

Guidance for the Development of Ultrasonic Examiner Qualification Programs

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Guidance for the Development of Ultrasonic Examiner Qualification Programs

1 Purpose

The purpose of this publication is to provide owner/users with guidelines for developing basic in-house qualification programs to identify industry-qualified ultrasonic testing (UT) angle beam examiners that are equivalent to those possessing an ultrasonic angle beam qualification from API (e.g. API QUTE/QUSE detection and sizing tests) for inspection of pressure equipment and piping as required by API 510 and API 570. The availability of high-quality and accurate UT data is often the cornerstone for weld and base metal discontinuity detection and sizing for equipment integrity assessments. As a result, API has implemented several certification programs to assist in defining the minimum criteria for assessing the performance of UT technicians. Examinations for these programs are administered differently than other Individual Certification Program (ICP) certifications in that they are based on hands-on performance demonstration tests. It should be noted that UT certifications are issued by accredited NDE certification authorities, such as the American Society for Nondestructive Testing (ASNT), and these API UT ICP certifications are considered performance demonstration qualifications by such NDE certification schemes.

1.1 Scope

This publication outlines the general guidelines for the development of owner/user ultrasonic examiner qualification programs that are consistent with API performance demonstration programs for detection, characterization, and crack height sizing of weld discontinuities in weldments. The performance demonstration programs covered in this publication include the following:

1.1.1 Qualification of Ultrasonic Testing Examiners for Detection and Characterization of Flaws Using Manual Angle Beam Testing: QUTE

QUTE exam description: Exam candidates use manual ultrasonic flaw-detection instruments to examine new construction carbon steel pipe and plate welds manufactured to ASME code requirements. Candidate performance measures include flaw detection, characterization, length sizing, and false calls.

1.1.2 Qualification of Ultrasonic Testing Examiners for Detection and Characterization of Flaws Using Manual UT-Phased Array: QUPA

QUPA exam description: Exam candidates use manual ultrasonic phased array instrumentation to examine new construction carbon steel pipe and plate welds manufactured to ASME code requirements. Candidate performance measures include flaw detection, characterization, length sizing, and false calls.

1.1.3 Qualification of Ultrasonic Testing Examiners for Manual UT-Angle Beam Crack Sizing: QUSE

QUSE exam description: Exam candidates use manual ultrasonic flaw detector instrumentation to size opposite side cracking in new construction carbon steel plate welds with and without weld crowns in place.

1.1.4 Qualification of Ultrasonic Testing Examiners for Manual UT-Phased Array Crack Sizing: QUSE-PA

QUSE-PA exam description: Exam candidates use manual ultrasonic phased array instrumentation to size opposite side cracking in new construction carbon steel plate welds with and without weld crowns in place.

1.2 Weld specimens for the QUTE, QUPA, QUSE, and QUSE-PA exams are single- or double-bevel carbon steel plate or pipe welds 0.50 in.–1.00 in. (12.5 mm–25 mm) in thickness. See Section 4 for specimen details.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

API 510, *Pressure Vessel Inspection Code: In-service Inspection, Rating, Repair, and Alteration*

API 570, *Piping Inspection Code*

API 653, *Tank Inspection, Repair, Alteration and Reconstruction*

API RP 577, *Welding Processes, Inspection, and Metallurgy*

ASNT-TC1A¹, *Qualification of NDT Personnel*

ASME², *Boiler and Pressure Vessel Code*, Section V, Article 4

3 Terms, Definitions, Acronyms, and Abbreviations

3.1 Terms and Definitions

For the purposes of this document, the following definitions apply.

3.1.1

centerline crack

A crack that occurs longitudinally in the center of a weld bead during solidification.

3.1.2

crack

A fracture of the material structure that separates the material without complete separation.

3.1.3

incomplete root fusion

A weld defect where the root of the weld is unfused.

3.1.4

incomplete root penetration

A weld defect where the depth of weld metal fused is incomplete.

