By ADJ

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PACIFIC GAS AND ELECTRIC COMPANY
DEPARTMENT OF ENGINEERING RESEARCH

NONDESTRUCTIVE EXAMINATION
SPECIFICATIONS AND PROCEDURES

ULTRASONIC EXAMINATION LONGITUDINAL WAVE PULSE-ECHO METHOD

1. SCOPE

1.1 This procedure is applicable to the ultrasonic examination techniques employing the longitudinal wave (straight beam) pulse-echo contact method.

1.2 This procedure shall be used prior to the shear wave girth weld examination of the seamless 304 stainless steel pressure retaining piping at Humboldt Bay Power Plant, Unit 3, nuclear.

1.2.1 This procedure shall be used when examining the volume of base material through which sound will travel in the shear wave examination of the piping mentioned in par. 1.2.

1.3 This procedure covers the examination of nominal pipe sizes of 2" (.218"w.t.), 3" (.300"w.t.), 4" (.337"w.t.), 6"(.562"w.t.), and 8"(.718"w.t.).

2. CALIBRATION

2.1 The longitudinal wave examination shall be preceded by the instrument and system alibration requirements specified in Section UCL-1.

3. EQUIPMENT

3.1 The equipment used for the examination shall be the same equipment used during calibration and shall conform to Section UCL-1, par. 2.

4. SURFACE PREPARATION

4.1 The contact surfaces shall be free from weld spatter and any surface roughness that would interfere with free movement of the transducer or impair transmission of ultrasonic vibrations.

4.2 Cleaning materials to be used on austenitic stainless steels shall be certified in compliance with Section No. PE-2, par. 4.2 and 4.2.1.

4.3 Necessary surface grinding, i.e., removal of weld spatter, shall not reduce the original wall thickness.

5. EXAMINATION METHOD

5.1 The entire volume of pipe metal through which sound will travel during shear wave examination shall first be examined for laminations and other reflectors by the longitudinal wave method for a distance of 6t from the weld.

5.2 The fitting or pipe metal on the opposite side of the weld shall be examined for a distance of 2t from the weld.

5.3 The examination shall be made from the outside surface of the pipe.

5.4 Scanning shall be continuous and in a direction perpendicular to the weld.

5.4.1 Transducer path overlap shall be at least 10% of the transducer diameter.

5.4.2 Scanning speed shall not exceed 4 inches/sec.

5.5 A stainless steel band, marked in 1/4 inch increments shall be placed around the girth of the pipe as a means of indicating the radial position of indications (Figure 1).

5.5.1 The "zero" radial reference point and the radial direction of scan around the girth of the pipe shall be marked on the pipe with a vibrator type marking tool as shown in Figure 1. Depth of markings shall not be deeper than 1/64 inch.

5.5.2 The lateral direction of scan, unless otherwise specified, shall be clockwise when looking in the normal direction of flow.

5.5.3 The stainless steel band may be secured away from the weld at a point which allows for the band to be used as a stop during longitudinal transducer movement.

5.5.4 The position of an indication in the longitudinal direction shall be measured from the center of the weld. This shall be referred to as the "reference line."

5.6 Scanning shall be performed at a minimum gain setting of twice the primary reference level.

5.7 Evaluation of discontinuities is done with the gain control set at the primary reference level.

6. RECORDS

6.1 Volumetric indications with amplitudes greater than 20% of the primary reference response shall be recorded.

6.1.1 The maximum percent of screen height, discontinuity depth, search unit radial position, and the discontinuity location (distance from the "reference line") shall be recorded on Form UERL-1 (Appendix A).

