

**PAUT TOFD Examination Report***“Advanced Ultrasonic Testing”***Report #:** P-18-009-01**Revision #:** 0.0**Date:** Mar. 22, 2018**Pages:** Page 1 of 11**Job Details**

<b>Client:</b>	Husky Energy	<b>Streamline Job #:</b>	18-158
<b>Representative:</b>	Greg Guenette	<b>Procedure:</b>	UT-PA01/02/TOFD01 Rev.0.0
<b>Project:</b>	Bullet A0571635; In-Service Inspection	<b>Client PO:</b>	8401259896 / GL 6050009
<b>Location:</b>	Ansell Gas Plant, AB, LSD: 07-27-51-19W5	<b>Client WO:</b>	81282318
<b>Code/Specification:</b>	ASME V Art. 4	<b>Acceptance Criteria:</b>	Client Information
<b>Technique and Job Scope:</b>	Semi-automated/Manual PAUT (Phased Array Ultrasonic Testing) and TOFD (Time of Flight Diffraction) on NGL Bullet SAP Equipment ID: 66130683; A0571635		

**Equipment and Setup Details**

Instrument:		Make & Model:		Zetec Topaz		S/N:		690160		Cal. Due Date:		Jan. 17, 2019		
		Software Ver.:		3.8R13		Mode:		Pitch-Catch		Pulsers/Channels:		32:128		
Search Unit(s)	ID	Model		S/N		Freq. (MHz)	# of Elem	Pitch (mm)	Gap (mm)	Height (mm)	Wedge Model		Wedge Nat. Ref. Angle (°)	
	1	5L16-A1		F2855		5.0	16	0.62	0.08	10	SA1-N55S		55	
	2	5L16-A1		F2901		5.0	16	0.62	0.08	10	SA1-N55S		55	
	3	C543-SM		561022		5.0	1	-	-	-	ST1-55L		55	
	4	C543-SM		564641		5.0	1	-	-	-	ST1-55L		55	
Scanner:		Make:	Zetec			Model:	Weld Crawler			Encoder Resolution:			1mm	
Other:		Cable Length & Type:			Fixed, 6'			Couplant Brand & Type:			Water			
Calibration:		Block ID:	PCB-0750			Dia. & Thk.:		0.750", Flat			Material Grade:		Carbon Steel	
		Block ID:	PCB-0500			Dia. & Thk.:		0.500", Flat			Material Grade:		Carbon Steel	
		Block ID:	PCB-1000			Dia. & Thk.:		1.000", Flat			Material Grade:		Carbon Steel	

**Item Details and Examination Conditions**

<b>Item Inspected</b>	<b>Item Type:</b>	Circ & Long Seams/Nozzle Welds			<b>Surface Condition:</b>	Painted				
	<b>Material Grade:</b>	CS			<b>Surface Temp. (°C):</b>	~5				
	<b>Thickness:</b>	0.828" Shell / 0.487" Heads			<b>Product Form(s):</b>	Welded Plate				

**Results**

<b>Identification of Item(s) Examined:</b>	100% of all accessible circ and long seams on shell and segmented heads. Nozzle Welds A, B, C, D, F, H.
<b>Area(s) Examined:</b>	Bottom third of weld plus HAZ
<b>Damping, Reject Used, Final Display Processing Level:</b>	None used

**Detailed Results:****Scope:**

To perform semi-automated PAUT and TOFD on 100% of all accessible circ and long seams on the shell and segmented heads. Perform manual PAUT on all accessible nozzle welds without re-pads. See scan details on pages 6 and 7 for more information. See scan map on pages 8 and 9 for inspected areas.

**Method:**

Semi-automated PAUT was performed on all shell circ and long seams, and segmented head long seams as per "POLAR-UT-PA02 Rev 0.0 PAUT Linear Scan Examination – Welds" procedure. The transducers were fixed at 30mm from the weld centerline on all shell welds, 19mm from the weld centerline on all head welds to ensure full coverage and encoded data of the targeted weld volume and HAZ. Offline data analysis was performed upon completion of encoded scans. This was used as the primary method of inspection for any in-service type defects such as cracking.

Semi-automated TOFD was performed on all shell circ and long seams, and segmented head long seams as per "POLAR-UT-TOFD01 Rev 0.0 TOFD Examination – ASME Welds" procedure. The TOFD probe pair was centered at a probe separation distance of 58mm on all shell circ and long seams, and at a probe separation distance of 50mm on all head long seams. The ultrasonic beam was focused at or near the ID surface for optimal resolution. This was used as a supplementary technique to PAUT.

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Manual PAUT was performed on all accessible nozzles and the segmented head circ seams as per “POLAR-UT-PA01 Rev 0.0 PAUT Manual Examinations – Welds” procedure. The transducer was manually rastered around the entire circumference of the weld ensuring full volumetric coverage of the weld ID and HAZ. Additionally, manual PAUT was used to scan all welds for transverse indications with a mutli-directional raster using a 10° to 15° skew. Analysis was performed in real time and was used as the primary method of inspection for any in-service type defects such as cracking.

**Evaluation:**

Imperfections which produce a response greater than 20% of the reference level shall be investigated to the extent that the shape, identity, and location of all such imperfections can be determined. All imperfections interpreted as in-service type defects shall be reported. This record shall locate each area, the response level, the dimensions, the depth below the surface, and the classification.

