

QAP 5953 Quality Assurance Procedure

Method of Test For

Ultrasonic Inspection Procedure for Complete Joint Penetration (CJP) Welds in a T-Joint

1. SCOPE

1.1 This procedure is applicable to weld sizes 1/4 inch through 9/16 inch with attachment plate thicknesses 3/8 inch through 1 inch. CJP welds using T-joints, both skewed with dihedral angles between 60 and 135 degrees, and normal (90 degrees) are tested using this procedure. This procedure may be used in lieu of using a 3.5-5 Mhz transducer and the AASHTO/AWS D1.5M/D1.5: current edition, Section 6 procedure.

1.2 This procedure provides for the detection, location and evaluation of discontinuities located in the filler metal (weld), though heat affected zone cracks may be indicated. Piping porosity, slag inclusions, and cracks are indicated. Whereas complex analytical techniques are applicable to classify discontinuities, this procedure simplifies evaluation by utilizing high sensitivity and resolution, while providing accurate length measurements.

1.3 The probability of detection for centerline cracking (solidification, hot tear) cracks, using this procedure, has been established at 87.5% at the 95% confidence level.

1.4 Ultrasonic testing shall be performed in accordance with AASHTO/AWS D1.5M/D1.5:2015, Chapter 6 Part C except as amended by this procedure.

2. PERSONNEL

2.1 Personnel performing ultrasonic testing of fillet welds shall be qualified in accordance with the American Society for Nondestructive Testing's (ASNT) Recommended Practice No. SNT-TC-1A. Only Level II individuals that have been examined by a Level III meeting the requirements of AASHTO/AWS D1.5M/D1.5: current edition, Section 6.1.3.4 shall perform this test. The Level II individual shall demonstrate the ability to apply the technique as specified in this procedure.

3. APPARATUS

3.1 Ultrasonic equipment shall meet the requirements of AASHTO/AWS D1.5M/D1.5: current edition, Section 6.15 with the following exceptions:

Initial Scanning Search Unit

3.1.1 The transducer crystal shall be a round, 0.5" diameter, with a nominal central frequency of 3.5 MHz.

3.1.2 The search unit shall produce a refracted longitudinal wave at:

45 ± 1 degree when testing from Faces A or B. 35 ± 1 degree when testing from Face C.

(Testing is performed from Faces A or B whenever possible - see Figure 1)

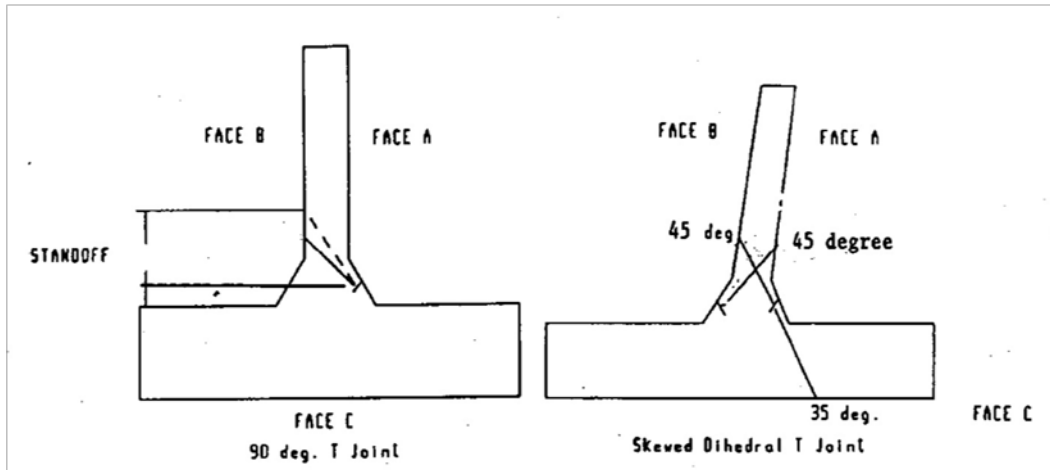


Figure 1

3.1.3 The maximum internal reflections of the search unit shall be established as follows:

Calibrate in accordance with AASHTO/AWS D1.5M/D1.5: current edition, Sections 6.18.5.2 and 6.21.2.4. The sensitivity shall be increased 24 dB. Maximum internal reflections shall not exceed 50% of screen height beyond 1/2" sound path.

