APGA Convention 2025

EPRG Research Update

Back to the Fundamentals

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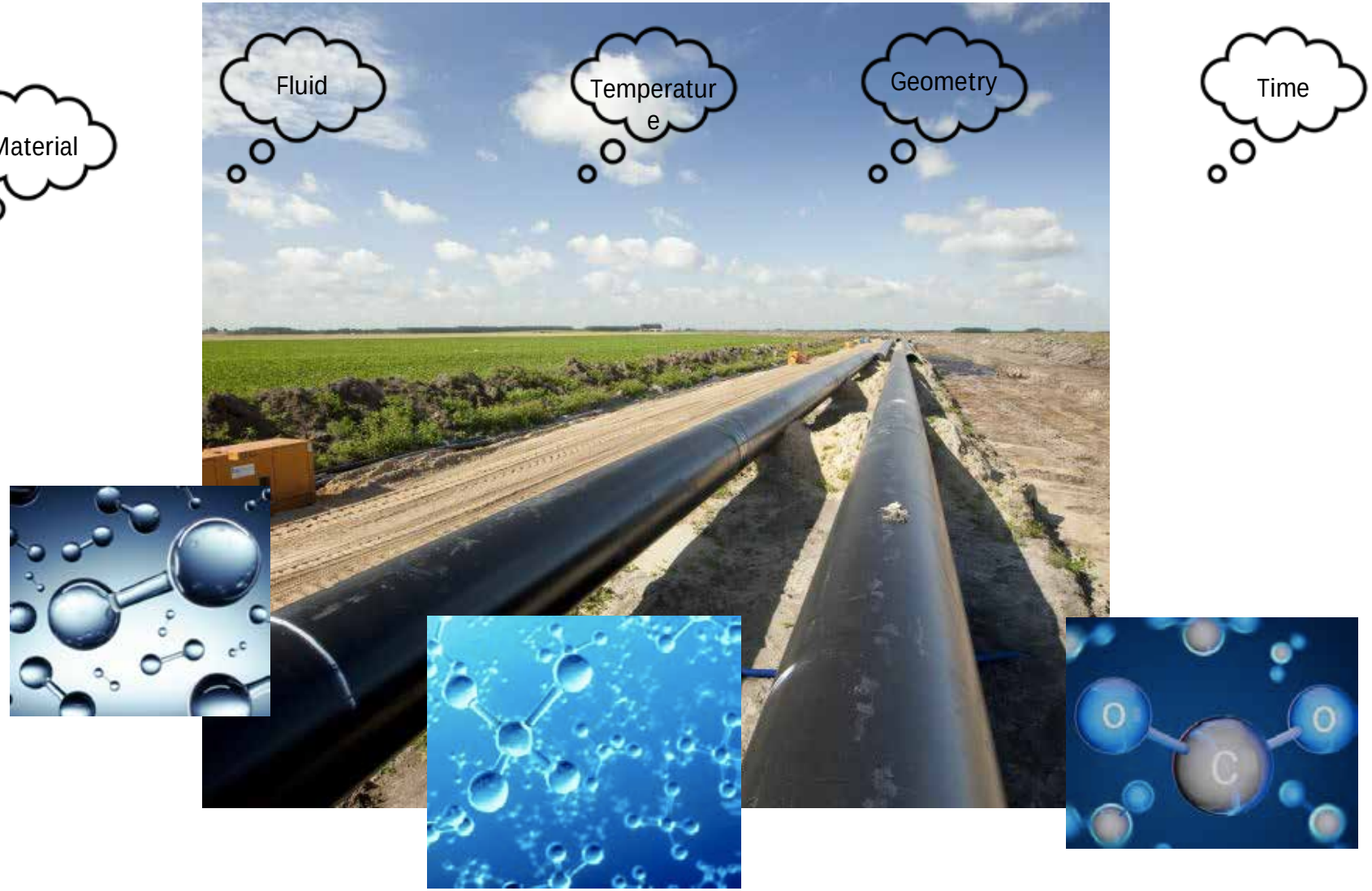
Back to the fundamentals