The minimum detectable defect size is 0.013”. This value is an approximation based on the nominal carbon steel shear wave velocity value of 3.25mm/sec using 5.0 MHz transducers.

**Acceptance/Rejection:**

No in-service type defects such as cracking was found in any of the inspected circ seams, long seams or nozzle welds. All welds are deemed acceptable based on the absence of in-service type defects.

**Limitations:**

95% of all shell circ seams, 98% of shell long seams and 100% of all segmented head circ and long seams were inspected. The top portion of each circ seam (approximately 0.5m) was inaccessible with JLG use. Approximately 2.0m of LS8 was inaccessible due to a permanent platform obstruction. Nozzles with repads were not inspected due to repad configuration and general inaccessibility.



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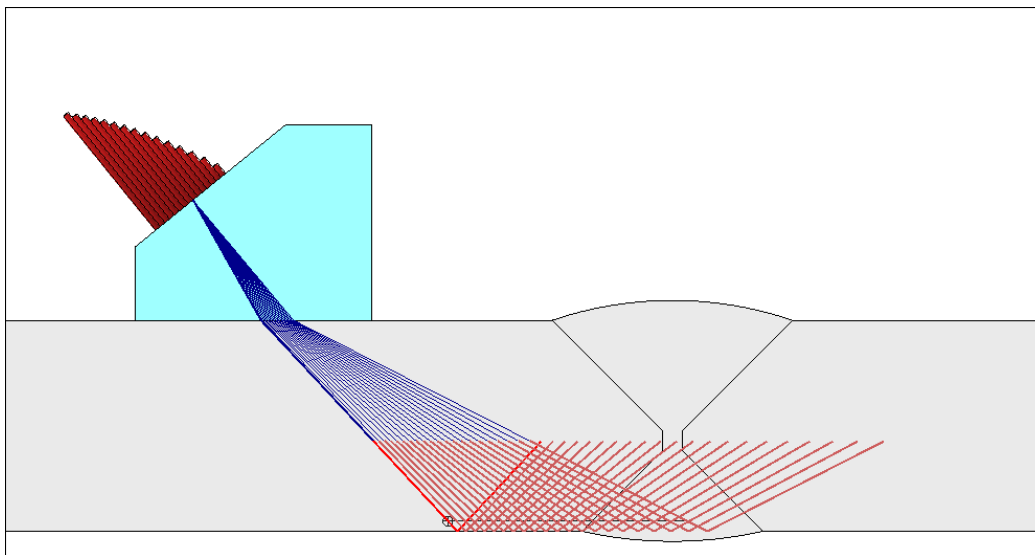
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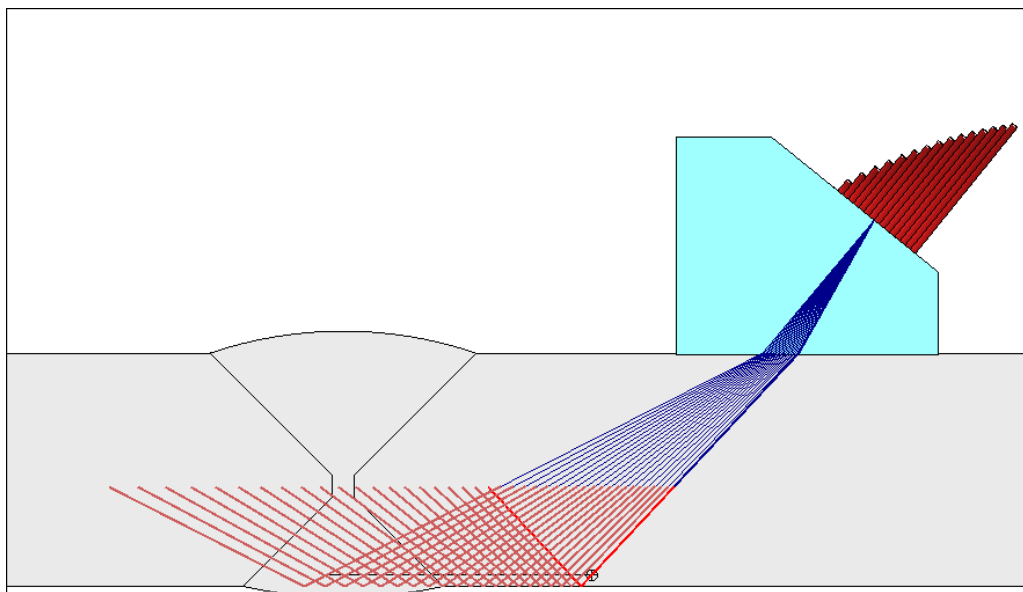
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## Scan Plan and Focal Law Parameters

