

**MANUAL ULTRASONIC MEASUREMENT OF MATERIAL THICKNESS AND
INTERFERING CONDITIONS**

1. **PURPOSE**

- 1.1. To establish a standardized method for conducting manual ultrasonic examinations which comply with the ASME Boiler and Pressure Vessel Code, Sections, I, III, V, VIII, XI, ASME B31.1, and B31.7 up to and including 2001 Edition, 2003 Addenda.
- 1.2. To describe the process for performing ultrasonic (UT) thickness measurements and inspections for interfering conditions using manual, contact, and longitudinal wave techniques.
- 1.3. Applicable to material/product forms in which ultrasonic waves will propagate at a constant velocity throughout the part, and from which back reflections can be obtained and resolved.

2. **MATERIAL AND SPECIAL EQUIPMENT**

2.1. **Material**

NOTE: Control, use and removal of couplant shall be in accordance with specific plant procedures.

- 2.1.1. Select any nuclear grade couplant, which is non-detrimental to the surface condition of the component under examination, and provides an intimate contact for the conduction of high frequency ultrasonic sound.
- 2.1.2. Verify that the manufacturer's suggested couplant temperature range is applicable to the temperature range expected during the examination process.
- 2.1.3. Use calibration standards of the same material and product form as the material under examination and with a thickness range, which encompasses the anticipated examination thickness (multiple back reflections are allowed).
- 2.1.4. As an alternate, if it can be proven that the standard and the material to be examined are ultrasonically equivalent (mechanical vs. ultrasonic measurement) then the standard is considered acceptable for use with the approval of an Exelon NDE UT Level III.
- 2.1.5. If marking pens for gridding will be used, then verify that the pens are approved by the specific sites chemical control procedures.

2.2. **Equipment**

170

2.2.1. Use an ultrasonic flaw instrument or ultrasonic thickness gauge with an A-Scan presentation. D-Meters without an A-Scan presentation shall only be used with the approval of an Exelon NDE UT Level III.

1. Capable of generating and receiving frequencies over the range of at least 1 Mhz to 5 Mhz others may be used with the approval of an Exelon NDE UT Level III.
2. Equipped with an A-Scan presentation.
3. Calibrated in accordance with Reference 6.1, when applicable.

NOTE: Special transducers/cables may be used with the approval of an Exelon NDE UT Level III.

2.2.2. Use a transducer/cable:

1. Allowed by the ultrasonic instrument's design.
2. Within the frequency range of 0.5 mhz to 30 mhz.
3. Within the size range of 0.125" to 1.125" diameter.
4. Applicable to the temperature range expected during examination.

2.2.3. Use a contact surface thermometer to Verify temperature range variables as needed.

3. **PRECAUTIONS, LIMITATIONS, AND PREREQUISITES**

3.1. **Precautions**

3.1.1. Applicable safety equipment is acceptable for use.

3.2. **Limitations**

3.2.1. Part temperature shall be within the temperature range acceptable for the equipment selected.

NOTE: The use of special equipment may be utilized outside the manufacturers suggested ranges with the approval of an Exelon NDE UT Level III. New ranges may require successful demonstration.

3.2.2. Part thickness shall be within the thickness range acceptable for the equipment selected.

3.3. **Prerequisites**

- 3.3.1. Verify applicable work order / activity has been released to work.
- 3.3.2. Verify Exelon personnel performing examinations to this procedure are certified in accordance with Reference 6.2 as applicable.
- 3.3.3. Verify contractor personnel performing examinations to this procedure are certified in accordance with the contractor's written practice, which has been approved by Exelon, or they may be certified in accordance with Reference 6.2 as applicable.
- 3.3.4. Verify individuals performing examinations are certified to a minimum of NDE UT Level I. A Level I examiner shall work under the supervision of a Level IIL, Level II or Level III examiner.

NOTE: Personnel performing "gridding" or manually recording data need not be certified.

- 3.3.5. Verify individuals evaluating and accepting or rejecting examination results are certified to a minimum of NDE UT Level IIL.

