ULTRASONIC EXAMINATION OF STAINLESS STEEL PIPING FOR INTERGRANULAR STRESS CORROSION CRACKING (IGSCC)

NIAGARA MOHAWK POWER CORPORATION

NINE MILE POINT, UNIT 1

Project Application	Prepared By	Date
5530 - ISI	S. Foote	7/30/80

APPROVALS

TITLE/DEPT.	SIGNATURE		DATE
UT Level III		F. T. Carr	8/5/80
Mgr. Field Operations		M. C. Stamm	8/5/80
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NMPC - QC Operations.	Gary R. Leskiw		2/19/81

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6 APRIL '82
Date

ISI FIELD CHANGE AUTHORIZATION

Document Title ULTRASONIC EXAMINATION OF STAINLESS STEEL PIPING FOR INTERGRANULAR STRESS CORROSION CRACKING (IGSCC) Document No. 80A2818 Rev. 1

Field Change No. FC-001 Originator M STAMM

Description of Field Change:

PARAGRAPH 5.2.2 : DELETE ITEMS 1 & 2

PARAGRAPH 6.1 : CHANGE ITEM 2 TO SAY - Search Unit : dual 1.5 MHz, 1.6 MHz or 2.25 MHz

CHANGE ITEM 4 TO SAY - Search Unit : single element 1.5 MHz, 1.6 MHz or 2.25 MHz of appropriate size to accomidate wedge.

Reason for Change: IMPROVE TECHNIQUE

Approvals:

NES M. Stamm 5/18/82

NMPC Gary L. Leskiw 5/20/82

Distribute to all Controlled Copy holders of affected Document.

Note: A copy of this authorization shall be attached to the affected document until a subsequent revision incorporates the field change.

Figure 4.1

NUCLEAR ENERGY SERVICES, INC.
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June 3, 1982
Date

ISI FIELD CHANGE AUTHORIZATION

Document Title Ultrasonic Examination of Stainless Steel Piping for Intergranular Stress Corrosion Cracking Document No. 80A2818 Rev. 1

Field Change No. FC-002 Originator M. Stamm

Description of Field Change:

Change item 5.1.1 to read:

The nominal examination frequency shall be 2.25MHz for all straight beam examinations, a 5.0MHz may be used to provide better resolution.

Reason for Change:

To include use of a 2.25MHz on straight beam examinations.

Approvals:

NES	Michael Stamm UTIII	6/3/82
NMPC	Gary R. Leskiw UT III	6/11/82

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Figure 4.1

NUCLEAR ENERGY SERVICES, INC.
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June 7, 1982
Date

ISI FIELD CHANGE AUTHORIZATION

Document Title ULTRASONIC EXAMINATION OF STAINLESS STEEL PIPING FOR INTERGRANULAR STRESS CORROSION CRACKING Document No. 80A2818 Rev. 1

Field Change No. FC-003 Originator R. Barnes

Description of Field Change: Add to page 6, item 7.2 the following;

7.2.3 All indications will be recorded at the scanning sensitivity level. Any indication that is not recordable at reference sensitivity, will be recorded indicating the percent (%) of DAC and the location given with the use of a number belt. Disposition by the examination supervisor will be required.

Reason for Change:

Clarification of recorded indications.

Approvals:

NES [signature] 6/10/82

NMPC Gary R. Leaker 6/11/82

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Figure 4.1

NUCLEAR ENERGY SERVICES, INC.
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September 24, 1982
Date

ISI FIELD CHANGE AUTHORIZATION

Document Title ULTRASONIC EXAMINATION OF STAINLESS STEEL PIPING FOR INTERGRANULAR STRESS CORROSION Document No. 80A2818 Rev. 1

Field Change No. FC-005 Originator M. Stamm

Description of Field Change:

Para. 6.1 Item 3, change to read:

3. Search Units: 0°, 1/4" - 1/2" or 1/2" X 1" (for large diameter pipe) 2.25 MHz or 5.0 MHz.

Reason for Change:

To include a 1/2" X 1" size transducer for large diameter piping.