Weld Joint Type:		Double V					Thickness (in):		0.828/0.487		Material:		Carbon Steel		
Adjacent Base Metal Coverage (in):				0.828/0.487		Focal Plane Used:		Depth			Curvature:		Curved		
Single or Dual Sided Scanning:				Both		Scanning Surface:		OD		Scan Type:		Semi-Auto/Manual			
Group	Scan Type	Search Unit ID	PCS or Offset (mm)	Focal Value (mm)	Angle(s)	Start Elem	# of Elem	Angle or Element Increment	Ref. Gain (dB)	Cal Reflector Type and Depths					
	1	S-Scan	1	-30	20.0	43 <sup>0</sup> to 63 <sup>0</sup>	1	16	1 <sup>0</sup>	1.3	2.5mm SDH 1/4t to 1 3/4t				
	2	S-Scan	2	30	20.0	43 <sup>0</sup> to 63 <sup>0</sup>	1	16	1 <sup>0</sup>	2.3	2.5mm SDH 1/4t to 1 3/4t				
	3	TOFD	3 & 4	58	20.7	55 <sup>0</sup>	-	1	-	40.0	2.5mm SDH 1t				
	4	S-Scan	1	-19	11.5	52 <sup>0</sup> to 70 <sup>0</sup>	1	16	1 <sup>0</sup>	1.3	2.5mm SDH 1/4t to 1 3/4t				
	5	S-Scan	2	19	11.5	52 <sup>0</sup> to 70 <sup>0</sup>	1	16	1 <sup>0</sup>	2.2	2.5mm SDH 1/4t to 1 3/4t				
	6	TOFD	3 & 4	50	17.8	55 <sup>0</sup>	-	1	-	34.0	2.5mm SDH 1t				



Group 1 – Shell Welds Skew 90 PAUT



Group 2 – Shell Welds Skew 270 PAUT



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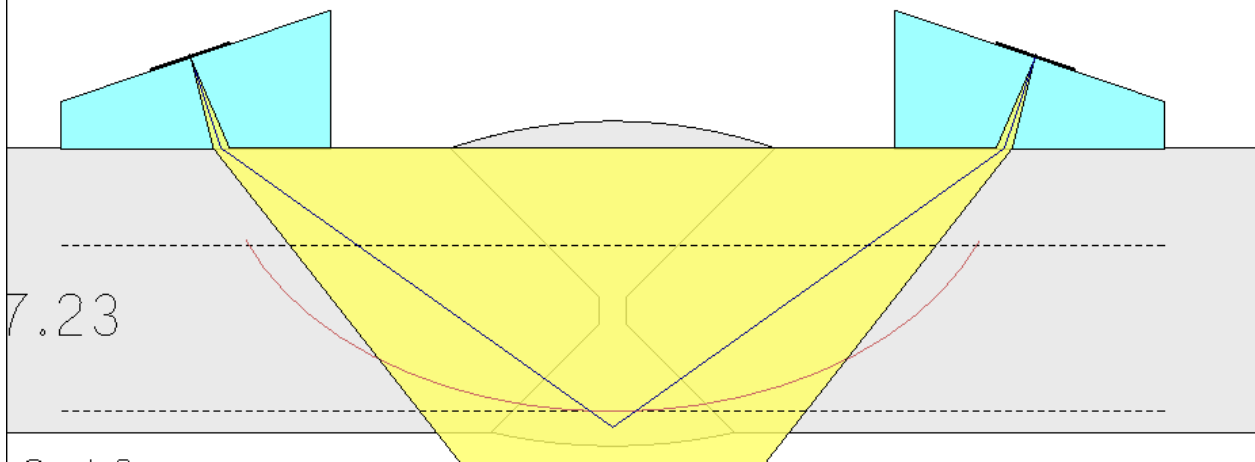
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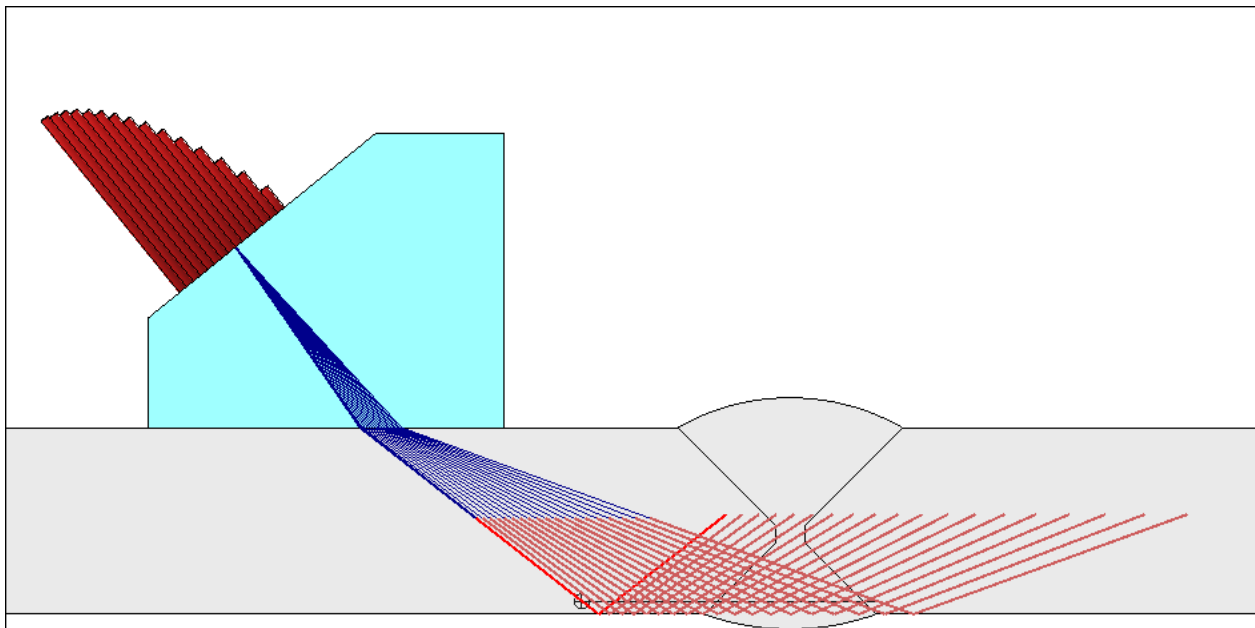
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Group 3 – Shell Welds TOFD



