

# Risk Identification and Mitigation Strategies using ILI and ITD Inspection for Vintage ERW/EFW pipe

A photograph of an industrial facility at night, viewed from an elevated position. The facility includes several large buildings, some with bright lights, and a fenced-in area. In the foreground, there is a field of tall, dry grasses and wildflowers. The background shows a dark landscape with some distant lights.

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**Asset Integrity**  
**The Williams Companies**  
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## NATURAL GAS TRANSMISSION: Crack Management Pipe Body and SEAMS

Williams West : first ILI tool run in 1994. Had to install Launchers & Receivers + change out every Valve on older Pipelines. A bit of a "Safety Culture" step change was required to overcome the "how much is this going to COST" viewpoint.

To-Date: 35 separate ILI Runs (Primarily CMFL; USCD & EMAT sparingly for Problem Children) since 2001 with First USCD run. CMFL began in 2006. 1.5 D Bend tools needed. WA, OR, ID, CO, VA. EMAT + CMFL showing very encouraging results in seams.

Rough Tally:  $\pm$ 1300 miles of ILI, 400 Excavations, 85 Composite Repairs, 46 Type A – mostly Petrosleeve Compressive Sleeves, 93 Cutouts.

Burst testing backs up fact that a majority of these indications are RESIDENT NON-Injurious over Long Term

## NATURAL GAS TRANSMISSION

Crack Program built on choosing the right tool(s), understanding the fatigue related threat, confirming ILI calls with detailed NDT ITD, burst testing and/or hydrostatic testing where needed to confirm results on Higher Relative Risk lines.

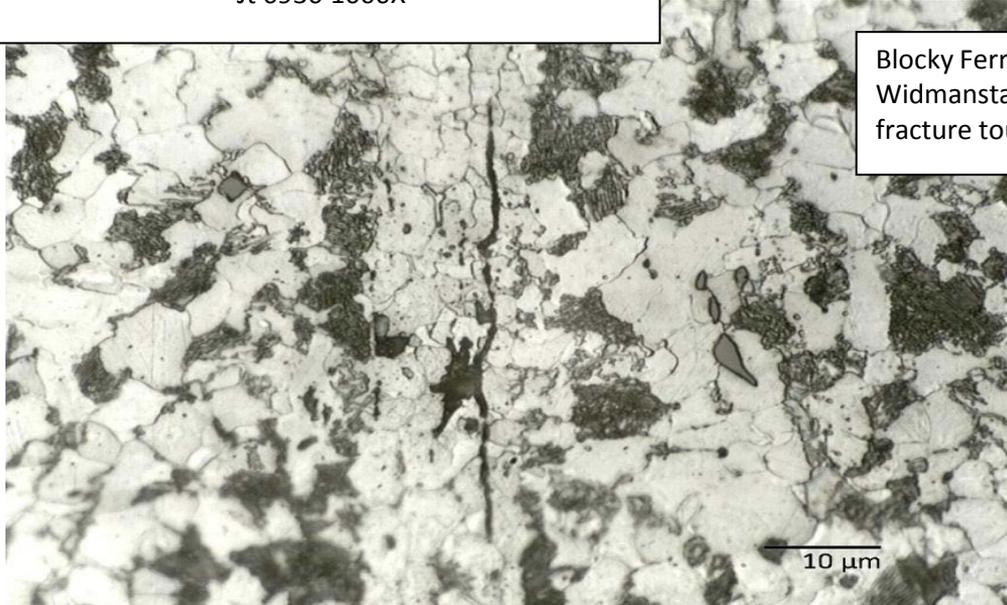
Based on Consequence and Likelihood of Risk:

22 Miles of Vintage 16 inch ERW has been replaced in Spokane, WA and Oregon City, OR. 5 to 8 year process, yet safely managed. Large amount of 26 inch DSAW capacity was replaced in 2006 in WA.

PHMSA - Western Region & WUTC have worked closely with Williams and our ILI Providers (Analysts ITD with us) since 1994 to prove up these ILI technologies to reduce the risk of operating Vintage Pipelines.

