SPECIAL PROCESS STANDARD		SPS NUT-NC-1A
		REV. 4
Nuclear Ultrasonic Testing Procedure Ultrasonic Inspection of Welds, in the 1/4" to 2-1/2" Thickness Range.	PREPARED BY - DATE T. G. Lambert 1/1/75	EFFECTIVE DATE January 1, 1975
	APPROVED BY - DATE T G Lambert 1/1/75	PAGE 1 OF 17

1.0 SCOPE

1.1 This document covers the general procedure and requirements for ultrasonic examination of welds in Nuclear Reactor Piping Systems, and meets the requirements of the ASME Code, Section III, Appendix 9, Paragraph 3400 and, Section XI of the ASME Code.

2.0 SPECIFICATIONS

2.1 The indicated revision of the following specifications shall form a part of this document.

2.1.1 ASME Code Section III Nuclear Vessels (Summer 1974 Addenda).

2.1.2 ASME Code Section XI Rules for Inservice Inspection of Nuclear Reactor Coolant Systems (Summer 1974 Addenda).

2.1.3 ASME Code Section V Nondestructive Examination (Summer 1974 Addenda).

2.2 Other Specifications

2.2.1	ASTM E114	Recommended Practices for UT.
2.2.2	ASTM A-388	UT of Heavy Steel Forgings.
2.2.3	ASNT-TC-1A	Qualification and Certification of Nondestructive Testing Personnel, Supp. C.
2.2.4	NUT-PQ-1	Nuclear Services Corporation Personnel Qualification Procedure.
2.2.5	NUT-NC-3	Procedure for Automatic Recording of Ultrasonic Test Data.
2.2.6	NUT-NC-1E	Ultrasonic Testing Calibration Procedure.

3.0 PERSONNEL QUALIFICATIONS

3.1 All personnel engaged in ultrasonic inspection shall be qualified in accordance with ASME Code requirements as either Level I (operator), Level II (inspector), or Level III (examiner) as defined in SNT-TC-1A, Supplement C and NUT-PQ-1, Rev. 0. Only a Level II Inspector or Level III Examiner shall make judgment as to the acceptance or rejection of indications. The Nuclear Services Corporation Level III Examiner will submit to the Purchaser, upon request, a copy of personnel qualifica-

3.1 (continued)

tions and qualified ultrasonic procedures. Personnel shall, at the request of the Purchaser, demonstrate their knowledge and understanding of pertinent specifications and procedures, and their ability to satisfactorily operate all required equipment prior to performing an ultrasonic inspection. The job shall be provided with adequate equipment to perform and fulfill the contractual requirements. It shall be the responsibility of Nuclear Services Corporation to set up the equipment, perform the examination, interpret the results, and make reports. Final reports shall be submitted to the Purchaser for disposition.

3.1.1 Certification of Personnel to NUT-P requirements shall be directed by the Nuclear Services Corporation Authorized Level III Examiner.

3.1.2 Level III Examiners appointed by Nuclear Services Corporation shall conform to SNT-TC-1A, Supplement C and the Nuclear Services Corporation Personnel Qualification Procedure, NUT-PQ-1.

3.2 Personnel Certification

3.2.1 Certification of personnel shall conform to SNT-TC-1A, Supplement C and Nuclear Services Corporation Personnel Qualification Procedure, NUT-PQ-1.

3.2.2 In order to attain certification in any level, the candidate must demonstrate to the Nuclear Services Corporation Level III Examiner's satisfaction a thorough knowledge of the procedures and requirements contained in this document.

3.3 Visual Acuity Requirements

Visual requirements for near distance acuity and color shall conform to SNT-TC-1A, Supplement C and Nuclear Services Corporation Personnel Qualification Procedure, NUT-PQ-1.

3.4 Records

3.4.1 Records of personnel certification, including copies of test results, eye examination results, and certification documents, shall be maintained by the Nuclear Services Corporation Level III Examiner at the home office and at the job site and shall conform to SNT-TC-1A, Supplement C and Nuclear Services Corporation Personnel Qualification Procedure, NUT-PQ-1.

4.0 INSPECTION METHODS

The method used to fulfill the inspection requirements shall be the Pulse Echo Method.

4.1 Pulse Echo Method

This method consists of transmitting a sound beam into a specimen and interpreting the returned echos. Pulse Echo Testing shall be conducted using either straight beam or angle beam techniques.

