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Testing • Engineering • Service • Training
515 Aldo Avenue
Santa Clara, CA 95050
408-980-9333

PROCEDURE COVER SHEET AND QUALIFICATION RECORD

Procedure No. UT-10 Revision No. 11

Procedure Title Ultrasonic Examination of Nuclear Coolant System Piping

LMT, Inc. QA Review and Approval D B MacGill 11-13-82
(Quality Assurance Officer)

Client Approval _____

Authorized Nuclear Inspector Approval _____

Specific Qualification Record

Job Site	Component	Examiners	Date

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TITLE: ULTRASONIC EXAMINATION OF NUCLEAR COOLANT SYSTEM PIPING

I. PURPOSE AND SCOPE

A. Purpose

This procedure sets forth the instructions for ultrasonic examination of full penetration welds and adjacent base metal in piping and fittings with nominal wall thicknesses of 0.2" through 6.0".

B. Scope

1. This procedure is applicable to full penetration circumferential, longitudinal, attachment and branch connection welds in ferritic and austenitic stainless steel materials where successful calibration is achieved .

2. This procedure is applicable when a minimum of 1/2 node metal path examination is utilized.

QUALIFICATION:

Prepared by: T. G. Lambert

Approved for use T G Lambert 11/12/82
DB Mcdill 11-13-82

I. B. 3. This procedure is applicable when remote instrumentation is used.

II. REFERENCES

A. This procedure is in compliance with the applicable portions of the following referenced documents:

1. American Society of Mechanical Engineers Boiler and Pressure Vessel Code;

a) Section V, "Nondestructive Examination, 1977 edition, Summer 1978 addenda;

b) Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components", 1977 edition, addenda through Summer 1978, including Appendix III, "Ultrasonic Examination Method for Class 1 and 2 Piping Systems Made from Ferritic Steels."

2. American Society for Nondestructive Testing;

a) Recommended Practice No. SNT-TC-1A, June 1975, "Personnel Qualification and Certification in Nondestructive Testing."

3. a) LMT Procedure QA-6, "Qualification and Certification of NDE Personnel."

b) LMT Operating and Quality Assurance Manual.

III. DEFINITIONS

None.

IV. RESPONSIBILITY

A. The Technical Manager, LMT, Inc., is responsible for the generation and control of this procedure and shall so indicate by a dated signature on Page 1.

B. The responsible Level III Field Supervisor, LMT, or his designated Level III alternate, LMT, shall qualify the procedure for a particular examination.

V. PROCEDURE QUALIFICATION

The procedure may be qualified for specific examinations, personnel, and equipment by performing and documenting a successful calibration.

VI. PERSONNEL REQUIREMENTS

A. Personnel shall be qualified and certified according to the requirements of ASME XI, SNT-TC-1A, and LMT, Inc. Procedure QA-6, "Qualification and Certification of NDE Personnel."

VI. B. Examiners shall be certified Trainee, Level I, Level II, or Level III, by LMT, in ultrasonic testing. If Level I personnel are used for angle beam scanning, a Level II must be able to view the results on the CRT. Trainees may be used to operate recorders and record data.

C. When using a remote ultrasonic master/slave tester system, examinations shall be controlled by a Level II using the master unit and performed by a Level I using the slave unit.

D. Personnel evaluating ultrasonic data or interpreting strip charts shall be certified a minimum Level II, by LMT, in ultrasonic testing.

E. LMT personnel reviewing examination reports for conformity to the requirements of this procedure shall be certified Level III.

VII. EQUIPMENT AND MATERIAL REQUIREMENTS

A. Ultrasonic testers shall be of the pulse echo type. Instruments shall have an amplitude display linear within 5% of calibrated screen height over 80% of that height; and an attenuator, stepped in increments of 2 dB or less, which is accurate over the range of the test to

VII. A. ±20% of nominal value. Instruments shall have had their internal alignment and calibration verified within 90 days of any implementation of this procedure.

1. A record of calibration shall be available at the jobsite for client audit.

B. The ultrasonic master/slave tester system shall be of the pulse echo type. The master unit shall house the control functions, and the slave unit shall house a scope display, telephone communication, and a transducer connection.

1. Vertical linearity of ±5% of the full screen range over at least 80% of the calibrated screen height shall be required for both the master and slave units.
2. Amplitude control accurate over the useful range of the instrument to ±20% of nominal value shall apply to the master unit.
3. Amplitude controls calibrated in units of 2 dB or less shall apply to the master unit.
4. A record of calibration shall be available at the jobsite for client audit.

VII. C. Connecting cables shall be coaxial, and their length limited to less than that at which significant signal degradation (2 dB) occurs, but shall not exceed 200 feet.

D. Electronic recording equipment, when used, shall be electronically aligned within 180 days of use.

E. Search units shall be certified by the manufacturer, or LMT, as to essential properties, including bandwidth, damping, center frequency within 10% of nominal, and relative gain.

1. Transducers should be selected according to Table 1. Additional search units may be used for evaluation or in unusual circumstances; however, such use shall be documented by an approved Field Change to this procedure as per LMT, Inc. Quality Assurance Procedure QA-5.

Material Thickness	Angle Beam	
	Max. Size	Max Freq.
Up to .5"	3/8"x3/8" PE or P/C	5.0 MHz
Over .5" through 2"	1/2"x1/2" P/C	1.5 MHZ
Over 2"	1"x1" PF or P/C	2.25 MHz

Table 1

VII. E. 2. Angle beam transducer wedges shall provide refracted angles of 45°, ±3°, in the calibration block.

a) Refracted angles shall be determined as follows:

1) Using an IIW or Rompas block, determine the wedge exit point and angle.

2) Position the transducer on the calibration block for maximum response from the far side notch.

3) Measure the distance along the block surface from the side of the notch nearest the transducer to the wedge exit point.

4) Calculate the refracted angle using the following formula:

$\phi = \arctan \frac{h}{t}$, where

ϕ = refracted angle

h = horizontal distance from notch to exit point

t = block thickness

b) Other angles or sizes may be used for evaluation, and when geometric and weld configuration or wall thickness impede effective use of 45°.

VII. E. 3. Search unit contact angle beam wedges shall meet the criterion of Table 2 for coverage of attachment weld root areas, as shown in Figure 1, when the examination is limited to half-node (half-vee path).

Beam Angle	Required Index to Weld Centerline Distance A
45°	.93T
60°	1.6 T
70°	2.47T

Table 2

F. Couplant materials shall be as low as practicable in sulfur and halogen content. Certification shall be provided on a generic basis for each brand of couplant. Analysis for halogens and sulfur shall be made according to ASTM D-129-64 and ASTM D-808-63.

1. Residual halogens and sulfur shall not exceed 1% by weight.

2. LMT Gel and Ultra-Gel are satisfactory couplants.

G. Calibration blocks shall be of the form as described in ASME XI (1977), Appendix III, Summer 1978 addenda. Calibration blocks shall be of the same nominal size, thickness, material, and surface finish as the area of

VII. (F) major interest in the material to be examined (Fig-
(G) ure 2).

1. Calibration notches shall be one inch long, not more than one-quarter inch wide, and a depth selected according to Table 3.

Nominal Pipe Wall Thickness, t, in.	Notch Depth (d) in.	Tolerance
Less Than 0.312	.05t	+10% -20%
0.312 to 6.0	.05t	+10% -20%

Table 3

2. Calibration holes for use in half-node examinations only shall be drilled perpendicular to the ends of the block to the centerline of the pipe, one and one- half inches deep. The diameters and location shall conform to Table 4.

VII. F. 2.

Pipe Wall (T)	Hole Ø	Hole Location
1 in. or Less	3/32"	1/2T
over 1 in. through 2 in.	1/8"	1/4T and 3/4T
over 2 in. through 4 in.	3/16"	1/4T, 1/2T and 3/4T
over 4 in. through 6 in.	1/4"	1/4T, 1/2T and 3/4T

Table 4

3. Other reflectors may be included in block designs for informational purposes.

VIII. PREPARATION

A. Documentation

1. The following preliminary documentation requirements shall be reviewed by the examin r with the client for review before beginning any examination program:

a) Procedure Qualification

b) Calibration Sheets

c) Inspection Reports

d) Material and Equipment Certifications

VIII. A. 1. e) Personnel Certifications

f) NRC Form 4 (Operating Nuclear Plants Only)

g) NRC Form 5 (Operating Nuclear Plants Only)

h) Status Indicators (Hold Tags)

i) Radiation Work Permits (when applicable)

B. Physical Preparation

1. The following physical preparation requirements shall be reviewed by the examiner with the client before specific examinations are performed:

a) Insulation removal

b) OSHA requirements (ladders, lighting, fresh air, scaffolding, etc.)

c) Cleanup requirements

d) Safety precautions (other work in area, etc.)

C. Surface Preparation

1. Responsibility

It shall be the responsibility of the Level II examiner to determine the need for surface preparation.

2. Surface shall be sufficiently smooth and clean so that a meaningful examination may be performed.

3. Welds shall be identified and all required marking procedures completed before performing any examinations.

IX. LIMITATIONS

1. This procedure is based on ASME Nuclear Requirements; it may not be applicable to military, API, or AWS requirements without modification.
2. The procedure is limited to carbon and austenitic steels unless specifically qualified for other materials.

X. CALIBRATION

A. Test calibration is performed on a complete system. Any change in the ultrasonic instrument, transducer cable, or transducer requires test recalibration. A change in qualified personnel, recording instrumentation, or recorder connection cable requires a calibration check; however, instrument alignment verification need not be made with the transducer used for testing.

B. Instrument alignment verification for screen height and amplitude control linearity shall be performed before the initial examination in any given series and repeated on a daily basis.

1. Instrument Linearity Verification

a) Position the angle beam search unit on a calibration block to obtain two echoes with a 2:1 amplitude ratio.

X. B. 1. b) Set the larger echo to 80% of calibrated screen-height.

c) Vary the amplitude of the larger echo from 100% to 20% of calibrated screen height in 10% increments.

d) Note that at each increment the smaller echo remains 1/2 the larger within a tolerance band of ±5% of full screen height.

e) Record successful performance of the verification on a Calibration Report form (Figure 3).