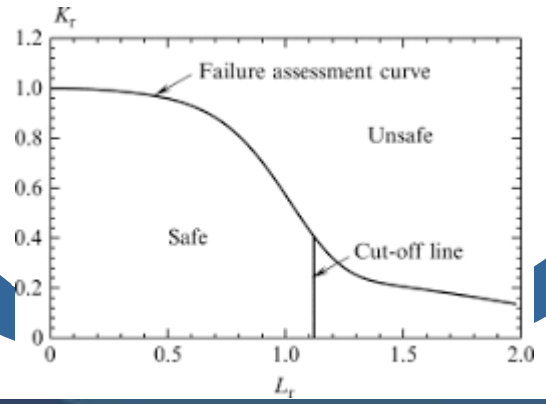
New challenge for existing pipelines



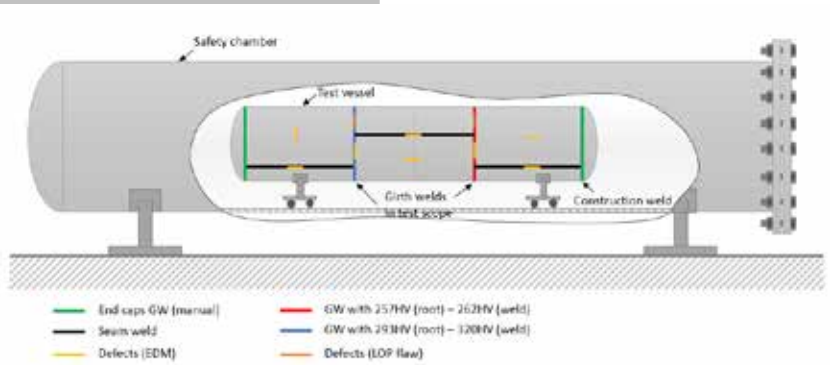
Bridging the scale

Lab scale
- Size effects
- Sampling
- Stress state
- Loading rate
- Exposure time

