34"	—	—
		CCW 100%	7 mm	1/4"	270°	6 3/4"	34"		
9	270°-0°	CW 100%+4db	8 mm	1/4"	0°	4"	32"	—	—
		CCW 100%+2db	8 mm	5/16"	0°	4"	32"		
10	0°-90°	CW 80%	8 mm	3/16"	90°	3 3/4"	31"	—	—
		CCW 80%	8 mm	1/4"	90°	3 3/4"	31"		
11	0°-90°	CW 100%+2db	7 mm	3/16"	90°	7"	31 1/2"	—	—
		CCW 100%+2db	7 mm	3/8"	90°	7"	31 1/2"		
12	270°-0°	CW 100%+3db	9 mm	3/8"	270°	6 1/4"	37"	—	—
		CCW 50%	9 mm	1/4"	270°	6 1/4"	37"		
13	270°-0°	CW 90%	8 mm	3/16"	270°	7 3/4"	38 3/4"	—	—
		CCW 60%	8 mm	3/16"	270°	7 3/4"	38 3/4"		
14	270°-0°	CW 100%	9 mm	3/16"	270°	8 3/4"	39 1/2"	—	—
		CCW 60%	9 mm	1/4"	270°	8 3/4"	39 1/2"		
15	270°-0°	CW 100%+2db	9 mm	1/4"	0°	1 1/4"	37 1/2"	—	
		CCW 100%	9 mm	1/4"	0°	1 1/4"	37 1/2"		

NOZZLE BORE EXAMINATION DATA SHEET - 2

Plant/Unit NORTH ANNA II

Calibration Data Sheet # 1 & 2

Comp/System REACTOR NOZZLE LOOP 'B' INLET

Examiners 1. Michael Roberts Level II

2. [illegible] Level I

Date 3-19-80 & 3-20-80

Reviewer [illegible] Date 3/24/80

POOR ORIGINAL

Indication #	Between Axes	70° Longitudinal Data			Location			0°-70° Data	
		Amplitude	Depth	Length	Nearest Axis	Distance from N.A.	Distance from Safe End	Ampl.	Dep
16	270°-0°	CW 9-%	8 mm	1/4"	0°	3 1/8"	37 3/4"	—	—
		CCW 100%+3db	8 mm	3/16"	0°	3 1/8"	37 3/4"		
17	0°-90°	CW 50%	9 mm	1/4"	90°	8 1/2"	35 1/2"	—	—
		CCW 90%	9 mm	1/4"	90°	8 1/2"	35 1/2"		
18	0°-90°	CW 100%+2db	9 mm	1/4"	0°	7 1/4"	35"	—	—
		CCW 80%	9 mm	1/4"	0°	7 1/4"	35"		
19	0°-90°	CW 100%	8 mm	5/16"	90°	9 5/8"	37 1/2"	—	—
		CCW 80%	8 mm	3/8"	90°	9 5/8"	37 1/2"		
20	0°-90°	CW 100%+5db	8 mm	1/4"	0°	4"	41"	—	—
		CCW 100%+3db	8 mm	3/16"	0°	4"	41"		
21	0°-90°	CW 100%+8db	7 mm	7/16"	90°	5 3/8"	42 1/4"	—	—
		CCW 100%+1db	8 mm	3/16"	90°	5 3/8"	42 1/4"		
22	0°-90°	CW 100%	8 mm	5/16"	0°	9 3/4"	42 1/2"	—	—
		CCW 50%	8 mm	1/4"	0°	9 3/4"	42 1/2"		
23	180°-270°	CW 90%	8 mm	3/8"	180°	4 3/4"	27 1/2"	—	—
		CCW 100%+1db	8 mm	1/4"	180°	4 3/4"	27 1/2"		
24	180°-270°	CW 100%	9 mm	1/4"	180°	6 1/4"	32"	—	—
		CCW 60%	9 mm	1/4"	180°	6 1/4"	32"		
25	180°-270°	CW 100%	7 mm	5/16"	180°	5 1/4"	34 1/2"	—	—
		CCW 75%	7 mm	1/4"	180°	5 1/4"	34 1/2"		
26	180°-270°	CW 100%+2db	9 mm	3/8"	180°	6 3/8"	41 1/2"	—	—
		CCW 70%	9 mm	1/4"	180°	6 3/8"	41 1/2"		
27	90°-180°	CW 50%	8 mm	1/4"	90°	5"	32 1/2"	—	—
		CCW 100%+1db	8 mm	1/4"	90°	5"	32 1/2"		
28	90°-180°	CW 100%+1db	10 mm	1/4"	180°	13 1/2"	41 1/2"	—	—
		CCW 60%	9 mm	1/4"	180°	13 1/2"	41 1/2"		
		CW							
		CCW							
		CW							

Plant/Unit North Anna II
Comp/System Reactor Nozzle Bore

CALIBRATION DATA SHEET
3

Data Sheet No.
Procedure No.
Subject
Rev/Change No.
Calibration Block No.
Surface

INSTRUMENT SETTINGS	
Mfg/Model No.:	Sonic Mk I
Serial No. :	00869E
Sweep Length :	0.78
Sweep Delay :	2.28
Pulse Length/Damping:	MIN.
Freq.: 2 Mhz Rep. Rate:	3K
Filter: Hi Video:	Jack: N/A
DEC/Gate Switch: N/A	Range: 1"
Mode Select: N/A	Reject: OFF
Gain (coarse): 80	(fine): 4

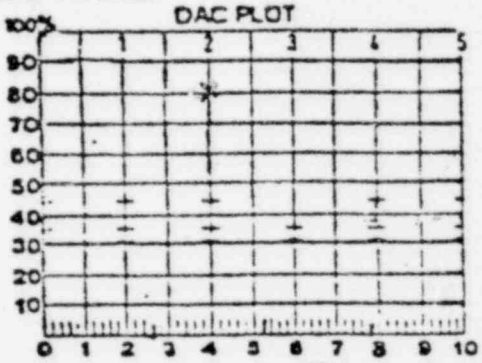
SEARCH UNIT	
Scan Angle: 70°	Mode: R-L
Fixturing (if any):	
Style or Type No. :	RTD-BAM
Size & Shape :	18mm
Frequency :	2 MHz.
Serial No/Brand:	591-172
Measured Angle :	70°
Couplant Brand:	SONOTRACE 40
Couplant Batch:	79284

IDENT	DEPTH	AMPL. %	ATTEN dB
A	3mm		
B	7mm		
C	11mm		
D	8mm	80%	~~91~~ 84

INSTR. LINEARITY CAL.					
Amplitude					
	High	Low		High	Low
1			5		
2			6		
3			7		
4			8		

SCAN AREA	

DAC PLOT



AMPL. CONTROL LINEARITY		
Initial	Δ dB	Result
80	-6	40
80	-12	20
40	+6	80
20	+12	80

