ISQ-O&G

Manual Ultrasonic Testing Shear Wave ASME Weld Quality Examination

ASNT Certification Services, LLC

Document UT-PTP8
Revision 02

Revision	Date	Summary of Changes
00	12-17-2020	Original document draft
01	07-01-2021	LLC and logo changes to the document
02	01-03-2024	Editorial changes only

TABLE OF CONTENTS

1. **PURPOSE**
2. **SCOPE**
3. **REFERENCES**
4. **ACRONYMS**
5. **DEFINITIONS**
6. **RESPONSIBILITIES**
7. **EQUIPMENT**
8. **SAMPLES**
9. **STANDARDIZATION**
10. **EXAMINATION**
11. **REPORTING**
12. **APPENDIX A: Exam Discontinuity Evaluation Guidance**

1.0 Purpose

1.1 This procedure provides instructions for candidates performing manual Ultrasonic Testing Shear Wave (UTSW) weld quality examinations for detection and characterization of common weld fabrication discontinuities. This procedure is to be used exclusively for the ASNT Certification Services, LLC (ASNT CS) ISQ-O&G-UTSW) weld quality exam, referred to as ISQ-O&G UTSW exam throughout this document.

2.0 Scope

2.1 This procedure describes the method for performing manual (nonencoded), contact, single-element pulse echo shear wave ultrasonic weld examinations on carbon steel test samples for the ISQ-O&G-UTSW examination. This procedure is not applicable for use outside of the ASNT Certification Services LLC ISQ-O&G-UTSW examination.

2.2 This procedure is only applicable to carbon steel samples in the material thickness range of 0.250 to 3.000 in. (6.35 to 76.20 mm).

3.0 References

3.1 Unless otherwise specified, the latest edition of the referenced documents are applicable.

3.1.1 **QP-ISQ-2** Industry Sector Qualification Oil & Gas Program

3.1.2 **ASNT Recommend Practice No. SNT-TC-1A:** *Personnel Qualification and Certification in Nondestructive Testing Personnel*

3.1.3 **O&G UTSW-4** Ultrasonic Shear Wave Pressure Equipment Weld Examination Protocol

3.1.4 **O&G UTSW-5.2** Exam Sample Scanning Instructions

3.1.5 **O&G UTSW-6.1, 6.2, 6.3, and 6.4** Exam Report Forms

3.1.6 ***ASME BPVC*** Section V: *Nondestructive Examination*, Article 4, *Ultrasonic Examination of Welds*

4.0 Acronyms

4.1 **AEP–**Authorized Examination Proctor

4.2 **ANSI–**American National Standards Institute

4.3 **ASNT–**American Society for Nondestructive Testing

4.4 **ASNT CS**–ASNT Certification Services LLC

4.5 **ASTM–**ASTM International

4.6 **ASME–**American Society of Mechanical Engineers

4.7 **ID–**Inside Diameter, also considered the opposite surface from the scanning surface for purposes of this ISQ-O&G UTSW exam.

4.8 **ISQ**–Industry Sector Qualification

4.9 **IIW–**International Institute of Welding

4.10 **NDT–**Nondestructive Testing

4.11 **OD–**Outside Diameter, also considered the scanning surface for purposes of this ISQ-O&G UTSW exam.

4.12 **O&G–**Oil and Gas

4.13 **UTSW–**Ultrasonic Testing Shear Wave

4.14 **DAC–**Distance Amplitude Curve

4.15 **TCG–**Time-Corrected Gain

5.0 Definitions

5.1 **Certification Management Committee (CMC):** The ASNT CS committee that has the overall responsibility for developing and maintaining the technical content of all ASNT CS certification programs and shall have the sole responsibility for the determination of certification outcomes in those programs.

5.2 **Industry Sector Qualification (ISQ):** A qualification program where practical demonstration examinations are given to an NDT examiner, for a specific NDT technique applicable to a given industry sector, to assess competency in performing examinations. The ISQ shall be awarded upon successful passing of the examination.