2. Attenuator Linearity Verification

a) Position the search unit to obtain an 80% of full scale echo on the calibrated screen.

b) Adjust the sensitivity control to decrease the system gain by 6 dB and 12 dB. Compare the response with Table 5 and determine its acceptability. Estimate system response to ±1% of calibrate full scale.

c) Position the search unit to obtain a 40% of full scale echo on the calibrated screen.

d) Adjust the sensitivity control to increase the system gain by 6 dB. Compare the response with Table 5 to determine its acceptability. Esti-

X. B. 2. d) mate system response to ±1% of calibrated full screen.

e) Position the search unit to obtain a 20% of full scale echo on the calibrated screen.

f) Adjust the sensitivity control to increase the system gain by 12 dB. Compare the response with Table 5 to determine its acceptability. Estimate system response to ±1% of calibrated full scale.

g) Record successful performance of the verification on a Calibration Report form (Figure 3).

Indication Set	Gain Change	Indication Tolerance Limits
80%	-6 dB	32% to 48%
80%	-12 dB	16% to 24%
40%	+6 dB	64% to 96%
20%	+12 dB	64% to 96%

Table 5

3. The remote ultrasonic master/slave tester system instrument performance shall be verified before each day's examination.

X. C. Examination Calibration

1. Straight beam examination scans are optional. When used, straight beam examination scans shall be calibrated at the same time of examination on a representative sample of the material examined by placing the first back reflection at 80% amplitude and four sweep divisions.

2. Angle Beam Examination (Axial Scanning)

Calibration is performed on a complete system on an appropriate basic calibration block at the beginning of each day's testing of the material.

a) Calibration shall be performed on a calibration block whose temperature is within ±25°F of the material to be examined.

b) Set the sweep range on the calibrated tester screen according to Table 6.

Thickness (T)	Metal Path	I.D./O.D. Points
Up to 1/2"	2-1/2 Vee Paths	2,4,6,8,10 Div.
1/2" - 1"	2 Vee Paths	2.5,5,7.5,10 Div.
1" - 2"	1-1/2 Vee Paths	3,6,9 Div.
>2"	1 Vee Paths	4,8 Div.
Cast Stainless - or Clad Pipe	1/2 Vee Path	8 Div.

Table 6

X. C. 2. c) For examinations utilizing metal paths greater than one-half node, test sensitivity at any range is established by setting the amplitude of the nearest circumferential notch echo to 80% of full calibrated scale. The responses from the remaining circumferential notch echoes in the test region shall then be obtained at this sensitivity, joined together in a smooth DAC curve on the tester face, and similarly recorded on the Calibration Report form (Figure 3). The DAC curve so generated is the Primary Reference Level.

d) For examinations utilizing a half-node metal path, DAC curve shall be generated using the side drilled holes in a basic calibration block so that the maximum hole response is set to 80% calibrated screen height. This response shall be obtained with the transducer centerline aligned with the hole half length and the beam perpendicular to the SDH, to prevent possible erroneous corner responses. The DAC shall be clearly marked on the tester face and smoothly extrapolated to cover the full examination

X. C. 2. d) range, 0 to T inches. The DAC shall also be recorded on the Calibration Report form (Figure 3). The DAC curve is the Primary Reference Level.

e) After the Primary Reference Level has been established on the basic block, a calibration reference response may be established on a Rompas or other standard reference block. The response should include both sweep and amplitude calibration points and should be recorded as a calibration check response on the Calibration Report form. This response may be used for calibration check when an appropriate basic block is not available.

3. Angle Beam Examination (Circumferential Scanning)

The angle beam calibration required for axial scanning, (X.C.2), is considered acceptable for circumferential scanning if the amplitude of the axial calibration is within ±2 dB of the the amplitude obtained from the axial notch echoes and its sweep location is within ±10% of the calibrated reference response value recorded on the calibration sheet. If these tolerances cannot be met, a complete new

X. C. 3. calibration is required following the requirements of X.C.2 of this procedure.

4. When using the remote ultrasonic master/slave tester system amplitude peak responses on the slave unit shall agree with the master unit within 20% of full scale height and within 5% of sweep range full scale.

XI. PERFORMANCE

A. Straight Beam Scan

1. The material through which angle beam sound will travel during the examinations may be examined with longitudinal beams for thickness information, geometry, weld locations and laminations to supplement the angle beam examinations.

2. A Rectilinear scan pattern shall be used.

B. Calibration Check

1. A calibration check is required before and after each examination and with any change in test personnel. In no case shall a calibration check exceed four hours.

2. The calibration check shall as a minimum consist of verification of the DAC curve by a two-point amplitude and range check using the basic calibration block or a portable block such as the calibration

XI. B. 2. block or a portable block such as the Rompas whose response has been related to that of the basic block.

a) The amplitude response of the reference reflector during the calibration check shall be within ±2 dB, and its sweep location within ±10% of the calibration reference response value recorded on the calibration sheet to be acceptable.

b) An unacceptable calibration check shall be cause for full examination of the test system to determine the reason for the calibration change. Typical causes for calibration change are ambient temperature effects on transducers and electronics, control settings inadvertently changed, and loss of couplant between the transducer and wedge. If, in the judgment of the examiner, the cause of the calibration change has been corrected or may be compensated for by a change in control settings, calibration may be restored using the calibration check response.

XI. B. 2. c) Any examination that has been performed in a non-calibrated condition shall be repeated.

C. Sensitivity

The scanning sensitivity shall be a minimum of 2x (6dB) greater than the reference sensitivity level.

D. Coverage

1. Each area shall be scanned with a nominal 15% overlap of the transducer width (diameter) for each scan path. In no case shall transducer overlap be less than 10%.
2. For angle beam examinations the search unit shall be oscillated + and - 45 degrees to ensure maximum coverage.
3. Any obstruction or other condition preventing full coverage of the examination shall be recorded on the examination report.

E. Scanning Speed

Scanning speed shall not exceed four inches per second.

F. Limitations

Physical or other limitations that prevent full compliance with the requirements of this procedure shall be recorded on the Examination Report form, Figure 4.

XI. G. Automatic Alarms

Automatic alarms or recording may be used as an aid to the examiner.

XII. EVALUATION

A. Recording of Indications

1. Evaluation shall be at the Primary Reference (DAC) Sensitivity.
2. Evaluate and record all reflectors.
   a) Indications shall be evaluated and recorded to the extent that the examiner can determine their size, shape, identity and location.
3. Any indication determined to be non-geometric shall be recorded, regardless of size, on the form shown in Figure 5.

B. Reference System for Reporting Indications

The reference system of Figure 6 shall be used to locate indications.

C. Acceptance Criteria

The acceptance criteria contained in Paragraph IWB-3514 of ASME XI, 1977, Summer 1978 addenda, and summarized in the tables drawn in Figures 7 and 8 may be used as a guide for acceptance.

XIII. RECORDS

A. A Report of Visual and Ultrasonic Examination (Figure 4) shall be prepared for each item examined, and shall be related to a Report of Ultrasonic Calibration (Figure 3).

B. Oscillograph chart records shall be made of all angle beam examinations.

1. Chart records used in indication analysis shall utilize two channels, one corresponding to vertical deflection of the tester signal and the other to horizontal. These channels shall be calibrated to match the oscilloscope display. That is, an indication 90% of vertical amplitude appearing at five divisions on the tester screen should have a nine division deflection on one chart channel and a five division deflection on the other.

2. Chart records shall include pre and post test calibration checks made at the same scanning speed as the test.

3. Location and other pertinent information shall be manually noted on each chart.

XIII. B. 3. a) Pertinent information includes, but is not limited to date, time, item, equipment, examiners, scans, gain, and recorder settings and speed.

C. Alternate Recordings

Other types of recording, such as event or alarm monitoring and magnetic taping may be used as an aid to the examiner where feasible.

XIV. REVIEW

A. Examination Reports shall be subject to review by an assigned LMT Level III examiner for conformity to the requirements of this procedure.

B. Following the final LMT review, the reports will be transmitted for review by the client and the Authorized Nuclear Inspector.

XV. DOCUMENTATION STORAGE AND DISTRIBUTION

A. Original examination documentation shall become the property of the client upon sign-off by the ISI Field Coordinator. Additional reports which may include examination documentation as reference material shall be generated from copies.

XV. B. Field storage facilities shall provide a safe storage area, and access to files shall be limited to the LMT Field Supervisor, his designated representatives, client representatives and the Authorized Nuclear Inservice Inspector.

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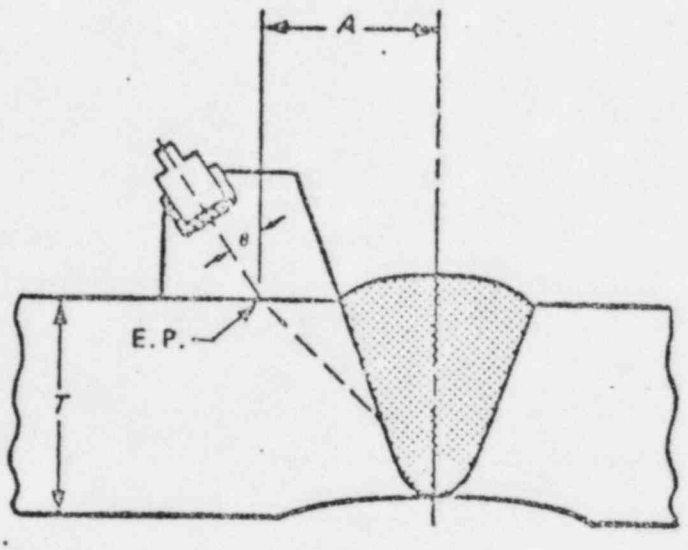
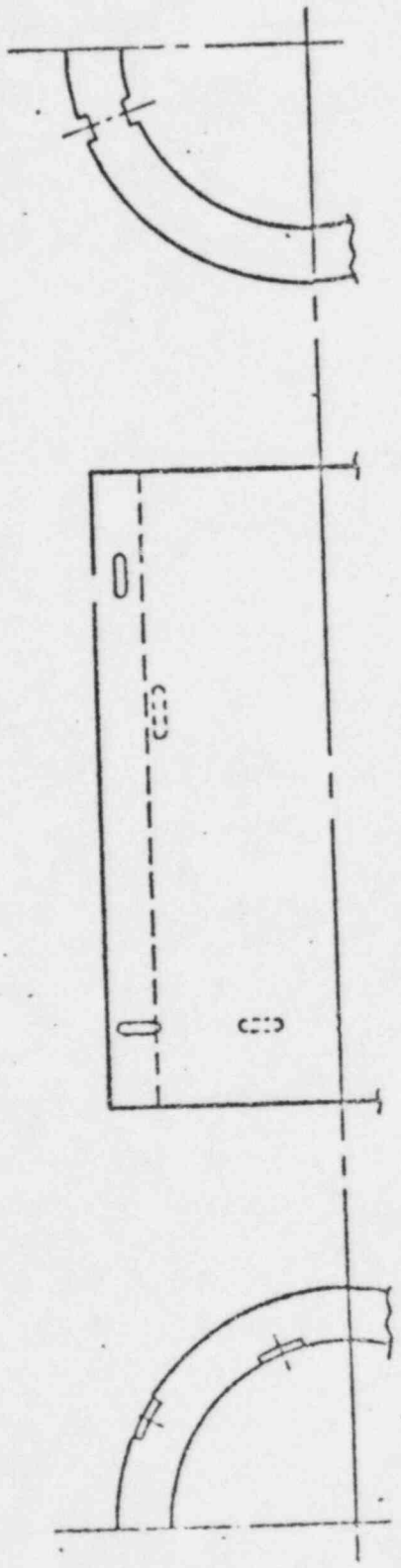


