

**TABLE OF CONTENTS**

1.0 Purpose ..... 1  
 2.0 Scope ..... 1  
 3.0 References ..... 1  
 4.0 Acronyms and Definitions ..... 1  
 5.0 Personnel ..... 2  
 6.0 Equipment ..... 2  
 7.0 Calibration Standard ..... 3  
 8.0 Procedure ..... 3  
 9.0 Calibration ..... 4  
 10.0 Surface Preparation ..... 4  
 11.0 Examination ..... 4  
 12.0 Reporting ..... 4  
 13.0 Attachments ..... 5  
 14.0 Form 1 -- Ultrasonic Thickness Test Report ..... 6

**RECORD OF REVISIONS**

Rev	Date	Description	POC	RM
0	10/08/2015	Original issue.	David Bingham, <i>ES-EPD</i>	Larry Goen, <i>ES-DO</i>
1	11/28/2018	Major Revision, including addition of Olympus 38DL Plus as acceptable instrument.	David Bingham, <i>ES-EPD</i>	Larry Goen, <i>ES-DO</i>

Contact the Welding Standards POC for upkeep, interpretation, and variance issues.

ITM-1306-NDE-UT-100	<a href="#">Welding POC and Committee</a>
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This document is online at <http://engstandards.lanl.gov>

**1.0 Purpose**

This procedure establishes the minimum requirements for LANL personnel performing contact, pulse-echo, ultrasonic thickness examinations using an A-scan capable instrument when specified by a referencing code section, engineering design, drawings, or other requirements.

This Procedure meets the requirements of the ASME Boiler and Pressure Vessel Code, Section V, Article 5 *Ultrasonic Examination Methods for Materials*; and of ASTM E797 *Std. Practice for Measuring Thickness by Pulse-Echo Contact Method*. The process involves propagating ultrasonic waves at a constant velocity through the item being tested. Back reflections are obtained and resolved to evaluate and determine thickness. Testing is performed to ensure that items conform to design specifications and acceptance criteria that originate with the customer or design agency.

**2.0 Scope**

This procedure establishes the technique, tools, equipment, calibration requirements, and personnel qualification requirements necessary to perform ultrasonic thickness examinations. Thickness examinations shall be performed by the Manual Ultrasonic Pulse-Echo Contact Method.

This procedure is not intended for use on elevated temperature components (above 210F).

**3.0 References**

The following references form a part of this Procedure to the extent specified herein.

ASME Boiler and Pressure Vessel Code Section V, *Nondestructive Examination*

ASME Boiler and Pressure Vessel Code Section VIII, *Rules for Construction of Pressure Vessels*

ASME Boiler and Pressure Vessel Code Section IX, *Qualification standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators*

ASTM E797, *Measuring Thickness by Manual Pulse-Echo Contact Method*

ASTM E1316, *Standard Terminology for Nondestructive Examinations*

LANL Procedure - *Written Practice for NDE Personnel Qualification & Certification, ESM Chapter 13, Vol. 6, Section WIGN 6-02, Att 3*

**4.0 Acronyms and Definitions**

<b>Acronym / Term</b>	<b>Description</b>
<b>Calibration Standard</b>	A block that is used both as a measurement scale and as a means of providing an ultrasonic reflection of known characteristics. The calibration standard may be measured, identified and treated as M&TE, or may be verified as a transfer standard by using a calibrated micrometer, caliper, or other calibrated measurement device.
<b>contact examination</b>	A technique in which the search unit makes contact directly with the test piece through a thin layer of couplant.
<b>couplant</b>	A substance used between the search unit and examination surface to permit or improve transmission of ultrasonic energy.
<b>documented</b>	The condition of being in written form

Acronym / Term	Description
<b>ES-EPD</b>	Engineering Services Division, Engineering Project Delivery Group
<b>NDE SME Level III</b>	A LANL Level III certified in the Ultrasonic Test Method.
<b>WPA</b>	Welding Program Administrator (LANL)

**5.0 Personnel**

- A. Personnel employed at LANL who perform ultrasonic thickness examinations and are certified by the LANL Welding Program Administrator (WPA) to WIGN 6-02, *NDE Inspector Qualification*.
  - 1. Personnel will normally be certified to Level II UT as outlined in WIGN 6-02, *NDE Inspector Qualification*.
  - 2. Personnel may also be certified for UT limited/restricted Thickness Measurements after demonstrating competence for set-up, calibration, and use of a specific piece of UT equipment to the satisfaction of the WPA’s SME NDE Level III for UT. The Level I-Limited certification is commonly utilized for this activity, with supervision by a Level II or Level III not required.
  - 3. The inspection planning activity is performed by an Inspector, and is not a part of this Procedure. The Inspector and the Level I-Limited may be the same individual, although this is not required.
  - 4. Personnel may also be subcontracted to an off-site NDE Agency as approved by the LANL NDE UT Level III.