EXAMINATION WELD/AREA	RECORDABLE INDICATION Yes	No	COMMENTS/REASON FOR INCOMPLETED SCAN(S)
Loop "B" Outlet	✓		SEE ATTACHED SHEET

CALIBRATION CHECKS	TIME
Initial Cal.	8:40
Intermediate	11:45
Intermediate	13:40
Intermediate	17:30
Final Cal.	19:05

ADDITIONAL SHEETS? (CHECK BOX)			
Continuation			
Supplements		None	

EXAMINERS 1 [illegible] Date 3-21-80 Level II
2 [illegible] Date 3-21-80 Level II
REVIEWER [illegible] Date 3/24/80

POOR ORIGINAL

Plant/Unit NORTH ANNA II
Comp/System REACTOR NOZZLE BORE

CALIBRATION DATA SHEET # 4

Data Sheet No.
Procedure No.
Subject
Rev/Change No.
Calibration Block No.
Surface

INSTRUMENT SETTINGS	
Mfg/Model No.:	SONIC MK I
Serial No. :	00869E
Sweep Length :	0.78
Sweep Delay :	2.28
Pulse Length/Damping:	MIN.
Freq.: 2 MHz Rep. Rate:	3K
Filter: HI Video: Jack:	N/A
DEC/Gate Switch: OFF Range:	1"
Mode Select: N/A Reject:	OFF
Gain (coarse): 80 (fine):	4

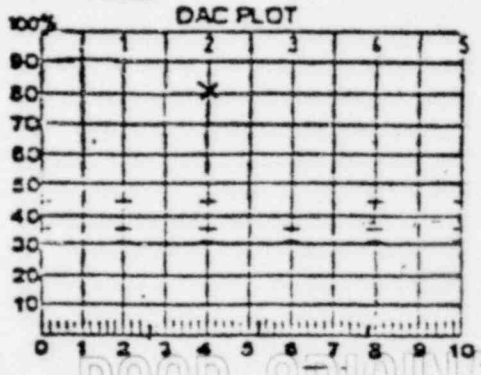
SEARCH UNIT	
Scan Angle: 70° Mode:	RL
Fixturing (if any):	
Style or Type No. :	RTD-BAM
Size & Shape :	18mm
Frequency :	2 MHz
Serial No/Brand:	591-172
Measured Angle :	70°
Couplant Brand:	SONOTRACE 40
Couplant Batch:	79284

IDENT	DEPTH	AMPL. %	ATTEN. DB
A	3mm		
B	7mm		
C	11mm		manual
D	8mm	80%	~~AT~~
			84db

INSTR. LINEARITY CAL.					
Amplitude					
	High	Low		High	Low
1			5		
2			6		
3			7		
4			8		

SCAN AREA	

DAC PLOT



POOR ORIGINAL

AMPL. CONTROL LINEARITY		
Initial	Δ dB	Result
80	-6	39
80	-12	19
40	+6	81
20	+12	83

EXAMINATION WELD/AREA	RECORDABLE INDICATION Yes	No	COMMENTS/REASON FOR INCOMPLETED SCAN(S)
LOOP "B" OUTLET	✓		SEE ATTACHED SHEET

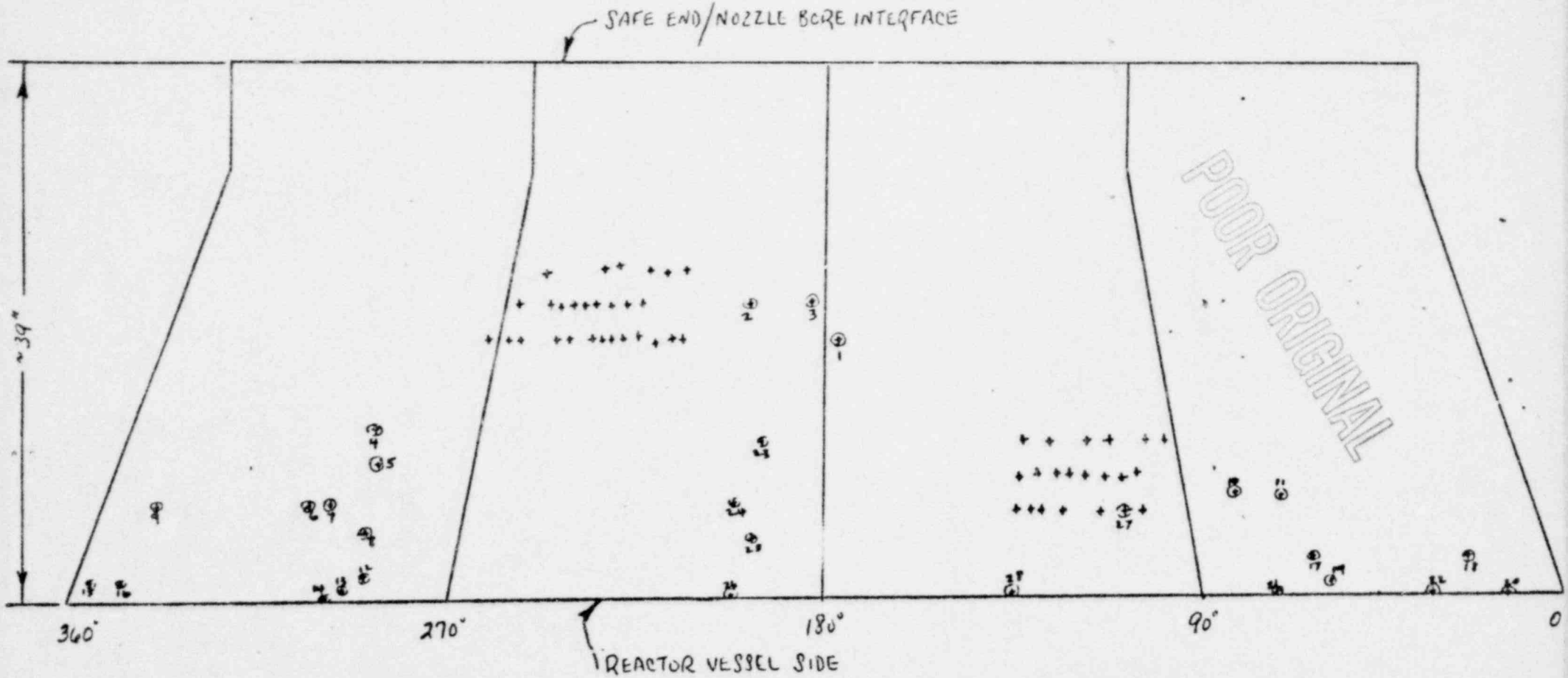
CALIBRATION CHECKS	TIME
Initial Cal.	09:30
Intermediate	11:40
Intermediate manual ~~13:40~~	
Intermediate	
Final Cal.	13:40

ADDITIONAL SHEETS? (CHECK BOX)			
Continuation			
Supplements		None	

EXAMINERS 1 W M Roberts Date 3-22-80 Level II
2 Sylvester Stroud Date 3-22-80 Level II
REVIEWER R. C. Simmons Date 3/24/80

note: only these sections taken to demonstrate repetition of indications
circled and numbered indications have been recorded

