Crack Management – Pipeline Operator Perspectives

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On Behalf Of
Interstate Natural Gas Association of America
For:
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Chicago, IL

Guiding Principles of Pipeline Safety

- **Our goal is zero incidents** - a perfect record of safety and reliability for the national pipeline system. *We will work every day toward this goal.*
- **We are committed to safety culture** as a critical dimension to continuously improve our industry's performance.
- **We will be relentless in our pursuit of improving** by learning from the past and anticipating the future.
- **We are committed to applying integrity management principles on a system-wide basis.**
- **We will engage our stakeholders** - from the local community to the national level - so they understand and can participate in reducing risk.

Presentation Content

1. Nomenclature – Manage Those Defects Injurious to Integrity
2. Detection (Identification and Characterization)
3. Long-Term Management
   - Hydrostatic testing
   - DA
   - ILI
4. Prevention
5. Fatigue
6. Summary

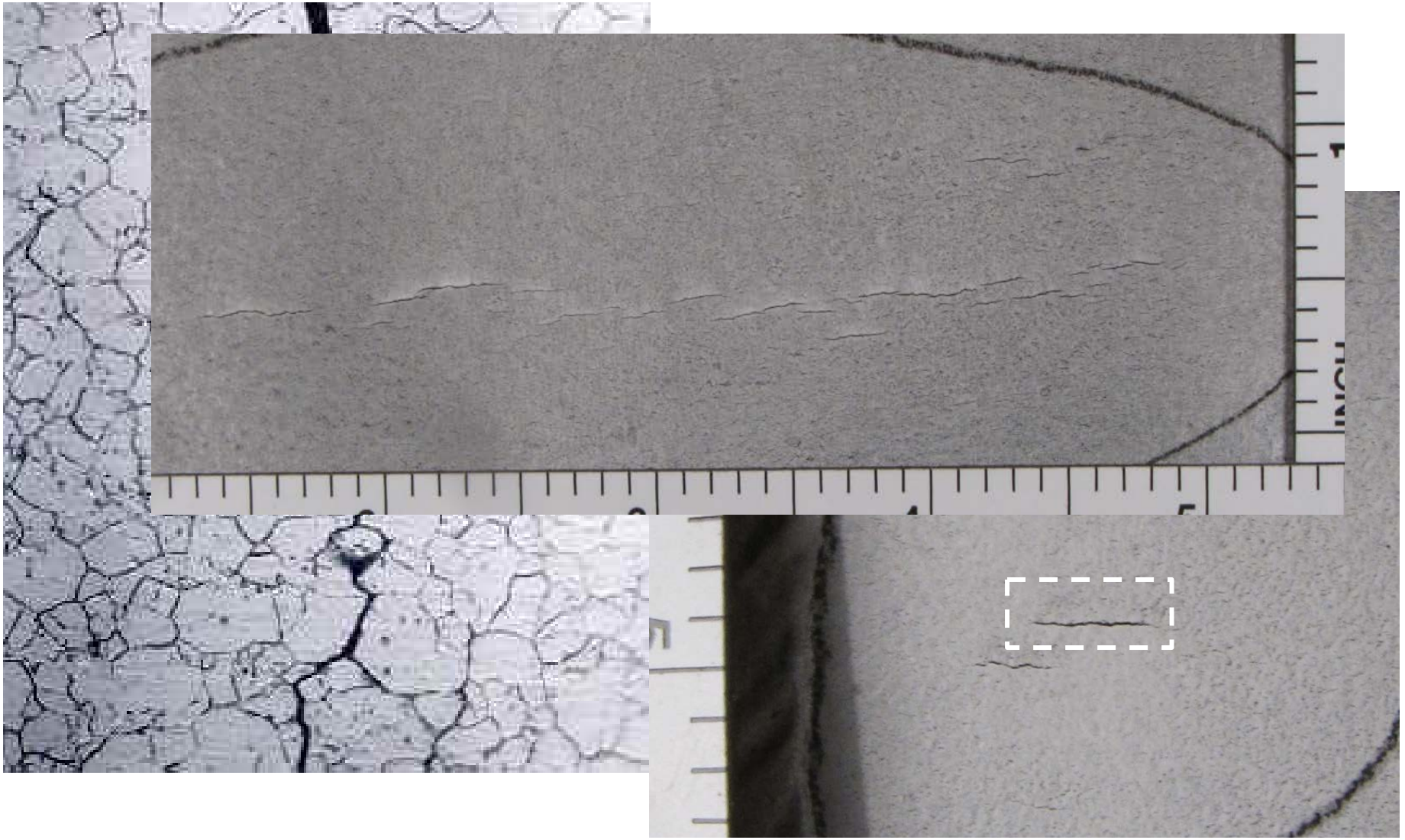
Nomenclature

1. Nomenclature EC, EAC's and Resident Features
   - Resident features
   - Environmentally-assisted cracking (EAC), including SCC
   - Grooving or slotting corrosion