**6.0 Equipment**

- A. The evaluated and approved ultrasonic thickness equipment to be used for this procedure is listed in the Attachment(s). They include the specific essential variables to be used for that equipment for inspection in accordance with this procedure.

Attachment	Equipment
Attachment 1	Krautkramer DMS 2/2E
Attachment 2	Olympus 38DL Plus

- B. The couplant used shall be Magnaflux Ultragel II, or an equivalent couplant providing adequate sound transmission and of sufficient viscosity to facilitate the ultrasonic measurement. Any couplant or cleaning solution for austenitic stainless steel, nickel-based alloys, and titanium shall contain less than 250 ppm halogens (chlorine and fluorine) and less than 250 ppm sulfur. Such values for halogens and sulfur shall be documented, either by the manufacturer or by other laboratory results for that batch of couplant.
- C. Only transducers manufactured by the instrument manufacturer, and manufactured for thickness measurement with the given instrument, shall be used.
  - 1. Single element transducers are generally used for precision thickness measurement of materials that have flat and parallel surfaces.

2. Dual element transducers (“pitch-catch”) are normally used for inspections of pipe, vessels, etc., in the shop or in the field or operation. These transducers are produced to have a focal range, in which the most accurate measurements can be made. That focal range is normally specified in the documentation that accompanies that transducer. Dual element transducers shall not be used on thicknesses outside of the focal range specified by the manufacturer.

## **7.0 Calibration Standard**

- A. The calibration standard must be representative of the material being measured in order to obtain an accurate value for the thickness. Standards may be of two types, informational or certified:
  1. An informational standard will often be a material sample that has been measured with a micrometer or calipers, have no material certification or traceability, and is used to obtain thickness values “for information only.” This does not mean that the measurement is necessarily in error, but rather that the measurement cannot be certified because the standard material cannot be traced and/or the dimensions of the sample are not identified.
  2. A certified standard will have material pedigree information associated with it, is of known thickness and dimensions, and is serialized to provide traceability to the documentation. A certified standard is considered M&TE.
- B. A standard that is not certified may still be used to perform a certified measurement. To do so, the thickness of the step(s) used for calibration shall be measured with a calibrated micrometer or caliper (i.e., valid M&TE), and the measured value used to calibrate the instrument. This is only permissible if the material used is known to be the same as that under test, or compatible as listed below.
  1. Comparable or equivalent steel materials are ASME Boiler and Pressure Vessel Code P Numbers 1, 3, 4, 5A, 5B, 5C, and 15A-15F.
- C. The calibration standard thickness should be at least twice that of the material under test, and should accommodate a two-point calibration, one thickness below that to be measured and one thickness above.

## **8.0 Procedure**

- A. This Procedure should be used in conjunction with an inspection plan, developed by the responsible or cognizant individual who is qualified to determine the thickness measurement requirements. At minimum, a description of the required measurement locations, acceptable range (if applicable), and the measurement precision needed are required.
- B. The item to be inspected shall be clean and free of contaminants that could interfere with measuring equipment or the inspection. If surface contamination is present, clean the area of interest or the entire part, as needed, with the most appropriate approved solution or method as allowed by the material. The clean area shall be at least 1 inch beyond either side of the area of interest or the entire part as applicable. The probe and part must be within 25°F of each other when the measurement is performed.
- C. Ensure that UT equipment is calibrated for the material and range expected prior to starting measurement.

## **9.0 Calibration**

- A. The Ultrasonic Flaw Detector/Thickness Tester must be calibrated before use. Calibration shall reflect the known thickness value of the standard within  $\pm 0.001$ ".
- B. Calibration using two points should be used whenever possible, with one point below the expected minimum thickness and one point above. Additional points can be used; single point calibration is discouraged. The use of a single point calibration shall be noted on the test report.
- C. Calibration shall be verified at intervals not to exceed 60 minutes. Calibration shall be verified at the conclusion of the measurement process.
- D. Acceptable verification shall provide values within 3% of the original calibration thickness value.
- E. The standard must be of known thickness and same material composition (acoustic velocity) of test item.
  - 1. For the purpose of this paragraph, P-Nos. 1, 3, 4, 5A through 5C, and 15A through 15F materials are considered equivalent. P-Number listings are found in the ASME Boiler and Pressure Vessel Code, Section IX.
  - 2. Reference blocks fabricated specifically for use under unique circumstances shall be verified using calibrated M&TE and documented before use by the qualified inspector. Use of traceable reference blocks is always preferable.
- F. At least two back reflections should be displayed on the A-scan.
- G. The gate threshold should be at 40% of screen height or greater. Use of a lower threshold risks errors due to baseline noise. Some instruments, however, do not have an adjustable threshold, such as the Olympus 38DL Plus—in those cases, that feature is controlled by the instrument.