5.3 **ASNT CS Certification Department:** The ASNT CS Certification Department is responsible for the administration and facilitation of ASNT CS certification programs in accordance with procedures developed by the ASNT CS CMC.

5.4 **Steering Committee:** The group of O&G owner/operator subject matter experts responsible for the development and maintenance of the ISQ program. The committee fairly and equitably represents the interests of all parties significantly concerned with the ISQ-O&G scheme without any particular interest predominating. The parent committee is the ASNT CS CMC over the Oil & Gas owner/user steering committee for the ISQ-O&G program.

5.5 **Test sample:** A sample of a product form containing known discontinuities used in practical examinations.

6.0 Responsibilities

6.1 The examination sample scanning instructions O&G-UTSW-5.2 and this examination procedure UT-PTP8, shall be read and understood by the candidate before applying for the ISQ-O&G UTSW exam. The candidate shall be expected to follow the UTSW examination instructions and the UTSW examination procedure during the examination. Failure to do so may cause a failure on the exam.

6.2 ISQ-O&G UTSW candidates are responsible for bringing and utilizing their own equipment,

including: ultrasonic flaw detector, transducers, cables, reference standards, couplant, and rags. The candidate is responsible for referring to this procedure and selecting the proper equipment for use during their ISQ UTSW exam.

6.3 The candidate shall perform manual (nonencoded) contact ultrasonic testing shear wave on the ISQ-O&G UTSW test samples assigned to them during their exam which may, or may not, contain manufactured discontinuities.

6.4 The candidate shall complete their UTSW examination and the associated reporting in compliance with O&G UTSW-5.2 exam sample scanning instructions.

6.5 The ISQ Oil & Gas Steering Committee and CMC are responsible for this ISQ-O&G UTSW procedure and any revisions required for this procedure.

7.0 Equipment

7.1 Ultrasonic Instruments

7.1.1 A candidate shall use an ultrasonic testing) flaw detector. Digital or analog instruments may be used. A candidate should take the ISQ-O&G UTSW exam with the instrument they normally use on a regular basis during their work duties.

7.1.1.1 For instruments with additional B-scan, C-scan, Sector scan, and/or Full Matrix Capture (FMC) functions, these functions shall be switched off and only the A-scan function shall be utilized during the exam.

7.1.2 Flaw detector instrumentation should be capable of generating frequencies within the range of 1 to 10 MHz, with 2.25 to 5 MHz being the typical range of frequency for use with this procedure.

7.1.3 Ultrasonic instruments used to this procedure should have been calibrated within the last year.

7.2 Transducers

7.2.1 Any single element shear wave transducers applicable to weld discontinuity detection, characterization, and length sizing are acceptable for use with this procedure.

7.2.2 Shear wave transducers with element sizes from 0.25 to 1 in. (6.35 to 25.40 mm), round or square in shape, may be used with this procedure.

7.2.3 Wedges used in UTSW examination should be compatible with selected transducers and can be integral or nonintegral. At a minimum, the following wedge angles should be used on all welds examined in accordance with this procedure: 45°, 60°, and 70° shear wave refracted angles in carbon steel. Other angles are acceptable as well at the candidate's discretion but should be used in addition to the three primary angles listed above.

7.2.4 The selection of transducer frequency, type, and diameter will depend on the test sample thickness and weld configuration.

7.2.4.1 In general, the search unit frequencies utilized should be from 2.25 to 5 MHz for this exam. For thin test samples, a higher frequency is more likely to give more accurate readings. Table 1 provides frequency ***recommendations*** based on thickness however adequate results may be achieved outside of these ranges.