Group 4 – Head Welds Skew 90 PAUT

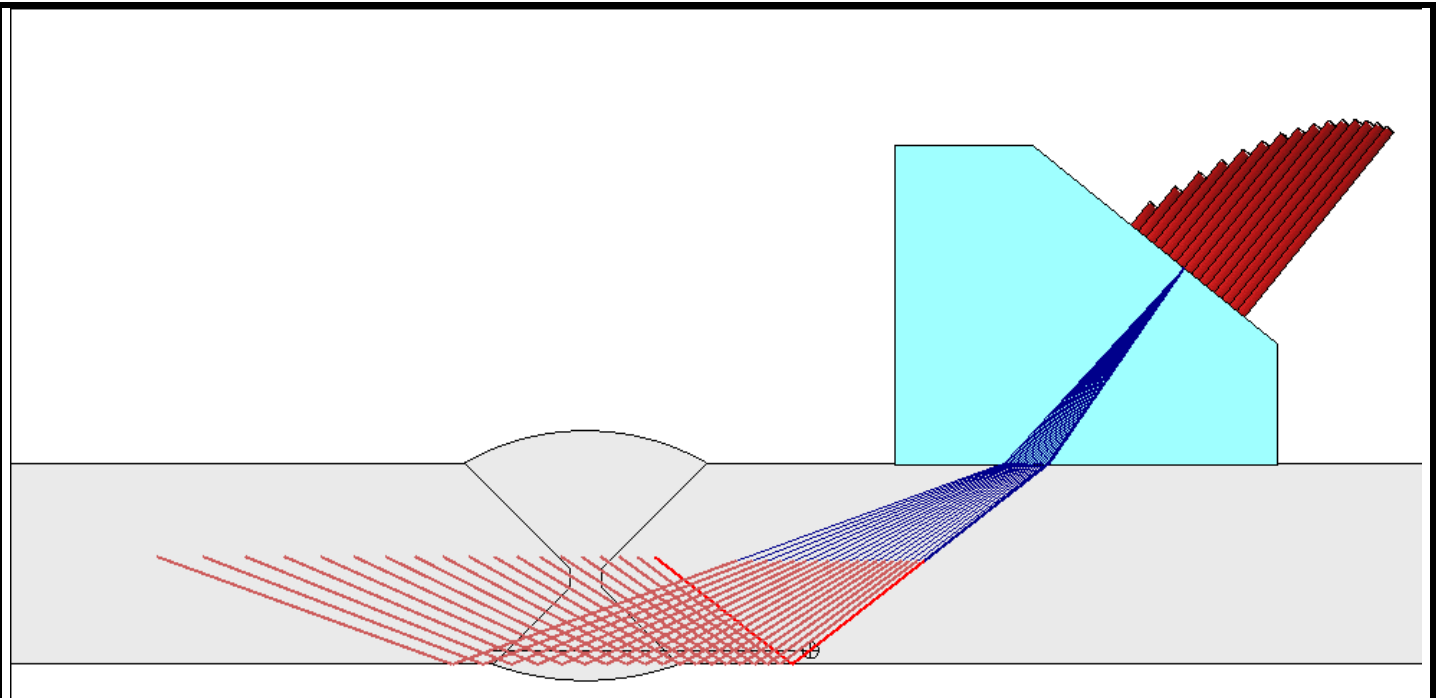
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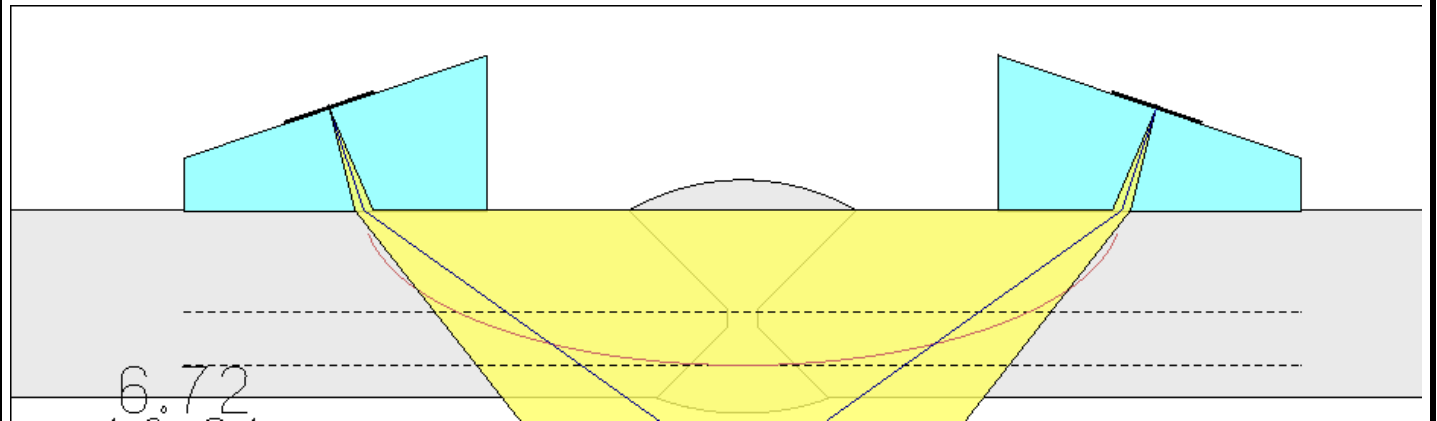
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Group 5 – Head Welds Skew 270 PAUT



