REX2024
PRCI Research Exchange

Deep Dive:
Pipeline Hard Spots, ILI and Crack Management

Panel Discussion

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February 28, 2024

PRCI LEADING PIPELINE RESEARCH
Pipeline Research Council International

Hard Spot Creation – Our Best Guess

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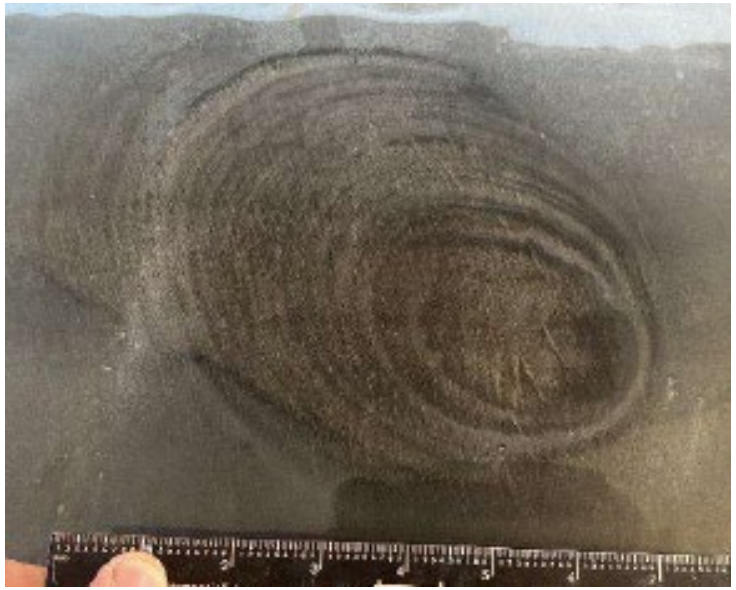

OR

Phase transformation occurring during casting process → Martensite Microstructure → Hard Spot

Hard Spot Susceptibility and Threat Mechanism

Hard Spots: Found in plate manufactured from ingots or blooms

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Seam Types: DSAW, EFW, DC-ERW

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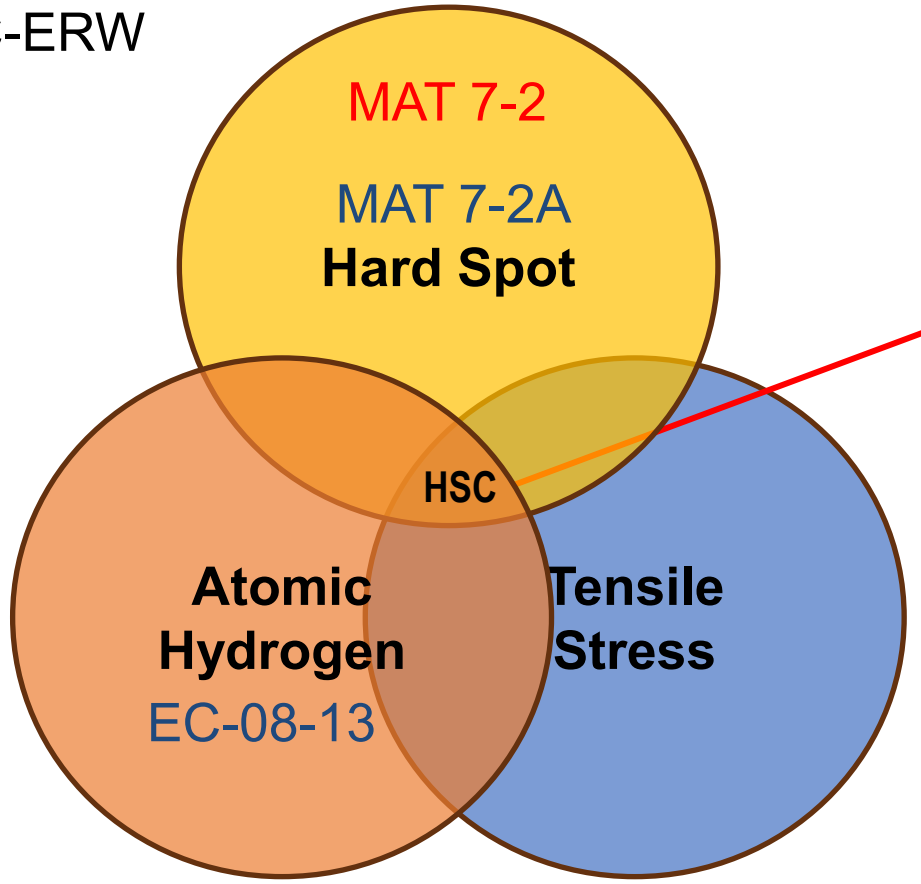
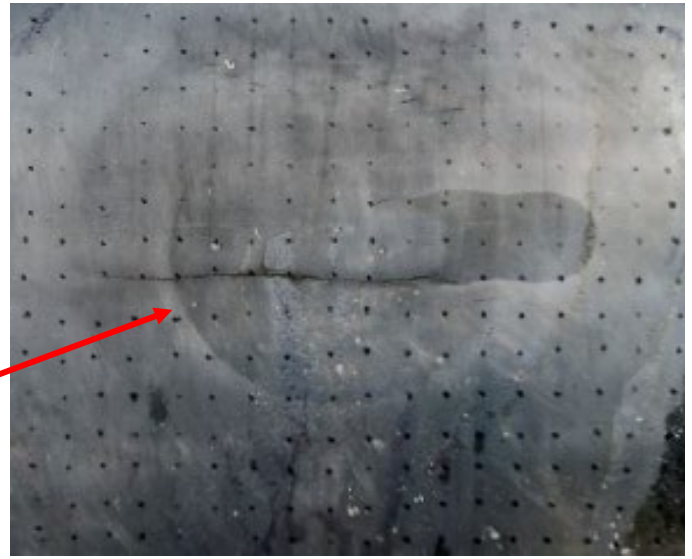
Manufacturers (Mostly pre-1960s)
A.O. Smith
Bethlehem
Consolidated Western
Kaiser
Republic
National Tube
Welland Tube
Youngstown S&T*