Approvals:

NES M. Stamm 9/30/82

NMPC Gary R. Leskiw 10/4/82

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Figure 4.1

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REVISION LOG

NUCLEAR ENERGY SERVICES, INC.

DOCUMENT NO. 80A2818

REV. NO.	DATE	PAGE NO.	DESCRIPTION	APPROVAL
1	2/16/81	3	Para. 1.1 added last sentence	EJP
		4	Para. 2.2 deleted and renumbered	
		5	Para. 6.1 deleted Item 10 and added camera	
		6	Para. 6.2(5) and 7.2.1 changed standard to block	
		6	Para. 8.1 added...at least 80%	
		7	Para. 8.2.2(2) revised CRA 1722	

FORM # NES 206 2/80

ULTRASONIC EXAMINATION OF STAINLESS STEEL PIPING FOR INTERGRANULAR STRESS CORROSION CRACKING

(IGSCC)

1. SCOPE

1.1 INTENT

This procedure shall be used in conjunction with NES Procedure 80A2308 unless otherwise specified. 80A2308 contains all of the general requirements applicable to this examination procedure. This procedure contains all of the specific application requirements for the examination of areas specified in Section 1.2. The intent of this procedure is to cover the piping ID surface adjacent to welds. The interest is in the detection of cracks which originate at the ID surface of service sensitive piping. This is a new procedure to the Inservice Inspection Program Plan. 1

1.2 AREA OF EXAMINATIONS

This document covers the ultrasonic examination procedures of stainless steel piping for intergranular stress corrosion cracking (IGSCC). IGSCC is typically detected in the area between the weld heat affected zone and a point 1/2" outward.

1.3 TYPE OF EXAMINATION

1.3.1 Volumetric examination shall be performed using ultrasonic pulse echo nominal 45° angle beam shear wave and 0° longitudinal straight beam techniques applied to the outside surfaces of the piping.

1.3.2 The examination shall be performed using manual search units (transducers).

1.4 WELD CONFIGURATION

1.4.1 The typical weld configurations and areas of IGSCC covered by this procedure are shown in Figure 1.

1.4.2 Nominal weld thicknesses range from 0.300" to 1.546".

1.5 MATERIALS

The piping is constructed of austenitic stainless steel.

2. REFERENCES

2.1 80A2308 NES Procedure; "Ultrasonic Examination General Requirements."

2.2 Electric Power Research Institute (EPRI), Project Report 892 (1/79): Workshop on Inservice Inspection of Stainless Steel Piping in Nuclear Systems. (1)

2.3 USNRC Bulletin 79-17 (7/26/79).

3. PROCEDURE CERTIFICATION

The examination procedures described in this document, in conjunction with NES Procedure 80A2308, comply with Section XI of the ASME Boiler and Pressure Vessel Code 1974 Edition, Summer 1975 Addenda except where examination coverage is limited by part geometry or access.

4. PERSONNEL CERTIFICATION

Each person performing ultrasonic examinations governed by this procedure shall be certified in accordance with the documents referenced in Procedure 80A2308.

5. EXAMINATION REQUIREMENTS

5.1 EXAMINATION FREQUENCY

5.1.1 The nominal examination freuency shall be 5.0MHz for all straight beam examinations to provide greater resolution.

5.1.2 The nominal examination frequency shall be 1.5 or 1.6MHz for all angle beam examinations.

5.2 EXAMINATION ANGLES AND COVERAGE

5.2.1 The rate of search unit movement shall not exceed two (2) inches per second. The search unit shall be swiveled a full 90° during axial scanning (45° left and 45° right).

5.2.2 Each weld and one (1) inch on each side of the weld shall be ultrasonically examined 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,

1. For wall thicknesses $\geq$ 0.375", the EPRI-type dual search unit shall be used.

2. For wall thicknesses < 0.375", a single element search unit shall be used.

5.2.3 0° straight beam techniques shall be utilized to accurately measure wall thickness, precisely locate counterbore, and to detect laminar conditions which may interfere with the angle beam examination.