### Lack of Fusion in Weld Seam

Jt 6930 1000X



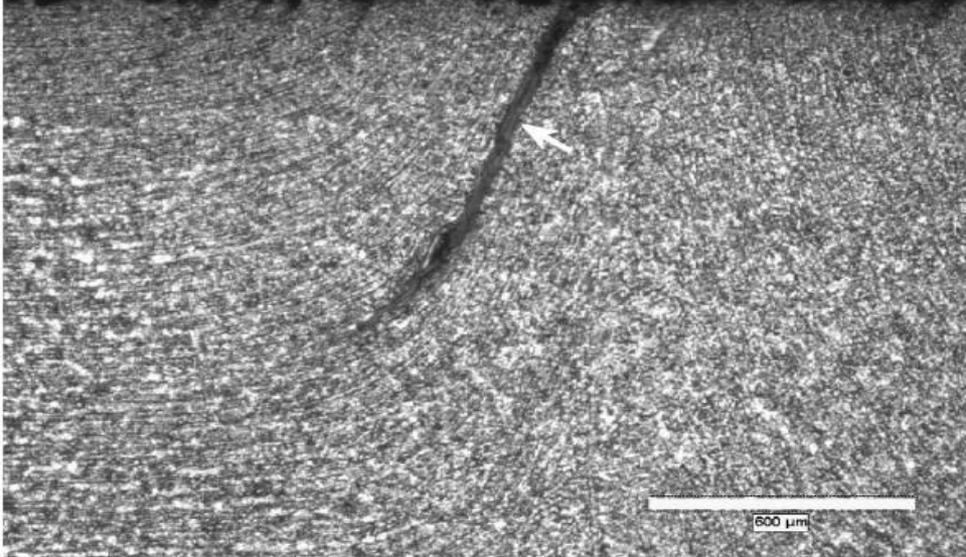
Blocky Ferrite observed rather than more brittle acicular or Widmanstatten Ferrite, which, in part, accounts for higher fracture toughness and higher burst test pressures.