3.1.4 The dimensions of the search unit shall be such that the maximum distance from the entry point to the leading edge of the search is 1/4". **Evaluation Scanning Unit**

3.1.5 The transducer and search unit shall be as described in 3.1.1 - 3.1.4 to evaluate discontinuities which have a measured length $\geq 9/16$ inch.

3.1.6 A 0.5 inch diameter, 3.5 Mhz focused transducer with a search unit which provides a focal length = sound path to the reflector ± 0.2 inch shall be used to evaluate the length of discontinuities which, using the scanning transducer have an apparent length $\leq 5/8$ inch.

3.1.7 The search unit shall meet the criteria of 3.1.2 - 3.1.4.

3.1.8 The instrument shall be set to produce a pulse repetition rate of 2 kHz.

Equipment Qualification

3.1.9 Equipment shall be qualified in accordance with AASHTO/AWS D1.5M/D1.5: current edition, Sections 6.17 and 6.21, with the following exceptions:

3.1.9.1 After each 4 hours of search unit use, verify:

3.1.9.1.1 The search unit contact face is flat within ± 0.005 inch, and the focused search unit focal length is established.

3.1.9.1.2 Both the actual refracted angle and the squint angle are within ± 1 degree. The actual refracted angle shall be used to calculate the theoretical sound path (as defined in paragraph 5.4 and evaluation purposes.

The squint angle (see Fig. 2) shall be adjusted for the minimum value, i. e., the transducer has been mounted on the wedge such that this angle is minimized. The squint angle shall be measured as follows:

- (A) Position the search unit at position A on the IIW or position K on the DSC block.
- (B) Maximize the signal from the side drilled hole.
- (C) Measure the angulation of the search unit from normal to the hole axis and record.

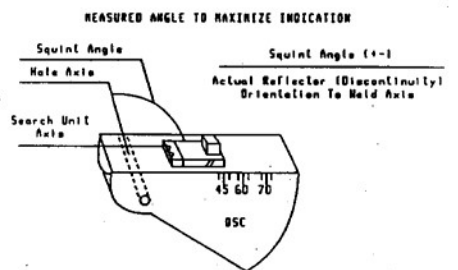


Figure 2

4. CALIBRATION FOR TESTING

Initial Scanning Transducer

4.1 Calibration (initial scanning transducer 3.1.1 - 3.1.4) shall be performed in accordance with AASHTO/AWS D1.5M/D1.5: current edition, except as follows:

4.1.1 All calibrations and evaluations shall be made with reject off, unless optimization of the damp and reject controls are made such that:

4.1.1.1 Vertical linearity meets the requirements of AASHTO/AWS D1.5M/D1.5: current edition, Section 6.15.4.

4.1.1.2 Resolution on the RC block is comparable to the resolution with reject off.

4.1.2 The horizontal sweep shall be calibrated using the IIW block, DC - distance reference block, or the DSC - distance and sensitivity reference block. The distance calibration shall be made using either the 2, 5 inch scale (Gating, magnification, and use of digital readout are useful in establishing accurate measurements). The lowest range that includes the longest sound path for complete volumetric scanning of the weld and heat affected zone shall be used. Complete volumetric scanning is defined as:

0.50" x Sound Path Length to the opposite fillet toe + 0.1 inch

Calibrate the distance as follows:

(1) Set a straight beam transducer in position G on the IIW block. Set the transducer in position G on the IIW block. Set the transducer in position M on the DSC block.

(2) Adjust the search unit to produce signals at:
1",2" etc.

Note: Indications are measured at the intersect of the left side of the signal at the base line.

(3) Couple the angle beam search unit to position J on the DSC block and sweep the 1" radius signal to 1" for the range used (adjustment will be necessary as the angle beam search unit has introduced delay in the horizontal range relative to the straight beam transducer calibration made previously).

4.1.3 The reference level shall be established in accordance with AASHTO/AWS D1.5M/D1.5: current edition, Section 6.21.2.4 or may be established from the 1/8" diameter hole in the DSC block, provided correlation to the 0.060" hole in the IIW block is established.

Evaluation Scanning Unit

4.1.4 The focal length shall be established on 0.060 holes at 1/16 inch incremental depths. This shall be performed every 40 hours.

