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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>

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

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

1.0 Purpose

This procedure establishes the minimum requirements for LANL (and Subcontractor personnel working on behalf of LANL) performing ultrasonic thickness examinations when specified by a referencing code section, engineering design, drawings, or other requirements.

It meets the requirements of ASME Section V, Article 5 *Ultrasonic Examination Methods for Materials*, and of ASTM E797 *Std. Practice for Measuring Thickness by Pulse-Echo Contact Method*. This procedure also meets the intent for ultrasonic thickness examinations identified by other codes and standards, e.g., AWS D1.1, NBIC, etc.¹

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 Manual Ultrasonic Pulse-Echo Contact Method. These inspections are performed by qualified personnel using calibrated measurement and test equipment (M&TE).

Examinations shall be performed by personnel who are certified by LANL in accordance with ESM Ch. 13 Vol. 6 Section WIGN 6-02, *NDE Inspector Qualification*, which will ensure compliance with ASME Section V Article 5. Subcontractor personnel approved by the WPA's NDE Level III may also perform examination to this procedure.

Because of procedural requirements of ASME Section V Article 5, the specific requirements of each UT unit are addressed in appendices to this procedure.

This procedure does not apply to other personnel approved by LANL to perform Manual Ultrasonic Thickness examinations (e.g., approved fabricator personnel, Subcontractor personnel, or Subcontractor-hired third-party inspection agency) approved by LANL but representing the Subcontractor and work to their own quality assurance plan and procedures.

3.0 References

ASNT-CP-105, *Topical Outlines for Qualification of Nondestructive Testing Personnel*

ASME B&PVC Section V, *Nondestructive Examination*

ASME B&PVC Section VIII, *Rules for Construction of Pressure Vessels*

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

ASTM E1316, *Standard Terminology for Nondestructive Examinations*

LANL MOF-CM WI-400-282, *Inspection and Test for Acceptance*

LANL Engineering Standards Manual (ESM) and Master Specifications

¹ Evidence of this procedure meeting the essential and non-essential variables of these codes is contained in a separate record filed with this document on the Standards Program server.

LANL Procedure [P330-2](#), *Control and Calibration of Measuring and Test Equipment (M&TE)*

LANL Procedure P330-6, *Nonconformance Reporting*

LANL Procedure P330-8, *Inspection and Test for Acceptance*

LANL Procedure [P1020-1](#), *Laboratory Records Management*

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

National Board Inspection Code/NBIC (ANSI-NB-23), published by the [National Board of Boiler and Pressure Vessel Inspectors](#)

4.0 Acronyms and Definitions

Acronym / Term	Description
amplitude	The vertical pulse height of a signal, usually base to peak, when indicated by an A-scan presentation.
A-Scan Presentation	A method of data presentation utilizing a horizontal base line that indicates distance, or time, and a vertical deflection from the base line which indicates amplitude.
B-Scan Presentation	A means of ultrasonic data presentation which displays a cross section of the specimen indicating the approximate length (as detected per scan) of reflectors and their relative positions.
calibrate	To check, adjust, or determine by comparison with a standard or reference block.
contact examination	A technique in which the search unit makes contact directly with the test piece through a thin layer of couplant.
certification	Written testimony of qualification
Certifying Authority	The person or persons properly designated in WIGN 6-02, <i>NDE Inspector Qualification</i> to sign certifications on behalf of LANL; specifically, the LANL Engineering Services–Engineering Project Delivery (ES-EPD) Welding Program Administrator (WPA) or other Level III designated by the WPA
Certifying Agency	LANL ES-EPD is the organization certifying NDE personnel for this procedure, as specifically authorized by the LANL WPA or other Level III designated by the WPA
comparable	Being at an equivalent or similar level of NDE responsibility and difficulty as determined by the LANL WPA
couplant	A substance used between the search unit and examination surface to permit or improve transmission of ultrasonic energy.
documented	The condition of being in written form
ES-EPD	Engineering Services Division, Engineering Project Delivery Group
gain	A measure of the ability of a circuit (often an amplifier) to increase the power or