5.0 SCANNING TECHNIQUE

Scanning shall be performed manually by moving the search unit in a directed path at a maximum scanning rate of 6 inches per second. A minimum of 15 per cent overlap shall be used.

5.1 Contact Scanning

This method requires the search unit to be placed in direct contact with the specimen surface. A coupling fluid is required to make effective contact between the search unit and the specimen surface.

5.1.1 Coupling Fluids

For the sound beam to be transmitted into the specimen, the surface of both the transducer and the specimen must be wet by a transmission medium. A water base halogen free couplant shall be used for contact testing and the type recorded on the inspection report.

6.0 SURFACE REQUIREMENT

The surfaces of material for inspection shall be clean, uniformly smooth, and free of surface defects such as laps, weld splatter, or irregularities that would interfere with free movement of the search unit or impair the transmission of ultrasonic vibrations. The surface of a weld should merge smoothly into the surfaces of the adjacent base material.

7.0 ULTRASONIC EXAMINATION OF BUTT WELDS IN THE 1/4" to 2-1/2" THICKNESS RANGE

7.1 Welds shall be examined by the angle beam method where practical. In the examination of weldments where geometry does not allow angle beam examination from both sides of the weld from a single surface or a combination of surfaces, either a combination of angle beam and straight beam or straight beam in two (2) directions at 90 degrees to each other shall be used.

7.2 Calibration Reference Reflectors

Side drilled holes shall be used as basic calibration reflectors to establish the primary reference response of the equipment and to construct a distance-amplitude correction curve. These holes shall be located either in the production material or in a basic calibration block of an equivalent P-number grouping conforming to Figure 1.

7.2.1 Basic Calibration Block (Figure 1 and 6)

If a basic calibration block is used, it shall have a thickness related to the production material thickness, according to the table of Figure 1. Where two or more thicknesses are involved, the calibration thickness shall be determined by the thickness of the production material to which the search unit is applied. For examination of circumferential welds on material with contact surface curvature greater than 20 inches in diameter, flat, basic calibration block or blocks of essentially the same curvature as the part to be examined shall be used. The basic calibration block contact surface shall be curved for material contact surface curvatures less than 20 inches in diameter. A curved basic calibration block shall be used to calibrate the examination on contact surfaces in the range of curvature from 9/10 to 1-1/2 times the basic calibration block diameter. For example, the 8 inch diameter curved block may be used to calibrate the examination on material contact surfaces in the range of curvatures from 7.2 to 12 inches in diameter.

7.2.2 Basic Calibration Holes

Basic Calibration Holes shall conform to Figure 1.

7.2.3 Portable Calibration Check Block

An IIW-2 block or similar portable block containing side drilled holes may be used as a calibration stability reference, where the use of the basic block is not feasible.

7.2.4 Calibration Procedure

Calibration and Calibration Recording Procedures are contained in Nuclear Services Corporation Procedure NUT-NC-1E.

7.3 Angle Beam Method

7.3.1 Before angle beam examination is attempted, the volume of the base material through which the sound will travel in angle beam examination shall be completely scanned with a straight beam search unit to detect reflectors which might affect the interpretation of angle beam results. Consideration must be given to these reflectors during interpretation of weld examination results, but their detection shall not be a basis for rejection of the base material.

7.3.2 Calibration of Equipment for Angle Beam Testing

a) Transducer Frequency and Size

The nominal transducer frequency shall be 2.25 MHz unless large grain structure or geometry necessitate the use of other frequencies. The maximum size of the transducer shall be 1" by 1".

b) Beam Angle

The beam angle in the production material shall be in the range of 40 degrees to 75 degrees.

c) Distance-Amplitude Correction

Compensation for the distance traversed by the ultrasonic beam as it passes through the material shall be provided by the use of correction curves as described below:

d) Determination of the Distance Amplitude Correction Curve for Angle Beam Testing

1. Nodal Method

Distance-amplitude correction curves (see Figure 2) shall be constructed by utilizing the responses from the basic calibration holes described in 7.1.2.2. The first point on the curve is obtained by placing the search unit as near the basic calibration hole as possible and adjusting the tester gain for maximum response at 75 per cent of full scale. This is the primary reference response. Without changing the gain, the search unit shall be placed similarly at other nodal positions, and the sweep adjusted to display 2-1/2 nodes to extend the calibrated examination into the half node region.