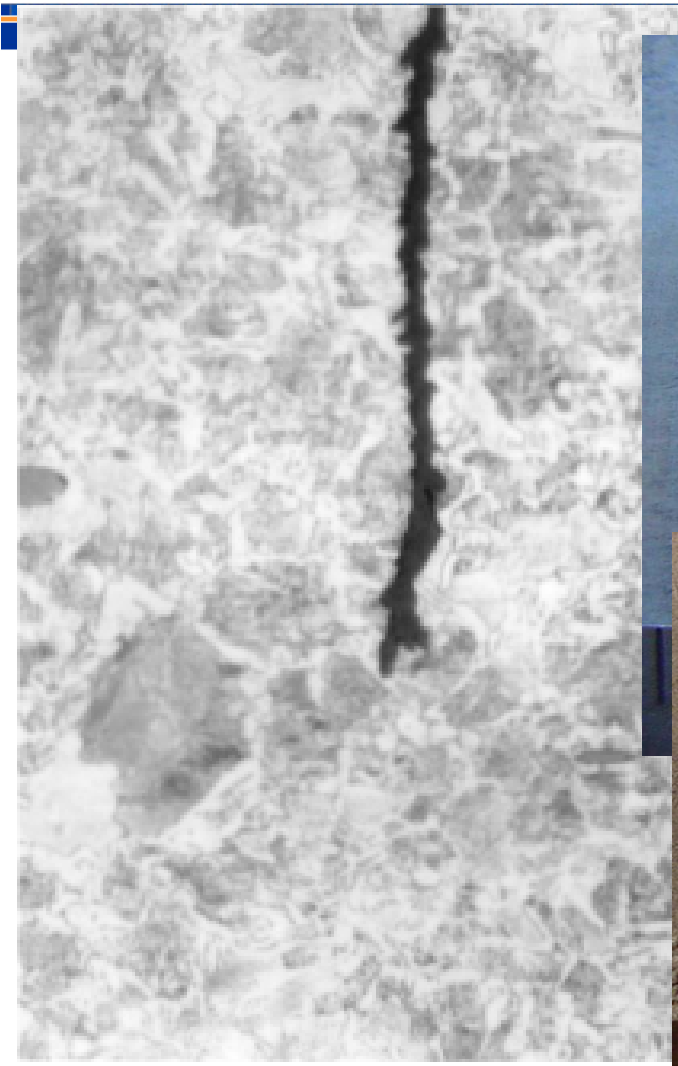
EAC's – Onshore Pipelines

- SCC (is the most common)
- Corrosion Fatigue

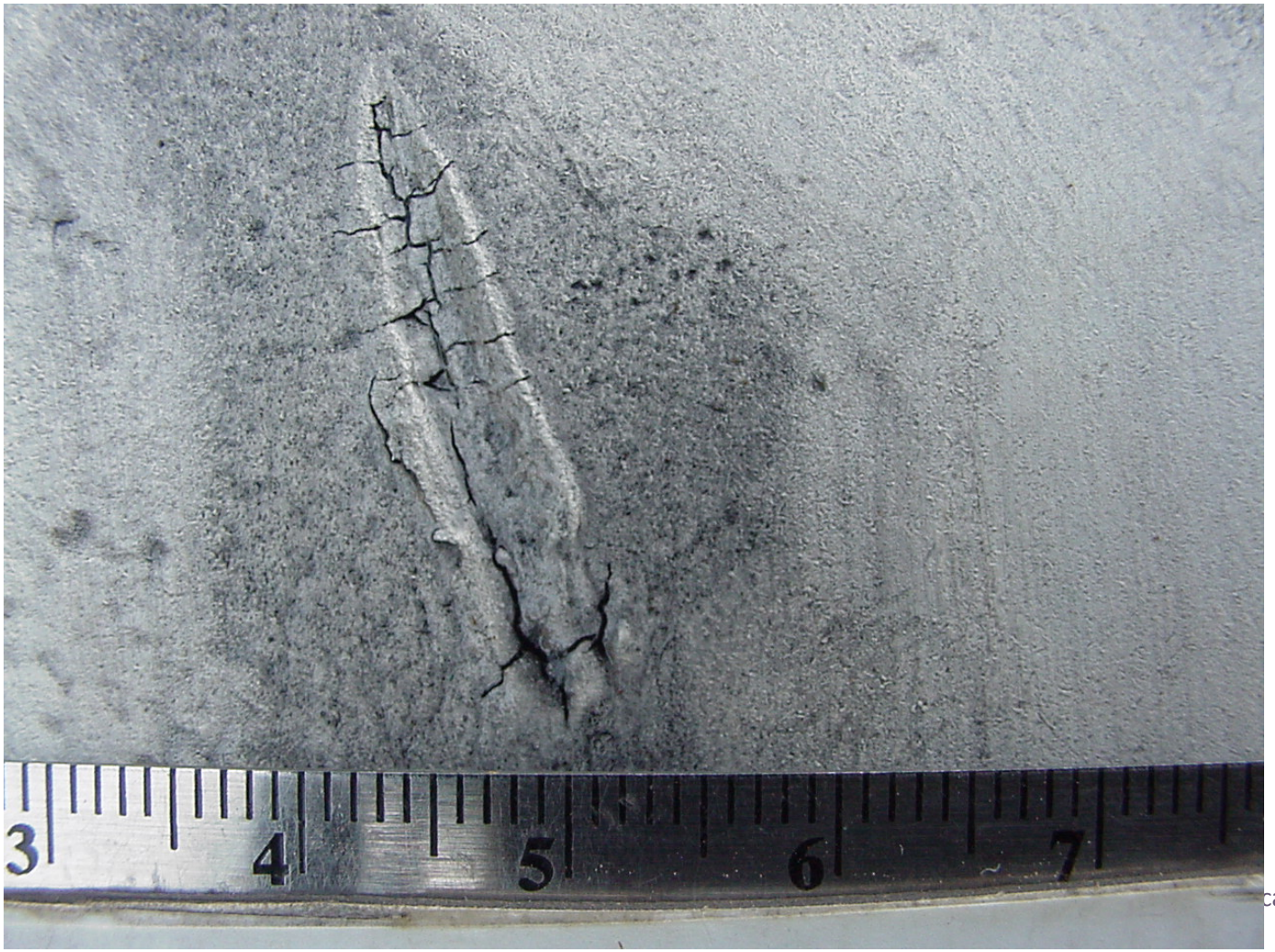
High pH



Low pH



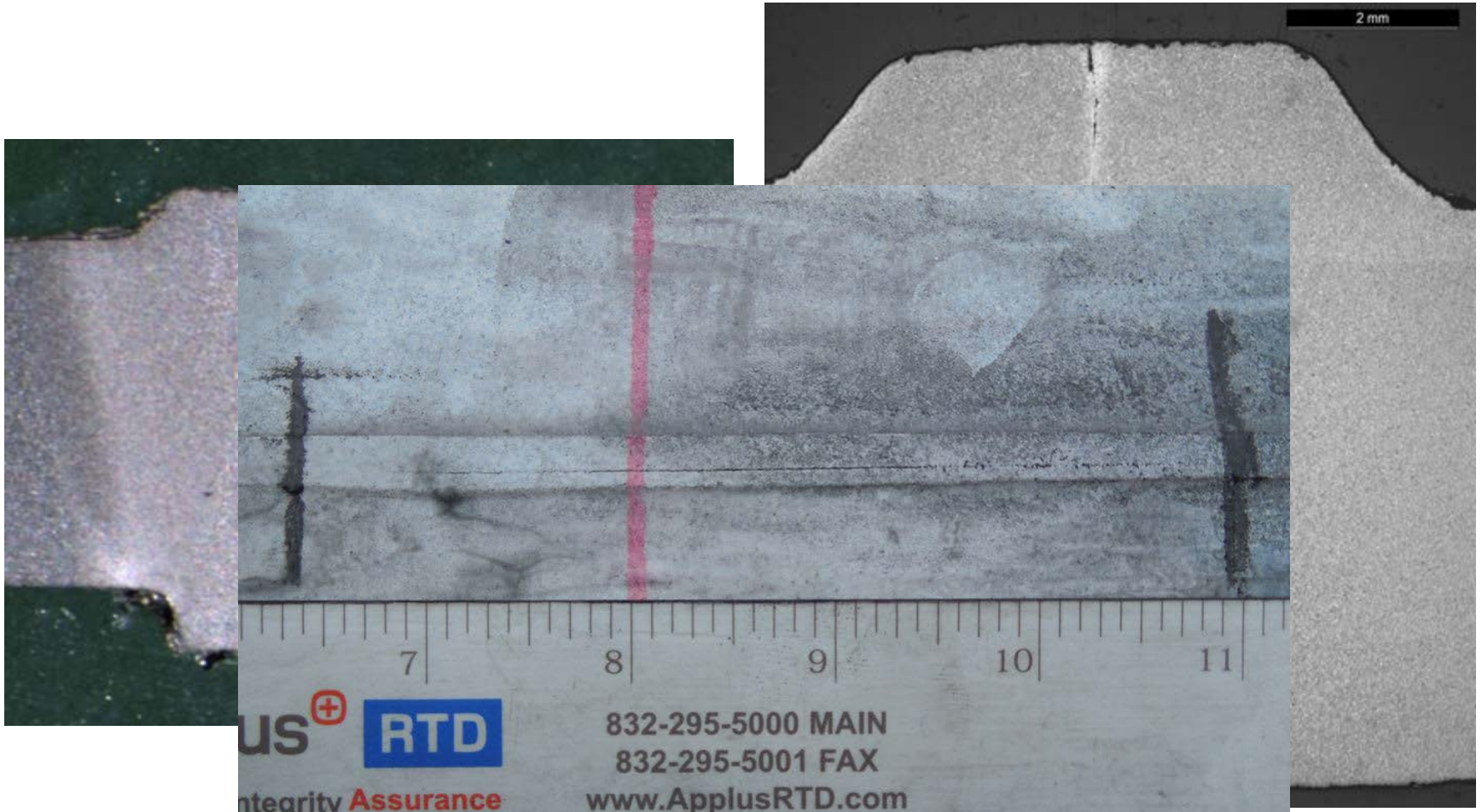
Hydrogen Related Cracking



Resident Threats

- "Resident" from the manufacturing of the pipe
  - Focus on injurious defects
  - Monitor operations and environment to detect growth
- Often associated with the "welded" longitudinal seam
  - Lack of Fusion
  - Hook cracks
- Fabrication of non injurious indications during plate manufacture
  - Contact marks
  - Trimming Edge
  - Offset Plate/Skelp Edges
  - Surface Breaking Laminations