NOTE: Thin evenly painted surfaces that do not adversely affect the thickness readings are allowed. However examinations performed through heavy painted or unevenly coated surfaces must have the following conditions met: a) The coating shall be tightly adhered and capable of transmitting ultrasonic sound, b) "Calibration" and "Measurements" shall be performed using the distance between the 1st and 2nd back wall signals (echo to echo), c) D-Meters shall have an A-scan presentation and be capable of displaying readings between the 1st and 2nd back wall signals, d) The operator must be aware that thickness inspections are usually requested due to a corrosion attack, and that severely corroded areas may not be capable of generating multiple back reflections. If the 2nd back wall signal is not obtained continuously during scanning and corrosion is suspected, then the exam shall be stopped and the paint/coating removed, and e) Approval by an Exelon UT Level III.

- 3.3.6. Verify the contact surfaces on the material to be examined are free from weld spatter, roughness, of other conditions, which may interfere with free movement of the search unit or impair the transmission of ultrasound.
- 3.3.7. Verify the part temperature is within 25 degrees F of the calibration standard as applicable.

4. MAIN BODY

4.1. Calibration

- 4.1.1. **PERFORM** the following system calibration prior to commencing any measurements.
- 4.1.2. **ADJUST** the instrument's "zero/delay" and "velocity/range" settings in accordance with the instrument's operation manual (if available), to obtain a linear screen range that encompasses the anticipated examination thickness range. **If** using an "A-Scan" type instrument, **then ADJUST** the gain (as needed) to maintain a signal amplitude at 40 to 80% full screen height (FSH).
- 4.1.3. **VERIFY** the thickness range on the applicable calibration standard at a minimum of two (2) points, one above and one below the anticipated examination thickness. **If** the accuracy is less than 2% from the actual calibration standard thickness, **then REPEAT** step 4.1.2. (As material becomes thin, readings may fall outside of the minimum range in 4.1.3 then recalibration is needed in accordance with this paragraph. If thickness reading (s) fall below 0.100", no additional calibration is required due to the nature of contact ultrasonic testing.
- 4.1.4. **RECORD** the calibration standard thickness and the readings obtained on the applicable data sheet.

4.1.3. 4.1.4

4.2. Examination

NOTE: If it is observed during a calibration verification that the distance calibration has changed by more than 5%, all measurements referring to the calibration in question and performed after the last valid calibration verification shall be voided.

- 4.2.1. If during the examination any of the following apply, **then REPEAT** the calibration sequence:
1. The start of a series of measurements.
 2. Every 4 hours.
 3. Substitution of search unit, search unit cable, power source, couplant, or examination personnel.
 4. Any time when, in the opinion of the examiner, there is doubt as to the validity of the calibration.
 5. The finish of a series of measurements.

4.2.2. **PERFORM** the examination on the areas specified in the applicable code and/or engineering documents, using a "Continuous Scan", "Spot Method" or a combination of both.

4.2.3. If using the continuous scanning method, **then**:

1. **USE** an ultrasonic flaw detector or a D-Meter in the rapid response setting only.
2. **ENSURE** a minimum of 10% overlap of the search unit's active element.
3. **ENSURE** a maximum scanning speed of 6" per second.

4.2.4. If using the spot method, **then**:

1. **ENSURE** that the search unit is firmly coupled to the test area.
2. **ENSURE** the down pressure exerted on the search unit shall be approximately the same as used for calibration.

4.3. Recording/Acceptance Criteria

4.3.1. **RECORD** readings as directed by the applicable work instructions, applicable code requirements, and/or other engineering documents.

4.3.2. **EVALUATE** readings as specified by the applicable code and/or engineering documents.

4.3.3. If specific acceptance criteria do not exist, **then EVALUATE** reading less than 87.5% of nominal thickness as **REJECTABLE**.

4.4. Reports

4.4.1. **PREPARE** a report for each examination including at least the following information, electronic reports that meet the minimum requirements below are acceptable for documentation. Attachment 3

1. Station/Unit.
2. Component ID.
3. Inspection Procedure.
4. Type and serial number of instrument.
5. Size, frequency, and type of search unit.
6. Thickness and location of readings required to be recorded.