WELD COVERAGE

Figure 1



UT CALIBRATION BLOCK DESIGN FOR PIPING

Figure 2

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Location _____
Cal. No. _____ Time _____
Job No. _____
Date _____
Page _____ of _____

REPORT OF ULTRASONIC CALIBRATION

SIGN

Examiner/Level _____ Examiner/Level _____ Review/Level _____

Authorized Inspector _____ Customer _____

EQUIPMENT

Instrument _____ S/N _____ ReCal Due _____ Cable _____
Recorder _____ S/N _____ ReCal Due _____
Recorder _____ S/N _____ ReCal Due _____

Vertical Linearity Check . Check Completed _____

Signal 1	100	90	80	70	60	50	40	30	20	10
Signal 2										

Signal 2 shall equal 50% of Signal 1 ±5% of full scale

Attenuator Linearity Check Check Completed _____

Tester Gain	Set	-6	-12	Set	+12	Set	+6
Signal Amp.	80%	32 to 48	16 to 24	20%	64 to 96	40%	64 to 96
Actual Value							

Signal amplitude must fall within listed values

Transducers

S/N _____ Mfg. _____ Type _____ Size _____ Freq. _____ Index _____ Angle _____
S/N _____ Mfg. _____ Type _____ Size _____ Freq. _____ Index _____ Angle _____
S/N _____ Mfg. _____ Type _____ Size _____ Freq. _____ Index _____ Angle _____
S/N _____ Mfg. _____ Type _____ Size _____ Freq. _____ Index _____ Angle _____

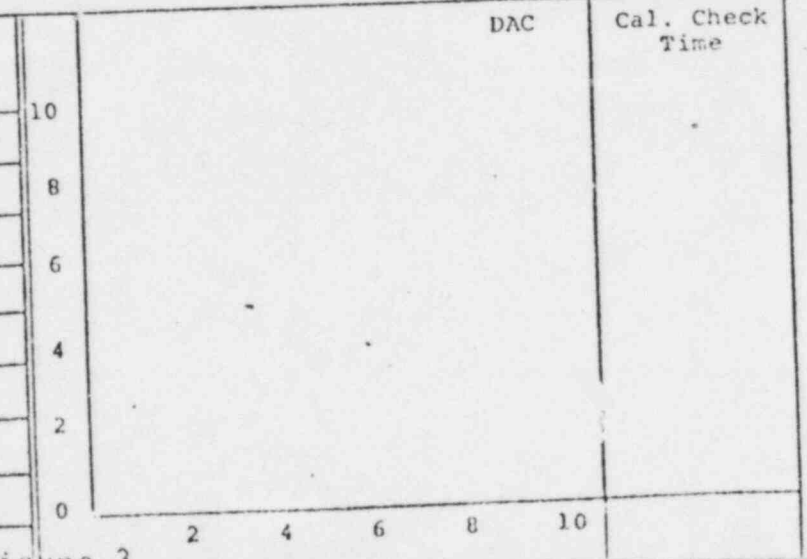
PROC

Procedure _____ Rev. _____ Date _____

CALIBRATION

Cal. Block Type _____ S/N _____ Ref. Refl. _____ Temp. _____
Verification/Ref. Blk. _____ S/N _____ Ref. Refl. _____ Temp. _____

Instrument Settings			
	L	∠	
Gain			
Sweep			
Delay			
Reject			
Damp.			



Cal. Check Time

Figure 3

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Location _____
Report No. _____
Cal.No. _____ Time _____
Job No. _____
Date _____
Page _____ of _____

REPORT OF VISUAL AND ULTRASONIC EXAMINATION

ITEM
Description _____ Size _____ Material _____ S/N(s) _____
Location _____ Preparation _____ Temp _____

SIGN
Examiner/Level _____ Examiner/Level _____ Review/Level _____
Authorized Inspector _____ Customer _____

EQUIPMENT
Tester 1 _____ S/N _____ 2 _____ S/N _____
Recorder 1 _____ S/N _____ 2 _____ S/N _____
Transducer 1 _____ 2 _____
3 _____ 4 _____
Couplant _____ Cable _____ Marker _____ Photo _____

PROC
Calibration Procedure _____ Rev. _____
Examination Procedure _____ Rev. _____
Recording Procedure _____ Rev. _____

CALIB
Calib. Blk. _____ Temp. _____ Ref. _____ Amp. _____ Sweep _____
Ref. Gain _____ Damp. _____ Reject _____ Gate _____
Alarm ____ Mag. Tape Count _____ Chart _____ Cal. Check Time _____

EXAMINATION
Cal. Ref. Blk. _____ Ref. Refl. _____ Amp. _____ Sweep Position _____
Scan Gain _____ Ref. Dwg. _____ Reject Level _____ Report Level _____

NAD = No Apparant Disc. L = Linear G = Geometry S = Spot M = Multiples

Scan	Type	Disp.	Scan	Type	Disp.	Scan	Type	Disp.
0	PT							
1	Visual		7			13		
2	Base Metal		8			14		
3			9			15		
4			10			16		
5			11			17		
6			12			18		

Scan	Description of Indications

Sketch

Figure 4

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Location_____
Report No._____
Job No._____
Date_____
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ULTRASONIC INDICATION DATA TABULATION

I. INDICATION NO._____ SCAN NO. _____

II. MAXIMUM AMPLITUDE DATA

1. Amplitude _____
2. Percent DAC_____
3. Sweep_____ Metal Path_____
4. Transducer Position_____

III. INDICATION LENGTH

1. Length measured between ___% DAC limits
2. Indication length_____
3. Transducer position_____

IV. INDICATION CROSS SECTION DATA AT _____ INTERVALS ALONG THE INDICATION'S LENGTH BETWEEN ___% DAC POINTS

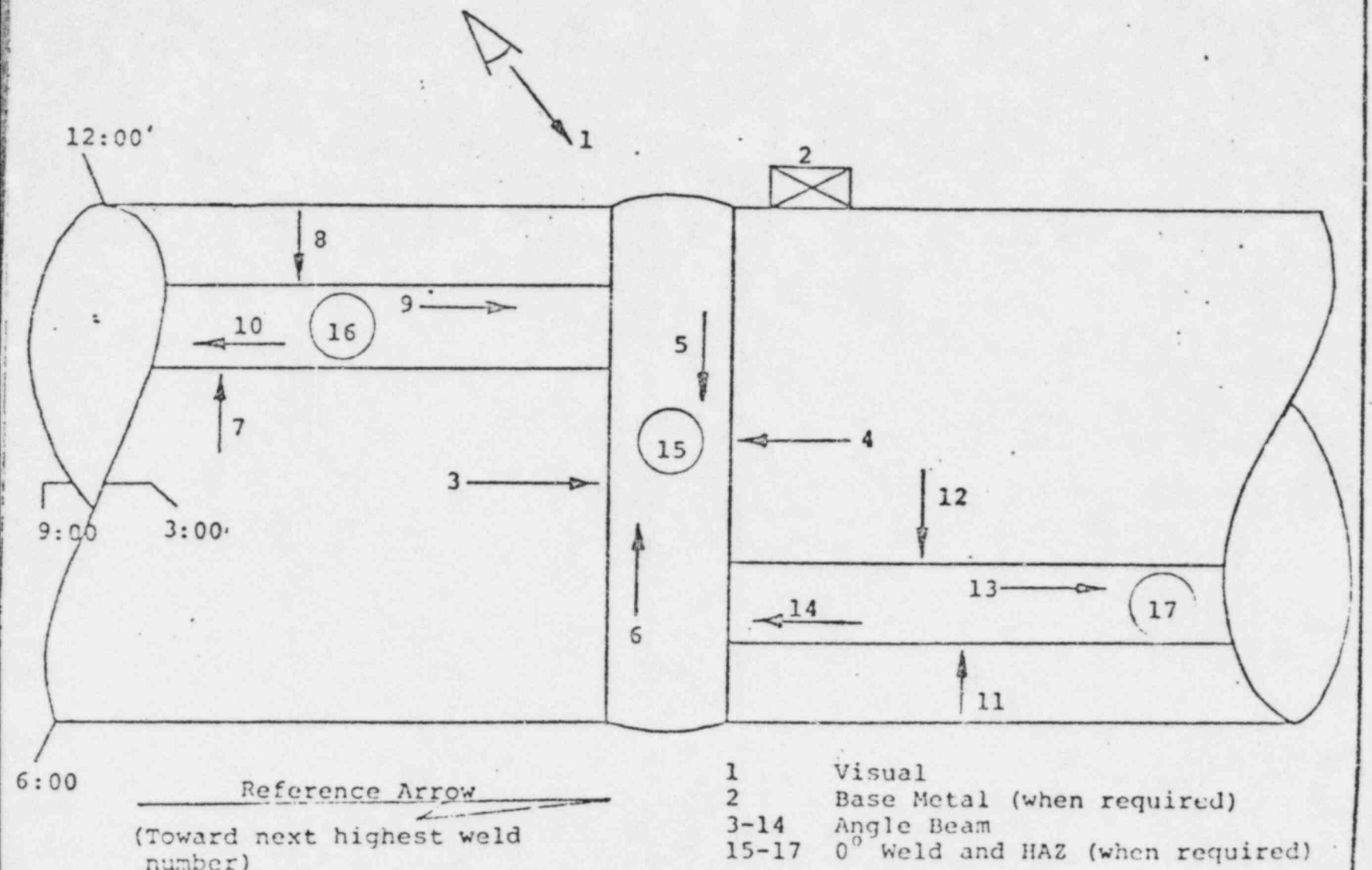
1. Reference is from weld 0° and weld centerline (or)
   Reference is _____
2. Transducer perpendicular to indication.