Acronym / Term	Description
	amplitude of a signal from the input to the output. In ultrasonic testing it is represented in decibels (dB).
noise	Any undesired signal (electrical or acoustic) that tends to interfere with the reception, interpretation, or processing of the desired signal.
pulse echo method	An inspection method in which the presence and position of a reflector are indicated by the echo amplitude and time.
qualification	Demonstrated skill and knowledge, along with documented training and experience required for personnel to properly perform the duties of a specific job.
range	The maximum sound path length that is displayed.
recommended practice	A set of guidelines to assist the employer in developing uniform procedures for the qualification and certification of NDE personnel to satisfy the employer's specific requirements
reference block	A block that is used both as a measurement scale and as a means of providing an ultrasonic reflection of known characteristics.
training	An organized program developed to impart the knowledge and skills necessary for qualification
ultrasonic	Pertaining to mechanical vibrations having a frequency greater than approximately 20,000 Hz.
ultrasonic testing (UT)	A nondestructive method of examining materials by introducing ultrasonic waves into, through or onto the surface of the article being examined and determining various attributes of the material from effects on the ultrasonic waves.
WPA	Welding Program Administrator (LANL)

5.0 Certification

- 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*.
 - Personnel will normally be certified to Level II UT as outlined in WIGN 6-02, *NDE Inspector Qualification*.
 - 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 NDE Level III for UT.
 - Personnel may also be subcontracted to an off-site NDE Agency as approved by the LANL NDE UT Level III.

B. Education, Training, and Experience Requirements

1. Personnel will be thoroughly familiar with the specific ultrasonic thickness equipment to be used and able to perform calibration and examinations based on the requirements. This shall be demonstrated, verified and documented by the LANL WPA or his NDE UT Level III.
2. Trained in the use of specific equipment and ensure that the equipment is calibrated if required in accordance with P330-2. If required, on-the-job training shall be provided by the LANL WPA or his designed NDE Level III.
3. Able to interpret and evaluate results with respect to applicable codes, standards and specifications.
4. Able to organize and report the results of the examination and handle in accordance with P1020-1.
5. Level II personnel shall exercise assigned responsibility for on-the-job training and guidance of Level I and trainee personnel, if applicable.

C. Vision Requirements

Personnel performing visual or dimensional examination shall be given an annual vision examination in accordance with WIGN 6-02.

Where differentiation of colors is critical to job performance, the capability to distinguish and differentiate contrast among colors or shades of gray used in the method shall also be demonstrated annually.

Records of visual examinations shall be maintained by the LANL WPA.

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. At initial issue, this included:

Attachment	Equipment
Attachment 1	Krautkramer DMS 2/2E
Attachment 2	TBD

- B. Ultrasonic equipment shall be clean, undamaged, and in good working condition. Ensure that instrument calibration is current, as applicable. Discard and replace damaged or deteriorated inspection equipment. Ensure that equipment that has been lost, damaged, or returned from calibration with the “as-found” condition out-of-tolerance is documented and evaluated by NCR per P330-6.
- C. The surface under inspection shall have sufficient lighting (natural or artificial white light). Sufficient lighting is defined by the ability to detect a 1/32 inch (0.8 mm) black line on an 18 percent neutral gray card or a 1/32 inch increment on a machinist’s scale or equivalent under the conditions of inspection.

- D. 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. Grinding wheels and wire brushes used for surface cleaning shall be in accordance with engineering specifications. At a minimum; when using mechanical means such as wire wheels or brushes, use only like materials (e.g., stainless steel with stainless steel).

NOTE: Personal protective equipment appropriate to the work area shall be worn at all times while using cleaning solvents and/or mechanical cleaning methods in preparation for dimensional inspections. All safety, environmental, and radiological requirements of the area where the examination is to be performed shall be complied with. The Material Safety Data Sheet for any chemical to be used for cleaning shall be immediately available for employee examination.

7.0 UT Thickness Examination

- A. Review work documents for the purpose of identifying the basis for examination and acceptance and performance criteria. This includes, but is not limited to:
1. Specifications, drawings, work instructions, procedures, lockout/tagout requirements, referenced codes and standards, and procurement documents.
 2. When, during the work process, inspections/tests are to be performed. Consider post-installation inspections/tests and retesting, if applicable.
 3. Measuring and test equipment needed to perform the inspection/test, including calibration per P330-2; type, range, accuracy, and tolerance requirements.
 4. Provisions for ensuring that prerequisites for the given test have been met.
 5. Hold and/or witness points.
 6. Provision for recording inspection/test results and creating project records per P1020-1.
- B. Testing personnel must plan the inspection based on the inspection requirements, risk, and complexity. The plan must consider the following key areas (an example of an Inspection Plan is found in P330-8, *Inspection and Test for Acceptance*, Attachment B):
1. Item to be inspected shall be dry 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. Allow both the part to be measured and the UT equipment to be used to stabilize at ambient temperature if required.
- C. Verify that the acceptance criteria provided is appropriate to perform the measurement.
- D. Ensure that UT equipment is calibrated for the material and range expected prior to starting measurement.