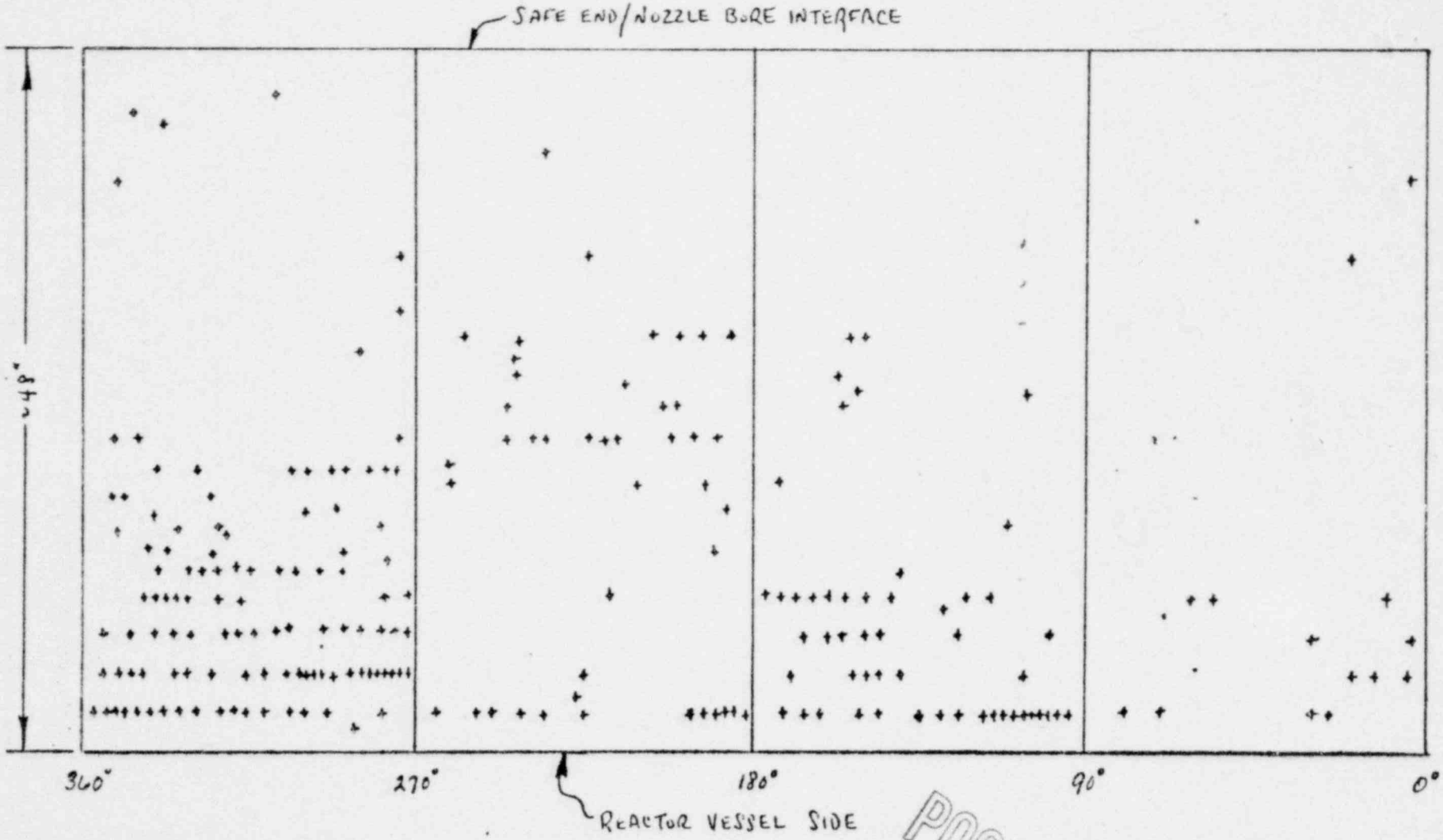
SMALL INNER DIAMETER - ~28"
LARGE INNER DIAMETER - ~35"