TRANSDUCER POSITION ALONG INDICATION	MIN SWEEP			MAX AMPLITUDE				MAX SWEEP			DEPTH	DISTANCE FROM SURFACE
	SWP	MP	POSIT	AMP	SWP	MP	POSIT	SWP	MP	POSIT		

Figure 5

Examiner_____
Signature Level
Asst. Examiner_____
Signature Level

Contractor Review_____



MANUAL SCAN DIRECTIONS

Figure 6

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TABLE IWB-3514-2
ALLOWABLE PLANAR INDICATIONS
Material: Ferritic steels that meet the requirements of NB-2300 and specified minimum yield strength of 50 ksi or less at 100 F

	Volumetric Examination Method										Surface Examination Method	
	Nominal Wall Thickness, t, in., 0.312 or less[2]		1.0		2.0		3.0		4.0 and over			
Aspect Ratio, a/ℓ	Surface Indication, at, %	Subsurface Indication, at, %[3]	Surface Indication, at, %	Subsurface Indication, at, %[3]	Surface Indication, at, %	Subsurface Indication, at, %[3]	Surface Indication, at, %	Subsurface Indication, at, %[3]	Surface Indication, at, %	Subsurface Indication, at, %[3]	Nom. Wall Thickness, t, in.	Indication Length, ℓ, in.[1]
Preservice Examination												
0	7.4	9.2	6.7	8.4	5.7	7.2	4.7	5.8	3.7	4.6		
0.05	7.9	9.5	7.2	8.7	6.2	7.5	5.0	6.1	4.0	4.8	0.312 or less	1/8
0.10	8.7	10.4	7.9	9.5	6.8	8.1	5.5	6.6	4.3	5.2		
0.15	9.6	11.5	8.8	10.5	7.5	9.0	6.1	7.3	4.8	5.8	1.0	3/16
0.20	9.6	11.5	9.9	11.8	8.4	10.1	6.9	8.2	5.4	6.5		
0.25	9.6	11.5	9.9	11.8	9.5	11.4	7.8	9.3	6.1	7.3	2.0	1/4
0.30	9.6	11.5	9.9	11.8	9.5	11.4	8.8	10.5	6.9	8.2		
0.35	9.6	11.5	9.9	11.8	9.5	11.4	8.8	11.8	6.9	9.3	3.0	1/4
0.40	9.6	11.5	9.9	11.8	9.5	11.4	8.8	11.8	6.9	10.4		
0.45	9.6	11.5	9.9	11.8	9.5	11.4	8.8	11.8	6.9	11.6	4.0 and over	1/4
0.50	9.6	11.5	9.9	11.8	9.5	11.4	8.8	11.8	6.9	11.6		
Inservice Examination												
0	11.1	13.8	10.0	12.6	8.5	10.8	7.0	8.7	5.5	6.9		
0.05	11.8	14.4	10.8	13.0	9.3	11.2	7.5	9.1	6.0	7.2	0.312 or less	0.2
0.10	13.0	15.6	11.8	14.2	10.2	12.1	8.2	9.9	6.4	7.8		
0.15	14.4	17.2	13.2	15.7	11.2	13.5	9.1	10.9	7.2	8.7	1.0	0.3
0.20	14.4	17.2	14.8	17.7	12.6	15.1	10.3	12.3	8.1	9.7		
0.25	14.4	17.2	14.8	17.7	14.2	17.1	11.7	13.9	9.1	10.9	2.0	0.6
0.30	14.4	17.2	14.8	17.7	14.2	17.1	13.2	15.7	10.3	12.3		
0.35	14.4	17.2	14.8	17.7	14.2	17.1	13.2	17.7	10.3	13.9	3.0	0.8
0.40	14.4	17.2	14.8	17.7	14.2	17.1	13.2	17.7	10.3	15.6		
0.45	14.4	17.2	14.8	17.7	14.2	17.1	13.2	17.7	10.3	17.4	4.0 and over	0.8
0.50	14.4	17.2	14.8	17.7	14.2	17.1	13.2	17.7	10.3	17.4		

NOTES:
(1) For intermediate flaw aspect ratios a/ℓ, and thickness t, linear interpolation is permissible.
(2) t is nominal wall thickness or actual wall thickness as determined by UT examination.
(3) The total depth of subsurface indication is $2a$.

Figure 7

TABLE IWB-3514-3
ALLOWABLE PLANAR INDICATIONS
Material: Austenitic steels that meet the requirements of minimum yield strength of 35 ksi or less at 100 F

Aspect Ratio, a/ℓ[1]	Volumetric Examination Method: Nominal Wall Thickness t, in. 0.312 or less[2] — Surface Indication, at, %	Volumetric Examination Method: Nominal Wall Thickness t, in. 0.312 or less[2] — Subsurface Indication, at, %[3]	Volumetric Examination Method: 1.0 — Surface Indication, at, %	Volumetric Examination Method: 1.0 — Subsurface Indication, at, %[3]	Volumetric Examination Method: 2.0 — Surface Indication, at, %	Volumetric Examination Method: 2.0 — Subsurface Indication, at, %[3]	Volumetric Examination Method: 3.0 — Surface Indication, at, %	Volumetric Examination Method: 3.0 — Subsurface Indication, at, %[3]	Surface Examination Method: Nom. Wall Thickness, t, in.[1]	Surface Examination Method: Indication Length, ℓ, in.
Preservice Examination										
0	9.4	9.4	8.5	8.5	8.0	8.0	7.6	7.6	0.312 or less	1/8
0.05	9.6	9.6	8.6	8.6	8.2	8.2	7.7	7.7		
0.10	9.8	9.8	8.8	8.8	8.3	8.3	7.8	7.8	1.0	3/16
0.15	9.9	9.9	8.9	8.9	8.4	8.4	7.9	7.9		
0.20	10.0	10.0	9.1	9.1	8.6	8.6	8.1	8.1	2.0	1/4
0.25	10.0	10.0	9.2	9.2	8.7	8.7	8.2	8.2		
0.30	10.0	10.0	9.4	9.4	8.9	8.9	8.3	8.3	3.0 and over	1/4
0.35	10.0	10.0	9.5	9.5	9.0	9.0	8.5	8.5		
0.40	10.0	10.0	9.7	9.7	9.1	9.1	8.6	8.6		
0.45	10.0	10.0	9.8	9.8	9.3	9.3	8.7	8.7		
0.50	10.0	10.0	10.0	10.0	9.4	9.4	8.9	8.9		
Inservice Examination										
0	11.7	11.7	10.6	10.6	10.0	10.0	9.5	9.5	0.312 or less	0.2
0.05	12.0	12.0	10.7	10.7	10.2	10.2	9.6	9.6		
0.10	12.2	12.2	11.0	11.0	10.4	10.4	9.7	9.7	1.0	0.25
0.15	12.4	12.4	11.1	11.1	10.5	10.5	9.9	9.9		
0.20	12.5	12.5	11.4	11.4	10.7	10.7	10.1	10.1	2.0	0.45
0.25	12.5	12.5	11.5	11.5	10.9	10.9	10.2	10.2		
0.30	12.5	12.5	11.7	11.7	11.1	11.1	10.4	10.4	3.0 and over	0.65
0.35	12.5	12.5	11.9	11.9	11.2	11.2	10.6	10.6		
0.40	12.5	12.5	12.1	12.1	11.4	11.4	10.7	10.7		
0.45	12.5	12.5	12.2	12.2	11.6	11.6	10.9	10.9		
0.50	12.5	12.5	12.5	12.5	11.7	11.7	11.1	11.1		

NOTES:
(1) For intermediate flaw aspect ratios a/ℓ and thickness t, linear interpolation is permissible.
(2) t is nominal wall thickness or actual wall thickness as determined by UT examination.
(3) The total depth of subsurface indication is $2s$.

Figure 8

Lambert • MacGill • Thomas, Inc.
Testing • Engineering • Service • Training
771 East Brokaw Road
San Jose, Ca. 95112
408-297-8766

Location BSEP-II
Cal. No. DBM-01 / Time 0825
Job No. CPL-014
Date 5-2-82
Page 1 of 7

REPORT OF ULTRASONIC CALIBRATION

SIGN

Examiner/Level DBM MACGILL/III THOMAS/III Examiner/Level STORY/II MORRIS/II Review/Level CAROPINO/I DBM/JTL/III

Authorized Inspector _____ Customer _____

EQUIPMENT

Instrument Nortec Mstr/S/N S/N 311/2 ReCal Due 7-8-82 Cable 6' Dual

Recorder Tec FM2300S S/N 124 ReCal Due 6-1-82

Recorder Brush S/N 0647/3018 ReCal Due 9-1-82/10-1-82

Vertical Linearity Check Check Completed DBM

Signal 1	100	90	80	70	60	50	40	30	20	10
Signal 2	50	45	40	36	30	26	22	16	10	6

Signal 2 shall equal 50% of Signal 1 ±5% of full scale

Attenuator Linearity Check Check Completed DBM

Tester Gain	Set	-6	-12	Set	+12	Set	+6
Signal Amp.	80%	32 to 48	16 to 24	20%	64 to 96	40%	64 to 96
Actual Value	XXXX	40	22	XXXX	73	XXXX	82

Signal amplitude must fall within listed values

Transducers

S/N 0943	Mfg. Hsonic	Type P/C	Size .5x.25	Freq. 1.5MHz	Index 1	Angle 47° Rem.
S/N _____	Mfg. _____	Type _____	Size _____	Freq. _____	Index _____	Angle _____
S/N _____	Mfg. _____	Type _____	Size _____	Freq. _____	Index _____	Angle _____
S/N _____	Mfg. _____	Type _____	Size _____	Freq. _____	Index _____	Angle _____