Group 6 – Head Welds TOFD

**Report Sign Off and Acceptance**

Technician Sign Off		Job Billing Details		Client Acceptance	
Name:	Tibor Szabo	Hours:		Name:	Greg Guenette
Signature:		Km:		Signature:	
		Other:			
Certification:	CGSB 8221 UT Level III PCN310367 PAUT/TOFD Level II SNT-TC-1A UT Level III SNT-TC-1A TOFD Level II	Assist:		Title:	Asset Integrity

Results provided are based on an interpretation of data collected using an approved test method, not a guarantee.

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Scan No.	Scan Start (mm)	Scan Stop (mm)	Scan Distance (mm)	Single or Dual Sided	Group Nos.	Scan Type	Method
CS1_01	400	2630	2230	Dual	2, 4, 6	Semi-automated	PAUT TOFD
CS1_02	2630	5260	2630	Dual	2, 4, 6	Semi-automated	PAUT TOFD
CS1_03	5260	7890	2630	Dual	2, 4, 6	Semi-automated	PAUT TOFD
CS1_04	7890	10420	2530	Dual	2, 4, 6	Semi-automated	PAUT TOFD
CS2_01	0	2630	2630	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS2_02	2630	5260	2630	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS2_03	5260	7890	2630	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS2_04	7890	10420	2530	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS3_01	400	2630	2230	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS3_02	2630	5260	2630	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS3_03	5260	7890	2630	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS3_04	7890	10420	2530	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS4_01	400	2630	2230	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS4_02	2630	5260	2630	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS4_03	5260	7890	2630	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS4_04	7890	10420	2530	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS5_01	400	2630	2230	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS5_02	2630	5260	2630	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS5_03	5260	7890	2630	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS5_04	7890	10420	2530	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS6_01	400	2630	2230	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS6_02	2630	5260	2630	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS6_03	5260	7890	2630	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS6_04	7890	10420	2530	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS7_01	400	2630	2230	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS7_02	2630	5260	2630	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS7_03	5260	7890	2630	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS7_04	7890	10420	2530	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS8_01	400	2630	2230	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS8_02	2630	5260	2630	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS8_03	5260	7890	2630	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS8_04	7890	10420	2530	Dual	1, 2, 3	Semi-automated	PAUT TOFD
CS9_01	640	2630	1990	Dual	1, 5, 6	Semi-automated	PAUT TOFD
CS9_02	2630	5260	2630	Dual	1, 5, 6	Semi-automated	PAUT TOFD
CS9_03	5260	7890	2630	Dual	1, 5, 6	Semi-automated	PAUT TOFD
CS9_04	7890	10420	2530	Dual	1, 5, 6	Semi-automated	PAUT TOFD
LS1	0	2916	2916	Dual	1, 2, 3	Semi-automated	PAUT TOFD
LS2	0	2994	2994	Dual	1, 2, 3	Semi-automated	PAUT TOFD
LS3	0	2995	2995	Dual	1, 2, 3	Semi-automated	PAUT TOFD
LS4	0	2994	2994	Dual	1, 2, 3	Semi-automated	PAUT TOFD
LS5	0	2990	2990	Dual	1, 2, 3	Semi-automated	PAUT TOFD
LS6	0	2991	2991	Dual	1, 2, 3	Semi-automated	PAUT TOFD
LS7	0	2992	2992	Dual	1, 2, 3	Semi-automated	PAUT TOFD
LS8A	0	996	996	Dual	1, 2, 3	Semi-automated	PAUT TOFD
LS8B	1460	2994	1534	Dual	1, 2, 3	Semi-automated	PAUT TOFD

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Scan No.	Scan Start (mm)	Scan Stop (mm)	Scan Distance (mm)	Single or Dual Sided	Group No.	Scan Type	Method
WHCS_01	N/A	N/A	Full Length	Dual	4, 5	Manual	PAUT
WHLS_01	0	1635	1635	Dual	4, 5, 6	Semi-automated	PAUT TOFD
WHLS_02	0	1635	1635	Dual	4, 5, 6	Semi-automated	PAUT TOFD
WHLS_03	0	1635	1635	Dual	4, 5, 6	Semi-automated	PAUT TOFD
WHLS_04	0	1635	1635	Dual	4, 5, 6	Semi-automated	PAUT TOFD
WHLS_05	0	1635	1635	Dual	4, 5, 6	Semi-automated	PAUT TOFD
WHLS_06	0	1635	1635	Dual	4, 5, 6	Semi-automated	PAUT TOFD
EHCS_01	N/A	N/A	Full Length	Dual	4, 5	Manual	PAUT
EHLS_01	0	1645	1645	Dual	4, 5, 6	Semi-automated	PAUT TOFD
EHLS_02	0	1645	1645	Dual	4, 5, 6	Semi-automated	PAUT TOFD
EHLS_03	0	1645	1645	Dual	4, 5, 6	Semi-automated	PAUT TOFD
EHLS_04	0	1645	1645	Dual	4, 5, 6	Semi-automated	PAUT TOFD
EHLS_05	0	1645	1645	Dual	4, 5, 6	Semi-automated	PAUT TOFD
EHLS_06	0	1645	1645	Dual	4, 5, 6	Semi-automated	PAUT TOFD
Nozzle A	N/A	N/A	Full Length	Single	4	Manual	PAUT
Nozzle B	N/A	N/A	Full Length	Single	4	Manual	PAUT
Nozzle C	N/A	N/A	Full Length	Single	4	Manual	PAUT
Nozzle D	N/A	N/A	Full Length	Single	4	Manual	PAUT
Nozzle F	N/A	N/A	Full Length	Single	1	Manual	PAUT
Nozzle H	N/A	N/A	Full Length	Single	1	Manual	PAUT





