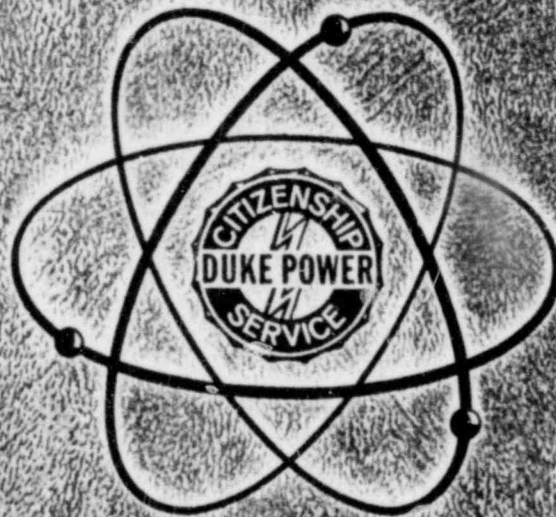


SRG-78-01  
REV. 2

# AUGMENTED INSERVICE INSPECTION FOR PIPE RUPTURE PROTECTION

McGUIRE NUCLEAR STATION  
UNITS 1 & 2

VOLUME 2



JUNE 15, 1981

DUKE POWER COMPANY  
DESIGN ENGINEERING DEPARTMENT  
MECHANICAL & NUCLEAR DIVISION

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Appendix I - Procedures and Calibration Standards

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INSERVICE INSPECTION PROCEDURE

SUBJECT ULTRASONIC EXAMINATION OF CLASS 1&2 PIPING WELDS JOINING SIMILAR & DISSIMILAR MATERIALS	ISI-120, REV. 6
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1. SCOPE: This examination procedure shall govern the ultrasonic examination of similar and dissimilar metal Class 1&2 piping welds ranging in thickness from 0.1 to 6 inches. Circumferential, longitudinal, attachment, hanger, support, nozzle, etc. weld seams in piping are covered by this procedure. This procedure is in accordance with the requirements of Section XI of the ASME Code.
2. SURFACE PREPARATION: The examination surface shall be free of dirt, loose scale, machining or grinding particles, weld splatter, or other loose foreign material. Surface preparation shall be performed on an area which includes the weld and the area for two times the thickness on both sides of the weld.
3. OPERATOR QUALIFICATIONS:
  - 3.1 Operator: The operator performing the examination shall be qualified to Level II in accordance with B&W Construction Company Quality Control Administrative Procedure 9A-169. The Level II shall be responsible for and shall accept the results of the examination.
  - 3.2 Assistant: The assistant shall be qualified to at least Level I in accordance with B&W Construction Company Quality Control Administrative Procedure 9A-169. The Level I shall not independently evaluate or accept the results of the examination.
4. EQUIPMENT:
  - 4.1 UT Scope: A pulse-echo type ultrasonic flaw detection instrument shall be used. The instrument shall be equipped with a stepped gain control calibrated in units of 2dB or less.
  - 4.2 Search Units:
    - 4.2.1 Straight Beam: Either ceramic, lithium sulfate or barium titanate 2.25 MHz single element or a 2.25 or 5.0 MHz dual element search units shall be used. The element shall have an effective area from .049 to 1.0 square inches inclusive. If grain structure is such that 2.25 MHz cannot penetrate, a 1.0 MHz search unit of the types listed above may be used. Other search units may be used upon approval of the B&W Construction Company Level III.
    - 4.2.2 Angle Beam: Either ceramic, lithium sulfate or barium

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titanate 2.25 MHz, 45 degree (-2 degrees) angle beam single element search unit shall be used. The element shall have an effective area from .049 to 1.0 square inches inclusive. Other angles may be used to evaluate indications, or where wall thickness or geometric configuration impedes the effective use of 45 degree angle beam for examination. If grain structure is such that 2.25 MHz cannot penetrate, a 1.0 MHz search unit may be used. Other search units may be used upon approval of the B&W Construction Company Level III.

4.2.2.1 Exit Point: A standard steel IIW block will be used before examinations are performed each day to verify or correct the exit point on the transducer shoe.

4.2.2.2 Beam Angle: After the exit point has been determined, the angle shall be checked with the IIW block to confirm that the transducer meets angle ranges specified in 4.2.2.

4.3 Couplant: A suitable liquid, semi-liquid, or paste couplant medium, such as water, oil, glycerin, grease or Hamikleer shall be applied to the examination surface.

5. CALIBRATION BLOCK:

5.1 Material: The block shall be fabricated from a component prolongation where possible. If it is not possible to fabricate the block from material taken from the component, it shall be fabricated from a material similar to the component. When the examination is to be performed from only one side of the joint, the calibration block shall be of the same material as where the search unit is applied.

5.2 Size: The length of the calibration block shall be determined by the angle of the search unit and the Vee path that will be used. A minimum length of 6T is desirable.

5.2.1 Thickness:

5.2.1.1 Prior to the W'75 Code:<sup>1</sup> The thickness of the block shall be as allowed in Figure 1 for the material thickness examined. Where two or more component thicknesses are joined, the block shall be selected to cover the largest thickness.

<sup>1</sup> Winter 1975 Code Addenda to Section XI, throughout this procedure.

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5.2.1.2 W'75 Code and Later: The thickness of the block shall be the same nominal dimension as the pipe being examined. Where two or more component thicknesses are joined, the block shall be selected to cover the thickness where the search unit is applied.

5.3 Calibration Block Reflectors:

5.3.1 Holes:

5.3.1.1 Prior to the W'75 Code: The calibration holes shall be drilled parallel to the contact surface for flat blocks. For curved blocks, longitudinal holes shall be drilled parallel to the contact surface and circumferential holes, when used, shall be drilled parallel to a tangent to the contact surface. The diameter and depth of these holes shall conform to those stated in Figure 1 for the block thickness.

5.3.1.2 W'75 Code and Later: Side drilled holes may be placed in the calibration block at  $1/4$  and  $3/4$  T with a depth of  $1-1/2$  inch minimum. The holes shall be located so they will not interfere with the notches. Hole diameters shall be as stated in Table III for the block thickness.

5.3.2 Notches:

5.3.2.1 Prior to the W'75 Code: The calibration block doesn't require the use of notches.

5.3.2.2 W'75 Code and Later: The calibration block shall contain ID and OD circumferential and longitudinal notches with their sides perpendicular to the surface. The notches shall have a length of 1.0 inch minimum, a width no greater than  $1/4$  inch and a depth as shown in Table II for Ferritic and Austenitic materials.

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5.4 Configuration:5.4.1 Prior to the W'75 Code:

5.4.1.1 Flat Block: For the examination of circumferential or longitudinal welds on piping with contact curvatures greater than 20 inch diameter, a flat block or blocks of essentially the same curvature as the part to be examined may be used.

5.4.1.2 Curved Blocks: For examination of circumferential or longitudinal welds on piping with contact curvatures equal to or less than 20 inch diameter, a curved block shall be used. A single curved basic calibration block may be used to calibrate for contact surfaces in the curvature range from 9/10 to 1-1/2 times the calibration block diameter.

5.4.2 W'75 Code and Later: The calibration block shall be of the same nominal diameter as the component being examined.

5.5 Block Temperature:

5.5.1 W'75 Code and Later: The temperature of the calibration block and the component shall be within 25 degrees F (14 degrees C) of each other.

6. CALIBRATION:6.1 Straight Beam for Laminar Defects:

6.1.1 Prior to the W'75 Code: Examination of the base metal shall be performed on the component for the detection of laminar type discontinuities that may interfere with the angle beam examination.

6.1.2 W'75 Code and Later: If the component has previously received a laminar type examination, the laminar examination does not apply.

6.1.3- Range: The sweep range calibration shall be performed using an IIW block or the calibration block. The maximum thickness should appear at no greater than 80% of the full screen sweep.

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6.1.4 Back Wall Amplitude Calibration: The search shall be coupled to the examination material to produce a minimum 50% to a maximum 75% full screen back reflection from the opposite side of a defect free area of the part to be examined.

If calibration from the oppsite side of the component is not possible or unreliable, calibration shall be established using the calibration block. The calibration block back reflection shall be set at a minimum of 50% and maximum 75%.

6.2 Straight Beam for Area of Interest:

6.2.1 Prior to the W'75 Code: Examination of the Area of Interest with a straight beam shall be performed.

6.2.2 W'75 Code and Later: The straight beam examination of the Area of Interest does not apply.

6.2.3 Range: The sweep range calibration may be performed using a IIW block or the calibration block itself. The back reflection of the part to be examined should appear on the screen at no greater than 80% of the full screen sweep.

6.2.4 Distance-Amplitude Correction:

6.2.4.1 Position the transducer for the maximum response from the hole which gives the highest amplitude. Adjust the sensitivity control to provide an 80% of full screen indication from the hole. Mark the peak of the indication on the screen.

6.2.4.2 Position the search unit for maximum response from each of the remaining holes and mark the peak of each on the screen.

6.2.4.3 Connect the screen marks and extend through the thickness to provide the distance-amplitude curve. If only one hole is available, this is the primary reference level for the thickness range.

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6.3 Range and Calibration:

6.3.1 Range: The sweep range calibration shall be performed using an IIW Block, or the calibration Block. The sweep range should be set to cover the range of thickness to be examined. The maximum thickness should appear at no greater than 80% of full screen sweep.

6.3.2 Distance-Amplitude Correction Prior to the W'75 Code: Normally the reject control shall be in the off position; but due to the grain boundary noise, it may be necessary to use reject to obtain a screen presentation with the maximum signal to noise ratio.

6.3.2.1 Position the search unit for maximum response from the hole which gives the highest amplitude. Adjust the sensitivity control to provide an 80% of full screen signal from that hole with the reject control in the off position. Mark the peak of the signal on the screen.

6.3.2.1.1 If necessary, increase the reject control. A signal to noise ratio of 10 to 1 or better is preferable, but a signal to noise ratio as low as 4 to 1 is acceptable. Record the drop in signal, as a percentage of full screen, in a note on the calibration sheet. Recheck the range and make any fine adjustments. Re-position the search unit to obtain the highest response and increase the sensitivity control until the signal is at 80% of full screen height. Mark the peak of the signal on the screen.

6.3.2.2 Position the search unit for maximum response from each of the remaining holes and mark the peak of each on the screen.

6.3.2.3 Connect the screen marks and extend through the thickness to be examined.

6.3.3 Distance-Amplitude Correction, W'75 Code and Later: Position the search unit for maximum response from the ID notch.



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Adjust the amplitude to 80% full screen height and mark its peak on the screen. Without changing the instrument controls, obtain a reflection from the 1V (OD notch) and 1-1/2V path and mark their peak on the screen. Connect these points to form a distance-amplitude curve (DAC). This curve is the primary reference level. If the 1-1/2 Vee path notch cannot be obtained, extrapolate the curve to the nearest 1/4T.

6.3.3.1 When the 1V path notch calibration technique as outlined in 6.3.3 cannot be performed, the examination shall be done using the 1/2 Vee path technique.

Calibration shall be accomplished using side drilled holes to construct the DAC curve only. After the curve has been constructed, position the search unit so it reflects the ID notch, adjust its amplitude to the DAC curve. This is the primary reference level.

6.4 With the above-mentioned techniques, some variables may be encountered; variables such as weld preparation, weld crown width, etc.

These variables may be eliminated by:

1. Reducing the dimension of the wedge-edge to beam exit point.
2. Reducing search unit size.
3. Increasing beam angle.

6.5 Calibration Confirmation: Sweep range and DAC curve shall be verified:

- A. At the beginning of each day of examination.
- B. At least every four hours of examination.
- C. With every change of examination personnel.
- D. At the finish of examinations for each thickness range.
- E. If the operator suspects any malfunction of the UT system.
- F. After change in search units, shoes, couplants, cables, ultrasonic instruments, or any other parts of the examination system.
- G. In the event of any power loss.

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The original and final calibration must be performed on the basic calibration block. Intermediate calibration checks may be performed on a calibration block simulator. If a calibration block simulator is used, it shall be able to produce known amplitude and sweep readings. The simulator-produced amplitude and sweep reading shall be recorded on the calibration sheet at initial calibration and each calibration check. If multiple DAC curves are used for different types of examinations, the calibration block simulator shall be used for each type.

- 6.6 Calibration Changes: If any point on the distance-amplitude correction (DAC) curve has changed by more than 20% of its amplitude or 10% on the sweep range, all data sheets since the previously successful calibration check shall be marked void. A new calibration shall be made and recorded and the void examination area shall be reexamined.

7. SCANNING REQUIREMENTS:

- 7.1 Base Metal Outside the Area of Interest: This area shall include all the base metal through which the angle beam(s) will pass. For example, when examining with a 45 degree angle beam with a 1/2 Vee path calibration, the typical extent of scanning is 1T added to each side of the area of interest. The extent of a 60 degree, 1/2 Vee path scan should be 1.8T added to each side of the area of interest.
- 7.2 Area of Interest: The Area of Interest is the volume to be examined and shall include the weld, any weld metal previously applied to either side of the weld, and the base metal in both directions for a distance of one wall thickness for Codes prior to Winter 1975; or the base metal in both directions for a distance of 1/2 wall thickness or one inch whichever is the lesser for Winter 1975 and later Codes.

7.2.1 Application:

- 7.2.1.1 Prior to the W '75 Code: The Area of Interest shall be examined by a straight beam and from four directions by one angle beam. Direct the angle beam normal to the weld from both sides, and parallel to the weld in both directions. The beams shall pass through all of the weld material on each of the scans where practicable.



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8. RECORDING STANDARDS:8.1 Definitions

- 8.1.1 Damps on Surface with Screen Correlation: The terminology used here is to describe the kind of dampable indication, on the surface, whose location on the screen presentation is at the 8/8 node location. This is the only type of dampable indication that does not require T. W. D. information.
- 8.1.2 Damps on Surface with no Screen Correlation: This refers to an indication that damps on the surface, but whose screen presentation displays it at a location other than the 8/8 node location. The point at which the indication damps should be recorded, but the indication should be treated as an indication that does not damp. (See Figure 5)
- 8.1.3 Traveling Indication: An indication, due to its orientation in the area of interest, that causes a screen presentation in which the signal changes depth as the transducer moves over the dimensions of the indication shall be called a traveling indication. Be advised that this type of indication may be the result of the configuration of the examination area. The examiner should use discretion and evaluate the possibility of this type of condition existing. In cases where it does exist, the condition should be stated in a note.
- 8.1.4 One - Depth Indication: A single depth indication does not travel in depth and maintains a constant depth throughout the area of interest. When characterizing 360° intermittent, 360° continuous, and separate indications, the depth of the one-depth indication can fluctuate. The amount of fluctuation will depend on the thickness of part to which the transducer has been applied:
- For part thicknesses up to and inclusive of one inch, the amount of fluctuation shall be  $\pm 10\%$  of the part thickness.
  - For parts over one inch in thickness, up to, and inclusive of ten inches, the amount of fluctuation shall be  $\pm .100$  of an inch.

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- c. For part thicknesses over ten inches, the amount of fluctuation is  $\pm .200$ " of an inch.

8.1.5 360° Intermittent Indication:

- A. A one-depth indication that fluctuates above and below 50% DAC, with No limitation on the amount of Fluctuation, for the Entire Length of the Weld.
- B. A traveling indication that also fluctuates above and below 50% can be characterized as a 360° intermittent indication with one stipulation. The indication must be maintained on the screen at all times, with no less than a 2.1 signal/noise ratio. The examiner may adjust the sensitivity of the instrument to compensate for the changes in attenuation of the material and/or the changes in the physical dimensions of the indication to locate this condition along the length of the weld.

8.1.6 360° Continuous Indication: Any indication of a one-depth nature or a traveling depth nature, that fluctuates in amplitude above 50% DAC for the entire length of the weld.

- 8.1.7 Separate Indication: Any indication that does not meet the above characteristics. An indication that does not have the same depth as any other indication. A traveling indication that does not travel meeting the amplitude requirements of a 360 INT & 360 CON indication shall be characterized as a separate indication. When in doubt as to the characterization of a given indication, record it also as a separate indication.

8.2 Base Metal Outside the Area of Interest (All Codes):

- 8.2.1 Back Wall Method: All indications which exceed 50% of the resultant back reflection shall be investigated with the search unit in a position which produces the maximum amplitude.

- 8.2.1.1 If the maximum amplitude equals or exceeds 100% of the resultant back reflection, the following shall be recorded:

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- A. Amplitude: The maximum height as a percentage of the resultant back reflection. The amplitude shall be recorded to the nearest 10 percent increment.
- B. Depth: The distance from the examination surface as read on the CRT.
- C. Size: The 100 to 100% length and width of the indication.
- D. Location: The search unit distance from the weld centerline and the nearest reference point. These measurements shall be taken at the point of maximum amplitude.

8.2.2 Calibration Block Method: If the part geometry does not produce a back reflection, evaluation shall be done to the calibration standard.

Indications which exceed 100% of the original back reflection from the calibration standard and cannot be contained in a 2 inch diameter circle shall be recorded as in Paragraph 8.2.1.1 B, C, and D. The amplitude shall be recorded as a percentage of the calibration standard back reflection.

8.2.3 If a base material condition exists which is recordable, the angle beam examination shall be performed from both the inside and outside surfaces wherever possible. If the opposite side is not accessible, these areas shall be recorded on the data sheet and the inspection performed on a best effort basis.

8.3 Angle or Straight Beam (From DAC) Indications within Area of Interest:

8.3.1 All Codes: All indications which produce a response greater than 20% of DAC reference level shall be investigated to the extent that the operator can determine the shape, identity, and location of all such reflectors.

8.3.2 Prior to W'75 Coder

8.3.2.1 If the maximum amplitude exceeds 50% of the DAC reference calibration, the following shall be recorded on the data sheet:

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- A. Amplitude: Record the amplitude, to the nearest 10 percent increment, of the maximum signal (Highest Peak) in the appropriate block. In the case of recording 360° intermittent and 360° continuous indications, it is also necessary to record the range of amplitudes and the number of peaks, over 100% DAC, as a note.
- B. Depth: When recording the depth, no matter what type of indication is involved, always record the depth at the max signal (Highest Peak) in the block provided. Note that, when recording traveling indications, it is also necessary to record the range of depths as a note to assist in characterizing the indication.
- C. Length: The 100/100% length and the 50/50% length are to be recorded on each indication. Where 360° intermittent or 360° continuous indications are involved the length recorded shall be the entire length of the weld. When recording straight beam indications, it is also necessary to record the width of the indications.
- D. Distance: To properly document the location of the indication, it is necessary that the distance from surface one or two, and distance from position "A" or "B" should be recorded. This information should be taken from the location of the max signal (Highest Peak). For traveling indications, the range of distances from the opposite surface should also be recorded as a note. It is not necessary to record the distance "A" or "B" when documenting 360° intermittent or 360° continuous indications.

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E. Through Wall Dimension (TWD): The TWD is measured by obtaining the minimum and maximum sweep readings (depth in inches) for which the indication signal reduces to 100% DAC. The TWD may not necessarily be measured in line with the highest indicated amplitude depth, nor do the minimum and maximum amplitude have to occur on the same scan line. The TWD is the difference between the minimum and maximum depths. An example of TWD measurements is given in Figure 4.

On separate, 360° continuous, and 360° intermittent indications that meet the requirement of an "INDICATION THAT DAMPS ON THE SURFACE WITH SCREEN CORRELATION," T.W.D. information is not necessary. On indications 100% of DAC and below, there is no need to record T.W.D. information.

