EBASCO SERVICES INCORPORATED

Two World Trade Center, New York, NY 10048

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ULTRASONIC EXAMINATION FOR THE DETECTION OF INTERGRANULAR STRESS CORROSION CRACKING EBASCO

J.A. FITZPATRICK NUCLEAR POWER PLANT

PROCEDURE NO. JAF-UT-5



EBASCO	EBASCO SERVICES INCORPORA QUALITY ASSURANCE ENGINE INSERVICE INSPECTIO	ERING	PROC	PAGE 1	of 15 JAF-UT-5
ULTRASONIC EX INTERGRANULAR	AMINATION FOR THE DETECTION OF STRESS CORROSION CRACKING	R - INDICATES REVISION	DATE	10/23/81	
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- 1.0 SCOPE
 - 1.1 This procedure defines the requirements for manual ultrasonic examination of stainless steel piping for intergranular stress corrosion cracking.
 - 1.2 This procedure covers both straight beam and 45^o angle beam shear wave techniques applied to the outside of the austenitic stainless steel piping.

2.0 APPLICABLE DOCUMENTS, CODES AND STANDARDS

- 2.1 The following documents form a part of this procedure to the extent specified herein.
 - 2.1.1 Ebasco Documents
 - 2.1.1.1 Ebasco Services Incorporated Procedure for Qualification and Certification of Nondestructive Examination Personnel.
 - 2.1.2 Codes and Standards
 - 2.1.2.1 American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code.
 - a. Section III, Nuclear Vessels, 1974 Edition including Code case Nos. 1698, June "75" and 1705, March "76".
 - b. Section XI, Inservice Inspection of Nuclear Reactor Coolant Systems, 1974 Edition, Summer "75" Addenda.
 c. Section V, 1974 Edition, Summer "75" Addenda.
 - 2.1.2.2 American Society for Nondestructive Test (ASNT)
 - a. SNT-TC-1A, Nondestructive Testing Personnel Qualification, 1975 Edition.

3.0 DESCRIPTION

3.1 The examination volume and area where IGSCC is typically detected is the area between the weld root and the outboard edge of the weld heat affected zone.

The typical weld configurations and areas of IGSCC concred by this procedure are shown in Figures 1 and 2.

EBASCO SERVICES INCORPORATED QUALITY ASSURANCE ENGINEERING INSERVICE INSPECTION

PROCEDURE NO.JAF-UT-5

TITLE	ULTRASONIC EXAMINATION FOR THE DETECTION OF INTERGRANULAR STRESS CORROSION CRACKING	R - INDICATES REVISION	DATE	10/23/81	
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REQUIREMENTS

1328 A/12-75

4.1 Personnel

4.1.1 All personnel performing the nondestructive examinations in accordance with this procedure shall be qualified and certified to at lease Level I in accordance with SNT-TC-1A and Ebasco Services Incorporated Procedure for Qualification and Certification of Nondestructive Examination Personnel. NOTE: At least one member of each examination crew shall have a minimum qualification of Level II.

4.2 Equipment

- Pulse-echo ultrasonic equipment (Krautkramer USM2, USL-38, 4.2.1 Sonic MK1, or equivalent) shall be used. The ultrasonic instrument shall be equipped with a fine gain and/or attentuation control graduated in units no larger than 2 db.
- Straight beam examination shall be performed using a longitudinal 4.2.2 wave search unit having a nominal frequency of 2.25 MHz or 5 MHz.
- Angle beam examinations shall be performed using a 45° (+ 3°) 4.2.3 angle beam shear wave search unit having a nominal frequency range of 1.5 MHz to 5 MHz. For search unit size see Table 3. NOTE: When performing initial calibration, beam angle shall be checked on the IIW block and noted on the calibration data sheet.
- At the discretion of the Level III, transducers of different 4.2.4 size, shape, and frequency may be used as permitted by Section V. Article 5 Para. T-535 and T-536. These changes shall be documented on the data sheets.
- Equipment certification shall be transmitted to the customer. 4.2.5

4.3 Calibration Blocks

- Piping calibration blocks shall be those provided by th. 4.3.1 customer (PASNY).
- Standard calibration blocks such as IIW blocks, miniature angle 4.3.2 beam, DSC blocks, etc. may be used to establish distance (metal path) during calibration.
 - NOTE: The piping calibration blocks shall be within 25° of the component temperature.