6. EQUIPMENT REQUIREMENTS

6.1 EXAMINATION CONTRACTOR'S EQUIPMENT

The following test equipment or its equivalent shall be provided by the Examination Contractor (as a minimum) for examination of welds specified in this procedure:

1. Pulse echo ultrasonic instrument
2. Search Unit: dual 1.6MHz or 1.5MHz for T $\geq$ 0.375"
3. Search Units: 0°; 1/4" - 1/2" dia.; 5.0MHz
4. Search Unit: 1.6MHz, 1/2" dia.; single element for T < 0.375"
5. Wedges: 45° shear and longitudinal, 1/2", 60° shear for wall thickness 0.200" and less
6. Couplant
7. Minature angle beam verification block
8. Thermometer
9. Camera (1)

6.2 PLANT OWNER'S EQUIPMENT

The Plant Owner, or his Agent, shall provide the following service facilities and equipment as required:

1. Scaffolding

2. Water, air, and electricity
3. Adequate temporary lighting
4. Moving or lifting devices
5. Calibration Blocks (Listed in the Program Plan) 1
6. Test surface preparation (cleaning and finishing)
7. Drawings of each examination area
8. Radiation monitoring and shielding devices
9. Post-examination cleanup.

7. CALIBRATION REQUIREMENTS

7.1 CALIBRATION DATA PACKAGES

Calibration Data Packages shall be numbered 2818-1, 2818-2, 2818-3, etc., and shall be signed by the examiner(s) upon completion, noting applicable NDE certification levels. A Calibration Data Package shall consist of a Calibration Data Sheet(s), and an Indication Report Sheet as required.

7.2 REFERENCE SENSITIVITY LEVEL

7.2.1 The reference sensitivity level shall be the distance-amplitude curve initially obtained directly from the piping calibration block and shall be the sensitivity level used for evaluating and recording all indications. 1

7.2.2 During actual weld scanning, the reference sensitivity level shall be increased at least 2X (6dB) but no more than 10dB greater.

8. EXAMINATION SYSTEM CALIBRATION

8.1 STRAIGHT BEAM CALIBRATION FOR BASE MATERIAL

Straight beam calibration for all base material through which the angle beams will pass shall be performed at a sensitivity level which gives an initial back reflection signal amplitude from the component of at least 80% Full Screen Height (FSH). 1

8.2 ANGLE BEAM CALIBRATION

8.2.1 Metal Path Calibration

See Procedure 80A2308 for the appropriate horizontal linear range calibration.

8.2.2 Angle Beam Calibration: 1-1/2 Vee Technique

One and one-half vee path calibration shall be the preferred method of calibration for the examinations described in this procedure and shall be accomplished as follows:

1. Obtain maximized signal responses from the notches and mark the signal response positions on the instrument's CRT screen.
2. Maximize the signal from the notch producing the highest resonse and set its amplitude to 80% FSH. 1
3. Without changing sensitivity settings, maximize successive notch indications and mark their peak amplitudes on the CRT screen, and on the Calibration Data Sheet.
4. This is the reference sensitivity level. Record all sensitivity control settings on the appropriate Calibration Data sheet.
5. Upon completion of calibration, ensure that all data and instrument settings are recorded on the Calibration Data Sheet. The examiner(s) shall sign the completed data sheet, noting applicable NDE certification levels.

8.2.3 Angle Beam Calibration: 1/2 Vee Technique

One-half vee calibration shall be used if conditions prevent the use of 1-1/2 full vee and shall be accomplished as follows:

1. Select a search unit of such angle and size that the root of the weld will be within the 1/2 vee path.
2. The shape and slope of the DAC curve is established by obtaining maximized responses from the side drilled holes within the 1/2 vee path.
3. Set the highest amplitude signal at 80% FSH and mark its amplitude and position on the CRT screen. Without changing sensitivity, maximize the signal(s) from the remaining hole(s) and mark the amplitude(s) at the appropriate position(s) on the CRT. Note signal response amplitudes, positions, and the sensitivity settings on the Calibration Data Sheet.