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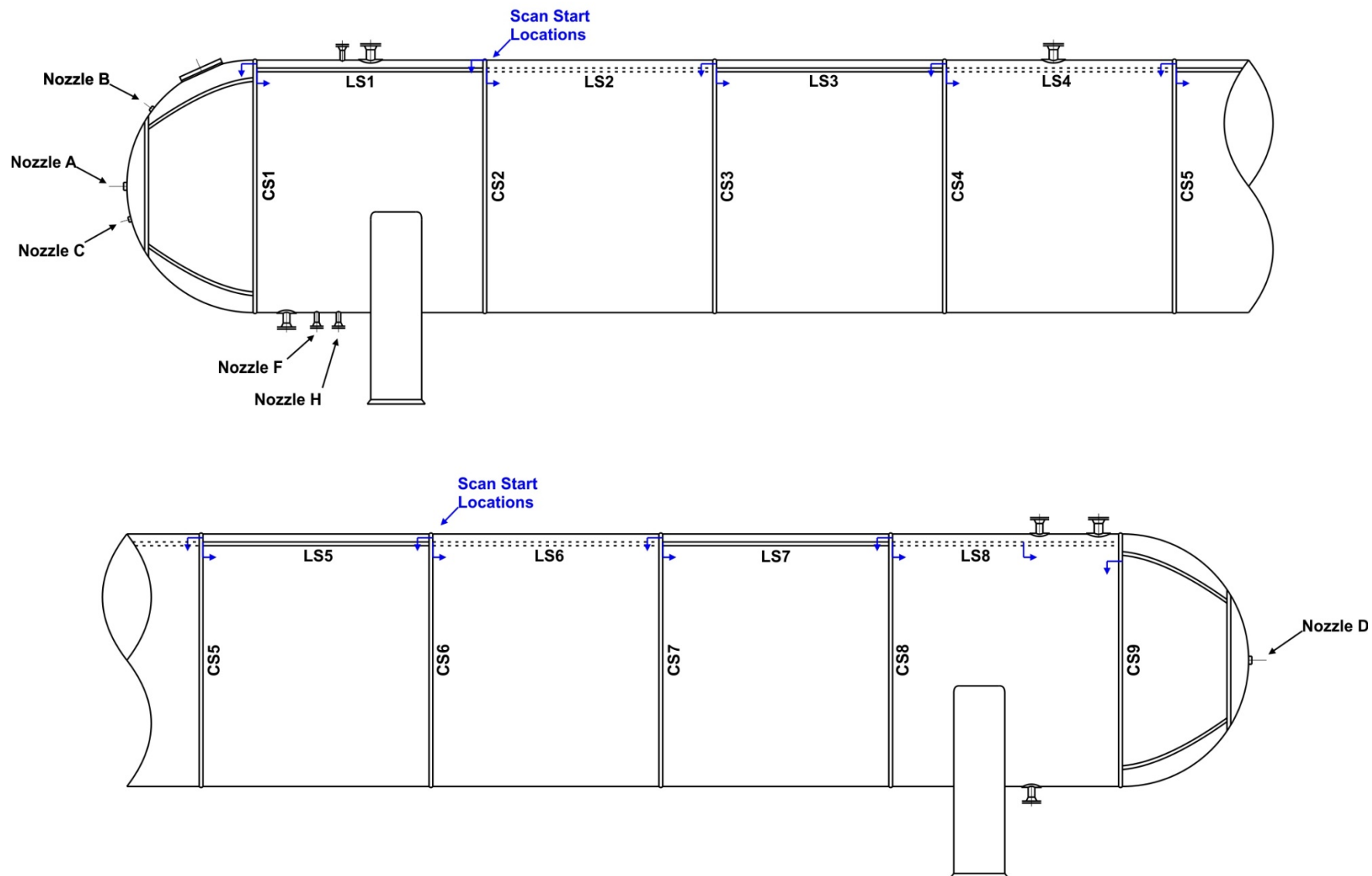
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East →