PROC

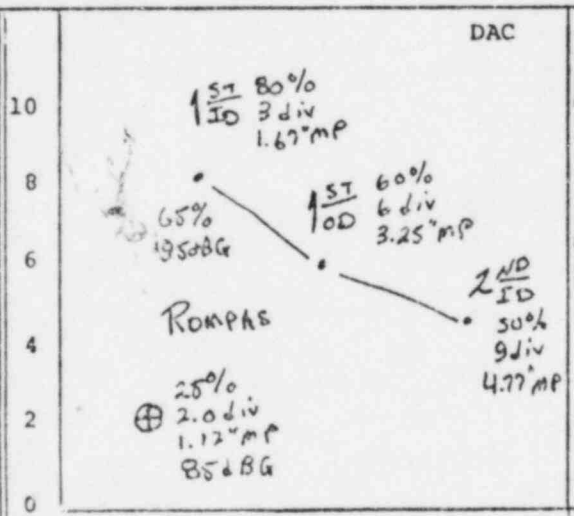
Procedure UT-22/UT-24 Rev. 0/1 Date 5-9-80/1-25-79

CALIBRATION

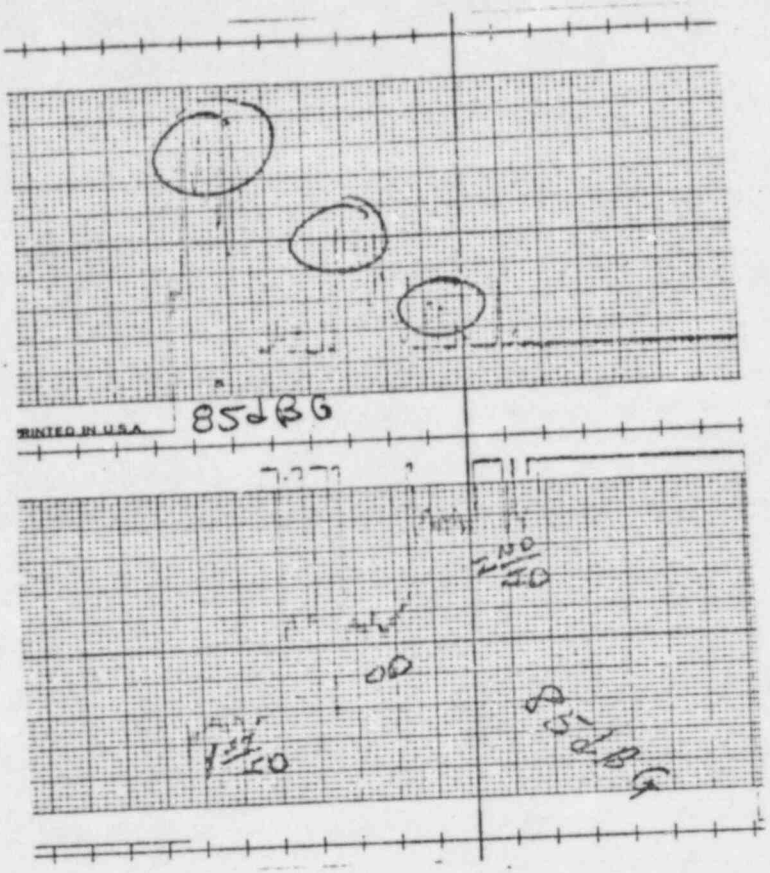
Cal. Block Type Pipe Seg. S/N KX7795 Ref. Refl. ID Notch Temp. 85°F

Verification/Ref. Blk. Rompas S/N 4 Ref. Refl 5/64 ϕ SDH Temp. 85°F

Instrument Settings	L	∠	Digital Cal
Gain		85 dB G	1"R = 1.00
Sweep		3T = 9 div	4"R = 4.00
Delay		0" = 0 div	
Reject		off	
Damp.		Min	
Freq		WB	
RepRate		1K	
Filter		(+)	



Cal. Check Time
0825
0957
1350
1523
1546
1640
1710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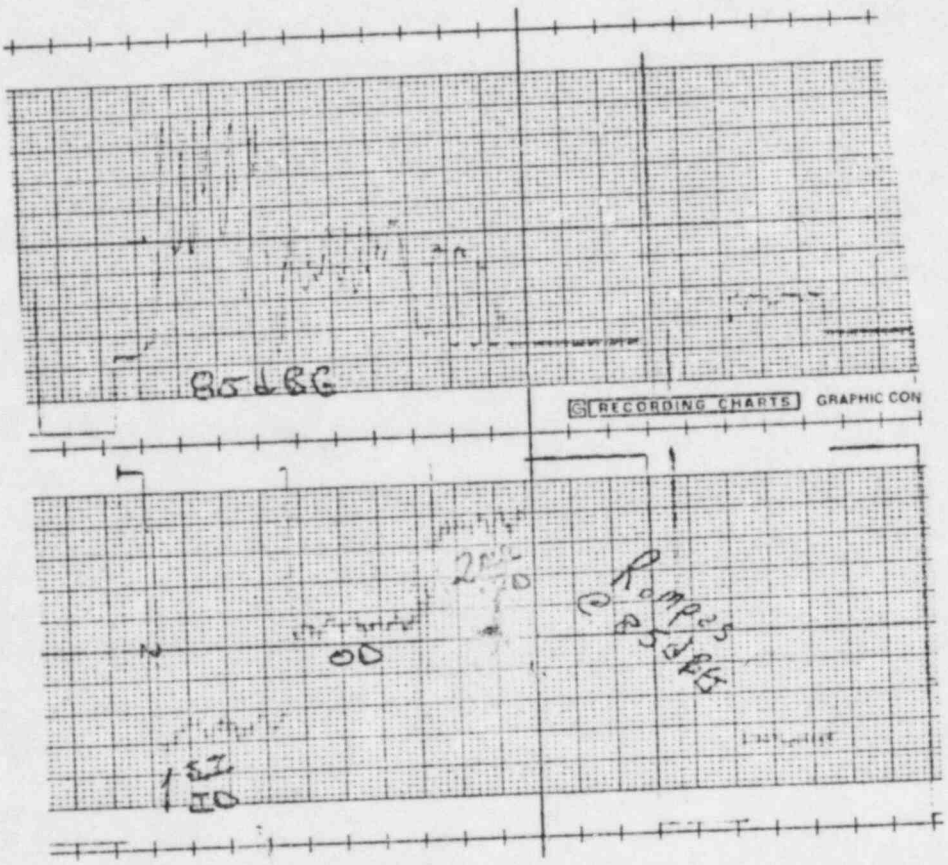
85dBG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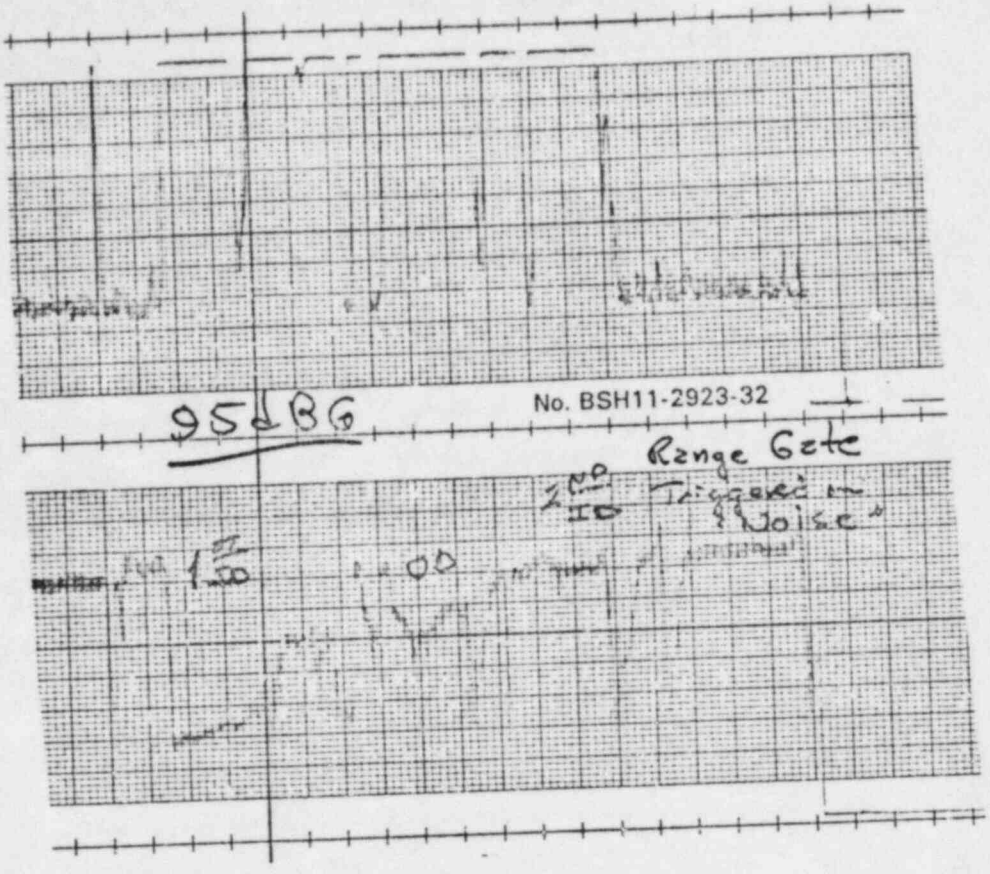
GRAPHIC CON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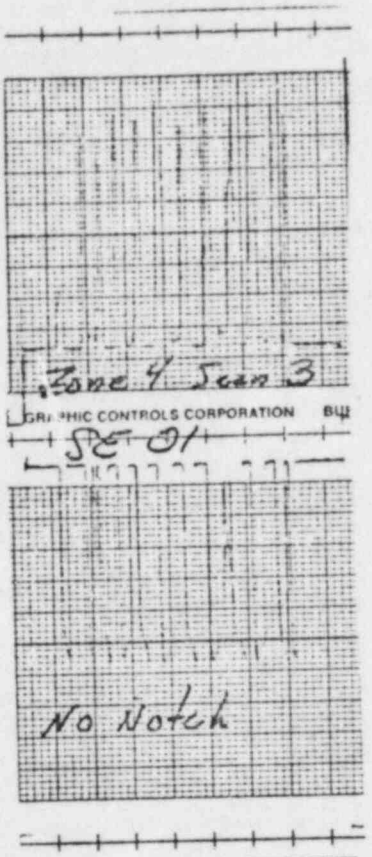
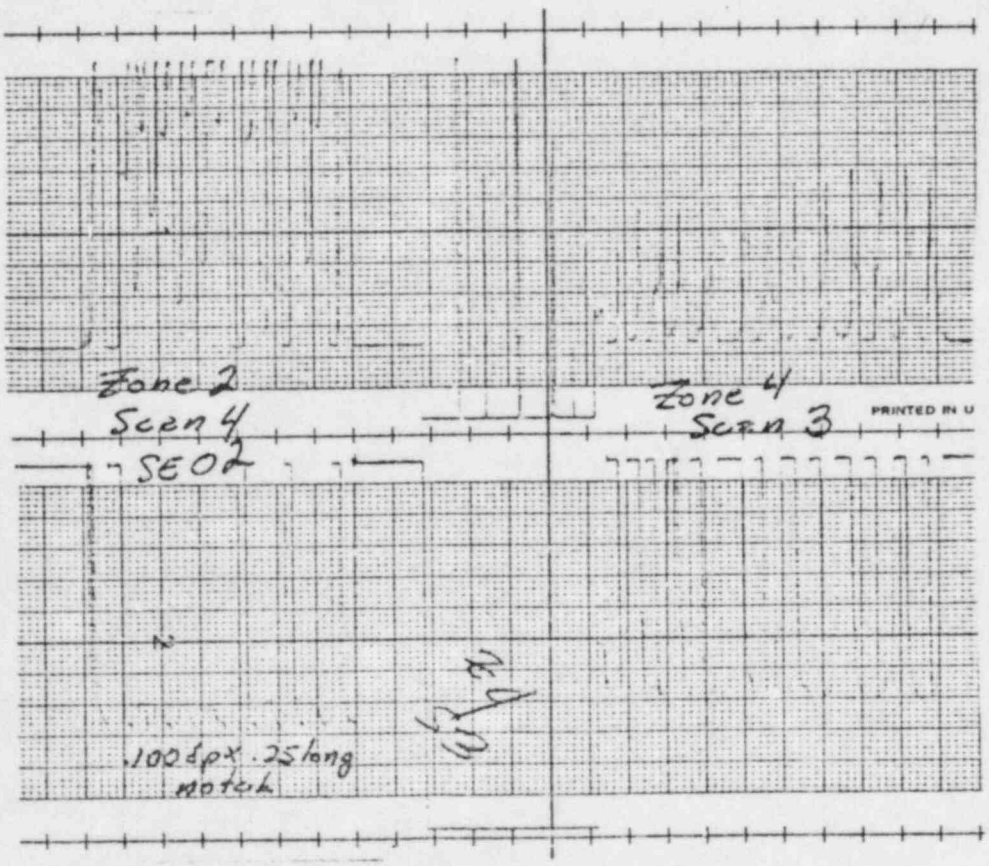
Range Gate
Trigger
Noise