4. Plot a DAC curve by connecting the locations (marked on the CRT) with a continuous line extended to cover the full examination range. (Front surface to back surface.)

5. Obtain a maximized signal from the ID notch, (if available) and adjust the instrument sensitivity to bring its peak to the DAC line (mark position on the CRT).

6. This is the reference sensitivity level. Record all sensitivity control settings on the appropriate Calibration Data Sheet.

7. Upon completion of calibration ensure that all data and instrument settings are recorded on the Calibration Data Sheet. The examiner(s) shall sign the completed data sheet, noting applicable NDE certifiction levels.

8.3. CALIBRATION CHECKS

Calibration checks are to be performed in accordance with Procedure 80A2308.

9. EXAMINATION PROCEDURES

9.1 STRAIGHT BEAM EXAMINATION OF BASE MATERIAL

Straight beam examination of all base material shall be performed at the sensitivity level established in paragraph 8.1.

9.2 ADDITIONAL STRAIGHT BEAM EXAMINATION
(When indications are detected).

9.2.1 In order to accurately plot indications, the ID and OD weld contour must be established. The OD contour shall be recorded with the use of a contour gauge. The ID contour is established by performing a thickness check of the weld and adjacent base material to establish the location, depth, and slope of any existing counterbore.

9.2.2 The thickness and contour data is then plotted on a full scale weld profile. Angle beam recordings are transferred to this plot to determine the true nature of all indications.

9.3 ANGLE BEAM EXAMINATION

9.3.1 The scan sensitivity shall be a minimum of 2X (6dB) greater, but no more than 10dB greater, than the calibrated reference sensitivity level.

9.3.2 The search unit shall be swivelled (45° 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.

9.3.3 The examiner shall pay particular attention to indications which originate adjacent to the weld root and up to 0.5" out from the root. These typical locations of IGSCC are of ID origin.

9.3.4 Any such indications which may be considered as counterbore must be verified by 0° thickness check.

10. EVALUATION CRITERIA

10.1 RECORDING OF INDICATIONS

10.1.1 Indications from the weld crown and from other OD geometric origins may be ignored. The liquid penetrant examination will cover this area.

10.1.2 All other indications regardless of amplitude shall be recorded in the following manner:

1. Use the Indication Report Sheet to record the following information:

   A. Maximum % of DAC.

   B. Metal path (read directly from the CRT) at the maximum amplitude position.

   C. Distance from the weld centerline to the search unit exit point at the maximum amplitude position.

   D. Move the search unit forward (toward the indication) until the indication is at half maximum amplitude. Record the metal path as in (B) and the "W" dimension as in (C).

   E. Move the search unit away from the indication (backward) causing the signal to peak again and then drop to a half amplitude position. Record the metal path as in (B) and the "W" dimension as in (C).

   F. Now record the distance from weld datum zero (L max.).

   G. Move the search unit sideways toward datum zero. During this movement the signal shall be maintained by a slight swivel motion of the search unit. When the signal is lost, record this location from datum zero as "L1".

   H. Move sideways in the opposite direction in the same manner to establish the total length of the indication. Record this end point (signal loss) as "L2".

2. Observe signal shape, behavior, and search unit distance from the weld centerline. This will yield information as to the nature of the indication. Make notes of your observations during the recording process.