## **10.0 Surface Preparation**

- A. The examination must be performed from either major surface of item being examined.
- B. The surface must be sufficiently clean and able to maintain a first back wall reflection of at least 40% of full screen height during scanning.
- C. Scale or paint removal may be required to achieve the necessary reflection needed.

## **11.0 Examination**

- A. Scanning, grids, or NDT points will be based on area of interest and the written request from the customer. NDT Inspection points shall be clearly marked for future testing, unless otherwise specified.
- B. Ensure pitch-catch UT transducers are orientated correctly to achieve the most accurate results (most important on tight radius).
- C. All evaluations must be done using the A-Scan screen presentation. Digital readout shall be used only after evaluation of A-Scan presentation to eliminate erroneous readings by machine.

## **12.0 Reporting**

A spreadsheet template for reporting is provided with this procedure as Form 1. Minimum information required includes, but is not limited to:

- A. Project/Location

- B. Specification or Procedure and revision
- C. Date of Test
- D. Ultrasonic Flaw Detector/Thickness Tester
  - Manufacturer
  - Serial Number, Manufacturer, Model
- E. Transducer
  - Manufacturer
  - Serial Number, Size, Frequency
- F. Calibration standard
  - Description
  - Serial Number
  - Thickness(es)
- G. Couplant
  - Manufacturer
  - Type
- H. On-site Calibration
  - Time
  - Temperature
  - Date
  - Inspector
  - Calibration verification(s)
- I. Material Attributes
  - Type
  - Nominal Thickness
- J. Instrument Parameters
  - Gate Threshold
  - Gain
  - Range
- K. Inspector/Operator Signature, Level of Certification
- L. All NDT test point data variances

### **13.0 Attachments**

Attachment 1- Krautkramer DMS 2/2E Essential Variables

Attachment 2 – Olympus 38DL Plus Essential Variables

14.0 Form 1 -- Ultrasonic Thickness Test Report

(example only, use XLS file posted on web with procedure)

Point		ID/ Location	Measured Thickness	Difference	% Change	Comments
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
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19						
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23						
24						
25						
26						
27						
28						
29						
30						

<b>Los Alamos NATIONAL LABORATORY</b> <small>EST. 1945</small>		<b>Ultrasonic Thickness Test Report</b>		Report #
Project		Location: Bldg. Rm.		Date
Cost Center	Program Code	Cost Account	Work Package	Work Order #
Product Nomenclature		Specification or Procedure		<input type="checkbox"/> Tank <input type="checkbox"/> Pressure Vessel <input type="checkbox"/> Plate <input type="checkbox"/> Piping <input type="checkbox"/> Other <input type="checkbox"/> Ambient <input type="checkbox"/> High Heat
UT Thickness of		ITM-1306-NDE-UT-100		Temperature: ___°F / ___°C
				<b>Base Material</b>
				Composition
				Nominal Thickness
				<b>Flaw Detector / Thickness Tester Data</b>
				Manufacturer
				Serial Number
				Model
				M&TE # / Cal. Date
				Gate Threshold (%)
				Gain (dB)
				Range (inches)
				Velocity (in/μ sec)
				<b>Transducer Data</b>
				Manufacturer
				Model
				Serial Number
				Size (inches)
				Frequency (MHz)
				<b>Reference Block Data</b>
				<input checked="" type="checkbox"/> Traceable <input type="checkbox"/> Fabricated
				Type
				Serial Number
				Material Composition
				Thickness
				<b>Couplant</b>
				Manufacturer
				Type
				Temperature Range
				<b>Equipment / System / Material Data</b>
				ID Tag
				P.O. / Heat #
				Serial Number
Calibration Date		Time	Completed By	Certification Level
Notes:				<input type="checkbox"/> Information Only (No Prev. Data Avail.)  Inspector's Signature: _____ Level: _____  This inspection was performed in accordance with the above named procedure/specification.
_____				
_____				
_____				
_____				

Form FM01, last revised 10/8/2015