WDI-TJ-1044-NP, Rev. 1,

"Demonstration Report/Technical Basis Document: Ultrasonic Examination of Diablo Canyon Unit 2 Reactor Pressure Vessel Nozzle to Safe End Welds from the ID Surface Through A Welded Protective Layer"

WESDYNE INTERNATIONAL
A Westinghouse Electric Company

DOCUMENT NUMBER & REV:

WDI-TJ-1044-NP, Rev. 1

TITLE:

Demonstration Report/Technical Basis Document: Ultrasonic Examination of Diablo Canyon Unit 2 Reactor Pressure Vessel Nozzle to Safe End Welds from the ID Surface Through a Welded Protective Layer

COVER SHEET FOR:

- ☐ CALIBRATION PROCEDURE
- ☐ DESIGN SPECIFICATION
- ☐ EQUIPMENT MANUFACTURE & TEST PROCEDURE
- ☐ FUNCTIONAL SPECIFICATION
- ☐ FUNCTIONAL TEST PROCEDURE
- ☐ QUALIFICATION PROCEDURE
- ☒ TECHNICAL JUSTIFICATION
- ☐ TRAINING PLAN
- ☐ USERS MANUAL
- ☐ OTHER

PLANT SITE/PLANT ALPHA: Diablo Canyon 2 / PEG

KEY WORDS: RPV DM Weld Examination

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The procedure approval signature of the cognizant manager below confirms that prior concurrence of required review groups has been obtained.

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Cognizant Manager D. C. Adamonis	**Signature**	**Date*** 6/1/10

*Effective/Revised Date

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Demonstration Report/Technical Basis Document: Ultrasonic Examination of Diablo Canyon Unit 2 Reactor Pressure Vessel Nozzle to Safe End Welds from the ID Surface Through a Welded Protective Layer

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Demonstration Report/Technical Basis Document: Ultrasonic Examination of Diablo Canyon Unit 2 Reactor Pressure Vessel Nozzle to Safe End Welds from the ID Surface Through a Welded Protective Layer

1.0 PURPOSE

The Diablo Canyon Unit 2 Reactor Pressure Vessel Nozzle Piping weld design configuration is sketched in Figure 1.1 for the outlet nozzles and Figure 1.2 for the inlet nozzles. The materials of construction include a SA508, Class 2 carbon steel forging (nozzle) welded to a SA-182 Type 316 stainless steel forging (nozzle extension piece) which is then welded to either to an A-376 Type 316 stainless steel forged pipe (outlet nozzle) or to an A-351 CF8M cast stainless steel elbow (inlet nozzle). The weld material is Alloy 182 for the nozzle to safe end weld, and is stainless steel for the safe end to piping weld. On the inner diameter and outer diameter surfaces of the nozzle extension piece and dissimilar metal weld, a nominal 0.090-inch thick layer of 312L stainless steel and Alloy 82 cladding exists [Refs. 9.1, 9.2, 9.20 and 9.21]. These layers were added during the fabrication of the reactor vessel. These are referred to as welded protective layers in this document since they were added to isolate a potentially sensitized material from the surrounding environment.

The inlet and outlet nozzle to safe end welds, and inlet and outlet nozzle safe end to pipe welds were inspected during the Diablo Canyon Unit 2 10-Year RVISI in 2006 and will be re-examined in 2011. The examinations are conducted using a WesDyne International automated ultrasonic examination process qualified in accordance with the ASME Code Section XI, Appendix VIII Supplement 14 as modified by the Performance Demonstration Initiative (PDI). The WesDyne inspection procedure is PDI-ISI-254-SE [Ref. 9.3]. This procedure is qualified for detection and length sizing as defined in PDQS No. 634 [Ref. 9.4], and has a demonstrated through-wall sizing capability that is greater than 0.125" RMS but within 10% of the nominal wall thickness. The actual performance RMS for through-wall sizing is obtained from PDI by Licensee request.

The 312L stainless steel and Alloy 82 cladding, added as a protective layer on the ID surface, is outside of the PDI qualification parameters as defined in the procedure. The PDI program allows for site specific demonstrations in accordance with the PDI Dissimilar Metal Weld Mock-Up Criteria [Ref. 9.5] and with the PDI Guideline for Ultrasonic Examination of Corrosion Resistant Cladding [Ref. 9.6]. The remainder of the weld and adjacent surfaces are compatible with the PDI qualification parameters (material, diameter, thickness) and no additional demonstration is necessary.

The intent of a site specific demonstration is to expand on currently qualified essential variables (such as beam angles, probe element sizes, sound focal depths, probe contouring, scan patterns, etc.) and to allow the inspection personnel to gain specific knowledge of potential sources of UT responses associated with these welds. These sources may be from metallurgical, geometric, and defect conditions.

It is noted that site specific demonstrations have been implemented that are relevant to justifying the examination approach for the Diablo Canyon Unit 2 nozzle to safe end welds and nozzle safe end to pipe welds. These include a site specific demonstration conducted in 2006 by WesDyne International for Indian Point Unit 2 and 3 [Ref. 9.7], and the weld inlay equivalency demonstration conducted in 2007 by EPRI under PWROG funding [Refs. 9.8 - 9.10]. The Indian Point Unit 2/3 demonstration was witnessed by the site Level III and their ANII. The weld inlay equivalency test demonstration was witnessed by EPRI PDI personnel. Both demonstrations were performed under non-blind conditions using the same automated ultrasonic examination techniques defined in PDI-ISI-254-SE. As such, no new site specific demonstrations are necessary.

This report serves as the demonstration report/technical basis document similar to that required by PDI [Refs. 9.5 and 9.6] in order to expand the applicability of the PDI-qualified procedure, PDI-ISI-254-SE, for use at Diablo Canyon Unit 2. It uses the information from the two previous demonstrations as justification.

Completed Site Specific Demonstration Checklists are provided in Attachment 1. These checklists provide the specific paragraph reference in this document where demonstration report/technical basis requirements, as defined in References 9.5 and 9.6, can be found.

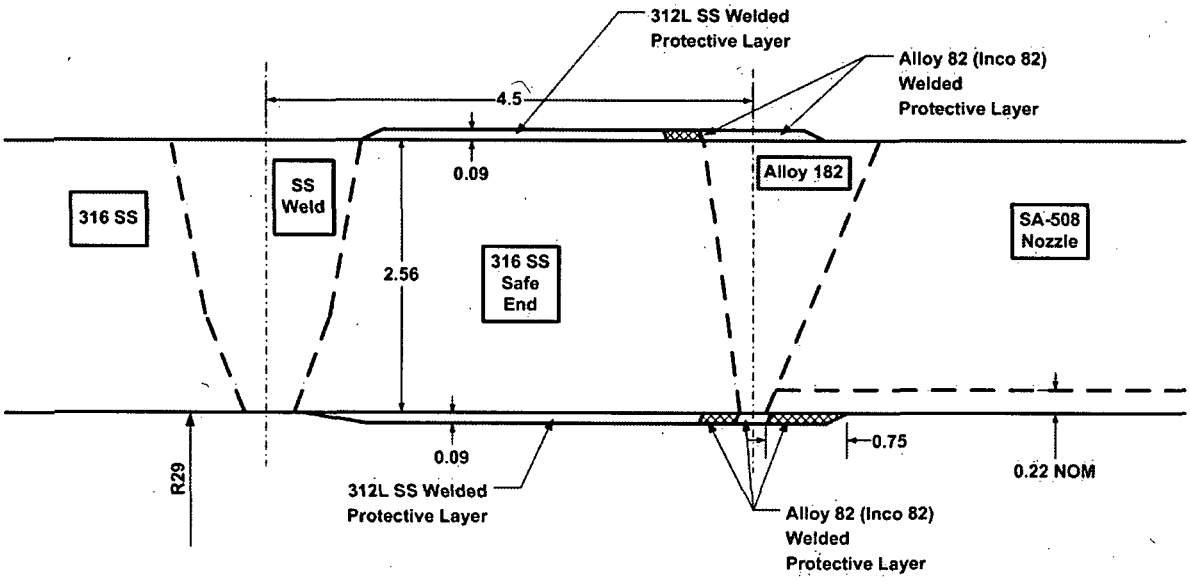

Figure 1.1: Diablo Canyon Unit 2 Reactor Pressure Vessel Nozzle to Safe End and Safe End to Pipe Weld Design Configuration – Outlet Nozzle [Refs. 9.1, 9.2, 9.19, 9.20 and 9.21]

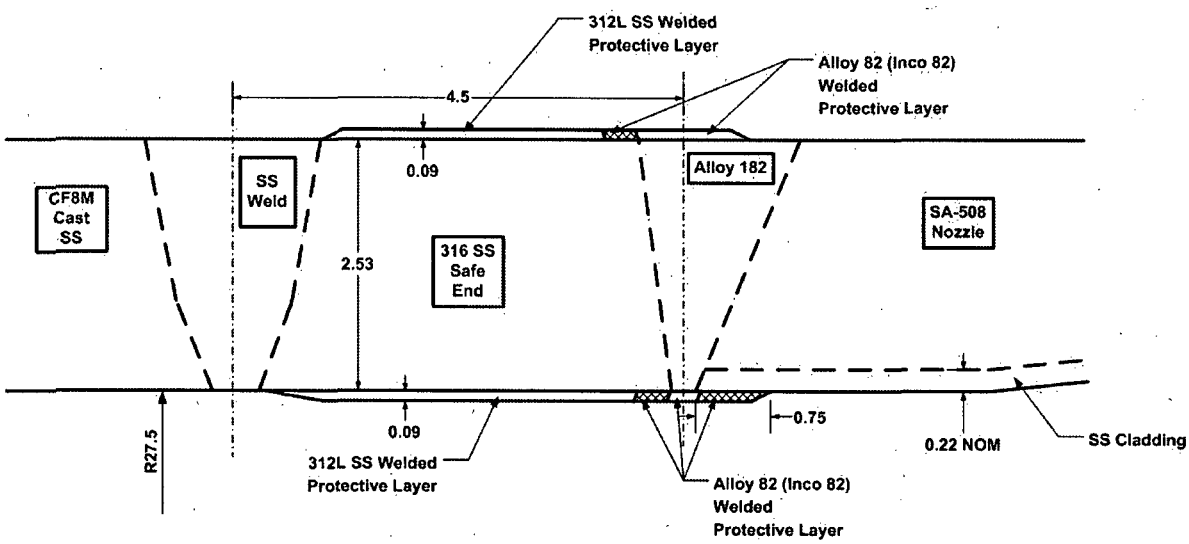

Figure 1.2: Diablo Canyon Unit 2 Reactor Pressure Vessel Nozzle to Safe End and Safe End to Elbow Weld Design Configuration – Inlet Nozzle [Refs. 9.1, 9.2, 9.19, 9.20 and 9.21]

2.0 EQUIPMENT

The essential equipment defined in Table 2.1 (Indian Point Unit 2/3 Demonstration) and Table 2.2 (Weld Inlay Equivalency Demonstration) was used for the previous site specific demonstrations. There were no changes in equipment from that specified in PDI-ISI-254-SE.

Table 2.1: List of Essential Equipment Used in the Site Specific Demonstration for Indian Point Unit 2 and 3 [Ref. 9.7] [1]

Equipment	Specific Equipment Definition	Serial Number / Version etc.
UT System	PARAGON Acquisition Software	3.2.0
	PARAGON Analysis Software	6.1.0
	PARAGON Pulser-Receiver: [ ]a,c	[2]
	Digital Cards: [ ]a,c	[2]
	Pulse Generator Cards: [ ]a,c	[2]
Cables	4-ft. long, RG-174 pigtail, Impulse 16 pin to male Suhner	---
	150-ft. long, RG-174, Impulse 16 pin to Lemo	---
	60-in. long, RG-174, BNC to SMC	---
Search Units	Krautkramer, 70° TRL, [ ]a,c	[ ]a,c [3]
	Krautkramer, 45° TRL, [ ]a,c	[ ]a,c [3]
Calibration Blocks	Stainless Steel Navships Test Block	[2]
Reference Blocks	Stainless Steel Navships Test Block	[2]
Couplant	De-mineralized Water	---
Thermometer		229969

Note 1: PDI-ISI-254-SE, Revision 1 used.
Note 2: Report did not identify specific serial numbers only the equipment type used. The equipment type is the same for all revisions of PDI-ISI-254-SE.
Note 3: Whereas this serial number is recorded in Reference 9.7 it is not consistent with the model number used nor is it realistic for use on a flat block. The serial number corresponds to a transducer having a contour of R5.94" axial. The model number in the Specific Equipment Definition is consistent with the equipment essential variable and is consistent with that recorded in the text of Reference 9.7.

Table 2.2: List of Essential Equipment Used in the Site Specific Demonstration for Weld Inlay Equivalency Testing [Ref. 9.8] [1]

Equipment	Specific Equipment Definition	Serial Number / Version etc.
UT System	PARAGON Acquisition Software	3.5.0 Proto. 2
	PARAGON Analysis Software	6.3.0
	PARAGON Pulser-Receiver: [ ]a,c	SAP104592
	Digital Cards: [ ]a,c	SAP104591 (PARAGON)
	Pulse Generator Cards: [ ]a,c	SAP104591 (PARAGON)
Cables	4-ft. long, RG-174 pigtail, Impulse 16 pin to male Suhner	---
	150-ft. long, RG-174, Impulse 16 pin to Lemo	---
	40-in. long, RG-174, BNC to SMC	---
Search Units	Krautkramer, 70° TRL, [ ]a,c	[ ]a,c
	Krautkramer, 45° TRL, [ ]a,c	[ ]a,c
	Krautkramer, 60° TRL, [ ]a,c	[ ]a,c
	Krautkramer, 37° TRL, [ ]a,c	[ ]a,c
	Krautkramer, 45° TRL, [ ]a,c	[ ]a,c
	Krautkramer, 0° PE, [ ]a,c	[ ]a,c
Calibration Blocks	Stainless Steel Navships Test Block	SAP103155 / SAP103933
Reference Blocks	Stainless Steel Navships Test Block	SAP103155 / SAP103933
	B1 (Rompas) Block	SAP 103939
Couplant	• Ultragel (calibration) • Water (examination)	---
Thermometer		SAP105509

Note 1: PDI-ISI-254-SE, Revision 2 used.

3.0 PROCEDURES

The inspection procedure, PDI-ISI-254-SE, which has been qualified in accordance with the PDI implementation of ASME Section XI, Appendix VIII was used in both of the previous site specific demonstrations.

In the Indian Point Unit 2/3 demonstration, Revision 1 of this procedure was used. In the weld inlay equivalency testing demonstration, Revision 2 of this procedure was used. For the Diablo Canyon Unit 2 RVISI examinations in 2006, Revision 2 was the applicable revision [Ref. 9.19]. Revision 3 is the current revision.

The procedure changes from Revision 1 to Revision 2 and from Revision 2 to Revision 3 were reviewed by EPRI and were determined to be associated with modifications that had no effect on essential variables [Refs. 9.11 and 9.12].

There were no changes in essential variables as a result of these site specific demonstrations. As such Revisions 1, 2 and 3 to PDI-ISI-254-SE are all equivalent.

4.0 MOCK-UPS

The Indian Point Unit 2/3 site specific demonstration was conducted on a modified Indian Point reference standard (IPP-RV-73). This standard is a 6" wide by 18.5" long flat weldment block containing a dissimilar weld (Inconel) between an A508 carbon steel forging (nozzle) and a 316 stainless steel forging (safe end), and a similar metal weld (stainless steel) between a 316 stainless steel forging and an A351 Grade CF8M stainless steel casting (pipe/elbow). The block includes a welded stainless steel protective layer on the top surface (OD surface of the actual nozzle/piping configuration) and a welded stainless steel/Inconel protective layer on the bottom surface (ID surface of the actual nozzle/piping configuration). These protective layers are approximately 0.25-inch in thickness. The block contains two thermal fatigue cracks initiating at the protective layer/base metal interface. A drawing of this mock-up is included as Figure 4.1. Specifics on the two cracks are provided in Table 4.1. The mock-up was intended to be representative of the nozzle/piping configuration of Indian Point Unit 2 and 3. It is similarly representative of the Diablo Canyon Unit 2 configuration albeit with a thicker protective layer.

The weld inlay equivalency test site specific demonstration was conducted on an existing PDI 601 series weld configuration. This block is a full-scale, 360° mock-up, and is approximately 41-inches long and 27.5" ID. It contains a dissimilar metal weld (Inconel buttering and Inconel weld metal) between a SA-508 carbon steel forging (nozzle) and a 316 stainless steel forging (safe end), and a similar metal weld (stainless steel) between a 316 stainless steel forging and a 304 stainless steel forged pipe. An Alloy 52 (Inconel) weld inlay was added to three of the four quadrants across the dissimilar metal weld. The inlay thickness for each of the three quadrants was 0.2-inch, 0.07-inch, and 1.0-inch for the 2nd, 3rd and 4th quadrants, respectively. The 1st quadrant was not modified. Four alternative planar flaws were added to each of the three inlaid quadrants. These four flaws are essentially identical to flaws in the PDI 601 Series Practice Mock-up (Figure 4.3). In the 4th quadrant of the weld inlay mock-up where there is an 1.0-inch thick inlay, an embedded planar flaw was also inserted.

A drawing of the weld inlay equivalency test mock-up is included in Figure 4.2a and 4.2b. Specifics on the 13 flaws are provided in Table 4.2. The mock-up was intended to be representative of a nozzle to safe end dissimilar metal weld that has undergone an Alloy 600 PWSCC mitigation process. It is representative of the Diablo Canyon Unit 2 configuration with respect to a welded ID surface protective layer material on the ID surface.

A comparison of characteristics of these mock-ups against the plant specific mock-up criteria in Reference 9.5, §4.2 - §4.6 is provided in Table 4.3. Differences with the criteria are discussed later in this section, as referenced in Table 4.3.