7.3.2 (continued)

2. Multiple Hole Method

Multiple calibration holes may be drilled, covering the contemplated examination distance range and the corresponding responses marked on the screen. These points shall be joined by a smooth line, the length of which shall be sufficient to cover the examination range.

e) Inspection parameters, a, b, and c shall be recorded on suitable forms.

f) Calibration shall be performed on a daily basis before each day's examinations and checked before and after each examination, and at least every 4 hours during examination.

1. If a check indicates a change in system response recalibration is required.

g) Calibration and Calibration recording procedures are contained in Nuclear Services Corporation procedure NUT-NC-1E.

7.3.3 Reference Sensitivity Level

The reference level for monitoring discontinuities is the primary reference response corrected for distance by the Distance Amplitude Correction curve.

7.3.4 Scanning Sensitivity Level

When possible, scanning shall be performed at a minimum gain setting of two times the reference level sensitivity.

7.3.5 Coverage

Where possible, welds shall be examined from both sides of the weld (usually from one surface only).

7.3.5.1 Detection of Defects Parallel to the Weld

The search unit shall be placed on the contact surface with the beam aimed at the weld at about 90 degrees and manipulated laterally and longitudinally so that the ultrasonic beam passes through all of

7.3.5.1 (continued)

the weld metal in two different approaches of the beam, i.e., from both sides of the weld. Techniques employing two search units may be used to detect lack of penetration in double welded butt joints (see Figure 3).

7.3.5.2 Detection of Defects Transverse to the Weld

Two search units shall be placed on the contact surfaces adjacent to the weld, one on each side, making an angle of 45 degrees or less with the axis of the weld with the beam directed along the weld in such a manner that the entire depth and width of the weld is scanned (see Figure 4). Alternatively when the weld surface is suitable, one transducer may be placed on the centerline of the weld and manipulated so that the centerline of the beam covers the entire weld volume.

7.4 Straight Beam Method

7.4.1 Calibration of Equipment for Straight Beam Testing

a) Transducer Frequency and Size

The nominal frequency shall be 2.25 MHz unless grain structure or geometry necessitate the use of other frequencies. The maximum size of the transducer shall be one square inch.

b) Distance-Amplitude Correction

A distance-amplitude correction curve need not be constructed when the thickness of material is one inch or less. For greater thicknesses, using the proper basic calibration block (see Figure 1), position the search unit for maximum response from the basic calibration hole at 1/4T (see Figure 5). Adjust the signal amplitude to 50 per cent of full screen. This is the primary reference response. Without changing the gain control, position the search unit for maximum response from the basic calibration hole to 3/4T and marks its amplitude on the screen. Join the two points with a straight line and extend its length to cover the test range (see Figure 5).

7.4.1 (continued)

c) Inspection parameters a and b shall be recorded on suitable forms.

d) Calibration shall be performed daily before each days' examinations and checked before and after each examination.

e) If a check indicates a change in system response, recalibration is required.

f) Calibration and Calibration Recording procedures are contained in Nuclear Services Corporation procedure NUT-NC-1E.

7.4.2 Reference Sensitivity Level

The reference level for monitoring discontinuities is the primary reference response corrected for distance by the distance amplitude curve.

7.4.3 Scanning Sensitivity Level

When possible, scanning shall be performed at a minimum gain setting of two (2) times the primary reference level.

7.4.4 Verification of Penetration

Penetration shall be verified by obtaining a reflection on similar material while using approximately the same length of sound travel.

7.4.5 Coverage

The weld shall be examined by moving the search unit progressively along and across a sufficient contact area so as to scan the entire weld volume.

7.5 Transfer Mechanism

7.5.1 Transfer correction shall be one (0 db) when the basic calibration block is judged to be similar in surface condition to the material under test.

7.5.1.1 Such variables as coatings, scale, roughness, and curvature shall be considered in evaluating the above similarity.

7.5.2 Where there is dissimilarity between the calibration block and the material under test and the transfer mechanism is applied it shall be detailed on the technique sheet.

8.0 INDICATIONS

All indications which produce a response greater than 100 per cent of the reference level shall be investigated to the extent that the examiner can determine the shape, identity, and locate all such reflectors and evaluate them in terms of the acceptance standards. Oscillograph chart records of indication amplitude and range may be used as an aid in comparison of the indication response with that of the primary reference reflector.