POOR ORIGINAL

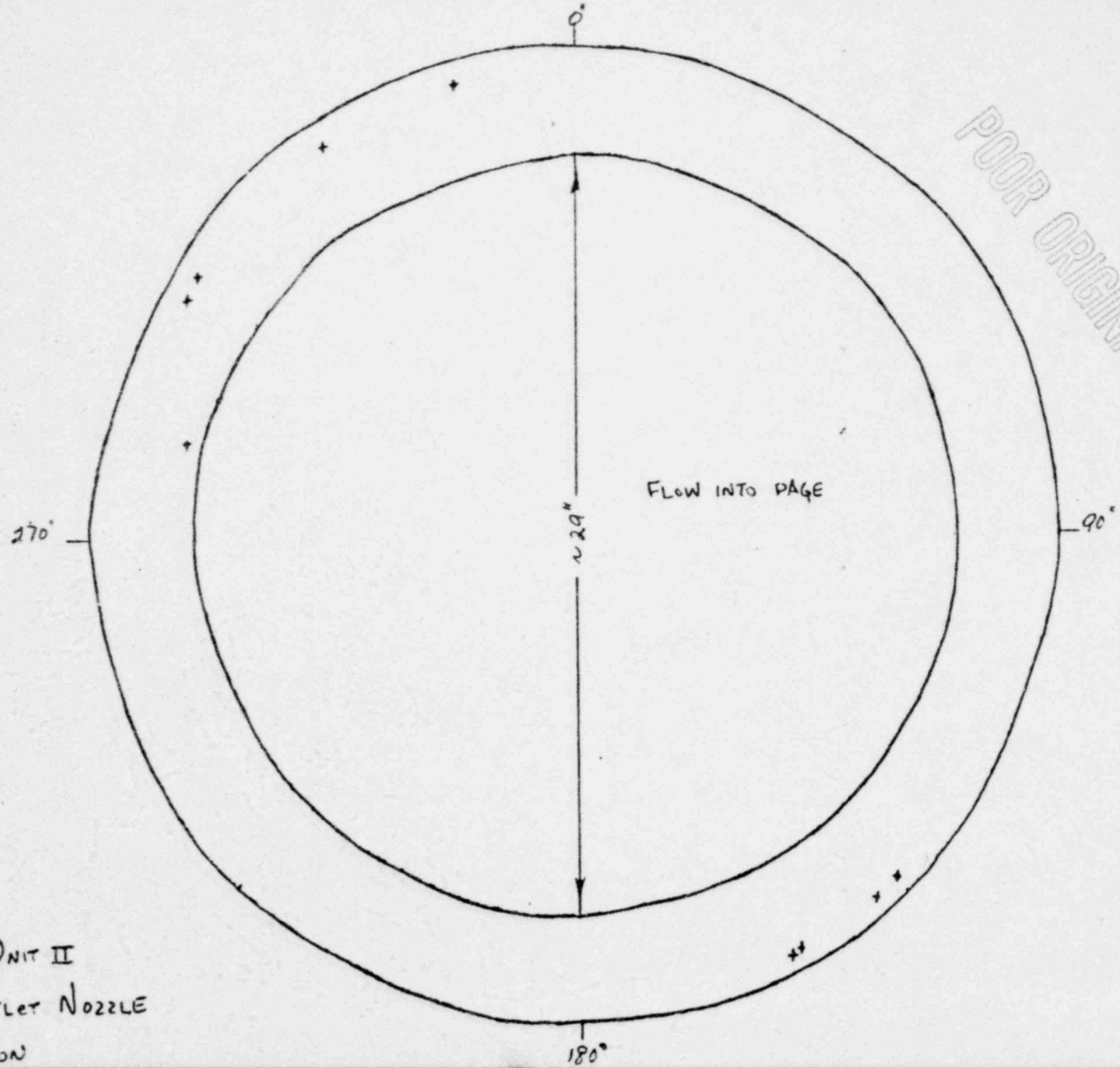
NORTH ANNA UNIT II LOOP B INLET NOZZLE

INNER DIAMETER - ~29"



POOR ORIGINAL

NORTH ANNA UNIT II LOOP B OUTLET NOZZLE



POOR ORIGINAL

North Anna Unit II
Loop B Outlet Nozzle
End Projection

POOR ORIGINAL

Plant/Unit: North Anna II
Comp/System: Reactor Nozzle Loop C Inlet

CALIBRATION DATA SHEET
1

Data Sheet No.
Procedure No.
Subject
Rev/Change No.
Calibration Block No.
Surface

INSTRUMENT SETTINGS	
Mfg/Model No.:	Sonic Mark I
Serial No. :	01057E
Sweep Length :	1-1.25
Sweep Delay :	2-0.05
Pulse Length/Damping:	MIN
Freq. 2 MHZ Rep. Rate:	3K
Filter: Hi Video: N/A Jack:	T
DEC/Gate Switch: OFF Range:	1"
Mode Select: N/A Reject:	OFF
Gain (coarse): 80 (fine):	6

SEARCH UNIT	
Scan Angle: 70° Mode:	RL
Fixturing (if any):	
Style or Type No. :	RTD-B1M
Size & Shape :	18mm ø
Frequency :	2.0 MHZ
Serial No/Brand:	Krautkramer 591-135
Measured Angle :	70°
Couplant Brand:	Surface 40
Couplant Batch:	79234

IDENT	DEPTH	AMPL.	ATTEN.
A	3MM		
B	7MM		
C	11MM		
D	5MM	50%	86

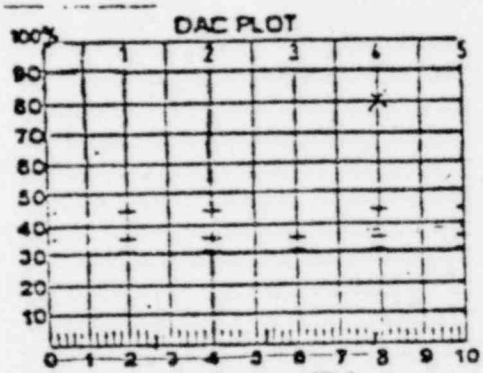
INSTR. LINEARITY CAL.

Amplitude

	High	Low		High	Low
1			5		
2			6		
3			7		
4			8		

SCAN AREA	

DAC PLOT



AMPL. CONTROL LINEARITY		
Initial	Δ dB	Result
80	-6	38%
80	-12	17%
40	+6	83%
20	+12	53%

EXAMINATION WELD/AREA	RECORDABLE INDICATION Yes	No	COMMENTS/REASON FOR INCOMPLETED SCAN(S)
Reactor Nozzle Loop C Inlet	✓		See Attached Sheet

CALIBRATION CHECKS	TIME
Initial Cal.	11:15
Intermediate	11:55
Intermediate	13:55
Intermediate	16:42
Final Cal.	17:45

ADDITIONAL SHEETS? (CHECK BOX)			
Continuation			
Supplements	✓	None	

EXAMINERS 1 [signature] Date 3-19-80 Level II
2 [signature] Date 3-19-80 Level I
REVIEWER [signature] Date 3/24/80

Plant/Unit NORTH ANNA II
Comp/System REACTOR NOZZLE LOOP C OUTLET AND INLET

CALIBRATION DATA SHEET # 2

Data Sheet No.
Procedure No.
Subject
Rev/Change No.
Calibration Block No.
Surface

INSTRUMENT SETTINGS	
Mfg/Model No.:	SONIC MARK I
Serial No. :	010576
Sweep Length :	1-1.36
Sweep Delay :	2-0.05
Pulse Length/Damping:	MIN
Freq. 2 MHZ Rep. Rate:	3K
Filter: Hi Video:	N/A Jack: T
DEC/Gate Switch:	off Range: 1"
Mode Select:	N/A Reject: off
Gain (coarse):	80 (fine): 5

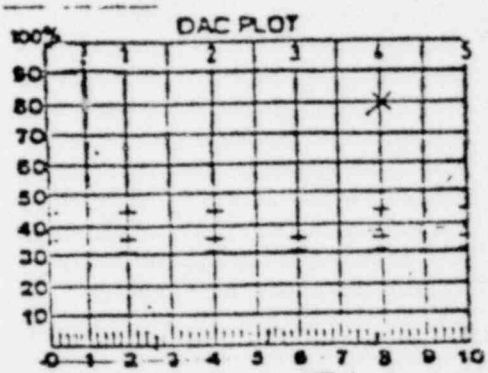
SEARCH UNIT	
Scan Angle: 70°	Mode: RL
Fixturing (if any):	
Style or Type No. :	RTD-BAM
Size & Shape :	18MM Ø
Frequency :	2.0MHZ
Serial No/Brand :	KRAUTKRAMER 591-135
Measured Angle :	70°
Couplant Brand:	SONOTRACE 40
Couplant Batch:	79284

IDENT	DEPTH	AMPL.	ATTEN DB
A	3 MM		
B	7 MM		
C	11 MM		
D	8 MM	80%	86

INSTR. LINEARITY CAL.					
Amplitude					
	High	Low		High	Low
1			5		
2			6		
3			7		
4			8		

SCAN AREA	

DAC PLOT



AMPL. CONTROL LINEARITY		
Initial	Δ dB	Result
80	-6	40%
80	-12	18%
40	+6	83%
20	+12	82%

EXAMINATION WELD/AREA	RECORDABLE INDICATION Yes	No	COMMENTS/REASON FOR INCOMPLETED SCAN(S)
REACTOR NOZZLE			SEE ATTACHED SHEET
LOOP C outlet	✓		
AND INLET			

CALIBRATION CHECKS	TIME
Initial Cal.	9:15
Intermediate	11:48
Intermediate	13:50
Intermediate	
Final Cal.	17:15