F. Damps: All indications should state whether or not they damp.

9. REPORTING STANDARDS:

9.1 Prior to W'75 Code: All indications detected in the Area of Interest which produce signal amplitudes greater than the DAC reference calibration curve and that have a linear dimension equal to or exceeding that given in Table I, shall be recorded and reported individually and an evaluation made to the acceptance standards involved in the original construction.

TABLE I

<u>Material Thickness Range (Inches)</u>	<u>Linear Dimension</u>
0 thru 3/4	1/4 inch
Over 3/4 thru 2-1/4	1/3 of thickness
Over 2-1/4	3/4 inch



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- 9.1.1 Where discontinuities are interpreted to be cracks or incomplete penetration, they are unacceptable regardless of discontinuity size or signal amplitude.
- 9.1.2 If there is any doubt regarding the proper interpretation of ultrasonic indications in the Area of Interest, such doubt may be resolved by radiography.
- 9.2 W'75 Code and Later: All indications detected in the Area of Interest which produce signal amplitudes greater than 100% of the DAC reference calibration curve shall be reported individually and an evaluation made in accordance with Table IWB-3514.2 and IWB-3514.3 of ASME Section XI, Winter '75 Addenda.
- 9.3 Any area where best effort inspection was performed due to configuration shall be recorded and reported.
10. RECORD OF EXAMINATION RESULTS: A copy of the examination data (Figure 3) shall be provided to the customer with the following information:
- A. Contract Number
  - B. Examination Personnel by name and/or ID number
  - C. Instrument by ID number
  - D. Method of Test
  - E. Couplant by batch or ID number
  - F. Calibration sheets
  - G. Weld Identification and Location
  - H. Type, Size and Frequency of Search Unit by ID number
  - I. Ultrasonic Wave Mode
  - J. Calibration Block Number
  - K. Chart of Results
  - L. Procedure number and revision
  - M. Dates of Examination
  - N. Examination Surface
  - O. Layout of Weld Seams as Detailed in ISI-360, ISI-361, ISI-362 or BLI-36
  - P. The number(s) of any Field Change Authorization(s) that affect(s) this procedure.

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TABLE II

SURFACE NOTCH DEPTHS FOR  
 ULTRASONIC CALIBRATION

<u>Nominal Pipe Wall Thickness (t) inches</u>	<u>Materials</u>	<u>Notch Depth (d) as a Percent of t</u>
Less than 0.312	Ferritic	10.0 + 0.005 in./-0.010 in.
0.312 to 6.0	Ferritic	10.4 minus 0.9t + 10%/-20%
Less than 0.312	Austenitic	10% of t + 10%/-20%
0.312 to 6.0	Austenitic	10% of t + 10%/-20%

TABLE III

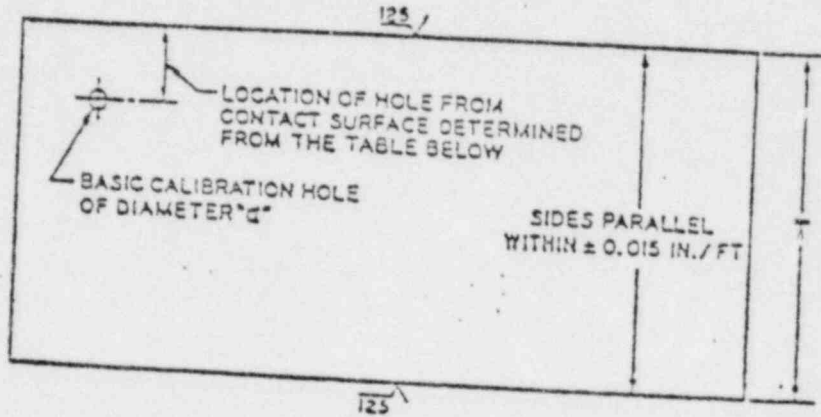
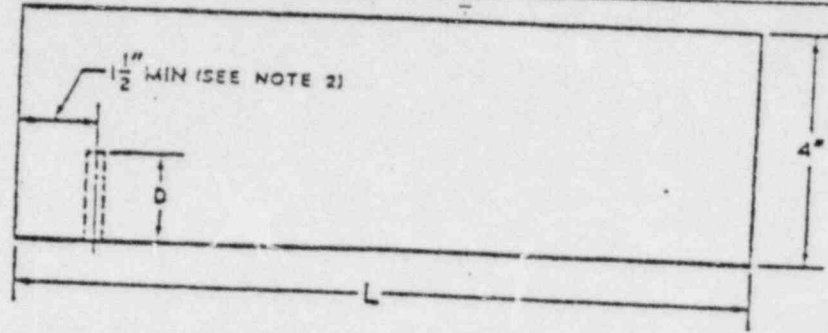
CALIBRATION BLOCK HOLE DIAMETERS

<u>Material Thickness (t) inches</u>	<u>Hole Diameter (d) inches</u>
Up to 1 inclusive	3/32
Over 1 thru 2	1/8
Over 2 thru 4	3/16
Over 4 thru 6	1/4

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- 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.	3/4 or t	1/8 T	3/32	1 1/2
Over 1 thru 2	1 1/8 or t	1/4 T	1/8	1 1/2
Over 2 thru 4	3 or t	1/4 T	1/4	1 1/2
Over 4 thru 6	5 or t	1/4 T	3/16	1 1/2
Over 6 thru 8	7 or t	1/4 T	1/4	1 1/2
Over 8 thru 10	9 or t	1/4 T	3/16	1 1/2
Over 10	t	1/4 T	3/8	1 1/2

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 1/2 T min. to prevent coincident reflections from the hole and the corner in the 1/4 th vee-path position. Blocks fabricated with a 1 1/8-in. minimum dimension need not be modified if the corner and hole indications can be easily resolved.

FIGURE 1  
BASIC CALIBRATION BLOCKS

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CALIBRATION SHEET

SHEET NO. \_\_\_\_\_ TIME: \_\_\_\_\_ HR DATE: \_\_\_\_\_

CUSTOMER: _____		CONTRACT NO.: _____		COMPONENT: _____	
EXAMINER: _____		ID#:	LEVEL:	COUPLANT:	
EXAMINER: _____		ID#:	LEVEL:	COUPLANT ID#:	

<b>INSTRUMENT</b> ID#: _____ LINEARITY CHECK <input type="checkbox"/> YES <input type="checkbox"/> NO REJECT: _____ DB MAT'L CAL: _____ DELAY: _____ PULSE ENERGY: _____ COARSE GAIN IN DB: _____ FINE GAIN IN DB: _____ FINE GAIN: _____ % SCREEN RANGE: _____ SCREEN DEPTH: _____ <input type="checkbox"/> S/E } OPERATION <input type="checkbox"/> NORMAL } FREQUENCY: _____ MHz <input type="checkbox"/> NORMAL } FREQ. <input type="checkbox"/> HIGH } REP. RATE: _____ ZERO CONTROL: _____ RESOLUTION: _____ A } B } ---DBC--- C } A } B } ---MONITOR--- C } <input type="checkbox"/> NORMAL } ECHO <input type="checkbox"/> FIRST ECHO } START	<b>CALIBRATION BLOCK</b> ID# _____ LENGTH _____ IN. OD _____ IN. THICKNESS _____ IN.	<b>CRYSTAL</b> ID# _____ TYPE _____ FREQ. _____ MHz SIZE _____ IN. ACTUAL _____	<b>CALIBRATION BLOCK SIMULATOR</b> SERIAL NO. _____ SIGNAL AMP _____ % SCREEN RANGE _____ IN. COARSE GAIN DB _____ FINE GAIN DB _____
	<b>SYSTEM CALIBRATION</b> ANGLE _____ ° NOSE _____		<b>SEARCH UNIT CABLE</b> TYPE _____ LENGTH _____ CAL. BLOCK TEMP _____ °F CAL. BLOCK SIMULATOR TEMP _____ °F (REQUIRED SUMMER TS FOR VESSELS REQUIRED WINTER TS FOR PIPING)

REFLECTOR	AMPLITUDE % OF FULL SCREEN	SCREEN READING IN INCHES	FIGURE NO(S) EXAMINED							
1/8 NOSE	5	IN.								
1/8 NOSE	5	IN.								
1/8 NOSE	5	IN.								
1/8 NOSE	5	IN.								
1/8 NOSE	5	IN.								
TOP NOTCH	5	IN.								
OPPOSITE NOTCH	5	IN.								
BKR CB*	5	IN.								
BKR P	5	IN.								

CALIBRATION CONFIRMATION												
TIME	HRS		HRS		HRS		HRS		HRS		HRS	
BLOCK REF.	5	IN.	5	IN.	5	IN.	5	IN.	5	IN.	5	IN.
BACK REFL.	5	IN.	5	IN.	5	IN.	5	IN.	5	IN.	5	IN.
1/8 NOSE	5	IN.	5	IN.	5	IN.	5	IN.	5	IN.	5	IN.
1/8 NOSE	5	IN.	5	IN.	5	IN.	5	IN.	5	IN.	5	IN.
1/8 NOSE	5	IN.	5	IN.	5	IN.	5	IN.	5	IN.	5	IN.
INITIALS												

\* BKR CB (BACK REFLECTION FROM CAL. BLOCK) \* BKR P (BACK REFLECTION FROM PART)

REVIEWED BY \_\_\_\_\_ LEVEL \_\_\_\_\_ DATE REVIEWED \_\_\_\_\_

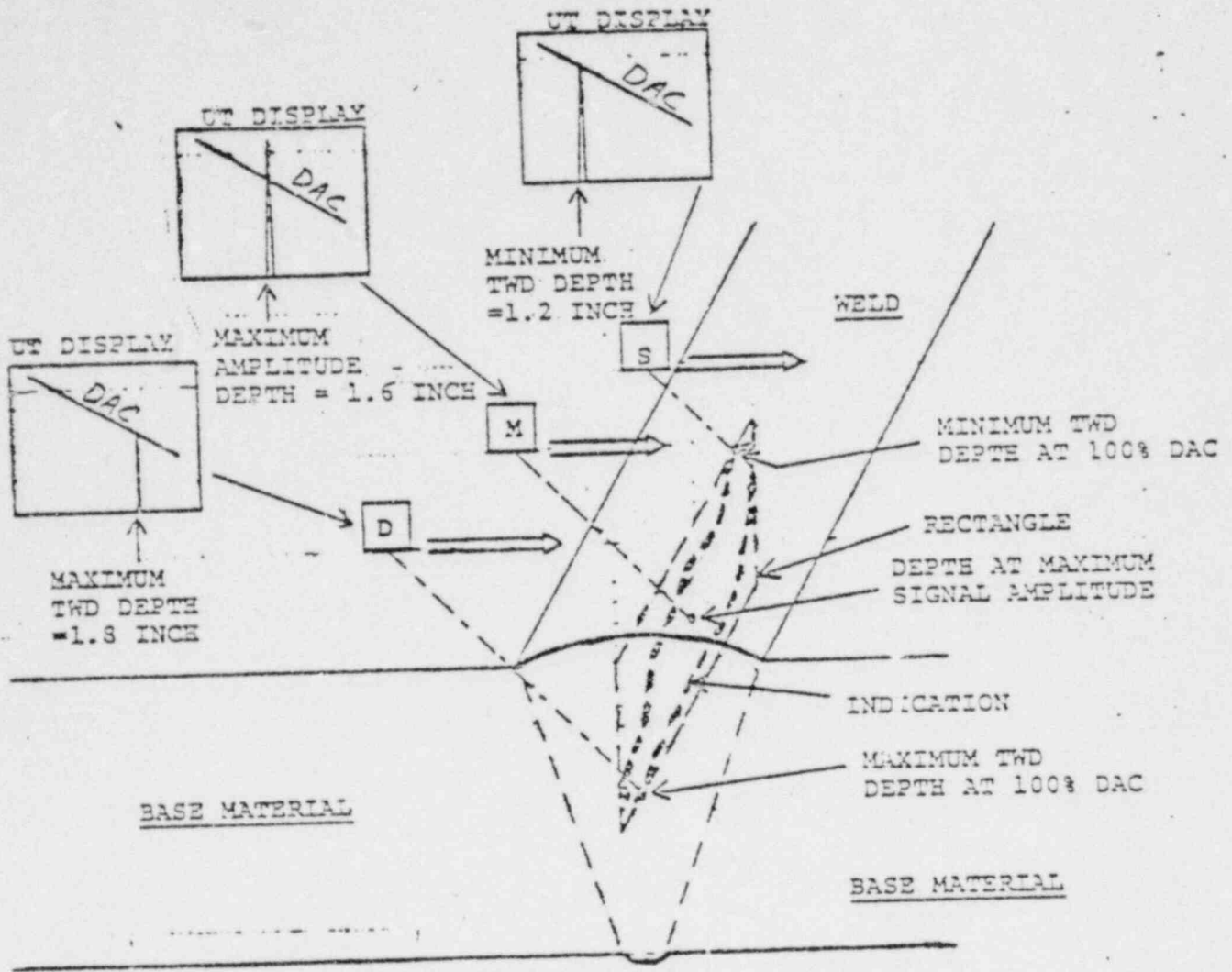
FIGURE 2  
TYPICAL CALIBRATION SHEET



INSERVICE INSPECTION PROCEDURE

SUBJECT ULTRASONIC EXAMINATION OF CLASS 1 & 2  
PIPING WELDS JOINING SIMILAR & DISSIMILAR  
MATERIALS

ISI-120, REV. 6



- = Beam direction and scan path
- = Angle beam path in base material and weld
- - - = Circumscribed rectangle
- - - = Typical indication source
- M = Transducer position for maximum signal amplitude
- S = Transducer position for minimum TWD path
- D = Transducer position for maximum TWD path
- TWD = 1.8 inch - 1.2 inch = 0.6 inch

FIGURE 4  
TWD EXAMPLE

INSERVICE INSPECTION PROCEDURE

SUBJECT ULTRASONIC EXAMINATION OF CLASS 1&2 PIPING WELDS JOINING SIMILAR & DISSIMILAR MATERIALS

ISI-120, REV. 6

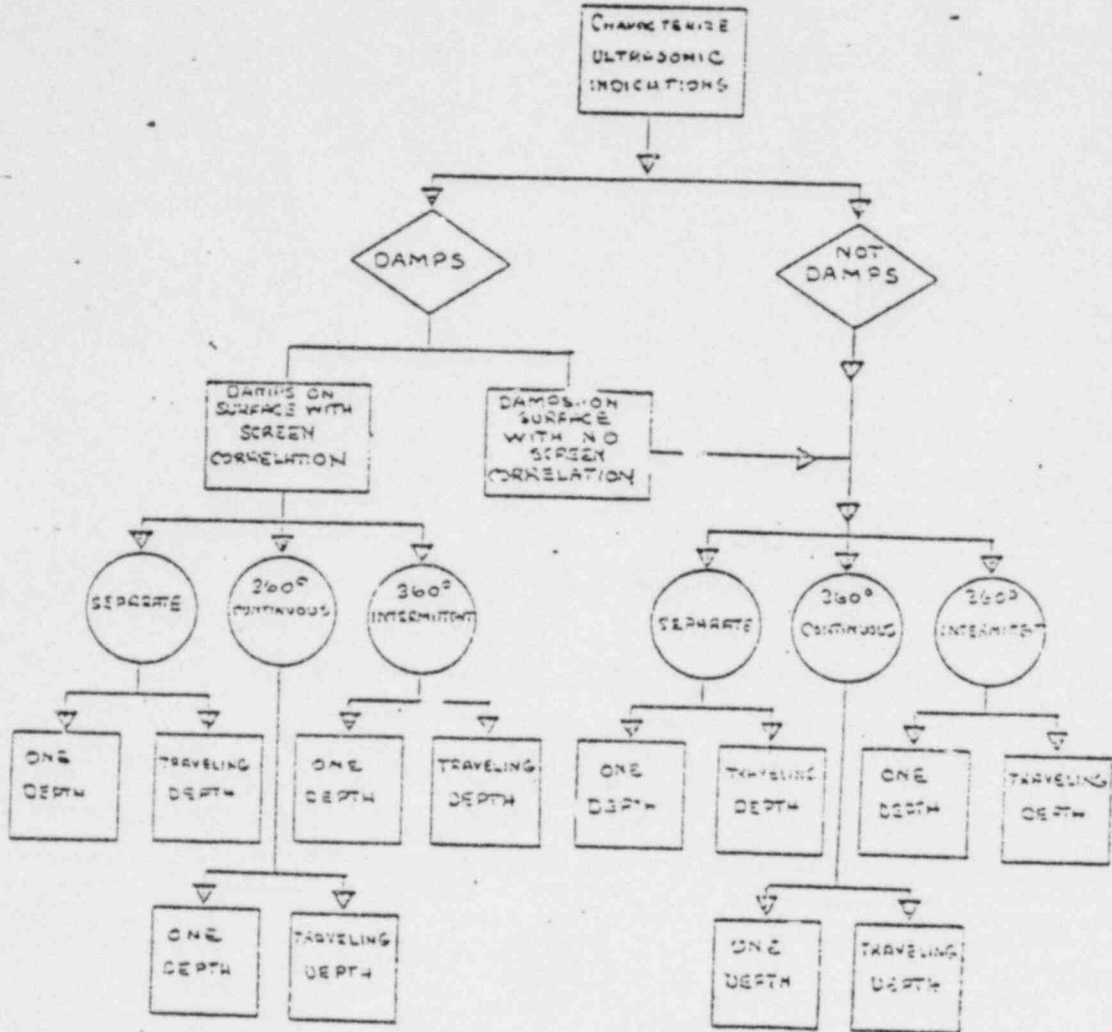


Figure 5

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 INSERVICE INSPECTION PROCEDURE

SUBJECT ULTRASONIC EXAMINATION FOR INTERGRANULAR STRESS CORROSION CRACKING IN STAINLESS STEEL OR NICKEL BASE ALLOY PIPING	ISI-125, REV. 0
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1. SCOPE: This examination procedure shall govern the ultrasonic examination of stainless steel and nickel base alloy piping for detection of stress corrosion cracks. The thickness range covered by this procedure is from 0.75 to 1.35 inches.
  
2. SURFACE PREPARATION: The examination surface shall be free of dirt, loose scale, machining or grinding particles, weld splatter, or other loose foreign material. Surface preparation shall be performed on an area which includes the weld and the area for two times the thickness on both sides of the weld. In addition, a prior examination of the structure shall have been completed using ISI-120.
  
3. OPERATOR QUALIFICATIONS:
  - 3.1 Operator: The operator performing the examination shall be qualified to Level II in accordance with B&W Construction Company Quality Control Administrative Procedure 9A-169. The Level II shall be responsible for and shall accept the results of the examination.
  
  - 3.2 Assistant: The assistant shall be qualified to at least Level I in accordance with B&W Construction Company Quality Control Administrative Procedure 9A-169. The Level I shall not independently evaluate or accept the results of the examination.
  
4. EQUIPMENT:
  - 4.1 UT Scope: A pulse-echo type ultrasonic flaw detection instrument shall be used. The instrument shall be equipped with a stepped gain control calibrated in units of 2dB or less.
  
  - 4.2 Search Units: A lead zirconate titanate, 1.5 MHz, 45 degree refracted (shear) angle beam, dual element search unit shall be used. The element shall have an effective area from 0.10 to 0.15 square inch inclusive. Other search units may be used upon approval of the B&W Construction Company Level III.
    - 4.2.1 Exit Point: A standard steel IIW block will be used before examinations are performed each day to verify or correct the exit point on the transducer shoe.

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4.2.2 Beam Angle: After the exit point has been determined, the angle shall be checked with the IIW block to confirm that the transducer meets the angle specified in 4.2.

4. Couplant: A suitable liquid, semi-liquid, or paste couplant medium, such as water, oil, glycerin, grease, or Hamiklear shall be applied to the examination surface.

