

TITLE: ULTRASONIC EXAMINATION OF CLASS 1 AND 2 PIPING WELDS
 JOINING SIMILAR AND DISSIMILAR MATERIALS

ISSUANCE AUTHORIZED BY	<i>[Signature]</i>	
PORC REVIEW	PORC 855 JAN 8- 1986	EFFECTIVE DATE 1-8-86

1.0 PURPOSE

1.1 This procedure describes the manual ultrasonic angle beam examination of full penetration piping welds ranging in thickness from 0.2 to 6 inches. This procedure is in accordance with the requirements of ASME Boiler and Pressure Vessel Code Section XI, 1980 up to and including Winter 81 Addenda.

2.0 APPLICABILITY

2.1 The principle objective of examination is the detection, location and evaluation of discontinuities within the weld and adjacent base metal. The weld shall be examined by the angle beam technique from the outside surface of the piping system.

3.0 GENERAL REQUIREMENTS

3.1 Personnel

3.1.1 All personnel performing nondestructive examination shall be certified in accordance with the nondestructive examination personnel qualification and certification which reflects the guidelines set forth by the scope of SNT-TC-1A.

3.2 Instrument

3.2.1 A pulse-echo ultrasonic flaw detection instrument shall be employed. It shall generate, receive, and present on a cathode-ray tube (CRT) screen, pulses in a frequency range from one to five MHz.

3.2.2 The instrument shall be equipped with a stepped gain control calibrated in units of 2 dB or less.

8601140225 860108
 PDR ADDCK 05000267
 P PDR

3.2.3 The system performance characteristics of the instrument shall be verified at least once a year.

3.3 Search Unit

3.3.1 Search units may contain either single or dual transducer elements.

3.3.2 The search units shall consist of a transducer and an angle beam wedge. The unit may be comprised of two separate parts or it may be an integral unit.

3.3.3 For general use, the search unit's transducer shall have an active area of not less than 0.04 sq inch nor more than 1.0 sq inch. Under certain circumstances, such as evaluation of indications, other sizes may be employed.

3.3.4 A nominal beam angle of 45 degrees in the material shall be employed. Other angles may be employed for evaluation of an indication, or where wall thickness, geometric configurations or metallurgical condition impedes effective use of 45 degrees angle beam for examination.

3.3.5 Nominal frequency of 2.25 MHz shall be employed. Other frequencies may be employed if variables, such as production material grain structure, necessitate the use of other frequencies in order to assure penetration or improve resolution.

3.3.6 In general, shear mode of wave propagation shall be used. Refracted longitudinal mode of wave propagation may be used if grain structure or other condition impedes the use of shear wave.

3.3.7 The angle beam wedges shall be within $\pm 3^\circ$ of nominal value. This shall be checked on a standard reference block such as IIW or Rompas whenever any doubt arises about the tolerances.

3.4 Couplant

3.4.1 An approved couplant, capable of conducting ultrasonic vibrations from the transducer to the examination surface, shall be used.

3.4.2 The couplant identification and batch number shall be recorded on the calibration data sheet.

3.5 Examination Coverage

3.5.1 Scanning shall be done with an overlapping of each scan at least by 10 percent of the transducer dimension measured perpendicular to the scan path.

3.6 Search Unit Movement

3.6.1 The rate of search unit movement shall not exceed 6 inches/second unless calibration has been verified at the higher scanning speed.

3.7 Scanning Sensitivity

3.7.1 Scanning shall be done at twice (+6 dB) the primary reference level as a minimum but recording of ultrasonic reflectors shall be done at the primary reference level.

3.8 Surface Preparation

3.8.1 The examination surface shall be free of irregularities, loose material, or coatings which may interfere with ultrasonic wave transmission.

3.9 Identification of Examination Areas

3.9.1 NED shall provide the proper identification system.

4.0 INSTRUMENT CALIBRATION

4.1 A check of the ultrasonic instruments screen height linearity shall be performed as described in Section 4.0, QCIM 36.

4.2 A check of the ultrasonic instruments amplitude control linearity shall be performed as described in Section 5.0 of QCIM 36.

4.3 The instrument calibration may be performed on any calibration block, including an IIW or Rompas block, and need not be performed with the same search unit used in the next examination.

4.4 The instrument calibration for screen height and amplitude control linearity shall be performed at the beginning of each period of extended use or every three months, whichever is less. This shall also be performed whenever any doubt arises about the instrument's functions.

5.0 BASIC CALIBRATION STANDARDS

- 5.1 The finish on the surfaces of the standard shall be representative of the surface finishes of the piping to be examined.
- 5.2 The calibration standard shall conform to ASME Section XI, 1980 up to and including Winter 1981 Addenda.