ADDITIONAL SHEETS? (CHECK BOX)			
Continuation			
Supplements	✓	None	

EXAMINERS 1 [signature] Date 3-20-80 Level II
2 [signature] Date 3-20-80 Level II
REVIEWER [signature] Date 3/24/80

POOR ORIGINAL

Plant/Unit NORTH ANNA II

Calibration Data Sheet # 2

Comp/System REACTOR NOZZLE LOOP C INLET

Examiners 1. [illegible] Level II

2. Robert W Paul Level I

Date 3-20-80

Reviewer [illegible] Date 3/24/80

POOR ORIGINAL

Indication #	Between Axes	70° Longitudinal Data			Location			0° 3-D Data	
		Amplitude	Depth	Length	Nearest Axis	Distance from N.A.	Distance from Seal End	Ampl.	Dep
1	270°-0°	CW 100% + 3db	6 mm	3/8"	270°	11"	33½"	—	—
		CCW 100% + 2db	6 mm	3/8"	270°	11"	33½"		
2	270°-0°	CW 100%	8 mm	1/4"	0°	6"	33"	—	—
		CCW 50%	8 mm	1/4"	0°	6"	33"		
3	270°-0°	CW 90%	8 mm	1/8"	0°	3"	33"	—	—
		CCW 50%	8 mm	1/8"	0°	3"	33"		
4	270°-0°	CW 100% + 4db	8 mm	3/8"	0°	7½"	33"	—	—
		CCW 60%	8 mm	3/8"	0°	7½"	33"		
5	270°-0°	CW 50%	8 mm	SPOT	0°	5"	33"	—	—
		CCW 40%	8 mm	SPOT	0°	5"	33"		
6	270°-0°	CW 90%	8 mm	1/4"	0°	8"	33"	—	—
		CCW 100% + 2db	8 mm	1/4"	0°	8"	33"		
7	270°-0°	CW 55%	7 mm	3/8"	0°	9"	33"	—	—
		CCW 40%	7 mm	3/8"	0°	9"	33"		
8	270°-0°	CW 70%	7 mm	1/8"	0°	11"	33"	—	—
		CCW 55%	7 mm	1/8"	0°	11"	33"		
9	270°-0°	CW 80%	8 mm	5/16"	0°	12"	33"	—	—
		CCW 50%	8 mm	5/16"	0°	12"	33"		
10	270°-0°	CW 90%	6 mm	3/16"	0°	12½"	33"	—	—
		CCW 30%	6 mm	3/16"	0°	12½"	33"		
11	0°-90°	CW 75%	8 mm	5/16"	90°	7"	30"	—	—
		CCW 70%	8 mm	5/16"	90°	7"	30"		
12	0°-90°	CW 50%	7 mm	3/16"	90°	11"	30"	—	—
		CCW 100%	7 mm	3/16"	90°	11"	30"		
13	0°-90°	CW 85%	8 mm	3/8"	0°	9½"	30"	—	—
		CCW 65%	8 mm	3/8"	0°	9½"	30"		
14	0°-90°	CW 30%	8 mm	1/4"	0°	5½"	30"	—	—
		CCW 100% + 2db	8 mm	1/4"	0°	5½"	30"		
15	0°-90°	CW 100%	8 mm	1/4"	0°	4½"	30"	—	—
		CCW 100% + 2db	8 mm	1/4"	0°	4½"	30"		

Plant/Unit NORTH ANNA II

Calibration Data Sheet # 3

Comp/System REACTOR NOZZLE LOOP C INLET

Examiners 1. [illegible] Level II

2. Robert W Clark Level I

Date 3-20-80

Reviewer [illegible] Date 3/24/80

POOR ORIGINAL

Indication #	Between Axes	70° Longitudinal Data			Location			0°-70° Data	
		Amplitude	Depth	Length	Nearest Axis	Distance from N.A.	Distance from Seal End	Ampl.	Dep.
16	0°-90°	CW 100%+2db	5 MM	3/16"	0°	3"	6"	—	—
		CCW 100%+3db	5 MM	3/16"	0°	3"	6"		
17	0°-90°	CW 100%	7 MM	1/8"	0°	0"	1"	—	—
		CCW 50%	7 MM	1/8"	0°	0"	1"		
		CW							
		CCW							
		CW							
		CCW							
		CW							
		CCW							
		CW							
		CCW							
		CW							
		CCW							
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		CCW							
		CW							
		CCW							
		CW							
		CCW							
		CW							
		CCW							
		CW							
		CCW							

POOR ORIGINAL

Plant/Unit NORTH ANNA
Comp/System REACTOR NOZZLE LOOP C INLET & OUTLET

CALIBRATION DATA SHEET
3

Data Sheet No.
Procedure No.
Subject
Rev/Change No.
Calibration Block No.
Surface

INSTRUMENT SETTINGS	
Mfg/Model No.:	SONIC MARK I
Serial No. :	01057E
Sweep Length :	1 - 1.36
Sweep Delay :	2 - 0.05
Pulse Length/Damping:	MIN
Freq.: 2 MHz	Rep. Rate: 3K
Filter: 4	Video: N/A Jack: T
DEC/Gate Switch: OFF	Range: 1"
Mode Select: N/A	Reject: OFF
Gain (coarse): 80	(fine): 5

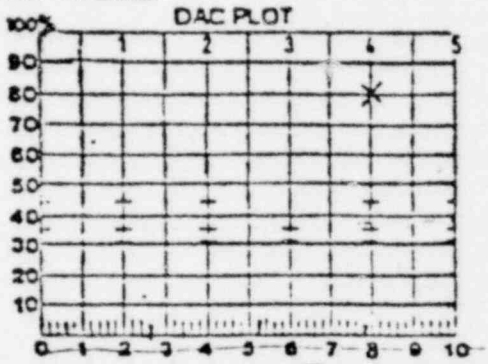
SEARCH UNIT	
Scan Angle: 70°	Mode: RL
Fixturing (if any):	
Style or Type No. :	RTD-BAM
Size & Shape :	18mm Ø
Frequency :	2.0 MHZ
Serial No/Brand :	MINTKRAMER 541-135
Measured Angle :	70°
Couplant Brand:	SONOTRACE 40
Couplant Batch:	79284

IDENT	DEPTH	AMPL. %	ATTEN. dB
A	3mm	—	—
B	7mm	—	—
C	11mm	—	—
D	8mm	80%	85

INSTR. LINEARITY CAL.					
Amplitude					
	High	Low		High	Low
1			5		
2			6		
3			7		
4			8		

SCAN AREA	

DAC PLOT



AMPL. CONTROL LINEARITY		
Initial	Δ dB	Result
80	-6	40%
80	-12	19%
40	+6	82%
20	+12	82%

EXAMINATION WELD/AREA	RECORDABLE INDICATION Yes	No	COMMENTS/REASON FOR INCOMPLETED SCAN(S)
REACTOR NOZZLE			SEE ATTACHED SHEETS
LOOP C INLET			
AND OUTLET	✓		