5. EXTENT OF TESTING

Production Welds

5.1 The last fabricated sequenced web to flange attachment weld on each member shall be ultrasonically tested as follows:

5.1.1 Ten feet on each end and five feet each side of the centerline of the member span shall be tested.

5.1.2 When discontinuities which do not meet the acceptance criteria are found, the remaining length of the weld shall be tested, and in addition, the next to last sequential web to flange attachment weld that was made on the same member shall be tested in accordance with 5.1.1 and this paragraph.

Attribute Welds

5.1.3 Attribute welds which due to workmanship or technique nonconformance may indicate subsurface cracks or other defects shall be tested as necessary.

6. TEST SURFACE PREPARATION

6.1 Prepare the test surface by removing all spatter, scale, rust and foreign material. Areas which have chain, or other lifting apparatus marks shall be ground to provide intimate coupling with the search unit. Intimate coupling requires no gap greater than 0.005 inch between the search unit and test surface.

7. TESTING AND EVALUATION PROCEDURE

The following test procedure shall be used:

7.1 Testing shall be performed with the sound progressing from Face A or B, whenever possible (Fig. 1). Testing with the sound progressing from Face C may be required for evaluation in accordance with 7.12.3.

7.2 Testing shall be performed in Leg I.

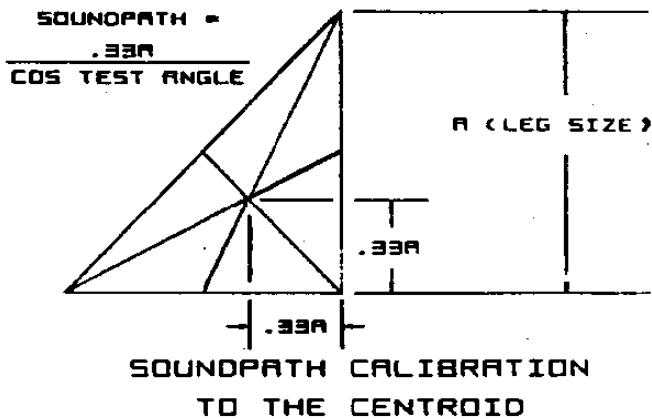
7.3 Measure the fillet weld size at each end of the weld test length, and which appears representative of the test weld. The fillet weld size for unequal leg fillet welds shall be taken as the average of the two legs. The size determined shall be the fillet size referenced in this procedure.

7.4 The standoff line and the sound path length shall be established from the centroid of the fillet weld to the test surface as follows (Fig 3,4):

$$\text{STANDOFF} = (T + 1/3 F) \times \text{Tangent A} \quad \text{SOUNDPATH} = (T + 1/3 F) / \text{Cosine A}$$

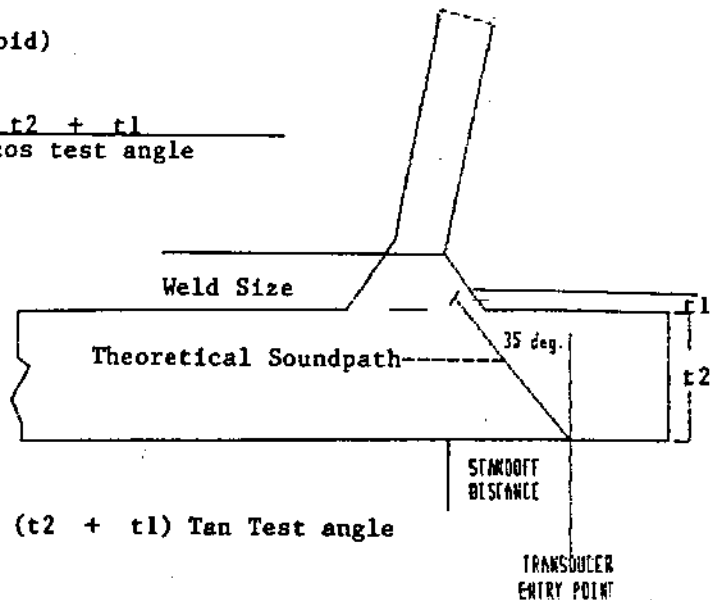
Where:

- T = Thickness of the plate from which tested for Leg I,
- A = Actual refracted angle of the search unit (nearest degree),
- F = Fillet weld size



$t1 = 0.33 \text{ Weld Size (Centroid)}$
 $t2 = \text{test plate thickness}$

Theoretical Soundpath = $\frac{t2 + t1}{\cos \text{ test angle}}$
To Weld Centroid



**Standoff Distance to
Intersect Weld Centroid =** $(t2 + t1) \tan \text{ Test angle}$

7.5 The standoff line shall be established on the test surface both on (1) a joint section (drawn to scale) with the actual dihedral angle, test plate thickness, and the weld size (2) on the actual test plate surface. The standoff line is established by determining the entry point position on the test surface which produces intercept of the center of the sound beam with the weld centroid.

