EPRI | ELECTRIC POWER RESEARCH INSTITUTE

PDI UT-8 Revision F and PDI UT-10 Revision C

Review of Changes

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ENCLOSURE 5

PDI UT-8 Revision F

- Itemized review of changes from revision E to revision F

PDI-UT-8 Revision F

Summary of Changes from Revision E to Revision F

1. Revised Table A for clarification.
2. Revised paragraph 6.6.1 c) 5 to add clarification on the calculations performed in Illustration 2.
3. Revised paragraph 6.8.1 to reduce confusion and clarify intent.
4. Revised Tables E1 and E2 to reduce confusion; rounded table values to a tenth of an inch, added note to allow for a 1mm tolerance on values.
5. Revised paragraph 6.9.1 to add clarification in using the formulas in Table G.
6. Added paragraph 7.1.2 to add guidance on evaluating examination system performance.
7. Revised Figure 5A to include new calibration block (3-CIRC-01).

PDI UT-8 Revision F

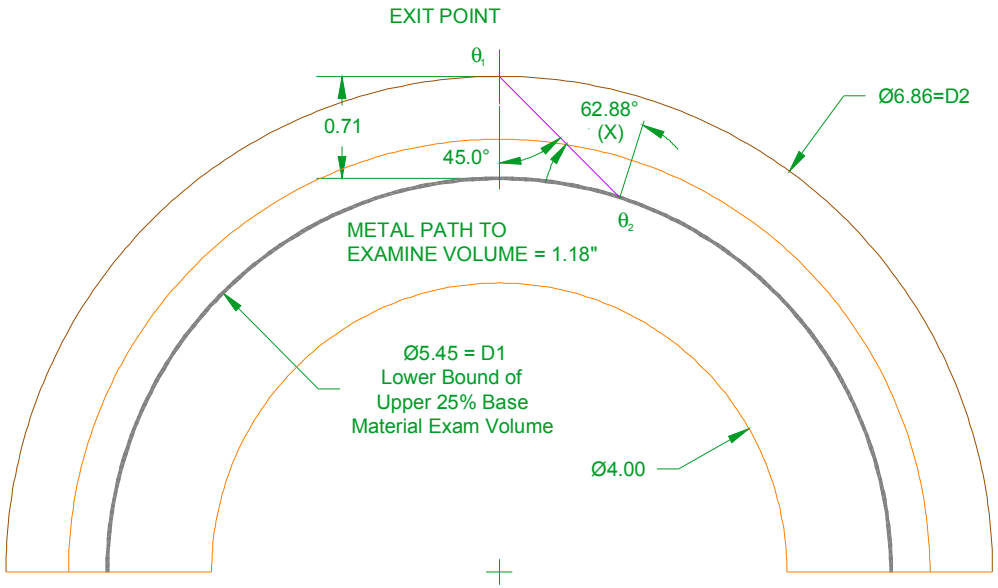
Table A
(Ranges of Applicability)

Material	Diameter Range (Component Diameter/Pre-Overlay)		Thickness Range (Weld Overlay Thickness)	
	PDI Demonstration	Field Applicability	PDI Demonstration	Field Applicability
Austenitic WOR	2.0" to 28.0"	1.8" and Greater	0.150" to 1.10"	0.050" to 1.35"

Deleted: Nominal Pipe

- The words “Nominal Pipe” replaced with “Component” and Pre-Overlay added
  - This was done for clarification purposes

PDI UT-8 Revision F



$$\frac{Sin\ \theta_1}{Sin\ \theta_2} = \frac{D_1}{D_2}$$

Example :

$$\frac{Sin\ \theta_1}{Sin\ \theta_2} = \frac{D_1}{D_2}$$

$$Sin\ \theta_1 (D_2) = Sin\ \theta_2 (D_1)$$

$$Sin\ 45 (6.86) = Sin\ \theta_2 (5.45)$$

$$.707\ (6.86) = Sin\ \theta_2 (5.45)$$

$$\frac{.707\ (6.86)}{5.45} = Sin\ \theta_2$$

$$\frac{4.85}{5.45} = Sin\ \theta_2$$

$$.890 = Sin\ \theta_2$$

$$Sin^{-1}(.890) = \theta_2$$

$$62.87° = \theta_2$$

$D_2 = OutSideDia \quad (6.86)$

$D_1 = InsideDia \quad (Upper\ 25\%) = (5.45)$

$\theta_1 = KnownAngle \quad (45°)$

$\theta_2 = Angle\ (X)\ AtExamVol$

Illustration 2: Formula for Angle of Impingement at a given Diameter

PDI UT-8 Revision F

5. If the formulas above require the use of examination angles less than those required by Tables C and D, it is recommended that the resulting angle impinge on the lower limit of the examination volume between 55° to 60° but in no case >87°. The relationship depicted in illustration 2 can be used to calculate the impingement angle for a specific transducer angle or calculate the necessary transducer angle to produce a desired impingement angle. This is accomplished by solving for Sin∅2 or Sin∅1 respectively. These angles must be qualified and listed on the Table 1 for this procedure.

