



# **PDI Process for Documenting Essential Variables**

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# Overview

- Review of current ASME Code requirements
- Review of the PDI procedure qualification process, including documentation
- Summary

# ASME Code Requirements

- VIII-2100(a) through (d)
  - Procedure scope - limits of procedure applicability
    - (materials, thickness, diameter, product form)
  - Single value or range of values for:
    - Instrument or system
    - Search unit manufacturer and model or series
      - Frequencies, bandwidths
      - Mode of propagation, nominal inspection angles
      - Number, size, shape & configuration of elements and wedges or shoes
    - Cable type, max length & no. of connectors

# ASME Code Requirements (continued)

- VIII-2100(a) through (d) - continued
  - Methods of calibration
  - Inspection and calibration data to be recorded
  - Method of recording data
  - Recording equipment, when used
  - Method and criteria for the discrimination of indications
  - Surface preparation requirements

# ASME Code Requirements (continued)

- VIII-3130 (a through b)
  - An essential variable or range of variables must be demonstrated via qualification test
  - Personnel performance demonstrations may be used to change essential variables
  - Each examiner need not demonstrate qualification over the entire range of essential variables
  - When the procedure does not specify a range for essential variables and establishes criteria for selecting values, the criteria shall be demonstrated

# ASME Code Requirements (continued)

- These variables are the minimum requirements established during the development of Appendix VIII
- The performance demonstration administrator (PDA) evaluates all variables used (not just the ones listed) during procedure qualification activities

# EPRI PD Program Process

- All procedures are reviewed by the PDA using a procedure review checklist
  - Ensure all required Appendix VIII requirements are addressed
  - Ensure all processes are adequately described, such that they can be objectively tested
  - General review of technical content

PIPING PROCEDURE REVIEW CHECKLIST

Company:		Contact:		
Procedure No.:		Version: 0	Issue Date:	
<b>Procedure Title:</b> PROCEDURE FOR AUTOMATIC ULTRASONIC INSPECTION FOR DETECTION AND LENGTH SIZING OF FLAWS IN NOZZLE TO SAFE END, NOZZLE TO PIPE AND SAFE END TO PIPE WELDS IN PWR VESSEL PRIMARY COOLING LOOPS, WITH ACCESS FROM THE INNER SURFACE				
<b>Applicability:</b>				
<b>PIPING:</b> <input checked="" type="checkbox"/> Automated <input type="checkbox"/> Manual <input checked="" type="checkbox"/> Detection <input checked="" type="checkbox"/> Length Sizing <input type="checkbox"/> Depth Sizing <input checked="" type="checkbox"/> DM <input type="checkbox"/> Ferritic <input type="checkbox"/> Austenitic <input type="checkbox"/> w/IGSCC <input type="checkbox"/> wo/IGSCC <input type="checkbox"/> WOR				
This checklist provides a tool for assessing and documenting essential and non-essential variables of examination procedures being qualified by demonstration. The items contained within this checklist are not applicable for all procedures and systems, and checklist items may be modified to include specific system requirements. Not-Applicable items (N/A) should be documented as such in the "Procedure Location or Note" column. Detailed and/or support information may be provided in the "notes" section at the end of the checklist.				
Item	Procedural Items			Procedure Location or Note
1.0	<b>Scope</b>			
	Verify that the procedure contains a statement of scope that specifically defines the limits of procedure applicability.			1.0
A	<b>Demonstrated Ranges</b>			
	Material Type:	Material Type:	Material Type:	1.0
	Dia. Min.:    Max.:	Dia. Min.:    Max.:	Dia. Min.:    Max.:	
	Thickness Min.:    Max.:	Thickness Min.:    Max.:	Thickness Min.:    Max.:	
	Access <input checked="" type="checkbox"/> Single Side <input checked="" type="checkbox"/> Dual Side	Access <input type="checkbox"/> Single Side <input type="checkbox"/> Dual Side	Access <input type="checkbox"/> Single Side <input type="checkbox"/> Dual Side	
	Product Form: Wrought	Product Form:	Product Form:	
	Clad Type:	Clad Type:	Clad Type:	
B	<b>Field Applicability Ranges</b>			
	Material Type:	Material Type:	Material Type:	1.0
	Dia. Min.:    Max.:	Dia. Min.:    Max.:	Dia. Min.:    Max.:	
	Thickness Min.:    Max.:	Thickness Min.:    Max.:	Thickness Min.:    Max.:	
	Access <input checked="" type="checkbox"/> Single Side <input checked="" type="checkbox"/> Dual Side	Access <input type="checkbox"/> Single Side <input type="checkbox"/> Dual Side	Access <input type="checkbox"/> Single Side <input type="checkbox"/> Dual Side	
	Product Form: Wrought	Product Form:	Product Form:	
	Clad Type:	Clad Type:	Clad Type:	
C	<input checked="" type="checkbox"/> Verify that the procedure describes weld type, configuration, and product form to be examined.			1.0
D	<input checked="" type="checkbox"/> Verify the procedure adequately addresses surface preparation.			1.5
E	<input checked="" type="checkbox"/> Verify that the procedure specifies the examination scanning surface.			1.1