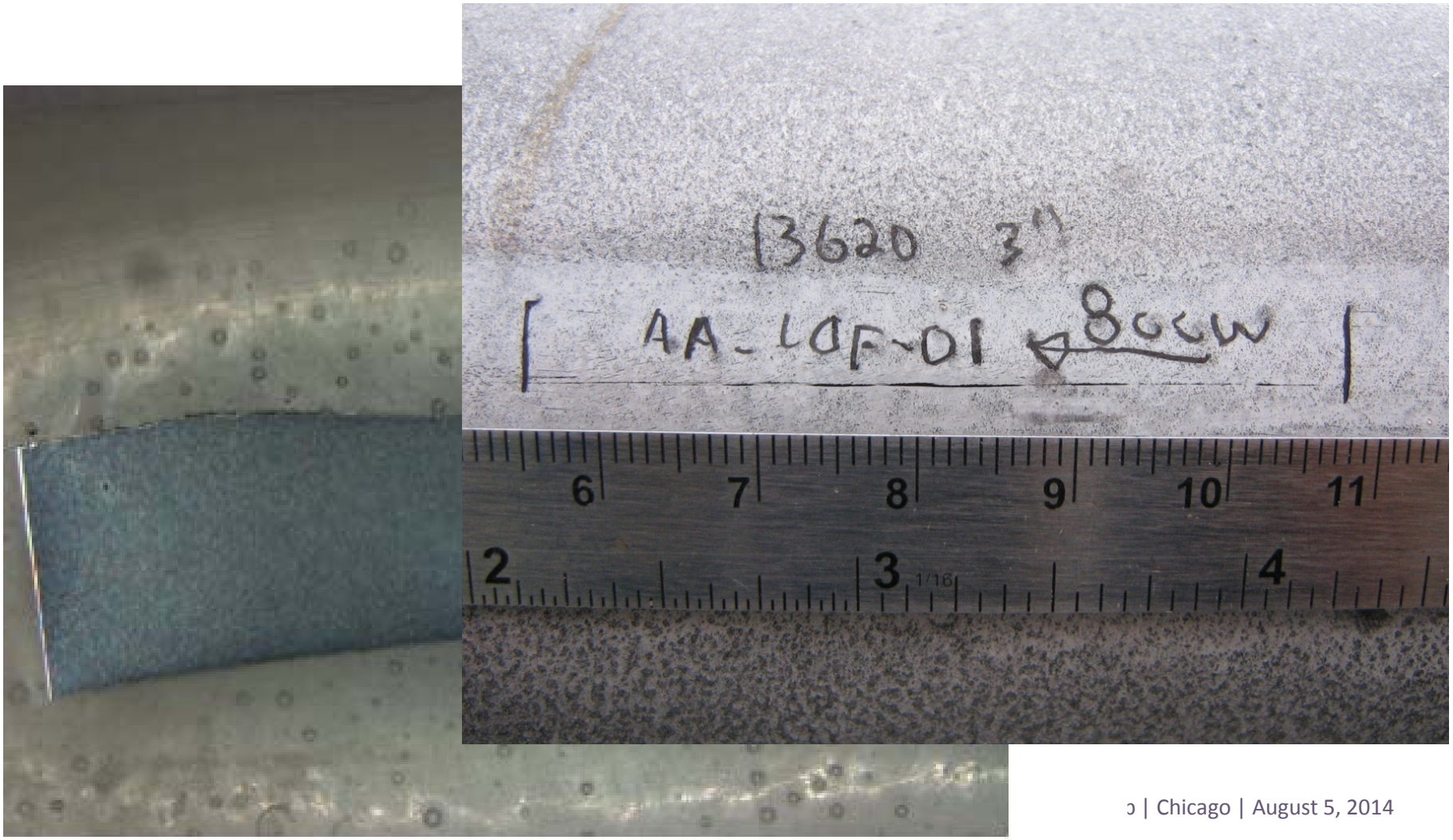
Resident Features - EFW Longseam



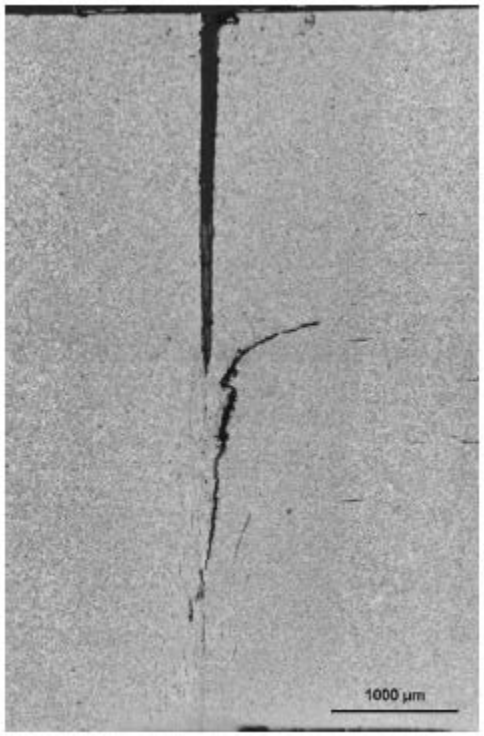
Resident Features– EFW Longseam

- Cross section weld polished specimen showing J anomaly or hook crack curving parallel to the surface

