ULTRASONIC EXAMINATION

JAICO

PREPARED BY : _____ DATE : _____

REVIEWED BY : _____ DATE : _____

APPROVED BY : _____ DATE : _____

CUSTOMER

REVIEWED BY : _____ DATE : _____

APPROVED BY : _____ DATE : _____

REMARK :

TABLE OF CONTENTS

1.0 SCOPE AND PURPOSE

1.1 This procedure describes the requirements and techniques for Ultrasonic Examination of ferrous materials and their welds in ASME Code job.

1.2 The application of this procedure is limited to straight beam and angle beam method of ultrasonically examining the welded joints, heat affected zone and adjacent base material using manual, contact and pulse-echo ultrasonic techniques.

1.3 The thickness range of the component to be examined will be in between 3mm to 50mm.

2.0 APPLICABLE CODES AND STANDARDS

The following Codes and Standards are referred to herein.

(a) ASME Code Sec.V ('95 Ed. & Latest Applicable Addenda)
(b) ASME Code Sec.VIII, Div.1 ('95 Ed. & Latest Applicable Addenda)
(c) SNT-TC-1A (Current Code Adopted Editions)

3.0 PERSONNEL QUALIFICATION

3.1 All personnel performing the UT shall be certified in accordance with the "JA-WR-1(Standard of NDE Personnel Qualification and Certification)" which complies with the requirements of SNT-TC-1A.

3.2 The results of ultrasonic examination shall be evaluated by only by personnel certified to JAICO UT Level II or Level III.

4.0 SURFACE CONDITION

4.1 The finished contact surfaces shall be free from weld spatter, paint, and any roughness that would interfere with free movement of the search unit or impair the transmission of ultrasound.

4.2 The weld surface shall be finished so that they cannot mask or be confused with reflections from defects, and shall merge smoothly onto the surface of the adjacent base materials.

5.0 EQUIPMENT & MATERIALS

5.1 Flaw Detector

The following instrument or equivalent shall be utilized for this examination.

5.1.1 The ultrasonic test instrument shall be of the pulse echo type ; Krautkramer USK-7, USK-7D, USD-10 or equivalent.

5.1.2 The ultrasonic test instrument shall generate, receive and present the relevant pulses on a CRT screen in the frequency range from 1 to 5 MHz.

5.1.3 The ultrasonic instrument shall provide linear vertical presentation within ±5% of the full screen height for 20% to 80% of the calibrated screen height (base line to maximum calibrated screen point(s)).
The procedure for evaluating screen height linearity is provided in Para. 6.1 and shall be performed at the beginning of each period of extended use (or every 3 months, whichever is less).

5.1.4 The ultrasonic instrument shall utilize an amplitude control accurate over its useful range to ±20% of the nominal amplitude ratio, to allow measurement of indications beyond the linear range of the vertical display on the screen. The procedure for evaluating amplitude control linearity is given in Para. 6.2 and shall be performed at the beginning of each period of extended use(or every 3 months, whichever is less).

5.2 Search Units

5.2.1 For straight beam examination, search units shall be produced longitudinal wave. For angle beam examination, search units shall be produced transverse wave in the material and Angle of refraction shall be either nominal 45°or 60°or 70°.

5.2.2 Search units with contoured contact wedges may be used to aid ultrasonic coupling. Calibration shall be done with the contact wedges used during the examination.

5.2.3 The circular transducer elements shall not greater than 1⅛ in. diameter, and the rectangular transducer elements shall not greater than ¾ in. high x 1 in. wide.

5.2.4 Based on the signal-to-noise ratio of the response pattern of the object to be examined, a frequency in the range from 1 to 5 MHz shall be used.

5.3 Calibration Blocks

5.3.1 Test instrument shall be calibrated using standard calibration block and basic calibration blocks fabricated from material that is acoustically similar to that being inspected.

5.3.2 Standard Calibration Blocks (Simulator)

(a) International Institute of Welding (IIW)

(b) Rompas (DIN 54122)

(c) Institute of Welding (IOW)

5.3.3 Basic Calibration Blocks

(a) Basic calibration block shall be material of the same material specification and product form or equivalent P-Number grouping as one of the materials being examined.

(b) Calibration block configuration requirements are specified in Fig.1 and Fig. 2.

(c) Additional reflectors may be installed ; these reflectors shall not interfere with establishing the primary reference.

(d) For examinations in materials where the examination surface diameter is greater than 20 in., a block of essentially the same curvature, or alternatively, a flat basic calibration block, shall be used.