CALIBRATION CHECKS	TIME
Initial Cal.	8:40
Intermediate	11:45
Intermediate	13:45
Intermediate	17:45
Final Cal.	19:05

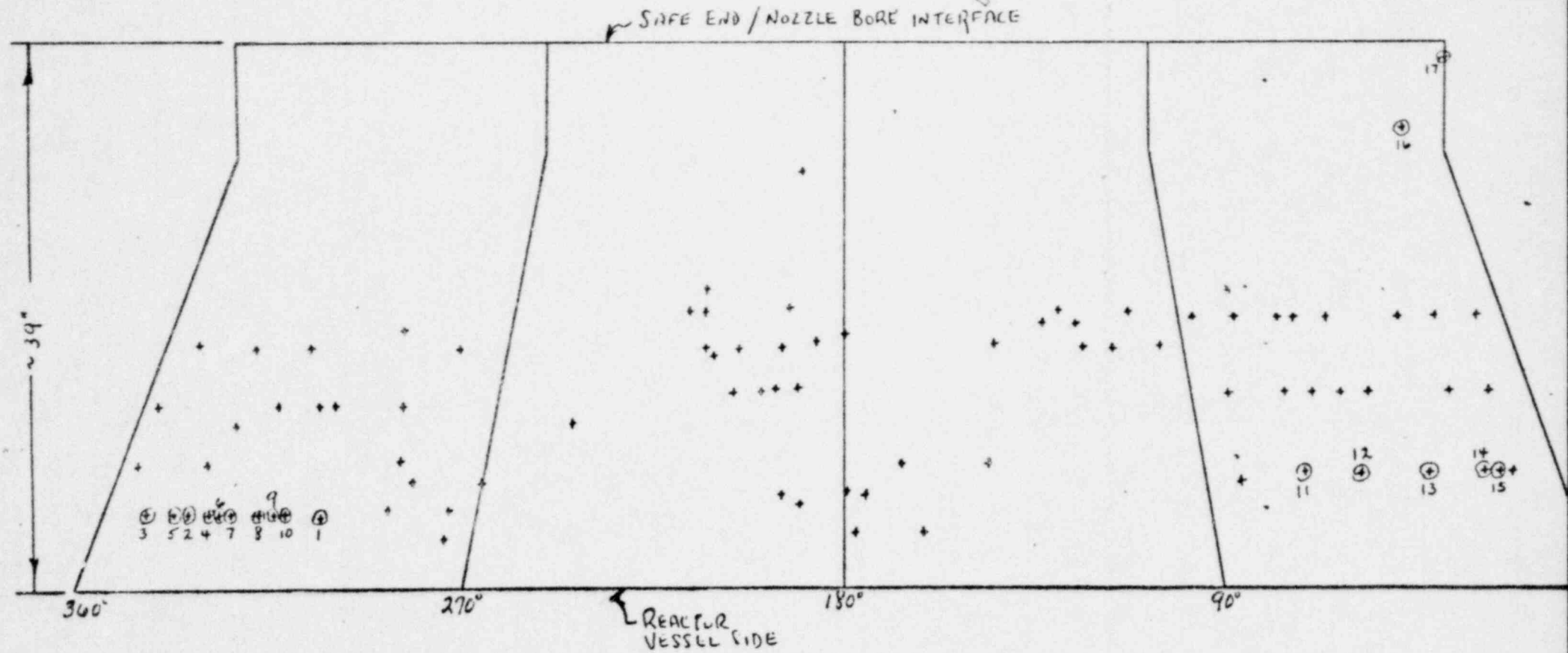
ADDITIONAL SHEETS? (CHECK BOX)			
Continuation			
Supplements	✓	None	

EXAMINERS 1 [signature] Date 3-21-80 Level II
2 [signature] Date 3-21-80 Level I
REVIEWER [signature] Date 3/24/80

note: circled and numbered indications have been recorded

POOR ORIGINAL

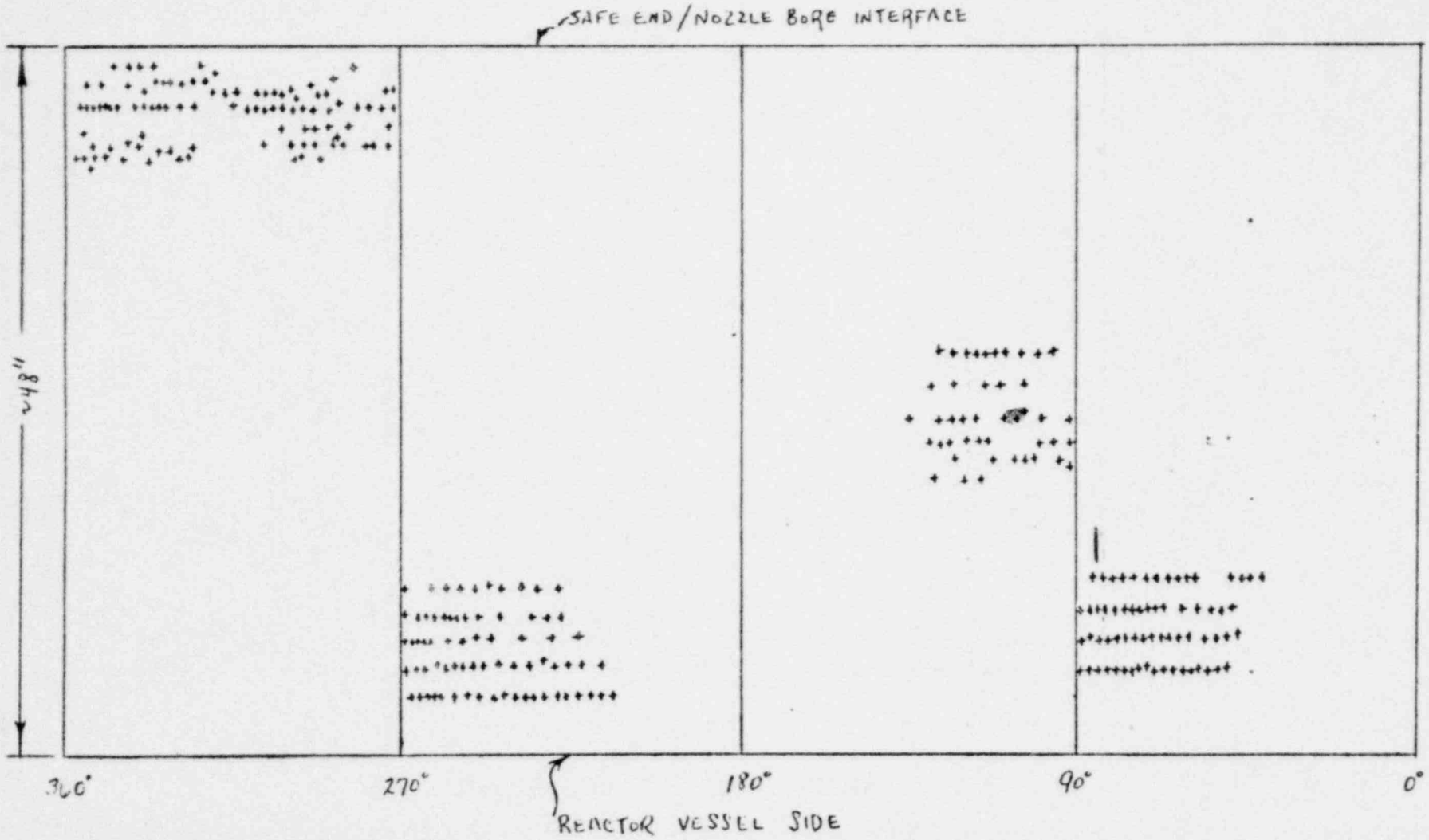
SMALL INNER DIAMETER - ~28"
LARGE INNER DIAMETER - ~35"