**Jt 1300: 95% of the wall BUT not so Cold of a Weld. Burst Test @ 1360 psig! 84% Psmys**

Cannot call these "COLD" WELDS

**Burst 1889 psig, 116% 15% depth**

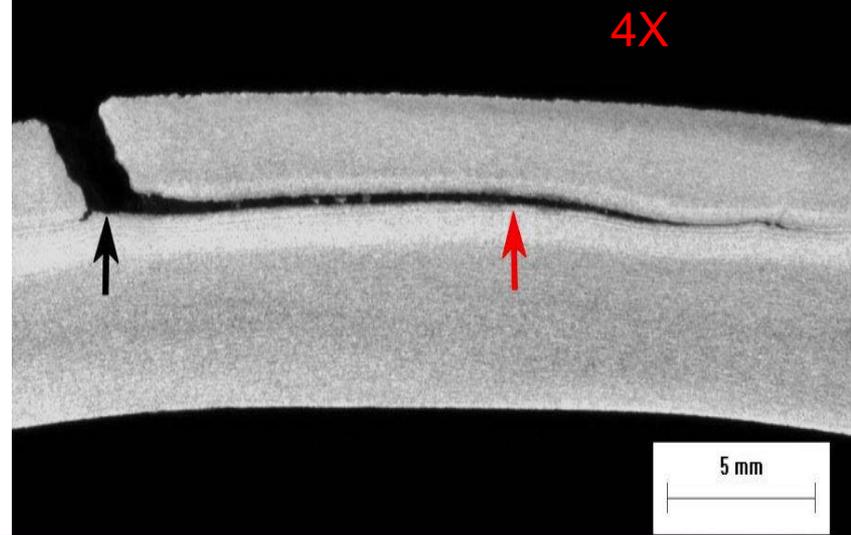


**Non Injurious Hook Crack**

60X  
Nital Etch

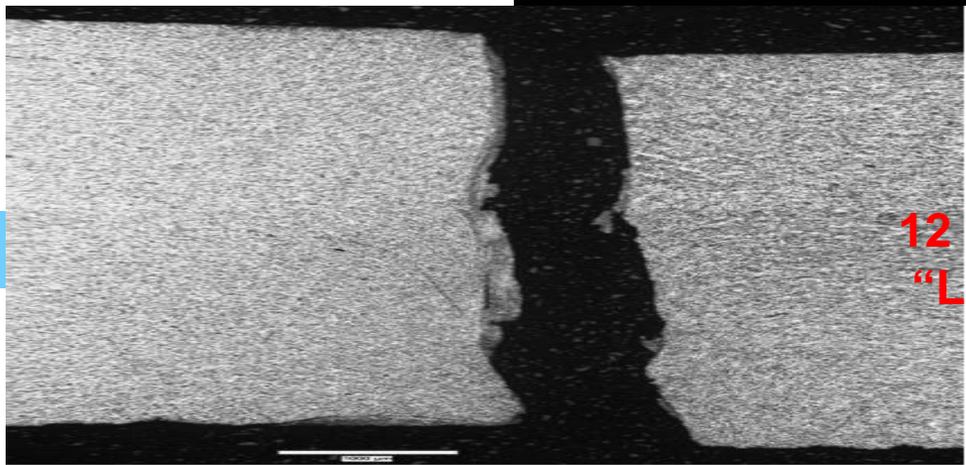
Figure 15

Photomicrograph of a cross section of a hook crack, arrow, at the outside surface adjacent to the ERW fusion line.



**Cross section of a longitudinal crack, black arrow, and lamination, red arrow**

**Weak Bond Line?**



**Burst 1754 psig, 108%**

**12 % depth  
"Lukewarm" Weld**

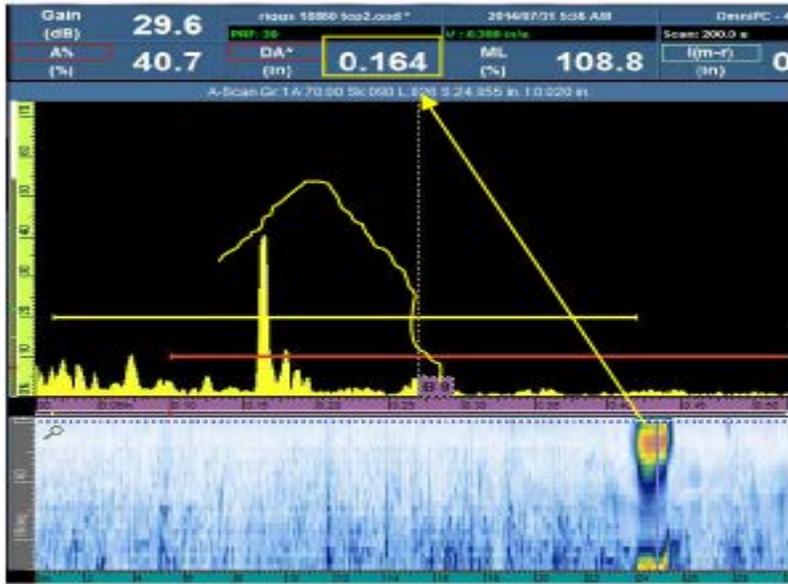
Pipe No. 1  
15X  
Nital Etch  
surface showing a weakly