# EPRI PD Program Process

- For encoded system qualifications, the procedure owner is required to have their own system expert list all system settings and address the value or range of values that are to be used during the examination
  - All systems are different, use different terminology; system settings will vary based on the variability of the internal components and software
  - This list or table must specify each setting as “essential” or “non-essential”

**Table 3 (Cont.)  
T-III SETTINGS (CONT.)  
Angle Beam Channels 1 & 2**

Setup Parameter	Setting	Essential Parameter
<b>Multi-Peak:</b>		
Source	N/A	No
Quantity	N/A	No
Threshold	N/A	No
<b>Pulser Receiver:</b>		
Configuration: Phased Array Pulse Echo		
Pulser:		
Element Number	1	Yes
Voltage (all channels)	200v	Yes
Pulse Width	332 ns for 1.25 Mhz Probe 333 ns for 1.50 Mhz Probe	Yes
Receiver:		
Element Number	N/A	Yes
Receiver	N/A	Yes
Pulser	Checked	Yes
Scale Type	LIN for System Ops. Log for Acquisition	Yes
Rectification	Bipolar for System Ops. Unsigned in log for Acquisition	Yes
Filters:		
High Pass	0.5 MHz (only in LIN) No filter for Acquisition	Yes
Low Pass	5.0 MHz (only in LIN) No filter for Acquisition	Yes
Smoothing	Digital	Yes
<b>Probe:</b>		
Material and Interface:		
Wave Type	Longitudinal	Yes
Sound Velocity	0.2271 in/us	Yes
Wedge Delay	As required for accurate time base	Yes
Selection:		
Show Total	Checked	No
Modify Probe	Unchecked	No
Modify Law	Unchecked	No
T and R	Information Field Only	No
Probe Name	Probe Serial Number	No
Position:		
Scan Axis Offset	As required based on Examination Plan	Yes
Index Axis Offset	As required based on Examination Plan	Yes
Adjust Resolution	N/A	No
Beam Orientation:		
Refracted Angle	Defined by Focal Law	Yes
Skew Angle	As required based on Examination Plan	Yes
<b>Alarms:</b>		
Default	Not Used	No
<b>I/O:</b>		
All Entries	All Boxes Unchecked (Not Used)	Yes
<b>Sequence Parameters:</b>		
All Entries	As required based on Examination Plan	Yes
<b>Encoder:</b>		
All Entries	As required based on Examination Plan	Yes

# EPRI PD Program Process (continued)

- During qualification testing, the PDA will verify that the non-essential system settings are in fact non-essential
- Any setting that affects the output of the test, is considered essential and must be listed as such

# EPRI PD Program Process (continued)

- The PDA verifies all aspects (calibration, data acquisition and analysis) of the demonstration using specially developed checklists customized to the procedure