Each batch of materials used on stainless steels or nickel base alloys shall have been tested for residual amounts of total halogen and total sulfur in accordance with ISI-60. The total residual amount of halogens and sulfur shall not exceed the requirements of ISI-60. The couplant identification or batch number shall be recorded on the data sheet.

5. CALIBRATION BLOCK:

5.1 Material: The block shall be fabricated from a component prolongation where possible. If it is not possible to fabricate the block from material taken from the component, it shall be fabricated from a material similar to the component. When the examination is to be performed from only one side of the joint, the calibration block shall be of the same material as that where the search unit is applied.

5.2 Size: The length of the calibration block shall be determined by the angle of the search unit and the Vee path that will be used. A minimum length of 6T is desirable.

5.2.1 Thickness: The thickness of the block shall be the same nominal dimension as the pipe being examined. Where two or more component thicknesses are joined, the block shall be selected to cover the thickness where the search unit is applied.

5.3 Calibration Block Reflectors: The calibration block shall contain ID and OD circumferential and longitudinal notches with their sides perpendicular to the surface. The notches shall have a length 1.0 inch minimum, a width no greater than 1/4 inch, and a depth of 5% of the total thickness.

5.4 Configuration:

5.4.1 Curved Blocks: For examination of circumferential or longitudinal welds on piping, curved blocks shall be used.

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5.4.2 The calibration block shall be of the same nominal diameter and thickness as the component being examined.

5.5 Block Temperature: The temperature of the calibration block and the component shall be within 25 degrees F (14 degrees C) of each other.

6. CALIBRATION:

6.1 Range: The sweep range calibration in "depth" shall be performed using an IIW block, or the calibration block. The sweep range should be set to cover the range of thickness to be examined. The maximum thickness should appear at 1.0 greater than 80% of full screen sweep.

6.2 Primary Distance Amplitude Correction: When examining circumferential welds utilizing curved block, DAC curves shall be constructed from notches perpendicular to the axis of the basic calibration block.

6.2.1 Position the angle beam search unit on the basic calibration block to obtain maximum response from the nodal position producing the highest amplitude. This node will be the primary reference response.

Nodal Positions

4/8, 8/8, 12/8

6.2.2 Adjust instrument gain controls to obtain the primary reference response at 80%  $\pm$  5% of full screen height (FSH) and mark this amplitude on the screen. The gain controls shall not be adjusted once the primary reference response has been established.

6.2.3 Position the search unit to obtain maximum response from the remaining nodal positions and mark each amplitude on the screen.

6.2.4 Join these points with a smooth curved line, the length of which shall extend 1/8 node beyond the last qualified calibration point.

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6.3 Secondary DAC Calibrations: If any points on the DAC curve do not appear at 20% FSH or greater, a secondary DAC curve shall be constructed as follows:

6.3.1 All secondary DAC curves shall contain at least 2 points.

6.3.2 The DAC point at 2 lines or greater in amplitude and adjacent to a DAC point that falls below 2 lines of amplitude shall be brought to the primary reference level by manipulating the gain controls of the instrument. This point shall then be marked on the instrument screen. The adjacent point, previously at less than 2 lines of amplitude, shall then be marked on the screen and the two points connected with a smooth curved line. The instrument gain settings for this secondary DAC curve shall then be recorded on the appropriate calibration sheet.

EXCEPTION

When the first DAC point is the only point above 2 lines of amplitude, then the next highest point shall be brought to the primary reference level. This point shall then be marked on the instrument screen. The adjacent point, previously at less than 2 lines of amplitude, shall then be marked on the screen and the two points connected with a smooth curved line. The instrument gain settings for this secondary DAC curve shall then be recorded on the appropriate calibration sheet.

6.4 Calibration Confirmation: Sweep range and DAC curve shall be verified:

- A. At the beginning of each day of examination.
- B. At least every four hours of examination.
- C. With every change of examination personnel.
- D. At the finish of examinations for each thickness range.
- E. If the operator suspects any malfunction of the UT system.
- F. After change in search units, shoes, couplants, cables, ultrasonic instruments, or any other parts of the examination system.
- G. In the event of any power loss.

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The original and final calibration must be performed on the basic calibration block. Intermediate calibration checks may be performed on a calibration block simulator. If a calibration block simulator is used, it shall be able to produce known amplitude and sweep readings. The simulator-produced amplitude and sweep reading shall be recorded on the calibration sheet at initial calibration and each calibration check.

- 6.5 Calibration Changes: If any point on the distance-amplitude correction (DAC) curve has changed by more than 20% of its amplitude or 5% on the sweep range, all data sheets since the previously successful calibration check shall be marked void. A new calibration shall be made and recorded and the void examination area shall be reexamined.

7. SCANNING REQUIREMENTS:

- 7.1 Area of Interest: The area of interest is the volume to be examined and shall include the inner one-third of the material thickness for both the weld and base material in both directions for a distance of one wall thickness from the edge of the weld.

7.1.1 Application:

- 7.1.1.1 The area of interest shall be examined from two directions by one angle beam. Direct the angle beam normal to the weld from both sides. During scanning, the search unit will be skewed at least 45 degrees in both the clockwise and counterclockwise directions. The beam shall pass through the inner one-third of the material thickness on each of the scans where practicable.

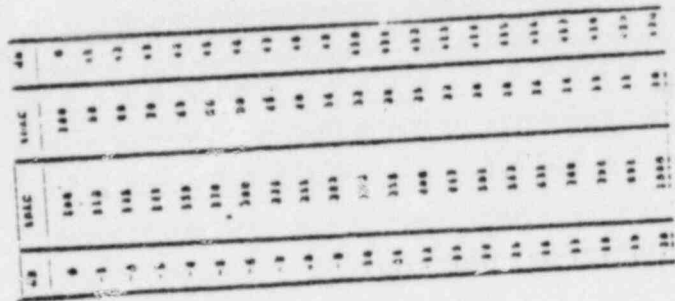
- 7.2 Movement Rate: The rate of search unit movement shall not exceed 6 in./sec., unless calibration is verified at scanning speed.

- 7.3 Search Unit Coverage: Each pass of the search unit shall overlap a minimum of 10% of the transducer active element dimension perpendicular to the direction of scan.

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7.4 Scanning Sensitivity: Scanning shall be performed after increasing the gain a minimum of 6dB above the reference level. Six dB would increase the signal amplitude by a factor of two making the primary reference curve a 50% DAC curve. Recording of peak indications requires that the signal amplitude be adjusted to the DAC curve using the dB control. True signal amplitude shall be obtained from the following chart using the observed change in the dB control.



7.5 Thickness Measurements: Thickness measurements shall be taken at a minimum of three points on the centerline of the weld and at one point in the base material on either side of the weld. Measurements shall be taken using ISI-120 by placing the 0 degree search unit on the appropriate position on the examination surface. These measurements shall be recorded on the appropriate data sheet (see Figure 3).

Contour of the weld to be examined shall be taken by utilizing a contour gage or by measuring the weld crown's height and width.

8. RECORDING STANDARDS:

8.1 Definitions:

8.1.1 Damps on Surface with Screen Correlation: The terminology used here is to describe the kind of dampable indication, on the surface, whose location on the screen presentation is at the 8/8 node location. This is the only type of dampable indication that does not require TWD information.

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- 8.1.2 Damps on Surface with No Screen Correlation: This refers to an indication that damps on the surface, but whose screen presentation displays it at a location other than the 8/8 node location. The point at which the indication damps should be recorded, but the indication should be treated as an indication that does not damp. (See Figure 5.)
- 8.1.3 Traveling Indication: An indication, due to its orientation in the area of interest, that causes a screen presentation in which the signal changes depth as the transducer moves over the dimensions of the indication shall be called a traveling indication. Be advised that this type of indication may be the result of the configuration of the examination area. The examiner should use discretion and evaluate the possibility of this type of condition existing. In cases where it does exist, the condition should be stated in a note.
- 8.1.4 One - Depth Indication: A single depth indication does not travel in depth and maintains a constant depth throughout the area of interest. When characterizing 360° intermittent, 360° continuous, and separate indications, the depth of the one-depth indication can fluctuate. The amount of fluctuation will depend on the thickness of the part to which the transducer has been applied:
- a. For part thicknesses up to and inclusive of one inch, the amount of fluctuation shall be +10% of the part thickness.
  - b. For parts over one inch in thickness, up to and inclusive of ten inches, the amount of fluctuation shall be +0.100 of an inch.
  - c. For part thicknesses over ten inches, the amount of fluctuation is +0.200 of an inch.
- 8.1.5 360° Intermittent Indication:
- A. A one-depth indication that fluctuates above and below 50% DAC, with no limitation on the amount of fluctuation, for the entire length of the weld.

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B. A traveling indication that also fluctuates above and below 50% can be characterized as a 360° intermittent indication with one stipulation. The indication must be maintained on the screen at all times, with no less than a 2.1 signal/noise ratio. The examiner may adjust the sensitivity of the instrument to compensate for the changes in attenuation of the material and/or the changes in the physical dimensions of the indication to locate this condition along the length of the weld.

8.1.6 360° Continuous Indication: Any indication of a one-depth nature or a traveling depth nature, that fluctuates in amplitude above 50% DAC for the entire length of the weld.

8.1.7 Separate Indication: Any indication that does not meet the above characteristics. An indication that does not have the same depth as any other indication. A traveling indication that does not travel meeting the amplitude requirements of a 360 intermittent and 360 continuous indication shall be characterized as a separate indication. When in doubt as to the characterization of a given indication, record it also as a separate indication.

8.2 Angle Beam (From DAC) Indications within Area of Interest:

8.2.1 All Codes: All indications which produce a response greater than 20% of DAC reference level shall be investigated to the extent that the operator can determine the shape, identity, and location of all such reflectors.

8.2.2 If the maximum amplitude exceeds 50% of the DAC reference calibration, the following shall be recorded on the data sheet:

A. Amplitude: Record the amplitude, to the nearest 10 percent increment, of the maximum signal (Highest Peak) in the appropriate block. In the case of recording 360° intermittent and 360° continuous indications, it is also necessary to record the range of amplitudes and the number of peaks, over 100% DAC, as a note.

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- B. Depth: When recording the depth, no matter what type of indication is involved, always record the depth at the max signal (Highest Peak) in the block provided. Note that, when recording traveling indications, it is also necessary to record the range of depths as a note to assist in characterizing the indication.
- C. Length: The 100/100% length and the 50/50% length are to be recorded on each indication. Where 360° intermittent or 360° continuous indications are involved, the length recorded shall be the entire length of the weld. When recording straight beam indications, it is also necessary to record the width of the indications.
- D. Distance: To properly document the location of the indication, it is necessary that the distance from surface one or two, and distance from position "A" or "B" should be recorded. This information should be taken from the location of the max signal (Highest Peak). For traveling indications, the range of distances from the opposite surface should also be recorded as a note. It is not necessary to record the distance "A" or "B" when documenting 360° intermittent or 360° continuous indications.
- E. Through Wall Dimension (TWD): The TWD is measured by obtaining the minimum and maximum sweep readings (depth in inches) for which the indication signal reduces to 50% DAC. The TWD may not necessarily be measured in line with the highest indicated amplitude depth, nor do the minimum and maximum amplitude have to occur on the same scan line. The TWD is the difference between the minimum and maximum depths. An example of TWD measurements is given in Figure 4.
- On separate, 360° continuous, and 360° intermittent indications that meet the requirement of an "INDICATION THAT DAMPS ON THE SURFACE WITH SCREEN CORRELATION," TWD information is not necessary.
- F. Damps: All indications should state whether or not they damp.



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9. ANALYSIS:

- 9.1 All indications detected in the area of interest shall be plotted to determine if they are root geometry or non-geometric indications.
- 9.2 Using the measured thickness, draw the cross section of the pipe through the weld on graph paper.
- 9.2.1 Use the profile gage to provide the weld crown geometry.
- 9.3 Using drafting equipment and the data recorded per Paragraph 8.0, plot the physical dimensions and corresponding metal depths on the cross-sectional view.

NOTE

More than one indication may be plotted on a single cross-sectional view. Figure A is an example of how a single indication would look.

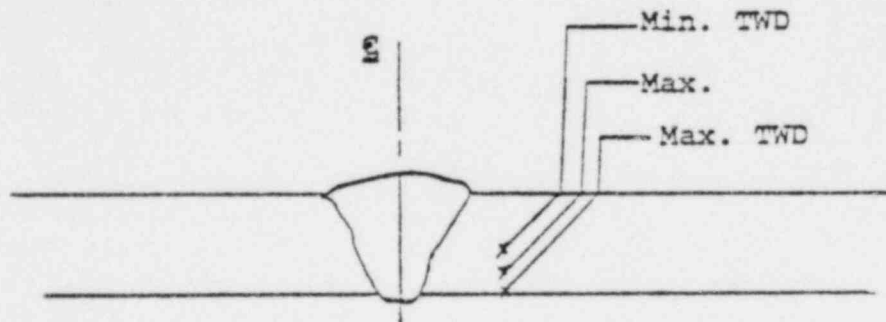


Figure A

- 9.4 Resolve all recorded indications by utilizing graphic plots as described above.
- 9.4.1 Resolution shall be divided into two basic categories as defined below.
- a. Root geometry - Metal depths which terminate on the far side of the weld centerline shall be defined as root geometry unless they coincide with indications plotted on that side of the weld. Figure B is an example of an indication defined as root geometry.

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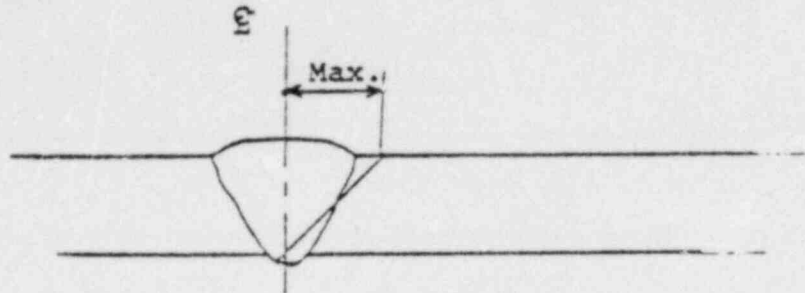


Figure B

- b. Non-Geometric indications - Metal depths which terminate within 1-1.25" of the centerline shall be identified as non-geometric indications, i.e. crack, lack of penetration, lack of fusion, slag, or porosity. The exact resolution (definition) along with the Through Wall Dimension physical measurements and length shall be recorded as per Paragraph 9.4. The resolution (definition) of each indication shall be based upon where the metal depth terminates and on its recorded characteristics, i.e. mid-wall on the fusion line would be defined as lack of fusion. Figure C is an example of an indication that would be defined as a crack.

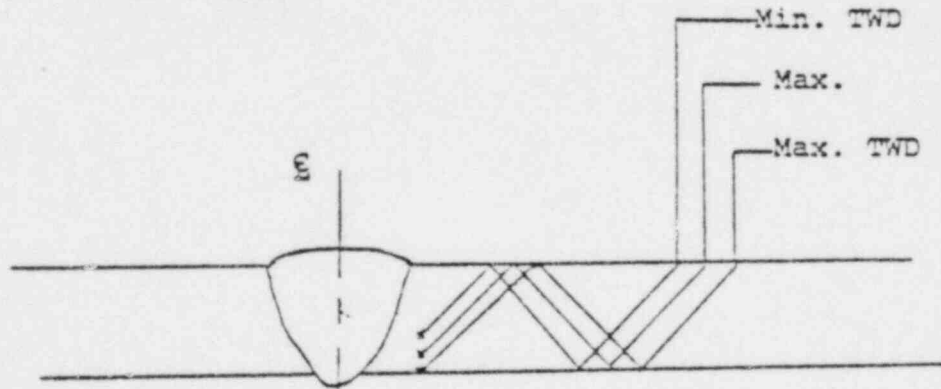


Figure C

9.5 Where discontinuities are interpreted to be cracks or incomplete penetration, they are unacceptable regardless of discontinuity size or signal amplitude.

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- 9.6 If there is any doubt regarding the proper interpretation of ultrasonic indications in the area of interest such doubt shall be resolved by review of radiographs or performing radiography.
- 9.7 Any area where best effort inspection was performed due to configuration shall be recorded and reported.
10. RECORD OF EXAMINATION RESULTS: A copy of the examination data (Figure 3) shall be provided to the customer with the following information:
- A. Contract Number
  - B. Examination Personnel by Name and /or ID Number
  - C. Instrument by ID Number
  - D. Method of Test
  - E. Couplant by Batch or ID Number
  - F. Calibration Sheets
  - G. Weld Identification and Location
  - H. Type, Size, and Frequency of Search Unit by ID Number
  - I. Ultrasonic Wave Mode
  - J. Calibration Block Number
  - K. Chart of Results
  - L. Procedure Number and Revision
  - M. Dates of Examination
  - N. Examination Surface
  - O. Layout of Weld Seams as Detailed in ISI-360, ISI-361, ISI-362, or BLI-36
  - P. The number(s) of any Field Change Authorization(s) that affect(s) this procedure.