TABLE 1

Recommended Frequency Ranges	
Material Thickness	Frequency (MHz)
¼ to ≤¾ in. (6.35 to19.05 mm)	5.0 to 7.5
>¾ to ≤1½ in. (19.05 to 38.1 mm)	2.0 to 5.0

7.2.4.2 Consideration for test sample curvature should be given when selecting transducers and wedges for examination. Transducers and wedges should be selected that will sit on curved surfaces to minimize errors due to transducer rocking. Curved exam samples shall not be less than ANSI 6 in. (152.4**0** mm) OD pipe sections per UTSW-4, with the standard being 8 in. (203.20 mm) and 12 in. (304.80 mm) pipe ODs.

7.2.4.3 Transducers with an associated wedge are referred to as "search units" throughout the rest of this document.

7.3 Couplant

7.3.1 A suitable couplant designed for use in ultrasonic testing should be used for the exam. The couplant shall be of a type that can be easily cleaned off samples with wiping a rag across the surface.

7.3.2 The same couplant that is used for equipment standardization (calibration) should be used for the examination.

7.3.3 All couplant shall be cleaned off samples before being returned to the sample holding area.

7.4 Reference Standards

7.4.1 An IIW block should be used to standardize (calibrate) the sweep range (linearity) displayed on the instrument screen. An IIW block should also be used to verify the transducer angle and exit point (sound emission point).

7.4.2 Reference standards in accordance with ASME Section V Article 4 T-434.2.1 for flat plates and T-434.3-1 for piping welds should be used for sensitivity standardization (calibration).

7.4.3 Reference standards should have similar acoustic properties as the low alloy carbon steel test samples.

7.4.4 Reference standards used for plate samples should contain side-drilled holes to create DACs according to ASME Section V Article 4, paragraph 434.2.

7.4.5 Reference standards used for pipe samples should contain notches to create DACs according to Section V Article 4, paragraph 434.3.

7.4.6 Alternative reference standards for pipes in accordance with ASME Section V Article 4, paragraph 434.3-2 containing notches and side-drilled holes can also be utilized.

8.0 Samples

8.1 Test samples in the ISQ-O&G UTSW exam shall have the following characteristics.

8.1.1 They shall be low alloy carbon steel.

8.1.2 The thickness range of UTSW test samples shall be from 0.250 to 1.500 in. (6.35 to 38.10 mm).

8.1.3 Test samples shall be of either flat plate or curved section product form. Curved exam samples shall not be less than ANSI 6 in. (152.40 mm) OD pipe sections, with the standard being 8 in. (203.20 mm) and 12 in. (304.80 mm) pipe ODs.

8.1.4 Test samples shall be free of coating.

8.1.5 Test samples shall contain either single-V or double-V weld configurations.

8.1.5.1 All pipe section samples shall contain single-V weld configurations.

8.1.5.2 Plate samples <1 in. (25.40 mm) in thickness shall contain single-V weld configurations.

8.1.5.3 Plate samples ≥1 in. (25.40 mm) in thickness shall contain double-V weld configurations.

9.0 Standardization

9.1 The UT instrument should be standardized (often referred to as calibrated or technique calibration) for horizontal linearity (sound path) and vertical linearity (sensitivity) with the use of the reference standards detailed in Paragraph 7.4.

9.2 The UT instrument standardization should be performed prior to examination and should be verified upon exam completion.

9.3 The candidate should also check standardization anytime during their examination when one of the following conditions occur:

9.3.1 Any equipment component is changed: transducer, cable, wedge, battery, etc.

9.3.2 The candidate doubts the accuracy of their standardization.

9.4 For UTSW examination, the search unit, exit point (sound emission point), and beam angle

should be determined prior to standardization. The following process is provided for reference.

9.4.1 Exit Point Measurement – Position the search unit perpendicular to the radius of the reference block and maximize the signal response. The exit point is the location where the side of the wedge/search unit coincides with the reference line on the IIW reference standard.

9.4.2 Beam Angle Measurement – Position the search unit perpendicular to the applicable beam angle measurement reflector on the IIW reference block and maximize the signal response. The actual refracted angle is the point where the measured exit point intersects with the angle gradients scribed on the reference block. The difference between actual beam angle and the nominal beam angle should be within ±2°. The measured angle should be used for instrument calculations and weld discontinuity plotting.