7. Examiner(s) name and Level(s).
 8. Calibration Standard serial number or Identification.
 9. Code or Specification used for examination/acceptance criteria.
 10. Surface condition.
 11. Calibration standard and part temperature.
 12. Inspection results.
 13. Date of inspection.
 14. Calibration readings.
 15. Couplant Type and batch number.
 16. Temperature and thermometer serial number or Identification
- 4.4.2. **PROCESS** all reports in accordance with specific site "Document Control" requirements.
- 4.4.3. **PROVIDE** a copy of the completed report to the requesting person/department.
5. **RETURN TO NORMAL**
- 5.1. **REMOVE** excess couplant material to ensure the component is left in the "as found" condition.
- 5.2. **NOTIFY** the applicable plant department of the exam status.
6. **REFERENCES**
- 6.1. ER-AA-335-009 "Ultrasonic Equipment Specific Performance Checks".
- 6.2. TQ-AA-122 "Qualification And Certification of Nondestructive (NDE) Personnel".
- 6.3. ASME Boiler and Pressure Vessel Code 2001 Edition, 2003 Addenda, Section I.
- 6.4. ASME Boiler and Pressure Vessel Code 2001 Edition, 2003 Addenda., Section III.
- 6.5. ASME Boiler and Pressure Vessel Code 2001 Edition, 2003 Addenda, Section V.
- 6.6. ASME Boiler and Pressure Vessel Code 2001 Edition, 2003 Addenda, Section VIII.
- 6.7. ASME Boiler and Pressure vessel Code 2001 Edition, 2003 Addenda, Section XI.
- 6.8. ANSI B31.1, Power Piping. 6.9. ANSI B31.7, Nuclear Power Piping

7. **ATTACHMENTS** –

- 7.1. Attachment 1, Straight beam for interfering conditions (lamination scans) of base materials
- 7.2. Attachment 2, Thickness measurements in support of weld coverage or plotting of indications.
- 7.3 Attachment 3, Thickness calibration sheet.
- 7.4 Attachment 4, Sketch sheet.
- 7.5 Attachment 5, T&C sheet.

ATTACHMENT 1**STRAIGHT BEAM FOR INTERFERING CONDITIONS (LAMINATION SCANS)
OF BASE MATERIALS****1. CALIBRATION AND EXAMINATION**

- 1.1. Straight beam examinations for interfering conditions (lamination scans) of base materials
 - 1.1.1. The surface shall be free of irregularities, loose material, or coatings, which interfere with the ultrasonic wave transmission.
 - 1.1.2. Adjust the instruments gain setting to maintain a backwall reflection between 40% to 80% full screen height.
 - 1.1.3. The instruments screen should be set to maintain a backwall reflection at 50% to 80% full screen width.
 - 1.1.4. The results of this examination shall be recorded on the angle beam calibration and or data report as a note, which will record the location of the lamination or inference.
- 1.2. Straight beam examinations to locate counter bore for ASME Code Section XI R-A category welds.
 - 1.2.1. The applicable base material shall be scanned in accordance with 1.1.2 and 1.1.3.
 - 1.2.2. The results of this examination shall be recorded on the angle beam calibration/data report as a note, which will record the location of the counterbore as a measurement from weld centerline or some established point or state that no counterbore was detected.

2. RECORDING

- 2.1.1. Record any unusual loss of signal or degradation of signal shape, amplitude and metal path.
- 2.1.2. Any mid-wall signal that results in a loss of backwall signal amplitude.
- 2.1.3. Map all areas that result in a total loss of the backwall signal.