10.2 PLOTTING OF INDICATIONS

All recorded indications shall be plotted full scale in the following manner:

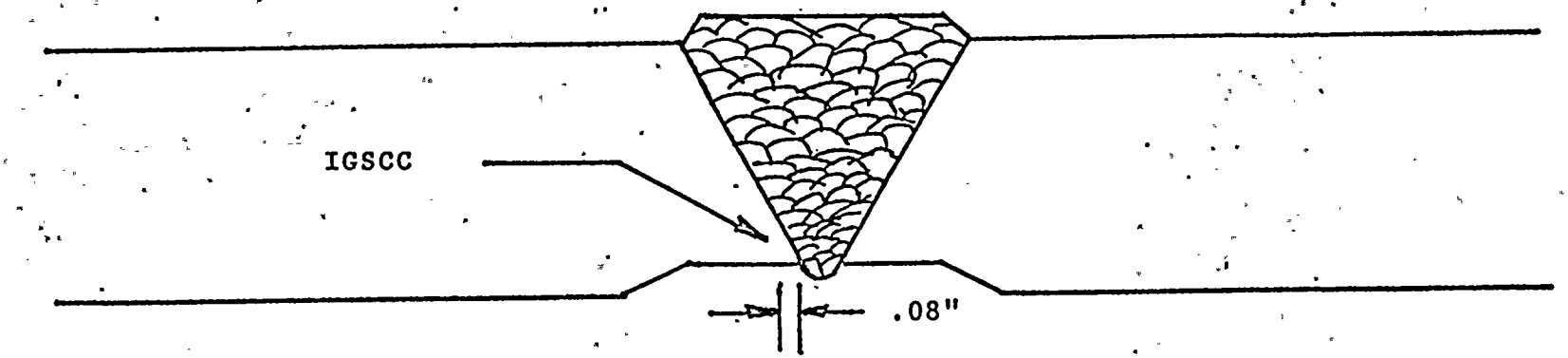
1. Trace the OD contour from the contour gauge.
2. Plot the thicknesses.
3. Connect the thickness points to reconstruct the ID contour.
4. Plot the "W max", "W_1", and "W_2" dimensions on the applicable side of the weld.
5. At the "W max" position use a protractor to lay out the actual metal path to the indication origin by measuring along the metal path.
6. For the forward measurements (W_1) use an angle which is 3 degrees less than the "W max" angle, this allows a reasonable amount for beam spread. Plot the metal path to termination.
7. For the backward measurements (W_2) use an angle which is 3 degrees greater than the "W max" angle. Plot the metal path to termination.
8. Connect the 3 metal path termination points to reconstruct the shape of the reflector.

10.3 EVALUATION OF INDICATIONS

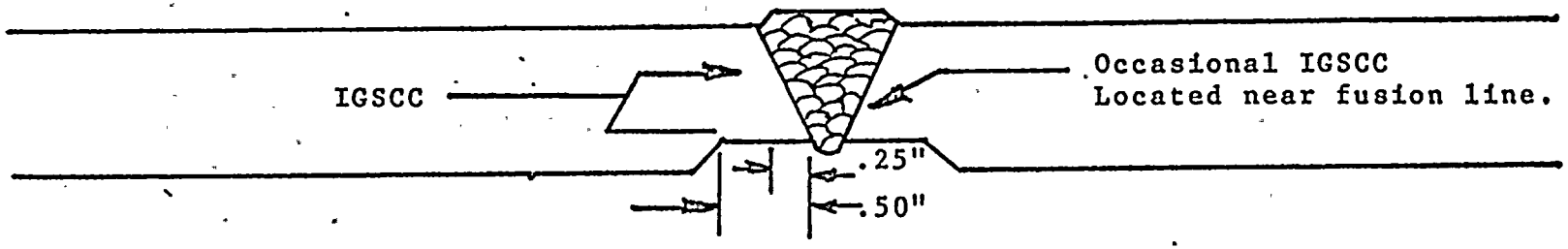
10.3.1 Indications where plots confirm that they are caused by geometry shall be marked as such.

10.3.2 Indications where plots confirm that they are cracks shall be reported to the examination supervisor who will notify the Plant Owner within 24 hours.

10.3.3 Indications where plots yield inconclusive information shall be reported to the examination supervisor for disposition.



Pipes > 14" Diameter



Pipes ≤ 14" Diameter

PREDOMINATE LOCATIONS OF INTER GRANULAR STRESS CORROSION CRACKING IN STAINLESS STEEL PIPING AS A FUNCTION OF PIPE SIZE.

FIGURE 1