In lieu of establishing a standoff line on the test surface, the offset of the search unit with respect to the edge of the flange (Face C) or the weld toe (Faces A, B) may be established on the joint section and referenced during evaluation.

Verify the required volume can be scanned without: (1) interfering reflections from the outside corner of the bottom flange (search unit overhang) when testing from Face C, or (2) geometrical interference of the weld toe, when testing from either Face A or B, which prevents the center of the beam from intersecting the weld centroid.

7.6 Scanning sensitivity shall be 24 dB above the reference level.

7.7 Scan with the entry point of the transducer on the standoff position (line) using scanning pattern F, as shown in Figure 5.

7.8 Scan from the standoff distance using pattern E from both directions (see Figure 6).

7.9 Scan from the standoff line moving $\pm 1/4"$ using combined movements A, B, and C (see Figure 5).

7.10 A gated alarm shall be used when testing in the daylight. The gate shall be set at range including the signal sound path distances indicated in paragraph 7.12.

7.11 The scanning rate shall not exceed 2 in/sec for scanning pattern F nor 3 in/sec for all other scanning patterns.

7.12.2 Maximized indications brought to reference level that occur within the boundaries of column C, and have a transducer entry position within the boundaries of column B shall be evaluated for length using the 6 dB drop method in accordance with AASHTO/AWS D1.5M/D1.5: current edition, Section 6.23.2.

Discontinuity lengths which are $\geq 5/8$ inch shall be evaluated for acceptance in accordance with 8.1.

Discontinuity lengths $\leq 9/16$ inch shall be evaluated using the focused transducer described in 3.1.2. The gain shall be adjusted so bring the reflector signal to reference height. The 6 dB drop method shall be used. The measured length shall be evaluated in accordance with 8.1.

7.12.3 Record the indication rating (though not a factor used in the acceptance criteria) as follows:

The indication rating (for instruments with gain in dB) =

Indication Level (a) - Reference Level (b)

7.12.4 Maximized indications brought to reference level and exhibit a soundpath length greater than:

SOUNDPATH (PAR. 7.4) + TABLE 1; COLUMN C (+)

shall be scanned from the opposite direction of the throat axis. That is, if originally scanned from Faces A or B, scan from Face C, and vice versa.

A	B	C
Fillet Weld Size	Deviation From Theoretical Standoff	Deviation from Theoretical Soundpath to Centroid
1/4"	+0, -1/16"	±0.03"
5/16"	+0, -1/8"	±0.04"
3/8"	+0, -1/8"	±0.05"
7/16"	+1/16, -3/16"	±0.06"
1/2"	+1/16, -3/16"	±0.07"
6/16"	+1/8, -1/4"	±0.08"

Perform evaluation in accordance with paragraphs 7.12.1 and 7.12.2. Acceptance shall be determined in accordance with paragraph 8.1

7.12.5 Maximized indications brought to reference level that exhibit a sound path equal to, or less than:

$$\frac{\text{Test Plate Thickness} *}{\cos(\text{Cosine Test Angle})} - 0.04"$$

* (From Which Tested)

shall be evaluated in accordance with paragraphs 7.12.1 and 7.12.2. Acceptance shall be determined in accordance with paragraph 8.1.

8. ACCEPTANCE - REJECTION CRITERIA

8.1 Ultrasonic acceptance criteria shall be as follows:

8.1.1 Welds subject to tensile stress under any condition of loading shall conform to the requirements of Figure 6.

9. DOCUMENTATION

9.1 Test reports shall include the:

- (1) Indication rating.
- (2) Indication sound path.
- (3) Transducer entry point from standoff, + (+ indicates an entry point position that is toward the weld axis from the standoff line).
- (4) Indication length. (5) Member number.
- (6) Test weld location within the member.
- (7) Defect location in the test weld.