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Deleted: See Illustration 2 below.

- Paragraph 6.6.1 C) 5. Modified to further describe the use of the formula in Illustration 2

PDI UT-8 Revision F

6.8 Search Unit Element Size

6.8.1 Element size has a direct impact on the focusing ability of a search unit. Tables E1 (FS, Focal Sound Path) and E2 (FD, Focal Depth) list the focusing ranges determined to be the most effective for a given search unit size, angle and frequency. The purpose of these tables is to provide criteria that shall be used for the selection of search unit size. The selection of search unit element size for refracted longitudinal wave search units is based on the required focusing as defined in Paragraphs 6.7.2 and 6.7.3. This required focusing range shall be compared to the values listed in Tables E1 and E2 for the applicable angle and frequency. A search unit size shall be selected that is capable of obtaining a focal distance within the requirements of Paragraphs 6.7.2 and 6.7.3. It is recognized that Tables E1 and E2 do not contain every possible search unit configuration. Therefore the following information is provided to address search unit parameters not included in the tables.

a) For angles not included in the tables, the ranges for the next closest angle shall be used.

b) For element sizes not included in the tables, the ranges for the next closest element size shall be used.

c) For frequencies not included in the tables, the ranges for the next closest frequency shall be used.

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- Changes made to further explain the use of Tables E1 & E2 and to provide criteria on selecting search units with configurations not addressed in the tables

PDI UT-8 Revision F

Minimum and Maximum Focus Ranges for RL Transducers													
Element Size		2(7x10)mm		2(8x14)mm		2(10x18)mm		2(15x25)mm		2(20x34)mm		2(24x42)mm	
Freq.	Angle	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1.0	45			0.4	1.0	0.6	1.2	0.8	2.2	1.2	3.2	1.6	4.7
	60			0.4	0.8	0.6	1.2	0.8	1.8	1.0	3.0	1.4	4.3
	70			0.4	0.8	0.6	1.2	0.6	1.8	1.0	3.0	1.2	3.9
1.5	45			0.4	1.2	0.6	1.6	0.8	2.6	1.4	3.9	1.8	5.3
	60			0.4	1.2	0.6	1.6	0.8	2.4	1.2	3.5	1.6	4.9
	70			0.4	1.0	0.6	1.2	0.8	2.4	1.2	3.4	1.4	4.5
2.0	45	0.4	1.0	0.6	1.2	0.8	1.8	1.0	3.4	1.6	5.1	1.8	6.3
	60	0.4	1.0	0.4	1.2	0.6	1.6	0.8	3.0	1.2	4.7	1.6	5.5
	70	0.4	0.8	0.4	1.0	0.6	1.4	0.8	2.8	1.2	4.3	1.4	4.9
4.0	45	0.4	1.4	0.8	2.4	1.0	3.5	1.2	3.9				
	60	0.4	1.4	0.6	2.2	0.8	2.8	1.0	3.5				
	70	0.4	1.2	0.4	2.0	0.6	2.6	0.8	3.4				

- Tables E1 & E2 rounded to one decimal place and a 1mm tolerance allowed for Metric to English conversions

PDI UT-8 Revision F

6.9 Search Unit Contouring

6.9.1 Search unit contouring for refracted longitudinal search units shall be performed as required by the following table. Both the calculations from Table G shall be performed in order to evaluate the contouring requirements.

Table G
(Contouring Formula)

Search units should be contoured if;		Search units shall be contoured if;	
$D \le \left[\frac{(A \times A)}{2}\right]$	MM	$D \le \left[\frac{(A \times A)}{3}\right]$	MM
$D \le \left[\frac{(A \times A)}{.079}\right]$	Inches	$D \le \left[\frac{(A \times A)}{.113}\right]$	Inches
A = The length of the search unit footprint when scanning in the circumferential direction and the width when scanning in the axial direction.		A = The length of the search unit footprint when scanning in the circumferential direction and the width when scanning in the axial direction.	
D = The actual outside diameter of the component.		D = The actual outside diameter of the component.	