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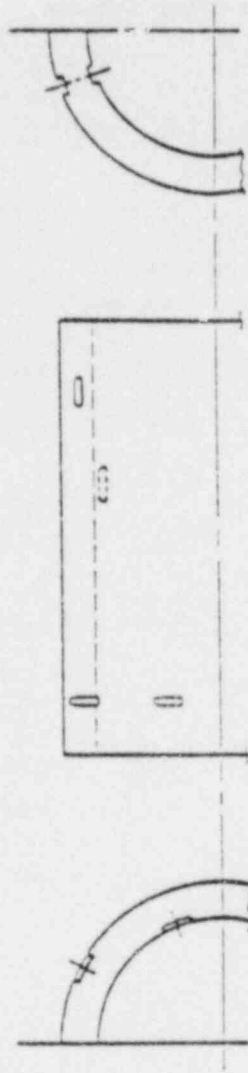


Figure 1  
Typical Curved Basic Calibration Block

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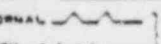
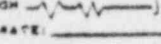
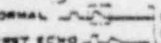
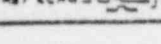
CALIBRATION SHEET

SHEET NO. \_\_\_\_\_ TIME: \_\_\_\_\_ MR \_\_\_\_\_ DATE: \_\_\_\_\_

CUSTOMER: \_\_\_\_\_ CONTRACT NO.: \_\_\_\_\_ COMPONENT: \_\_\_\_\_

EXAMINER: \_\_\_\_\_ ID#: \_\_\_\_\_ LEVEL: \_\_\_\_\_ COUPLANT: \_\_\_\_\_

EXAMINER: \_\_\_\_\_ ID#: \_\_\_\_\_ LEVEL: \_\_\_\_\_ COUPLANT ID#: \_\_\_\_\_

INSTRUMENT	CALIBRATION BLOCK	CRYSTAL	CALIBRATION BLOCK SIMULATOR				
			SERIAL NO.	SEARCH UNIT CABLE LENGTH			
ID# _____	ID# _____	ID# _____	SIGNAL AMP _____	SCREEN RANGE _____ IN.			
LINEARITY CHECK <input type="checkbox"/> YES <input type="checkbox"/> NO	LENGTH _____ IN.	TYPE _____	COURSE GAIN DB _____	FINE GAIN DB _____			
REJECT: _____ DB	OD _____ IN.	FREQ. _____ MHz					
MAT'L. CAL. _____	THICKNESS _____ IN.	SIZE _____					
DELAY: _____	SYSTEM CALIBRATION		CAL. BLOCK TEMP _____ °F				
PULSE ENERGY: _____	ANGLE _____ °	MODE _____	CAL. BLOCK SIMULATOR TEMP _____ °F				
COARSE GAIN IN DB: _____	REFLECTOR	AMPLITUDE % OF FULL SCREEN	REQUIRED SUMMER TS FOR VESSELS				
FINE GAIN IN DB: _____		SCREEN READING IN INCHES	REQUIRED WINTER TS FOR PIPING				
FINE GAIN _____	8 NODE	5	FIGURE NO(S) EXAMINED				
SCREEN RANGE: _____	8 NODE	5					
SCREEN DEPTH: _____	8 NODE	5					
<input type="checkbox"/> S/E } OPERATION	8 NODE	5					
<input type="checkbox"/> NORMAL	8 NODE	5					
FREQUENCY: _____ MHz	8 NODE	5					
<input type="checkbox"/> NORMAL  } FREQ.	TOP NOTCH	5					
<input type="checkbox"/> HIGH  } FREQ.	OPPOSITE NOTCH	5					
REP RATE: _____	SKR DB	5					
ZERO CONTROL: _____	SKR IN	5					
RESOLUTION: _____	CALIBRATION CONFIRMATION						
A _____	TIME	URS	URS	URS	URS	URS	URS
B _____	BLOCK SIM.	5	IN	5	IN	5	IN
C _____	BACK REFL.	5	IN	5	IN	5	IN
A _____	8 NODE	5	IN	5	IN	5	IN
B _____	8 NODE	5	IN	5	IN	5	IN
C _____	8 NODE	5	IN	5	IN	5	IN
<input type="checkbox"/> NORMAL  } ECHO START	INITIALS						
<input type="checkbox"/> FIRST ECHO  } ECHO START	* SKR DB BACK REFLECTION FROM CAL. BLOCK * SKR IN BACK REFLECTION FROM PART						

REVIEWED BY \_\_\_\_\_ LEVEL \_\_\_\_\_ DATE REVIEWED \_\_\_\_\_

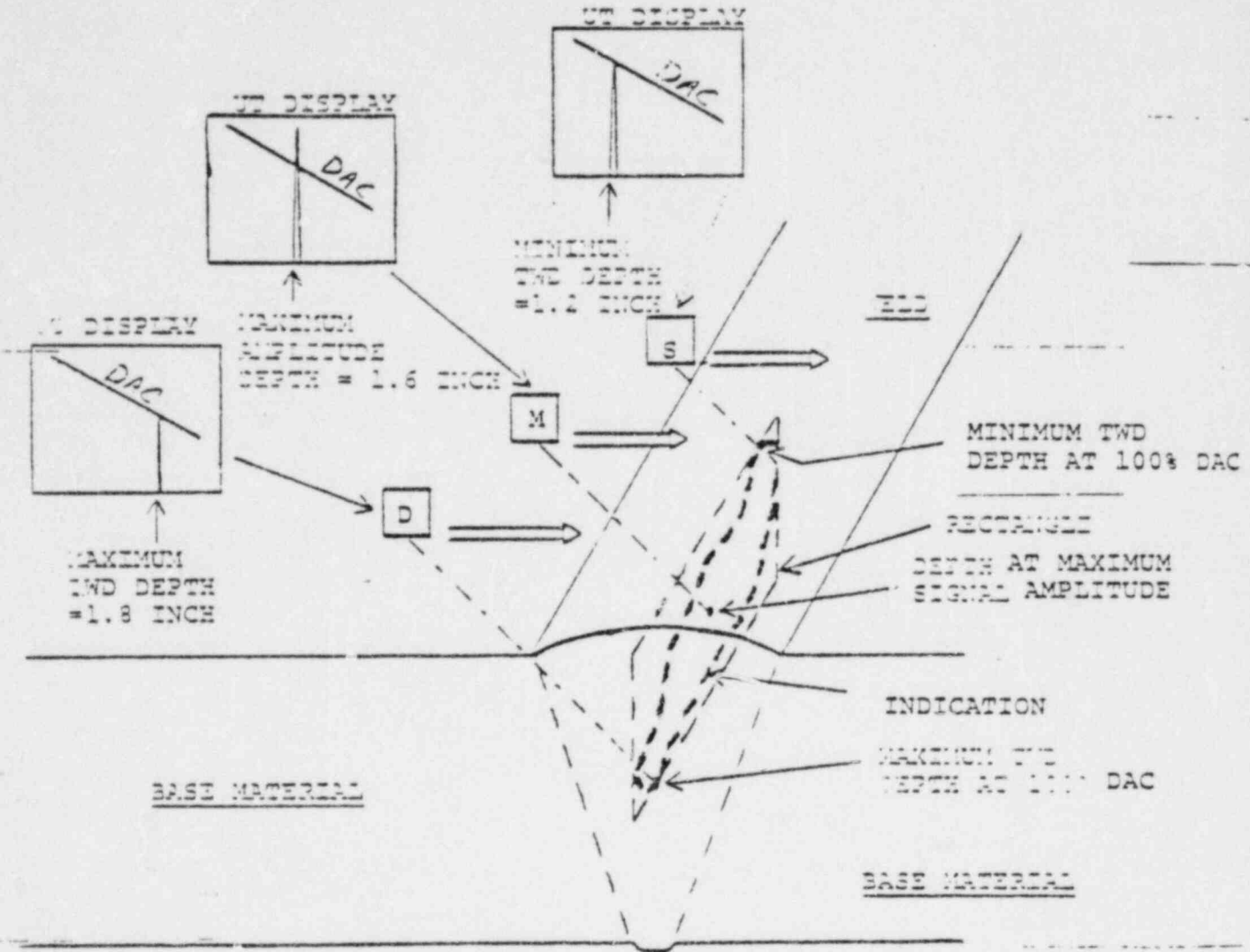
Figure 2  
Typical Calibration Sheet



BABCOCK & WILCOX  
 B&W Construction Company  
 INSERVICE INSPECTION PROCEDURE

SUBJECT ULTRASONIC EXAMINATION FOR INTERGRANULAR STRESS CORROSION CRACKING IN STAINLESS STEEL OR NICKEL BASE ALLOY PIPING

ISI-125, REV. 0



- = Beam direction and scan path
- - - - - = Angle beam path in base material and weld
- ▭ = Circumscribed rectangle
- ▭ = Typical indication source
- M = Transducer position for maximum signal amplitude
- S = Transducer position for minimum TWD path
- D = Transducer position for maximum TWD path
- TWD = 1.8 inch - 1.2 inch = 0.6 inch

Figure 4  
 TWD Example

INSERVICE INSPECTION PROCEDURE

SUBJECT ULTRASONIC EXAMINATION FOR INTERGRANULAR  
STRESS CORROSION CRACKING IN STAINLESS STEEL  
OR NICKEL BASE ALLOY PIPING

ISI-125, REV. 0

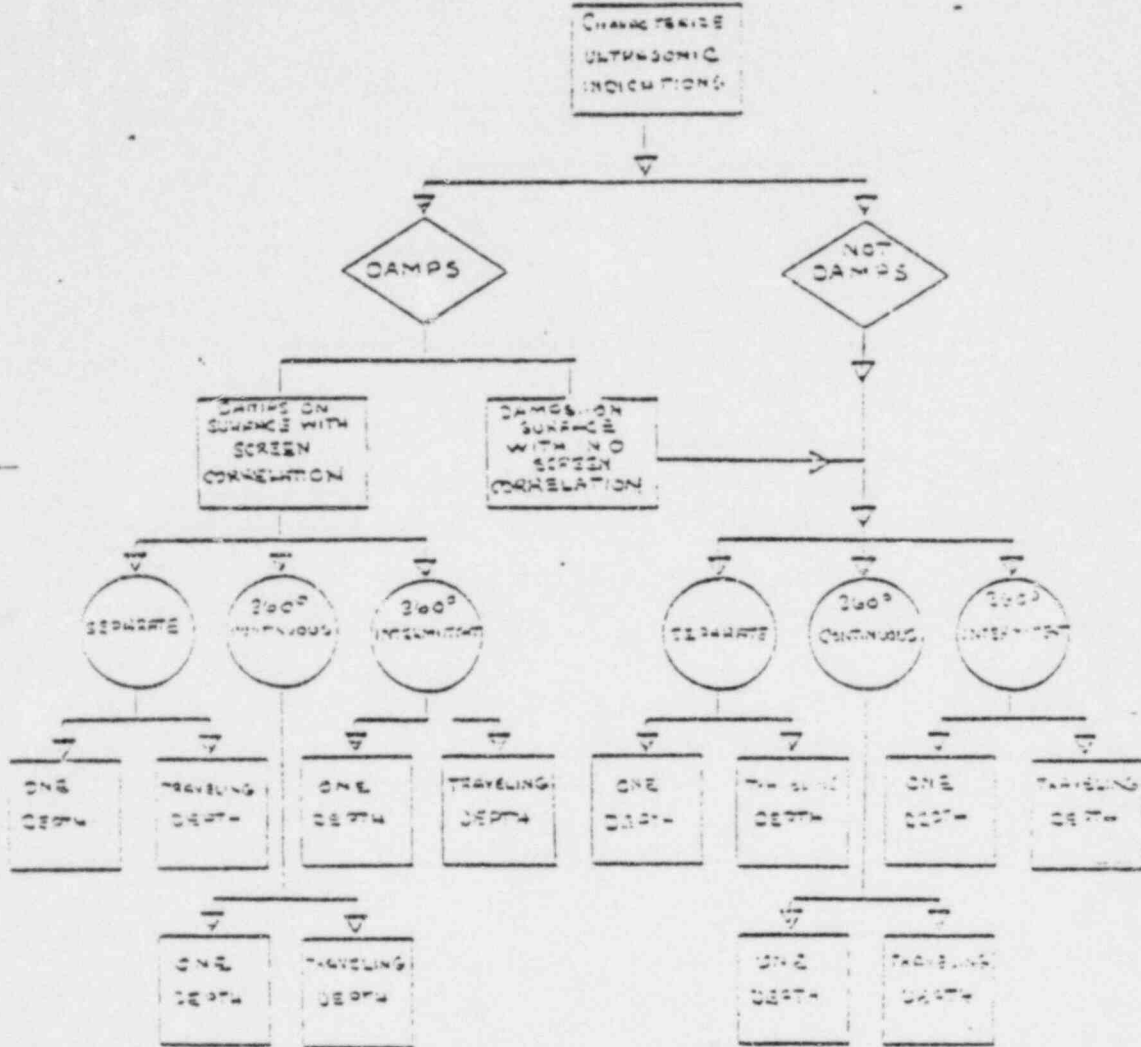


Figure 5  
Indication Flow Diagram



BABCOCK & WILCOX  
B&W Construction Company

INSERVICE INSPECTION PROCEDURE

SUBJECT	PENETRANT EXAMINATION OF WELD AND BASE MATERIALS INCLUDING STUDS, NUTS & WASHERS	ISI-240, REV. 3
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1. SCOPE: This procedure shall govern the penetrant method of examination in accordance with Section V, Article 24, Method A3 and B3. The examination described herein shall be used for the detection of indications open to the surface. This procedure shall apply to materials examined in accordance with the ASME Boiler and Pressure Vessel Code, Sections III and XI.
2. OPERATOR QUALIFICATION: The examiner performing the examination shall be qualified to at least Level I in accordance with B&W Construction Company Quality Control Administrative Procedure 9A-167. The examiner performing the evaluation shall be at least a Level II in accordance with B&W Construction Company Quality Control Administrative Procedure 9A-167.
3. AREA OF INTEREST: The area of interest shall include the areas stipulated by its category.
  - 3.1 Category A: Welds and weld metal cladding, shall include one wall thickness of adjacent base material on either side of the welds where applicable.
  - 3.2 Category B: Base material shall include unwelded surfaces as specified in Section XI of the ASME Code.
  - 3.3 Category C: Studs, Nuts, Bolts, and Washers shall be as specified in the Section XI for the part under examination.
4. SURFACE PREPARATION: The area of interest and adjacent surfaces within one inch shall be free of film, scale, dirt, grease, embedded sand, etc. Shot, sand and grit blasting shall not be performed on surfaces prior to penetrant examination. The examination surface(s) shall be prepared in accordance with ISI-50 except for machined parts.
5. APPROVED PENETRANTS, CLEANERS AND DEVELOPERS:
  - 5.1 Visible Penetrant Materials: The following materials produced by the Magnaflox Corporation may be used in combination with one another, but shall not be used in conjunction with other manufacturer's materials:

REVISED BY MLW	REVISION SECTION : 8.1	PAGE NO. 1 OF 5
REVISION DATE 5-20-77		ISSUE DATE 8-23-76

INSERVICE INSPECTION PROCEDURE

SUBJECT PENETRANT EXAMINATION OF WELD AND BASE MATERIALS INCLUDING STUDS, NUTS & WASHERS	ISI-240, REV. 3
--	-----------------

	<u>Combination No. 1</u>	<u>Combination No. 2</u>
Penetrant	SKL-S	SKL-NF
Developer	SKD-S	SKD-NF
Cleaner	SKC-S	SKC-NF

Combination No. 2 is preferred and shall be used whenever possible. Materials made by other companies are acceptable provided they are qualified on approved test plates using this procedure.

5.2 Fluorescent Penetrant Materials: The following materials produced by Magnaflux Corporation are acceptable:

Penetrant - (Zyglo)	EL-22A
Developer - (Zyglo)	ZP-9 Wet
Developer - (Zyglo)	ZP-4A Dry
Cleaner - (Zyglo)	ZC-7

Other fluorescent materials produced by other companies are acceptable provided they are qualified by demonstrating the adequacy of the materials to detect known defects in approved test plates.

5.3 Each batch of materials used on stainless steels or nickel based alloys shall have been tested for residual amounts of total halogen and sulfur in accordance with ISI-60. The total residual amount of halogens and sulfur shall not exceed the requirements of ISI-60. The penetrant, developer and cleaner batch numbers shall be recorded on the data sheet.

6. PRE-CLEAN:

The area of interest and adjacent surfaces, within one inch, shall be cleaned to ensure they are free of loose film, slag, dirt, etc. After final cleaning, the surface shall be checked with a lint-free cloth or absorbent paper to confirm that no dirt is present. The minimum drying time shall be 5 minutes before application of penetrant.

7. APPLICATION OF PENETRANT:

7.1 The area of interest shall be thoroughly and uniformly coated with the penetrant. The penetrant shall be applied by brushing, dipping or spraying.

INSERVICE INSPECTION PROCEDURE

SUBJECT	PENETRANT EXAMINATION OF WELD AND BASE MATERIALS INCLUDING STUDS, NUTS & WASHERS	ISI-240, REV. 3
---------	--	-----------------

- 7.2 The area shall remain wetted with the visible penetrant for a minimum of 10 minutes and a maximum of 30 minutes. For fluorescent penetrant, the surface shall remain wetted for a minimum of 5 minutes and a maximum of 30 minutes. On special applications, the maximum time limit may be increased when permitted by the Customer. Any complete drying of penetrant during the penetration time shall require recleaning of the surfaces and a repeat of the test. The work piece and the penetrant shall be at a temperature between 60 and 125 degrees F (16 and 52 C) during the penetrant examination.
- 7.3 After the penetrant has been on the area of interest for the prescribed amount of time, all excess penetrant shall be removed by the following steps:
  - A. Remove all possible penetrant with a clean, dry, lint-free cloth or absorbent paper.
  - B. Finish cleaning the surface with lint-free cloths or absorbent paper that have been dampened with the approved cleaner. Flushing of the surface with a cleaning solution for the purpose of removing excess penetrant shall be prohibited.
- 7.4 The drying of surfaces after removal of the excess penetrant will be accomplished by normal evaporation or by bolting with clean lint-free cloths or absorbent paper. A minimum drying of 5 minutes shall be maintained after all wiping operations have been completed before the developer is applied.

8. APPLICATION OF PENETRANT DEVELOPER:

- 8.1 The penetrant developer shall be applied to the surface within 15 minutes after the preceding operations have been completed. Liquid developer (solvent or water based) shall be thoroughly agitated and shall be applied by spraying or dipping. Dry developer may be used with fluorescent penetrants and shall be applied by soft brush, a hand powder bulb, a powder gun, or other means more suitable to the size and geometry of the specimen provided the powder is evenly dusted over the surface to be examined.
- 8.2 Regardless of the method of developer application a single thin coating of developer shall be uniformly applied. A heavy coating of developer shall be prohibited.

INSERVICE INSPECTION PROCEDURE

SUBJECT PENETRANT EXAMINATION OF WELD AND BASE MATERIALS INCLUDING STUDS, NUTS & WASHERS	ISI-240, REV. 3
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8.3 The developer shall dry for a minimum of 7 minutes before interpretation and the interpretation should be completed within 30 minutes. However, evaluation may continue after the 30 minute period has elapsed provided that the indications remain within applicable acceptance standards. Surfaces which are evaluated after 30 minutes and have indications exceeding the acceptance standards shall be cleaned and re-examined by the technique described in the preceding paragraphs except that interpretation shall be started after the developer has dried for 7 minutes and shall be completed within 30 minutes.

9. INTERPRETATION OF RESULTS:

9.1 Precautions shall be taken to prevent any object from touching the dry developer film as it is very fragile and easily damaged. When questionable results are obtained, the surfaces shall be re-examined.

9.2 Indications and defects in the surface shall be identified as stains against the developer, or a bright yellow or green fluorescent stain against the developer when viewed with the black light. A thin line may indicate a fine crack or a cold shut. Scattered dots may indicate porosity in the material and a line of dots may indicate a tightly closed crack.

9.3 When using fluorescent penetrant, the interpretation shall be made with the aid of a black light. With this intense black light, an extremely bright indication of any entrapped penetrant will be disclosed.

10. LIGHTING IN THE EXAMINATION AREA:

10.1 Visible Penetrants: The area in which the examination is performed shall be adequately illuminated for proper evaluation.

10.2 Fluorescent Penetrants: The examination shall be conducted in a darkened area using filtered black light. The filtered black light intensity shall be at least 90 foot candles at the work piece, as measured using a Wescon 703 Type III meter, or equivalent, without filter in the meter and with a 10X multiplier disk. The black light shall be filtered ultraviolet radiation in the range 3300-3900 angstrom units. The black light shall be allowed to warm up for a minimum of 5 minutes prior to its use in the examination.

BABCOCK & WILCOX  
B&W Construction Company  
INSERVICE INSPECTION PROCEDURE

SUBJECT PENETRANT EXAMINATION OF WELD AND BASE MATERIALS INCLUDING STUDS, NUTS & WASHERS	ISI-240, REV. 3
--	-----------------

11. RECORDING STANDARDS: Indications in welds, base materials and bolting materials, etc., shall be evaluated using the applicable ASME Section XI acceptance standards.
- 11.1 All indications revealed by liquid penetrant examinations are not necessarily defects, as non-relevant indications are sometimes encountered. However, all indications in the weld craters or in the line of fusion between base material and weld metal shall be treated as defects. All indications believed to be non-relevant shall be explored by surface conditioning and re-examined or shall be re-examined by other nondestructive methods. If re-examination reveals any indications, they shall be considered defects and be evaluated to the acceptance standards as specified in Paragraphs 11.4 and 11.5.
- 11.2 Linear defects are those defects in which the length is greater than three times the width.
- 11.3 Rounded defects are those defects which are circular or elliptical with the length less than three times the width.
- 11.4 Category A: Indications found in the area of interest (as defined in 3.1) shall be recorded if they equal or exceed the following:
- 11.4.1 Any crack or linear indication with major dimensions greater than a 1/16 inch.
- 11.4.2 All rounded indications with dimensions greater than 3/16 inch.
- 11.4.3 Four or more rounded indications with a major dimension greater than 1/16 inch, separated by 1/16 inch or less, as measured from edge to edge.
- 11.4.4 Ten or more rounded indications with a major dimension greater than 1/16 inch, located in any six square inches of surface, the major dimension of this area not to exceed six inches, with the area taken in the most unfavorable location relative to the indication being evaluated.