(e) The basic calibration block shall be curved for materials with diameters 20 in. and less. A single curved basic calibration block may be used to calibrate the examination on surfaces in the range of curvature from 0.9 to 1.5 times the basic calibration block diameter.

(f) The calibration block shall receive at least the minimum tempering treatment required by the material specification for the type and grade, and also a PWHT of at least 2 hr. P-Nos. 1, 3, 4 and 5 materials are considered equivalent.

5.3.4 Other calibration blocks may be used to establish equipment sensitivity for special items.

5.4 Couplants

Glycerin shall be used to couple the search unit to the test surface. Couplants may not be comparable to one another and the same couplant at a similar temperature shall be used for calibration and examination.

6.0 CHECKING AND CLAIBRATION OF EQUIPMENT

The proper functioning of the examination equipment shall be checked and the equipment shall be calibrated by the use of the calibration standard at the beginning and end of each examination, when examination personnel are changed, and at any time that malfunctioning is suspected, as a minimum. If during any check it is determined that the testing equipment is not functioning properly, all of the product that has been tested since the last valid equipment calibration shall be reexamined.

6.1 Screen Height Linearity

To verify the ability of the ultrasonic instrument to meet the linearity requirement of 5.1.3, position an angle beam search unit as shown in Fig.3 so that indications can be observed from both the $\frac{1}{2}$ and $\frac{3}{4}$T holes in a basic calibration block. Adjust the search unit position to give a 2:1 ratio of amplitudes between the two indications, with the larger set at 80% of full screen height.
Without moving the search unit, adjust sensitivity(gain) to successively set the larger indication from 100% to 20% of full screen height, in 10% increments(or 2dB steps if a fine control is not available), and read the smaller indication at each setting.
The reading must be 50% of the larger amplitude,within 5% of full screen height. The settings and readings must be estimated to the nearest 1% of full screen. Alternatively, a straight beam search unit may be used on any calibration block which will provide amplitude differences, with sufficient signal separation to prevent overlapping of the two signals.

]6.2 Amplitude Control Linearity

To verify the accuracy of the amplitude control of the ultrasonic instrument, as required in 5.1.4, position an angle beam search unit as shown in Fig.3 so that the indication from the ½T hole in a basic calibration block is peaked on the screen. With the increases and decreases in attenuation shown in the following table, the indication must fall within the specified limits. Other convenient reflectors any calibration block may be used with angle or straight beam search units.

Indication Set at % of Full Screen	dB Control Change	Indication Limits % of Full Screen
80 %	-6dB	32 to 48 %
80 %	-12dB	16 to 24 %
40 %	+6dB	64 to 96 %
20 %	+12dB	64 to 96 %

The settings and readings must be estimated to the nearest 1% of full screen.

7.0 SYSTEM CALIBRATION

7.1 General Requirements

Calibration shall include the complete ultrasonic examination system. The original calibration must be performed on the basic calibration block. Checks shall be made to verify the sweep range calibration and distance amplitude correction. Checks shall include the entire examination system. In all calibrations, it is important that maximum indications be obtained with the sound beam oriented perpendicular to the axis of the side-drilled holes and notches. The center line of the search unit shall be at least 1½ in. from the nearest side of the block (rotation of the beam into the corner formed by the hole and the side of the block may produce a higher amplitude at a longer beam path ; this beam path shall not be used for calibration). For contact examination, the temperature difference of the examination and basic calibration block surfaces shall be within 25°F.

7.2 Calibration Measurements

Each calibration shall be performed from the surface corresponding to the surface of the component from which the examination will be performed.

7.3 Techniques

Article 4, Appendices B and C, ASME Section V, gives general techniques for both angle beam and straight beam calibrations. Other techniques may be used.

7.4 Angle Beam Calibration

As applicable, the calibration shall provide the following measurements (Article 4, Appendix B contains a general technique) :

(a) Sweep range calibration ;

(b) Distance-amplitude correction ;

(c) Position calibration ;

(d) Echo amplitude measurement from the surface notch in the basic calibration block.

7.5 Straight Beam Calibration

The calibration shall provide the following measurements (Article 4, Appendix C gives a general technique):

(a) Sweep range calibration ;

(b) Distance-amplitude correction.