Shell Scan Map

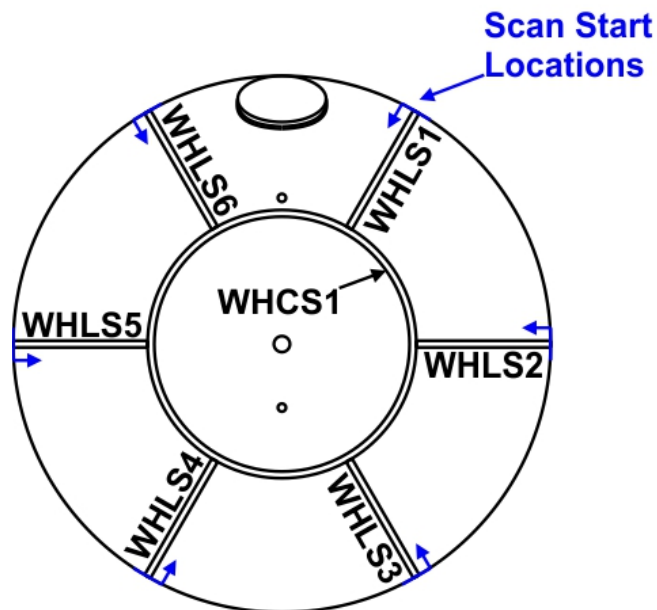
489A Sioux Road, Sherwood Park, AB T8A 4H2