EBASCO SERVICES INCORPORATED QUALITY ASSURANCE ENGINEERING

PAGE 3 OF 15

1328A/12-75

INSERVICE INSPECTION

PROCEDURE NO. JAF-UT-5

TTLE	ULTRASONIC EXAMINATION FOR THE DETECTION OF INTERGRANULAR STRESS CORROSION CRACKING	R - INDICATES REVISION	DATE	10/23/81	
			REPL	N/A	APPROVED
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4.4 Surface Preparation and Couplant

- The contact surface shall be clean and free of dirt, dust, weld 4.4.1 splatter, loose scale or other material which would interfere with free movement of the transducer or impair transmission of ultrasonic energy into the material. The weld surface shall also merge smoothly into the surfaces of the adjacent base materials.
- 4.4.2 Glycerine or approved couplant shall be used in sufficient quantity to maintain continuous sonic contact. The couplant used shall be noted on the calibration data sheet.

4.5 Scanning Requirements

- 4.5.1 The scanning speed shall not exceed 3 inches persecond.
- 4.5.2 The scan path of the search unit shall overlap adjacent scans by a minimum of 25% of the search unit width.
- 4.5.3 Scanning shall be performed at a gain setting of at least 2 times (6db) the reference level except for straight beam examination set up on a back reflection.
- 4.5.4 Examination areas shall include the entire circumference of the selected circumferential welds and at least a one foot length of each longitudinal weld intersecting the circumferential weld.

Weld Identification 4.6

4.6.1 Prior to examination, the welds shall be identified in accordance with the weld identification plan identified in the Inservice Inspection Program.

5.0 CALIBRATION

- 5.1 Instrument Calibration
 - At the beginning of each day, the ultrasonic instrument shall be 5.1.1 checked for amplitude linearity and amplitude control linearity as follows:

QUALITY ASSURANCE ENGINEERING

PAGE 4 OF 15

1328A/12-75

PROCEDURE NO.JAF-UT-5

TITLE	ULTRASONIC EXAMINATION FOR THE DETECTION OF INTERGRANULAR STRESS CORROSION CRACKING	R - INDICATES REVISION	10/23/81
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- A. Amplitude Linearity
 - Position a search unit (transducer) on the reference standard so that indications from both the 1/2T and 3/4T holes are visible. (Other reflectors which provide the 2 to 1 ratio required in (2) may be substituted).
 - (2) Manipulate search unit to establish a 2 to 1 ratio of amplitudes between the two indications with the larger at 80% FSH.
 - (3) Without moving search unit, adjust sensitivity to run the higher response from approximately 100% to 20% FSH in 2 db steps (10% if fine control available).
 - (4) Read and record the relative amplitudes of the two indications to the nearest 1%.
 - (5) If the smaller indication does not fall within 5% FSH or 50% of the larger indication, the instrument shall not be used for examinations until corrected.
- B. Amplitude Control Linearity
 - Position a search unit (transducer) on the reference standard to obtain an 80% FSH indication from the 1/2T hole. (any reflector providing 80% FSH may be substituted).
 - (2) Using amplitude control, decrease signal amplitude by 6 db and by 12 db to obtain nominal 40% FSH and 20% FSH signals. Read and record actual signal amplitudes to closest 1%.
 - (3) Obtain a 40% FSH indication from the 1/2T hole and increase amplitude with the amplitude control by 6 db to obtain a nominal 80% signal. Read and record as in (2).
 - (4) Obtain a 20% FSH indication from the 1/2T hole and increase amplitude with the amplitude control by 12 db to obtain a nominal 80% FSH signal. Read and record as in (2).
 - (5) If the indications obtained in (2), (3) and (4) are not within + 20% of nominal, the instrument shall not be used for examination until corrected.