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## 16" Burst Testing

Test Year	J.T. #	Feature Description	SMYS #	SMYS Failure	Actual Failure	Tool Depth	Actual Depth	Tool Length	Actual Length	Picture Link	Notes: (1) P Burst is calculated using R Streng Effective Area Method. (2) Bucket C is not a dig classification, just a quick way of saying other non detrimental defects.
2006 Leak Area	1890	Largest SCC area found and small ERW indications.	1625#	100%	1625#	N/A	15%	N/A	Continuous	<a href="#">See Photo</a>	ERW failure, caused by 0.020" ID LOF and 0.025" OD LOF
2006 Leak Area	1900	ERW indications	1625#	108%	1754#	N/A	12%	N/A	Continuous	<a href="#">See Photo</a>	ERW failure, caused by 0.010" ID LOF and 0.020" OD LOF
2006 Leak Area	1920	ERW indications	1625#	107%	1738#	N/A	15%	N/A	Continuous	<a href="#">See Photo</a>	ERW failure, caused by 0.020" ID LOF and intermittent -0.020" OD LOF
2006 Leak Area	1930	ERW indications	1625#	99%	1617#	N/A	20%	N/A	Continuous	<a href="#">See Photo</a>	ERW failure, caused by 0.040" ID LOF and 0.030" OD LOF
2006 Anomalies	2240	SCC and ERW indications	1625#	116%	1889#	N/A	12%	N/A	Continuous	<a href="#">See Photo</a>	ERW failure, caused by both OD and ID LOF, each 0.020"
2006 Anomalies	2250	SCC and ERW indications	1625#	100%	1629#	N/A	20%	N/A	Continuous	<a href="#">See Photo</a>	ERW failure, caused by both OD and ID LOF, each 0.025"
2006 Anomalies	3100	ERW indications, various depths	1625#	95%	1537#	N/A	65%	N/A	2"	<a href="#">See Photo</a>	ERW failure, caused by OD LOF "shark teeth" pattern with variable depth, at failure point depth was 0.165". Also continuous ID LOF of 0.015".
2008 Anomalies	1300	ERW Indications, AFD Anomaly B	1625#	84%	1360#	28%	95%	1.81"	1.75"	<a href="#">See Photo</a>	ERW failure. Defect appearance much larger than tool call (0.235"). If appearance was actual size, Pburst should have been closer to 1100#.
2008 Anomalies	1850	Ripples in bend, Geometry Dent	1625#	117%	1916#	2%	3%	NA	NA	<a href="#">See Photo</a>	Pipe test completed to help build database on ripples in bends. Failure occurred in ERW that showed no indications. Result showed ripples had no effect on yield strength.
2008 Anomalies	2860	SCC - EMAT Group 4	1625#	122%	1985#	N/A	N/A	NA	NA	<a href="#">See Photo</a>	Pipe test completed to test current SCC threat. ERW still proves to be the weakest link, even with no ERW indications.
2008 Anomalies	3910	ERW indications, AFD Anomaly A	1625#	100%	1640#	32%	55%	2.48"	3.0"	<a href="#">See Photo</a>	ERW failure. Defect appears larger than tool call.
2008 Anomalies	4550	ERW indications, AFD Anomaly A	1625#	128%	2086#	26%	7%	2.01"	2" Grind Out	<a href="#">See Photo</a>	Actual Pipe Thickness was 0.270" increasing yield. Tool call was determined to be a grind mark along seam, not a crack. ERW did have a 7% LOF on ID at failure point.
2009 Anomalies	400	ERW Indications, AFD Seam Weld Anomaly (Bucket "C")	1625#	>123%	>2000	N/A	N/A	N/A	N/A		Failed to Burst. Phased Array called ERW defects at 0.040" to 0.070".
2009 Anomalies	420	AFD Manufacturing Anomaly Multiple calls (Bucket "C")	1625#	123%	1998#	16%	24%	-3"	-4"	<a href="#">See Photo</a>	Gap or mismatch along the ERW created ILI tool calls of multiple manufacturing Anomalies. Failure didn't occur directly in line with mismatch location. Not crack like, 0.060" Gap.
2009 Anomalies	430	ERW Indications, AFD Seam Weld Anomaly (Bucket "C")	1625#	106%	1727#	N/A	N/A	N/A	N/A	<a href="#">See Photo</a>	Failure did not occur at seam weld anomaly. ERW had a continuous LOF of about 0.035" on the outside with an 0.025" LOF on the inside. Possibly connected at an angle?
2009 Anomalies	1820	ERW Indications, AFD Anomaly B	1625#	98%	1590#	24%	70%	1.89"	2.0"	<a href="#">See Photo</a>	LOF developed from the ID, unusual defect. Pburst predicted to be 1606# based on visual ERW indications, actual yield very similar. Burst entire seam length.
2009 Anomalies	6770	ERW Indications, AFD Manufacturing Anomaly (Bucket "C")	1625#	112%	1826#	16%	8%	3.58"	5"	<a href="#">See Photo</a>	Manufacturing Anomaly was slight scalp, although failure occurred at other ERW defect. ERW indication at the failure point was -3/16" wide by 0.040" deep on the OD combined with a continuous defect of 0.015" along the ID.
2009 Anomalies	6780	ERW Indications, AFD Anomaly B	1625#	113%	1837#	22%	20%	1.6"	1.5"	<a href="#">See Photo</a>	A metal loss defect was found on the ID of the pipe, not crack like. Yield occurred at a ERW LOF location that was 0.060" deep by 3/8" long, not at the tool call location.
2009 Anomalies	6800	ERW Indications, AFD "Clean Pipe	1625#	>102%	>1652	N/A	N/A	N/A	N/A		Test Joint was 6800, connected to 6' pup of 6810. 6810 failed before 6800. ERW LOF indications were sized to 0.060" to 0.075", not confirmed.
2009 Anomalies	6810	ERW Indications, AFD "Clean Pipe	1625#	102%	1652#	N/A	N/A	N/A	N/A	<a href="#">See Photo</a>	6810 was a pup that was explored for tie in locations. Max grind out was 0.060" at failure, LOF still remained. Hold down was attached near defect area, likely increasing burst (didn't expect failure on this pup).
2009 Anomalies	7640	ERW Indications, AFD Anomaly B	1625#	120%	1958#	34%	85%	0.67"	0.6"	<a href="#">See Photo</a>	Physical appearance of LOF indicates a depth of 85%. P Burst would have been predicted at 1890#, which is close to actual testing.
2009 Anomalies	7650	ERW Indications, AFD Seam Weld Anomaly (Bucket "C")	1625#	113%	1842#	N/A	N/A	N/A	N/A	<a href="#">See Photo</a>	"Bucket C" defect appears to have no impact on pipe yield. ERW LOF Stitching was found along the ID with a depth of about 0.020" and 0.055" by 1/8" Wide on the OD at the failure point.
2009 Anomalies	7660	ERW Indications, AFD "Clean Pipe	1625#	118%	1920#	N/A	N/A	N/A	N/A	<a href="#">See Photo</a>	ERW LOF Indications sized at 0.040" to 0.060" were found. Very short intermittent indications, usually less than 1/8".
2009 Anomalies	7670	ERW Indications, Multiple AFD Seam Weld Anomaly (Bucket "C")	1625#	118%	1922#	10%	3%	11"	10"	<a href="#">See Photo</a>	AFD Calls appeared to be slight metal loss, scrapes. ERW Failed at 1/4" wide LOF that was 0.100" deep.