NORTH ANNA UNIT II LOOP C INLET NOZZLE

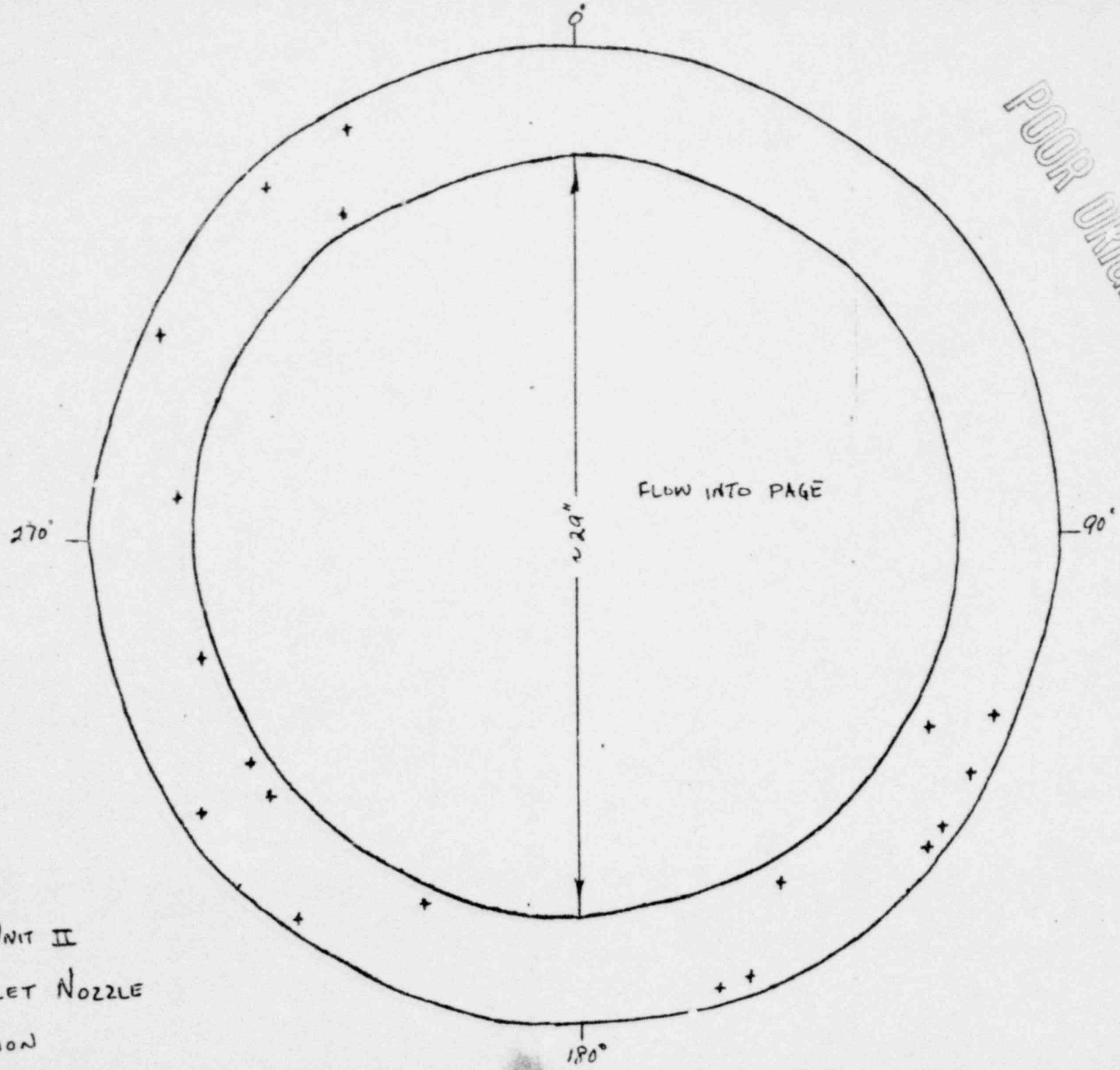
note: only these four sections taken to demonstrate repetition of indications.

INNER DIAMETER - ~ 29"



NORTH ANNA UNIT II LOOP C OUTLET NOZZLE

POOR ORIGINAL



POOR ORIGINAL

North Anna Unit II

Loop C Outlet Nozzle

End Projection

Plant/Unit NORTH ANNA II
Comp/System REACTOR NOZZLE BORE

CALIBRATION DATA SHEET # 5

Data Sheet No.
Procedure No.
Subject
Rev/Change No.
Calibration Block No.
Surface

INSTRUMENT SETTINGS	
Mfg/Model No.:	SONIC MK I
Serial No. :	00869E
Sweep Length :	0.78
Sweep Delay :	2.28
Pulse Length/Damping:	MIN.
Freq.: 2 MHz Rep. Rate:	3K
Filter: HI Video: Jack:	N/A
DEC/Gate Switch: OFF Range:	1"
Mode Select: N/A Reject:	OFF
Gain (coarse): 80 (fine):	4

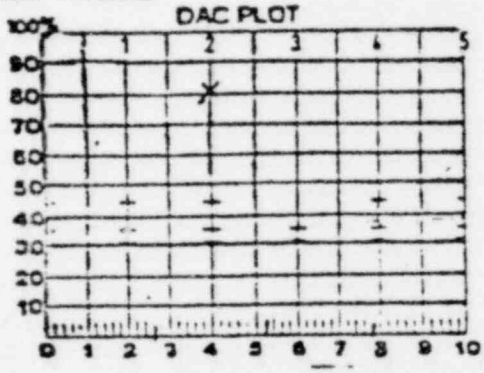
SEARCH UNIT	
Scan Angle: 70°	Mode: R-L
Fixturing (if any):	
Style or Type No. :	RTD-BAM
Size & Shape :	18 mm
Frequency :	2 MHz.
Serial No/Brand:	591-172
Measured Angle :	70°
Couplant Brand:	SONOTRACE 40
Couplant Batch:	79284