9.0 EVALUATION OF INDICATIONS

The angle of the flaw to the surface, dispersion characteristics of the metal which change the echo strength with depth, and the effect of surface curvature and narrow inspection faces shall be considered in estimating flaw size. Under certain conditions, non-standard reference blocks and/or special techniques will be used to determine the exact character of the actual defect.

10.0 ACCEPTANCE STANDARDS

10.1 The following shall constitute the minimum requirements for welds:

Linear type discontinuities are unacceptable if the amplitude exceeds the reference level and discontinuities have lengths which exceed the following:

1/4 in. for t up to 3/4 in. inclusive.
1/3 in. for t over 3/4 in. to 2-1/4 in. inclusive, and
3/4 in. for t over 2-1/4 in.

Where t is the thickness of the thinner portion of the weld being examined. Where discontinuities are interpreted to be cracks, lack of fusion, and incomplete penetration, they are unacceptable regardless of discontinuity length or signal amplitude.

11.0 REPORTS

11.1 Report of Ultrasonic Examination

The specific technique for each examination shall be recorded on form NSC-TS-003-6/74 and shall include the following minimum information (see attached form) which will be developed from information obtained when inspecting the first unit.

11.0 (continued)

a) Weld type and configuration, part or piece number to be tested, including thickness and diameter dimesions.

b) Automatic defect alarm and recording equipment or both, if used.

c) Special search unit, wedges, shoes, or saddles, if used.

d) Scanning mechanisms, if used.

e) Stage of manufacture when test was made.

f) The surface or surfaces from which the test was performed.

g) Surface finish.

h) Couplant.

i) Method(s) used.

j) Description of the calibration method(s) and method of correlating indications with defects.

k) Scanning method(s).

l) Types and sizes of transducers.

m) Test frequency.

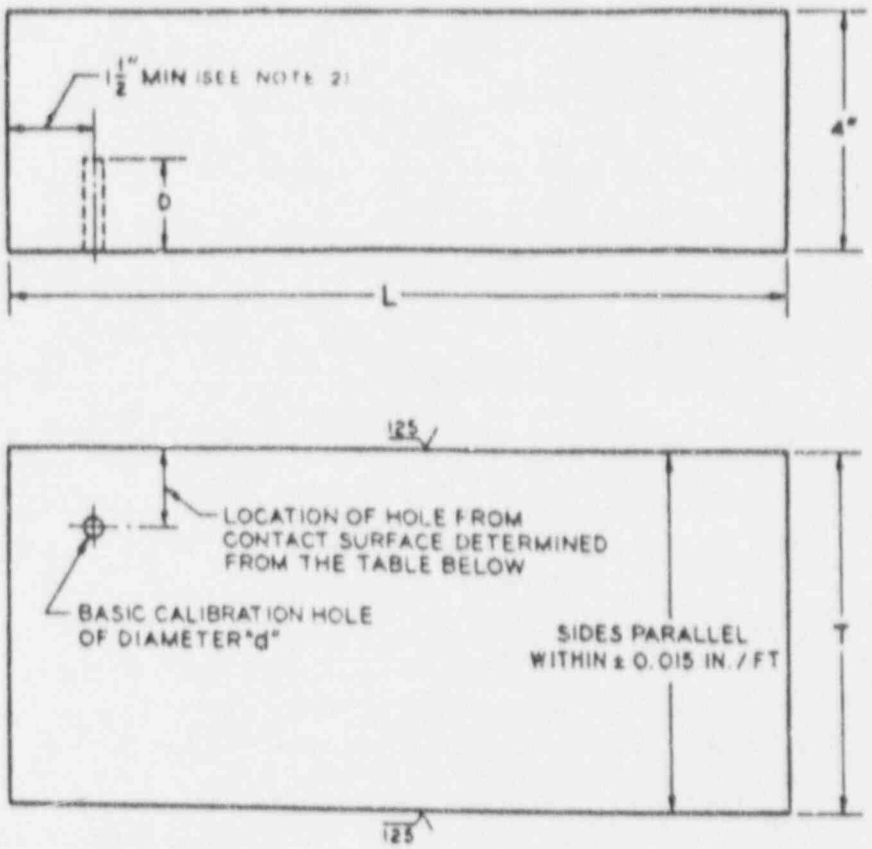
n) Calibration checks before and after each examination.