7.6 Calibration Check on Basic Calibration Block

When any part of the examination system is changed, a calibration check shall be made on the basic calibration block to verify that $\frac{1}{4}$T, $\frac{1}{2}$T and $\frac{3}{4}$T points on the sweep and distance amplitude correction values recorded satisfy the requirements of 8.0. Where original calibration data exist for the part of the system replaced, a check as permitted in 7.0 may be used.

7.7 Calibration Check on Basic Calibration Block or Simulator Check

A calibration check on at least one of the basic reflectors in the basic calibration block or a check using a simulator shall be made at the finish of each examination or series of similar examinations, every 4 hr during the examination, and when examination personnel (except for automated equipment) are changed.

7.8 Simulator Check

Any simulator checks that are used shall be correlated with the original calibration on the basic calibration block during the original calibration. The simulator checks may use different types of calibration reflector or block (such as IIW) and/or electronic simulation. However, the simulation used shall be completely identifiable on the calibration sheet(s). The simulator check shall be made on the entire examination system. The entire system does not have to be checked in one operation; however, for its check, the search unit shall be connected to the ultrasonic instrument and checked against a calibration reflector. Accuracy of the simulator checks shall be confirmed, using the basic calibration block, at the conclusion of each period of extended use, or every 3 months, whichever is less. The requirements for calibration confirmation of 8.0 and 8.1 shall be met.

8.0 CALIBRATION CONFIRMATION

Calibration shall be performed prior to use of the system in the thickness range under examination. A calibration check shall verify the sweep range calibration and distance amplitude correction.

8.1 Sweep Range Correction

If a point on the DAC curve has moved on the sweep line more than 10% of the sweep reading or 5% of full sweep, whichever is greater, correct the sweep range calibration and note the correction in the examination record. If reflectors are recorded on the data sheets, those data sheets shall be voided and a new calibration shall be recorded. All recorded indications since the last valid calibration or calibration check shall be reexamined with the corrected calibration and their values shall be changed on the data sheets.

8.2 DAC Correction

If a point on the distance-amplitude correction(DAC) curve has decreased 20% or 2dB of its amplitude, all data sheets since the last calibration or calibration check shall be marked void. A new calibration shall be made and recorded and the area covered by the voided data shall be reexamined. If any point of the distance-amplitude correction (DAC) curve has increased more than 20% or 2dB of its amplitude, all recorded indications since the last valid calibration or calibration check shall be reexamined with the corrected calibration and their values shall be changed on the data sheets.

9.0 GENERAL EXAMINATION REQUIREMENT

9.1 Examination Coverage

Wherever feasibles, the scanning of the examination volume shall be carried out from both side of the weld on the same surface. Where configuration or adjacent parts of the component are such that scanning from both sides is not feasible, this fact shall be included in the report of the examination. Each pass of search unit shall overlap a minimum 10% of the transducer dimension perpendicular to the direction of the scan.

9.2 Rate of Search Unit Movement

The rate of search unit movement for examination shall not exceed 6 in./ sec unless calibration is verified at scanning speed.

10.0 EXAMINATION TECHNIQUE

10.1 Surface Preparation

Surface preparation of base metal and weld metal shall be performed to the requirements of Para. 4.0.

10.2 Scanning

10.2.1 The scanning of the adjacent base metal shall be performed with the straight beam search unit to detect reflectors that might affect interpretation of angle beam results, and is not to be used as an acceptance/rejection examination. Locations and areas of such reflectors shall be recorded.

10.2.2 Angle Beam Scanning for Reflectors Oriented Parallel to the Weld.

The angle beam shall be directed at approximate right angles to the weld axis from two directions where possible. The search unit shall be manipulated so that the ultrasonic energy passes through the required volumes of weld and adjacent base metal. The scanning shall be performed at a gain setting at least two times the primary reference level. Evaluation shall be performed with respect to the primary reference level.

10.2.3 Angle Beam Scanning for Reflectors Oriented Transverse to the Weld.

The angle beam shall be directed essentially parallel to the weld axis. The search unit shall be manipulated so that the angle beam passes through the required volumes of weld and adjacent base metal. The scanning shall be performed at a gain setting at least two times the primary reference level. Evaluation shall be performed with respect to the primary reference level. The search unit shall be rotated 180°and the examination repeated.

10.2.4 Evaluation

Any imperfection which causes an indication in excess of 20% DAC shall be investigated to the extent that it can be evaluated in terms of the acceptance standards. The position of imperpection shall be indicated by the position of the search unit showing maximum amplitude. The moving distance of the search unit in the range where amplitudes exceed half the maximum amplitude shall be measured as the length of the imperpection.