BABCOCK & WILCOX  
 B&W Construction Company  
 INSERVICE INSPECTION PROCEDURE

SUBJECT PENETRANT EXAMINATION OF WELD AND BASE MATERIALS INCLUDING STUDS, NUTS & WASHERS	ISI-240, REV. 3
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- 11.5 Category B & C: Indications found in the area of interest (as defined in 3.2 or 3.3) shall be recorded if they equal or exceed the following:
  - 11.5.1 Only indications with major dimensions greater than 1/16 inch shall be considered relevant.
  - 11.5.2 Any linear indication greater than 1/16 inch long for materials less than 5/8 in. thick, greater than 1/8 in. long for materials from 5/8 in. thick to under 2 in. thick and 3/16 in. long for materials 2 in. thick and greater.
  - 11.5.3 Rounded indications with dimensions greater than 1/8 in. for thickness less than 5/8 in. and greater than 3/16 in. for thickness 5/8 in. and greater.
  - 11.5.4 Four or more indications in a line separated by 1/16 in. or less edge to edge.
  - 11.5.5 Ten or more indications in any six square inches of area whose major dimension is no more than six inches, with the dimension taken in the most unfavorable location relative to the indication being evaluated.
  - 11.5.6 In addition, all linear nonaxial indications 1/4 inch and greater in length are unacceptable and linear axial indications greater than 1 in. in length are unacceptable; on studs, nuts and bolts greater than 1 in. nominal bolt size.
- 11.6 Material exhibiting indications, in excess of those permitted in Paragraphs 11.4 and 11.5 after investigation by surface conditioning, shall be recorded.
- 11.7 If the areas are ground to remove the indications a re-examination shall be performed. Once the area is cleared, the retention of the required minimum wall thickness shall be verified from physical measurements. Alternately, the areas ground may be examined for minimum thickness (ISI-112). All cleared areas shall be recorded on the data sheet.

12. REPORTING STANDARDS:

Indications which exceed the applicable Section III or Section XI acceptance standards shall be reported.

SUBJECT PENETRANT EXAMINATION OF WELD AND BASE  
 MATERIALS INCLUDING STUDS, NUTS & WASHERS

ISI-240, REV. 3

13. FINAL CLEANING:

When the examination is ended, the penetrant materials shall be removed as soon as possible with cleaner or other approved solvents.

14. SAFETY PRECAUTIONS:

14.1 Repeated or prolonged contact of penetrant dye or developer with the skin shall be avoided since these liquids are skin irritants.

14.2 The solutions used in dye penetrant inspections shall be used in well ventilated areas, since they are highly volatile.

15. RECORD OF EXAMINATION RESULTS: A copy of the examination results with the following information shall be maintained and made available to the customer (Figure 1):

- A. Contract Number
- B. Method of Test
- C. Procedure number and revision
- D. Batch or ID number of penetrant, cleaner and developer
- E. Chart of Results
- F. Examination Personnel by name/or number
- G. Date(s) of Examination







A.I-49

*Cameron* BLOCK # 5020  
IRON WORKS, INC

P. O. BOX 1212  
HOUSTON, TEXAS 77001

Supplementéd 9 April 1971

Date 19 October 1971

Mill Power Supply CPO A-62898

Customer Order No. 02-4779	C.I.W. Sales Order No. F-13349	Specification * ASTM A376 TP 316 & ASME SA376 with UT
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Description of Material O.D. 10" x I.D. x WALL SCH 140
---

C.I.W. Part No. 86-3349-107-097

Heat No.	Location or Serial No.	CHEMICAL ANALYSIS							
		C	MN	P	S	SI	CR	NI	MO
54865		.053	1.49	.015	.012	.40	16.92	13.40	2.33
54874		.066	1.68	.015	.013	.46	16.78	12.65	2.29

Quantity or Serial No.	Heat No.	Tensile PSI	% 2 Offset Yield PSI	MECHANICAL PROPERTIES			
				% Elong. in.	% Red. Area	Macro Etch	Band Test
-	54865	77,700	37,500	51.3	69.3		OK
4	54874	80,200	41,200	52.5	67.9		OK

Form. Ser. #	Heat #
8918	54874
8919	54874
8920	54874
8921	54874
8922	54865
8923	54865

\* Each length of pipe ultrasonically inspected per ASME Sec. III Class I (Para. NB 2552) with 3% notch (CIW PU-8) and found acceptable.

This certifies that the above described piping meets the requirements of Ansl B31.7 (1969) Chapter I - III materials.

Hydrostatic Test Each length of pipe hydrostatically tested at 2700 psi for 5 Sec. and found acceptable

Heat Treatment:

Annealed. 1925°F., hold 1 hr. at temp. Water quench.

Subscribed and Sworn to before me this

Day of October 1971

*[Signature]*  
Notary Public

Notary Public

G. A. TOWNSEND

Notary Public in and for Harris County, Texas  
My Commission Expires June 1, 1974

CAMERON 1089 4/70

I certify these tests to be correct as contained in the reports of the company.

*[Signature]*  
Metallurgical Representative  
H. F. GILBERT

Appendix II - Preservice Inspection Examination Data  
Accumulator Injection System, Loops A, B, C, D

Examination Data

A-II-2 - A-II-26

Weld Cross Section Sketch #1

A-II-36

Note: Refer to Appendix III for Summary of Examinations and Isometric Drawings of Systems.



VOLUMETRIC TEST DATA  
FORM 106

BADCOCK & WILCOX  
B&W CONSTRUCTION COMPANY

CUSTOMER: DUKE POWER MCGUIRE UNIT #1		CONTRACT NO.: 192-066-006		COMPONENT: PIPELINE	
DESCRIPTION: CLASS 1 PIPING COOLANT SYSTEM PIPE		MATERIAL: S.S.		THICKNESS: 1.0 IN.	
WELD I.D.: INC 72-1		PROCEDURE: 120 R-5		TEST SURFACE: O.D.	
NO. POSITIONS: 4		#1 REFERENCE: 1004 PIRE		CAL. SHEET: 10492	
DEAM DIRECTION LONG SHEAR		LIMITED EXAM (NO) (YES IF SO WHY)		ANGLE: 45	
EXAMINER: C. MILDWITH		ID#: 117878		TIME START: 1100 HR.	
EXAMINER: J. JOHNSON		ID#: 55085		TIME STOP: 1315 HR.	
NOTES:		DATE: 12-16-77		PART TEMP: N/A OF	
NUMEROUS INDICATIONS AT VARIOUS DEPTH LESS THAN 50% RAP.		E.C.A.S.I.		DATE: 12-19-77	
		WELD HEIGHT: 2.1		WELD WIDTH: 0.85	
		SURFACE ONE TO SURFACE TWO			
		DIRECTION		DIRECTION	
		L.A.M.		L.A.M.	
		MAX AREA OF DAC		MAX AREA OF DAC	
		STATUS		STATUS	
		BREAK DIRECTION		BREAK DIRECTION	
		SURFACE		SURFACE	
		ANGLE (DEG.)		ANGLE (DEG.)	
		POSITION		POSITION	
		DEPTH		DEPTH	
		LENGTH		LENGTH	
		50% OR MORE		50% OR MORE	
		100%		100%	
		DISTANCE		DISTANCE	
		FROM		FROM	
		DIRECTION		DIRECTION	
		MINIMUM		MINIMUM	
		MAXIMUM		MAXIMUM	
		POSITION		POSITION	
		HAZ		HAZ	
		WELD		WELD	
		SM		SM	
		DATE		DATE	
		REMARKS		REMARKS	

REVIEWED BY: Charles E. Thompson  
DATE REVIEWED: 1-5-78  
LEVEL: II  
FIGURE NO.: 1.4.453.4  
PAGE 1 OF 2









VOLUMETRIC TEST DATA  
FORM 105

BABCOCK & WILCOX  
B&W CONSTRUCTION COMPANY

CUSTOMER: DUKE POWER MCGUIRE UNIT #1		CONTRACT NO.: 192-066-006		COMPONENT: PIPING	
DESCRIPTION: CLASS 1 REFLECTOR COOLANT SYSTEM ELBOW TO NOZZLE					
WELD I.D.: NCIF 107		PROCEDURE: 120 R-5		MATERIAL: S.S.	
THICKNESS: 1.0 IN.		TEST SURFACE: O.D.		CAL. SHEET: 6610492	
NO. POSITIONS: 4		DISTANCE: 2.5 IN.		#1 REFERENCE: OUTSIDE VIEW OF ELBOW	
CAL. SHEET: 6610486		ANGLE: 0°		ANGLE: 45°	
BEAM DIRECTION LONG <input checked="" type="checkbox"/> SHEAR <input type="checkbox"/> LIMITED EXAM <input type="checkbox"/> NO <input type="checkbox"/> YES (IF SO WHY)			TIME START: 1457 HR.		TIME START: 0910 HR.
EXAMINER: P. McEDITH		ID#: 117818		LEVEL: II	
EXAMINER: J. JOHNSON		ID#: JS085		LEVEL: I	
TIME STOP: 1512 HR.		TIME STOP: 0952 HR.		TIME STOP: HR	
PART TEMP: N/A °F		PART TEMP: N/A °F		PART TEMP: °F	
DATE: 12-16-77		DATE: 12-19-77		DATE:	
NOTES: LIMITED EXAM FOR 2 DUE TO NOZZLE CONFIGURATION  SEE SKETCH # 6			° INFORMATION ONLY WELD HEIGHT 0.03 WELD WIDTH 0.9 SURFACE ONE TO SURFACE TWO		
SM 0.9		HAZ 0.9		G WELD 1.0	
		HAZ 1.1		SM 1.25	

IND. NO.	A B		ANGLE (DEG.)	SURFACE	BEAM DIRECTION	STATUS	LAM.			(INCHES)				HALF MAXIMUM AMPLITUDE				DAMPS	REMARKS	
	POSITION OR PART ITEM						MAX AMP % DAC	DEPTH (IN.)	LENGTH	WIDTH	CRYSTAL DISTANCE FROM	MINIMUM		MAXIMUM		DISTANCE FROM SURFACE IN.	POSITION IN.			
	1	2										1	2	1	2		A			B
	NCIF 107	0°	SIDE	NOTE	1.00	NOTE	ALL OTHER AREAS CLEAR													
200	360	45	2	1	INT	65	2.2	34			2.3					YES NEAR TOE				
201	360	45	1	2	INT	82	1.0	34			1.0					NO				
202	360	45	1	2	INT	50	1.8	34			1.5					NO				
	NCIF 107	45°	SEE	NOTE	ABOVE															

REVIEWED BY: Charles E. Thompson	LEVEL: II	DATE REVIEWED: 1-5-78	FIGURE NO.: 4.4.453.6
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A.II-7





VOLUMETRIC TEST DATA  
FORM 106

BADCOCK & WILCOX  
B&W CONSTRUCTION COMPANY

*Handwritten:* #88 PDB OK

CUSTOMER: LUKE POWER MCGUIRE UNIT #1		CONTRACT NO.: 192-066-006		COMPONENT: PIPING	
DESCRIPTION: CLASS 1 REACTOR COOLANT SYSTEM PIPE TO FCBW					
WELD I.D.: INC 731		PROCEDURE: 170 R-5		MATERIAL: S.S.	THICKNESS: 1.0 IN.
NO. POSITIONS: 4	DISTANCE: 8.5 IN.	#1 REFERENCE: TYP PIPE		CAL. SHEET: 6104-77	CAL. SHEET: 6610500
BEAM DIRECTION LONG SHEAR		LIMITED EXAM <input type="checkbox"/> NO <input type="checkbox"/> YES (IF SO WHY)			
EXAMINER: C. MERRITH		ID#: M7918	LEVEL: II	TIME START: 7920 HR.	TIME START: 7100 HR.
EXAMINER: J. JOHNSON		ID#: J5085	LEVEL: I	TIME STOP: 1005 HR.	TIME STOP: 1122 HR.
PART TEMP: N/A °F		PART TEMP: N/A °F		PART TEMP: _____ °F	
DATE: 12-13-77		DATE: 12-14-77		DATE: _____	

NOTES:  
IND #200 (MIN) TWD NOT GIVEN BECAUSE OF  
TWO FEET OF SHOE WAS AGAINST WELD WHEN MAX  
SIGNAL WAS GIVEN

F.C.A. (S)

WELD HEIGHT .01 WELD WIDTH .7

SURFACE ONE TO SURFACE TWO

SM 1.0 0.05	HAZ 1.0 0.05	G WELD 1.0 0.05	HAZ 1.0	9M 1.0
-------------------	--------------------	-----------------------	------------	-----------

IND. NO.	A	B	ANGLE (DEG.)	SURFACE	BEAM DIRECTION	STATUS	L.A.M.			LENGTH (INCHES)				HALF MAXIMUM AMPLITUDE				DAMPS	REMARKS				
							MAX AMP % DAC	DEPTH (IN.)	20%	50% OR HMA	100%	MINIMUM		MAXIMUM		DISTANCE FROM SURFACE IN.	POSITION IN.			DISTANCE FROM SURFACE IN.	POSITION IN.		
												A	B	1	2		1				2	A	B
200	360	45	2	1	INT	3/16	1.5		34	34													
201	360	45	2	1	INT	80	1.0		34														
202	360	45	2	1	INT	50	1.25		34														
203	360	45	2	1	INT	50	1.9		34														
	INC 73-1	45			OTHER	AREA																	
204	360	0	2		INT	80	1.0		34														
	INC 73-1	0			OTHER	BEADS																	

REVIEWED BY: Charles E. Thompson      LEVEL: II      DATE REVIEWED: 1-5-78      FIGURE NO.: 44391.5

A.II-10

VOLUME I.R.C. TEST DATA  
FORM 106

BABCOCI VILCOX  
B&W CONSTRUCTION COMPANY

CUSTOMER: DUKE POWER MCGUIRE UNIT #1		CONTRACT NO.: 192-066-013		COMPONENT: PIPING	
DESCRIPTION: CLASS 2 or 3 REACTOR COOLANT SYSTEM PIPE TO ELBOW					
WELD I.D.: INC 73-1		PROCEDURE: 125-RO		MATERIAL: SS	THICKNESS: 1.0 IN.
NO. POSITIONS: 4	DISTANCE: 8.5 IN.	#1 REFERENCE: 201	CAL. SHEET: 660758	CAL. SHEET:	CAL. SHEET:
BEAM DIRECTION: $\perp$ LONG $\parallel$ SHEAR		LIMITED EXAM: <input checked="" type="checkbox"/> NO <input type="checkbox"/> YES (IF SO WHY)			
EXAMINER: M. HACKER		ID#: H9017	LEVEL: II	TIME START: 0931 HR.	TIME START: HR.
EXAMINER: R. PATTERSON		ID#: P3562	LEVEL: II	TIME STOP: 0938 HR.	TIME STOP: HR.
NOTES:		PART TEMP: N/A °F	PART TEMP: _____ °F	PART TEMP: _____ °F	PART TEMP: _____ °F
		DATE: 9-9-78	DATE:	DATE:	DATE:
		F.C.A.(S)	° INFORMATION ONLY WELD HEIGHT _____ WELD WIDTH _____ SURFACE ONE TO SURFACE TWO →		
9M	HAZ	C WELD	HAZ	9M	

IND. NO.	A		ANGLE (DEG.)	SURFACE	BEAM DIRECTION	STATUS	L.A.M.			LENGTH				WIDTH				CRYSTAL DISTANCE (INCHES)				HALF MAXIMUM AMPLITUDE				DAMPS	REMARKS
	POSITION OR PART ITEM	MAX AMP % DAC					DEPTH (IN.)	20%	50% OR HMA	100%	MINIMUM		MAXIMUM		MINIMUM		MAXIMUM		MINIMUM		MAXIMUM						
											POSITION IN.		POSITION IN.		POSITION IN.		POSITION IN.		POSITION IN.		POSITION IN.						
											1	2	1	2	1	2	1	2	1	2	1	2					
			45°		CLEAR																						

REVIEWED BY: M. S. Hacker	LEVEL: II	DATE REVIEWED: 9-10-78	FIGURE NO.: X.3.17.1
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A.II-11



VOLUMETRIC TEST DATA  
FORM 106

BADCOCK & WILCOX  
B&W CONSTRUCTION COMPANY

*Handwritten:* 100 PDB OK

CUSTOMER: DUKE POWER MCGUIRE UNIT #1			CONTRACT NO.: 192-066-006			COMPONENT: PIPING		
DESCRIPTION: CLASS 1 REACTOR COOLANT SYSTEM ELBOW TO NOZZLE								
WELD I.D.: N1C1F 109		PROCEDURE: 170 R-5		MATERIAL: S.S.		THICKNESS: 1.0 IN.		TEST SURFACE: O.D.
NO. POSITIONS: 4		DISTANCE: 8.5 IN.		#1 REFERENCE: OUTSIDE END OF ELBOW		CAL. SHEET: 10477		CAL. SHEET: 10495
BEAM DIRECTION: LONG SHEAR			LIMITED EXAM <input type="checkbox"/> NO <input checked="" type="checkbox"/> YES (IF SO WHY)			ANGLE: 45		ANGLE: 0
EXAMINER: C. MEREDITH		ID#: N7818		LEVEL: II		TIME START: 1040 HR.		TIME START: 1450 HR
EXAMINER: J. SCHWEN		ID#: J5085		LEVEL: I		TIME STOP: 1125 HR.		TIME STOP: 1505 HR
NOTES: LIMITED SCAN SUR 1 DUE TO NOZZLE CONFIGURATION			DATE: 12-13-77			DATE: 12-15-77		

SEE SKETCH # 6

WELD HEIGHT: 0.6 WELD WIDTH: 0.8  
SURFACE ONE TO SURFACE TWO

GM	HAZ	WELD	HAZ	GM
0.875	0.925	0.95	1.025	1.125

IND. NO.	A B		ANGLE (DEG.)	SURFACE	BEAM DIRECTION	STATUS	L.A.M.			LENGTH (INCHES)				HALF MAXIMUM AMPLITUDE				DAMPS	REMARKS			
	POSITION OR PART ITEM	MAX AMP % DAC					DEPTH (IN.)	20%	50% OR HMA	100%	MINIMUM		MAXIMUM		DISTANCE FROM SURFACE IN.	POSITION IN.				DISTANCE FROM SURFACE IN.	POSITION IN.	
											1	2	1	2		1	2					
											A	B	A	B		A	B					
200	360	45	2	1	INT	80	0.95		34			1.0					NO					
201	360	45	1	2	INT	95	1.1		34			1.0					NO					
202	360	45	1	2	INT	90	1.8		34			1.7					YES CRACK					
	N1C1F 109	45																ALL OTHER AREAS CLEAR				
	N1C1F 109	0°																ALL AREAS CLEAR SEE NOTE ABOVE				

REVIEWED BY: Charles E. Thompson	LEVEL: II	DATE REVIEWED: 1-5-78	FIGURE NO.: 4.4.391.8
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A.II-13