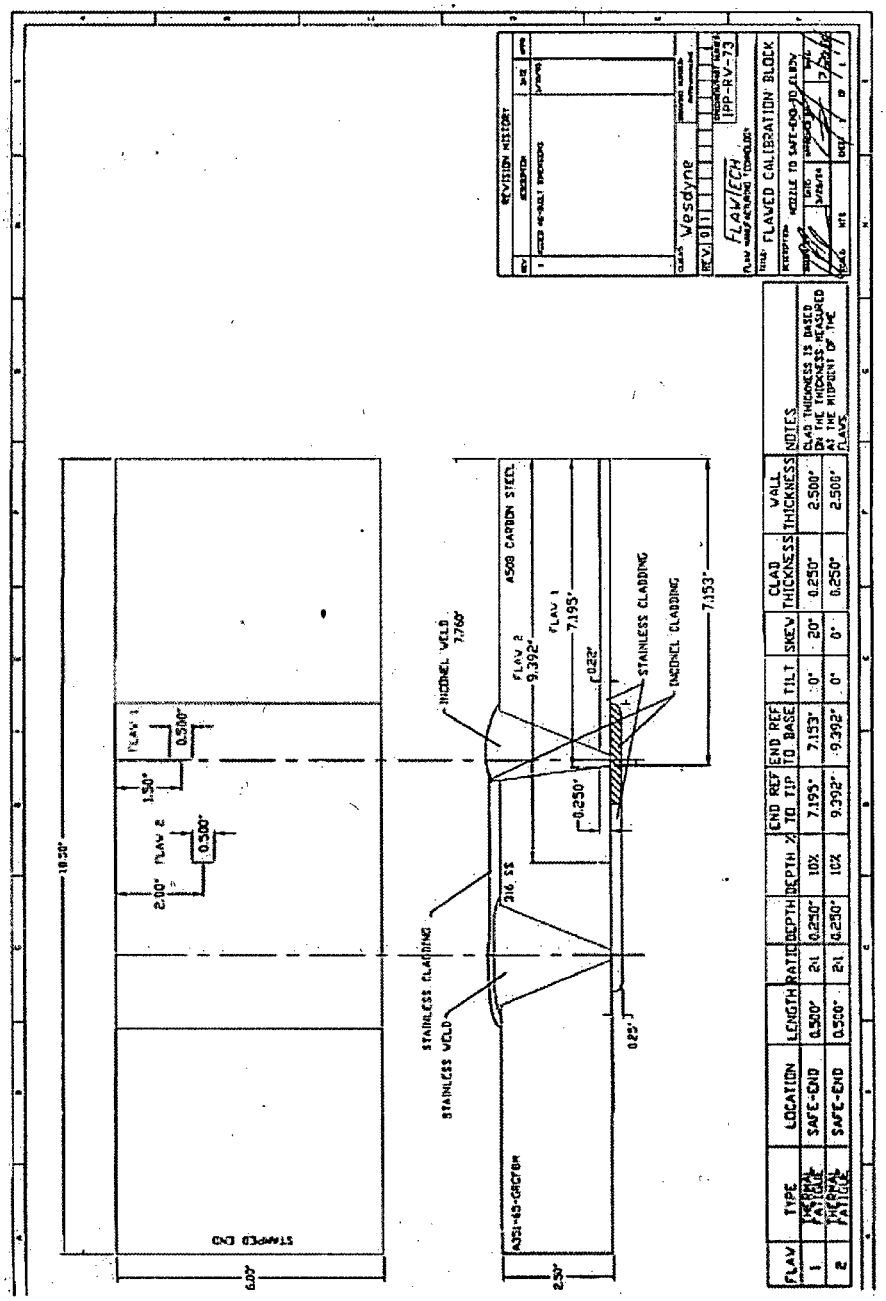

Figure 4.1: Drawing of Site Specific Demonstration Mock-up – Indian Point Units 2 and 3 Demonstration [Ref. 9.14]

a,c

[ ]

Figure 4.2a: Drawing of Site Specific Demonstration Mock-up – Weld Inlay Equivalency Test Demonstration [Ref. 9.9]

a,c

[ ]

Figure 4.2b: Drawing of Site Specific Demonstration Mock-up – Weld Inlay Equivalency Test Demonstration [Ref. 9.9]

a,c

[ ]

Figure 4.3: Drawing of PDI 601 Series Practice Mock-Up – Weld Inlay Equivalency Test Demonstration Original Configuration [Ref. 9.17]

Table 4.1: Description of Flaws in Mock-Up – Indian Point Unit 2 and 3 Demonstration [Ref. 9.14]

Flaw No.	Flaw Description		Flaw Dimensions		
	Location	Type	Length (in.)	Through-Wall (in.)	Width (in.)
1	At boundary between welded protective layer and safe end base material, and at safe end to weld interface; not exposed to ID surface; parallel to weld; 0° tilt, 20° skew	Thermal fatigue crack	0.50	0.25	---
2	At boundary between welded protective layer and safe end base material, and in safe end base metal; not exposed to ID surface; parallel to weld; 0° tilt, 0° skew	Thermal fatigue crack	0.50	0.25	---

Table 4.2: Description of Flaws in Mock-Up – Weld Inlay Equivalency Test Demonstration [1] [Ref. 9.9]

Flaw No.	Flaw Description		Flaw Dimensions		
	Location	Type	Length (in.)	Through-Wall (in.)	Width (in.)
1-Q2 1-Q3 1-Q4	In weld inlay on safe end side of weld; exposed to ID surface; parallel to weld; 0° tilt, 8° skew	Thermal fatigue crack	1.80	0.339	---
2-Q2 2-Q3 2-Q4	In weld inlay on nozzle side of weld; exposed to ID surface; parallel to weld; 0° tilt, 0° skew	Thermal fatigue crack	2.63	0.350	---
3-Q2 3-Q3 3-Q4	In weld inlay on safe end side of weld; exposed to ID surface; perpendicular to weld; 0° tilt, 11° skew	Alternate planar flaw (EDM representative of crack topography)	0.50	0.374	---
12-Q2 12-Q3 12-Q4	In weld inlay in center of weld; exposed to ID surface; parallel to weld; 0° tilt, 5° skew	Thermal fatigue crack	3.05	0.815	---
Embed	At interface between weld inlay and original weld; in center of weld; embedded with ligament to ID surface of 1-inch; parallel to weld; 0° tilt, 0° skew	Alternate planar flaw (EDM representative of crack topography)	2.23	0.70	---

Note 1: Flaws 1, 2, 3 and 12 in the PDI 601/1 Series Practice Mock-up [Ref. 9.17] have similar flaw descriptions and flaw dimensions as reported in this table. The only exception is Flaw 3 where the flaw length in the practice mock-up is reported to be 0.6-inch long. [Ref. 9.18]

Table 4.3: Comparison of Mockup Characteristics Against the Plant-Specific Mockup Requirements

Requirement Reference	Requirement	Actual Component	Indian Point Units 2 & 3 Demonstration Mock-Up	EPRI Weld Inlay Equivalency Test Mock-Up
Ref. 9.5, §4.2.1	Fabricated from same material type and product form	• Carbon Steel (CS) Forging (SA508) • 316 Stainless Steel (SS) Safe End • Alloy 182 weld metal • SS cladding on CS forging • 312L SS and Alloy 82 welded protective layer [Refs. 9.1 & 9.2]	• CS Forging (SA508) • 316 SS Safe End • Inconel weld metal • SS cladding on CS forging • SS and Inconel welded protective layer [Ref. 9.7]	• CS Forging (SA508) • 316 SS Safe End • Alloy 82/182 weld metal and buttering • SS cladding on CS forging • Alloy 52 inlay [Ref. 9.10]
			Criteria met due to similarity, see justification in §4.1	**Criteria assumed to be met due to similarity, see justification in §4.1**
Ref. 9.5, §4.2.2	Welding method and position simulate that which was used to fabricate component (SMAW in 1G position is acceptable for weld, buttering is welded in the same direction that was used to fabricate component; manual SMAW is acceptable for buttering)	Specifics not available	• Welded similar to field components [Ref. 9.7]	• Welded similar to field components [Ref. 9.10]
			Criteria considered met by replication of field component welding	**Criteria considered met by replication of field component welding**
Ref. 9.5, §4.2.3	Geometry such as tapers are represented	• Geometric discontinuity on ID surface between end of protective layer on nozzle and nozzle cladding • Outlet nozzle - ID is approximately 29-inches, thickness is approximately 2.7-inches • Inlet nozzle – ID is approximately 27.5-inches, thickness is approximately 2.7-inches [Ref. 9.1]	• Geometric discontinuity on ID surface between end of protective layer on nozzle and nozzle cladding • Mock-up is flat, thickness is approximately 3-inches [Ref. 9.7]	• No geometric discontinuity • ID is approximately 29-inches, thickness is approximately 2.9-inches [Ref. 9.10]
			Conditions not replicated but considered met, see justification in §4.2	**Conditions not replicated but considered met, see justification in §4.2**
Ref. 9.5, §4.2.4	Physical limitations are represented	• SS and Alloy 82 welded protective layer (0.090-inch thick)on ID surface of safe end with extension across dissimilar metal weld [Refs. 9.1 & 9.2]	• SS and Inconel welded protective layer (0.25-inch thick) on ID surface of safe end with extension across dissimilar metal weld [Ref. 9.7]	• Alloy 52 welded protective layers (0.070-inch, 0.2-inch and 1.0-inch thick inlaid on ID surface of safe end with extension across dissimilar metal weld [Ref. 9.10]
			Criteria considered met, see justification in §4.3	**Criteria considered met, see justification in §4.3**

Table 4.3: Comparison of Mockup Characteristics Against the Plant-Specific Mockup Requirements

Requirement Reference	Requirement	Actual Component	Indian Point Units 2 & 3 Demonstration Mock-Up	EPRI Weld Inlay Equivalency Test Mock-Up
Ref. 9.5, §4.2.5	Geometric condition(s) that require discrimination between geometry and flaw indications is represented	• Design drawings show dissimilar weld preparation interfaces of 7° (safe end side) and 22° (nozzle side) off normal • No buttering [Ref. 9.1]	• Design drawings show dissimilar weld preparation interfaces of 7° (safe end side) and 22° (nozzle side) off normal • No buttering [Ref. 9.13]	• Design drawing indicates buttering interface at 15° off normal, and weld/buttering and weld/safe end interfaces at 15° off normal • Buttering [Ref. 9.10]
			Criteria met	**Criteria considered met, see justification in §4.4**
Ref. 9.5, §4.2.6	Manufacture of mockup in accordance with QA programs that have following attributes: design control, procurement, procedures and drawings, material control, welding, controls for special processes, control of measurement and test equipment, inspection procedures, non-conformance program and document control procedures	N/A	• Utility reference block intended to duplicate plant configuration • Flaws inserted by FlawTech under their QA program [Ref. 9.7]	• Fabricated under EPRI QA program [Ref. 9.10]
			Criteria assumed to be met	**Criteria assumed to be met**
Ref. 9.5, §4.2.7	Commercial grade dedication of existing mock-ups are acceptable provided: • Base material, sample geometry and welding process used met requirements of above • Dimensions of flaws can be verified within applicable design tolerances using methods other than UT • Sample is free of unintended defects that could mask	N/A	• Base metal, sample geometry and welding process met requirements • Dimensions of flaws verified under FlawTech QA program • No unintended defects detected that could mask detection and characterization of the intended flaws	• Base metal, sample geometry and welding process met requirements • Dimensions of flaws verified under EPRI QA program • No unintended defects detected that could mask detection and characterization of the intended flaws
			Criteria assumed to be met	**Criteria assumed to be met**

Table 4.3: Comparison of Mockup Characteristics Against the Plant-Specific Mockup Requirements

Requirement Reference	Requirement	Actual Component	Indian Point Units 2 & 3 Demonstration Mock-Up	EPRI Weld Inlay Equivalency Test Mock-Up
	detection and characterization of intended flaws			
Ref. 9.5, §4.3	Licensee shall determine the quantity of flaws taking into consideration **§4.2.3, §4.2.4, §4.2.5, §4.4 and §4.6**	N/A	• 2 circumferential flaws • embedded type flaws [Ref. 9.7]	• 10 circumferential flaws and 3 axial flaws • ID and embedded type flaws [Ref. 9.10]
			Criteria met, see justification in §4.5	**Criteria met, see justification in §4.5**
Ref. 9.5, §4.4	Flaw depths between 10% and 20% of nominal wall thickness are acceptable; flaw heights > 20% are acceptable with technical justification	N/A	• Flaw depths are 10% of nominal wall thickness [Ref. 9.7]	• Circumferential ID flaws have flaw depths of 11.4%, 12%, and 27.4% of nominal wall thickness • Axial ID flaws have flaw depths of 12.6% of the nominal wall thickness • Circumferential embedded flaw has flaw depth of 24% of the nominal wall thickness [Ref. 9.10]
			Criteria met; appropriate flaw sizes represented	**Criteria met; appropriate flaw sizes represented**
Ref. 9.5, §4.5	Alternative flaws (e.g. HIP, CIP), cracks, or a combination thereof are to be represented; alternative flaws shall provide crack-like characteristics and a final width tip ≤ 0.002"	N/A	• Flaws are thermal fatigue [Ref. 9.7]	• Circumferential ID flaws are thermal fatigue • Axial ID flaws and circumferential embedded flaw are alternative flaws (EDM notches representing topography of crack) [Ref. 9.10]
			Criteria met	**Criteria met**
Ref. 9.5, §4.6	Flaws placed in locations susceptible to cracking; axial and circumferential flaw orientations to be included	N/A	• Flaws located in safe end and at safe end/weld interface (heat-affected zone) • Flaws are circumferentially oriented	• Flaws located in safe end and nozzle heat affected zones, and in weld • Flaws are circumferential and axial

Table 4.3: Comparison of Mockup Characteristics Against the Plant-Specific Mockup Requirements				
Requirement Reference	**Requirement**	**Actual Component**	**Indian Point Units 2 & 3 Demonstration Mock-Up**	**EPRI Weld Inlay Equivalency Test Mock-Up**
			Criteria conditionally met, see justification in §4.6	**Criteria met**

4.1 Justification – Materials of Construction

The underlying safe end, butt weld material and the nozzle forging materials of the demonstration mock-ups are the same, i.e. stainless steel, Ni-alloy and low alloy carbon steel, respectively. The Indian Point Unit 2/3 mock-up has the same welded protective layer materials (stainless steel and Ni-alloy). The weld inlay equivalency mock-up contains only a Ni-alloy weld protective layer.

Stainless steel and Ni-alloy weld materials are considered similar in terms of acoustic properties. Both materials will have the dendritic, coarse-grained weld structure common to welds. This anisotropic structure causes the more significant attenuation of the ultrasonic energy. EPRI has performed some investigations comparing stainless steel and Ni-based material used in structural weld overlays, and they have found no significant acoustic differences [Ref. 9.15]. The similarity in the signal-to-noise ratios for the two identical flaws in the Indian Point Unit 2/3 mock-up substantiates this minimal impact (see Table 6.1).

4.2 Justification – Geometry

The Indian Point Unit 2/3 mock-up is flat but does contain a more severe geometric discontinuity (taper) on the ID surface than the Diablo Canyon Unit 2 nozzle to safe end design configuration given the 0.16-inch difference in welded protective layer thickness. This geometric discontinuity affects the smoothness of the scan and can result in geometric responses in the ultrasonic test data. The flat geometry is not anticipated to impact defect detection and characterization since the smallest Diablo Canyon component diameter is greater than 27-inches. It is recognized in ASME Section XI, Appendix I, Supplement 3 that flat calibration blocks may be used in lieu of contoured calibration blocks if the diameter is greater than 20-inches. [Ref. 9.16]

The weld inlay equivalency mock-up represents a similar ID surface contour (27" ID) to the Diablo Canyon Unit 2 nozzle to safe end configuration but contains no geometric discontinuity.

Both mock-ups collectively represent the geometrical aspects of the Diablo Canyon Unit 2 nozzle to safe end configurations.

4.3 Justification – Physical Limitations

The Indian Point Unit 2/3 mock-up includes a 0.25-inch thick layer of dendritic, coarse-grained weld structure compared to the nominal 0.09-inch thick layer of the actual

Diablo Canyon Unit 2 components. This weld structure causes attenuation of the incident ultrasonic energy and beam angle shifts. The thicker weld structure is considered to be conservative in that this should result in greater attenuation and larger beam angle shifts.

The weld inlay equivalency mock-up includes three different thicknesses of dendritic, coarse-grained weld structure (0.07-inch, 0.2-inch and 1-inch) compared to the 0.09-inch thick layer of the actual Diablo Canyon Unit 2 components. Since these welded protective layer thicknesses span the actual component, the anticipated extent of ultrasound attenuation and beam angle shifts are considered.

Both mock-ups represent conservatively the physical aspects of the Diablo Canyon Unit 2 nozzle to safe end configurations particularly the impact of the welded protective layer on the incident ultrasonic energy. Similarly the safe end side of the safe end to piping weld is represented.

4.4 Justification – Geometric Conditions

The Indian Point Unit 2/3 mock-up weld configuration matches Diablo Canyon Unit 2 nozzle to safe end weld configuration. The weld bevel angles are the same and no buttering is present. Thus metallurgical reflectors from the weld bevel surfaces are expected to be similar.

The weld inlay equivalency mock-up contains an additional welded interface with the presence of the buttering. This welded interface will likely result in more metallurgical reflectors that will conservatively complicate the data analysis process.

The 15-degree bevel angle on the weld preparation in the weld inlay equivalency mock-up is different than the 7-degree and 22-degree bevel angles in the Diablo Canyon Unit 2 weld configuration. The 22-degree bevel angle provides a more normal beam impingement for the 70-degree detection transducer than a 15-degree bevel angle, which could result in more spurious metallurgical responses from the interface in the actual Diablo Canyon Unit 2 dissimilar metal weld examinations. The angles of impingement are 92-degrees and 85-degrees, respectively. This difference is considered minimal given the procedural instructions in PDI-ISI-254-SE for determining the validity of indications. The 7-degree bevel angle provides a less normal beam impingement for the 70-degree detection transducer (77-degree) and as such is not relevant.

4.5 Justification – Number of Flaws

The Indian Point Unit 2/3 mock-up contains two thermal fatigue cracks (one in the safe end and one that lies along the safe end to weld interface). One crack is underneath the stainless steel welded protective layer and the other is underneath the Ni-alloy welded protective layer. This positioning provides information on the relative difference in ultrasound attenuation between the two weld materials.

The weld inlay mock-up contains 10 circumferential flaws and 3 axial flaws that initiate at the ID surface and 1 embedded circumferential flaw. As such both flaw orientations are represented.

Both mock-ups collectively contain flaws in the Ni-alloy portion of the weld and offer the capability to determine the significance of stainless steel versus Ni-alloy welded protective layers.

4.6 Justification – Flaw Locations

The one flaw in the Indian Point Unit 2/3 mock-up is well within the safe end at a location that is not known to be susceptible to cracking. Its reason for inclusion in the flaw matrix was to obtain information on the relative difference in ultrasound attenuation between the two welded protective layer materials (stainless steel and Ni-alloy) and to be representative of the safe end side of the safe end to piping weld.

The remaining flaws in the two mock-ups are at locations that are known to be susceptible to cracking including the weld and the weld interfaces.

Both mock-ups collectively contain the flaw locations that are known to be susceptible to cracking.

5.0 PERSONNEL

The following personnel participated in the Indian Point Unit 2/3 demonstration:

- Dal Nelson – WesDyne International Level II UT qualified using procedure PDI-ISI-254-SE Rev. 0, and WDI-STD-119-C Rev. 0[1] (PDQS No. 466), data acquisition and data analysis
- David Kurek – WesDyne International Level III UT, data analysis support

The following personnel participated in the weld inlay equivalency test demonstration:

- Dal Nelson – WesDyne International Level II UT qualified using procedure PDI-ISI-254-SE Rev. 0, and WDI-STD-119-C Rev. 0 (PDQS No. 466), data acquisition
- Andre Moreau - WesDyne International Level II UT qualified using procedure PDI-ISI-254-SE Rev. 0, PDI-UT-2 Rev. C[2], and PDI-UT-3 Rev. B[3] (PDQS No. 1), data analysis

It is noted on the procedure PDQS [Ref. 9.4] that personnel qualified with PDI-ISI-254-SE, Revision 0 are also qualified with the Revision 2 issue with no re-qualification. Since there are no essential variable changes between Revision 3 and Revision 2 (see Section 3.0), personnel qualified to Revision 0 are also qualified to Revision 3 without no re-qualification. This is also stated in Reference 9.12.