Safe End Profile Blocks
85 & BG.





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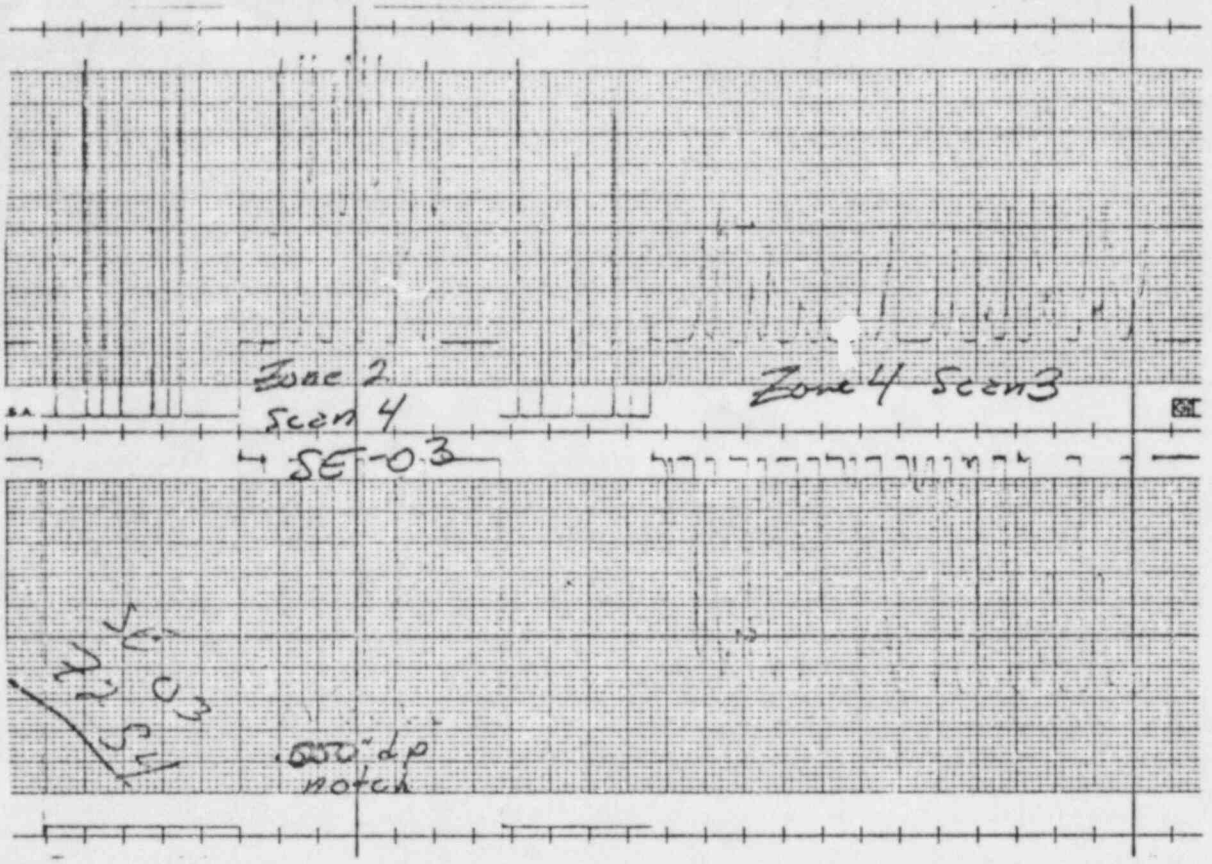
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Zone 4 Scan 3
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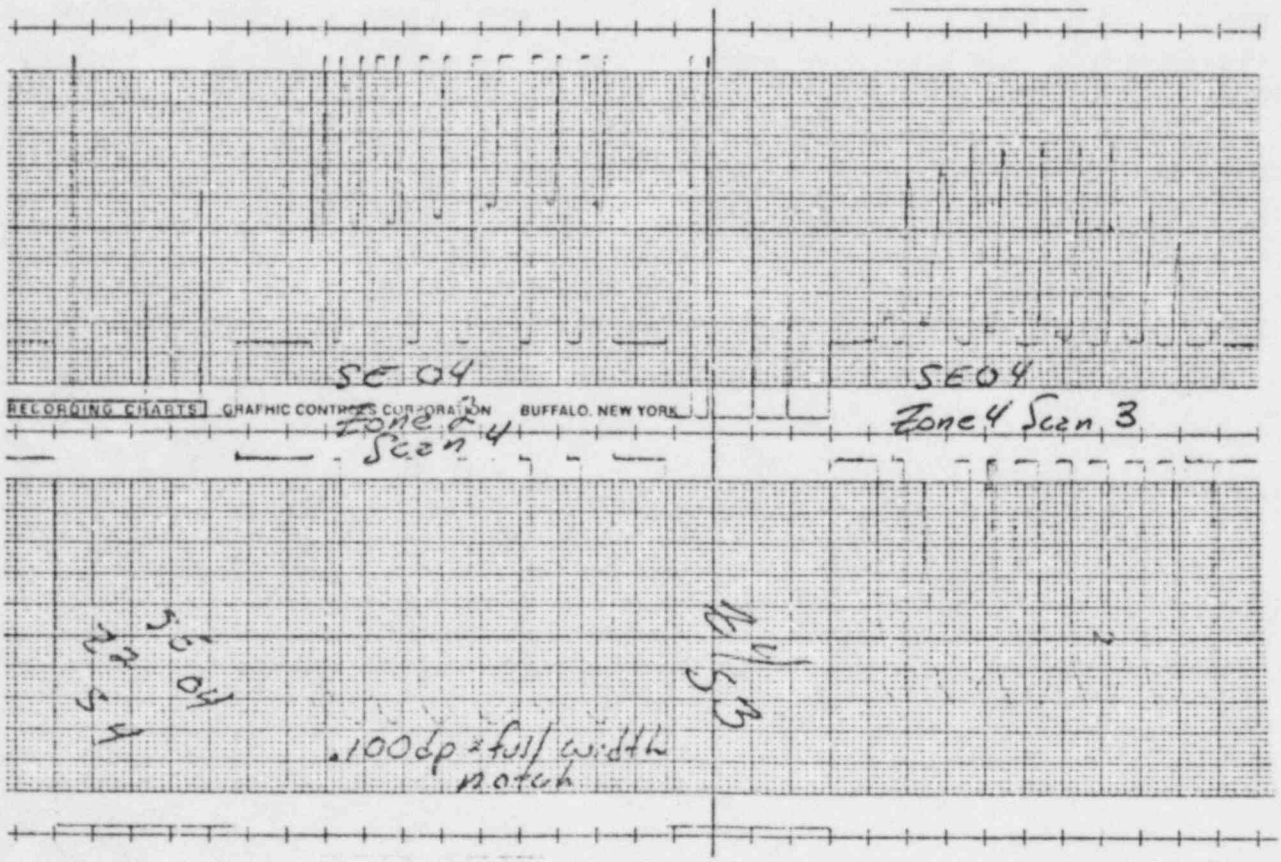
notch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SE04
RECORDING CHARTS GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
Zone 4
Scan 4
Zone 4 Scan 3
SE 03
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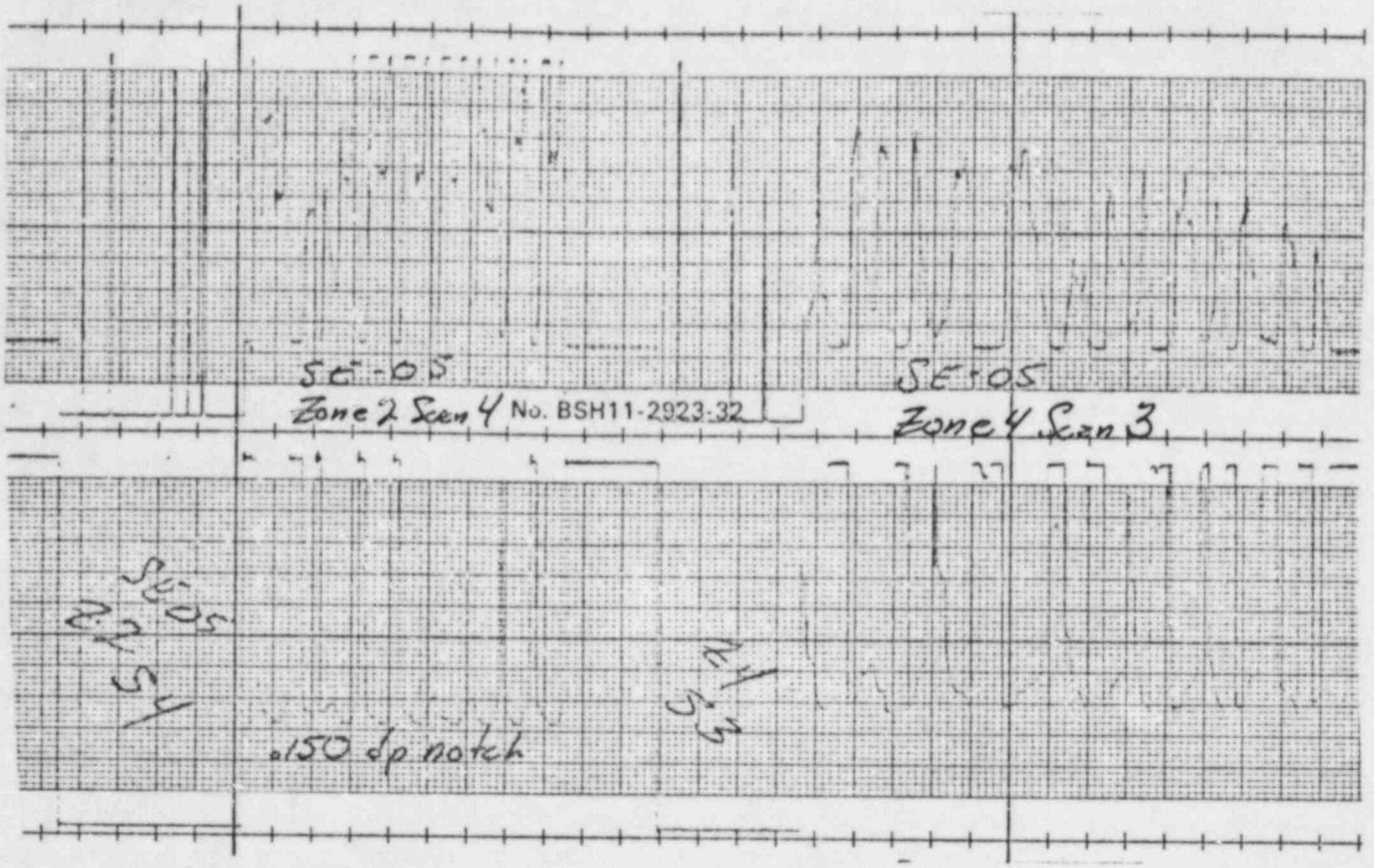