7.1 Calibration

- A. The Ultrasonic Flaw Detector/Thickness Tester must be calibrated before use and the calibration must be re-verified every 60 minutes.

- B. The material composition or thickness must be identified prior to testing to ensure proper calibration of the Ultrasonic Flaw Detector/Thickness Tester.
- C. The Ultrasonic Flaw Detector/Thickness Tester must be calibrated for a range two (2) times the thickness of the item being tested. *When possible, two (2) point calibrations should be done.*
- D. Reference block 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.

Note: Reference blocks fabricated specifically for use under unique circumstances must be verified using calibrated M&TE and documented before use by the qualified inspector. Use of traceable reference blocks is always preferable.

- E. *The gate threshold should be at 40% screen height or greater.*

7.2 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.

7.3 Examination

- A. Ultrasonic Flaw Detector / Thickness Tester must be pulsed-echo type.
- B. The transducer must be used in direct/contact method with a suitable couplant (e.g., within temperature range and will not cause degradation)
- C. Scanning, grids, or NDT points will be based on area of interest and request from customer. The transducer must provide sufficient contact of surface of tested area to allow for accurate evaluation.

Note: NDT Inspection points will be clearly marked for future testing, unless otherwise specified.

- D. Ensure pitch-catch UT transducers are orientated correctly to achieve the most accurate results (most important on tight radius).
- E. All evaluations must be done using the A-Scan screen presentation.

Note: Digital readout should be used only after evaluation of A-Scan presentation to eliminate erroneous readings by machine.

- F. *B-Scan data may be used as a supplement for evaluating areas of interest.*

7.4 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
- C. Date of Test

- D. Ultrasonic Flaw Detector/Thickness Tester
 - Manufacturer
 - Serial Number
 - Make
 - Model
 - Calibration Date
- E. Transducer
 - Manufacturer
 - Serial Number
 - Size
 - Frequency
- F. Reference Block
 - Type
 - Serial Number
 - Thickness
- G. Couplant
 - Manufacturer
 - Type
- H. On-site Calibration
 - Time
 - Temperature
 - Date
 - Inspector
 - Post Inspection verification of calibration
- I. Material Attributes
 - Type
 - Nominal Thickness
- J. Machine Parameters
 - Gate Threshold
 - Gain
 - Range
- K. Inspector/Operator Signature, Level of Certification
- L. All NDT test point data variances

8.0 Attachments

Attachment 1- Krautkramer DMS 2/2E Essential Variables

Form 1 -- Ultrasonic Thickness Test Report
 (example only, use XLS file webposted with procedure)

Project		Location: Bldg. Rm.		Date			
Cost Center	Program Code	Cost Account	Work Package	Work Order #	<input type="checkbox"/> Tank <input type="checkbox"/> Plate <input type="checkbox"/> Ambient	<input type="checkbox"/> Pressure Vessel <input type="checkbox"/> Piping <input type="checkbox"/> High Heat <input type="checkbox"/> Other	
Product Nomenclature			Specification or Procedure		Temperature ____°F / ____°C		
UT Thickness of			ITM-1306-NDE-UT-100				
Point	ID/ Location	Measured Thickness	Difference	% Change	Comments	Base Material	
						Composition	Nominal Thickness
1						Flaw Detector / Thickness Tester Data	
2						Manufacturer	
3						Serial Number	
4						Model	
5						M&TE # / Cal. Date	
6						Gate Threshold (%)	
7						Gain (dB)	
8						Range (inches)	
9						Velocity (in/μ sec)	
10						Transducer Data	
11						Manufacturer	
12						Model	
13						Serial Number	
14						Size (inches)	
15						Frequency (MH z)	
16						Reference Block Data	
17						<input checked="" type="checkbox"/> Traceable <input type="checkbox"/> Fabricated	
18						Type	
19						Serial Number	
20						Material Composition	
21						Thickness	
22						Couplant	
23						Manufacturer	
24						Type	
25						Temperature Range	
26						Equipment / System / Material Data	
27						ID Tag	
28						P.O. / Heat #	
29						Serial Number	
30							
Calibration Date		Time	Completed By		Certification Level	<input type="checkbox"/> Information Only (No Prev. Data Avail.)	
Notes:						Inspector's Signature _____ Level _____	
_____						This inspection was performed in accordance with the above named procedure/specification.	

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