VOLUMETRIC TEST DATA  
FORM 106

BABCOCK & WILCOX  
BAW CONSTRUCTION COMPANY

CUSTOMER: DUKE POWER MCGUIRE UNIT #1		CONTRACT NO.: 192-066-006		COMPONENT: PIPING	
DESCRIPTION: CLASS 1 REACTOR COOLANT SYSTEM PIPE TO ELBOW		WELD ID.: 102-1		THICKNESS: 1.0 IN.	
PROCEDURE: 120 R-5		MATERIAL: S.S.		TEST SURFACE: O.D.	
NO. POSITIONS: 4		DISTANCE: 8.5 IN.		CAL. SHEET: 6610485	
BEAM DIRECTION: LONG 45° SHEAR		LIMITED EXAM (NO DYES IF SO WHY)		ANGLE: 45°	
EXAMINER: C. MEREDITH		ID#: 117818		TIME START: 1100 HR.	
EXAMINER: J. JOHNSON		ID#: J55085		TIME STOP: 1222 HR.	
NOTES:		LEVEL: -1'		PART TEMP: 440 °F	
		LEVEL: 1'		DATE: 12-15-77	
		F.C.A. ISL		DATE: 12-16-77	
		0° INFORMATION ONLY		WELD HEIGHT 0.1	
				YIELD WIDTH 0.8	
				SURFACE ONE TO SURFACE TWO	
				HAZ 1.1	
				Q WELD 1.0	
				HAZ 1.0	
				SM 1.2	
				SM 1.0	
				REMARKS	

IND. NO.	A	B	POSITION OR PART ITEM	ANGLE (DEG.)	SURFACE	BEAM DIRECTION	STATUS	MAX AMP (DAD)	LAM. DEPTH (IN.)	LENGTH	CRYSTAL DISTANCE		CRYSTAL DISTANCE		CRYSTAL DISTANCE		DAMPS	REMARKS
											FROM	TO	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM		
200	360		INC 102-1	0°	A/C	CLEAR					A	B	1	2	A	9		
201	360		INC 102-1	45°	R	1	1st	34	34	34	1.35	1.8	1.0	1.5			NO	
	360		INC 102-1	45°	R	1	1st	34	34	34	1.1						NO	
	INC 102-1		INC 102-1	45°	A/C	1	1st	34	34	34								

REVIEWED BY: Charles E. Thompson  
 DATE REVIEWED: 1-5-78  
 LEVEL: 1'  
 FIGURE NO.: 4.4.325A  
 PAGE 1 OF 1  
 X.3.19.1





VOLUMETRIC TEST DATA  
FORM 102

BABCOCK & WILCOX  
BAW CONSTRUCTION COMPANY

CUSTOMER: DUKE POWER MCGUIRE UNIT #1		CONTRACT NO.: 192-066-006		COMPONENT: PIPING	
DESCRIPTION: CLASS 1 REACTOR COOLANT SYSTEM FLOW TO PIPE					
WELD I.D.: INC 102-2		PROCEDURE: 120 R-5		MATERIAL: S-S	
NO. POSITIONS: 4		DISTANCE: 8.5 IN.		CAL. SHEET: 6610485	
BEAM DIRECTION: LONG SHEAR		LIMITED EXAM: <input type="checkbox"/> NO <input type="checkbox"/> YES (IF SO WHY)		ANGLE: 0	
EXAMINER: C. MEREDITH		ID#: 17818		LEVEL: II	
EXAMINER: J. JOHNSON		ID#: J.5085		LEVEL: F	
NOTES:		DATE: 12-15-77		DATE: 12-16-77	
		F.C.A. (S)		WELD HEIGHT: 0.1 WELD WIDTH: 0.6	
				SURFACE ONE TO SURFACE TWO	
		9M: 1.05		HAZ: 1.05	
		C <sub>2</sub> WELD: .90		HAZ: 1.1	
				9M: 1.1	

INC 47

IND. NO.	POSITION OR PART ITEM		ANGLE (DEG.)	SURFACE	BEAM DIRECTION	STATUS	L.A.M.			LENGTH (IN.)				CRYSTAL DISTANCE (INCHES)				HALF MAXIMUM AMPLITUDE				DAMPS	REMARKS
	A	B					MAX AMP % DAC	DEPTH (IN.)	20%	50% OR HMA	100%	A	B	1	2	MINIMUM		MAXIMUM					
	POSITION IN.						DISTANCE FROM SURFACE IN.	POSITION IN.		DISTANCE FROM SURFACE IN.	POSITION IN.		DISTANCE FROM SURFACE IN.	POSITION IN.									
	1	2						1	2		1	2		1	2								
			0°	ALL CLEAR																			
200	1-4		45°	1	2	30P	160	1.5	1.0	2	1.5	1.3	1.45	1.1	1.6	0.5			NO	None			
208	360		45°	1	2	WT	65	.9	39														
	INC 102-2		45°	ALL	Other	Areas	Clear																

REVIEWED BY: Charles S. Thomas      LEVEL: II      DATE REVIEWED: 1-5-78      FIGURE NO.: 4 1 2 3 5 1

A.II-19





VOLUMETRIC TEST DATA  
FORM 106

BAHCOCK & WILCOX  
B&W CONSTRUCTION COMPANY

CUSTOMER: DUKE POWER MCGUIRE UNIT #1  
 DESCRIPTION: CLASS I REACTOR COOLANT SYSTEM PIPE TO PEBOW  
 CONTRACT NO.: 192-066-006  
 WELD ID.: INC 128-1  
 NO. POSITIONS: 4 DISTANCE: 3.5 IN.  
 BEAM DIRECTION: LONG SHEAR  
 EXAMINER: C. M. DILL  
 EXAMINER: J. T. HANSON  
 PROCEDURE: ASME SECTION V  
 #1 REFERENCE: 4  
 LIMITED EXAM (NO GIVES IF SO WHY)  
 ID#1: M7818 LEVEL: II  
 ID#2: 5085 LEVEL: I  
 NOTES: Due to undercut Sur #1 & #2  
 Numerous ind 20% to 40% various depths

THICKNESS: 1.0 IN.  
 CAL. SHEET: 6610806  
 ANGLE: 0°  
 TIME START: 0909 HR.  
 TIME STOP: 0928 HR.  
 PART TEMP: 140 °F  
 DATE: 12-14-77  
 TEST SURFACE: CAL. SHEET  
 ANGLE:  
 TIME START: HR.  
 TIME STOP: HR.  
 PART TEMP: °F  
 DATE:

IND. NO.	A	B	POSITION OR PART ITEX	ANGLE (DEG.)	SCRAPE	BREAK DIRECTION	STATUS	MAX AMP & OAC	LAMP	DEPTH (IN.)	HEIGHT WIDTH		LENGTH	(INCHES)			HALF MAXIMUM AMPLITUDE		HAZ	WELD	HAZ	SH
											HT	WD		CRISTAL.	DIS-TANCE	TRON	MINIMUM	MAXIMUM				
														POSITION IN.	POSITION IN.	MARKS						
														1	2	1	2					
200	360			45	1	2	INT	50	1.8		34		1.7	1.2	1.1	1.6	1.0	95	1.0	1.0		
201	360			45	1	2	INT	50	1.0		34		1.2	1.2	1.1	1.6	1.0	95	1.0	1.0		
202	360			45	2	1	INT	316	1.0		34		1.0	1.3	1.1	1.6	1.0	95	1.0	1.0		
203	360			45	2	1	INT	120	1.25		34		1.0	1.3	1.1	1.6	1.0	95	1.0	1.0		
111	0			0	4		INT	100	1.0		34		0	0	1.1	1.6	1.0	95	1.0	1.0		
001	360			0	4		INT	100	1.0		34		0	0	1.1	1.6	1.0	95	1.0	1.0		
100021	0			0	4		INT	100	1.0		34		0	0	1.1	1.6	1.0	95	1.0	1.0		

REVIEWED BY: Charles E. Thompson  
 DATE REVIEWED: 1-5-78  
 LEVEL: II  
 SURFACE ONE TO SURFACE TWO  
 WELD HEIGHT: 1.0 WELD WIDTH: 1.7  
 FIGURE NO: 192-066-006  
 X.3.21.1  
 PAGE 1 OF 1





FORM 200

VISUAL/SURFACE DATA

BABCOCK & WILCOX  
B&W CONSTRUCTION COMPANY

CUSTOMER: DUKE POWER MCGUIRE UNIT #1		CONTRACT NO: 192-066-013		COMPONENT: PIPING	
DESCRIPTION: CLASS 2 OF 3 REACTOR COOLANT SYSTEM ELBOW TO PIPE		PROCEDURE: 240 R3		MATERIAL: SS	
WELD ID: INC 128-2		DISTANCE: 10 IN. #1 REF: #2		THICKNESS: 1.0 IN. SURFACE: OD	
TEST METHOD: PT		NO. POSITIONS: 4		DATES: 8/14/78	
EXAMINERS: R. PITZ		ID# P0707		LEVEL: II	
EXAMINERS: R. CARMAN		ID# C6626		LEVEL: I	
<input type="checkbox"/> MAGNETIC PARTICLE (ONLY) <input type="checkbox"/> WET <input type="checkbox"/> DRY COLOR <input type="checkbox"/> VISIBLE <input type="checkbox"/> FLUORESCENT INSTRUMENT _____ METHOD _____ CURRENT _____ MACHINE# _____		<input checked="" type="checkbox"/> DYE PENETRANT (ONLY) CLEANER 63031 PENETRANT 64974 DEVELOPER 65011		NOTES:	
METHOD <input checked="" type="checkbox"/> VISIBLE <input type="checkbox"/> FLUORESCENT MACHINE# _____		DISTANCE FROM (INCHES) A B I Z		REMARKS	
PART ITEM OR POSITION A B		SIZE (INCHES)		SURFACE	
STATUS		ALL AREAS CLEAR			
IND. NO.					
REVIEWED BY: M. A. Hocken		DATE REVIEWED 8-31-78		FIGURE NO.: X.3.22	
LEVEL: II				PAGE 1 OF	

VOLUMETRIC TEST DATA  
FORM 106

BARCOCK & WILCOX  
DAW CONSTRUCTION COMPANY

*12/14/77*

CUSTOMER: DUKE POWER MCGUIRE UNIT #1		CONTRACT NO.: 192-066-006		COMPONENT: PIPELINE	
DESCRIPTION: CLASS 1 REACTOR COOLANT SYSTEM ELBOW TO PIPE					
WELD I.D.: 1N2 12B-2	PROCEDURE: 120 R-5	MATERIAL: S.S.	THICKNESS: 1.0 IN.	TEST SURFACE: P-O.	
NO. POSITIONS: 4	DISTANCE: 8.5 IN.	#1 REFERENCE: DR of ELB	CAL. SHEET: 6610313	CAL. SHEET: 6610502	CAL. SHEET:
BEAM DIRECTION: LONG SHEAR		LIMITED EXAM <input type="checkbox"/> NO WYES (IF SO WHY)	ANGLE: 45	ANGLE: 00	ANGLE:
EXAMINER: C McCall	ID#: 11818	LEVEL: II	TIME START: 1438 HR.	TIME START: 0934 HR.	TIME START: HR
EXAMINER: J. J. Wilson	ID#: 5085	LEVEL: I	TIME STOP: 1510 HR.	TIME STOP: 0953 HR.	TIME STOP: HR
NOTES: Limited Send Sur #1 & 2 Due to undercut			PART TEMP: N/A °F	PART TEMP: N/A °F	PART TEMP: °F
			DATE: 12-12-77	DATE: 12-14-77	DATE:
			° INFORMATION ONLY		
			WELD HEIGHT: 0.0 WELD WIDTH: 9		
			SURFACE ONE TO SURFACE TWO		
9M	HAZ	WELD	HAZ	9M	
1.0	.95	.9	1.0	1.075	

IND. NO.	A	B	ANGLE (DEG.)	SURFACE	BEAM DIRECTION	STATUS	LAM.			LENGTH (IN.)				CRYSTAL DISTANCE (INCHES)				HALF MAXIMUM AMPLITUDE				DAMPS	REMARKS
							MAX AMP % DAC	DEPTH (IN.)	20%	50% OR HMA	100%	A	B	1	2	MINIMUM		MAXIMUM					
																POSITION IN.	POSITION IN.	POSITION IN.	POSITION IN.				
							1	2	1	2	1	2	1	2									
200	360	45	1	2	INT	120	1.95		34	34			1.2	.8		1.0	1.0		1.3	NO			
201	360	45	1	2	INT	316	1.5		34	34			1.0	1.45		.8	1.65		1.2	NO	NEAR SH OF CRYSTAL		
202	360	45	1	2	INT	120	2.0		34	34			1.7							Yes	None Subject		
203	360	45	2	1	INT	60	2.1		34			20								Yes	Interfered		

A.II-25

REVIEWED BY: Charles E. Thompson	LEVEL: II	DATE REVIEWED: 1-5-78	FIGURE NO.: 4.4.269.6
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CALIBRATION SHEET

BASCOC' - COCK  
DAW CONSTR CO. PART

540353

*Handwritten initials*

DATE: 12-12-77

TIME: 1015 HR

CUSTOMER: DUKE POWER MCGUIRE UNIT #1  
 EXAMINER: C. MEREDITH  
 EXAMINER: J. JOHNSON  
 CONTRACT NO.: 192-066-006  
 COMPONENT: PIPING  
 LEVEL: II  
 LEVEL: I

INSTRUMENT: 12033  
 LINEARITY CHECK:  YES  NO  
 REJECT:  OFF  DB  
 MAT'L. CAL.: 460  
 DELAY: 168  
 PULSE ENERGY: 116A  
 COARSE GAIN IN DB: 20  
 FINE GAIN IN DB: 22  
 FINE GAIN: N/A %  
 SCREEN RANGE: 250 ft  
 SCREEN DEPTH: 5.0 IN.  
 T&R } OPERATION  
 NORMAL }  
 FREQUENCY: N/A MHZ  
 NORMAL } DISPLAY  
 RF }  
 REP. RATE: N/A  
 ZERO CONTROL: N/A  
 RESOLUTION: MIDDLE

CALIBRATION BLOCK  
 ID# 50201  
 LENGTH 3.0 IN.  
 OD 10.83 IN.  
 THICKNESS 1.02 IN.  
 CRYSTAL TYPE 3235B  
 FREQ. 2.25 MHZ  
 SIZE 4.0 IN.  
 ACTUAL 4.4

SYSTEM CALIBRATION  
 ANGLE 45° 0' NODE Full  
 REFLECTOR AMPLITUDE % OF FULL SCREEN SCREEN READING IN INCHES  
 1 1/8 NODE 80 % .15 IN.  
 2 1/8 NODE 55 % .40 IN.  
 3 1/8 NODE 80 % .75 IN.  
 5 1/8 NODE 40 % 1.35 IN.  
 6 1/8 NODE 30 % 1.60 IN.  
 7 1/8 NODE 20 % 1.80 IN.  
 4 1/8 NOTCH 30 % 2.20 IN.  
 OPPOSITE NOTCH  
 BKR CB\*  
 BKR P\*

CALIBRATION BLOCK SIMULATOR  
 SERIAL NO. R100 SCREEN RANGE 5.0 IN.  
 SIGNAL AMP 65 % SCREEN READING 1.5 IN.  
 COURSE GAIN DB 20 FINE GAIN DB 6  
 SEARCH UNIT CABLE TYPE MICRODOT LENGTH 6'  
 CAL. BLOCK TEMP. N/A °F  
 CAL. BLOCK SIMULATOR TEMP. N/A °F  
 (REQUIRED SUMMER 73 FOR VESSELS REQUIRED WINTER 75 FOR PIPING)  
 FIGURE NO(S). EXAMINED  
 4.4, 269.2 → X.3, 21.1  
 4.4, 269.1 → X.3, 21.1  
 4.4, 269.6 → X.3, 21.1

CALIBRATION CONFIRMATION

TIME	BLOCK SIM.	BACK REFL.	1/8 NODE	2/8 NODE	3/8 NODE	INITIALS	AMPLITUDE % OF FULL SCREEN	SCREEN READING IN INCHES	ANGLE	NODE	SEARCH UNIT CABLE TYPE	LENGTH	CAL. BLOCK TEMP. °F	CAL. BLOCK SIMULATOR TEMP. °F	FIGURE NO(S). EXAMINED	REQUIRED SUMMER 73 FOR VESSELS	REQUIRED WINTER 75 FOR PIPING
1245	65%	1.5	80%	55%	40%	J.J.	80%	.15	45°	0'	MICRODOT	6'	N/A	N/A	4.4, 269.2	73	75
1512	65%	1.5	80%	55%	40%	J.J.	80%	.15	45°	0'	MICRODOT	6'	N/A	N/A	4.4, 269.1	73	75
1525	65%	1.5	80%	55%	40%	J.J.	80%	.15	45°	0'	MICRODOT	6'	N/A	N/A	4.4, 269.6	73	75



CALIBRATION SHEET

BAGCOX  
B&W CON. CO. COMPANY

DATE: 12-15-77

TIME: 1040 HR

SHEET NO.: 5610405

CUSTOMER: DUKE POWER MCGUIRE UNIT #1  
 CONTRACT NO.: 192-066-006  
 COMPONENT: PIPING  
 EXAMINER: C. MEREDITH  
 ID#: 17818  
 LEVEL: F  
 EXAMINER: J. JOHNSON  
 ID#: J 5085  
 LEVEL: F

INSTRUMENT  
 ID#: 12016  
 LINEARITY CHECK  YES  NO  
 REJECT:  F  R  
 MAT'L. CAL.: 700  
 DELAY: 630  
 PULSE ENERGY: 7.9K  
 COARSE GAIN IN DB: 20  
 FINE GAIN IN DB: 6  
 FINE GAIN: N/A  
 SCREEN RANGE: 2.5 IN.  
 SCREEN DEPTH: 2.5 IN.  
 T&R } OPERATION  
 NORMAL }  
 FREQUENCY: N/A MHZ  
 NORMAL } DISPLAY  
 RF }  
 REP. RATE: N/A  
 ZERO CONTROL: N/A  
 RESOLUTION: N/A

CALIBRATION BLOCK  
 ID#: 50201  
 LENGTH: 8.0 IN.  
 OD: 16.83 IN.  
 THICKNESS: 1.03 IN.  
 CRYSTAL  
 ID#: 32144  
 TYPE: K1  
 FREQ.: 7.35 MHZ  
 SIZE: 12.8 IN.  
 ACTUAL: 6.0 IN.

SYSTEM CALIBRATION  
 ANGLE: 0° NODE: FULL

SEARCH UNIT CABLE  
 TYPE: ATTACHED LENGTH: 6'

CAL. BLOCK TEMP. N/A °F  
 CAL. BLOCK SIMULATOR TEMP. N/A °F  
 (REQUIRED SUMMER 73 FOR VESSELS  
 REQUIRED WINTER 75 FOR PIPING)

REFLECTOR	AMPLITUDE % OF FULL SCREEN	SCREEN READING IN INCHES
1 /B NODE	107.00%	.725 IN.
2 /B NODE	80%	.475 IN.
3 /B NODE	107.00%	.750 IN.
/B NODE	%	IN.
/B NODE	%	IN.
/B NODE	%	IN.
TOP NOTCH	%	IN.
OPPOSITE NOTCH	%	IN.
BKR CB*	%	IN.
BKR P*	%	IN.

FIGURE NOISY - EXAMINED  
 4.1, 325.4 → X.3.19.1  
 4.4, 325.6 → X.3.20.1  
 4.4, 325.8  
 4.4, 326.2  
 4.4, 341.8 → X.3.18.1

CALIBRATION CONFIRMATION

TIME	10.55 HRS	11.25 HRS	13.15 HRS	13.24 HRS	HRS
BLOCK SIM.	70% 0.7 IN.	70% 0.7 IN.	70% 0.7 IN.	70% 0.7 IN.	IN.
BACK REFL.	% IN.	% IN.	% IN.	% IN.	IN.
1 /B NODE	% IN.	% IN.	60% 225 IN.	60% 225 IN.	IN.
2 /B NODE	% IN.	% IN.	80% 225 IN.	80% 225 IN.	IN.
3 /B NODE	% IN.	% IN.	60% 225 IN.	60% 225 IN.	IN.
INITIALS	C.M.	C.M.	C.M.	C.M.	