[1] Includes single-sided detection and length sizing with IGSCC per Supplement 2

[2] Includes single-sided detection and length sizing with IGSCC per Supplement 2

[3] Includes through-wall depth sizing with IGSCC per Supplement 2

6.0 RESULTS

The results from the scans on the Indian Point Unit 2/3 mock-up are summarized in Table 6.1. Both thermal fatigue cracks were detected and sized. Images of these flaws are shown in Attachment 2.

The results from the scans on the weld inlay mock-up and the PDI 601 Practice Block are summarized in Figure 6.1. All of the cracks were detected and sized. The PDI 601 Practice Block does not contain an embedded flaw. Images of these flaws are shown in Attachment 3. It is noted that there was an increased level of noise that decreased the signal-to-noise ratio of both the axial and circumferential flaws (see Attachment 3, Figure 15). This increased noise was more pronounced for the circumferential scans [Ref. 9.10].

Coverage maps for the site-specific mock-ups are shown in Figures 6.2 and 6.3.

Table 6.1: Results Summary from Indian Point Unit 2/3 Demonstration [Ref. 9.7]

Flaw No.	Detected (Yes/No)	Scan Surface [4]	Scan Direction	Amp (%)	S/N Ratio [1]	Measured Length (in.)	Measured Depth (in.)	Transducer
1	Yes	ID	Toward Carbon Steel	65	6.0	N/A	N/A	70° TRL
	[2]	ID		100 [5]	---	0.625	0.22	45° TRL
	Yes	ID	Away from Carbon Steel	98	6.8	N/A	N/A	70° TRL
	[2]	ID		31 [5]	---	[3]	0.22	45° TRL
2	Yes	ID	Toward Carbon Steel	76	6.3	N/A	N/A	70° TRL
	[2]	ID		54 [5]	---	[3]	0.25	45° TRL
	Yes	ID	Away from Carbon Steel	100	6.6	N/A	N/A	70° TRL
	[2]	ID		47 [5]	---	0.625	0.29	45° TRL

Note 1: Signal-to-noise (SN) ratio levels determined using the PARAGON histogram feature from recent review of electronic data by T. Bushmire (PDQS 964, PDI-ISI-254-SE Rev. 1 detection and length sizing)
Note 2: 45° transducer not used for detection per PDI-ISI-254-SE; only used for sizing
Note 3: Not used; the longest length size is used.
Note 4: ID is bottom surface of block consistent with the ID surface of the actual component.
Note 5: Amplitude of strongest crack tip response

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PLANT: PDI Supplement 2 10 Demonstration
PROCEDURE: PDI-ISI-254-SE Rev. 2
COMPONENT: Actual Flaw size to UT results of 601 block and Inlay Block
ANALYST:

Indication	Actuals		601 Sizing		Inlay Sizing			
No.	Length	T/W	Length	T/W	Ind. No.	Length	T/W	COMMENTS
1	1.80"	0.339"	1.875"	0.37"	1-Q2	1.75"	0.37"	
2	2.63"	0.350"	2.75"	0.39"	2-Q2	2.75"	0.34"	
3	* 0.60" ** 0.50"	0.374"	0.40"	0.44"	3-Q2	0.64"	0.40"	
12	3.05"	0.815"	3.25"	0.79"	12-Q2	3.00"	0.81"	
embed	2.23"	0.70"						
					1-Q3	1.75"	0.42"	
					2-Q3	2.375"	0.33"	
					3-Q3	0.64"	0.37"	
					12-Q3	2.875"	0.81"	
					1-Q4	1.625"	0.36"	
					2-Q4	2.625"	0.37"	
					3-Q4	0.72"	0.27"	
					12-Q4	3.125"	0.77"	
					embed	2.25"	0.71"	

* 601 Block
** Inlay Block

Figure 6.1: Results Table from Weld Inlay Equivalency Demonstration [Refs. 9.8 & 9.10]

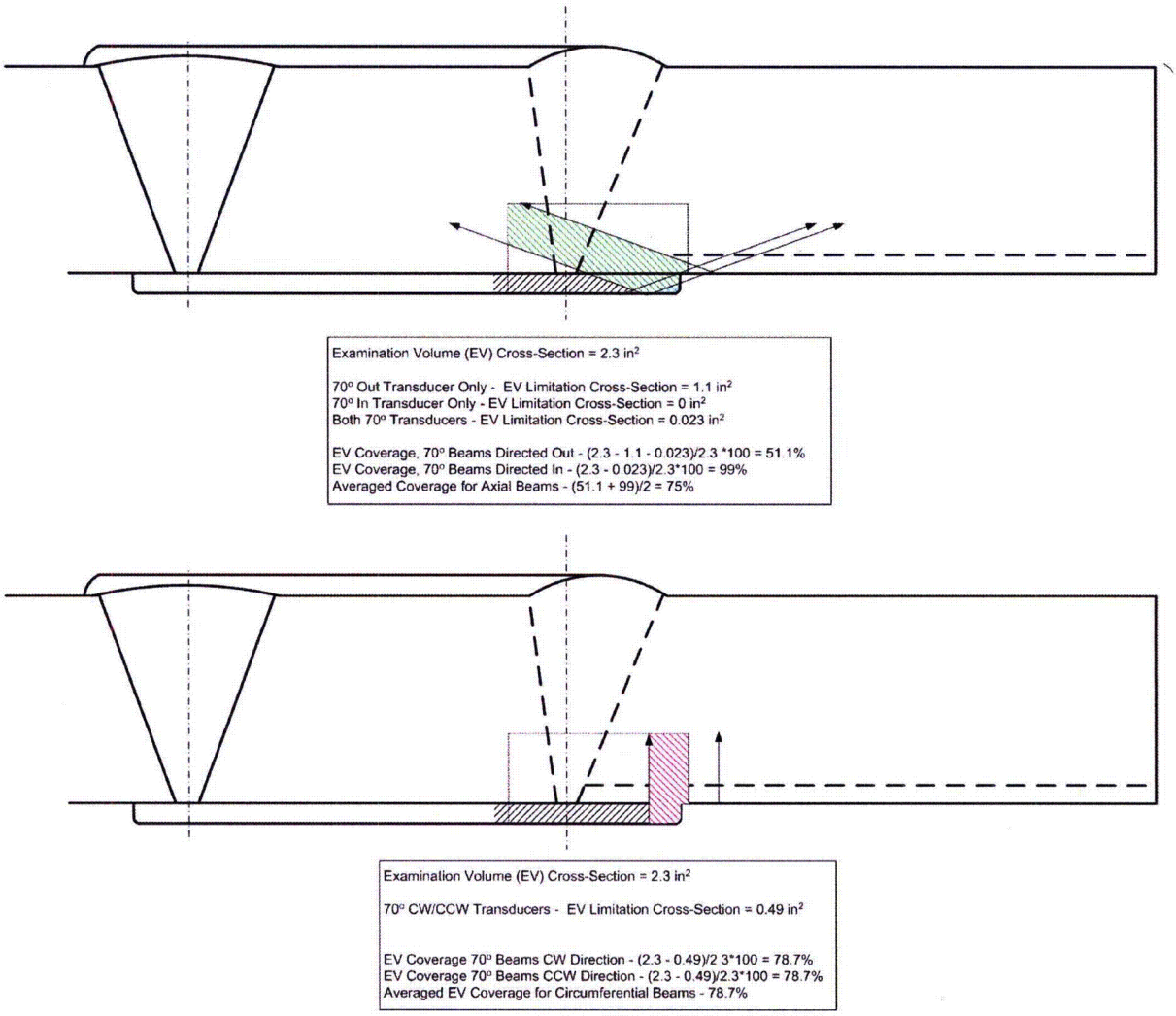


Figure 6.2: Coverage Map for the Indian Point Unit 2/3 Mock-up

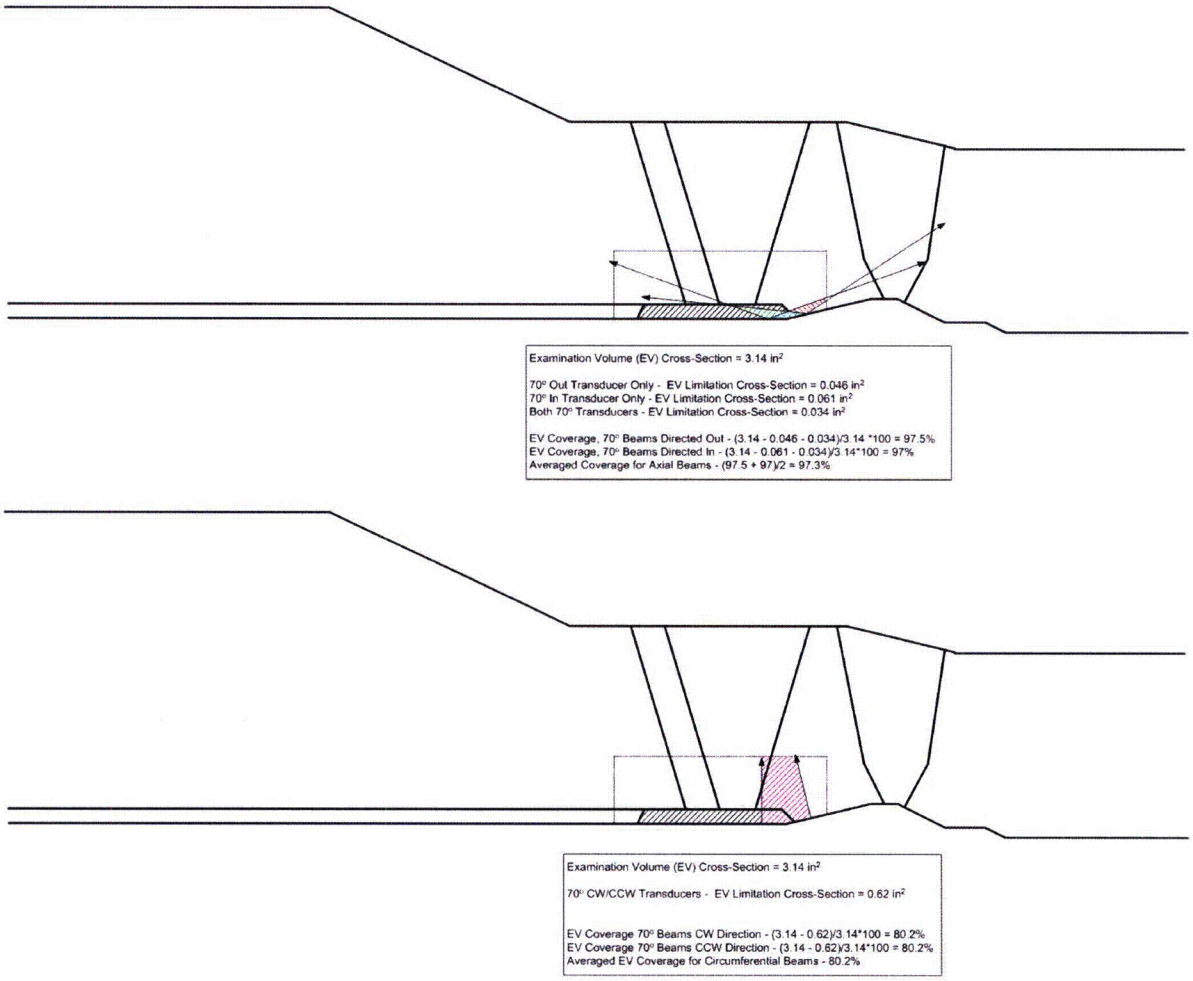


Figure 6.3: Coverage Map for the Weld Inlay Equivalency Mock-up

7.0 DISCUSSION OF RESULTS

7.1 Adherence to Acceptance Criteria

As stated in Section 1.0 the primary objective of the site specific demonstration is to support obtaining coverage credit for the ASME Code Section XI examinations through an ID surface welded protective layer. Both the Indian Point Unit 2/3 and weld inlay equivalency demonstrations are relevant in achieving this objective for the Diablo Canyon Unit 2 nozzle to safe end and safe end to piping weld configurations.

All of the flaws in the two welded protective layer mock-ups were detected using the data interpretation criteria in PDI-ISI-254-SE.

The correlation between actual flaw length and measured flaw length is shown in Table 7.1 and Figure 7.1 for the flaws in the two mock-ups (15 flaws). The calculated length RMS error is 0.135-inch, and the maximum length sizing error is 0.255-inch. Both of these values are within the ASME Section XI, Appendix VIII, Supplements 2 and 10 length sizing criteria (i.e. RMS error ≤ 0.75-inch).

The correlation between actual through-wall depth and measured through-wall depth is shown in Table 7.1 and Figure 7.2 for the flaws in the two mock-ups (15 flaws). The calculated through-wall depth RMS error is 0.041-inch, and the maximum through-wall sizing error is 0.104-inch. Both of these values are within the ASME Section XI, Appendix VIII, Supplements 2 and 10 through-wall sizing criteria (i.e. RMS error ≤ 0.125-inch).

Table 7.2 provides the actual flaw dimensions and the measured flaw measurements for the same flaws in the PDI 601 Practice Mock-up as are in the welded inlay equivalency test mock-up. The calculated RMS errors are 0.043-inch through-wall depth and 0.158-inch length. The maximum errors are 0.066-inch through-wall depth and 0.2-inch length. Such errors are equivalent with and without a welded protective layer.

Therefore these two demonstrations confirmed that flaws in the examination volume of a component with a welded protective layer can be detected, characterized, length sized and through-wall depth sized using the existing PDI-ISI-254-SE procedure. Whereas for the welded inlay equivalency demonstration there was a decrease in signal-to-noise ratio as a result of the welded protective layer, this decrease did not affect the capabilities of the procedure for flaw detection and sizing.

7.2 Limitations

The measured surface profiles for the Diablo Canyon Unit 2 Reactor Vessel Nozzle to Safe End Welds are shown in Figures 7.3 and 7.4. These profiles were obtained by WesDyne during the Diablo Canyon Unit 2 10-Year RVISI 2006 examinations.

Whereas Figures 1.1 and 1.2 indicate design configurations that have a definitive ID surface geometric discontinuity at the start of the welded protective layer on the nozzle side of the nozzle to safe end weld, the actual configurations exhibit a gradual taper that does not cause localized areas of transducer non-contact. As such 100% examination volume coverage for each of the nozzle to safe end welds was reported in the 2006 examinations [Ref. 9.19].

Figures 1.1 and 1.2 indicate that the end of the welded protective layer on the safe end side of the safe end to piping weld creates a counterbore that could cause a localized area of transducer non-contact. This is consistent with the profiles in Figures 7.3 and 7.4 however weld 'suck-up' is also a contributor to examination volume limitations. However these surface conditions still allowed for essentially 100% (>90%) examination volume coverage for each of the safe end to piping welds as reported in the 2006 examinations [Ref. 9.19]; the least examination volume coverage reported was 90.33% (Outlet Nozzle @158°), and the best examination volume coverage reported was 92.84% (Inlet Nozzle @247°).

It is noted that automated eddy current inspection is also conducted on the ID surface of the nozzle to safe end and safe end to piping welds. The ECT probes have a small footprint and are able to detect ID surface-initiating flaws in the regions not covered by the 70° TRL transducers. Whereas the ECT process is not formally qualified in the US, it does provide relevant information regarding the presence of ID surface-connected flaws.

7.3 Changes to Essential Variables

The site-specific demonstrations resulted in no changes to the essential variables as defined in inspection procedure, PDI-ISI-254-SE.

Table 7.1: Comparison of Sizing Results

Mock-Up	Flaw No.	Actual Through-Wall Depth (in.)	Measured Through-Wall Depth (in.)	Through-Wall Depth Error [meas. – actual] (in.)	Actual Length (in.)	Measured Length (in.)	Length Error [meas. – actual] (in.)
Indian Point Units 2/3	1	0.25	0.22	-0.03	0.5	0.625	0.125
Indian Point Units 2/3	2	0.25	0.29	0.04	0.5	0.625	0.125
Weld Inlay	1-Q2	0.339	0.37	0.031	1.8	1.75	-0.05
Weld Inlay	1-Q3	0.339	0.42	0.081	1.8	1.75	-0.05
Weld Inlay	1-Q4	0.339	0.36	0.021	1.8	1.625	-0.175
Weld Inlay	2-Q2	0.35	0.34	-0.01	2.63	2.75	0.12
Weld Inlay	2-Q3	0.35	0.33	-0.02	2.63	2.375	-0.255
Weld Inlay	2-Q4	0.35	0.37	0.02	2.63	2.625	-0.005
Weld Inlay	3-Q2	0.374	0.4	0.026	0.5	0.64	0.14
Weld Inlay	3-Q3	0.374	0.37	-0.004	0.5	0.64	0.14
Weld Inlay	3-Q4	0.374	0.27	-0.104	0.5	0.72	0.22
Weld Inlay	12-Q2	0.815	0.81	-0.005	3.05	3.0	-0.05
Weld Inlay	12-Q3	0.815	0.81	-0.005	3.05	2.875	-0.175
Weld Inlay	12-Q4	0.815	0.77	-0.045	3.05	3.125	0.075
Weld Inlay	Embed	0.7	0.71	0.01	2.23	2.25	0.02
			Max. Error	**-0.104**		**Max. Error**	**-0.255**
			RMS Error[1]	**0.041**		**RMS Error[1]**	**0.135**

Note 1: RMS is as defined in ASME Section XI, Appendix VIII, Article VIII-3120.

Table 7.2: Sizing Results for Flaws in Non-Weld Inlaid 601 Practice Mock-Up

Mock-Up	Flaw No.	Actual Through-Wall Depth (in.)	Measured Through-Wall Depth (in.)	Through-Wall Depth Error [meas. – actual] (in.)	Actual Length (in.)	Measured Length (in.)	Length Error [meas. – actual] (in.)
601 Practice Mock-Up	1	0.339	0.37	0.031	1.8	1.875	0.075
601 Practice Mock-Up	2	0.35	0.39	0.04	2.63	2.75	0.12
601 Practice Mock-Up	3	0.374	0.44	0.066	0.6	0.4	-0.2
601 Practice Mock-Up	12	0.815	0.79	-0.025	3.05	3.25	0.2
			Max. Error	**0.066**		**Max. Error**	**0.2**
			RMS Error[1]	**0.043**		**RMS Error[1]**	**0.158**

Note 1: RMS is as defined in ASME Section XI, Appendix VIII, Article VIII-3120.