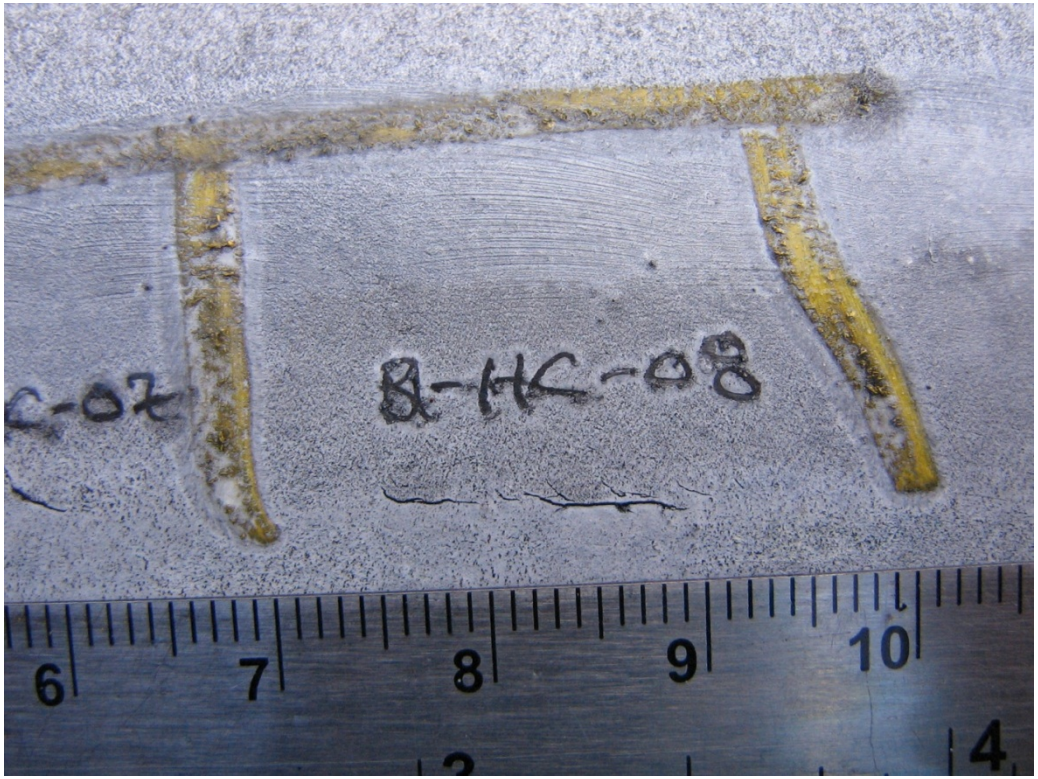
Resident Features - ERW - LoF



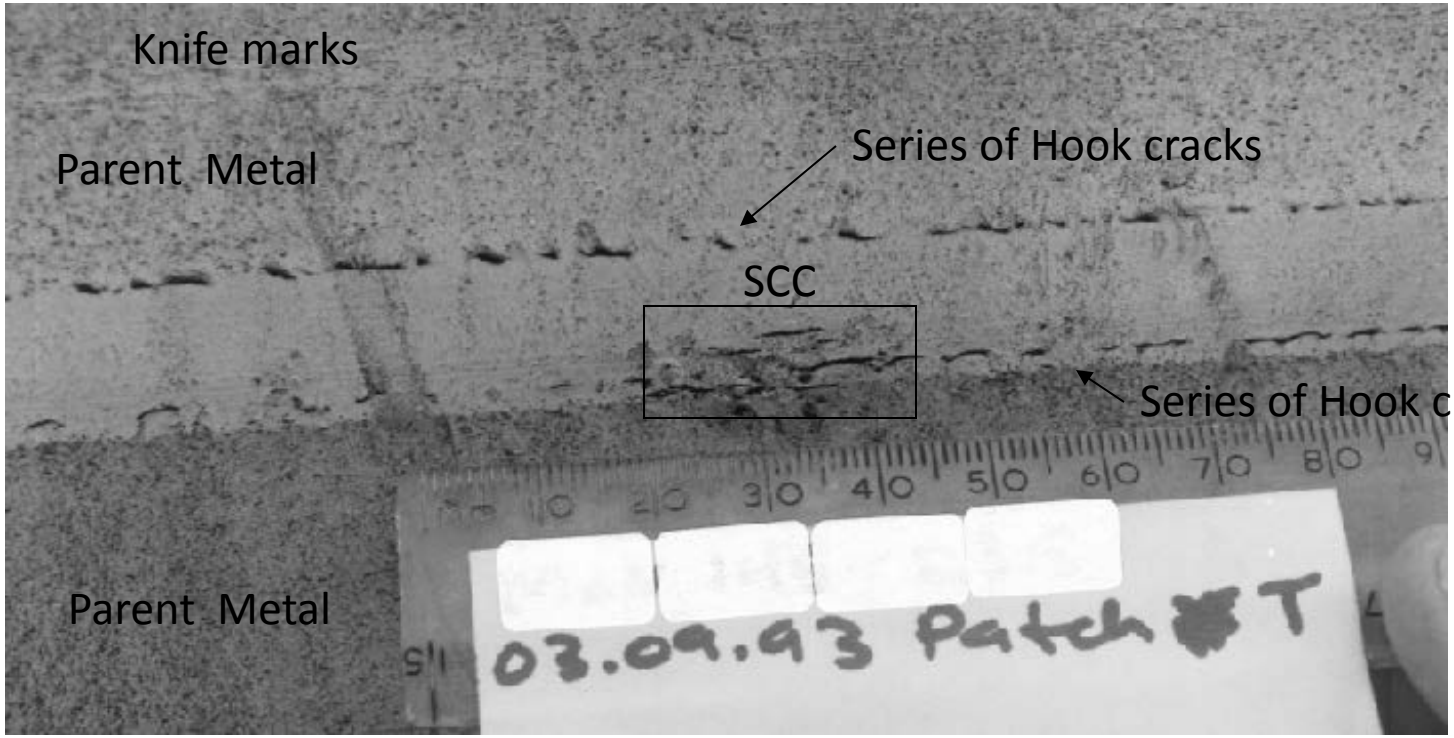
Resident Features – ERW Hook Cracks



From Dr. J. Beavers DNVGL



Resident and EAC – Hook Cracks and Short, Shallow SCC



WELD

There is no lack of fusion here

Resident - Manufacturing

External Corrosion

- Grooving or slotting corrosion
- Can occur in the longseam or body

2. Detection

Predominant EAC is stress corrosion cracking

Susceptibility

- INGAA members use ASME B31.8S criteria for high pH and near neutral SCC

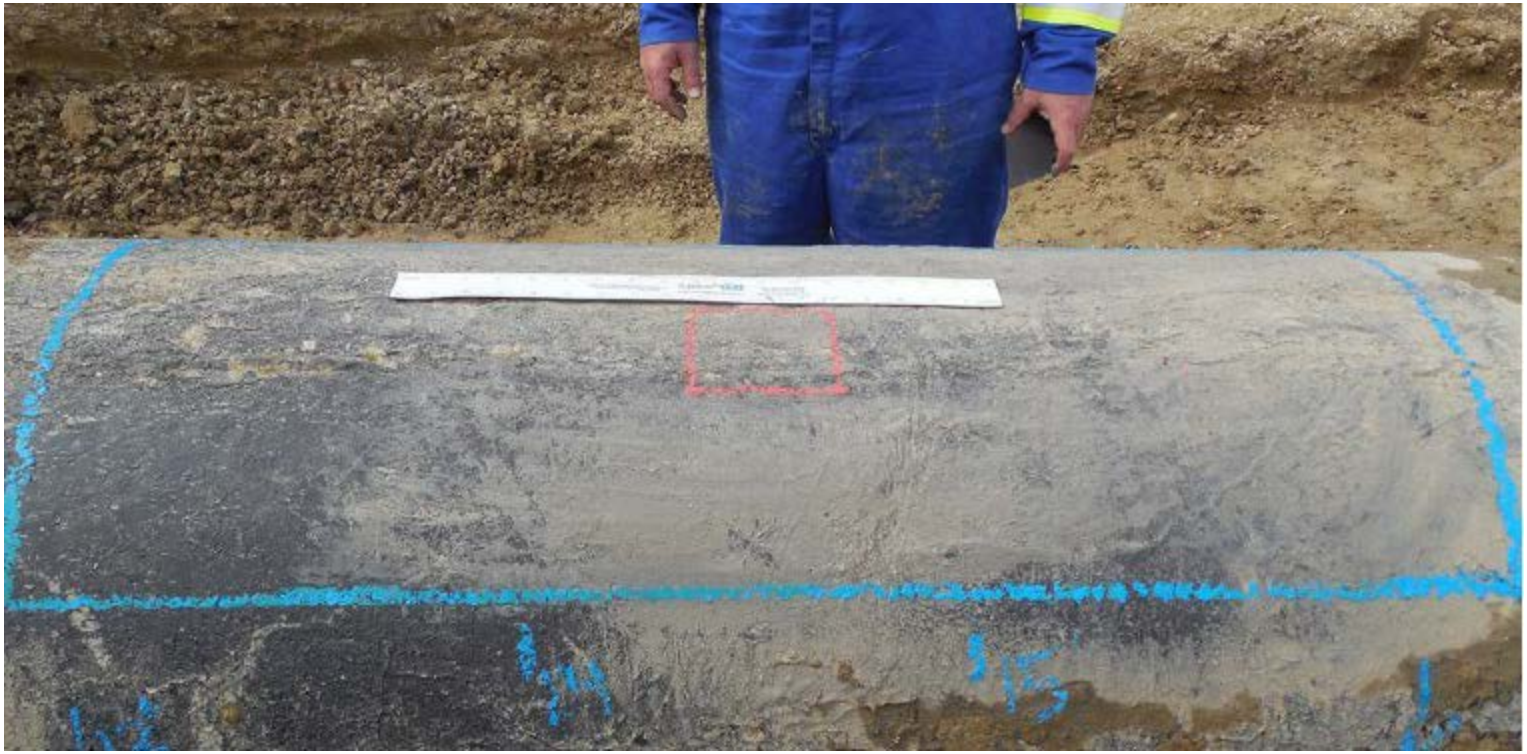
Identification and Characterization

- INGAA members conduct non-destructive examination on every integrity-related excavation with an established disbonded coating to inspect for the presence of cracking
  - Body
  - Long Seam
  - Girth Welds
- Establishes where cracking is absent