REVIEWED BY: Charles E. Anderson  
 DATE REVIEWED: 1-5-78

CALIBRATION SHEET

BABCOCK & WILCOX  
B&W CONSTRUCTION COMPANY

SHEET NO.: 6610466

TIME: 1:40 HR

DATE: 12-16-77

CUSTOMER: DUKE POWER MCGUIRE UNIT #1  
 CONTRACT NO.: 192-066-006  
 COMPONENT: PIPING  
 EXAMINER: C. MEROITH  
 ID#: 117818  
 LEVEL: II  
 EXAMINER: J. JOHNSON  
 ID#: J5085  
 LEVEL: I

INSTRUMENT  
 ID#: 12016  
 LINEARITY CHECK: OYES [ ] NO [ ]  
 REJECT: OFF  
 MAT'L. CAL.: 700  
 DELAY: 630  
 PULSE ENERGY: T3R  
 COARSE GAIN IN DB: 20  
 FINE GAIN IN DB: 6  
 FINE GAIN: N/A  
 SCREEN RANGE: 2.5  
 SCREEN DEPTH: 2.5  
 TAR } OPERATION  
 NORMAL }  
 FREQUENCY: 14A MHz  
 NORMAL } DISPLAY  
 RF }  
 REP. RATE: 14A  
 ZERO CONTROL: 4A  
 RESOLUTION: 14A

CALIBRATION BLOCK  
 ID#: 20207  
 LENGTH: 8.0 IN.  
 OD: 12.53 IN.  
 THICKNESS: 1.02 IN.  
 TYPE: 6.51  
 FREQ: 2.25 MHz  
 SIZE: 12.8  
 ACTUAL: 0

CRYSTAL  
 ID#: 32124

SYSTEM CALIBRATION  
 ANGLE: 0 ° NODE: HALF

REFLECTOR	AMPLITUDE % OF FULL SCREEN	SCREEN READING IN INCHES
1 /B NODE	76.70 %	.70 IN.
2 /B NODE	80 %	.45 IN.
3 /B NODE	76.50 %	.75 IN.
/B NODE	%	IN.
/B NODE	%	IN.
/B NODE	%	IN.
TOP NOTCH	%	IN.
OPPOSITE NOTCH	%	IN.
BKR CB*	%	IN.
BKR CB-24	70 %	1.0 IN.

CALIBRATION BLOCK SIMULATOR  
 SERIAL NO. R113 SCREEN RANGE 2.5 IN.  
 SIGNAL AMP 70 % SCREEN READING 0.7 IN.  
 COURSE GAIN D9 20 FINE GAIN DB 6

SEARCH UNIT CABLE  
 TYPE ATTACHED LENGTH 6'

CAL. BLOCK TEMP. N/A F°  
 CAL. BLOCK SIMULATOR TEMP. 44A F°  
 (REQUIRED SUMMER 73 FOR VESSELS  
 REQUIRED WINTER 75 FOR PIPING)

FIGURE NO(S). EXAMINED  
 4.4.453.6 → X.3.16.1  
 4.4.453.4  
 4.4.453.2

CALIBRATION CONFIRMATION

TIME	15:20 HRS		HRS		HRS		HRS	
	BLOCK SIM.	BACK REFL.	1 /B NODE	2 /B NODE	3 /B NODE	INITIALS	%	IN.
	%	%	70 %	80 %	50 %	JJA	%	IN.
	%	%	70 %	80 %	50 %	JJA	%	IN.
	%	%	70 %	80 %	50 %	JJA	%	IN.
	%	%	70 %	80 %	50 %	JJA	%	IN.
	%	%	70 %	80 %	50 %	JJA	%	IN.

REVIEWED BY: Charles E. Thompson  
 DATE: 12-16-77





SHEET NO.: 6610492 TIME: 0845 HR DATE: 12-19-77

CUSTOMER: DUKE POWER MCGUIRE UNIT #1 CONTRACT NO.: 192-066-006 COMPONENT: PIPING

EXAMINER: C. MEREDITH ID#: M7818 LEVEL: II

EXAMINER: G. JOHNSON ID#: J5083 LEVEL:

EXAMINER: J. WARRICK ID#: W6055 LEVEL:

INSTRUMENT

ID#: 12033 CALIBRATION BLOCK ID#: 50204 CRYSTAL ID#: 32358

LINEARITY CHECK  YES  NO TYPE: AERO

REJECT: OFF LENGTH: 8.0 IN. FREQ.: 2.25 MHZ

MAT'L. CAL.: 418 THICKNESS: 1.02 IN. ACTUAL: 1.44 IN.

DELAY: 154

PULSE ENERGY: HIGH

COARSE GAIN IN DB: 40

FINE GAIN IN DB: 40

FINE GAIN: N/A

SCREEN RANGE: 250 mV

SCREEN DEPTH: 5.0 IN.

T&R OPERATION

NORMAL

FREQUENCY: N/A MHZ

NORMAL  DISPLAY

RF  N/A

REP. RATE: N/A

ZERO CONTROL: N/A

RESOLUTION: 0.5 IN

A } -DGC OFF

B } -GATE OFF

C } -ECHO START

SYSTEM CALIBRATION

ANGLE 45 ° NODE FULL

REFLECTOR	AMPLITUDE % OF FULL SCREEN	SCREEN READING IN INCHES
1 / 8 NODE	80 %	.15
2 / 8 NODE	65 %	.40
3 / 8 NODE	80 %	.75
5 / 8 NODE	35 %	1.35
6 / 8 NODE	25 %	1.60
7 / 8 NODE	30 %	1.80
OPPOSITE NOTCH	30 %	2.20
BKR CB*	%	IN.
BKR P*	%	IN.

SEARCH UNIT CABLE

TYPE MICRODOT LENGTH 6'

CAL. BLOCK TEMP. N/A °F

CAL. BLOCK SIMULATOR TEMP. N/A °F

REQUIRED SUMMER 73 FOR VESSELS

REQUIRED WINTER 75 FOR PIPING

FIGURE NO(S). EXAMINED

4.4.453.2

4.4.453.4

4.4.453.6 → X.3.16.1

CALIBRATION CONFIRMATION

TIME	BLOCK SIM.	BACK REFL.	1 / 8 NODE	2 / 8 NODE	3 / 8 NODE	INITIALS
0905 HRS	70 %	0.7	%	%	%	CJA
1140 HRS	70 %	0.7	%	%	%	CJA
1430 HRS	70 %	0.7	%	%	%	CJA
1450 HRS	%	IN.	%	%	%	CJA
			80 %	15	40	
			65 %	75	80	
			80 %	75	75	

REVIEWED BY: Charles E. Thompson LEVEL II

BKR "B" (BACK REFLECTION FROM CAL. BLOCK) \* BKR P (BACK REFLECTION FROM PART)

DATE REVIEWED 1-5-78

CALIBRATION SHEET

BABCOCK & COX  
BAW CONSTRUCTION COMPANY

*Bob*

DATE: 12-14-77

1 E: 0830 HR

SHEET NO.: 6610300

CUSTOMER: DUKE POWER MCGUIRE UNIT #1		CONTRACT NO.: 192-066-006	
EXAMINER: C. MEREDITH	ID#: M7818	LEVEL: II	COMPONENT: PIPING
EXAMINER: ROBERT J. JOHNSON	ID#: J5095	LEVEL: I	COUPLANT: HAMKLEER
CALIBRATION BLOCK ID# 50104 LENGTH 8.0 IN. OD 10.83 IN. THICKNESS 1.03 IN.		SERIAL NO. R103 SIGNAL AMP 70 % COURSE GAIN D9 40 FINE GAIN DB 12	
INSTRUMENT ID#: 12033 LINEARITY CHECK <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO REJECT: OFF MAT'L. CAL.: 407 DELAY: 167 PULSE ENERGY: HIGH COARSE GAIN IN DB: 40 FINE GAIN IN DB: 12 FINE GAIN: N/A % SCREEN RANGE: 50 mm SCREEN DEPTH: 2.5 IN.		CALIBRATION BLOCK SIMULATOR SEARCH UNIT CABLE TYPE ATTACHED LENGTH 6'	
SYSTEM CALIBRATION ANGLE 0° NODE FULL		CAL. BLOCK TEMP. N/A °F CAL. BLOCK SIMULATOR TEMP. N/A °F (REQUIRED SUMMER 73 FOR VESSELS REQUIRED WINTER 75 FOR PIPING)	
REFLECTOR	AMPLITUDE % OF FULL SCREEN	SCREEN READING IN INCHES	FIGURE NO(S). EXAMINED
1 /B NODE	60 %	.225 IN.	4.4, 391.6 → X.3.17.1
2 /B NODE	80 %	.45 IN.	4.4, 391.4 → X.3.22.1
3 /B NODE	50 %	.75 IN.	4.4, 269.6 → X.3.21.1
/B NODE	%	IN.	4.4, 269.9 → X.3.21.1
/B NODE	%	IN.	4.4, 269.2
TOP NOTCH	%	IN.	
OPPOSITE NOTCH	%	IN.	
BKR 90ALC	80 %	1.05 IN.	
BKR 1348	80 %	1.0 IN.	

CALIBRATION CONFIRMATION

TIME	1140 HRS	1500 HRS	HRS	HRS	HRS	HRS	HRS
BLOCK SIM.	70 %	0.7 IN	%	IN.	%	IN.	%
BACK REFL.	%	IN	%	IN.	%	IN.	%
1 /B NODE	%	IN	60 %	.225 IN	%	IN.	%
2 /B NODE	%	IN	80 %	.45 IN	%	IN.	%
3 /B NODE	%	IN	50 %	.75 IN	%	IN.	%
INITIALS	C. M.		R. J.		A. L.		

REVIEWED BY: Charles E. Johnson  
 DATE OF REVIEW: 1-5-78  
 \* BKR CB (BACK REFLECTION FROM CAL. BLOCK) \* BKR P (BACK REFLECTION FROM PART)

CALIBR. ON SHEET

BABCOCK WILCOX  
BAW CONSTR ION COMPANY  
DATE: 9-8-78

SHEET NO.: 6610751

TIME: 1205 HR

CUSTOMER: DUKE POWER MCGUIRE UNIT #1  
EXAMINER: A. GLADNEY  
EXAMINER: M. HACKER / R. PATTERSON  
CONTRACT NO.: 192-066-013  
LEVEL: II  
LEVEL: II/I

COMPONENT: PIPING  
COUPLANT: HAMIKLEE &  
COUPLANT ID#: 62009  
SERIAL NO. R114 SCREEN RANGE 12.5 IN.  
SIGNAL AMP 62 % SCREEN READING 1 IN.  
COURSE GAIN DB 20 FINE GAIN DB 14

CALIBRATION BLOCK SIMULATOR  
CALIBR. BLOCK ID# 5041  
TYPE TQC  
FREQ. 2.25 MHZ  
SIZE 1.5 IN.  
ACTUAL 0

SEARCH UNIT CABLE LENGTH 6'  
TYPE ATTACHED  
CAL. BLOCK TEMP. N/A F0 V/A F0  
CAL. BLOCK SIMULATOR TEMP. V/A F0  
(REQUIRED SUMMER 73 FOR VESSELS  
REQUIRED WINTER 75 FOR PIPING)

REFLECTOR	AMPLITUDE % OF FULL SCREEN	SCREEN READING IN INCHES
1 /B NODE	50 %	.2 IN.
2 /B NODE	80 %	.4 IN.
3 /B NODE	65 %	.6 IN.
/B NODE	%	IN.
/B NODE	%	IN.
/B NODE	%	IN.
TOP NOTCH	%	IN.
OPPOSITE NOTCH	%	IN.
BKR CB*	%	IN.
BKR P*	75 %	.85 IN.

FIGURE NOISI. EXAMINED

X.3.11.1  
X.3.12.1  
X.3.13.1  
X.3.14.1

SYSTEM CALIBRATION  
ANGLE 0 NODE 1/2

CALIBRATION CONFIRMATION

TIME	BLOCK S.M.	BACK REF.	1 /B NODE	2 /B NODE	3 /B NODE	INITIALS	HRS	IN.	%	HRS	IN.	%	HRS	IN.	%	HRS	IN.	%
1545			50	80	65	MH												

INSTRUM. NT  
ID#: 12036

LINEARITY CHECK  YES  NO

REJECT: OFF DB

MAT'L. CAL.: 532

DELAY: 260

PULSE ENERGY: 70P

COARSE GAIN IN DB: 20

FINE GAIN IN DB: 14

FINE GAIN: 40 %

SCREEN RANGE: .5

SCREEN DEPTH: 2.5 IN.

T&R } OPERATION  
 NORMAL }  
FREQUENCY: \_\_\_\_\_ MHZ

NORMAL } DISPLAY  
 RF }  
REP. RATE: \_\_\_\_\_

ZERO CONTROL: 0

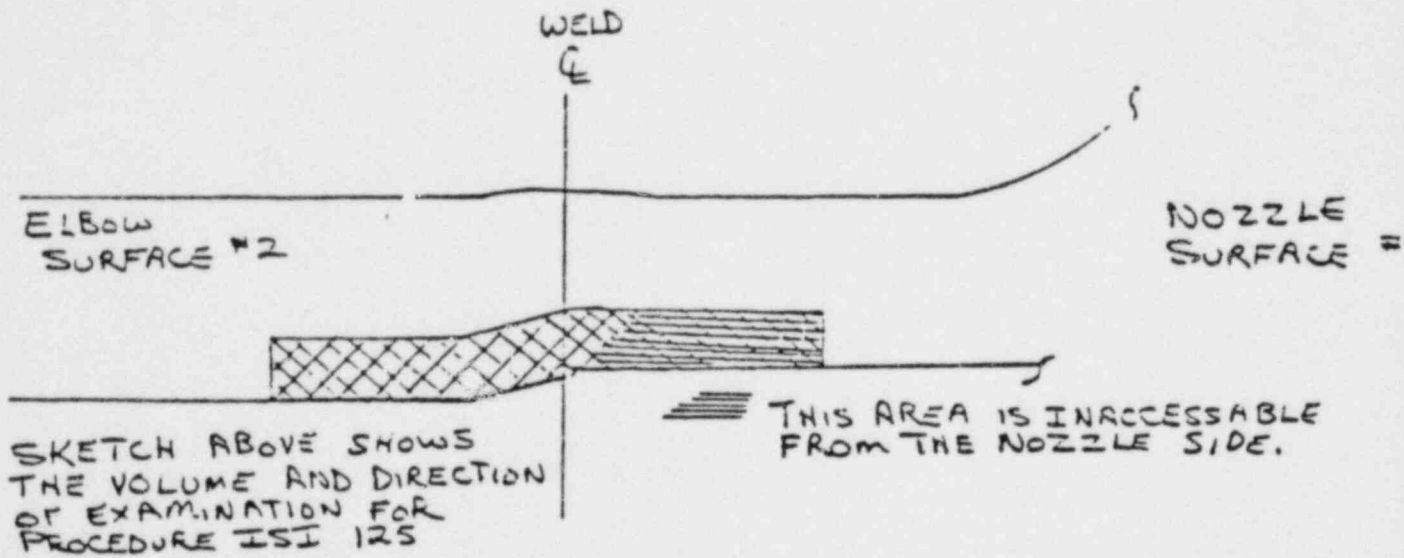
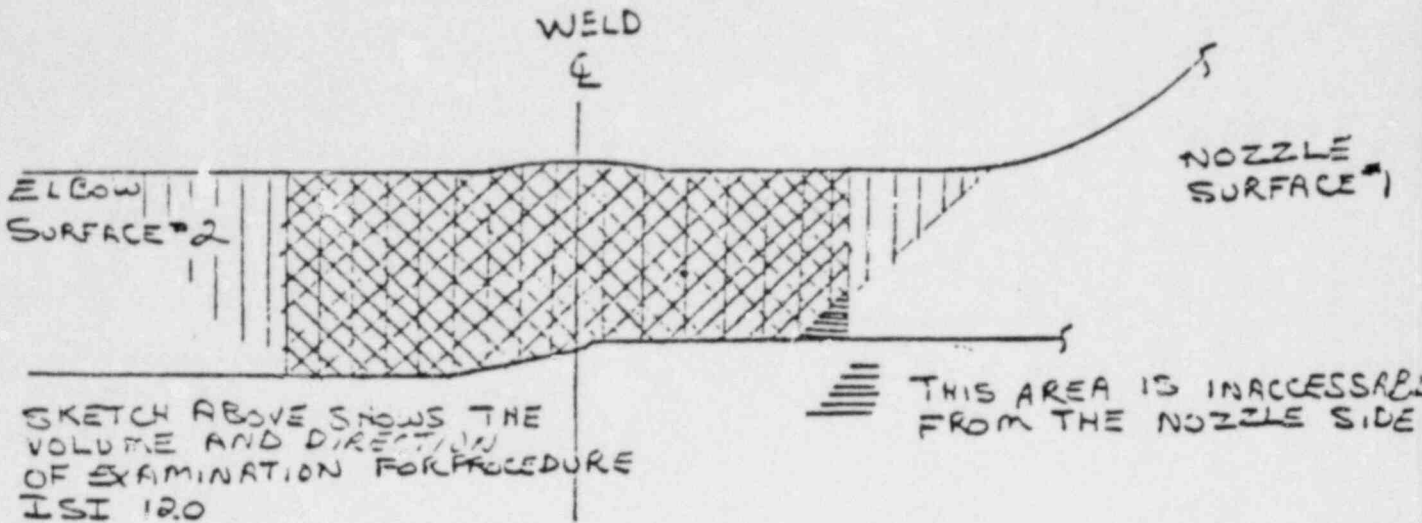
RESOLUTION: \*

A } DGC  
B }  
C }  
A } GATE  
B }  
C }

NORMAL } ECHO  
 FIRST ECHO } START



FIG. NO. X.3.16.1  
X.3.18.1



SKETCH NO. 1

Appendix III - Augmented Inservice Inspection Program

Section I - Listing of Examinations	A. III-2
Section II - NDE Schedule	A. III-5
Section III - Pressure Test Schedule	A. III-6
Drawing Location of Break Points	A. III-7 - A. III-10
Isometric Drawing	A. III-11

## APPENDIX III

## Section I: Listing of Examinations

Fig. No.	Break No.	Description	Ref. Dwg.	NDE	Procedure	Mat.	Thick (In.)	Diameter (In.)	Cal. Block
X.3.15	152	Safety Inj Accum 1A to RC Loop 1A Pipe to Elbow Duke Shop Weld INC 72-1	MCFI-INC-47	PT	ISI 240	TYP 316 SS	1.0	10	
X.3.15.1	152	Safety Inj Accum 1A to RC Loop 1A Pipe to Elbow Duke Shop Weld INC 72-1	MCFI-INC-47	UT	ISI 120,125	TYP 316 SS	1.0	10	50209
X.3.16	153	Safety Inj Accum 1A to RC Loop 1A Elbow to Nozzle Field Weld NCIF 107	MCFI-INC-47	PT	ISI 240	TYP 316 SS	1.0	10	
X.3.16.1	153	Safety Inj Accum 1A to RC Loop 1A Elbow to Nozzle Field Weld NCIF 107	MCFI-INC-47	UT	ISI 120,125	TYP 316 SS	1.0	10	50209
X.3.17	75	Safety Inj Accum 1B to RC Loop 1B Pipe to Elbow Duke Shop Weld INC 73-1	MCFI-INC-47	PT	ISI 240	TYP 316 SS	1.0	10	
X.3.17.1	75	Safety Inj Accum 1B to RC Loop 1B Pipe to Elbow Duke Shop Weld INC 73-1	MCFI-INC-47	UT	ISI 120,125	TYP 316 SS	1.0	10	50209