11.2 Nuclear Services Corporation Certification Form NSC-TS-003-6/74 shall be filled out completely by qualified personnel and the report shall be signed by Nuclear Services Corporation certified inspector. When requested, all rejectable indications will be shown on a drawing or chart of the item and an inspection technique sheet shall be provided. Two copies of the certification form(s) shall be retained by Nuclear Services Corporation and three copies shall be given to the client.

11.3 Applicable oscillograph strip chart records of the examination generated according to Nuclear Services Corporation Procedure NUT-NC-3 shall be attached to the report.

12.0 QUALITY ASSURANCE

12.1 It shall be the responsibility of the Nuclear Services Corporation Level III Examiner to enforce the requirements of this procedure.



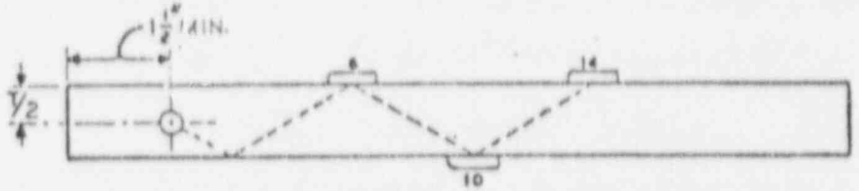
L = Length of block determined by the angle of search unit and the vee-path used
T = Thickness of basic calibration block (see table below)
D = Depth of side-drilled hole (see table below)
d = Diameter of side drilled hole (see table below)
t = Nominal production material thickness

Nominal Production Material Thickness (*t*), in.	Basic Calibration Block Thickness (*T*), in.	Hole Location	Hole Diameter (*d*), in.	Minimum Hole Depth (*D*), in.
Up to 1 incl.	¾ or *t*	½ *T*	3/32	1½
Over 1 thru 2	1½ or *t*	¾ *T*	⅛	1½
Over 2 thru 4	3 or *t*	¼ *T*	5/32	1½
Over 4 thru 6	5 or *t*	¼ *T*	¼	1½
Over 6 thru 8	7 or *t*	¼ *T*	5/16	1½
Over 8 thru 10	9 or *t*	¼ *T*	⅜	1½
Over 10	*t*	¼ *T*	See Note 1	1½

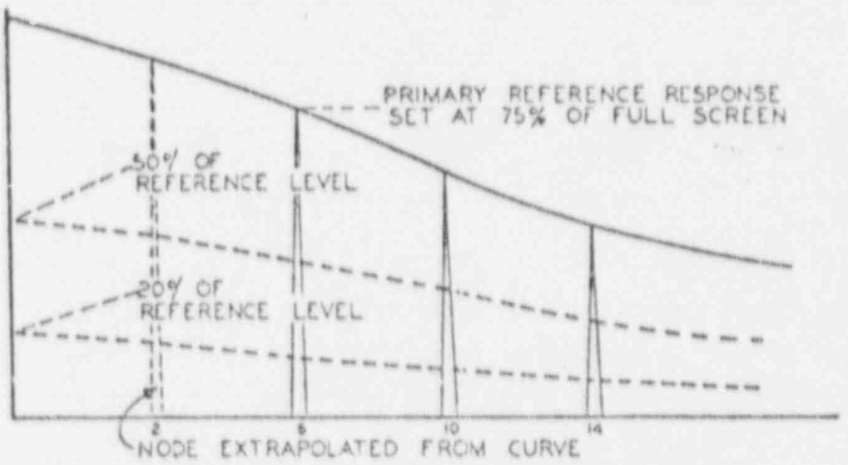
Note 1: For each increase in thickness of 2 in. or a fraction thereof, the hole diameter shall increase 1/16 in.

Note 2: For block sizes over 3 in. in thickness (*T*), the distance from the hole to the end of the block shall be ½*T* min. to prevent coincident reflections from the hole and the corner in the ¾ th vee-path position. Blocks fabricated with a 1½-in. minimum dimension need not be modified if the corner and hole indications can be easily resolved.