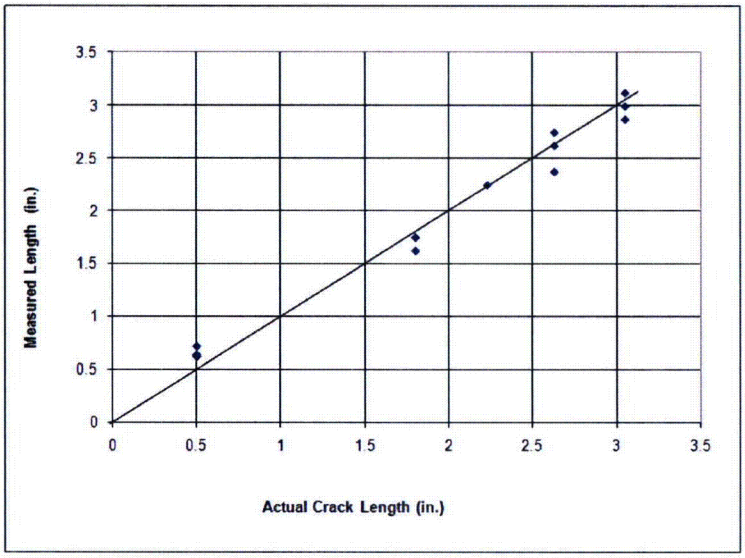


Figure 7.1: Correlation of Actual Flaw Length and Measured Flaw Length for the 15 Flaws in the Two Demonstration Mock-Ups

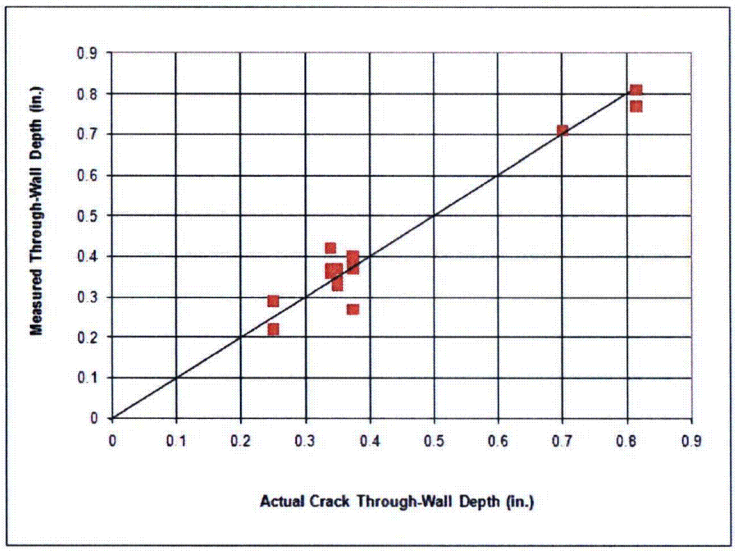
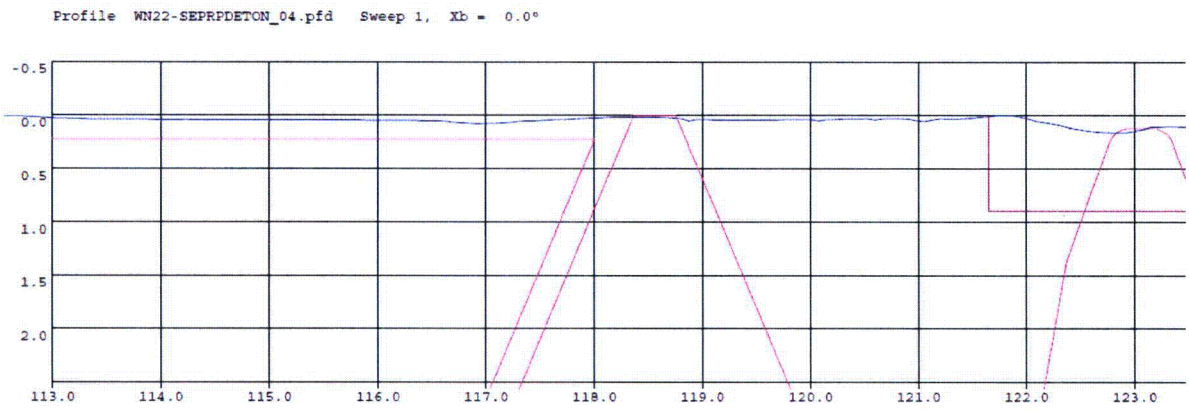
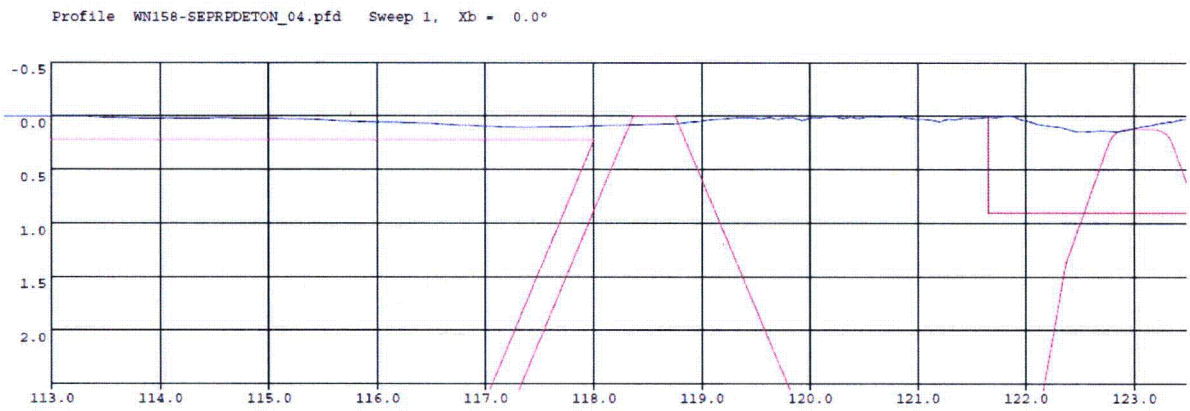


Figure 7.2: Correlation of Actual Flaw Through-Wall Depth and Measured Flaw Through-Wall Depth for the 15 Flaws in the Two Demonstration Mock-Ups



Diablo Canyon Unit 2 Outlet Nozzle @ 22°



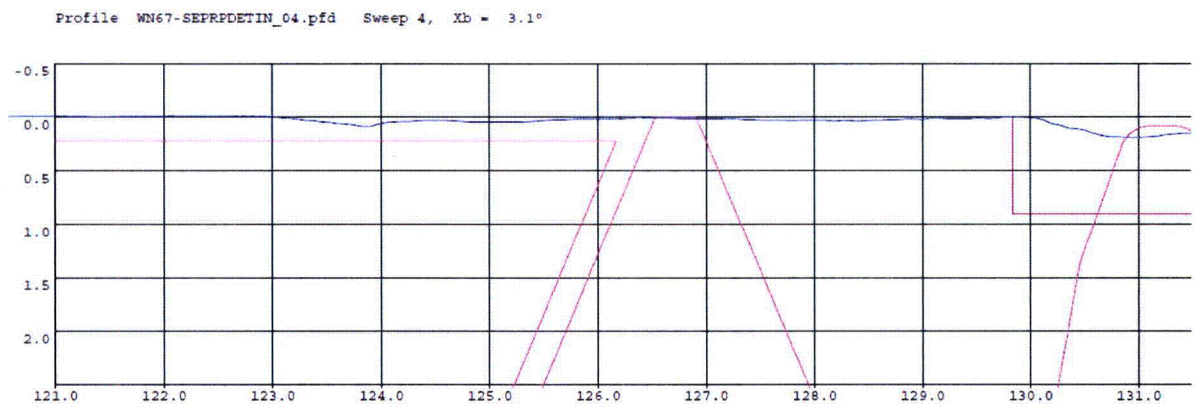
Diablo Canyon Unit 2 Outlet Nozzle @ 158°

Figure 7.3a: Measured Surface Profiles for the Diablo Canyon Unit 2 Reactor Vessel Nozzle to Safe End and Safe End to Pipe Welds – Outlet Nozzles (data from 2006 examinations)

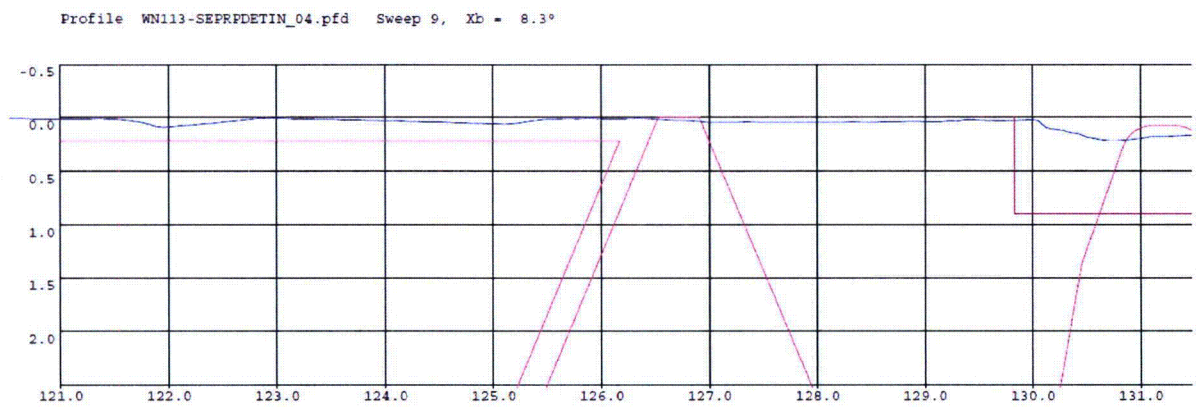
Diablo Canyon Unit 2 Outlet Nozzle @ 202°

Diablo Canyon Unit 2 Outlet Nozzle @ 338°

Figure 7.3a: Measured Surface Profiles for the Diablo Canyon Unit 2 Reactor Vessel Nozzle to Safe End and Safe End to Pipe Welds – Outlet Nozzles (data from 2006 examinations)

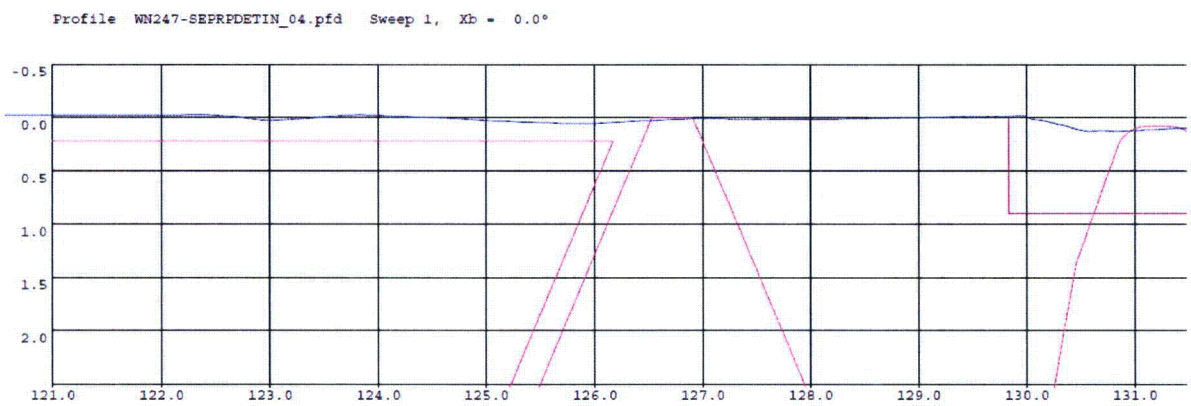


Diablo Canyon Unit 2 Inlet Nozzle @ 67°

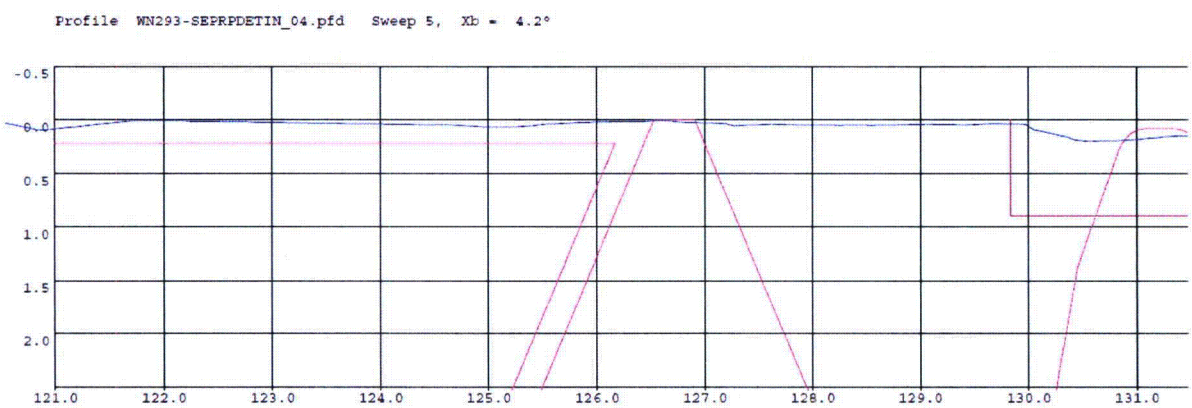


Diablo Canyon Unit 2 Inlet Nozzle @ 113°

Figure 7.4a: Measured Surface Profiles for the Diablo Canyon Unit 2 Reactor Vessel Nozzle to Safe End and Safe End to Pipe Welds – Inlet Nozzles (data from 2006 examinations)



Diablo Canyon Unit 2 Inlet Nozzle @ 247°



Diablo Canyon Unit 2 Inlet Nozzle @ 293°

Figure 7.4b: Measured Surface Profiles for the Diablo Canyon Unit 2 Reactor Vessel Nozzle to Safe End and Safe End to Pipe Welds – Inlet Nozzles (data from 2006 examinations)

8.0 CONCLUSIONS

The following conclusions can be made from this work:

1. All of the flaws in both the Indian Point Units 2/3 and welded inlay equivalency mock-ups were detected with no change in procedure essential variables.

2. All of the flaws in both the Indian Point Units 2/3 and welded inlay equivalency mock-ups were length sized and through-wall sized consistent with the RMS error criteria in ASME Code Section XI, Appendix VIII, Supplements 2 and 10, and with no change in procedure essential variables.

3. Similar flaws in the PDI 601 Practice Sample (no welded protective layer) and the welded inlay equivalency mock-up (welded protective layer) were detected, length sized and through-wall depth sized and shown to be equivalent. While an increase noise (and thus a decreased signal-to-nose ratio) was observed in the test data for the flaws in the welded inlay equivalency mock-up, there was no impact to flaw detection, flaw length sizing and flaw through-wall depth sizing.

4. The flaws in the mock-ups were located in the dissimilar metal weld or in the safe end representative of the nozzle to safe end weld (Supplement 10 weld) condition and the safe end side of the safe end to piping weld (Supplement 2 weld) condition in Diablo Canyon Unit 2. Since the demonstrated flaw indication detection, length sizing and through-wall sizing capabilities using the PDI-qualified Supplement 14 procedure, PDI-ISI-254-SE, were maintained on these flaws, this procedure can be extended for use on the welded protective layer surfaces as present on the Diablo Canyon Unit 2 nozzle to safe end weld and the safe end.

5. The transition from the nozzle onto the welded protective layer in the Diablo Canyon Unit 2 nozzles was not observed in the measured surface profiles. As such 100% examination volume coverage was obtained.

6. The transition from the safe end onto the adjacent stainless steel safe end to piping weld in the Diablo Canyon Unit 2 nozzles was observed in the measured surface profiles. However such surfaces still allowed for essentially 100% (>90%) examination volume coverage.

7. The inspection procedure, PDI-ISI-254-SE, requires no changes in essential variables for the qualification extension.

9.0 REFERENCES

9.1 Combustion Engineering Inc. Drawing, E234-155: Nozzle Details, 173" ID PWR, Revision 3.

9.2 Combustion Engineering Detail Welding Procedures:

9.2.1 GTAA-801-0 for welding of P8 to P8 materials, clad overlay, September 9, 1971.

9.2.2 GTAA-901-0 for welding of P8 to P43 materials, clad overlay, September 9, 1971.

9.2.3 GTAA-1002-0 for welding of P43 to P43 materials, clad overlay, September 9, 1971.

9.3 WesDyne International Field Service Inspection Procedure, PDI-ISI-254-SE: Remote In-service Examination of Reactor Vessel Nozzle to Safe End, Nozzle to Pipe, and Safe End to Pipe Welds, Revision 3.

9.4 Performance Demonstration Initiative Program Specific Detail of Qualifications, PDQS No. 634, Procedure: PDI-ISI-254-SE, Revision 2, Addenda 0 - Remote In-service Examination of Reactor Vessel Nozzle to Safe End, Nozzle to Pipe, and Safe End to Pipe Welds.

9.5 Performance Demonstration Initiative (PDI), Dissimilar Metal Weld Mock-Up Criteria, Revision A.

9.6 Performance Demonstration Initiative (PDI), PDI-GL-002: Guideline for Ultrasonic Examination of Corrosion Resistant Cladding (CRC), Revision B, January 29, 2003.

9.7 WesDyne International Report, Demonstration of Procedure Capabilities for Examination of Reactor Vessel Primary Loop Dissimilar and Similar Metal Piping Welds from the I.D. Surface – Indian Point Units 2 and 3, Revision 1, March 2006.

9.8 WesDyne International Report, WDI-DFD-2009-QDP-001: Demonstration of Technique – Report Summary for Supplements 2 and 10 Flaw Comparisons Between EPRI Block 601 and the Inlay Test Block, Revision 0, December 2007.

9.9 EPRI Report, 1016543: Nondestructive Evaluation – Ultrasonic Equivalency Testing of Weld Inlaid and Weld Onlaid Components, December 2008 [used with permission from PG&E].

9.10 EPRI Report, 1016655: Nondestructive Evaluation – Ultrasonic Equivalency Testing of Weld Inlaid Components, April 2008 [used with permission from PG&E].

9.11 EPRI Letter dated January 17, 2005, C. Latiolais (EPRI) to J. Munson (WesDyne International).

9.12 EPRI Letter dated July 30, 2009, Ronnie Swain (EPRI) to Steve Sabo (WesDyne International).

9.13 Combustion Engineering Inc. Drawing, E234-045-1: Nozzle Details for Westinghouse Electric Corp. 173" ID Reactor Vessel, Revision 1.

9.14 FlawTech Drawing, RV73resoric1: Flawed Calibration Block, Nozzle to Safe-End to Elbow, IPP-RV-73, Revision 1.

9.15 Personal communication between Carl Latiolais (EPRI) and Rick Rishel (WesDyne International).

9.16 American Society of Mechanical Engineers (ASME), Section XI: Rules for In-Service Inspection of Nuclear Power Plant Components, 1989 Edition with No Addenda.

9.17 Sonaspection Drawing, EPRI 2098601-1 AB: PDI DSMW Test Sample, 601/1 PWR Outlet Nozzle/Pipe As-Built, Revision 1.

9.18 EPRI Excel ®[4] Spreadsheet, 601_1 noz to SE rev 2 08.08.02.

9.19 WesDyne International Field Service Report, WDI-PJF-1303340-FSR-001: Diablo Canyon Nuclear Power Plant Unit 2 10 Year Reactor Vessel In-Service Examination, Outage 2R13, Period 3, Interval 2, 2006.

9.20 Combustion Engineering Weld Procedure Assignment, A-245-725-8: Sheet for E-234-155 Nozzle Details, 173" ID PWR, Rev. 8.

9.21 Westinghouse Electric, WCAP-14576: Aging Management Evaluation for Class 1 Piping and Associated Pressure Boundary Components, August 1996.

[4] Excel ® is a registered trademark of Microsoft Corporation.