3.1.5

grading unit

A length of a weld that may contain a weld discontinuity on either side of the weld in the QUTE and QUPA performance demonstration specimens. (e.g. 2 in.–3 in.). A designated grading unit for a given exam may or may not be from the same exam specimen.

3.1.6

lack of sidewall fusion (LOF)

A non-standard term indicating a weld discontinuity in which fusion did not occur between weld metal and fusion faces or adjoining weld beads.

3.1.7

owner/user

An owner or user of pressure vessels or piping who exercises control over the operation, engineering, inspection, repair, alteration, maintenance, pressure testing, and rerating of those pressure vessels and piping systems.

¹ American Society for Nondestructive Testing, PO Box 28518, 1711 Arlingate Lane, Columbus, Ohio 43228, www.asnt.org.

² American Society of Mechanical Engineers, Two Park Avenue, New York, New York 10016, www.asme.org.

3.1.8**porosity**

A cavity-type discontinuity formed by gas entrapment during solidification or in thermal spray deposit.

3.1.9**program administrator**

An employee of the owner/user or an individual contracted by the owner/user who is responsible for all aspects of the ultrasonic examiner qualification program(s).

3.1.10**slag**

A nonmetallic product resulting from the mutual dissolution of flux and nonmetallic impurities in some welding and brazing processes.

3.1.11**slag inclusion**

A discontinuity consisting of slag entrapped in the weld metal or at the weld interface.

3.1.12**test administrator**

The individual designated by the owner/user to be directly responsible for the performance demonstration test administration.

NOTE The owner/user may also designate this individual to be responsible for overall security of the performance demonstration program.

3.1.13**test proctor**

An employee of the owner/user or an individual contracted by the owner/user who is directly responsible for conducting the ultrasonic examiner qualification test(s).

NOTE The program administrator may serve as the test proctor if designated by the owner/user.

3.2 Acronyms and Abbreviations

For the purposes of this document, the following acronyms and abbreviations apply.

API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
Δ TOF	Delta time of flight
AATT	Absolute arrival time technique
HALT	High angle refracted longitudinal wave technique
HAST	High angle refracted shear wave technique
IDCR	ID creeping wave method
PATT	Pulse arrival time technique
RATT	Relative arrival time technique
SPOT	Satellite pulse observation sizing technique
TOF	Time of flight
UT	Ultrasonics

4 Specimens for Performance Demonstration Tests

The specimens used for the API QUTE, QUPA, QUSE, and QUSE-PA ultrasonic examiner qualification programs represent simplified weld geometries that are commonly encountered in piping throughout the refining, production, and chemical process industries. Typical exam specimen designs for the detection and characterization (QUTE, QUPA) exams and the crack height sizing performance demonstration (QUSE and QUSE-PA) exams are outlined below. Photographs of each test set are shown in [Figure 1](#). These exam sets are commercially available from flaw specimen manufacturers.



Figure 1—Photograph of Performance Demonstration Test Sets for Detection and Characterization (left) and Crack Sizing (right)

4.1 Sample Identification

Every specimen used in any of the performance demonstration programs should be given a permanent unique identification/serial number. This number should be masked out of view from the test candidate.

4.2 Detection and Characterization Test Set Specimen Design

An owner/user developing a performance demonstration should have a minimum of two complete test sets. An individual test set for the detection and characterization (i.e. QUTE and QUPA) performance demonstration test should include both flat plate and curved pipe samples with circumferential butt welds. Examples may include:

- a) one carbon steel (P1) ½-in. (12-mm)-thick plate with a single “V” weld prep;
- b) one carbon steel (P1) 1-in. (25-mm)-thick plate with a single or double “V” weld prep;
- c) one carbon steel (P1) 8-in. (200-mm) NPS pipe with a ½-inch (12-mm)-thick pipe wall with a single “V” weld prep
- d) One-half segment 12-in. (300-mm) NPS pipe with a ½-in. (12-mm) thick pipe wall with a single “V” weld prep

4.2.1 [Figure 2](#) shows a typical cross-sectional view for each of the detection and characterization specimens.