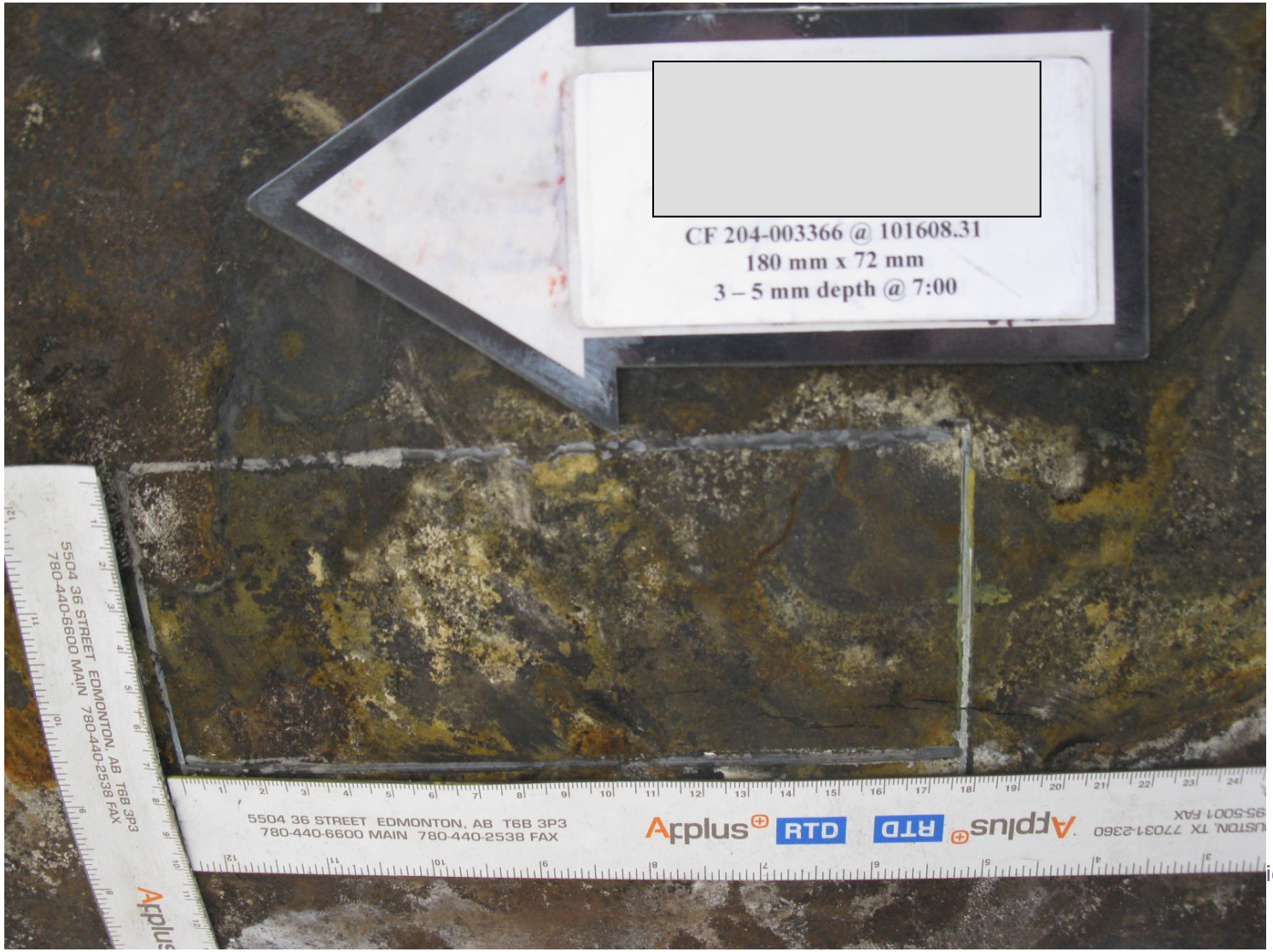
The status of EMAT ILI - Process

- Hydrotests and EMAT ILI are not ‘equal’
  - provide different information.
  - EMAT ILI can be used instead of hydrotesting if each approach results in the absence of flaws that would otherwise result in failure.
- Issues and uncertainties regarding EMAT ILI center on:
  - possibility of missing or misidentifying a crack,
  - uncertainty in crack sizing and
  - inaccuracies in predicted failure pressure
- JIP developed a process with rigor to address these issues and uncertainties
- Through 2012, JIP participants had completed over 45 EMAT ILI runs (>3000 miles), finding several hundred SCC flaws of which more than 100 were confirmed as SCC that would probably have failed a hydrostatic test
- For over twenty of these runs, hydrostatic testing has been undertaken after EMAT ILI and remediation - no false positives