notch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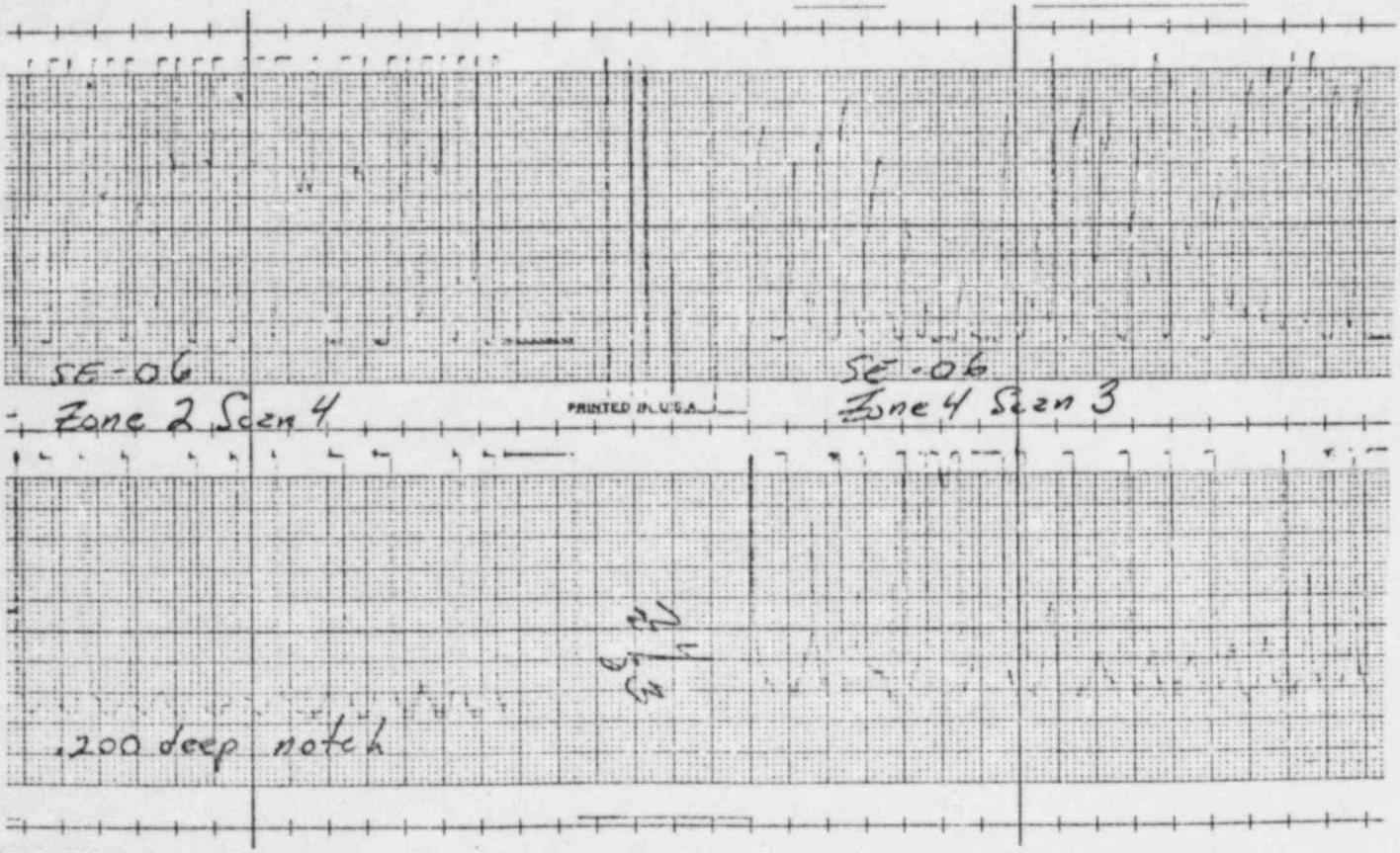
S3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Zone 2 Scen 4
PRINTED IN U.S.A.
SE-0.6
Zone 4 Scen 3
Z2
S4
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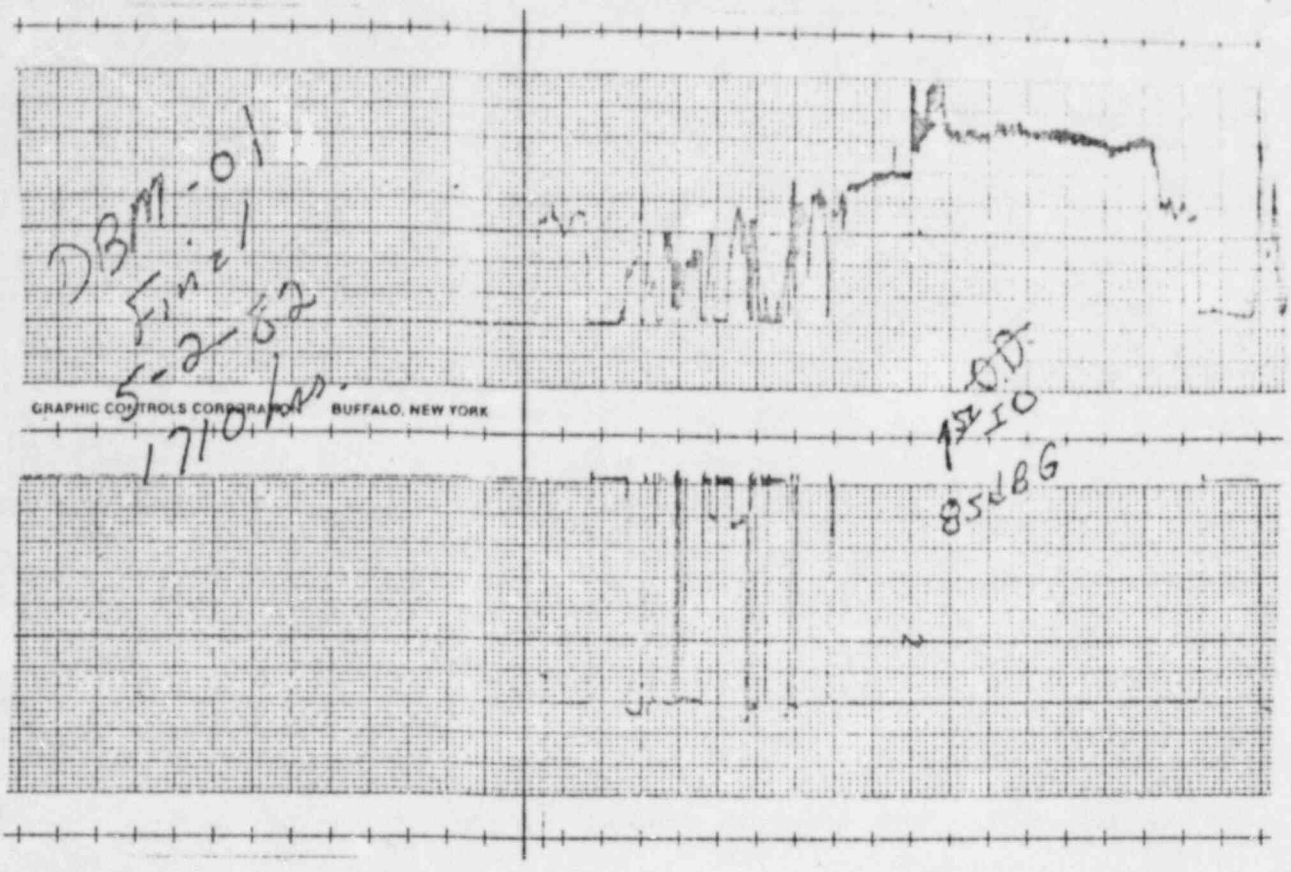
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5-2-82
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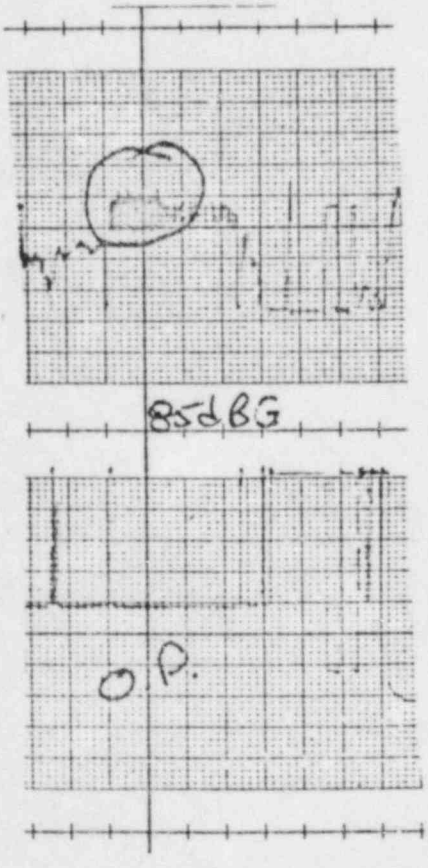
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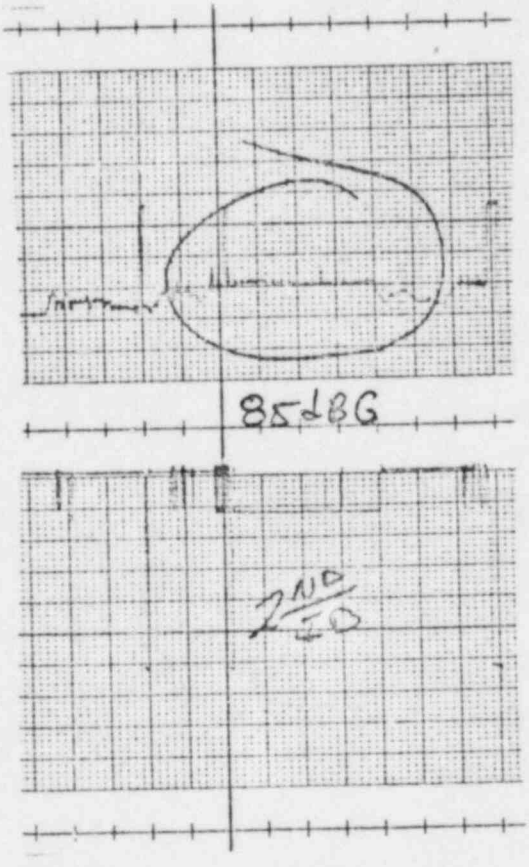
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Attachment 4