9.5 Horizontal Linearity should be standardized by use of the curved section of the IIW reference standard. The two different curved sections with the two different distances should be utilized to establish accurate linearity over the range of sound path to be used for the material thickness range on this exam.

9.5.1 Screen Range should be selected to ensure full view of the sound path required to provide full coverage of the material thickness range on this exam.

9.6 Sensitivity DACs should be constructed using reference standards described in Section 7.4. The recommended initial DAC point, reflector with the shortest sound path, should be set to 80 to 100% full screen height. For instruments that support TCG, TCG may be used in lieu of a DAC. The DAC built or TCG set up, should cover the greatest sound path to be used for the weld and material thickness to be examined.

9.7 The temperature differential between the reference standard and the examination surface should be within ±25 °F (14 °C).

10.0 Examination

10.1 Sample surface condition.

10.1.1 Prior to examination, the test samples should be visually examined, in the area to be contacted by the transducer. This is to ensure the scanning surface is free of couplant residue, loose paint, dirt, mill scale, machining or grinding particles, or other loose foreign matter that would impair the free movement of the search unit or affect the accuracy of the examination results.

10.1.2 No transfer correction is required on the ISQ-O&G UTSW exam.

10.2 Place search unit on test sample and scan in a raster pattern to cover the entire region of weld and heat-affected zone (HAZ) on both sides of the weld.

10.2.1 The raster scanning pattern may be back and forth perpendicular to the welds and shift along the weld or moving the probe parallel to the weld axis and step in the direction perpendicular to the weld. There should be at least 10% overlap between each raster scan to increase the probability of detection.

10.2.2 Scanning should also be performed parallel to the weld axis to examine the weld for transverse discontinuities to the weld axis on both the near and far surfaces.

10.2.3 Scanning speed should not exceed 6 in. (152.40 mm) per second.

10.3 Scanning shall be performed from both the upstream and downstream sides of the weld.

10.4 The candidate should consider using, at a minimum, three (3) beam angles to improve performance in defect detection, characterization, and length sizing. Recommended angles to be used are 45°, 60°, and 70°. At a minimum the following uses for each angle should be considered:

10.4.1 A 45° search unit should be used to evaluate weld toes, on the OD for single-V welds and on both the OD and ID for double-V welds. It should also be used to evaluate the upper portion of single-V welds and both the upper and lower portion of double-V welds.

10.4.2 A 60° search unit should be used to evaluate weld fusion zones for lack of side wall fusion discontinuities on both single-V and double-V welds. It should also be used to evaluate the middle and lower sections of both single-V and double-V welds.

10.4.3 A 70° search unit should be used to evaluate the root region of single-V welds and the lower portion of double-V welds.

10.5 Scanning may be performed with an additional +6 dB above reference level sensitivity (DAC) to detect small discontinuities; however, all evaluation should be carried out at reference level sensitivity. If a higher dB gain setting—other than the established reference sensitivity level from the ASME reference standards—is used to evaluate discontinuities, it could lead to false calls where no reportable discontinuities exist.

10.6 Any indications above the evaluation threshold of 20% of the reference sensitivity (DAC) should be interrogated to determine the nature of the indication.

10.7 Any indication that has a signal response that is >20% of the reference sensitivity and characterized as one of the following discontinuity types shall be reported on the exam report form.

10.7.1 Weld toe crack

10.7.2 Root crack on ID

10.7.3 Haz crack

10.7.4 Lack of sidewall fusion

10.7.5 Sidewall crack

10.7.6 Lack of root fusion

10.7.7 Incomplete penetration

10.7.8 Centerline crack

10.7.9 Slag inclusion

10.7.10 Porosity

10.8 Appendix A provides supplemental information on discontinuity evaluation guidance to help candidates with detection and characterization interpretation.