## PROCEDURE COMPLIANCE VERIFICATION CHECK SHEET - Acquisition -

Sample Name: \_\_\_\_\_ Collection Date: \_\_\_\_\_ Session: \_\_\_\_\_

File Name: \_\_\_\_\_ Type of Scan: Axial Circ  
TWS

I. The following items shall be verified during data acquisition:

Check Point	Verification Point	
Assure probe cables are plugged in.	Observation	
Verify that the correct set up file is loaded. _____	Observation	
Verify transducer location in probe holder	Observation	
Verify correct values for component are entered in project manager. Height=                      T=                      R=	Observation	
Verify X and Y starts and stops on sample.	Observation	
Verify Index and Scan Increments	Observation	
Verify scan speed is set IAW procedure. Scan speed = _____	Observation	
Verify data is taken in accordance with scan plan.	Observation	
Verify scan sensitivity is set to logarithmic.	Observation	
Set Computer time and date to 0000 am 1/1/2012	Observation	

# EPRI PD Program Process (continued)

- For non-encoded system qualifications, the PDA works with whomever is qualifying a new instrument, to determine the optimum system settings
  - These are captured in a Table 2 document for that procedure
- Qualified instrument settings for vendor specific encoded procedures are contained within the procedure itself and are considered proprietary

TABLE 2  
PDI-UT-2

## STAVELEY INSTRUMENT SETTINGS

Sonic 136							
Search Unit Frequency (MHz)	Pulse Width (nS)	Damping (Ohms)	Pulse Rep. Rate (kHz)	Display Mode (Filter)	Instrument Freq. (MHz)	Reject	Voltage
1.0	500	500	4 (Note 1)	1, 2, or 3	1.0	Off	Fixed
1.5	334	500	4 (Note 1)	1, 2, or 3	2.25	Off	Fixed
2.0	250	500	4 (Note 1)	1, 2, or 3	2.25	Off	Fixed
2.25	222	500	4 (Note 1)	1, 2, or 3	2.25	Off	Fixed
3.0	168	500	4 (Note 1)	1, 2, or 3	2.25	Off	Fixed
3.5	144	500	4 (Note 1)	1, 2, or 3	2.25	Off	Fixed
4.0	126	500	4 (Note 1)	1, 2, or 3	5.0	Off	Fixed
5.0	100	500	4 (Note 1)	1, 2, or 3	5.0	Off	Fixed

Sonic 137							
Search Unit Frequency (MHz)	Pulse Width (nS)	Damping (Ohms)	Pulse Rep. Rate (kHz)	Display Mode (Filter)	Instrument Freq. (MHz)	Reject	Voltage
1.0	500	200	4 (Note 1)	1, 2, or 3	1.0	Off	300
1.5	334	200	4 (Note 1)	1, 2, or 3	2.25	Off	300
2.0	250	200	4 (Note 1)	1, 2, or 3	2.25	Off	300
2.25	222	200	4 (Note 1)	1, 2, or 3	2.25	Off	300
3.0	168	200	4 (Note 1)	1, 2, or 3	2.25	Off	300
3.5	144	200	4 (Note 1)	1, 2, or 3	2.25	Off	300
4.0	126	200	4 (Note 1)	1, 2, or 3	5.0	Off	300
5.0	100	200	4 (Note 1)	1, 2, or 3	5.0	Off	300

Sonic 1200							
Search Unit Frequency (MHz)	Pulse Width (nS)	Damping (Ohms)	Pulse Rep. Rate (kHz)	Display Mode (Filter)	Instrument Freq. (MHz)	Reject	Voltage
1.0	500	200	Note 2	Full Wave	1.0	Off	300
1.5	334	200	Note 2	Full Wave	2.25	Off	300
2.0	250	200	Note 2	Full Wave	2.25	Off	300
2.25	250	200	Note 2	Full Wave	2.25	Off	300
3.0	168	200	Note 2	Full Wave	2.25	Off	300
3.5	144	200	Note 2	Full Wave	2.25	Off	300
4.0	126	200	Note 2	Full Wave	5.0	Off	300
5.0	100	200	Note 2	Full Wave	5.0	Off	300

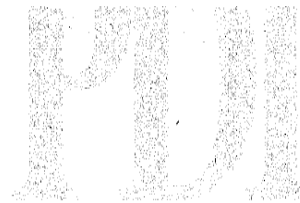
**Note 1:** The pulse repetition rate or frequency settings (PRR/PRF) identified in these tables provide the most adequate signal brightness and screen presentations without displaying signal wrap-around. PRR/PRF settings other than those listed are acceptable provided adequate signal brightness is achievable and scan speeds do not exceed 3" per second.