MF



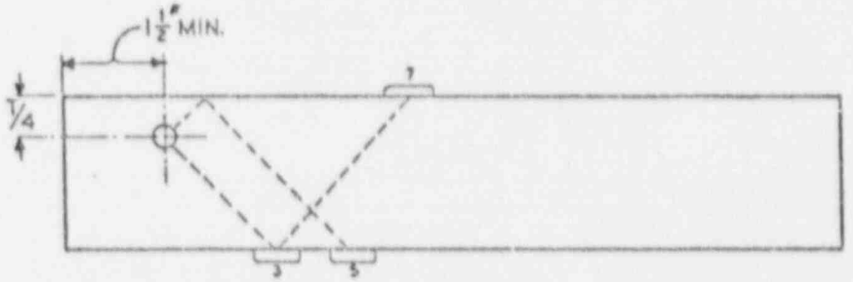
FOR THICKNESS 1 INCH OR LESS



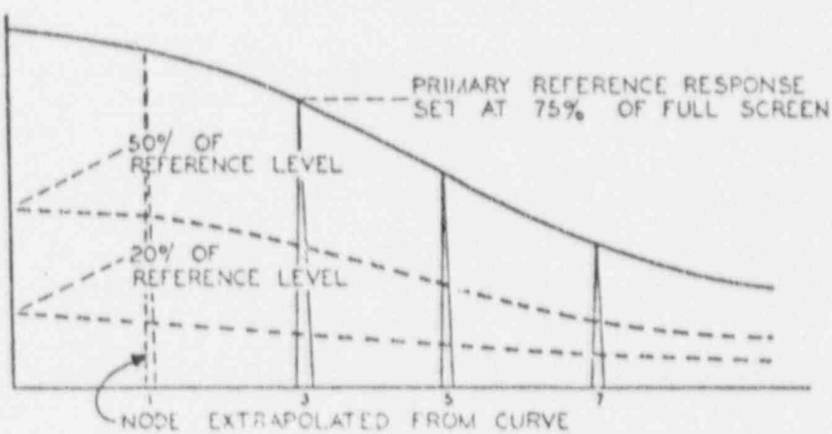
TYPICAL DISTANCE AMPLITUDE CORRECTION CURVE

(ANGLE BEAM METHOD)

DISTANCE IN EIGHTHS OF A NODE. FOR EXAMPLE 14 IS $\frac{14}{8}$ NODE



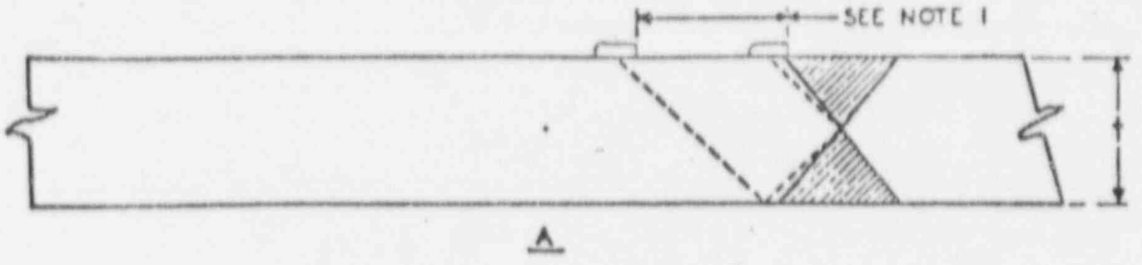
FOR THICKNESS OVER 1 INCH



TYPICAL DISTANCE AMPLITUDE CORRECTION CURVE

(ANGLE BEAM METHOD)

DISTANCE IN EIGHTHS OF A NODE. FOR EXAMPLE 14 IS $\frac{14}{8}$ NODE



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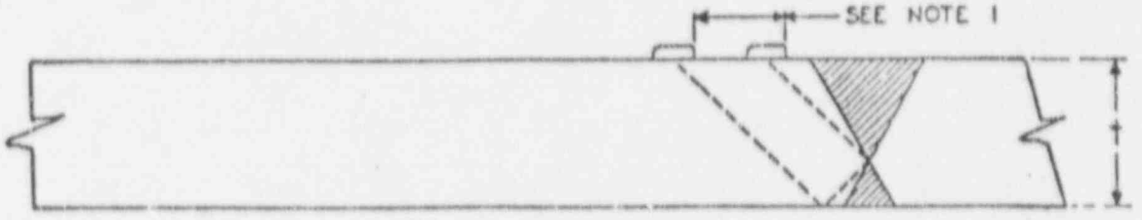

B

NOTE 1

THE POSITION OF THE SEARCH UNITS WILL VARY BECAUSE THE SEARCH UNITS MUST BE LOCATED IN RELATIONSHIP TO THE SOUND BEAM TRAVEL.