- Clarify the intent that both calculations need to be performed to fully assess the need for contoured search units

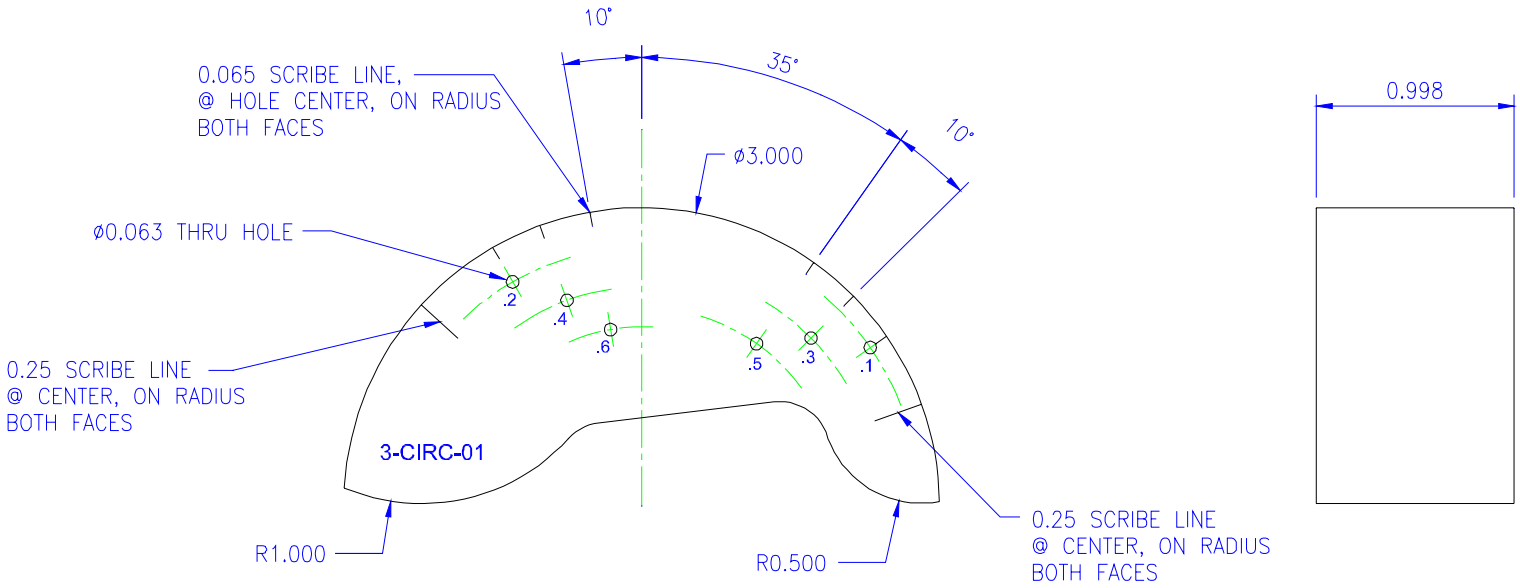
PDI UT-8 Revision F

7.1.2 If a minimum of a 5:1 signal to noise ratio can not be obtained from a reference reflector, the examiner should attempt to ascertain the cause. Items to consider include, the instrument, transducer, cable, coupling, or any other conditions that could result in a lowered signal to noise ratio.

- Moved the signal to noise ratio evaluation into the calibration section
  - Signal to noise from a reference reflector has not been demonstrated as an affective basis for flaw detection. However is a valuable assessment of system performance

PDI UT-8 Revision F

3–CIRC–01



- Incorporated a new reference block design

Summary of Changes to PDI-UT 8 Rev. F

- Changes made mostly for clarification purposes
- Tables E1 & E2 rounded to one decimal
  - No affect on original qualification
  - All transducers used for procedure qualification meet the requirements of these tables

PDI UT-10 Revision C

- Itemized review of changes from revision B to revision C

PDI-UT-10 Revision C

Summary of Changes from Revision B to Revision C

1. Revised paragraph 4.2.1 to allow for the use of PDI Dissimilar Metal Weld Mockup Criteria document.
2. Deleted paragraph 6.7.1 b) to reduce confusion over focusing requirements.
3. Revised paragraph 6.8.1 to reduce confusion.
4. Revised paragraph 6.8.2 a) to provide more specific guidance on the actions required when exceeding the limits of Tables E1 and E2.
5. Revised Tables E1 and E2 to reduce confusion; rounded table values to a tenth of an inch, added note to allow for a 1mm tolerance on values.
6. Revised paragraph 6.9.1 to add clarification in using the formulas in Table G.
7. Added paragraph 7.1.4 to add guidance on evaluating examination system performance.
8. Revised paragraph 7.5.2 to reduce confusion and clarify the use of ASME calibration blocks.
9. Revised paragraph 7.5.3 to add clarification.