ATTACHMENT 1: Site Specific Demonstration Checklist

Site Specific Demonstration Checklist for WDI-TJ-1044, Rev. 1			
DM Weld Mockup Criteria [Ref. 9.5] Requirement Reference	**Requirement**	**Paragraph Reference in Demonstration Report/Technical Basis Document**	**Checker Initials / Date**
§3.1	Personnel have current Supplement 10 PDI qualification for intended application	§5.0	RDR 3/9/2010
§3.2	Personnel performing Generic Letter 88-01 examinations have current Supplement 2 PDI qualification with IGSCC endorsement for intended application	N/A	---
§4.1	Plant-specific mockups shall be required if the configuration being examined is not included in the PDI test set or any of the conditions in §4.1.1 – §4.1.4 apply	§1.0	Note 1 RDR 3/9/2010
§4.2	Plant specific mockups meet the stated requirements in §4.2.1 – §4.2.7 and §4.3 – §4.6	§4.0, Table 4.3	Note 2 RDR 3/9/2010
§5.1	Technical basis document is prepared for each site-specific mockup to document its applicability to qualified essential variables including:		
	• Drawing of site-specific mockup and configuration of joint to be examined	§4.0, Figures 4.1 - 4.2 and §1.0, Figures 1.1 – 1.2	RDR 3/9/2010
	• Documentation detailing actual attributes of flaw size distribution, placement and orientation of mockup flaws	§4.0, Tables 4.1 and 4.2 and §4.0, Figures 4.1 and 4.2	RDR 3/9/2010
	• Demonstrated coverage map	§6.0, Figures 6.2 and 6.3	RDR 3/9/2010
	• Full documentation of probes not previously demonstrated for use with qualified procedure	N/A	Note 3 RDR 3/9/2010
§5.2	Exceptions to the qualified procedure are noted (probe angle, metal path focal point, contouring, scan pattern)	§7.3	Note 4 RDR 3/9/2010
§6.1	Licensee has ensured that examination personnel are familiar with data collection and analysis processes used in demonstration	Qualification Sign-Off Sheet requirement	Note 5 RDR 3/9/2010

Site Specific Demonstration Checklist for WDI-TJ-1044, Rev. 1			
DM Weld Mockup Criteria [Ref. 9.5] Requirement Reference	**Requirement**	**Paragraph Reference in Demonstration Report/Technical Basis Document**	**Checker Initials / Date**
§6.2	Plant specific demonstrations are conducted either blind or non-blind	§1.0	RDR 3/9/2010
§6.3	ANII witnessed the demonstration	Not included	Note 6 RDR 3/9/2010
§6.4	Licensee Level III or its Level III representative witnessed demonstration	Not included	Note 6 RDR 3/9/2010
§6.5	Changes to essential variables defined in qualified procedure are documented	§7.3	Note 7 RDR 3/9/2010
§7.1	Flaws are discernible in accordance with examination procedure	§7.1	RDR 3/9/2010
§7.2	ANII noted his review and acceptance of modified procedure and the Technical Basis Document	Qualification Sign-Off Sheet	RDR 3/9/2010
§8.0	Limitations in coverage of examination volume are documented	§7.2	RDR 3/9/2010
§9.1	Demonstration report is prepared detailing the procedure defined details and for automated techniques, images of flaws are included	this document including Attachments 2 and 3	RDR 3/9/2010
§9.2	Demonstration report includes a drawing and technical basis for the number and location of flaws in the site-specific mockup(s)	§4.0, Figures 4.1 - 4.3; §4.0, Table 4.3; §4.5; §4.6	RDR 3/9/2010
§9.3	Licensee included specific examination requirements in their site examination procedure	Qualification Sign-Off Sheet requirement	RDR 3/9/2010
§9.4	Licensee maintains demonstration report basis document for future reference	Qualification Sign-Off Sheet requirement	RDR 3/9/2010

Note 1: Reference 9.5 §4.1.4 and Reference 9.6 §3.2 state that ASME Section XI, Appendix III is applicable for examining welds with corrosion resistant cladding; Appendix III has no specific performance demonstration requirements. The ID surface welded protective layer associated with the Diablo Canyon Unit 2 nozzle-to-safe end welds and the safe end side of the safe end to piping welds can be classified as a corrosion

Site Specific Demonstration Checklist for WDI-TJ-1044, Rev. 1			
DM Weld Mockup Criteria [Ref. 9.5] Requirement Reference	**Requirement**	**Paragraph Reference in Demonstration Report/Technical Basis Document**	**Checker Initials / Date**

resistant cladding since it was intended to isolate a potentially sensitive material from the primary water environment. These welded protective layers were applied during the reactor vessel fabrication stage and are not considered structural weld inlays.

Note 2: Variations associated with materials of construction, geometry, physical limitations, geometric conditions, number of flaws, and flaw locations were noted. Justification is provided in §4.1 - §4.6 of this report.

Note 3: All search units have been previously demonstrated for use with the qualified procedure, PDI-ISI-254-SE. As such documentation is not included.

Note 4: There are no exceptions to the qualified procedure, PDI-ISI-254-SE.

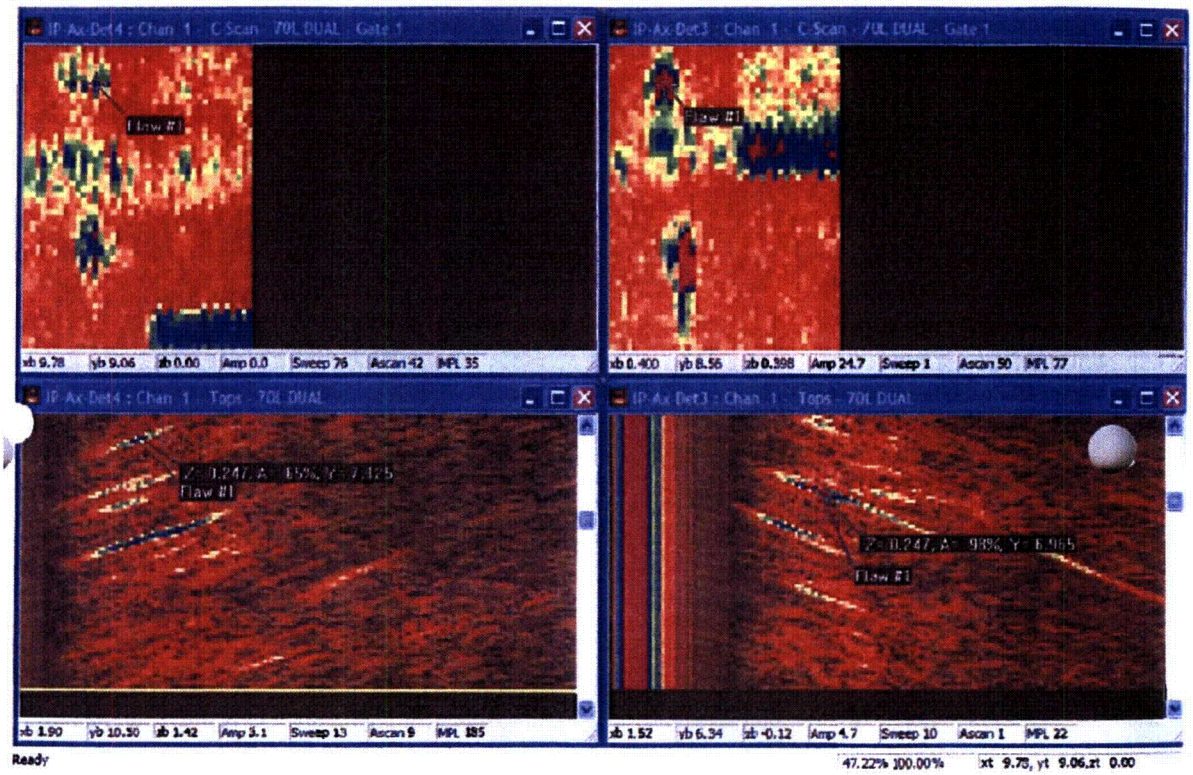
Note 5: Requirement noted on Qualification Sign-off Sheet.

Note 6: The Diablo Canyon Unit 2 ANII and site Level III personnel were not present for these demonstrations. The Indian Point Units 2/3 demonstration was witnessed by the Indian Point Units 2/3 Level III and their ANII. The weld inlay equivalency demonstration was witnessed by EPRI PDI personnel.

Note 7: There are no changes to the essential variables in the qualified procedure, PDI-ISI-254-SE.

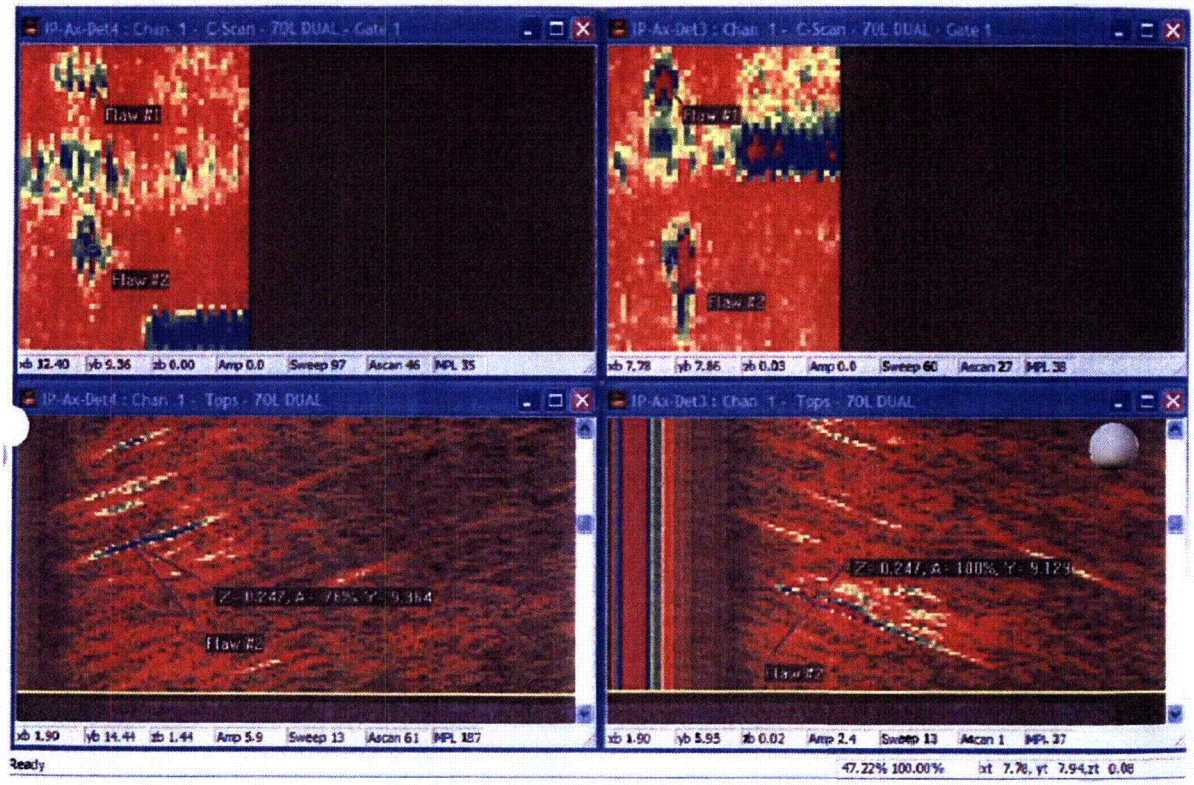
Site Specific Demonstration Checklist for WDI-TJ-1044, Rev. 1			
Corrosion Resistant Cladding (CRC) Qualification Criteria [Ref. 9.6] Requirement Reference	**Requirement**	**Paragraph Reference in Demonstration Report/Technical Basis Document**	**Checker Initials / Date**
§4.1.1.1	Personnel have current PDI Supplement 2 IGSCC qualification for the task at hand; refracted longitudinal waves shall be utilized for examination of the CRC and personnel shall have demonstrated capability in their use.	§5.0	RDR 3/9/2010
§4.1.2.1	Personnel have current PDI Supplement 10 qualification for the task at hand	§5.0	RDR 3/9/2010
§4.2.1	The combination of personnel, procedure, and equipment shall demonstrate the capability to locate planar reflectors in the CRC on a site-specific mock-up.	§6.0	RDR 3/9/2010
§4.3	This guideline proposes no changes to any other factors in the examination process, such as the examination frequency, scanning directions, examination volume, acceptance criteria, etc.	§7.3	RDR 3/9/2010
§5.1	Adequate records shall be maintained to provide evidence of personnel, equipment, and procedure qualification. Demonstrated variations in the qualified procedure , caused by site-specific conditions, shall be documented.	This report	RDR 3/9/2010

ATTACHMENT 2: Images of Flaws (Indian Point Unit 2/3 Mock-up)



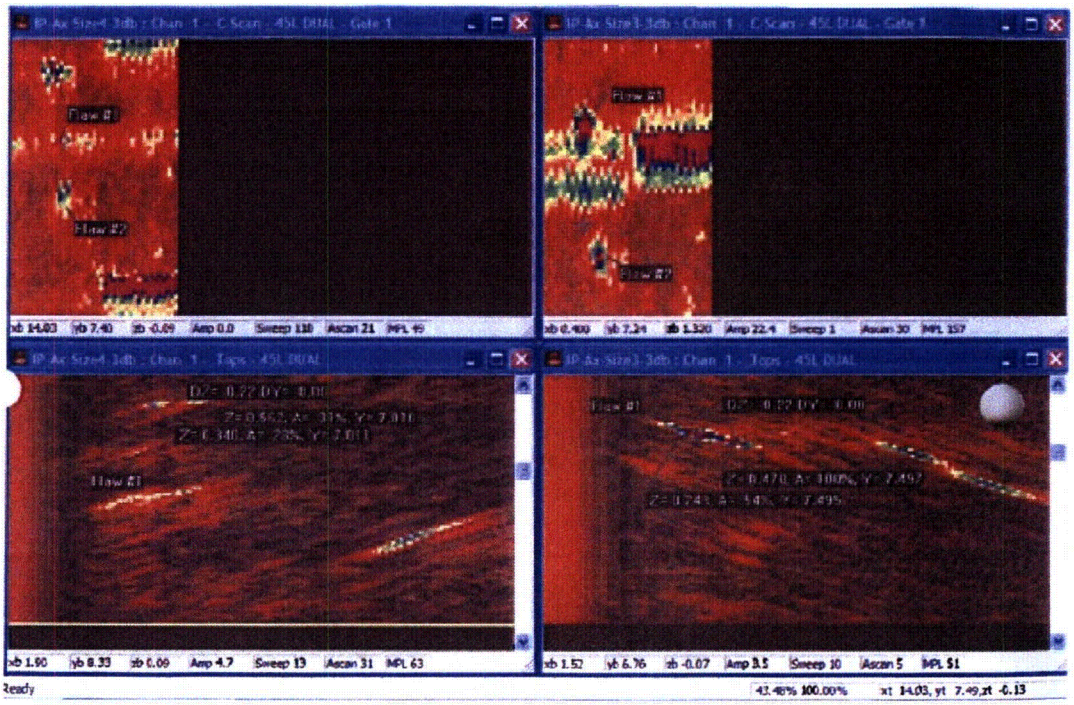
70° IN 70° OUT

Attachment 2, Figure 1: Flaw 1 – Detection with 70° TRL Transducers

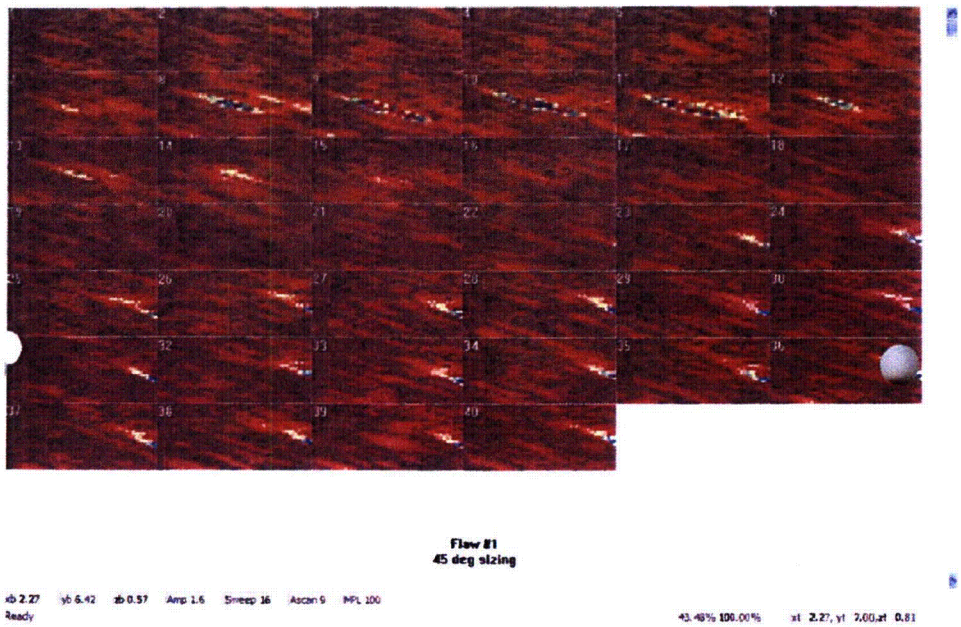


70°IN 70° OUT

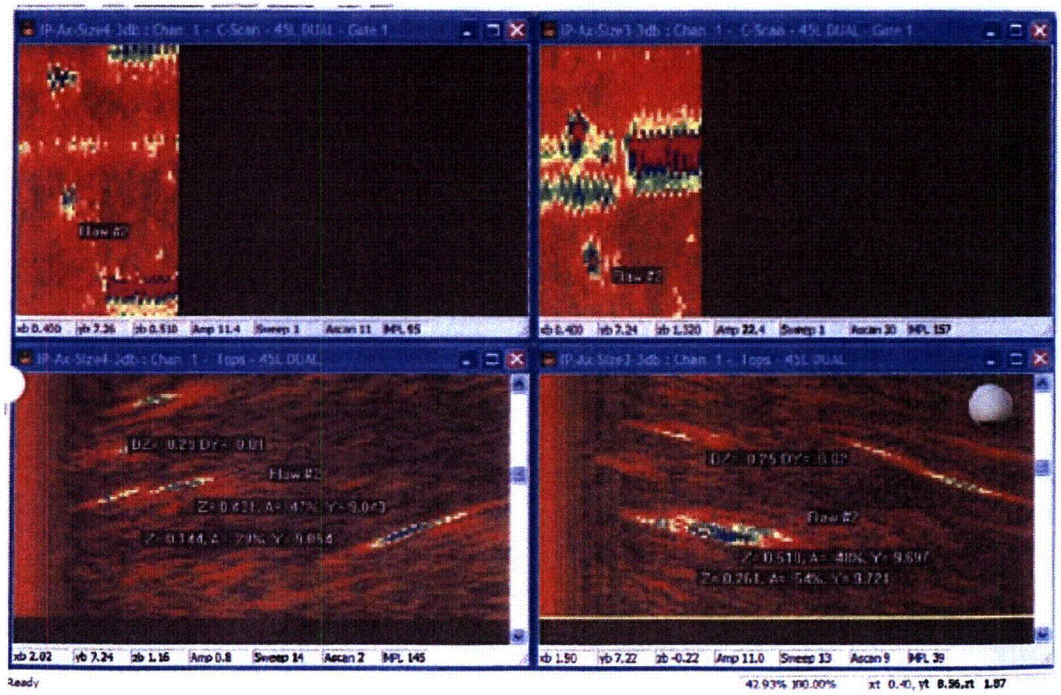
Attachment 2, Figure 2: Flaw 2 – Detection with 70° TRL Transducers