6.1.2 Lamination depth and boundary shall also be recorded in accordance with par. 6.1.1.

7. PERSONNEL

7.1 Personnel performing the calibration and examination shall meet the requirements of Section No. PQC-1.

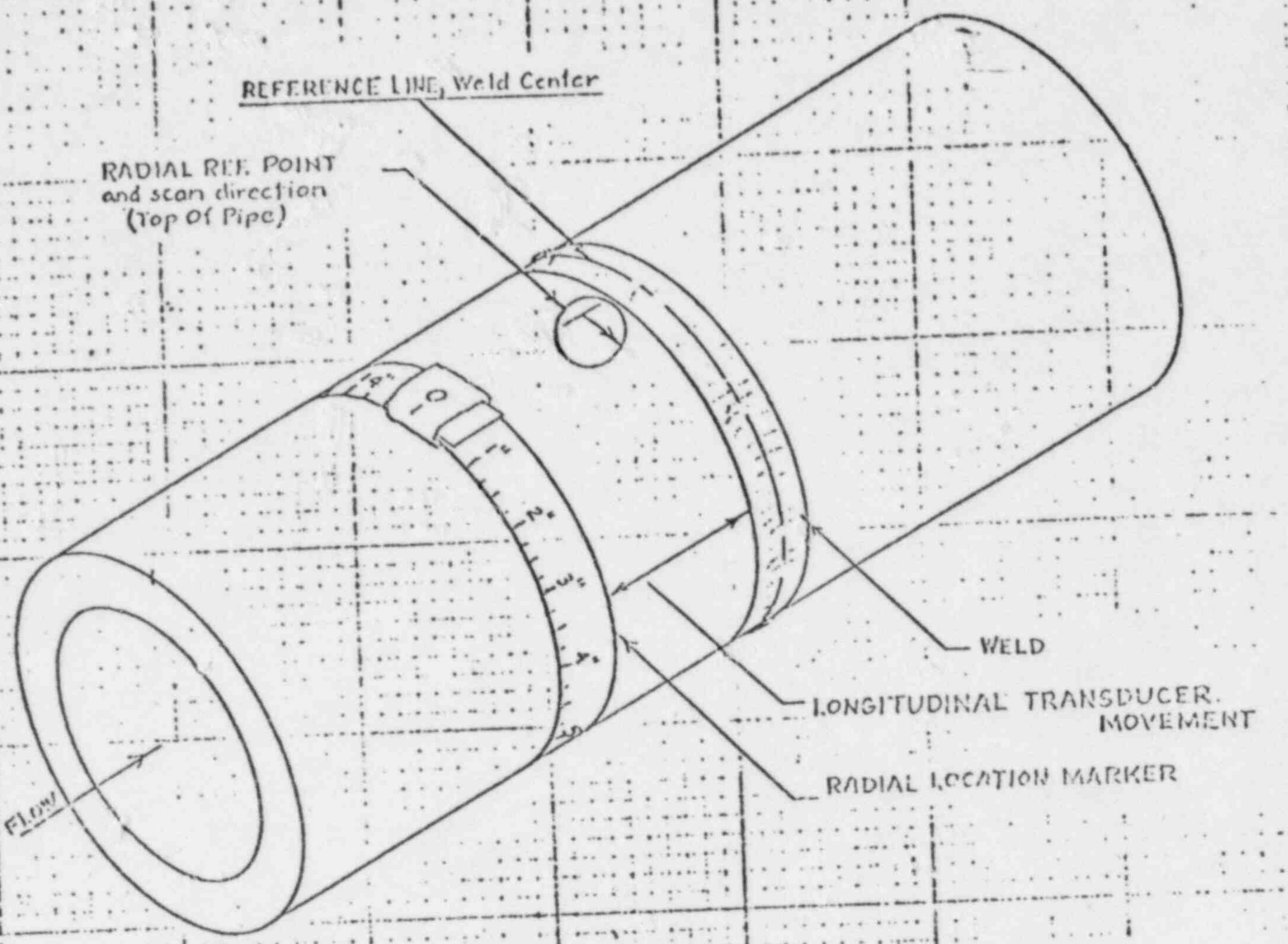
REFERENCE LINE, Weld Center
RADIAL REF POINT
and scan direction
(Top Of Pipe)
WELD
LONGITUDINAL TRANSDUCER MOVEMENT
RADIAL LOCATION MARKER
FLOW

FIG. 1

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NONDESTRUCTIVE EXAMINATION
SPECIFICATIONS AND PROCEDURES

ULTRASONIC CALIBRATION
SHEAR WAVE
PULSE-ECHO METHOD

1. SCOPE

1.1 This procedure is applicable to the calibration of ultrasonic examination equipment using the shear wave (angle beam), pulse-echo contact method.

1.2 This procedure covers nominal pipe sizes of 2" (.218"w.t.), 3" (.300"w.t.), 4" (.337"w.t.), 6" (.562"w.t.), and 8" (.718"w.t.).

2. EQUIPMENT

2.1 Electronic Apparatus

2.1.1 Sonic Model FTS Mark I Ultrasonic Flaw/Thickness Scope shall be used.

2.1.1.a The unit may be operated by either a-c or d-c power supply.

2.1.1.b The unit contains switched testing frequencies of 1.0, 2.25, 5.0, and 10.0 MHz, and also contains a broad band function.

2.1.1.c The temperature operating range for the instrument shall be 35°F to 120°F.

2.1.1.d Warmup time shall be at least 20 minutes.

2.1.1.e The damping and reject functions shall be set at zero or minimum during all calibrations.