PDI UT-10 Revision C

4.2 Search Units

4.2.1 Any search unit may be used with this procedure provided it has been qualified as an instrument/search unit combination by successful PDI performance demonstration or demonstrated in accordance with the PDI Dissimilar Metal Weld Mock-up Criteria document. Table 1 for this procedure contains a listing of qualified refracted longitudinal search units that can be used with this procedure. Table 1 for PDI-UT-2 shall be used to select shear wave search units to be used with this procedure. Additional information regarding search units may be found in Section 6.0.

- Added statement to allow transducers demonstrated on a site specific mock ups to be used

PDI UT-10 Revision C

Deleted: <#>The search unit must be capable of achieving a minimum of a 10-to-1 signal to noise ratio in the area of interest. The signal to noise ratio shall be measured within the focal ranges specified in Paragraphs 6.7.2 and 6.7.3.¶

- Similar change as UT-8
  - Signal to noise from a reference reflector has not been demonstrated as an affective basis for flaw detection. However is a valuable assessment of system performance

PDI UT-10 Revision C

6.8 Search Unit Element Size

6.8.1 Element size has a direct impact on the focusing ability of a search unit. Tables E1 (FS, Focal Sound Path) and E2 (FD, Focal Depth) list the focusing ranges determined to be the most effective for a given search unit size, angle and frequency. The purpose of these tables is to provide criteria that shall be used for the selection of search unit size. The selection of search unit element size for refracted longitudinal wave search units is based on the required focusing as defined in Paragraphs 6.7.2 and 6.7.3. This required focusing range shall be compared to the values listed in Tables E1 and E2 for the applicable angle and frequency. A search unit size shall be selected that is capable of obtaining a focal distance within the requirements of Paragraphs 6.7.2 and 6.7.3. It is recognized that Tables E1 and E2 do not contain every possible search unit configuration. Therefore the following information is provided to address search unit parameters not included in the tables.

a) For angles not included in the tables, the ranges for the next closest angle shall be used.

b) For element sizes not included in the tables, the ranges for the next closest element size shall be used.

c) For frequencies not included in the tables, the ranges for the next closest frequency shall be used.

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- Changes made to further explain the use of Tables E1 & E2 and to provide criteria on selecting search units with configurations not addressed in the tables

PDI UT-10 Revision C

6.8.2 If the required focusing is at the upper or lower limit of the values shown in these tables it is recommended that the next larger size search unit be selected for the upper limit and the next smaller size search unit be selected for the lower limit.

a) Examinations performed on thick components may require focusing in excess of the limits in Tables E1 and E2. In these cases a demonstration of probe performance shall be performed on a PDI sample or site specific mockup of sufficient thickness to validate the search unit's performance at the focal sound paths required in Paragraph 6.7.

6.8.3 The maximum search unit size for non-contoured shear wave search units is shown in Table F. This size can be exceeded if the search units are contoured. (See Section 6.9)

Deleted: verification

Deleted: for the required examination volume

Deleted: The search units shall be capable of achieving a minimum of 10-to-1 signal to noise ratio.

- Added more specific detail on the actions required when the values of Tables E1 & E2 must be exceeded
- Removed the signal to noise requirements

PDI UT-10 Revision C

Minimum and Maximum Focus Ranges for RL Transducers													
Element Size		2(7x10)mm		2(8x14)mm		2(10x18)mm		2(15x25)mm		2(20x34)mm		2(24x42)mm	
Freq.	Angle	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1.0	45			0.4	1.0	0.6	1.2	0.8	2.2	1.2	3.2	1.6	4.7
	60			0.4	0.8	0.6	1.2	0.8	1.8	1.0	3.0	1.4	4.3
	70			0.4	0.8	0.6	1.2	0.6	1.8	1.0	3.0	1.2	3.9
1.5	45			0.4	1.2	0.6	1.6	0.8	2.6	1.4	3.9	1.8	5.3
	60			0.4	1.2	0.6	1.6	0.8	2.4	1.2	3.5	1.6	4.9
	70			0.4	1.0	0.6	1.2	0.8	2.4	1.2	3.4	1.4	4.5
2.0	45	0.4	1.0	0.6	1.2	0.8	1.8	1.0	3.4	1.6	5.1	1.8	6.3
	60	0.4	1.0	0.4	1.2	0.6	1.6	0.8	3.0	1.2	4.7	1.6	5.5
	70	0.4	0.8	0.4	1.0	0.6	1.4	0.8	2.8	1.2	4.3	1.4	4.9
4.0	45	0.4	1.4	0.8	2.4	1.0	3.5	1.2	3.9				
	60	0.4	1.4	0.6	2.2	0.8	2.8	1.0	3.5				
	70	0.4	1.2	0.4	2.0	0.6	2.6	0.8	3.4				