45° OUT 45° IN

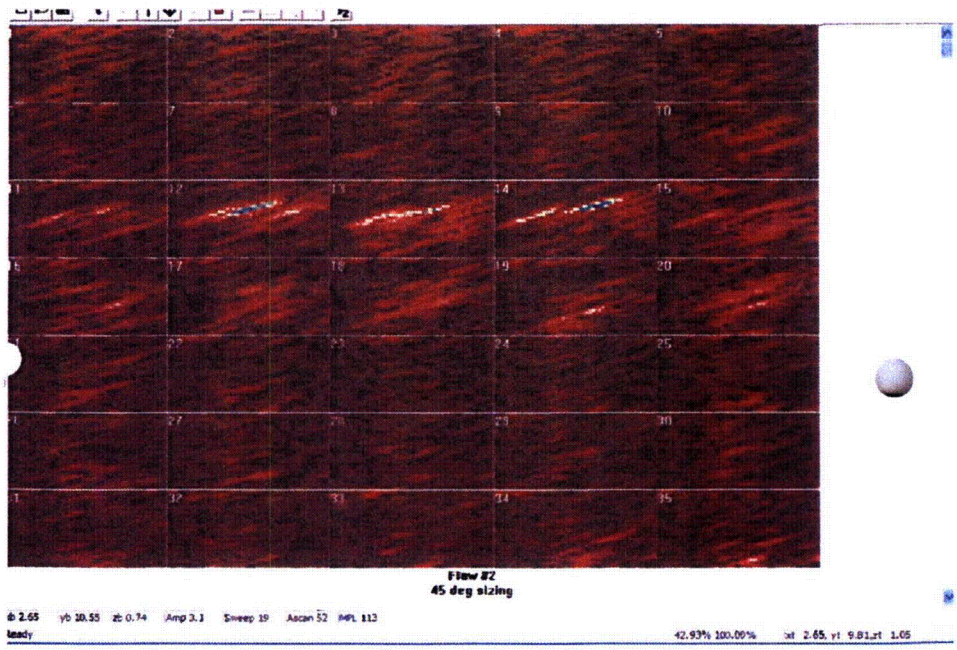


Attachment 2, Figure 3: Flaw 1 – Sizing with 45° TRL Transducers



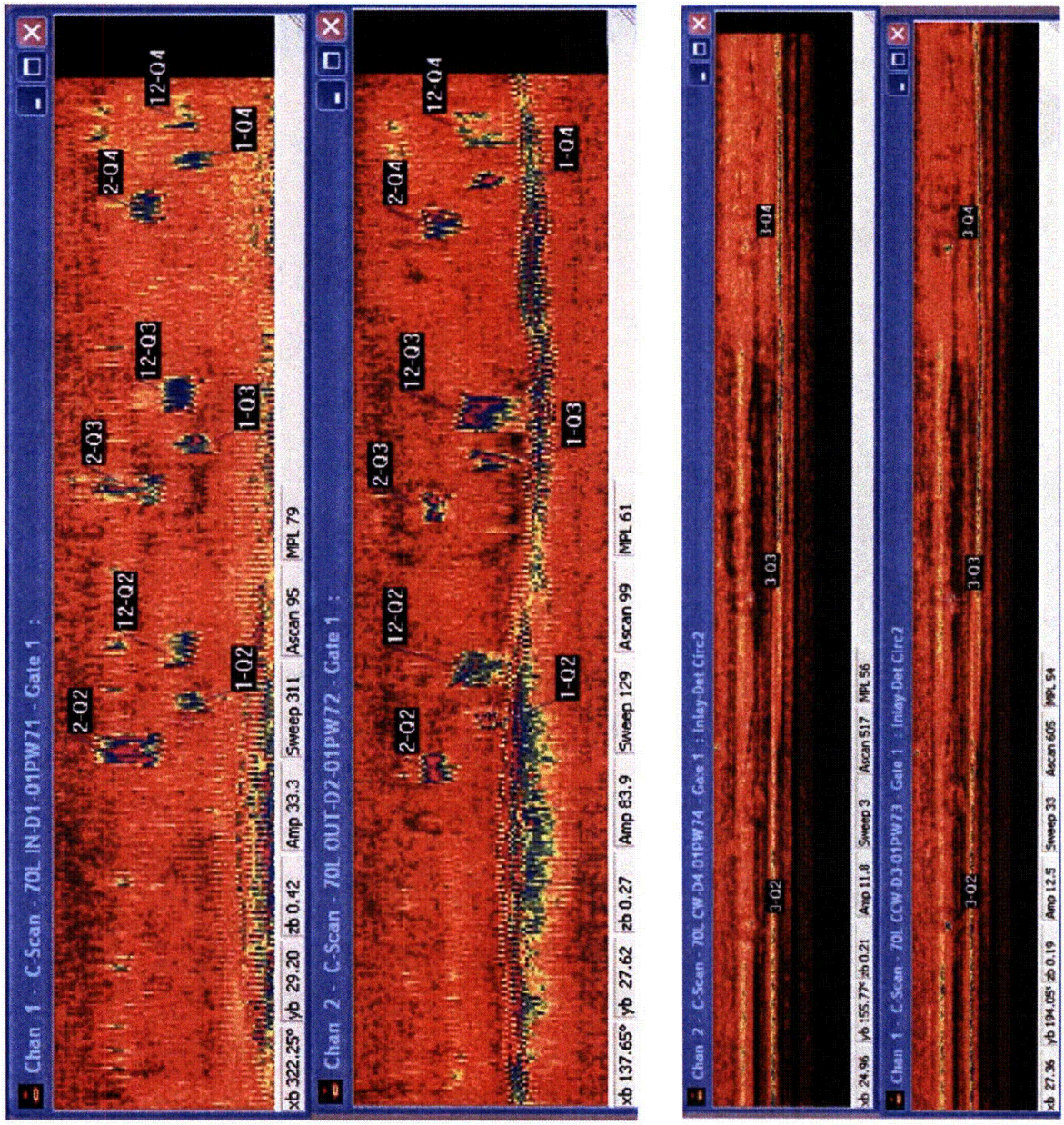
45°OUT

45°IN



Attachment 2, Figure 4: Flaw 2 – Sizing with 45° TRL Transducers

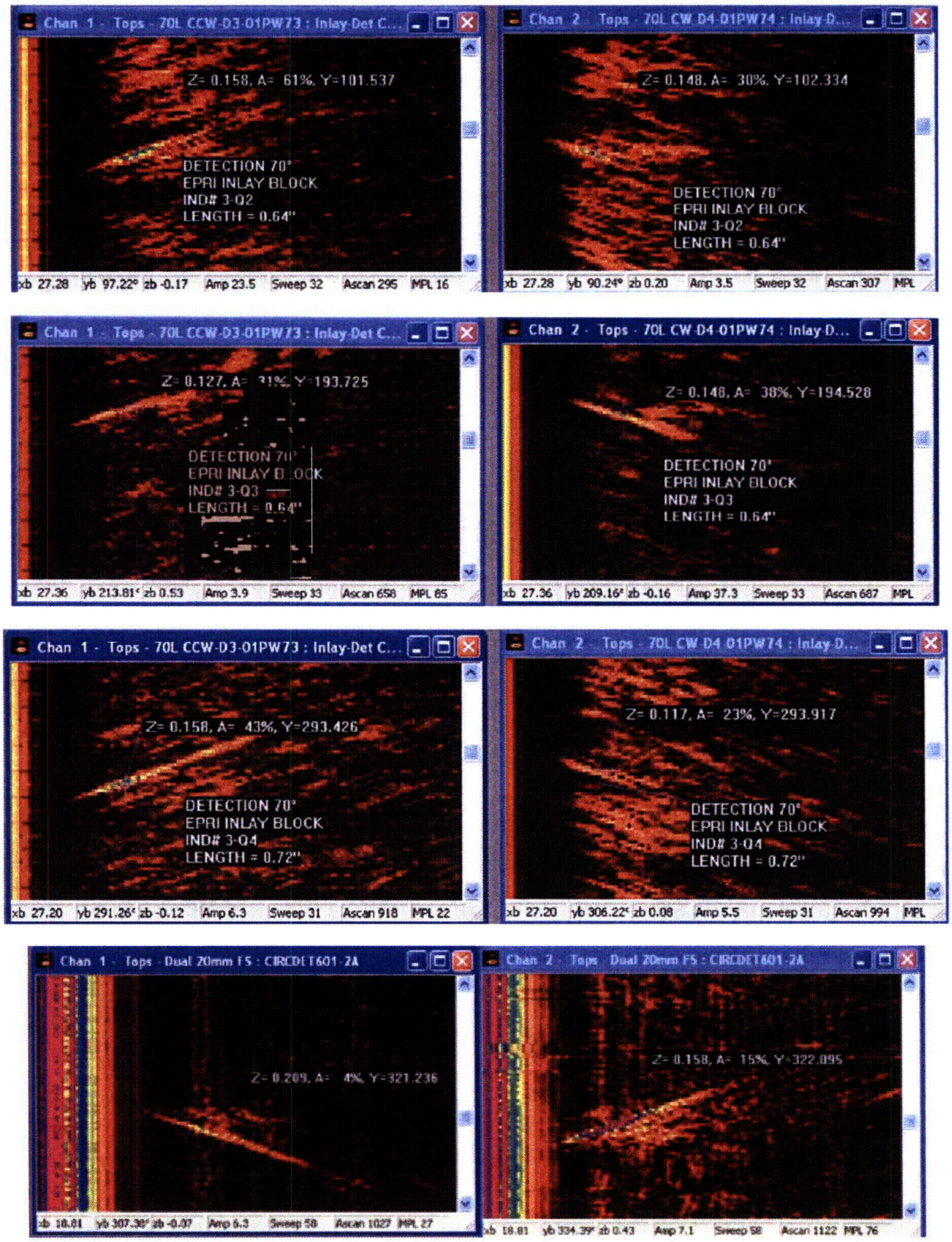
ATTACHMENT 3: Images of Flaws (Weld Inlay Equivalency Mock-up)



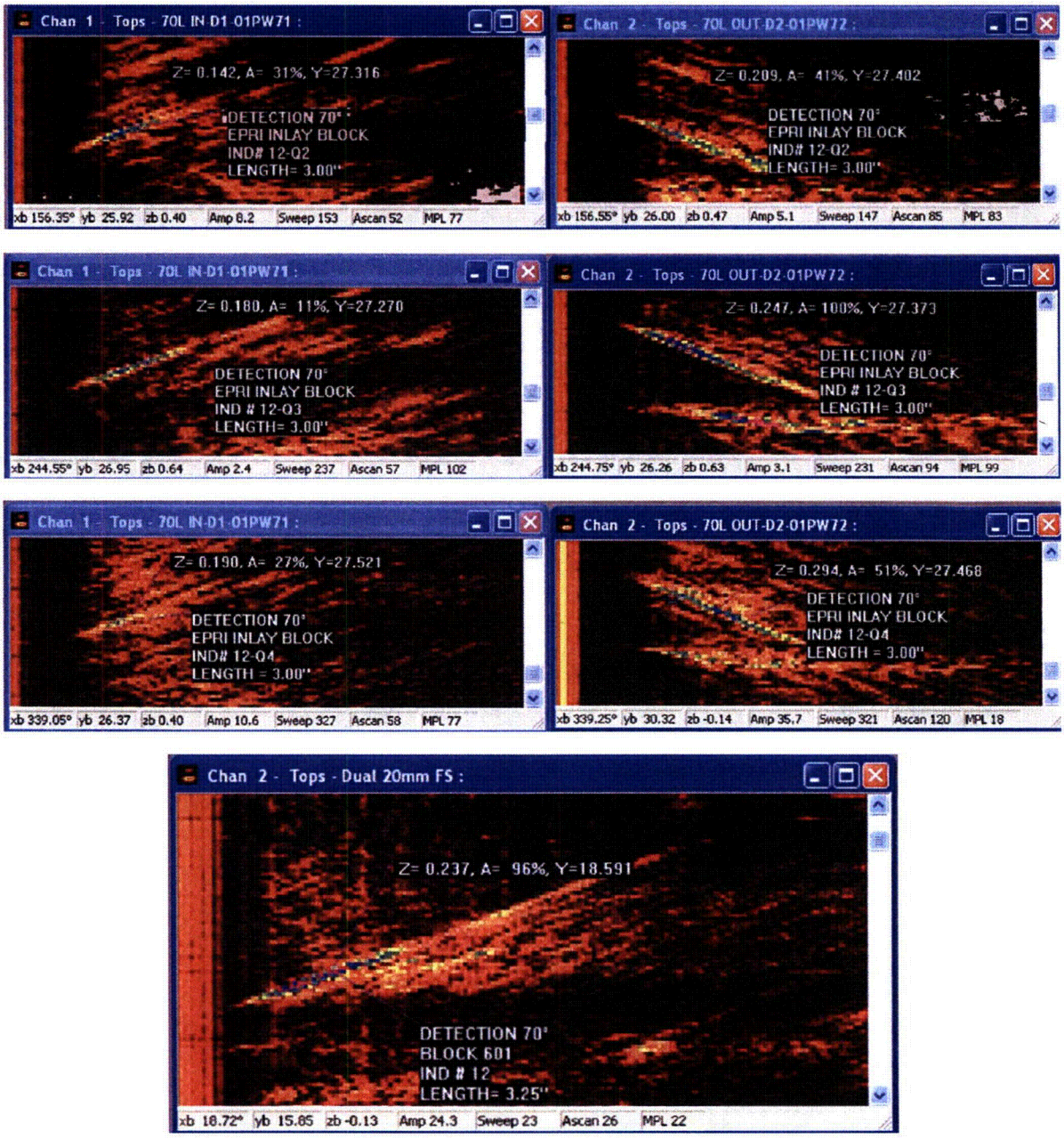
Attachment 3, Figure 1: All Flaws – Detection with 70° TRL Axial Beam Transducers

Attachment 3, Figure 2: Flaw 1 (-Q2, -Q3, -Q4, PDI 601/1) – Detection with 70° TRL Axial Beam Transducers

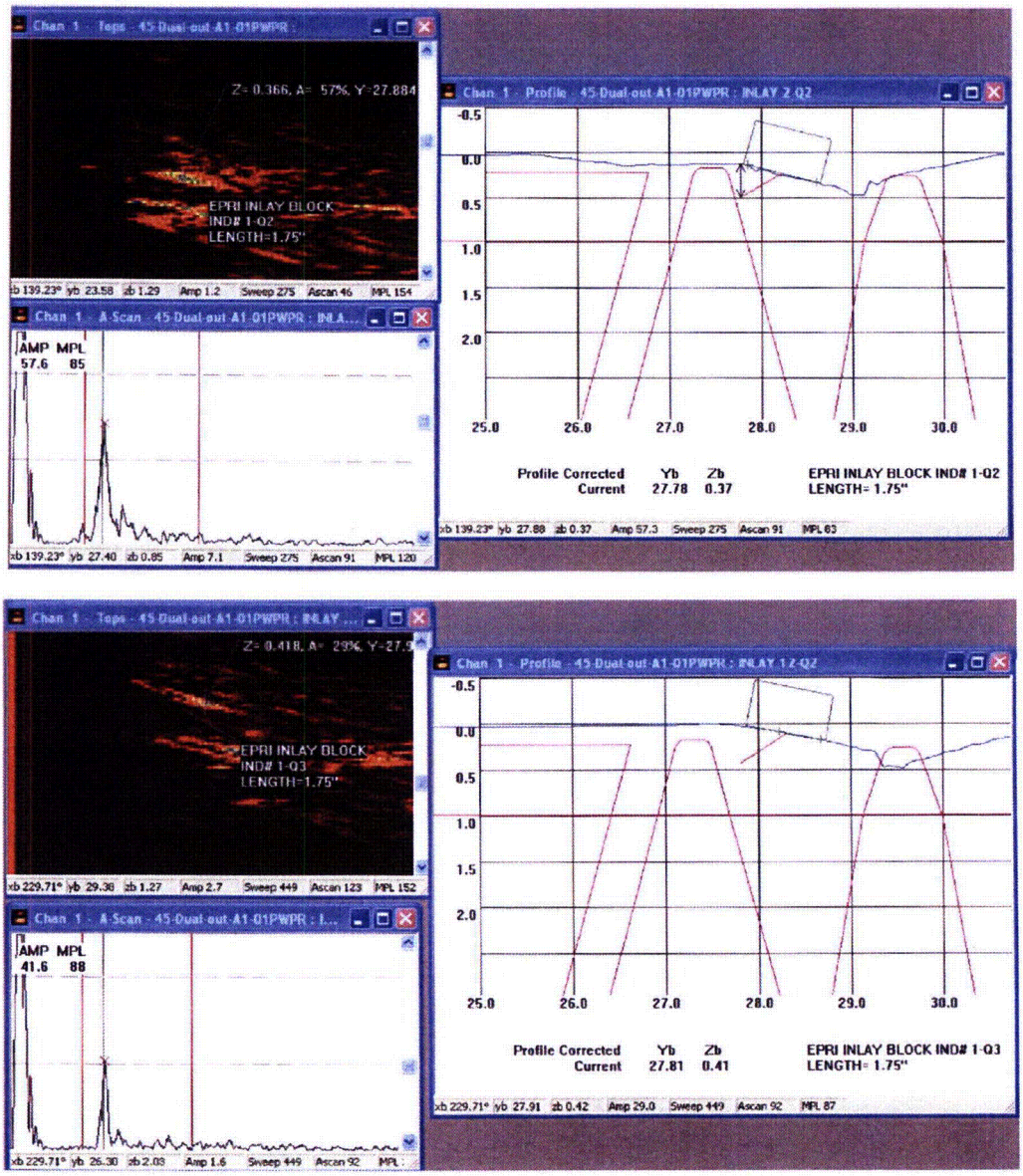
Attachment 3, Figure 3: Flaw 2 (-Q2, -Q3, -Q4, PDI 601/1) – Detection with 70° TRL Axial Beam Transducers