2.2 Transducer

2.2.1 The transducer shall be selected to give optimum performance and screen presentation with respect to pipe diameter, wall thickness, and surface roughness.

2.2.1.a Aerotech 1/2" diameter miniature transducer may be used, depending on the radius of curvature of the pipe.

2.2.1.b 45° replaceable lucite flat bottom wedges shall be used for the examination.

2.2.1.c No transducer shall be placed in contact with surface temperatures below -4°F or above 125°F.

2.2.1.d The transducer may be driven at the frequency which displays optimum amplitude and screen presentation. The use of broadband is optional.

2.3 Couplant

2.3.1 The couplant used during calibration shall be the same as that used for the examination.

2.3.2 Aerotech "Exosen" series couplants shall be used as the coupling medium.

2.3.2.a Based on the surface condition of the pipe to be examined, the couplant weight for calibration may be selected at the discretion of the examiner.

3. INSTRUMENT CALIBRATION

3.1 Amplitude Linearity

3.1.1 The ultrasonic instrument amplitude linearity shall conform to the requirements of ASME Section XI, 1974 edition, par. I-4110.

3.1.1.a Instrument amplitude linearity determinations shall be made prior to use of the system in each ISI.

3.1.1.b Amplitude linearity data shall be recorded in Form UCRS-1.

3.1.1.c Amplitude linearity shall be verified at the beginning of each day of examination. Deviations shall be recorded in Form UCRS-1.

3.1.2 The calibration block used for amplitude linearity determinations shall be made to the specifications shown in Figure 1.

3.2 Amplitude Control Linearity

3.2.1 The ultrasonic instrument amplitude control linearity shall conform to the requirements of ASME Section XI , 1974 edition, par. I-4120.

3.2.2 Par. 3.1.1.a, b, c and par. 3.1.2 above also apply to amplitude control linearity and the requirements shall be met as specified.

4. ANGLE BEAM CALIBRATION

4.1 Calibration Material

4.1.1 Pipe sections one foot in length and of the same material, size, and schedule as the pipe to be examined shall be used as the basic calibration block. The temperature of the calibration material shall be within 25°F of the examination material.

4.2 Calibration Reflector

4.2.1 The calibration reflectors shall be 1/2 inch radius and 1/32 inch wide notches milled transverse to the longitudinal axis of the pipe.

4.2.2 The notches shall have square bottoms and parallel sides and shall be milled to a depth of 3% and 10% of the calibration pipe wall thickness.

4.2.3 The notches shall be milled at both the inner and outer surfaces.

4.2.4 The location of the calibration reflectors in the calibration pipe is specified in Figure 2 of this document.

4.3 Sweep Range Calibration

4.3.1 The 10% calibration reflector shall be used for 2", 3", 4", 6", and 8" nominal pipe sizes.

4.3.2 Adjust the delay and range controls so that the maximum indication from the outside and inside surface calibration reflectors appear at the following locations on the horizontal scale:

Horizontal scale	2	3	4	5	6	7	8	9	10
Node points*	4	6	8	10	12	14	16	18	20

*One full node equals one full skip or vee path. One node point equals 1/8 of one full node.

4.4 Distance-Amplitude Correction

4.4.1 Adjust the sensitivity control to provide an 80% of full screen indication from the reflector at 8 node points (n.p.). Mark the peak of the indication on the screen with a grease pencil.

4.4.2 Position the search unit for maximum response at 16 node points and mark the corresponding peak on the screen without changing the sensitivity control.

4.4.3 Connect the screen marks at 8, 16, and 24 n.p. to provide the distance amplitude correction curve. This is the primay reference response. Note: The sweep may be adjusted to bring the 24 n.p. position onto the screen in order to plot its amplitude.

4.4.4 The DAC curve used for the examination shall be drawn and recorded on Form UCRS-1. The record shall be maintained in Appendix A.

4.5 Electronic Distance Amplitude Correction

4.5.1 The Sonic Mark I instrument is equipped with an electronic DAC.

4.5.2 The electronic DAC may be used at the discretion of the examiner. The option shall be recorded on Form UCRS-1 with the original plotted DAC curve.

4.6 Sound Beam Exit Point

4.6.1 The point at which the center of sound beam leaves the lucite transducer shoe shall be determined by using the IIW-2 4340 steel angle beam calibration block.

4.6.2 The exit point shall be scribed on the lucite shoe.

4.7 Shear Wave Angle Determination

4.7.1 The shear wave angle of the transducer beam centerline in 304 stainless steel shall be determined using the 3/4T side drilled hole in the calibration block shown in Figure 1. The ability to peak the indication while accurate measurements are taken is important.