Stress rule index (SRI) for the weld joints in the nonconforming, service sensitive piping (IV.B.1.b(6) of NUREG-0313, Rev. 1).

LOOP A		LOOP B	
Weld No.	SRI	Weld No.	SRI
B32-RECIRC-12"-AR-A-1	1.08	B32-RECIRC-12"-BR-F-1	1.12
B32-RECIRC-12"-AR-A-2	1.48	B32-RECIRC-12"-BR-F-2	1.53
B32-RECIRC-12"-AR-A-3	1.46	B32-RECIRC-12"-BR-F-3	1.45
B32-RECIRC-12"-AR-A-4	1.27	B32-RECIRC-12"-BR-F-4	1.46
B32-RECIRC-12"-AR-B-1	1.06	B32-RECIRC-12"-BR-G-1	1.10
B32-RECIRC-12"-AR-B-2	1.39	B32-RECIRC-12"-BR-G-2	1.51
B32-RECIRC-12"-AR-B-3	1.51	B32-RECIRC-12"-BR-G-3	1.53
B32-RECIRC-12"-AR-B-4	1.36	B32-RECIRC-12"-BR-G-4	1.42
B32-RECIRC-12"-AR-C-1	1.57	B32-RECIRC-12"-BR-H-1	1.59
B32-RECIRC-12"-AR-C-2	1.58	B32-RECIRC-12"-BR-H-2	1.57
B32-RECIRC-12"-AR-C-3	1.54	B32-RECIRC-12"-BR-H-3	1.53
B32-RECIRC-12"-AR-C-4	1.60	B32-RECIRC-12"-BR-H-4	1.53
B32-RECIRC-12"-AR-D-1	1.08	B32-RECIRC-12"-BR-J-1	1.06
B32-RECIRC-12"-AR-D-2	1.46	B32-RECIRC-12"-BR-J-2	1.41
B32-RECIRC-12"-AR-D-3	1.44	B32-RECIRC-12"-BR-J-3	1.45
B32-RECIRC-12"-AR-D-4	1.35	B32-RECIRC-12"-BR-J-4	1.30
B32-RECIRC-12"-AR-E-1	1.14	B32-RECIRC-12"-BR-K-1	1.07
B32-RECIRC-12"-AR-E-2	1.57	B32-RECIRC-12"-BR-K-2	1.42
B32-RECIRC-12"-AR-E-3	1.53	B32-RECIRC-12"-BR-K-3	1.38
B32-RECIRC-12"-AR-E-4	1.58	B32-RECIRC-12"-BR-K-4	1.25
B32-RECIRC-4"-A-1	1.22	B32-RECIRC-4"-B-1	1.22
B32-RECIRC-4"-A-11	1.19	B32-RECIRC-4"-B-11	1.20

Three dissimilar welds have had no SRI number calculated due to the fact that these inspections are performed each refueling outage or other planned outage per previous commitment on NUREG-0313, Rev. 1.

Weld No.	SRI
E11-RHR-24"-A-DISCH-12	N/A
E11-RHR-24"-B-DISCH-12	N/A
E11-RHR-20"-A-SUCT-2	N/A

Attachment 5

Stress rule index (SRI) number for the welded joints in the nonconforming, nonservice sensitive piping (IV.B.2.b of NUREG-0313, Rev. 1).

LOOP A		LOOP B	
Weld No.	SRI	Weld No.	SRI
B32-RECIRC-28"-A-2	1.08	B32-RECIRC-28"-B-2	1.03
B32-RECIRC-28"-A-3	1.46	B32-RECIRC-28"-B-3	1.34
B32-RECIRC-28"-A-4	1.41	B32-RECIRC-28"-B-4	1.32
B32-RECIRC-28"-A-5	0.95	B32-RECIRC-28"-B-5	0.93
B32-RECIRC-28"-A-6	0.97	B32-RECIRC-28"-B-6	0.94
B32-RECIRC-28"-A-7	1.38	B32-RECIRC-28"-B-7	1.36
B32-RECIRC-28"-A-8	1.41	B32-RECIRC-28"-B-8	1.36
B32-RECIRC-28"-A-9	1.07	B32-RECIRC-28"-B-9	1.05
B32-RECIRC-28"-A-10	1.58	B32-RECIRC-28"-B-10	1.51
B32-RECIRC-28"-A-11	1.52	B32-RECIRC-28"-B-11	1.46
B32-RECIRC-28"-A-12	1.12	B32-RECIRC-28"-B-12	1.12
B32-RECIRC-28"-A-13	1.13	B32-RECIRC-28"-B-13	1.12
B32-RECIRC-28"-A-14	1.51	B32-RECIRC-28"-B-14	1.48
B32-RECIRC-28"-A-15	1.42	B32-RECIRC-28"-B-15	1.40
B32-RECIRC-28"-A-16	0.98	B32-RECIRC-28"-B-16	0.97
B32-RECIRC-28"-A-17	1.02	B32-RECIRC-28"-B-17	1.01
B32-RECIRC-28"-A-18	0.95	B32-RECIRC-28"-B-18	0.95
B32-RECIRC-28"-A-9BC	1.20	B32-RECIRC-28"-B-9BC	1.20
B32-RECIRC-28"-A-12BC	1.04	B32-RECIRC-28"-B-12BC	1.04
B32-RECIRC-28"-A-15BC	0.98	B32-RECIRC-28"-B-15BC	0.98
B32-RECIRC-22"-AM-1	1.15	B32-RECIRC-22"-BM-1	1.14
B32-RECIRC-22"-AM-2	1.11	B32-RECIRC-22"-BM-2	1.20
B32-RECIRC-22"-AM-3	1.03	B32-RECIRC-22"-BM-3	1.21
B32-RECIRC-22"-AM-4	1.24	B32-RECIRC-22"-BM-4	1.14
B32-RECIRC-22"-AM-5	1.18	B32-RECIRC-22"-BB-1BC-A	1.16
B32-RECIRC-22"-AM-6	1.14	B32-RECIRC-22"-BB-1BC-B	1.19
B32-RECIRC-22"-AM-3BC-A	1.2	B32-RECIRC-22"-BB-3BC-A	1.18
B32-RECIRC-22"-AM-3BC-B	1.20	B32-RECIRC-22"-BB-3BC-B	1.21
B32-RECIRC-22"-AM-5BC-A	1.19		
B32-RECIRC-22"-AM-5BC-B	1.16		

Three dissimilar welds have had no SRI number calculated due to the fact that these inspections are performed every refueling outage or other planner outage per previous commitment on NUREG-0313, Rev. 1.

Weld No.	SRI
E11-RHR-24"-A-DISCH-12	N/A
E11-RHR-24"-B-DISCH-12	N/A
E11-RHR-20"-SUCT-2	N/A