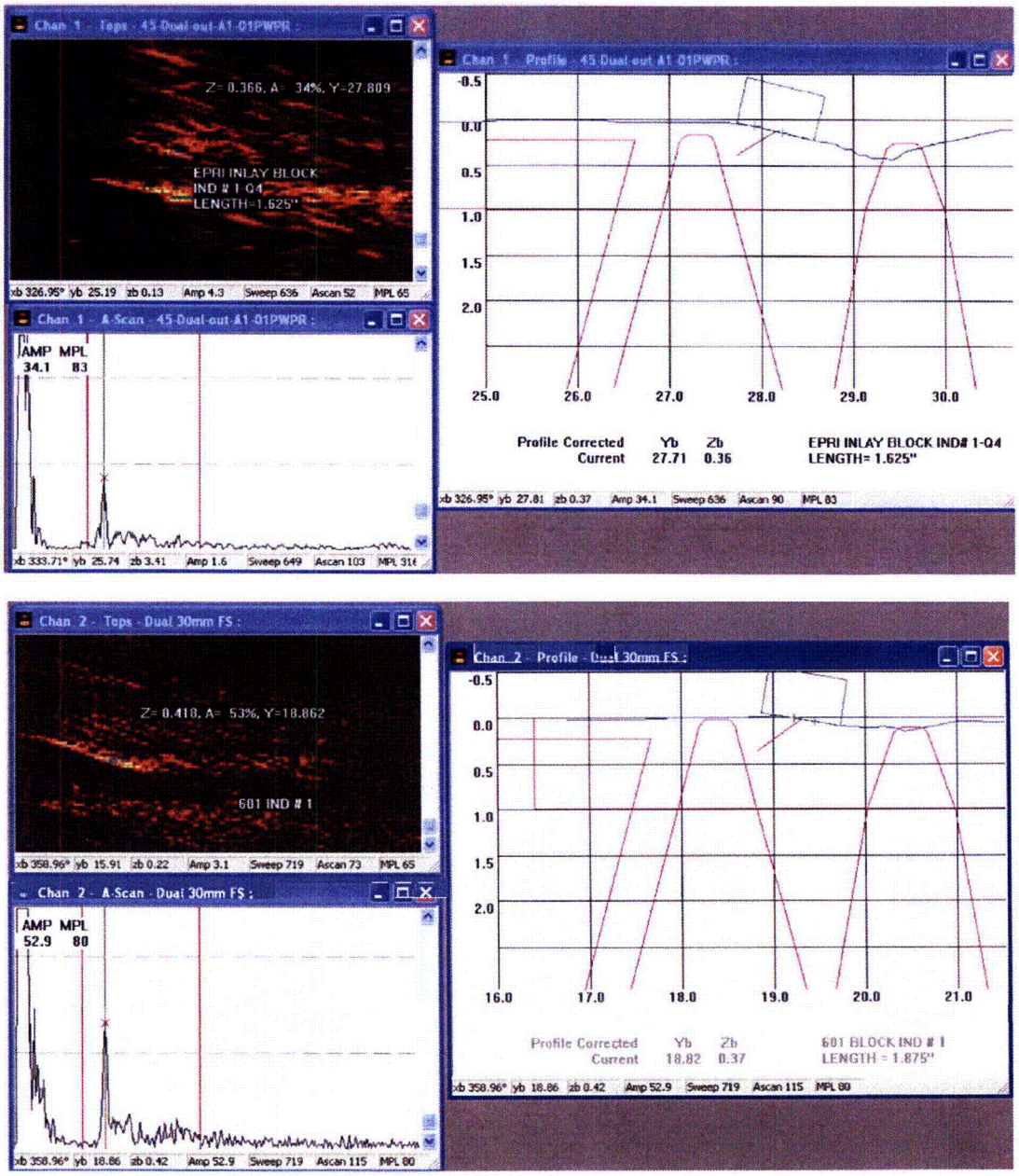
Attachment 3, Figure 4: Flaw 3 (-Q2, -Q3, -Q4, PDI 601/1) – Detection with 70° TRL Circumferential Beam Transducers



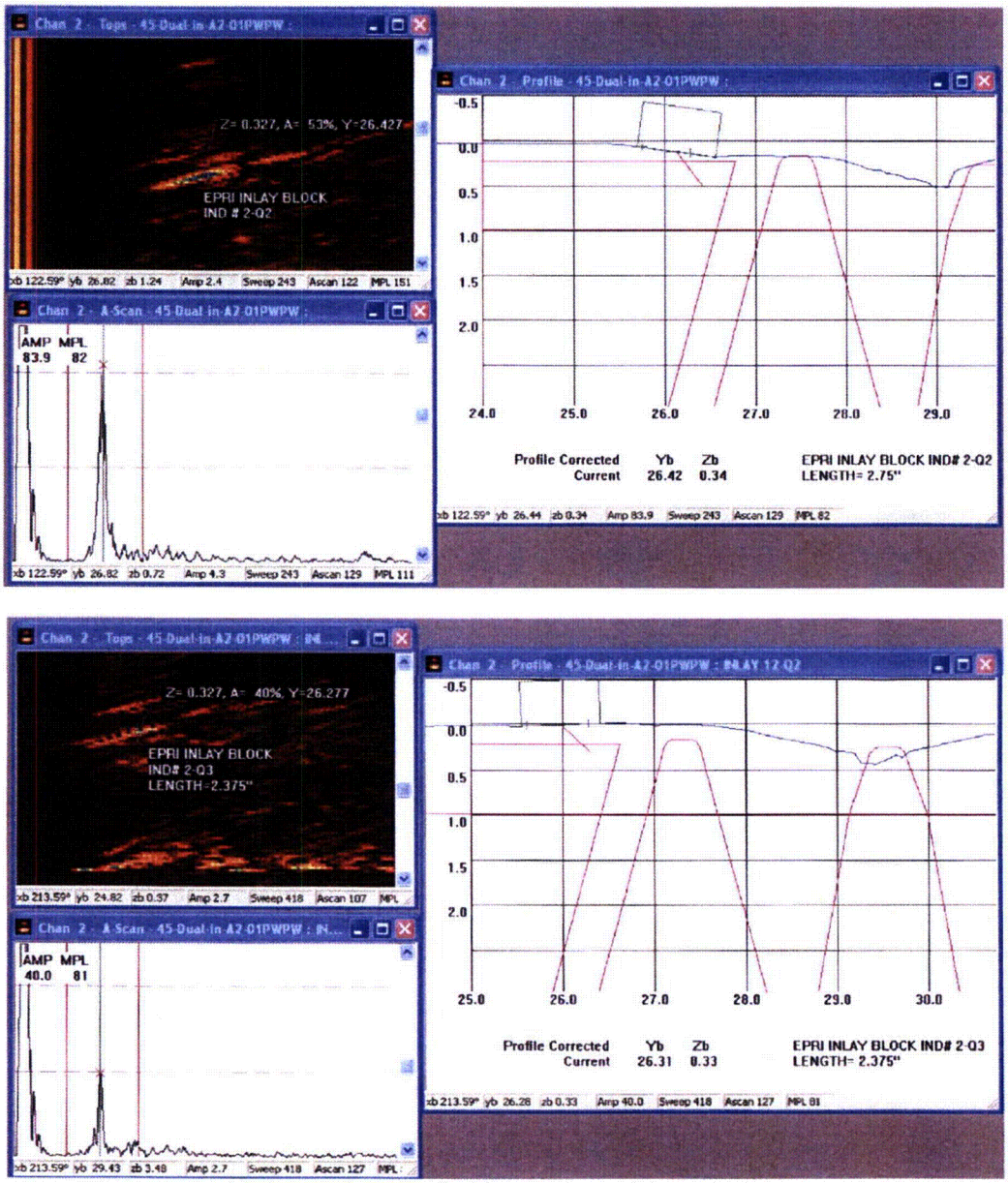
Attachment 3, Figure 5: Flaw 12 (-Q2, -Q3, -Q4, PDI 601/1) – Detection with 70° TRL Axial Beam Transducers



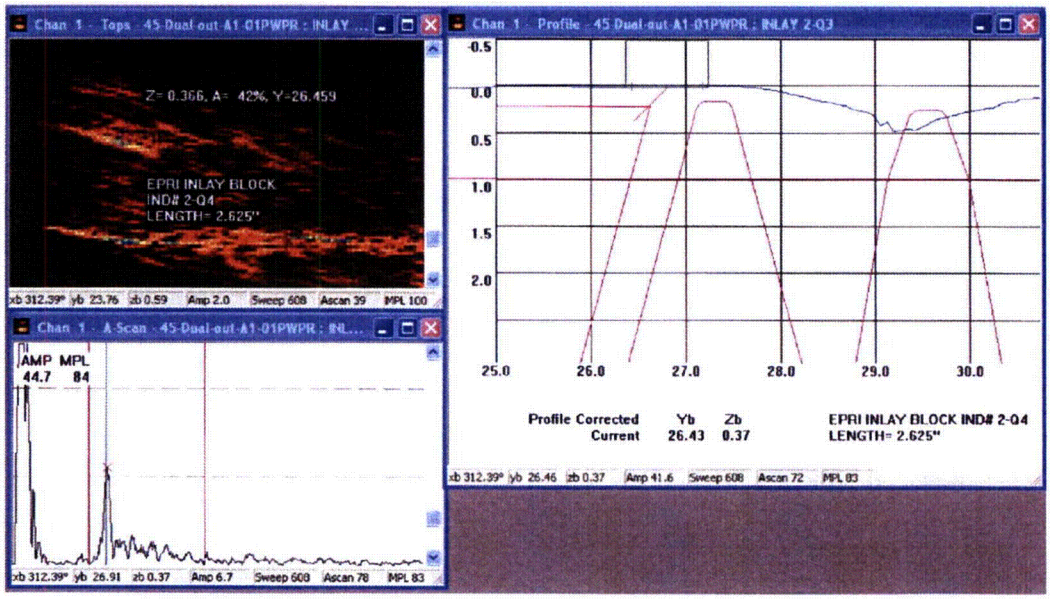
Attachment 3, Figure 6: Flaw 1 (-Q2, -Q3) – Sizing with 45° TRL Axial Beam Transducer

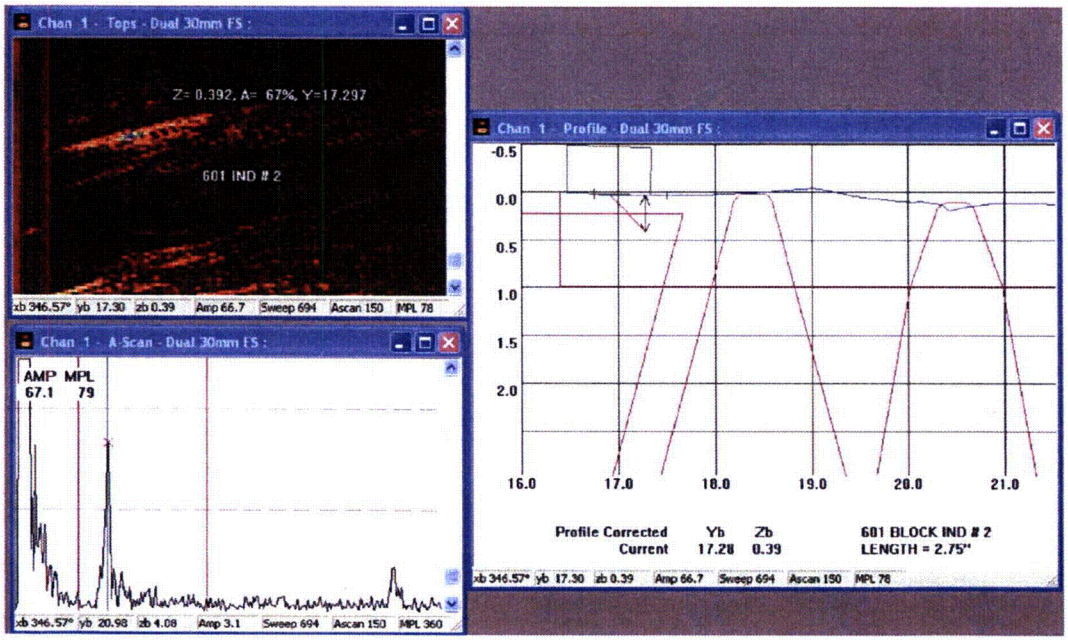


Attachment 3, Figure 7: Flaw 1 (-Q4, PDI 601/1) – Sizing with 45° TRL Axial Beam Transducer

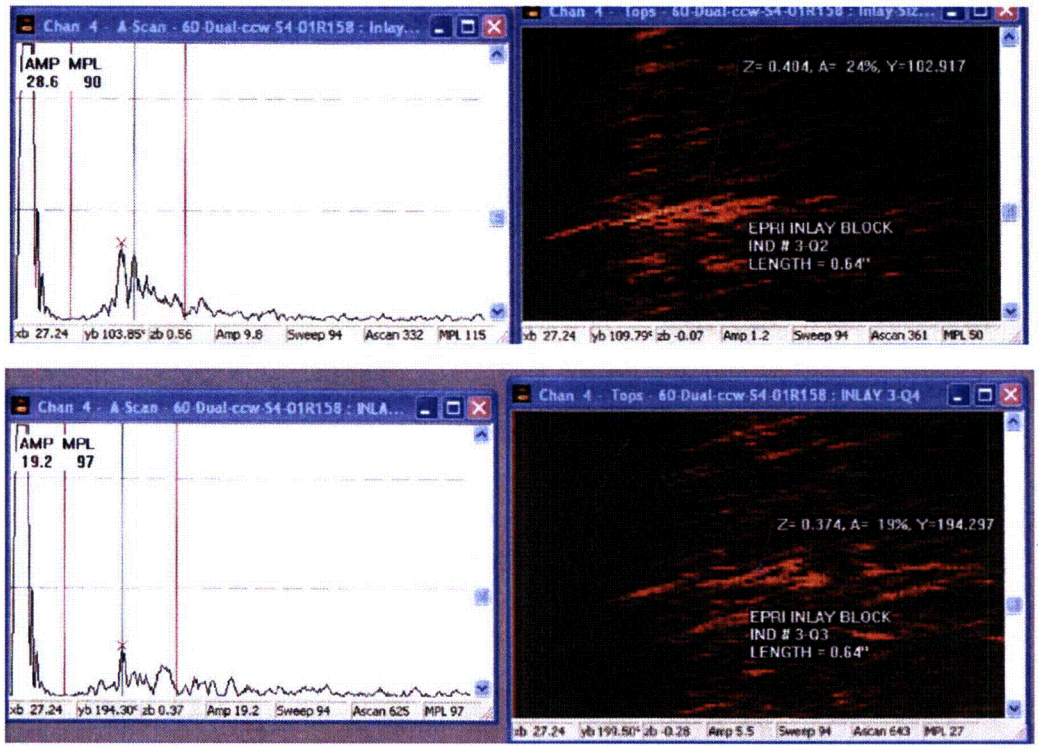


Attachment 3, Figure 8: Flaw 2 (-Q2, -Q3) – Sizing with 45° TRL Axial Beam Transducer

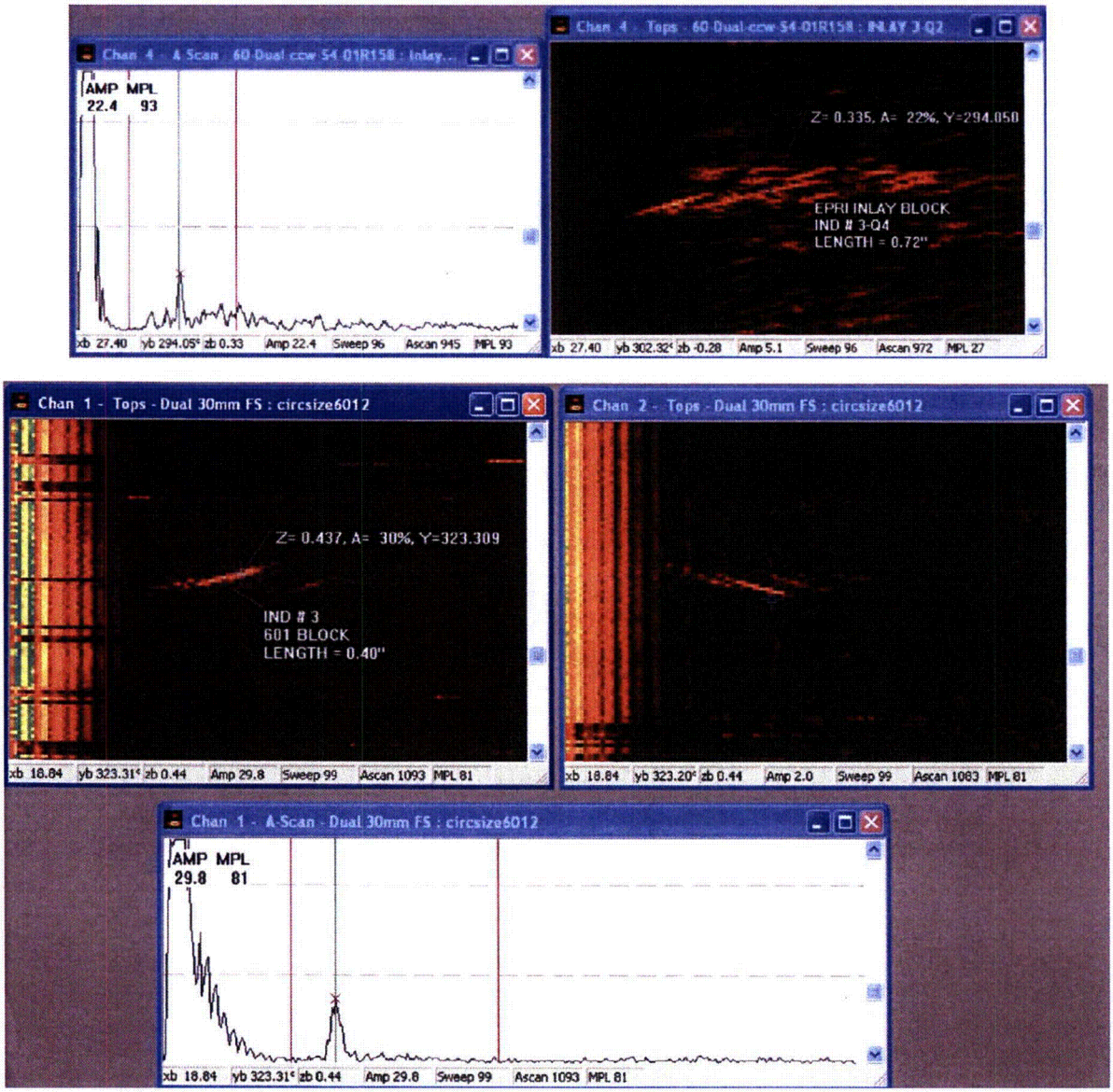




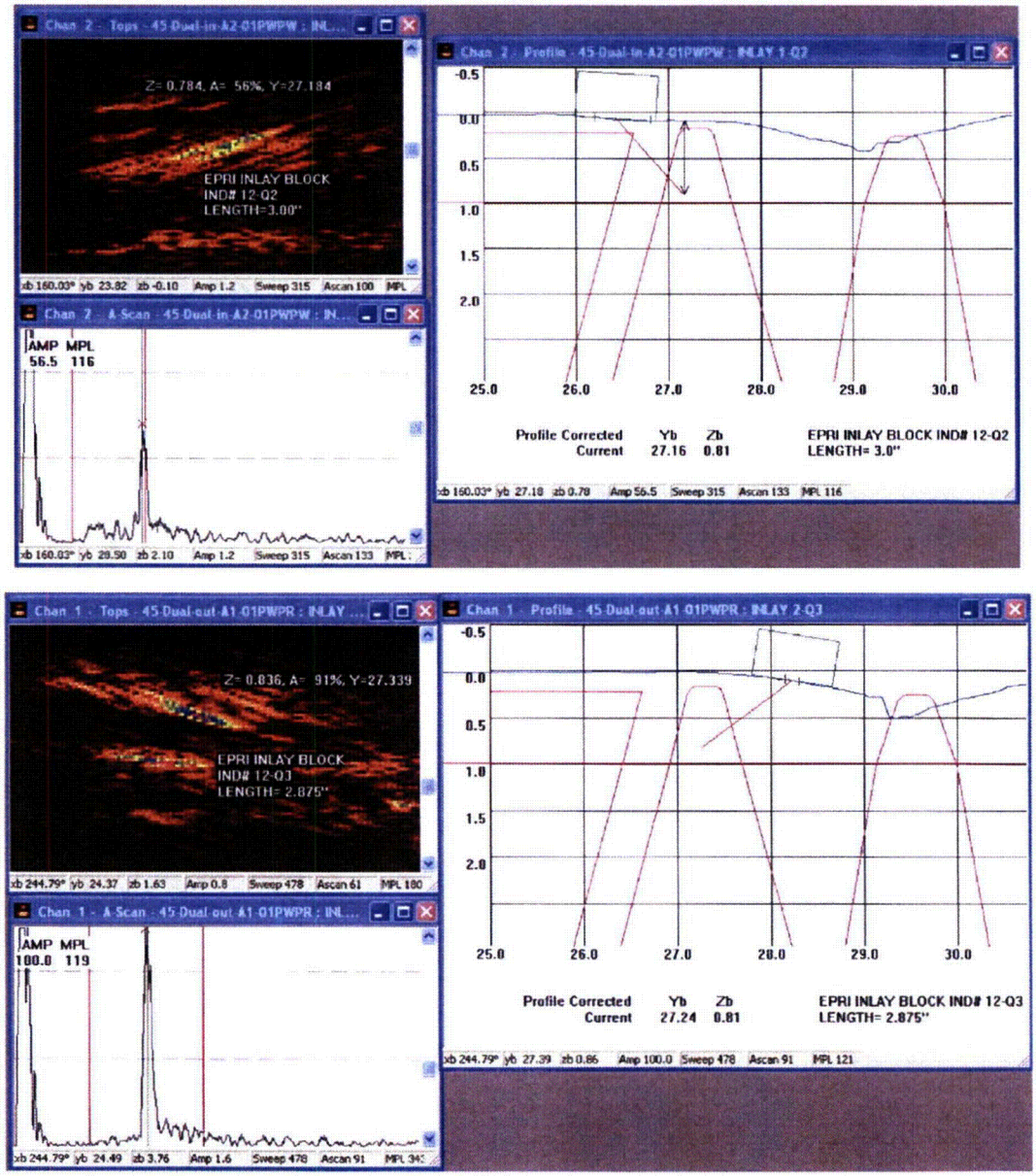
Attachment 3, Figure 9: Flaw 2 (-Q4, PDI 601/1) – Sizing with 45° TRL Axial Beam Transducer