4.7.2 The method is shown in Figure 3.

4.7.3 The actual measured angle may be checked by calculations using the IIW-2 block (4340 steel) and Snell's Law. The shear wave acoustic velocity at 70°F for 4340 steel is 1.26×10^5 in/sec and for 304 stainless steel 1.18×10^5 in/sec.

4.7.4 The actual measured beam angle shall be recorded in Form UCRS-1.

4.8 Beam Spread, Vertical Plane

4.8.1 Transducer beam spread in the vertical plane shall be determined as specified in ASME Section XI, 1974 Edition, par. I-4460. The plot shall be recorded on Form UCRS-1.

4.8.2 In lieu of the requirement specified in par. 4.8.1 above, beam spread determinations made by the transducer manufacturer with special instrumentation may be accepted. The records shall be maintained in Appendix A.

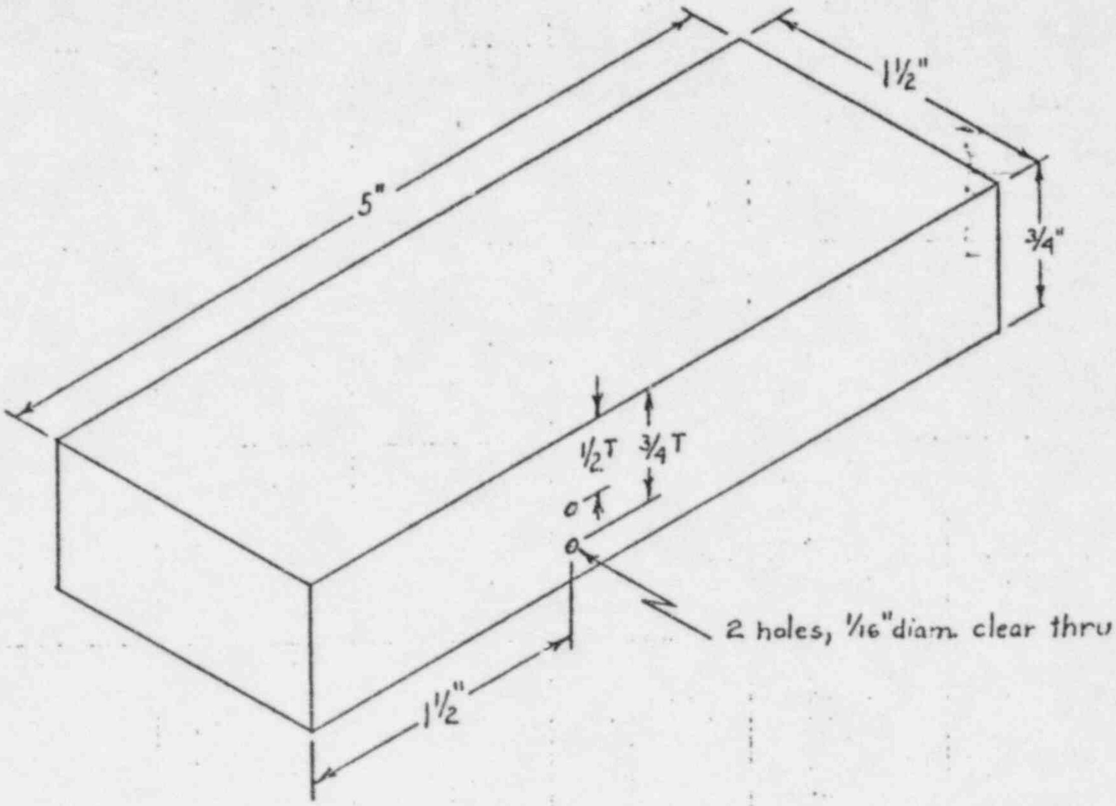

5"
1½"
¾"
½T
¾T
2 holes, 1/16"diam. clear thru
1½"

FIG. 1.