**Note 2:** The Sonic 1200 automatically adjusts based on the Range and Pulse width settings with a maximum PRR setting of 1 kHz.



# EPRI PD Program Process (continued)

- If a procedure is successfully demonstrated a Performance Demonstration Qualification Summary (PDQS) is produced
- Documents
  - Demonstrated diameter and thickness ranges
  - Examination surface
  - Limitations
  - Comments
  - Field applicability



## Automated Inside Surface Ultrasonic Examination of Piping Welds Using Phased Array

PDQS Rev: 0  
 Date of Issue: 25-Feb-05  
 Hardware: RD/Tech Tomoscan III  
 Category: Piping

Analysis SW Type/Rev: Tomoview, 2.2Q14  
 Operator SW Type/Rev: Tomoview, 2.2Q14  
 Scan Application: Fully-Automatic  
 ExamSurface: Inside

### Ranges Demonstrated:

<b>Date:</b> 25-Feb-05	<b>MinDiam:</b> 27.50	<b>MinThick:</b> 2.340	<b>Date:</b> 25-Feb-05	<b>MinDiam:</b> 27.50	<b>MinThick:</b> 2.400
<b>MaxDiam:</b> 29.00	<b>MaxThick:</b> 2.540		<b>MaxDiam:</b> 29.00	<b>MaxThick:</b> 2.930	
<b>Material:</b> Austenitic without IGSCC			<b>Material:</b> Dissimilar Metals		
<b>Examination:</b> Detection			<b>Examination:</b> Detection		
<b>Access:</b> Double Sided			<b>Access:</b> Double Sided		
<b>Weld Condition:</b> Ground Flush			<b>Weld Condition:</b> Ground Flush		
<b>Weld Condition:</b> As Welded			<b>Weld Condition:</b> As Welded		
<b>Examination:</b> Length Sizing			<b>Examination:</b> Length Sizing		
<b>Access:</b> Double Sided			<b>Access:</b> Double Sided		
<b>Weld Condition:</b> Ground Flush			<b>Weld Condition:</b> Ground Flush		
<b>Weld Condition:</b> As Welded			<b>Weld Condition:</b> As Welded		

When "Length Sizing" is indicated, the 0.750 RMS acceptance criteria per the PDI Program Description has been achieved.  
 When "Through Wall Sizing" is indicated, the 0.125 RMS acceptance criteria per the PDI Program Description has been achieved.

#### Tolerances for field applications as follows:

**Diameter:** Lower: .500" can be subtracted from the minimum diameter demonstrated.  
 Upper: Diameters greater than 24" need not be demonstrated

**Thickness:** Lower: 0.100" can be subtracted from the minimum thickness demonstrated for both austenitic and ferritic  
 25% of the minimum thickness demonstrated for dissimilar metal welds  
 Upper: 1.000" can be added to the maximum thickness demonstrated for ferritic material.  
 0.500" can be added to the maximum thickness demonstrated for austenitic material.  
 25% of the maximum thickness demonstrated for dissimilar metal welds

**Comments:**

- 1 See Table 1 for this procedure for list of qualified search unit instrument combinations.
- 2 Detection, length and depth sizing of embedded flaws has not been demonstrated during this qualification.
- 3 The diameters noted on this document are inside diameters.
- 4 The thickness values shown on this PDQS exclude the clad thickness where applicable.
- 5 For both Supplement 2 and 10 the term "As Welded" defined under weld condition in the dissimilar metal weld qualifications refers to the ferritic base metal clad condition and the root condition of the closure weld configurations.

**Limitations:**

- 1 This procedure/candidate is not qualified to length size axial flaws.
- 2 This procedure/candidate is not qualified for examinations performed from the cast stainless steel side of a component.
- 3 This procedure/candidate is not qualified for depth sizing

# Summary

- The procedure demonstration process is a iterative process that is designed to exercise and document all essential variables used during a successful performance demonstration
- Detailed documentation is captured and stored with the qualification records
- Various documents are published to clearly identify the essential variables and the range of applicability of the successful procedures