10.3 Post Examination Cleaning

10.3.1 Post examination cleaning is necessary in those cases where residual couplant or examination remnant could interfere with subsequent processing or with service requirements.

10.3.2 The residual couplant or examination remnant may be removed by wiping with a cloth or absorbent paper.

11.0 ACCEPTANCE STANDARDS

Imperfections which produce a response greater than 20% of the reference level shall be investigated to the extent that the operator can determine the shape, identity and location of all such imperfections and evaluate them in terms of the acceptance standards given in 11.1 and 11.2 below.

11.1 Indications characterized as cracks, lack of fusion, or incomplete penetration are unacceptable regardless of length.

11.2 Other imperfections are unacceptable if the indications exceed the reference level amplitude and have lengths which exceed ;

(1) $\frac{1}{4}$ in. for t up to $\frac{3}{4}$ in. ;
(2) $\frac{1}{3}$ t for t from $\frac{3}{4}$ in. to 2 in. incl.

For ASME Sec.VIII Div.1, t is the thickness of the weld excluding any allowable reinforcement. For a butt weld joining two members having different thicknesses at the weld, t is the thinner of these two thicknesses. If a full penetration weld includes a fillet weld, the thickness of the throat of the fillet shall be included in t.
For ASME Sec.I & B31.1, t is the thickness of the weld being examined. If the weld joins two members having different thicknesses at the weld, t is the thinner of these two thicknesses.

12.0 REPORTS AND RECORDS

12.1 Examination Reports.

A report of the examinations shall be made. The reports shall include a record indicating the weld(s) or volume examined (this may be marked-up sketched), the location of each recorded reflector, and the identification of the operator who carried out each examination or part there of as detailed in Para. 12.3.

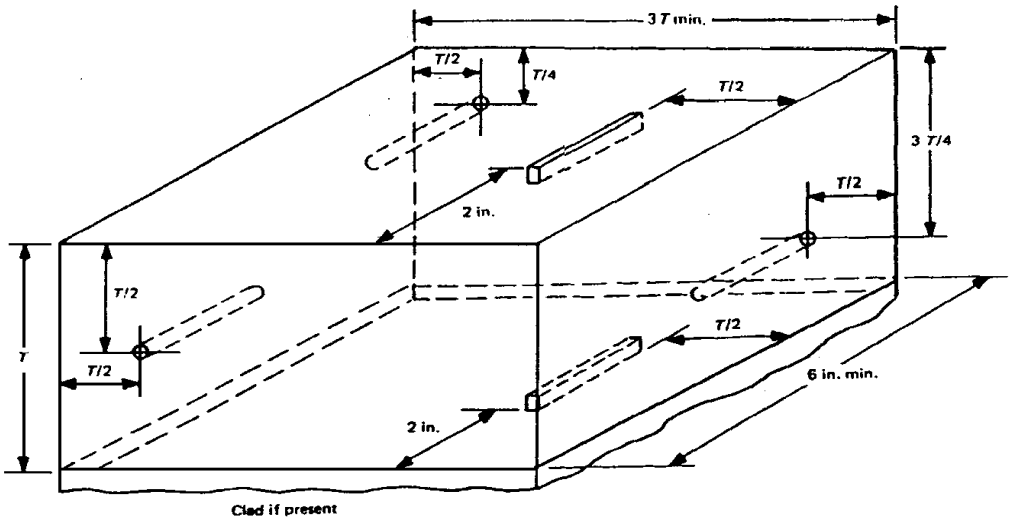
12.2 A record of all reflections from uncorrected areas having responses that exceed 50% of the reference level shall be maintained. This record shall locate each area, the response level, the dimensions, the depth below the surface, and the classification.

12.3 Examination condition and interpretation & evaluation shall be recorded on the Report of Ultrasonic Examination (Exhibit 1-1,1-2) attached to this procedure.

13.0 ATTACHMENT

REPORT OF ULTRASONIC EXAMINATION

EXHIBIT 1-1 : REPORT OF ULTRASONIC EXAMINATION (A)
EXHIBIT 1-2 : REPORT OF ULTRASONIC EXAMINATION (B)



Weld Thickness t	Basic Calibration Block Thickness T	Hole Diameter	Notch Size
1 in. or less	3/4 in. or t	3/32 in.	Width = 1/8 in. to 1/4 in.
Over 1 in. through 2 in.	1-1/2 in. or t	1/8 in.	
Over 2 in. through 4 in.	3 in. or t	3/16 in.	Depth = 2% T or 0.04 in.,
Over 4 in. through 6 in.	5 in. or t	1/4 in.	whichever is greater,
Over 6 in. through 8 in.	7 in. or t	5/16 in.	into the base metal.
Over 8 in. through 10 in.	9 in. or t	3/8 in.	
Over 10 in.	t ±1 in.	[No (1)]	Length = 2 in. min.