ATTACHMENT 2

THE MEASURED MATERIAL THICKNESS ALONG WITH THE ACTUAL WELD CONTOURS SHALL BE RECORDED ON A SKETCH SHEET OR OTHER SIMILARLY CONFIGURED PLOT SHEET

1. CALIBRATION AND EXAMINATION

- 1.1. Thickness measurements in support of weld coverage.
 - 1.1.1. The surface shall be free of irregularities, loose material, or coatings, which interfere with the ultrasonic wave transmission.
 - 1.1.2. Thickness measurements should be made at 5 positions at a minimum, across the weld if possible. Additional readings may be recorded as necessary at the discretion of the technician, in order to support the evaluation of the indications.
 - 1.1.3. Thickness and contour (T&C's) measurements in support of weld coverage verification should be taken on piping components at the Lo location where practical, or in a location that is representative of the overall component contour. In some instances, it may be necessary to take multiple T&C's at varying locations as directed by the Level III, in order to achieve a true representation of the varying component configuration.
 - 1.1.4. In the instances where the T&C's are being acquired in support of the evaluation of indications, they should be acquired in the area of interest or as specified by the level III. In addition, the UT operator should scan the surface from position upstream and downstream, noting where along the scan path (in inches from the weld centerline) the thickness changes. Record this dimension and thickness on the data sheet or note that counter-bore was/was not observed.
 - 1.1.5. Using the contour gage, make an impression or multiple impressions as necessary, of the surface area, which is representative of the surface contour where the UT thicknesses were acquired. If it is impractical to utilize a contour gauge, physical measurements may be utilized in determining the contour.
- 1.2. Thickness measurements performed to meet site requirements.
 - 1.2.1. Detailed instructions shall be provided by site personnel to include component configuration, the location thickness readings are to be taken, the number of readings to be taken, the accuracy of the dimension values if different than the above documentation require.

2. RECORDING

- 2.1. The measured material thickness along with the actual weld contours shall be recorded on a Sketch sheets or other comparable sheet.
- 2.2. Acceptations and or other techniques can be made/used if approved by an Exelon NDE UT Level III

ATTACHMENT 3

		ULTRASONIC THICKNESS CALIBRATION DATA SHEET		Report Number: _____
Plant: _____	Unit: _____	Date: _____	Page _____ of _____	
Procedure Number/Rev: _____			W/O # _____	
<u>Equipment Data</u>				
Instrument Information		Transducer Information		
Manufacturer: _____	Manufacturer: _____	Size: _____		
Model _____	Serial Number: _____	Freq: _____		
Serial Number _____	Style: _____	Couplant: _____		
		Batch: _____		
<u>Calibration Data</u>				
Calibration Block		Calibration Block Readings		
Type: _____	Actual (T): _____	Measured (T): _____		
Material: _____	_____	_____		
Cal Blk S/N: _____	_____	_____		
Cal Blk Temp _____	_____	_____		
Temp S/N _____	_____	_____		
Cal Time in: _____		Cal Check: _____		Cal Out time: _____
<u>Component Examination Information</u>				
System	Component Numbers	Component Temp	Acceptance Criteria	Inspection Results
Comments: <div style="border: 1px solid black; height: 40px; width: 100%; margin-top: 5px;"></div>				
Examiner: _____		Level: _____		Date: _____
Reviewer: _____				Date: _____
ANII: _____				Date: _____

ATTACHMENT 4

Exelon

SKETCH SHEET

Station: _____

Unit: _____

Page: _____ of _____

Procedure \ Revision : _____

Report Number: _____

Component: _____

System: _____

Examiner \ Level : _____

Reviewer: _____

ANII: _____

Date: _____

Date: _____

Date: _____

Exelon Nuclear Energy					WALL THICKNESS PROFILE SHEET		SITE: _____ UNIT: _____	REPORT NO.: _____									
SYSTEM: _____					COMPONENT ID NO.: _____												
POSITION	0°	90°	180°	270°	CROWN HEIGHT: _____												
1					CROWN WIDTH: _____												
2					NOM DIAMETER: _____												
3					WELD LENGTH: _____												
4																	
5																	
<div style="border: 1px dashed black; width: 100%; height: 100%;"></div>																	

DRAWN BY: _____	LEVEL: _____	DATE: _____	UTILITY REVIEW: _____
REVIEWED BY: _____	LEVEL: _____	DATE: _____	DATE: _____

PAGE: _____ OF: _____
FORM 117-01 REV. 4

U777P0T

ACRORDHZ.PDF
10/17/06 07:15 AM