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5.2 System Calibration

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- 5.2.1 Basic system calibration shall be performed using the appropriate reference standard, search units and instrumentation immediately prior to examination, or series of similar examination.
- 5.2.2 Examination system calibration verifications shall be performed at least at the beginning and at the completion of each 4 hour period of examination and/or when any change is made in examination personnel or system combination. In addition, system calibration shall be checked and DAC curve verified after any interruption in power when using AC or after any change in power supply. (e.g. from AC to battery or vice versa).
- 5.2.3 Calibration verification shall be checked at the primary reference sensitivity level.
- 5.2.4 Signal response obtained during calibration verification shall be within plus or minus 20% of that established during basic system calibration.
- 5.2.5 If any point on the DAC curve has changed by more than 20% of its amplitude, the examiner shall:
 - (1) Mark all weld data sheets since previous calibration void.
 - (2) Recalibrate examination system.
 - (3) Reexamine voided areas.
- 5.2.6 If any point on the DAC curve has moved horizontally more than 5% of the sweep line from its original settings, the examiner shall:
 - Correct the sweep calibration and note it on the Calibration Data Sheet.
 - (2) Void any data sheets made since the previous calibration which have recorded indications and reexamine those areas.
- 5.3 If configuration or adjacent parts of the component are such that scanning from both sides of the weld is not practicable, it shall be recorded on the examination data sheet.

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1328A/12-75

EBASCO SERVICES INCORPORATED QUALITY ASSURANCE ENGINEERING INSERVICE INSPECTION

PROCEDURE NO.JAF-UT-5

ULTRASONIC EXAMINATION FOR THE DETECTION OF INTERGRANULAR STRESS CORROSION CRACKING	R - INDICATES REVISION	10/23/81
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5.4 The reject control shall be set at the minimum position unless approved by the cognizant Level III provided the instrument linearity is within the requirements of Section 5.1 of this procedure. Approval by the Level III shall be documented by signing the Calibration Data Sheet.

6.0 EXAMINATION

- 6.1 Straight Beam Base Metal Examination for Laminar Reflectors
 - 6.1.1 Using a reference standard such as one referenced in 4.3.2 set up sweep to accurately display the thickness range of the weld be inspected.
 - 6.1.2 Place the search unit in a defect free area of the base material adjacent to the weld. Adjust instrument sensitivity to produce a minimum 50% to a maximum 75% of full screen reference back reflection and record actual thickness of base material.
 - 6.1.3 The area of the base material through which the sound will travel in angle beam examination, as shown in figure 2, shall be completely scanned with a straight beam search unit to detect reflectors which might affect interpretation of angle beam results. (This is not intended as an acceptance-rejection examination).
 - 6.1.4 Using applicable columns on Indication Data Sheet record all areas which produce a continuous indication equal to or greater than the remaining back reflection and which can not be contained within 1 square inch.
- 6.2 Straight Beam Examination of Weld and Heat Affected Zone
 - NOTE: To be performed only if angle beam examination per 6.3 can not be accomplished.
 - 6.2.1 (A) Material thickness (T) 1 inch and less
 - Position straight beam transducer on appropriate calibration standard to obtain maximum signal amplitude from the 1/2T hole.
 - (2) Adjust the gain to produce a 50 percent full screen height response. Mark the sweep position and amplitude on the CRT screen.