EMAT Investigative Procedures



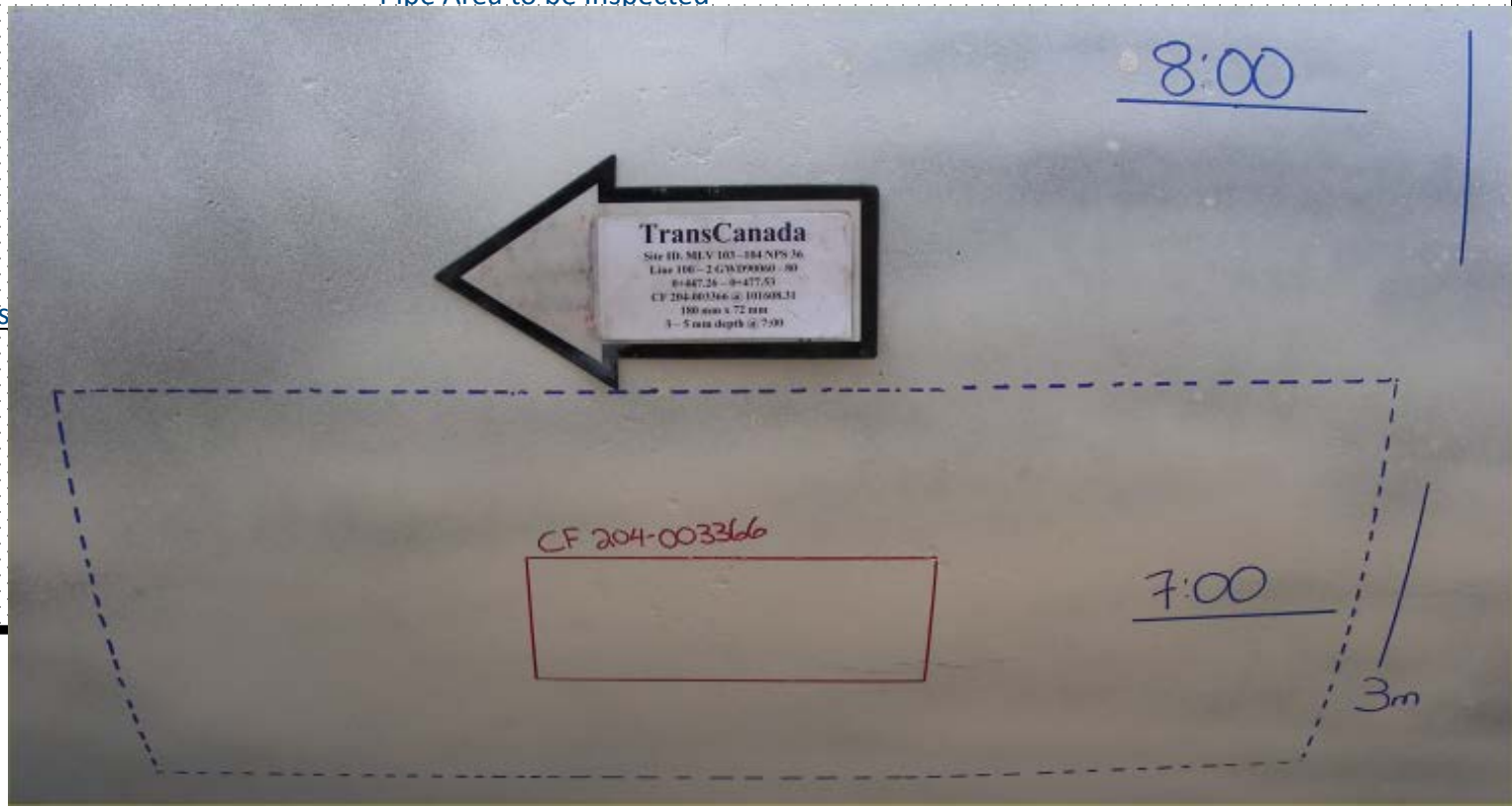
EMAT Investigative Procedures



EMAT Feature Mark-up

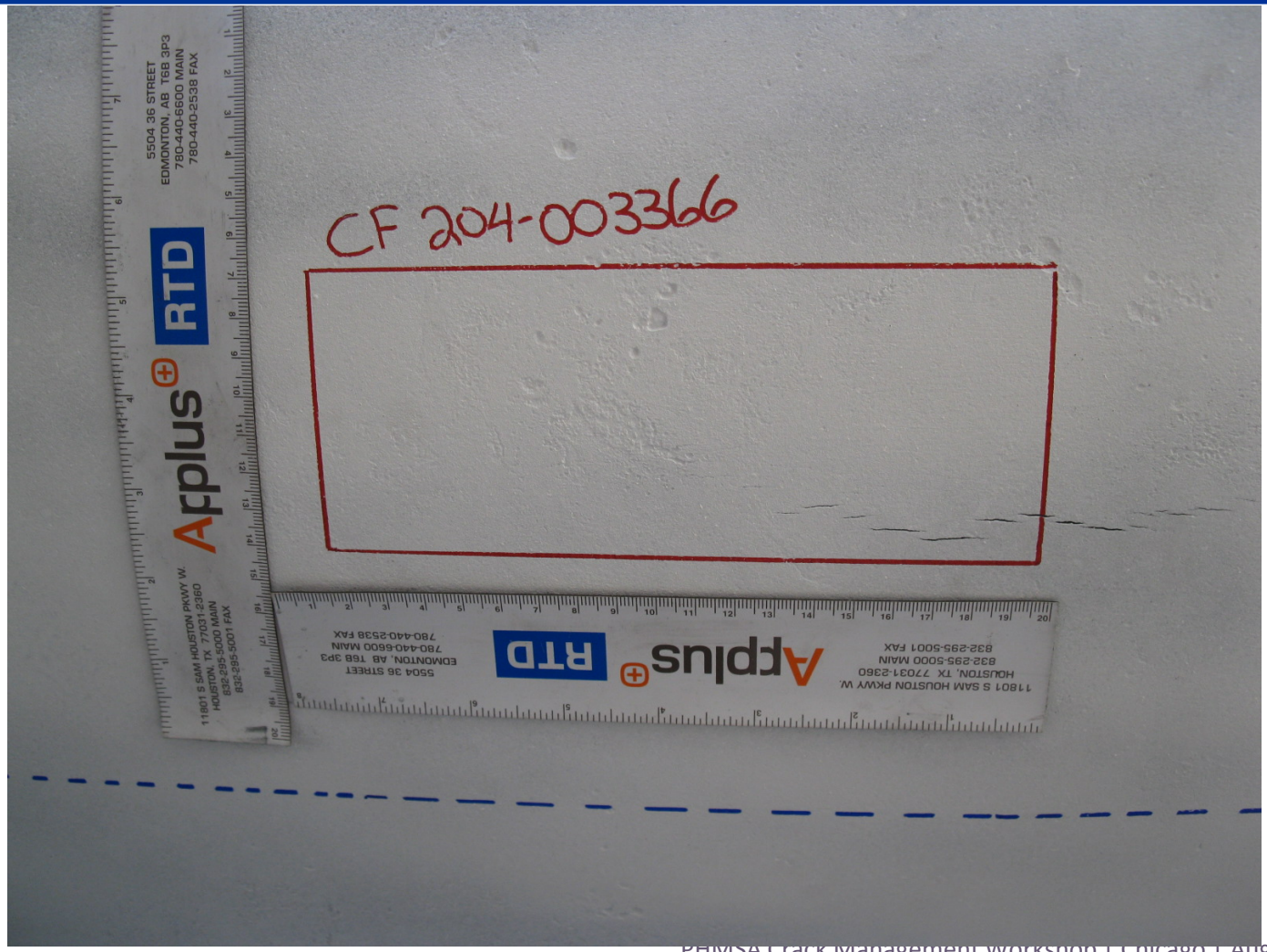
Pipe Area to be Inspected

Distance from Ups

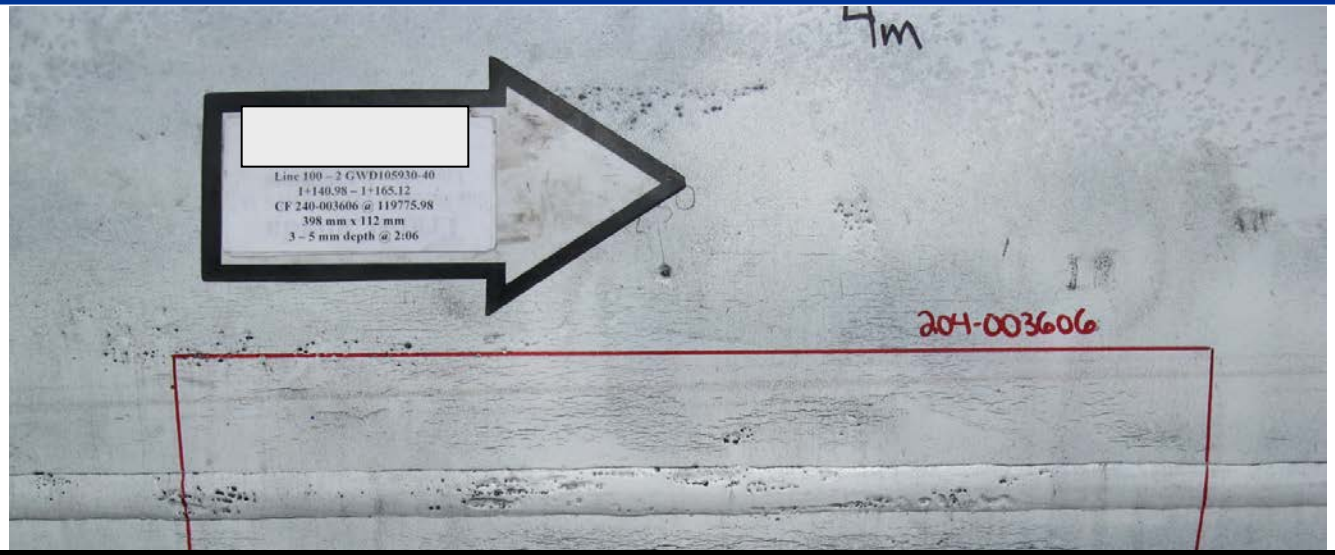


Marking out pipe for inspection – keeping in mind specific ILI Tool's tolerances

EMAT Procedures - Results



EMAT Procedures - Results



GWD 105940

Method	I.D.	W.T. (mm)	Axial (m)	Length (mm)	Width (mm)	Depth	Clock pos.	Toe/SCC
ILI	240-003606	9.14	3.73	398	112	3-5mm	2:06	Crack Feature
MT		N/A	3.690	398		N/A	2:13	
PA		9.3				46.20 %	2:13	

The status of EMAT ILI - Process

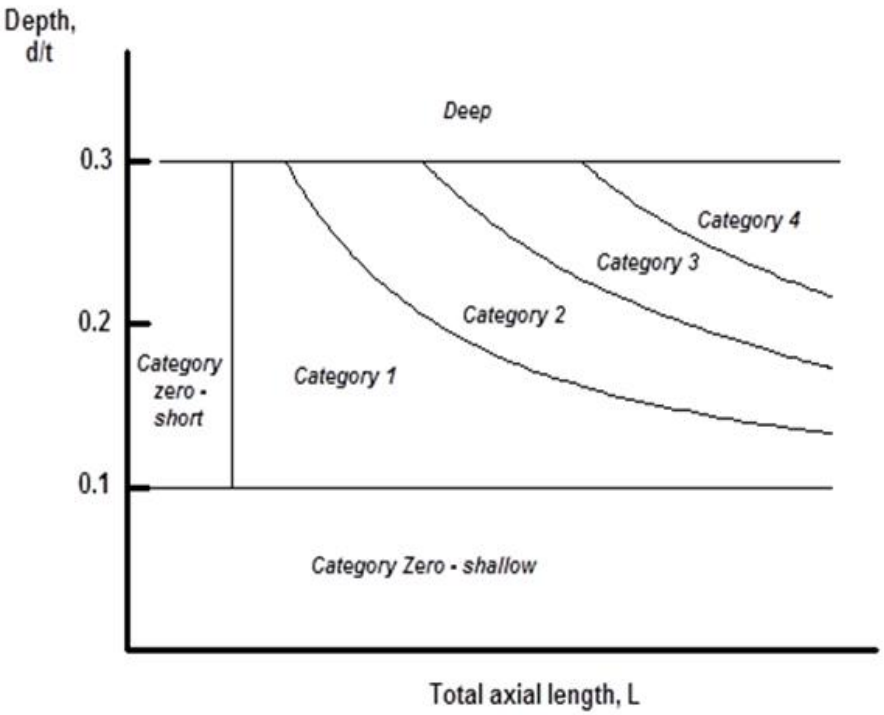
- Analytical and field experience collected during the JIP have enabled issues uncertainties to be understood and addressed
- Recent positive experiences from valve sections that have been hydrotested after EMAT ILI, leads to the conclusion that EMAT ILI can be utilized instead of hydrotesting for SCC threat management

JIP database of SCC tests and failures

- 85 well-documented cases
- 15 in-service failures
- 46 hydrostatic test leaks
- 24 pipe burst tests
- Range in size from 8-42 inch diameter, Grade X45-70

- 35 cases have sufficient detail on flaw profile and material properties to enable comparisons of PFP using Ln-Secant, API 579-1/ASME FFS-1, 2007 Level 2, CorLAS® and PAFFC

ASME Crack Severity Categories



Cat	Failure Pressure Range	Significance	Minimum Time to Failure, years	
			110% SMYS Hydro	100% SMYS Hydro
0	a	So small it can be monitored	15-25	15-25
1	>110% SMYS	Would survive 110% hydrostatic test	10	6