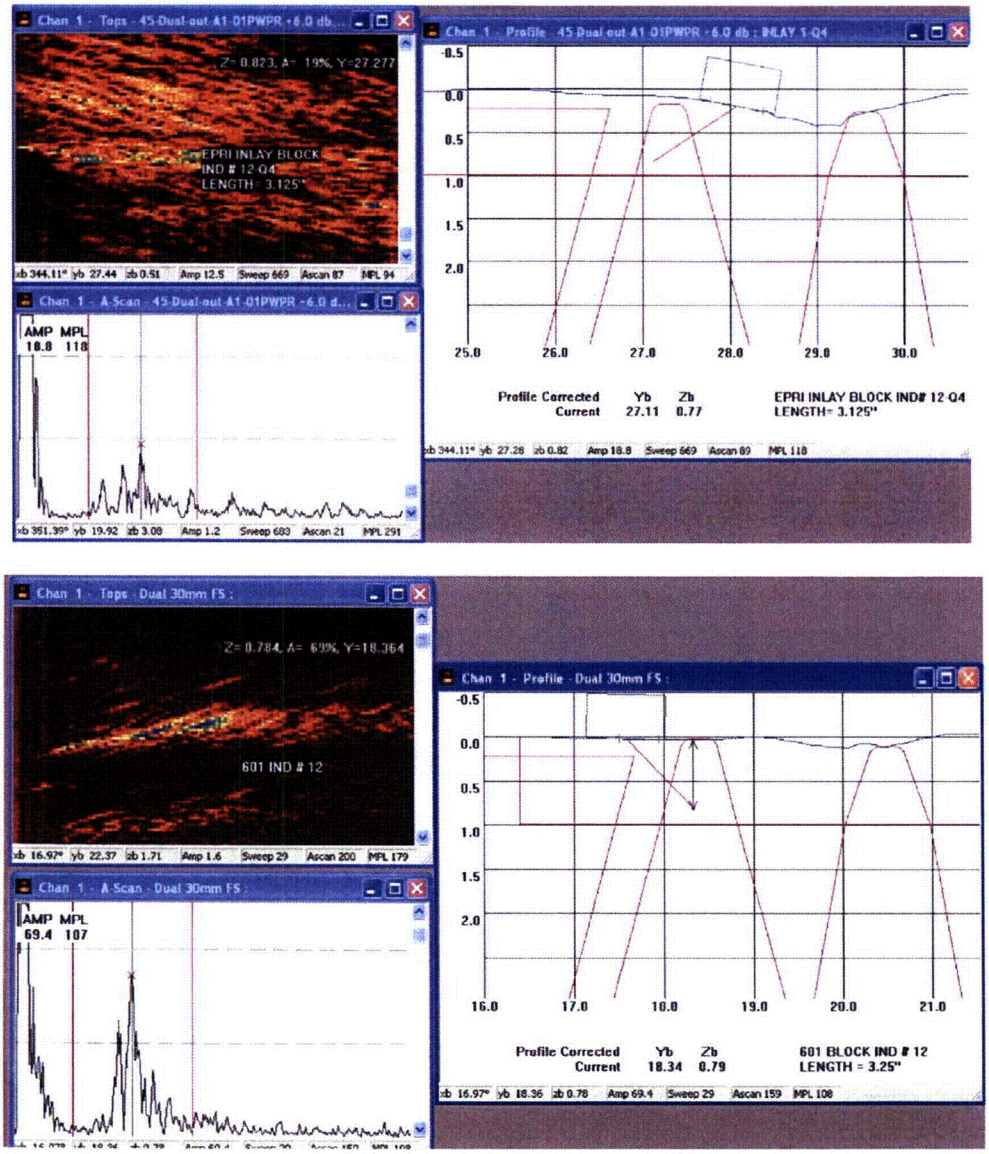
Attachment 3, Figure 10: Flaw 3 (-Q2, -Q3) – Sizing with 60° TRL Circumferential Beam Transducer



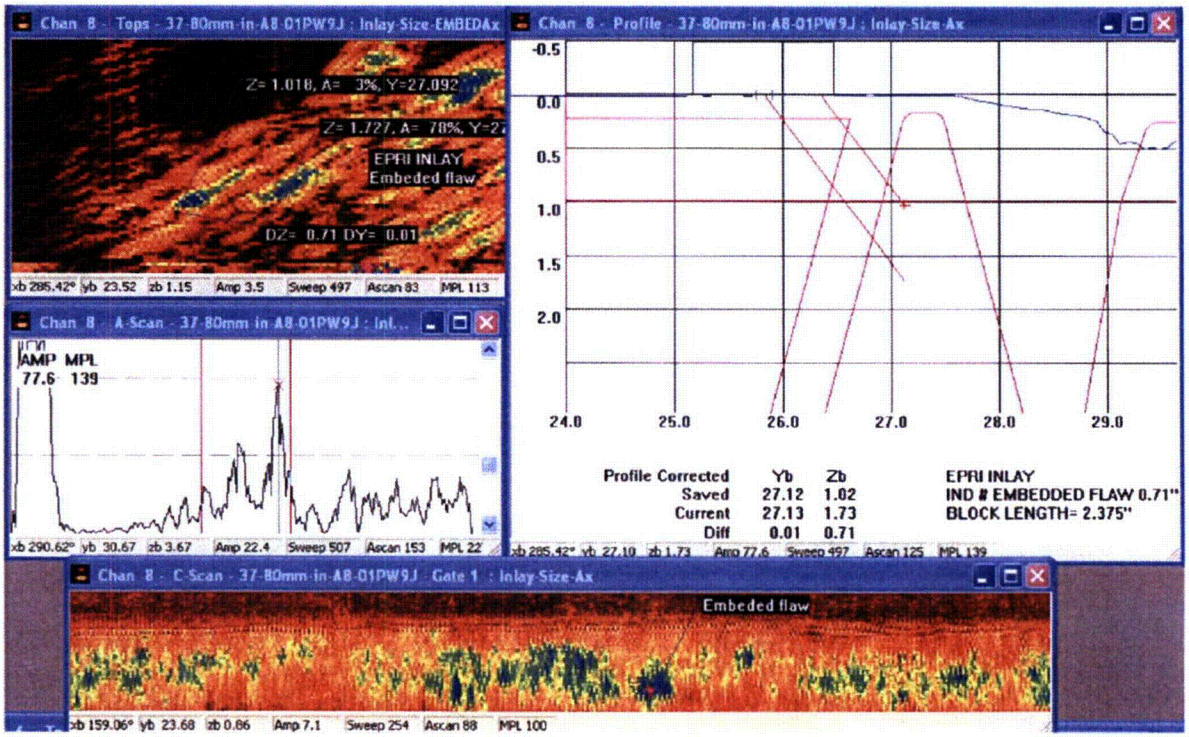
Attachment 3, Figure 11: Flaw 3 (-Q4, PDI 601/1) – Sizing with 60° TRL Circumferential Beam Transducer



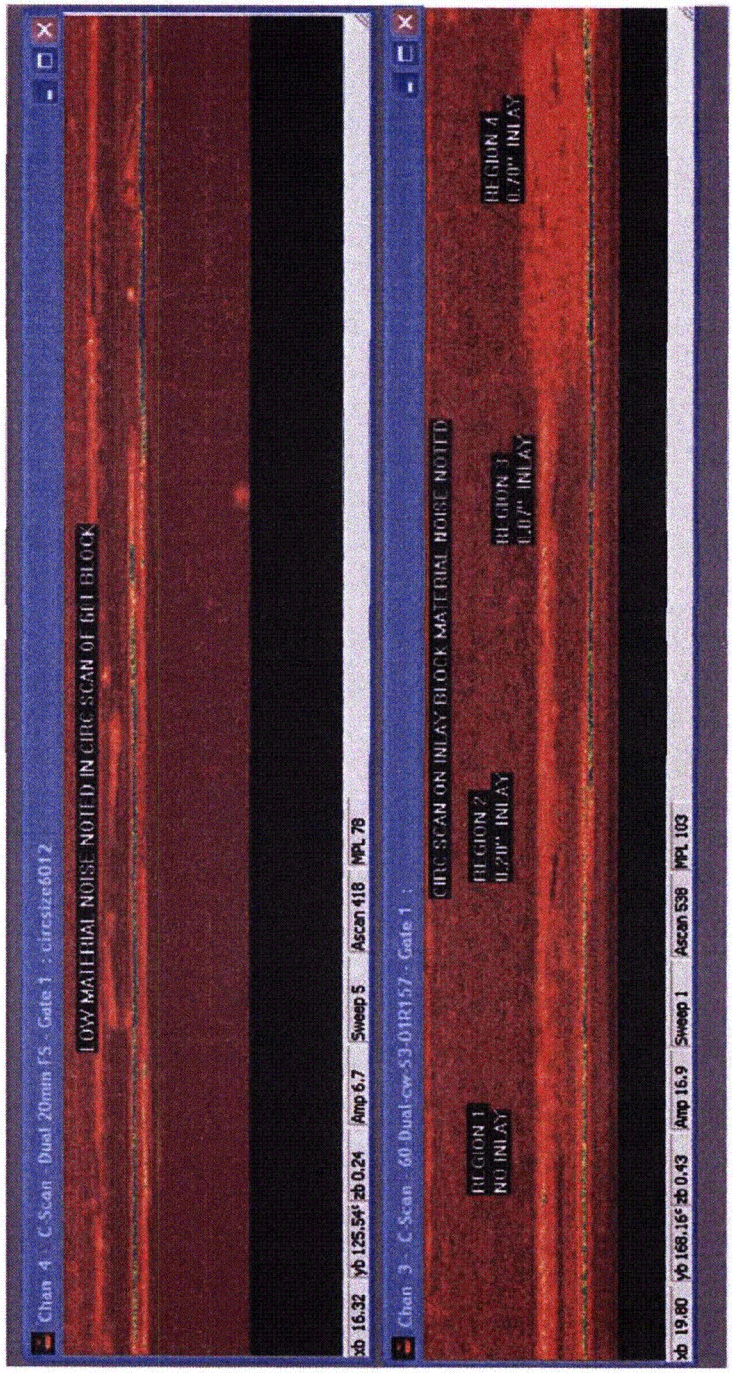
Attachment 3, Figure 12: Flaw 12 (-Q2, -Q3) – Sizing with 45° TRL Axial Beam Transducer



Attachment 3, Figure 13: Flaw 12 (-Q4, PDI 601/1) – Sizing with 45° TRL Axial Beam Transducer



Attachment 3, Figure 14: Embedded Flaw (-Q4) – Sizing with 37° TRL Axial Beam Transducer



Attachment 3, Figure 15: Noise Comparison Between Weld Inlay Equivalency Test Mock-Up and Non-Overlaid 601/1 Practice Block - 60° TRL Circumferential Beam Transducer

Westinghouse authorization letter, CAW-10-2851,
Accompanying Affidavit, Proprietary Information Notice,
and Copyright Notice

Westinghouse

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Proj letter PGE-10-33

CAW-10-2851

June 14, 2010

APPLICATION FOR WITHHOLDING PROPRIETARY
INFORMATION FROM PUBLIC DISCLOSURE

Subject: WDI-TJ-1044-P, Revision 1, "Demonstration Report/Technical Basis Document: Ultrasonic Examination of Diablo Canyon Unit 2 Reactor Pressure Vessel Nozzle to Safe End Welds from the ID Surface Through a Welded Protective Layer" (Proprietary)

The proprietary information for which withholding is being requested in the above-referenced report is further identified in Affidavit CAW-10-2851 signed by the owner of the proprietary information, Westinghouse Electric Company LLC. The affidavit, which accompanies this letter, sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b)(4) of 10 CFR Section 2.390 of the Commission's regulations.

Accordingly, this letter authorizes the utilization of the accompanying affidavit by Pacific Gas & Electric.

Correspondence with respect to the proprietary aspects of the application for withholding or the Westinghouse affidavit should reference this letter, CAW-10-2851 and should be addressed to J. A. Gresham, Manager, Regulatory Compliance and Plant Licensing, Westinghouse Electric Company LLC, P.O. Box 355, Pittsburgh, Pennsylvania 15230-0355.

Very truly yours,

J. A. Gresham, Manager
Regulatory Compliance and Plant Licensing

Enclosures

CAW-10-2851

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared J. A. Gresham, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this Affidavit on behalf of Westinghouse Electric Company LLC (Westinghouse), and that the averments of fact set forth in this Affidavit are true and correct to the best of his knowledge, information, and belief:

J. A. Gresham, Manager
Regulatory Compliance and Plant Licensing

Sworn to and subscribed before me
this 14th day of June 2010

Notary Public

COMMONWEALTH OF PENNSYLVANIA
NOTARIAL SEAL
Renee Giampole, Notary Public
Penn Township, Westmoreland County
My Commission Expires September 25, 2013

(1) I am Manager, Regulatory Compliance and Plant Licensing, in Nuclear Services, Westinghouse Electric Company LLC (Westinghouse), and as such, I have been specifically delegated the function of reviewing the proprietary information sought to be withheld from public disclosure in connection with nuclear power plant licensing and rule making proceedings, and am authorized to apply for its withholding on behalf of Westinghouse.

(2) I am making this Affidavit in conformance with the provisions of 10 CFR Section 2.390 of the Commission's regulations and in conjunction with the Westinghouse Application for Withholding Proprietary Information from Public Disclosure accompanying this Affidavit.

(3) I have personal knowledge of the criteria and procedures utilized by Westinghouse in designating information as a trade secret, privileged or as confidential commercial or financial information.

(4) Pursuant to the provisions of paragraph (b)(4) of Section 2.390 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse.

(ii) The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public. Westinghouse has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitutes Westinghouse policy and provides the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of

Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage, e.g., by optimization or improved marketability.

(c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

There are sound policy reasons behind the Westinghouse system which include the following:

(a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

(b) It is information that is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.

(c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.

(d) Each component of proprietary information pertinent to a particular competitive advantage is potentially as valuable as the total competitive advantage. If competitors acquire components of proprietary information, any one component may be the key to the entire puzzle, thereby depriving Westinghouse of a competitive advantage.

(e) Unrestricted disclosure would jeopardize the position of prominence of Westinghouse in the world market, and thereby give a market advantage to the competition of those countries.

(f) The Westinghouse capacity to invest corporate assets in research and development depends upon the success in obtaining and maintaining a competitive advantage.

(iii) The information is being transmitted to the Commission in confidence and, under the provisions of 10 CFR Section 2.390; it is to be received in confidence by the Commission.

(iv) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.

(v) The proprietary information sought to be withheld in this submittal is that which is appropriately marked in WDI-TJ-1044-P, Revision 1, "Demonstration Report/Technical Basis Document: Ultrasonic Examination of Diablo Canyon Unit 2 Reactor Pressure Vessel Nozzle to Safe End Welds from the ID Surface Through a Welded Protective Layer" (Proprietary) dated June 1, 2010, for submittal to the Commission, being transmitted by Pacific Gas & Electric letter and Application for Withholding Proprietary Information from Public Disclosure, to the Document Control Desk. The proprietary information as submitted by Westinghouse is that associated with justifying an in-service inspection approach on a unique weld configuration and may be used only for that purpose.

This information is part of that which will enable Westinghouse to provide a uniquely qualified in-service inspection technology to our customers in order to address required examinations of reactor pressure vessel nozzle to safe end welds.

Further this information has substantial commercial value as follows:

(a) Westinghouse plans to sell the use of similar information to its customers for purpose of justifying a similar in-service inspection approach consistent with the unique weld configuration.

(b) The information requested to be withheld reveals the distinguishing aspects of a methodology which was developed by Westinghouse.

Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar inspection technology and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

The development of the technology described in part by the information is the result of applying the results of many years of experience in an intensive Westinghouse effort and the expenditure of a considerable sum of money.

In order for competitors of Westinghouse to duplicate this information, similar technical programs would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended.

Further the deponent sayeth not.

PROPRIETARY INFORMATION NOTICE

Transmitted herewith are proprietary and/or non-proprietary versions of documents furnished to the NRC in connection with requests for generic and/or plant-specific review and approval.

In order to conform to the requirements of 10 CFR 2.390 of the Commission's regulations concerning the protection of proprietary information so submitted to the NRC, the information which is proprietary in the proprietary versions is contained within brackets, and where the proprietary information has been deleted in the non-proprietary versions, only the brackets remain (the information that was contained within the brackets in the proprietary versions having been deleted). The justification for claiming the information so designated as proprietary is indicated in both versions by means of lower case letters (a) through (f) located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower case letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (4)(ii)(a) through (4)(ii)(f) of the affidavit accompanying this transmittal pursuant to 10 CFR 2.390(b)(1).

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