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OF 15 PAGE 7

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ULTRASONIC EXAMINATION FOR THE DETECTION OF

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PROCEDURE NO.JAF-UT-5 DATE - INDICATES 10/00/01

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- (3) Draw a horizontal line across the display screen at the 50% FSH level. This is the primary reference sensitivity. Record this information on the Calibration Data Sheet.
- 6.2.1 (B) Material thickness (T) greater than 1 inch
 - (1) Using the appropriate calibration standard, position the transducer for maximum response from the 1/4T hole.

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- (2) Adjust the gain to produce a 50 percent FSH response. Mark the sweep position and amplitude on the CRT screen.
- (3) Without changing the gain control, maximize the response from the 3/4T hole andjoin the two points with a straight line on the screen to cover the test range. This is the primary reference sensitivity. Record this information on the Calibration Data Sheet.
- Examination coverage shall include the weld and 1T on each side 6.2.2 of the weld.

Angle Beam Examination 6.3

- 6.3.1 One-half vee path examination techniques using the search units referenced in Table 2, shall be the preferred method and performed as follows:
 - (1) Select the appropriate search unit for the piping wall thickness and diameter from Table 2.
 - (2) Using a standard calibration block, such as one referenced in 4.3.2, set up the sweep display so that each major horizontal screen division on the CRT represents 1/4" of sound path.
 - (3) Using the appropriate piping standard, obtain maximized responses from the side drilled holes at 1/4T, 1/2T, 3/4T and 1 1/4T (if possible). Mark the positions on horizontal sweep of the CRT using a grease pencil or similar marker to establish a range reference.

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PAGE 8 OF 15

PROCEDURE NO. JAF-UT-5

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TITLE

DATE EGEND ULTRASONIC EXAMINATION FOR THE DETECTION OF - INDICATES . 10/23/81 INTERGRANULAR STRESS CORROSION CRACKING REVISION



- (4) Without altering the range established above, maximize the signal response from the ID notch, and using the sensitivity controls, set the signal to 80% of full screen height (FSH). Mark its amplitude and position on the CRT as above. This notch response is the primary reference sensitivity.
- (5) Draw a horizontal line across the CRT from the 1/2T hole position to the notch position. This line shall delineate the area of interest and the primary reference sensitivity. Record all sensitivity control settings on the appropriate Calibration Data Sheet.
- (6) Upon completion of calibration, ensure that all instrument settings and search unit data are recorded on the Calibration Data Sheet.
- (7) Each weld shall be scanned as shown in figs. 1 & 2 using 45° angle beam, techniques applied in two directions parallel to the weld axis and in two directions perpendicular to the weld axis, where geometry permits.
- If component geometry and/or accessibility prohibits the tech-6.3.2 nique referenced in 6.3.1, the following method shall be employed:
 - (1) A nominal 3.5MHz, 1/4 diameter transducer, affixed to an appropriate wedge to yield a nominal 45 degree refracted shear wave shall be used.
 - (2) Maximize the signal responses from the first ID notch, the OD notch, and the second ID notch (if possible) to generate a one and on-half vee range.
 - (3) Using the sensitivity control, set the highest response of 80% of FSH and mark its position and amplitude on the CRT screen. Without changing the sensitivity, maximize the settings from the remaining notches and mark the amplitudes and positions on the CRT.
 - (4) Plot a DAC curve by connecting the locations marked on the CRT with a continuous line from the from surface to the second ID notch (when possible).
 - (5) This is the reference sensitivity level. Record all instrument settings on the Calibration Data Sheet.

EBASCO SERVICES INCORPORATED QUALITY ASSURANCE ENGINEERING INSERVICE INSPECTION

PROCEDURE NO. JAF-UT-5

PAGE 9

OF 15

TITLE	ULTRASONIC EXAMINATION FOR THE DETECTION OF INTERGRANULAR STRESS CORROSION CRACKING	R - INDICATES REVISION	DATE	10/23/	81
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- (6) Each weld shall be scanned such that the area of interest, as shown in figure 1, is covered (access permitting) as referenced in 6.3.1 (7).
- NOTES: 1. If indication, other than geometry, are found in the area of interest it may be necessary to take additional thickness readings in that area to accurately plot the location. Straight beam may also be used to locate counterbore.
 - The search unit shall be swivelled (45^c each way) as it is moved along a rectilinear scan pattern to ensure a minimum of 25% overlap of the transducer width. This is required to detect cracks which may be oriented at odd angles.