## APPENDIX III

## Section I: Listing of Examinations (Cont'd)

Fig. No.	Break No.	Description	Ref. Dwg.	NDE	Procedure	Mat.	Thick (In.)	Diameter (In.)	Cal. Block
X.3.18	76	Safety Inj Accum 1B to RC Loop 1B Elbow to Nozzle Field Weld NCIF 109	MCFI-INC-47	PT	ISI 240	TYP 316 SS	1.0	10	
X.3.18.1	76	Safety Inj Accum 1B to RC Loop 1B Elbow to Nozzle Field Weld NCIF 109	MCFI-INC-47	UT	ISI 120,125	TYP 316 SS	1.0	10	50209
X.3.19	32	Safety Inj Accum 1C to RC Loop 1C Pipe to Elbow Duke Shop Weld INC 102-1	MCFI-INC-47	PT	ISI 240	TYP 316 SS	1.0	10	
X.3.19.1	32	Safety Inj Accum 1C to RC Loop 1C Pipe to Elbow Duke Shop Weld INC 102-1	MCFI-INC-47	UT	ISI 120,125	TYP 316 SS	1.0	10	50209
X.3.20	33	Safety Inj Accum 1C to RC Loop 1C Pipe to Elbow Duke Shop Weld INC 102-2	MCFI-INC-47	PT	ISI 240	TYP 316 SS	1.0	10	
X.3.20.1	33	Safety Inj Accum 1C to RC Loop 1C Pipe to Elbow Duke Shop Weld INC 102-2	MCFI-INC-47	UT	ISI 120,125	TYP 306 SS	1.0	10	50209

APPENDIX III

Section I: Listing of Examinations (Cont'd)

Fig. No.	Break No.	Description	Ref. Dwg.	NDE	Procedure	Mat.	Thick (In.)	Diameter (In.)	Cal. Block
X.3.21	105	Safety Inj Accum 1D to RC Loop 1D Pipe to Elbow Duke Shop Weld INC 128-1	MCFI-INC-47	PT	ISI 240	TYP 316 SS	1.0	10	
X.3.21.1	105	Safety Inj Accum 1D to RC Loop 1D Pipe to Elbow Duke Shop Weld INC 128-1	MCFI-INC-47	UT	ISI 120,125	TYP 316 SS	1.0	10	50205
X.3.22	106	Safety Inj Accum 1D to RC Loop 1D Pipe to Elbow Duke Shop Weld INC 128-2	MCFI-INC-47	PT	ISI 240	TYP 316 SS	1.0	10	
X.3.22.1	106	Safety Inj Accum 1D to RC Loop 1D Pipe to Elbow Duke Shop Weld INC 128-2	MCFI-INC-47	UT	ISI 120,125	TYP 316 SS	1.0	10	50209

APPENDIX III

Section II: NDE Schedule

Fig. No.	Break No.	Schedule 10-Year Interval	Examination Conditions
X.3.15	152	Per ASME Section II	System Pressure: 450 psig
X.3.15.1	152		System Temperature: 150°F
X.3.16	153	same	same
X.3.16.1	153		
X.3.17	75	same	same
X.3.17.1	75		
X.3.18	76	same	same
X.3.18.1	76		
X.3.19	32	same	same
X.3.19.1	32		
X.3.20	33	same	same
X.3.20.1	33		
X.3.21	105	same	same
X.3.21.1	105		
X.3.22	106	same	same
X.3.22.1	106		

APPENDIX III

Section III: Pressure Test Schedule

System	Break No.	Pressure Test
Reactor	152	Class A System - Reactor Coolant System will be pressure tested at the conclusion of each outage in accordance with Station Technical Specification. System will be hydrostatically tested in accordance with ASME Section XI once during the first Inspection Interval.
Coolant	153	
	75	
	76	
	32	
	33	
	105	
	106	













Appendix IV  
Calculated Allowable Crack  
Sizes Incorporating a "Net Section Collapse"  
Criterion

A1. Preface

The objective of this Appendix is to calculate allowable longitudinal and circumferential through wall crack sizes incorporating a "net section collapse" criteria for those lines where augmented inservice inspection is proposed. Allowable crack size is defined as that length of through wall crack which can be present prior to complete rupture of the process pipe. The basis for applying a "net section collapse" approach to this problem is derived from experiments conducted by the Electric Power Research Institute (Reference 1).

## A2. Introduction and Background Discussion

Austenitic stainless steel has high ductility and fracture toughness, consequently, a large service strength beyond the yield point. Because of these inherent material properties and based on tests conducted by EPRI, 2 conclusions regarding cracks in an austenitic stainless steel material are evident:

- 1) Crack growth will occur in the presence of large scale plastic deformations.
- 2) It would be overly conservative to use net section yield i.e., an elastic stress distribution, as a failure criterion. Hence, net section collapse is applicable as a failure criterion.

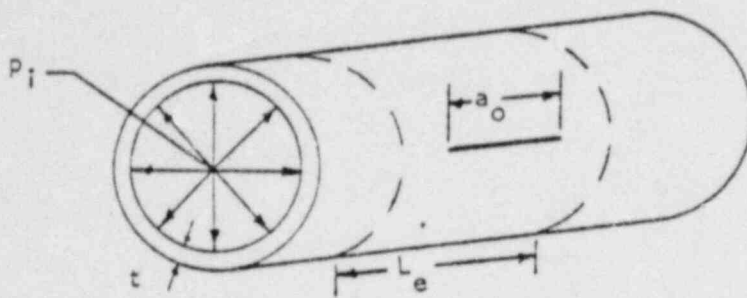
Research conducted by EPRI and presented in Reference 1 also indicate the following significant factors regarding the failure process:

- A) Because of crack tip blunting preceding crack growth, the applied stress at failure is independent of flaw sharpness.
- B) Flaw area (net) is more significant than flaw shape in determining the applied stress at failure.
- C) The presence of a weld near a flaw and the sensitization of the material in the heat affected zone surrounding a flaw do not significantly affect the applied stress at failure.

In the application of a net section collapse criterion, it is assumed that due to the large amount of plasticity, the stress distribution in the net section is uniform. Crack growth and fracture are governed by this stress distribution reaching a critical, temperature dependent, value. The research conducted by EPRI indicate that this value is well in excess of the yield point of the material. The critical value of this stress distribution will conservatively, be assumed as the yield stress of the material at the operating temperature. Equations for force and moment equilibrium can then be developed from which a net section area is derived. Knowing the net section area, the allowable crack size can be determined.

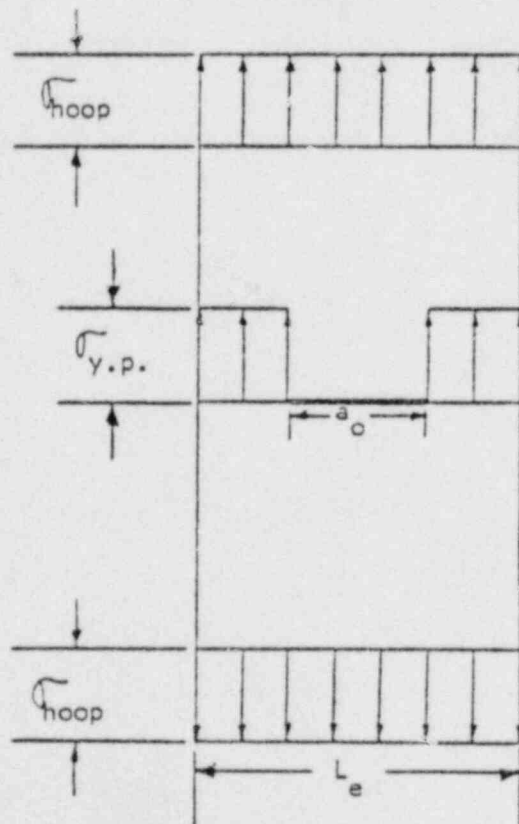
A3. Application of the Net Section Collapse Criterion to Longitudinal Through Wall Cracks

Consider a section of pipe with a through wall longitudinal crack:



- $a_o$  = Allowable crack length (in)
- $P_i$  = Hydrostatic pressure (psi)
- $t$  = Pipe wall thickness (in)
- $L_e$  = Effective length of pipe (in)

Assume that only the hoop stress due to internal pressure and the force associated with it will cause crack propagation. The assumed stress distribution across a length of pipe,  $L_e$ , is shown below:



- $\sigma_{hoop}$  = Hoop stress (psi)
- $\sigma_{y.p.}$  = Yield stress at temperature (psi)

Considering the equilibrium of forces:

$$(\sigma_{y.p.}) (A_{net}) = (\sigma_{hoop}) (L_e) (t)$$

$$\therefore A_{net} = \frac{(\sigma_{hoop}) (L_e) (t)}{(\sigma_{y.p.})} = t (L_e - a_o) \quad (\text{Equation 1})$$

$$\sigma_{hoop} = \frac{p_i (D-t)}{2t}$$

where:  $p_i$  = Hydrostatic pressure (psi)

$D$  = Pipe outside diameter (in)

$t$  = Pipe wall thickness (in)

$A_{net}$  = Net area (in<sup>2</sup>)

Substituting the expression for  $\sigma_{hoop}$  into equation 1 yields:

$$a_o = L_e - \frac{p_i (D-t) (L_e)}{2t (\sigma_{y.p.})}$$

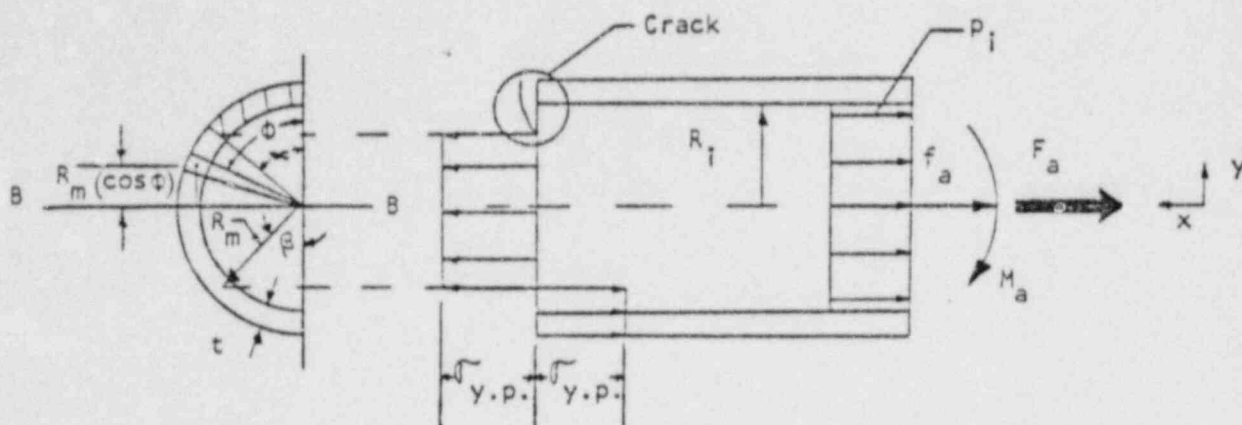

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A4. Application of the Net Section Collapse Criterion to Circumferential Through Wall Cracks

Consider the assumed stress distribution on a section of pipe with a circumferential through wall crack:



- Where:
- $p_i$  = Hydrostatic pressure (psi)
  - $f_a$  = Axial force due to thermal + seismic forces (lbs)
  - $F_a$  = Total applied axial force =  $(f_a + f_{press})/2$  (lbs)
  - $f_{press}$  = Axial force due to hydrostatic pressure (lbs)
  - $M_a$  = Maximum allowable moment (in-lbs)
  - $R_i$  = Inner radius (in)
  - $t$  = Pipe wall thickness (in)
  - $\alpha$  = 1/2 total allowable crack size (angular)
  - $\sigma_{y.p.}$  = Yield stress at temperature (psi)
  - $R_m$  = Mean radius (in)

Equation for force equilibrium:

$$(\pi - \alpha - \beta) (R_m) (t) (\sigma_{y.p.}) - (\beta) (R_m) (t) (\sigma_{y.p.}) = F_a$$

$$\therefore \beta = \frac{\pi - \alpha}{2} - \frac{F_a}{2 (\sigma_{y.p.}) (R_m) (t)} \quad (\text{Equation 2})$$

Where  $\beta$  is defined as the point of stress inversion for the net section.

Equation for moment equilibrium: (Moments taken about BB)

$$M_a = 2 (\sigma_{y.p.}) (R_m)^2 (t) \left[ \int_{\alpha}^{\pi-\beta} (\cos \phi) d\phi + \int_0^{\beta} (\cos \phi) d\phi \right]$$
$$M_a = 2 (\sigma_{y.p.}) (R_m)^2 (t) (2 \sin \beta - \sin \alpha) \quad (\text{Equation 3})$$



A5. CalculationsA5.1 Accumulator Injection Line

Since all the locations where augmented inservice inspected is proposed on the accumulator injection lines are identical with respect to pipe size, pipe material, and design operating conditions, the calculated longitudinal crack size will be identical at all the locations. The calculated circumferential crack size will vary only because the applied axial forces and bending moments vary. Node 105 (reference Figure 11.5.4), which has the largest applied axial forces and bending moments, will be used to calculate the smallest circumferential crack size.

A5.1.1 Longitudinal Cracks

Pipe material: SA-376, TYPE 316

Pipe schedule: SCH-140

O.D. = 10.75 in

I.D. = 8.75 in

t = 1.00 in

P<sub>i</sub> = 2485 psig

T = 650°F

σ<sub>yp</sub> = 18,500 psi

Assume an L<sub>e</sub> of 12 inches:

$$a_0 = L_e - \frac{P_i (D-t) (L_e)}{2t (\sigma_{y.p.})}$$

$$a_0 = 12 - \frac{(10.75 - 1.00) (12) (2485)}{2 (1.00) (18500)}$$

$$a_0 = \underline{\underline{4.09 \text{ in}}}$$

Note: The assumed length of 12 inches for L<sub>e</sub> was based on EPRI flat plate tests utilizing a center-cracked tension panel that was 12 inches wide.

A5.1.2 Circumferential Cracks

$$f_{press} = P_i \times \pi (I.D.)^2 / 4 = 14942 \text{ lbs.}$$

$$f_a = 18868 \text{ lbs.}$$

$$F_a = (f_a + f_{press}) / 2 = 84,599 \text{ lbs.}$$

$$M_a = 711,120 \text{ in-lb.}$$

$$R_m = 4.88 \text{ in.}$$

The applied axial forces and bending moments are a result of detailed stress analysis that considers the effects of gravity, seismic movements, and thermal expansion. The maximum moment is calculated from

$$M_a = [M_y^2 + M_z^2]^{1/2}$$

Simultaneous solutions to equations (2) and (3) yield

$$\alpha = 36^\circ$$

$$a_0 = 2\alpha (O.D.) = \underline{\underline{6.76 \text{ in}}}$$

## APPENDIX V

ANALYSIS OF CONSEQUENCES AND SHUTDOWN METHODS

The following tables describe the consequences of the postulated breaks for which physical protection cannot be provided and discusses the methods for shutting down the plant following the break. Worst case active failure is assumed to occur concurrently with the break.

TABLE V-1

ACCUMULATOR INJECTION LINE BREAKSPROBLEM NI-01

<u>Break Node</u>	<u>Circumferential Target</u>	<u>Longitudinal Target</u>	<u>Active Failure</u>	<u>Consequences</u>	<u>Shutdown Method</u>
152	16" SG Feedwater 2" SG Blowdown 3/4" NM Hot Leg Sample (2) 1" NM SG Sample		Outboard NM cont. isol. vlv.	LOCA plus loss of blowdown and sample lines. Resulting pressure and temperature transients are insufficient to cause containment overpressurization or temperatures above allowable limits. Additional loss of reactor coolant and additional steam release are insignificant due to orificed sample lines. Possible loss of containment integrity. (NM lines)	Emergency Core Cooling System (ECCS) is designed to protect core against consequences of this LOCA.
		4" Pzr Spray 3" Charging		Multiple cold leg LOCA breaks. Total break only approximately 9% of largest double ended cold leg break area.	ECCS designed to protect core against consequences of this LOCA.
		3/4" NM Hot Leg Sample (2) 1" NM SG Sample	Outboard NM cont. isol. vlv.	LOCA plus loss of sample lines. Additional loss of reactor coolant and additional steam release are insignificant due to orificed sample lines. Possible loss of containment integrity.	ECCS designed to protect core against consequences of this LOCA.
153	3/4" NM Hot Leg Sample (2) 1" NM SG Sample			Same as above.	Same as above.

TABLE V-1

ACCUMULATOR INJECTION LINE BREAKSPROBLEM NI-02

<u>Break Node</u>	<u>Circumferential Target</u>	<u>Longitudinal Target</u>	<u>Active Failure</u>	<u>Consequences</u>	<u>Shutdown Method</u>
75		2" Aux Spray 4" Pzr Spray	Any	Multiple cold leg LOCA breaks. Total break area only approximately 8% of maximum doubled ended cold leg break area.	ECCS designed to protect core against consequences of this LOCA.
	3/4" NM Hot Leg Sample (2) 1" NM SG Sample	3/4" NM Hot Leg Sample (2) 1" NM SG Sample	Outboard NM cont. isol. vlv.	LOCA plus loss of sample lines. Additional loss of reactor coolant and additional steam release are insignificant due to orificed sample lines. Possible loss of containment integrity.	ECCS designed to protect core against consequences of this LOCA.
76	Same as longitudinal targets above.		Same as above	Same as above.	Same as above.

TABLE V-1

ACCUMULATOR INJECTION LINE BREAKSPROBLEM NI-03

<u>Break Node</u>	<u>Circumferential Target</u>	<u>Longitudinal Target</u>	<u>Active Failure</u>	<u>Consequences</u>	<u>Shutdown Method</u>
32	16" SG Feedwater 2" SG Blowdown		Any	LOCA plus loss of blowdown line. Resulting pressure and temperature transients are insufficient to cause containment overpressurization or temperatures above allowable limits.	ECCS designed to protect core against consequences of this LOCA.
33		16" SG Feedwtr	Any	Same as above.	Same as above.
		3/4" NM Hot Leg Sample (2) 1" NM SG Sample	Outboard NM cont. isol. vlv.	LOCA plus loss of sample lines. Additional loss of reactor coolant and additional steam release are insignificant due to orificed sample lines. Possible loss of containment integrity.	ECCS designed to protect core against consequences of this LOCA.

TABLE V-1

ACCUMULATOR INJECTION LINE BREAKSPROBLEM MI-04

<u>Break Node</u>	<u>Circumferential Target</u>	<u>Longitudinal Target</u>	<u>Active Failure</u>	<u>Consequences</u>	<u>Shutdown Method</u>
105	16" SG Feedwater 2" SG Blowdown		Any	LOCA plus loss of blowdown line. Resulting pressure and temperature transients are insufficient to cause containment overpressurization or temperatures above allowable limits.	ECCS designed to protect core against the consequences of this LOCA.
106		6" Hot Leg Injection RTD	Any	Simultaneous cold leg and hot leg LOCA breaks. This combination of breaks is less severe than the limiting LOCA analysis in FSAR.	ECCS and Safety Injection System capable of mitigating consequences of these LOCA's.
		16" SG Feedwtr 2" SG Blowdown	Any	Same as circumferential node 105 targets.	Same as circumferential node 105 targets.
		3/4" NM Hot Leg Sample (2) 1" NM SG Sample	Outboard NM cont. isol. vlv.	LOCA plus loss of sample lines. Additional loss of reactor coolant and additional steam release are insignificant due to orificed sample lines. Possible loss of containment integrity.	ECCS designed to protect core against consequences of this LOCA.