6.0 SYSTEM CALIBRATION

6.1 General

- 6.1.1 Complete ultrasonic examination system calibration establishing the DAC curve, shall be performed prior to each examination, or series of similar examination.
- 6.1.2 Calibration shall include the complete ultrasonic examination system. Any change in search units, shoes, couplants, cables, ultrasonic instruments, recording devices, or any other parts of the examination system shall be the cause of calibration check. The original calibration shall be performed on the basic calibration standard and calibration checks shall be performed as per Article 6.3 of this procedure.
- 6.1.3 The maximum calibration indications shall be obtained with the sound beam oriented essentially perpendicular to the axis of the calibration reflector. The centerline of the search unit shall be at least 3/4 inch from the nearest side of the standard.
- 6.1.4 The temperature difference between the examination and calibration standard surfaces shall not exceed 25°F (14°C).
- 6.1.5 Calibration shall be performed from the outside surface of the calibration standard.

6.2 Calibration

- 6.2.1 The examination for reflectors parallel to the weld shall, in general, be performed by a one-half V path from two sides of the weld. If variables, such as those referenced in Section 7.1 of this procedure, prevent the use of one-half V examination, the beam path shall be increased a minimum of one-half V until complete examination volume is covered. The examination for reflectors transverse to the weld shall be performed by one-half V path in two directions along the weld. It may also be necessary, particularly in thin wall piping, to increase the examination beam angle.

6.2.2 One-half V Path Technique

To establish the sweep range, obtain the maximum response from the circumferentially oriented I.D. notch, position this response at 0 on the sweep. Next, obtain the maximum response from the O.D. notch, position this response at 8 on the sweep. Continue positioning these responses until no further adjustment is necessary. Again obtain the maximum response from the I.D. notch and using the delay control only, shift this response to 8 on the sweep. Lock the range and delay controls as the sweep is now established. Now obtain the maximum response from the axially oriented I.D. notch and mark its location on the screen. The slope and shape of the DAC curve shall be established using the 1/4T and 3/4T holes drilled parallel to the long axis of the calibration standard. Adjust the peak amplitude of the hole giving the higher response to 80 percent FSH. Mark the amplitude and location on the screen. Without adjusting the instrument controls, maximize response from the remaining hole and mark its amplitude and location on the screen. Connect the amplitude points with a smooth curve and extrapolate this curve an additional 1/4T to cover full examination range. Next establish reference sensitivity by setting the maximum response from the I.D. notch, at the DAC curve level. This curve (DAC) is the primary reference level and recording of ultrasonic reflectors shall be performed at this sensitivity.

As an alternate, a calibration using sound path may be used. The horizontal base line calibration, in inches, may be established using an IIW Block, Rompas Block or Miniature Angle Beam Block. The range selected shall be such that at least 60 percent of the base line will represent the examination area. After the sweep range is calibrated the slope and shape of the DAC curve and reference sensitivity shall be established by the technique described above.

6.2.3 Greater Than One-half V Path Technique

Using the required V paths, ie full V, one and one-half V etc., establish the sweep range calibration by positioning responses from the appropriate ID and OD notches at convenient intervals along the sweep and mark notch locations on the screen. The DAC shall be established by setting the maximum response from the one-half V path ID notch to 80 percent (FSH) and mark the location on the screen. Without adjusting the instrument controls, obtain the maximum response from the remaining notch echo(es) in the test region and mark the location(s) on the screen. Connect the maximum amplitude points with a smooth curve to form the DAC. This curve is the primary reference level and recording of ultrasonic reflectors shall be performed at this sensitivity.

6.2.4 Recording of Calibration Data

Particulars of system calibration shall be recorded on the Calibration Data sheet.

6.3 Calibration Check

6.3.1 A system calibration check, which is the verification of the instrument sensitivity and sweep range calibration, shall be performed at the start and finish of each examination or series of similar examination, with any change in examination personnel, and at least every 4 hours during an examination. Calibration checks may be performed on either the standard used for initial calibration, or a simulator.

6.4 Corrective Action

6.4.1 If any point on the DAC curve has decreased 20 percent or 2 dB of its amplitude, all data sheets since the last calibration shall be marked void. A new calibration shall be made and recorded and the voided examination area shall be reexamined.

6.4.2 If any point on the DAC curve has increased more than 20% or 2 dB of its amplitude, recorded indications taken since the last valid calibration or calibration check shall be reexamined.

6.4.3 If any point on the DAC curve has moved on the sweep line more than 10 percent of the sweep division reading, correct the sweep range calibration and note the correction on the examination record. If recordable reflectors are noted on the data sheets, those data sheets shall be voided, a new calibration shall be recorded, and the voided examination areas shall be reexamined.