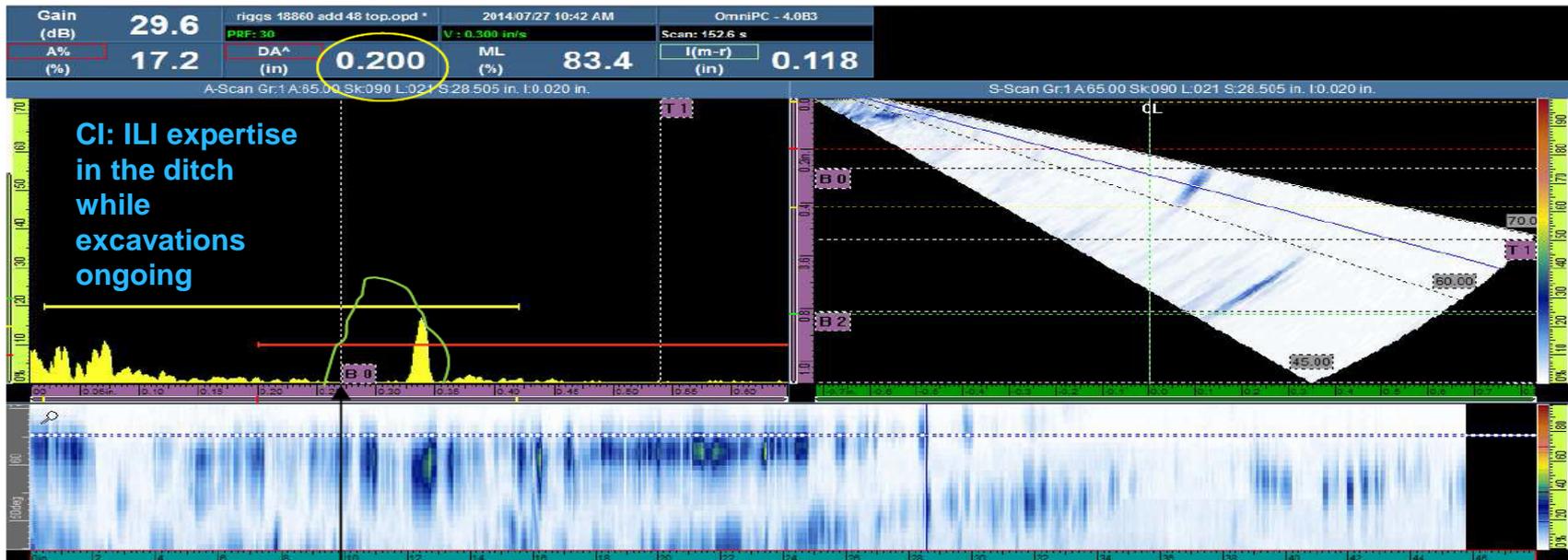


ID connected feature depth 0.164"