GENERAL NOTES:

(a) Holes shall be drilled and reamed a minimum of 1-1/2 in. deep, essentially parallel to the examination surface.

(b) Alternatively, the block may be constructed as shown in Fig. T-441.1.

(c) Curved surfaces: for curved surfaces, two curved blocks, one for each representative curvature: or two sets of calibration reflectors oriented 90 deg. from each other shall be used.

(d) Notches may be provided as required.

(e) The tolerance for hole diameter shall be ±1/32 in. The tolerance on notch depth shall be + 10 and -20%. The tolerance on hole location through the thickness shall be ±1/8 in.

NOTE:

(1) For each increase in weld thickness of 2 in. or fraction thereof over 10 in., the hole diameter shall increase 1/16 in.

FIG 1. BASIC CALIBRATION BLOCK

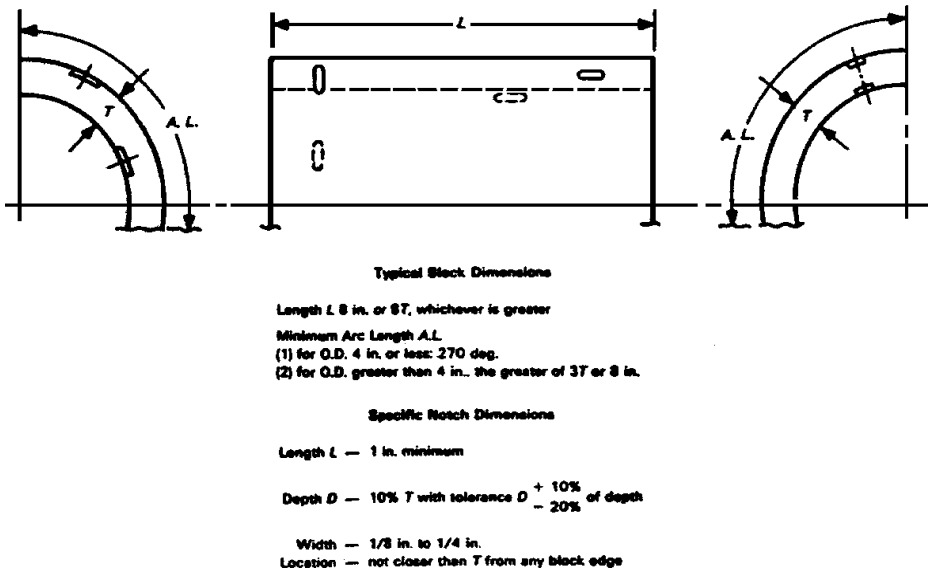


FIG 2. ANGLE BEAM CALIBRATION (PIPE WELD)

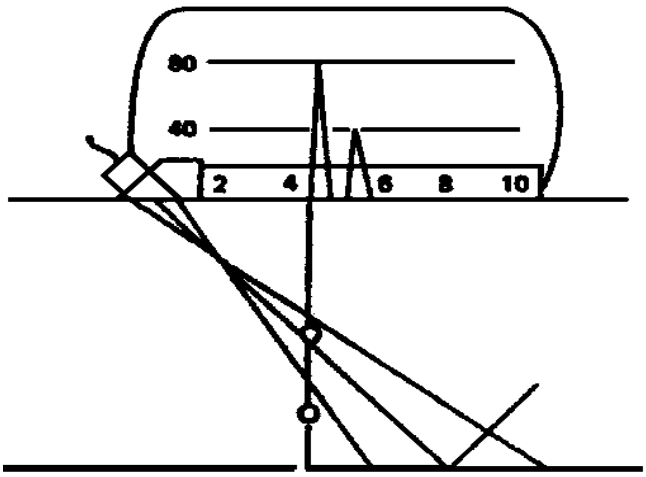


FIG 3. LINERITY

EXHIBIT 1-1 : REPORT OF ULTRASONIC EXAMINATION (A)

EXHIBIT 1-2 : REPORT OF ULTRASONIC EXAMINATION (B)