7.0 RECORDING AND EVALUATION OF TEST RESULTS

- 7.1 All indications which produce a response greater than 10% of the reference level shall be investigated to the extent that the operator can determine the shape, identity and location of all such reflectors.
- 7.2 All non-geometric indications within the area of interest regardless of length or signal amplitude shall be unacceptable and recorded on the Indication Data Sheet (sample attached).
- 7.3 Further evaluation of reportable indications to determine disposition and/or the need to make repairs shall be the responsibility of the Utility Owner who will evaluate in accordance with Section XI.

8.0 REPORTS

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1328A/12-75

- 8.1 A detailed ultrasonic examination report shall be prepared using the Indication Data Sheet and any additional sketches or photographs as may be applicable. If no reportable indications are detected it shall be so noted on report form. All final Data Sheets shall be in ink.
- 8.2 Prompt (24 hours) notification of recordable indications will be made to the representative designated by the Utility Owner.



steel piping as a function of pipe size.

FIGURE 1



NPS	Pipe Schedule	"t"	NPS	Pipe Schedule	"t"
3"	10	.120"	8"	20	.250"
3"	80	. 300"	10"	10	.165"
3''	160	. 438"	10"	20	. 250"
4"	10	.120"	12"	20	.250"
4"	80	. 337"	12"	140	1.125"
6"	10	.134"	18"	10	.250"
6''	80	. 432"	24"	10	. 250"
6"	120	.562"	28"	-	1.350"
6"	160	,718"	28"	-	1.411

FIGURE 2



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NOMINAL PIPE SIZE	WALL THICKNESS	ELEMENT SIZE	STYLE NUMBER
4" - 12"	. 25" 875"	1/4" X 1/4" each	11
10" - 18"	.6" - 1.0"	3/8" X 3/8" each	10
10" - 18"	.8" - 1.8"	3/8" X 3/8" each	16
16" and Larger	.8" - 1.5"	3/8" X 3/8" each	16

TABLE 2 SEARCH UNIT SELECTION

NOTE: The above search units are recommended for angle beam examination per 6.3.1. Others of similar design may be substituted.

Page 13 of 15

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EBASCO SERVICES INCORPORATED QUALITY ASSURANCE ENGINEERING INSERVICE INSPECTION

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UT INSTRUMENT CALIBRATION

INSTRUMENT MANUFACTURER		PROJECT
MODEL	SERIAL NO.	DATE

AMPLITUDE LINEARITY

dB CONTROL	ACTUAL	SCREEN HEIGHT	SCREEN HEIGHT*
CHANGE	dB	LARGER INDICATION	SMALLER INDICATION
Initial (OdB)			
+2dB			
0dB			
-2dB			
- 4dB			
-6dB			
-8dB			
-10dB			
-12dB			
Must be 50% of the Larger A	mplitude, within ±5% of Full Ser	een Height	

AMPLITUDE CONTROL LINEARITY

AT % FSH	dB CONTROL	INDICATION LIMITS	ACTUAL
80	- 6dB	32 to 48	
80	- 12dB	16 to 24	
40	+ 6 dB	64 to 96	
20	+12dB	64 to 96	

	ACCEP	TABLE		
)	YES	NO	EXAMINER(S)	
Amplitude Linearity			1.	TC-1A LEVEL
Amplitude Control Linearity			2.	TC-1A LEVEL

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CONTINUATION ATTACHED - Vos 0 No

1. TC-IA LEVEL

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ATTACHMENT NO. 4