10.9 For all indications determined to be discontinuities during evaluation, measure and record the following: discontinuity type, discontinuity start position from datum, discontinuity length, and cross-sectional location (zone) in the weld according to the upstream and downstream weld sides.

10.9.1 The 6 dB drop sizing method should be used to determine the start position and length of discontinuities.

10.9.2 The upstream and downstream side of the welds are identified on the report forms.

10.9.3 The weld zones are identified on the report forms.

10.10 Utilize the examination report forms and sketch note sheet provided by the AEP to record notations during the exam. Transfer recorded notes/answers from the sketch note sheet to the report forms, O&G UTSW-6.1 through 6.4, also provided by the AEP, for data recording during the exam.

10.11 Clean off all residual couplant from test samples before returning them to the holding area and retrieving any subsequent samples.

11.0 Reporting

11.1 All indications determined to be actual discontinuities > 20% of the primary reference level shall be reported and interrogated to determine their classification, location, and position. All discontinuities shall be reported on the UTSW report forms provided by the AEP.

11.2 During the exam, the report forms provided by the AEP shall be used for recording examination results. The following details shall be recorded for each test sample:

11.2.1 When numbering discontinuities, begin with the discontinuity closest to the datum and continue numbering discontinuities sequentially based on their increasing distance from the datum.

11.2.2 The discontinuity start position shall be reported in the “distance from datum” data entry location.

11.2.3 The discontinuity length shall be reported in the “length” data entry location.

11.2.4 The discontinuity-type determined shall be recorded in the “classification” data entry location. The discontinuity types are detailed in Paragraph 10.7.

11.2.5 The discontinuity cross-sectional location within the weld shall be recorded in the “zone” data entry location. The zone maps and descriptions are provided on the report forms.

Only one zone may be chosen. Select the zone where the signal response is at its greatest strength.

11.3 After examination completion the candidate shall follow the instructions provided in O&G UTSW-5.2 exam samples scanning instructions for report completion and submission.

Appendix A: Exam Discontinuity Evaluation Guidance

A.1 Candidates should prepare indication plot drawings to clearly understand the location of reflectors, this will aid in the interpretation of discontinuities.

A.2 Candidates should evaluate indications with multiple angles whenever possible. Weld Caps can cause physical access restrictions, that can limit this with some angles for some areas of the weld. This can support signal evaluation with the optimal angle by verifying which search unit provides the greatest indication coverage and amplitude response.

A.3 Candidates should verify indications from both sides of the weld whenever possible. This can assist with differentiating geometry reflectors from weld discontinuities.

A.4 Candidates need to carefully identify signals generated from weld discontinuities as opposed to geometric reflectors such as root-generated responses from – single-V welds and weld crown generated responses from single-V and double-V welds.

A.5 Candidates should take care in differentiating planar discontinuities from volumetric discontinuities:

A.5.1 Planar discontinuities are the group of discontinuities that have a primary orientation reflecting surface. The discontinuities in this category are linear cracks, lack of penetration, and lack of fusion. These types of discontinuities typically have a strong dependence of returning signal amplitude as a function of angle between the incident wave and the reflected wave. When the discontinuity primary reflecting surface is perpendicular to the incident wave, the return signal is strongest, and when the probe angle is changed, the signal amplitude becomes much smaller or larger. Therefore, a considerable change in amplitude response can be typically observed when evaluating a planar indication with one angle search unit to another.

A.5.2 Volumetric discontinuities are porosity clusters and slag inclusions. The returned signal amplitude from these discontinuities does not change as drastically as planar discontinuities when the sound beam is incidental from a different angle. Therefore, a similar amplitude response can be typically observed when evaluating a volumetric discontinuity with one angle search unit to another.

A.6 The 6 dB drop method should be used for discontinuity length measurement on this ISQ-O&G UTSW exam. The distance from datum is measured by comparing the discontinuity start position to the 0-datum point at the plate edge or at the 0-datum reference mark on the pipe sample as per the drawing on the associated report form.