7.0 EXAMINATION

7.1 Reflectors Parallel to the Weld Seam

The angle beam examination for reflectors parallel to the weld shall, in general, be performed by a one-half V path from two sides of the weld.

If variables such as access, weld configuration or wall thickness preclude half V examination, the examination shall be performed by at least a full V path from one side of the weld.

7.2 Reflectors Transverse to the Weld Seam

The angle beam examination for reflectors transverse to the weld shall be performed on the weld crown on a single scan path to examine the weld root by one-half V path in two directions along the weld in a single beam path.

If variables such as weld surface conditions preclude circumferential scans on the weld crown. The examination shall be performed on the base material adjacent to the weld's toe employing the one-half V path 60° shear wave technique. Scanning approximately 15° towards the weld centerline on a single scan path, in two directions, on both sides of the weld crown, when accessible.

Calibration of the circumferential scan employing 15° skew angle shall be performed in conformance with 6.2.2, and by setting the sensitivity from the I.D. notch at approximately 15° from perpendicular.

7.3 Directions and Extent of Scanning

Ultrasonic energy shall pass in all the required directions and the extent of scanning shall be such that the ultrasonic beam passes through the entire examination volume as indicated in Attachment QCIM-38A of this procedure.

8.0 DATA RECORDING AND EVALUATION

- 8.1 Each indication that exceeds 20% DAC, shall be investigated to determine maximum percent of DAC.
- 8.2 For each indication that exceeds 50% of reference level (DAC) but does not equal 100% DAC, the following information shall be on the Indication Data Sheet.
 - 8.2.1 Search unit location at peak amplitude and scan direction.
 - 8.2.2 Peak amplitude as either Db from reference level, or as a percent of DAC.
- 8.3 For each indication that equals or exceeds 100% DAC, the search unit location, orientation and the following information, shall be recorded on the indication data sheet.
 - 8.3.1 Peak amplitude as either dB from the reference level (100% DAC), or as a percent of the DAC curve, sweep reading to reflector, search unit position (distance from weld centerline) and sound beam direction.
 - 8.3.2 Minimum sweep reading to reflector and position of search unit at reference level.
 - 8.3.3 Maximum sweep reading to reflector and position of search unit at reference level.
 - 8.3.4 Search unit positions or locations parallel to the reflector at the end points where the reflector amplitude equals the reference level. (length of reflector).
- 8.4 Indications that can be determined to be of a geometric or metallurgical origin (ie weld geometry, weld-to-base metal interface) need not be recorded on an indication data sheet. However, the amplitude and location from reference shall be recorded in the comments section of the calibration data sheet.
- 8.5 The presence of a reflector of geometric origin shall be confirmed by one of the following.

- 8.5.1 Review of the fabrication drawings of the pipe weld edge preparation.
- 8.5.2 Review of the records from previous non-destructive examinations.
- 8.5.3 Perform supplemental non-destructive examinations.

9.0 RECORDS

- 9.1 A detailed ultrasonic examination report shall be prepared using the applicable report forms provided at the end of this procedure and any additional sketches or photographs as may be applicable. If no reportable indications are detected it shall be so noted on the appropriate report form.
- 9.2 Data shall be entered, as required for each item in the blank space provided on the calibration data sheet, and if used, on the indication data sheet. Where data is not germane for the specific item the blank space shall be marked N/A to indicate that data is not applicable.
- 9.3 Prompt (24 hours) notification of reportable indications shall be made to the representative designated by NED.

10.0 REFERENCES

- 10.1 ASME Section XI, 1980 Edition up to and including Winter '81 Addenda.
- 10.2 QCIM-4 - Nondestructive Examination Personnel Qualification and Certification.
- 10.3 QCIM-36 - Calibration of Ultrasonic Flaw Detectors.