* Incidents for Youngstown are limited to pipe body HS

Hard Spot ILI Reliability (Detection/Identification/Sizing)

- **Hard Spots can come in different shapes and sizes**
  - Unique ILI signal characteristics
- **ILI Vendors are challenged to identify hard spots through unique signal characteristics**
  - Detection does not appear to be a challenge
  - Sizing and identification are current challenges
- **MAT 7-2A – Assess Hard Spot ILI Performance**
  - Benchmark current capabilities and limitations of ILI technology
  - Response to NTSB report from recent HS failure and other recent industry findings
- **Hard Spot ILI Re-analyses and/or Reassessments may be something for Operators to consider**

Hard Spot Integrity Assessment

- **Hard Spot Failure History (see MAT 7-2)**
  - Generally occurred above 350 Brinell
  - Generally harder with longer defects
- **No current fitness for service model available, yet (see MAT 7-2A)**
  - Assessing based on Hard Spot definition (327 Brinell and 2” or greater in any direction) may lead to a large # of digs and inefficient, but effective program.
- **Uncertainty in hardness sizing**
  - Typically ±50 Brinell @ 80% confidence and ±0.6-1” length/width @ 80% confidence

Hard Spot Repair

Challenges

- Consider in-ditch hardness uncertainty (can vary by measurement technology)
- Internal/mid-wall hardness imperfections or hard spots: are these an integrity threat?
- At what hardness levels and lengths/widths should a repair be required?
    - Does a recoat qualify as a repair if threat mechanism (atomic hydrogen) is removed from the equation?

Common Repairs Utilized

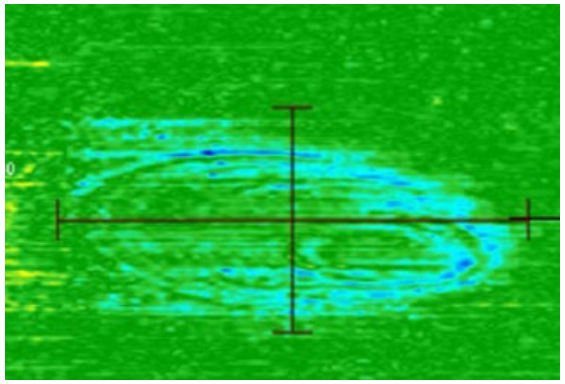
- Type B sleeves and cutouts
    - Type A sleeves have proven ineffective

Ongoing Work

- Joint Industry Project – ADV Integrity
    - Evaluating Type A Compressive Sleeves and Carbon Fiber Composite Repairs

Hard Spot ILI Validation

- **Performing API 1163 Validation for Hard Spot ILI**
  - Comparing ILI length/width to in-ditch length/width can be challenging



	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	159.4	161.5	161.7	182.7	176.7	175.3	167.6	166.4	161.2	165.4	158.3	161.5	158.1	156.1
2	171.8	152.8	175.1	261.6	192.9	210.5	191.6	185.8	173	176.5	173.3	161.2	157.5	155.7
3	169.1	180	174.6	279.4	250.8	262.4	336.1	290	229.5	212.8	180.2	166	162.3	150.6
4	170.8	183.3	182.5	288.8	310.5	300.8	323.4	314.6	280.4	255.3	193.9	176.7	168.8	166.8
5	171.1	176.8	189.2	295.7	320.9	332.3	320.4	341.5	322.8	338.5	264.3	190.1	164.9	165.6
6	168.9	166	188.1	212.4	280.4	302.7	308.6	326.3	334.5	350.8	271.7	228.4	171.1	160.9
7	167.5	178.3	177.1	187.6	237.9	287.1	294.4	314.4	325.6	359.4	299.3	198	172.7	161.5
8	166.3	166	165.1	179.7	197.7	232.9	251.6	260.7	246.1	293.8	229.7	185.4	166.8	168.5
9	156.7	158.6	161.7	167.4	183.1	195.8	193.5	209.3	227.6	189.5	185	182.2	168.1	155.9

  - Lacking industry guidance on grid spacing and samples collected for hardness testing
  - Highest hardness may not be on outside of pipe (could be internal or mid wall)
    - How to validate if hard spot is internal or not through-wall?
  - Correlating lab (Micro-Vickers) hardness, to in-ditch hardness, to ILI hardness is a challenge
    - Through-wall hardness on millimeter scale (lab) compared to surface measurements from in-ditch compared to single measurement from ILI -> lots of variability observed

thank you

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