FIG. 3

TYPICAL DOUBLE SEARCH UNIT TECHNIQUE

FOR DETECTING LACK OF PENETRATION IN DOUBLE WELDED JOINTS

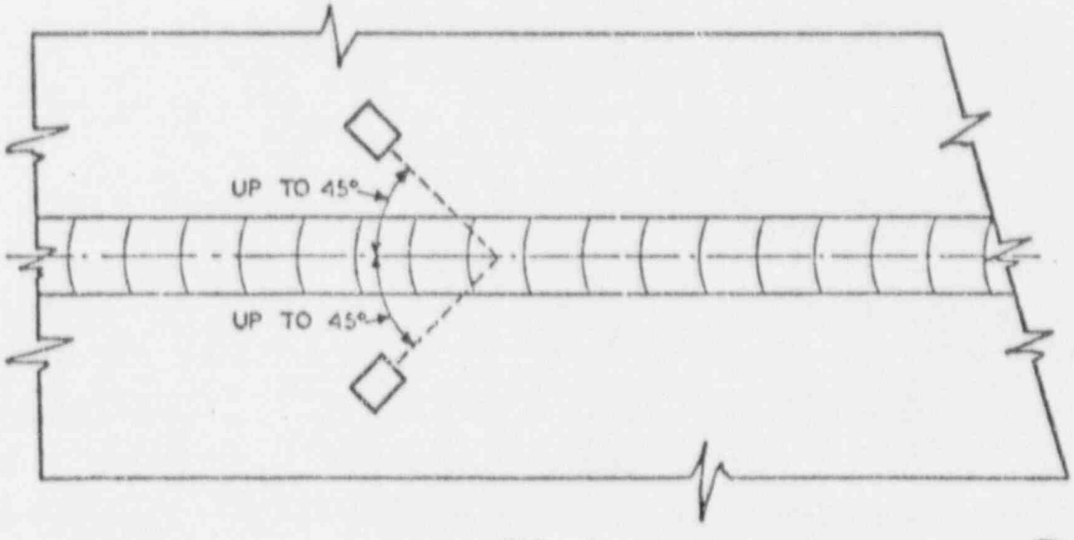

FIG. 4

TYPICAL TWO SEARCH UNIT TECHNIQUE

FOR DETECTING TRANSVERSE DISCONTINUITIES

FIG. 3 & 4

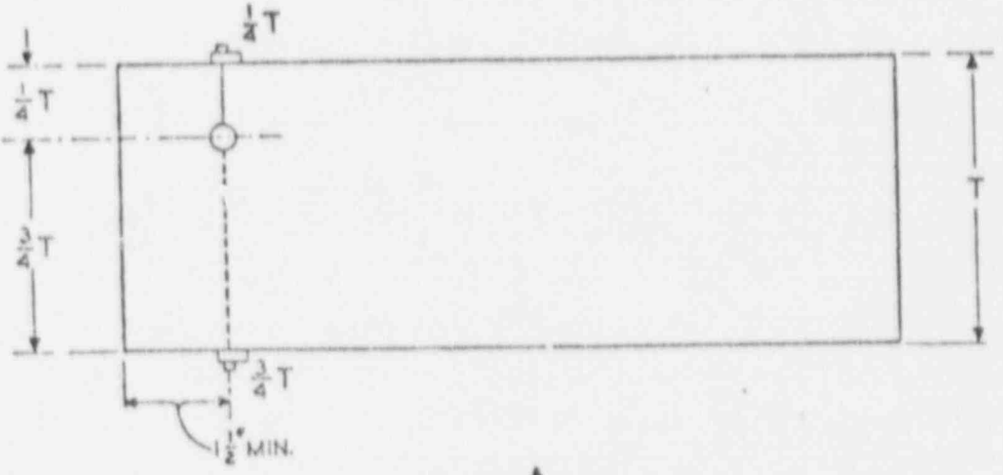

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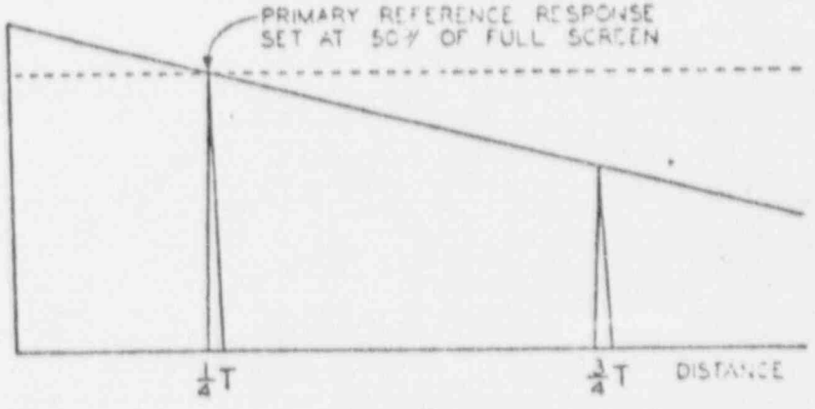
Figure 5



B

TYPICAL DISTANCE AMPLITUDE CORRECTION CURVE
(STRAIGHT BEAM METHOD)

NUCLEAR SERVICES CORPORATION

477 DIVISION STREET
CAMPBELL, CALIFORNIA 95008

CONSTRUCTION
OPERATION

(408) 374-1880

REPORT OF ULTRASONIC EXAMINATION

CUSTOMER			DATE	START TIME	FINISH TIME
JOB OR PROJECT LOCATION	JOB NO.		RPT. NO.		
COMPONENT DESCRIPTION			PLAN OR DWG. NO.		
IDENTIFICATION NUMBER	MATERIAL	SURFACE COND.	THICKNESS	TEMP.	RADIATION FIELD
INSPECTION CODE REFERENCE	NDE PROCEDURE REV.	EVALUATION LEVEL	REPORTING LEVEL		
U.T. EQUIPMENT S/N	ANGLE BEAM S/N ANGLE	L-WAVE S/N	TEST BLOCK DESC. S/N	SCANNING METHOD & SPEED	
CALIBRATION NO.	COUPLANT	EXAMINATION TYPE P.E. THROUGH T.	TRANSMISSION MODE LONG. SHEAR	OVERLAP	
SCAN ATTEN (DB) ANGLE STR.	GAIN	EDC	DAMPING - PULSE L. ANGLE STR.	REP. RATE	VIDEO RESPONSE