11.0 ATTACHMENTS

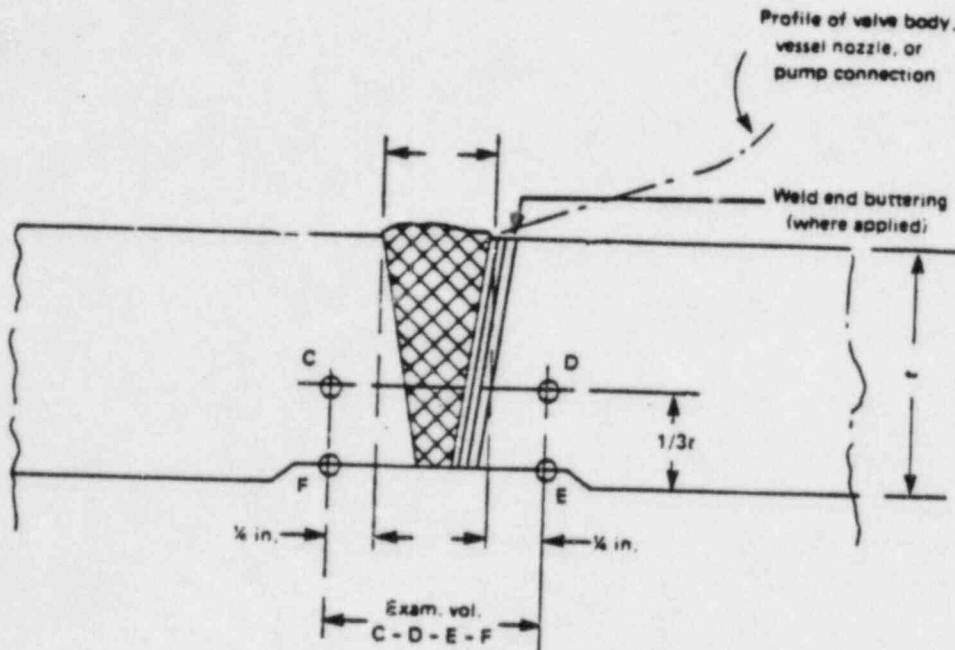
- 11.1 QCIM-38A - Examination Volume
- 11.2 QCIM-38B - Inservice Inspection Calibration Data
- 11.3 QCIM-38C - Inservice Inspection Indication Data
- 11.4 QCIM-38D - Inservice Inspection Sketch Sheet

12.0 COMMITMENTS

The step(s) and section(s) listed below may not be deleted without issuance of comparable controls. The procedure itself, if initiated as a result of commitment corrective action, may not be deleted without issuance of comparable controls.

7.1 None

EXAMINATION VOLUME





INSERVICE INSPECTION
CALIBRATION DATA

PROJECT _____
DATA SHEET NO. _____ DATE _____
PROCEDURE ISH-WT- _____ REV _____

COMPONENT OR SYSTEM _____ PIPE OD (IF APPLICABLE) _____
ITEM IDENTIFICATION NO(S). LISTED ON REVERSE SIDE - COMPONENT TEMP _____ EXAM SURFACE _____ °C _____ °F
CALIBRATION BLOCK NO. _____ THICKNESS _____ TEMP _____

SCAN COVERAGE

OF WHAZ OF BASE MATERIAL AXIAL CIRCUMFERENTIAL

EQUIPMENT DATA

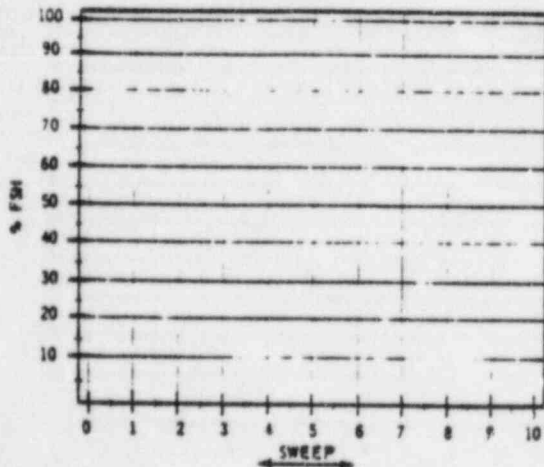
SEARCH UNIT

Manufacturer _____
Style _____
Serial No. _____
Size _____ Frequency _____
Angle _____ Mode _____
Couplant _____ Batch No. _____

INSTRUMENT

Manufacturer _____ Model _____
Serial No. _____ Coaxial Cable Length _____
Frequency _____ Reject _____
Rep Rate _____ Damping _____
dB Gain - Coarse _____ Fine _____
Primary Reference Response _____
Amplitude % Full Screen Height _____

DAC PLOT - TIME _____ AM, PM



NOTE: When performing examinations where no DAC is required, indicate reference reflector location and amplitude above.

CALIBRATION CHECKS

Time	AMPL \pm 20% \pm 2dB OF INITIAL AMPL		SWEEP \pm 5% OF INITIAL LOCATION	
	YES	NO	YES	NO

NOTE: If response above is "NO" refer to Calibration Check section of procedure.

EXAMINER(S):

1. _____ TC-1A LEVEL _____
2. _____ TC-1A LEVEL _____
REVIEWED BY _____ DATE _____



INSERVICE INSPECTION

SKETCH SHEET

LINE AND WELDS: _____

DATE _____

EXAMINER _____

PROJECT _____