Telephone: (587) 338 5008

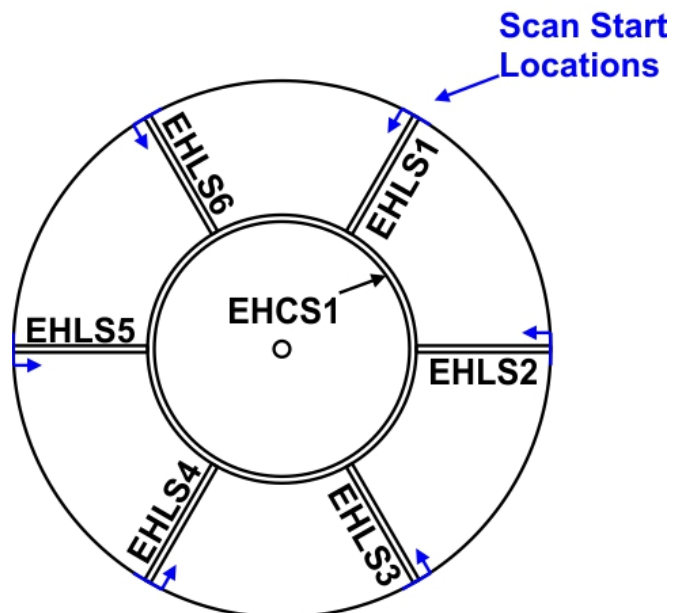




## West Head



## East Head



**Heads Scan Map**

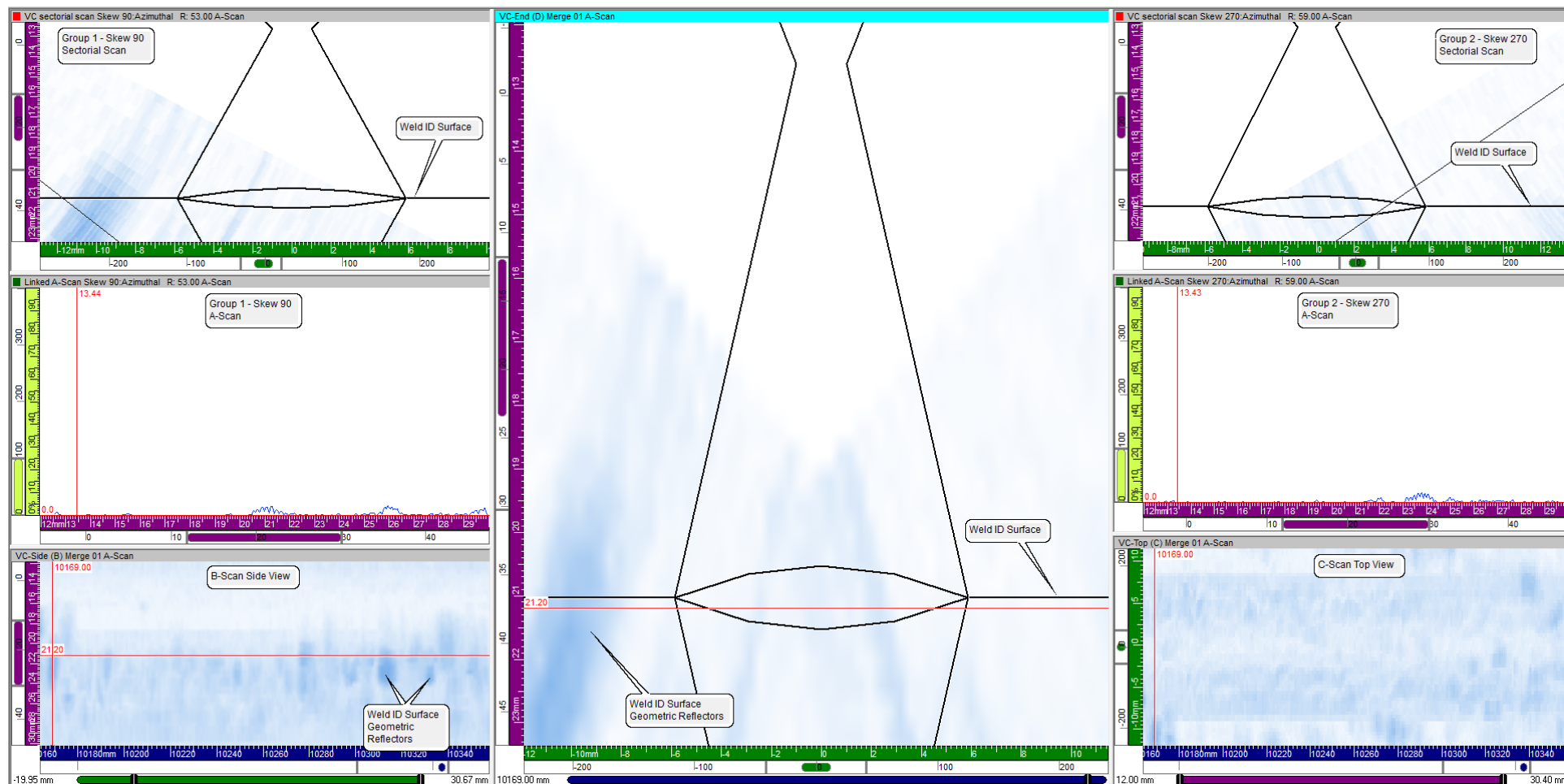


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Circ Seam 5 Scan 04 PAUT – Illustration of “Rolling ID” reflectors and absence of defects – image representative of all welds



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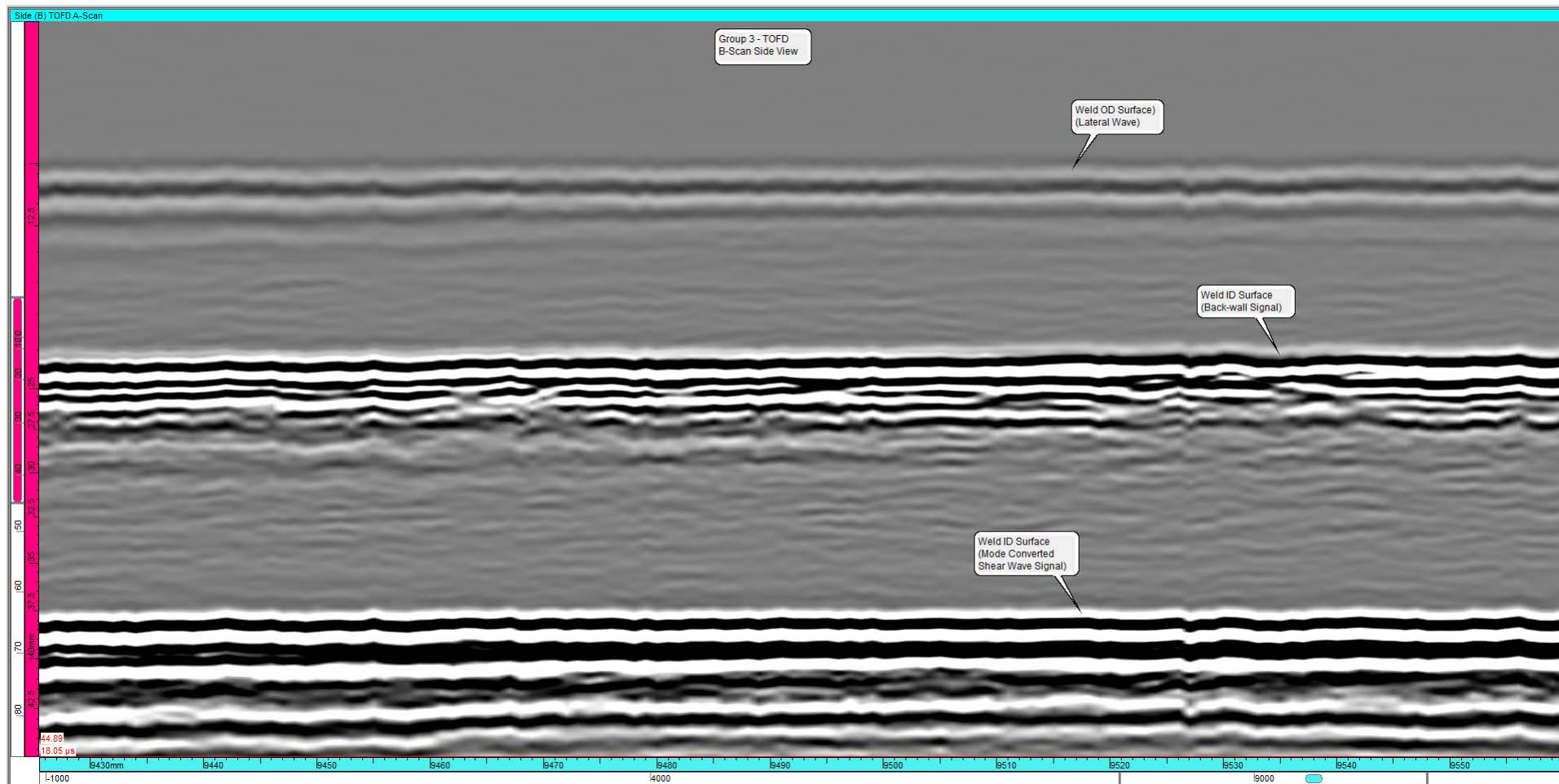
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**Circ Seam 5 Scan 04 TOFD – Illustration of absence of defects between OD and ID surface – image representative of all welds**