IDENT	DEPTH	AMPL. %	ATTEN. dB
A	3mm		
B	7mm		
C	11mm		WUR
D	8mm	80%	~~94~~ 84db

INSTR. LINEARITY CAL.					
Amplitude					
	High	Low		High	Low
1			5		
2			6		
3			7		
4			8		

SCAN AREA	

DAC PLOT



AMPL. CONTROL LINEARITY		
Initial	Δ dB	Result
80	-6	38
80	-12	19
40	+6	80
20	+12	80

EXAMINATION WELD/AREA	RECORDABLE INDICATION Yes	No	COMMENTS/REASON FOR INCOMPLETED SCAN(S)
LOOPS A,B,C	✓		END PROJECTIONS
OUTLET NOZZLES			*SEE ATTACHED SHEETS

CALIBRATION CHECKS	TIME
Initial Cal.	8:53
Intermediate	
Intermediate	
Intermediate	
Final Cal.	10:35

ADDITIONAL SHEETS? (CHECK BOX)			
Continuation			
Supplements		None	

EXAMINERS 1 [illegible] Date 3-23-80 Level II
2 [illegible] Date 3-23-80 Level I
REVIEWER [illegible] Date 3/24/80

POOR ORIGINAL

Plant/Unit NORTH ANNA II
Comp/System REACTOR NOZZLE BORE

CALIBRATION DATA SHEET
1

Data Sheet No.
Procedure No.
Subject
Rev/Change No.
Calibration Block No.
Surface

INSTRUMENT SETTINGS	
Mfg/Model No.:	SONIC MK II
Serial No. :	00869E
Sweep Length :	1.50
Sweep Delay :	0.38
Pulse Length/Damping:	M.N.
Freq.: 5	Rep. Rate: 3K
Filter: HI	Video: Jack: N/A
DEC/Gate Switch: OFF	Range: 1"
Mode Select:	Reject: OFF
Gain (coarse): 70	(fine): 1

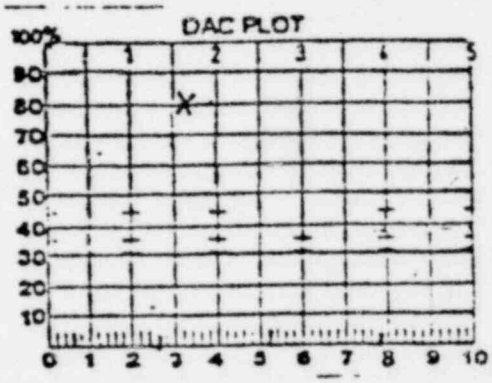
SEARCH UNIT	
Scan Angle: 0°	Mode: L
Fixturing (if any):	
Style or Type No. :	
Size & Shape :	1/4"
Frequency :	5.0 MHz.
Serial No/Brand:	KB 9002
Measured Angle :	0°
Couplant Brand:	SONOTRACE 40
Couplant Batch:	79284

IDENT	DEPTH	AMPL. %	ATTE dB
E	6 mm	80%	71 d
A	2 mm		
B	6 mm		
C	10 mm		

INSTR. LINEARITY CAL.					
Amplitude					
	High	Low		High	Low
1			5		
2			6		
3			7		
4			8		

SCAN AREA	

DAC PLOT



AMPL. CONTROL LINEARITY		
Initial	Δ dB	Result
80	-6	38
80	-12	19
40	+6	80
20	+12	80

EXAMINATION WELD/AREA	RECORDABLE INDICATION Yes	No	COMMENTS/REASON FOR INCOMPLETED SCAN(S)
LOOP "A" OUTLET			
LOOP "B" INLET			
LOOP "C" OUTLET			

CALIBRATION CHECKS	TIME
Initial Cal.	15:40
Intermediate	
Intermediate	
Intermediate	
Final Cal.	17:00

ADDITIONAL SHEETS? (CHECK BOX)			
Continuation			
Supplements		None	

EXAMINERS 1 [signature] Date 3-20-80 Level
2 [signature] Date 3-20-80 Level
REVIEWER [signature] Date 3/20/80

POOR ORIGINAL

Plant/Unit NORTH ANNA II
Comp/System REACTOR NOZZLE LOOP A INLET, LOOP C INLET, LOOP B OUTLET

CALIBRATION DATA SHEET # 5

Data Sheet No.
Procedure No.
Subject
Rev/Change No.
Calibration Block No.
Surface

INSTRUMENT SETTINGS	
Mfg/Model No.:	SONIC MARK I
Serial No. :	01057E
Sweep Length :	5-2.25
Sweep Delay :	1-4.20
Pulse Length/Damping:	MIN
Freq.: 5MHZ Rep. Rate:	3K
Filter: N/A Video: N/A Jack:	T
DEC/Gate Switch: N/A Range:	1/2"
Mode Select: N/A Reject:	OFF
Gain (coarse): 80 (fine):	5

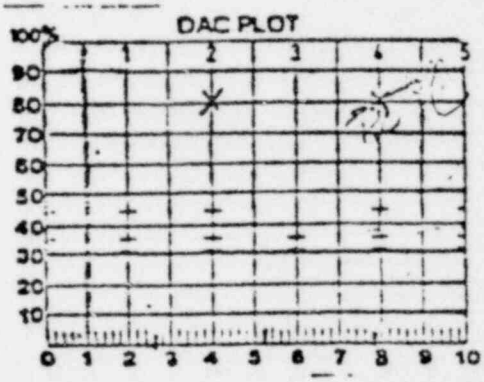
SEARCH UNIT	
Scan Angle: 0° Mode:	L
Fixturing (if any):	
Style or Type No. :	GAMMA DUFP
Size & Shape :	6mm ø
Frequency :	5MHZ
Serial No/Brand:	KRAUTKRAMER KB9002
Measured Angle :	0°
Couplant Brand:	SONOTRACE 40
Couplant Batch:	74284

IDENT	DEPTH	AMPL. %	ATTEN. dB
A	3MM		
B	7MM		
C	11MM		
E	6MM	80%	85

INSTR. LINEARITY CAL.					
Amplitude					
	High	Low		High	Low
1			5		
2			6		
3			7		
4			8		

SCAN AREA	

DAC PLOT



AMPL. CONTROL LINEARITY		
Initial	Δ dB	Result
80	-6	40%
80	-12	19%
40	+6	82%
20	+12	80%

EXAMINATION WELD/AREA	RECORDABLE INDICATION Yes	No	COMMENTS/REASON FOR INCOMPLETED SCAN(S)

CALIBRATION CHECKS	TIME
Initial Cal.	14:40
Intermediate	
Intermediate	
Intermediate	
Final Cal.	16:00

ADDITIONAL SHEETS? (CHECK BOX)			
Continuation			
Supplements		None	

EXAMINERS 1 [signature] Date 3-22-80 Level II
2 [signature] Date 3-22-80 Level I
REVIEWER [signature] Date 3/24/80

POOR ORIGINAL