



**API**

**Defined Procedure**

**for**

**Ultrasonic Thickness Measurement**

**API-UT-21**

This Procedure Defines the  
Recommended Ultrasonic Methods and  
Techniques for Thickness Measurements

## 1.0 PURPOSE

- 1.1 This procedure is applicable only to ultrasonic examinations conducted for American Petroleum Institute (API) Qualification of Ultrasonic Examiners Certification Program.
- 1.2 The following procedure addresses equipment and evaluation techniques for ultrasonic examination of carbon steel Tank Bottom plating using manual ultrasonic techniques only.
- 1.3 This procedure provides guidelines and techniques for ultrasonic thickness measurements of corroded areas on Tank Bottoms.
- 1.4 This procedure is applicable to material thicknesses from 0.250 inches and less to .0.500 inches.
- 1.5 This procedure outlines the requirements for contact methods, using longitudinal wave 0 degree straight beam techniques.

## 2.0 REFERENCES

- 2.1 American Society for Nondestructive Testing (ASNT), SNT-TC-1A
- 2.2 American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section V

## 3.0 PERSONNEL REQUIREMENTS

- 4.1 Personnel performing the thickness examination should be, as a minimum, certified to Ultrasonic Level II, Level II UT-Thickness Measurement or Ultrasonic Level III in accordance with their employer's written practice.

## 5.0 EQUIPMENT

### 5.1 Ultrasonic Instruments

- 5.1.1 Any manual pulse echo ultrasonic instrument may be used provided that it satisfies the requirements of this procedure. Ultrasonic instruments should be equipped with a calibrated dB gain or attenuation control stepped in increments of 2db or less. Ultrasonic imaging is prohibited.
- 5.1.2 Commercially available Digital Thickness Gauges with A-Scan or Ultrasonic Flaw Detectors may be used for point measurements or scanning techniques.

5.1.3 All ultrasonic instruments shall be calibrated according to the manufacturers specification for linearity.

## 5.2 Search Units

5.2.1 The search units shall be in the frequency range of 1 to 10 MHz

5.2.2 The search unit used shall be single or dual element type 0 degree longitudinal waves for the UT thickness technique. Search units may include single element dual element or delay tip single element transducers.

5.2.3 The search unit or transducer selection should consider near surface and far surface flaw sensitivity and resolution, near field and beam spread effects. Suitable standoff wedges may be used to account for coating effects and to improve thickness measurement accuracy.

## 5.3 Cabling

5.3.1 Any convenient type and length of cable may be used.

## 5.4 Couplant

5.4.1 Any couplant material may be used. Higher viscosity couplants are recommended for rough surfaces.

## 5.5 Calibration and Reference Blocks

5.5.1 Commercially available reference blocks with known thicknesses may be used. The calibration block shall provide

5.5.2 A thickness step wedge shall be used to establish the screen range calibration to cover the full range of material thicknesses expected.

5.5.3 The thickness calibration block used shall be fabricated from carbon steel or other metals provided that a calibration block of the same material is used for calibration.

5.5.4 For Test Specimens that are coated, a technique using multiple back wall echoes maybe used to determine the minimum wall thickness.

## 6.0 CALIBRATION

- 6.1 The temperature of the calibration block material shall be within 25 degrees F of the component to be examined.
- 6.2 The surface shall be free from scale, rust, dirt, or any other extraneous materials that would prohibit the transmission of ultrasonic sound waves into the component under examination.
- 6.3 For coated test samples, a calibration reference block shall be used for calibration of the ultrasonic system. As an alternative, coated examinations maybe compensated with an echo to echo measurement.

### 6.4 System Calibration

- 6.4.1 System calibration shall include the complete examination system. Any changes in search unit, shoes, couplant or instrument shall be cause for recalibration.
- 6.4.2 Calibration the ultrasonic instrument for the appropriate screen range to cover the maximum and minimum material thicknesses expected during inspection. .
- 6.4.3 For uncoated test specimens, a calibration block of similar material shall be used for calibration.
- 6.4.4 For glass reinforced (Coated Plates CE) test specimens, an appropriate screen range shall be used to accommodate the increase thickness due to the coating plus multiple back wall signals if using the echo-to-echo thickness measurement technique.

## 7.0 THICKNESS EXAMINATION

### 7.1 Scanning Requirements

- 7.1.1 The area designated by the API Test Administrator shall be investigated with the appropriate 0-degree technique.

- 7.1.2 Determine the orientation of each Test Plate.
- 7.1.3 Layout a 4 by 4-inch grid for UT-TM examination. There will be 16 grading units per Test Plate unless noted otherwise. See Figure 1

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

**Figure 1: Typical API QUTE-TM Test Specimen Grid**

- 7.1.4 The ultrasonic thickness examination of each test specimen shall be performed in each grading unit.
- 7.1.5 Scan each grading unit to determine the area(s) of corrosion.
- 7.1.6 Determine the minimum remaining wall thickness measurement for each grading unit.
- 7.1.7 The minimum remaining wall thickness for each Grading Unit shall be recorded on the API Thickness Measurement Report Form.
- 7.1.8 Determine the Grading Unit Flaw Category for each grading unit. See figure 2 for a list of Grading Unit Flaw Categories.

<b>Category</b>
A: No Corrosion
B: General Corrosion
C: Isolated Corrosion/Erosion
D: Pitting Corrosion

E: Base Metal Laminations
F: Base Metal Inclusions
G: Weld overlay Disbonds
E. External Corrosion

**Table 2: Grading Unit Flaw Categories**

7.1.8 The Grading Unit Flaw Category for each grading unit shall be recorded on the API Thickness Measurement Report Form.

7.1.9 Discontinuity Description and Evaluation

Corrosion:

-Appears in many configurations from random isolated irregular shaped pits to linear aligned large cavities with tapered wall loss areas. The signal characterization associated with corrosion:

- Difficulty maintaining back wall reflections
- Irregular changes in wall thickness
- Movement of the back wall signal

Mechanical Deformations:

-Appear in many configurations; scrapes; gouges; slight wall thinning, dents; normal mill operation distortions.

Laminations:

-Are formed when gas is entrapped and is flattened during the manufacturers rolling process and are generally elongated but parallel to the surface. Generally, a large lamination, which is greater than the diameter of the transducer, will cause a total loss of the back wall signal. The signal characteristics will be similar to the back wall signal.

Inclusions:

-Appear as small, less than 1/4 inch irregularly spaced linear stringers at varying depths. They are volumetric as such the back wall signal should still be present.

**8.0 THICKNESS MEASUREMENT EVALUATION AND RECORDING CRITERIA**

- 8.1.1 Recording: Record one minimum thickness reading for each grading unit to three significant digits (0.XXX")
- 8.1.2 Document the Grading Unit Flaw Category each of the 16 grading units in each test specimen.