2	>125% MAOP <110% SMYS	Exceeds safety margin	5	3
3	>110% MAOP <125% MAOP	Serious but no immediate threat	2	1
4	<110% MAOP	Imminent failure possible	<1	<1

Long-Term Management

- Historically, INGAA members have used hydrostatic testing to manage SCC
  - Spike tests to 100% SMYS or greater
  - Duration to stabilize test section, typically 30 minutes
  - Retest interval model developed and validated - Fessler

- With advent of integrity management, SCC DA was developed and integrated into IMP's
  - Typically applied on low to medium risk susceptible segments or those that are single source (i.e. non piggable) of gas

Fatigue

- Fatigue must always be considered; generally, fatigue lives in natural gas service are sufficiently long that they do not impact near to medium-term decision making
- Prior studies for gas pipelines conducted by GRI and PRCI coincident with Integrity Management rulemaking to provide operators with guidance
- INGAA has just initiated a project now ten years later to refresh and provide additional guidance for members

Prevention

- Newly constructed pipelines
- Applies to most pipelines since 1990s, and many since early 1980s
- Coating – fusion bonded epoxy, shot peen surface preparation
  - Including girth weld
- Variety of manufacturing standards and practices
  - Transportation of pipelines (rail and truck)
  - Field Applied Coatings Best Practices
  - Training Guidance for Welding and Coating Construction Workers and Inspectors
  - Specification and Purchase of Segmentable Induction Bends and Elbows

Questions:
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