OD & ID connected features

Using Two Primary NDT experts with PAUT experience on our pipeline: Coast-to-Coast & Integrity Specialists



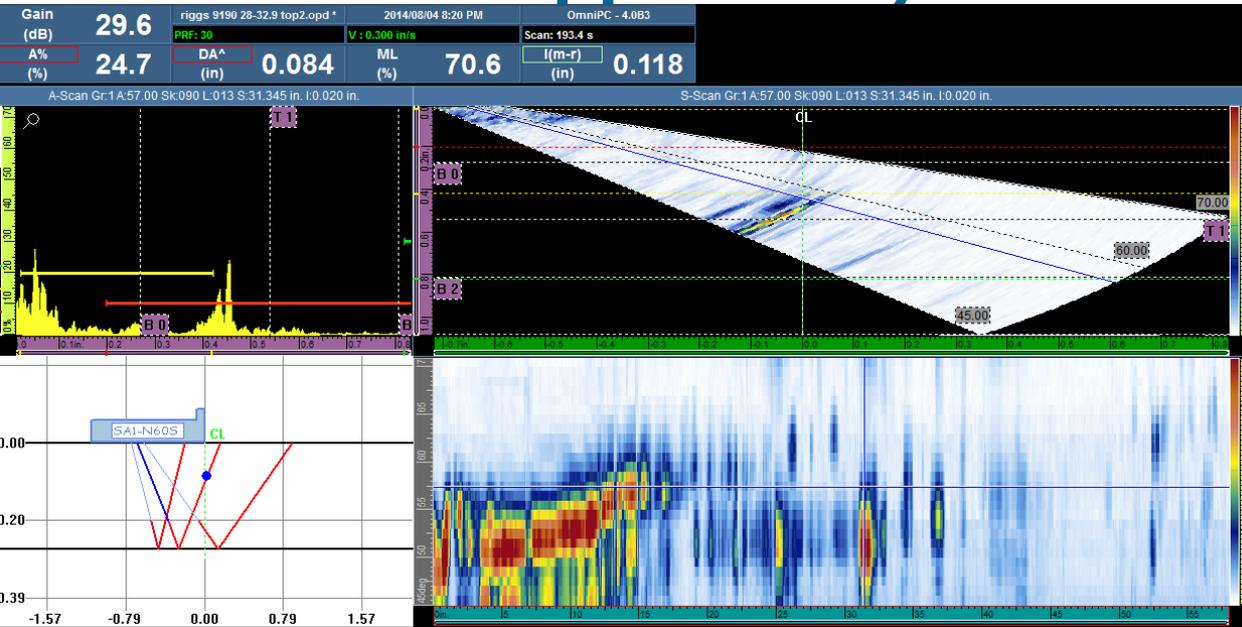
ID connected flaw, 0.200" from OD surface or 0.069" deep.

Time to scan seam improving with Encoder Module allowing saving of scan not just screenshots.

# What We Might Need to Move Forward

- ❑ Continued LONG TERM funding for our Joint PRCI – PHMSA ILI Pull Thru Facility, with Direct Linkage to our TDC
- ❑ Obtain more Hook Crack, Cold or Warm Weld, LOF, Lamination, Inclusions, trim, offset, etc samples of Common Vintage Long Seam Indications
- ❑ Combine these two “NEEDS” above to obtain info on POD and POI for various ILI Technologies with Repeated Pull Thru’s
- ❑ Characterized and Documented TDC provided samples used to “proof test”/ Op Qual our ITD NDE personnel
- ❑ COORDINATION AND COOPERATION as we move along into PHASE TWO of the ongoing ERW Study

# MANY THANKS for the Opportunity to Share Our Results



Cracking deviating from an axial plane