SWEEP IN ANGLE STR.	ANGLE BEAM TEST REF. REFLECTOR AMP. µS		STRAIGHT BEAM TEST REF. REFLECTOR AMP µS		
DELAY (IN) ANGLE STR.	CALIBRATION CHECK PERFORMED ANGLE BEAM L WAVE		CHECK REF. BLOCK	MATERIAL MARKER	PHOTO
GATED CIRCUIT: OFF MAN AUTO CHART	RECORDER S/N		LEVELS ALARM DAMP REJECT		

NAD = NO APPARENT DISCONTINUITIES S = SPOT INDICATION L = LINEAR INDICATION G = GEOMETRY

SCANS	ACC	REJ	IND	DESCRIPTION OF INDICATIONS AT EVALUATION SENSITIVITY LOCATION & LENGTH	RANGE	MAX AMP	MAX % DAC
VISUAL PER NVT-NCI							
BASE METAL PRE EXAM							

CONFIGURATION SKETCH AND SCANNING DIRECTIONS

TEST TECHNICIAN _____

ASST. TEST TECHNICIAN _____

Level III _____

CUSTOMER (Level III) _____

AUTHORIZED INSPECTOR _____ _____
SIGNATURE

ENCLOSURE ADDED
YES [ ] NO [ ]

PAGE _____ OF _____

INCLUDE ENCLOSURE PAGES

Record of Revisions

No.	Date	Revision	By
4	1/10/75	Revised	
3	3/1/74	Revised	
2	1/11/74	Revised	
1	7/30/73	Revised	
0	3/1/73	Issued for Comments	

Field Change for DUT-NC-1A Rev 4

January 3rd 1975

Examine the base metal near all stainless steel piping girth welds for a distance of at least one pipe radius, on all UT scans.

D. L. Lambert
NSC Corp Inspector
at the Monticello Site

P. J. Thompson