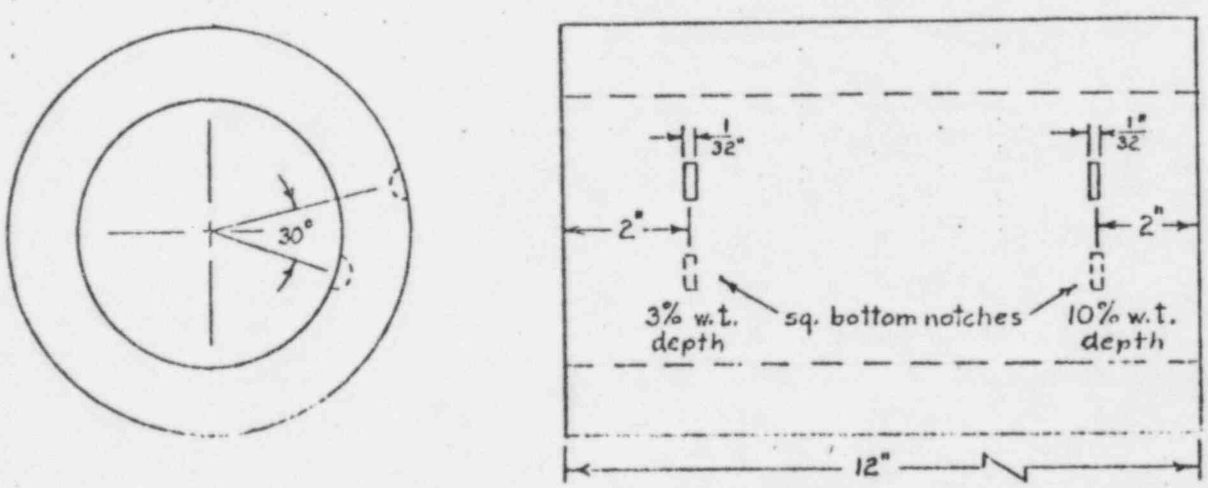
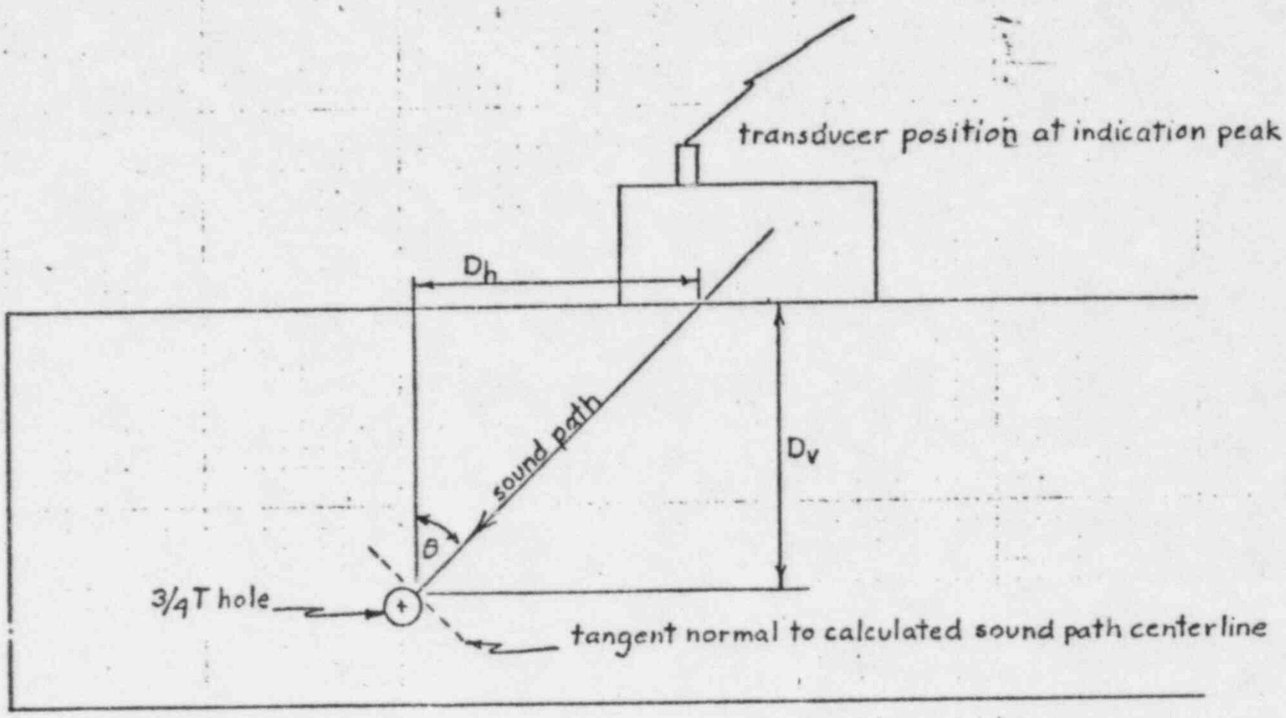

30°
1/32"
1"/32
2"
2"
3% w.t. depth
sq. bottom notches
10% w.t. depth
12"

FIG. 2.



$$\tan\theta = \frac{D_h}{D_v}$$

FIG. 3