- Tables E1 & E2 rounded to one decimal place and a 1mm tolerance allowed for Metric to English conversions

PDI UT-10 Revision C

6.9 Search Unit Contouring

6.9.1 Search unit contouring for refracted longitudinal search units shall be performed as required by the following table. Both the calculations from Table G shall be performed in order to evaluate the contouring requirements.

Table G
(Contouring Formula)

Search units should be contoured if;		Search units shall be contoured if;	
$D \le \left[\frac{(A \times A)}{2}\right]$	MM	$D \le \left[\frac{(A \times A)}{3}\right]$	MM
$D \le \left[\frac{(A \times A)}{.079}\right]$	Inches	$D \le \left[\frac{(A \times A)}{.113}\right]$	Inches
A = The length of the search unit footprint when scanning in the circumferential direction and the width when scanning in the axial direction.		A = The length of the search unit footprint when scanning in the circumferential direction and the width when scanning in the axial direction.	
D = The actual outside diameter of the component.		D = The actual outside diameter of the component.	

- Clarify the intent that both calculations need to be performed to fully assess the need for contoured search units

PDI UT-10 Revision C

7.1.4 If a minimum of a 5:1 signal to noise ratio can not be obtained from a reference reflector, the examiner should attempt to ascertain the cause. Items to consider include, the instrument, transducer, cable, coupling, or any other conditions that could result in a lowered signal to noise ratio.

- Moved the signal to noise ratio evaluation into the calibration section
  - Signal to noise from a reference reflector has not been demonstrated as an affective basis for flaw detection. However is a valuable assessment of system performance

PDI UT-10 Revision C

7.5.2 To establish reference sensitivity using an ASME calibration block or a welded mockup, maximize the signal response from an appropriate inside surface notch and adjust the amplitude to somewhere between 80% and 90% FSH, inclusive. Record the signal position, amplitude, and gain setting on the calibration data sheet. For ID impingement angles greater than 52° a side or end drilled hole that is within the effective range of the search unit shall be used to establish the reference sensitivity in lieu of a inside surface notch. For instances where the ASME calibration block does not contain an appropriate side or end drilled hole, an inside surface notch may be used to establish reference sensitivity provided that a 5:1 signal to noise ratio is achievable. Additionally standard reference blocks may be used if the ASME calibration block does not contain suitable side or end drilled holes. The focusing requirements of the search unit shall be as described in Paragraphs 6.7.2 and 6.7.3.

- Revised to incorporate an addenda to the procedure for the use of notches in ASME calibration blocks
  - Tests showed that ID notches require ≈ 6dB more than side drilled holes to obtain 80% amplitude

PDI UT-10 Revision C

7.5.3 To establish reference sensitivity using a standard reference block, position the search unit on the reference block and maximize the signal response from a inside surface notch or side drilled hole within the effective range of the search unit and adjust the amplitude to somewhere between 80% and 90% FSH, inclusive. Record the signal position, amplitude, and gain setting on the calibration data sheet. For ID impingement angles greater than 52° a side or end drilled hole that is within the effective range of the search unit shall be used to establish the reference sensitivity in lieu of a inside surface notch. The focusing requirements of the search unit shall be as described in Paragraphs 6.7.2 and 6.7.3.

Deleted: tip

Deleted: effective range

- Revised for clarification

Summary of Changes to PDI-UT 10 Rev. C

- Changes made mostly for clarification purposes
- Provided for the use transducers demonstrated on a site specific mock up
- Added more specific detail on the actions required when the values of Tables E1 & E2 must be exceeded
- Tables E1 & E2 rounded to one decimal
  - No affect on original qualification
  - All transducers used for procedure qualification meet the requirements of these tables
- Provided for the use of notches in ASME calibration blocks to establish reference sensitivity