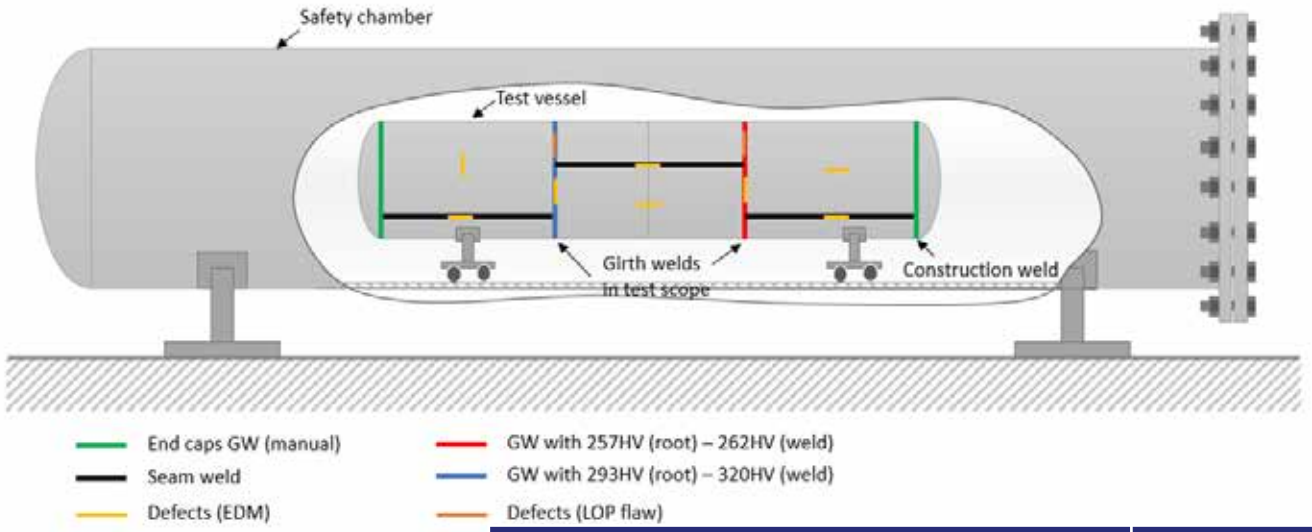
In air vs in environment



Full scale
- Natural defects
- Residual stress

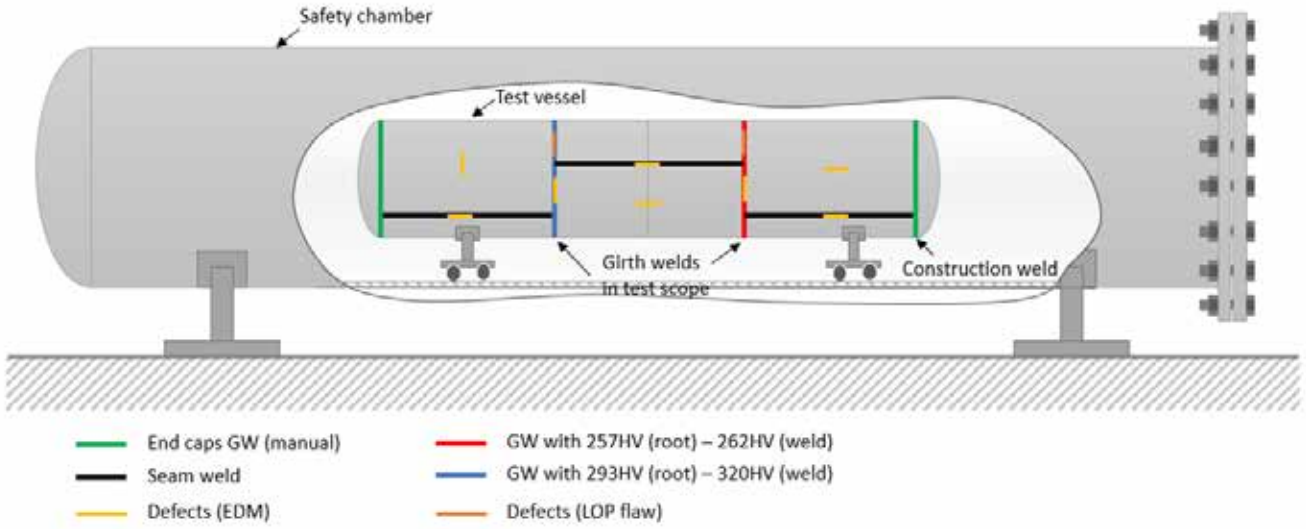


Full Scale Hydrogen Pressure Cycle Test

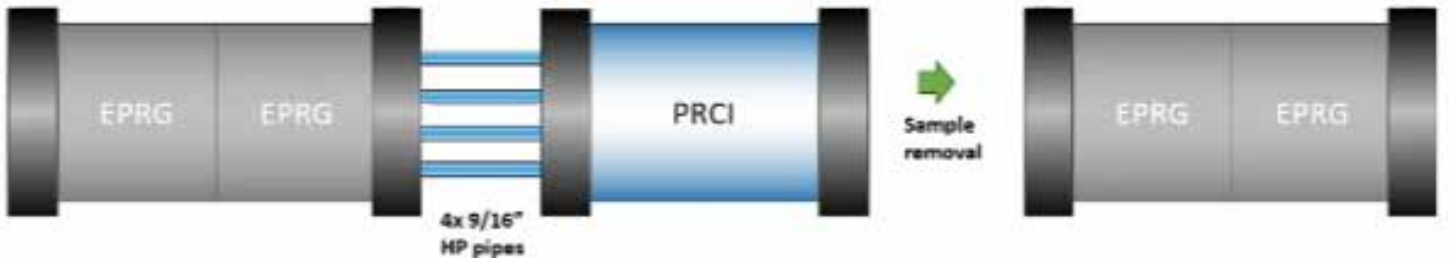


Parameter		Modern	Vintage European	Vintage North American
Pipe Material	Diameter	28"/DN 700	26"/DN650	26"/DN650
	Wall thickness	17.5 mm	11,13 mm	7,1 mm
	Grade	X70/L485M	X60/L415	X52
	Seam weld	DSAW	SAW	LF ERW
	Production Date	2021	1970's	1950's
Girth weld	Welding Process	Mechanized; normal and high hardness	1. Existing vintage cellulosic 2. Manual cellulosic/basic process	No girth weld

Full Scale Hydrogen Pressure Cycle Test



Option C)
First phase with PRCI sample and EPRG sample connected together. After PRCI failure, only EPRG sample



Summary first tests on modern pipe

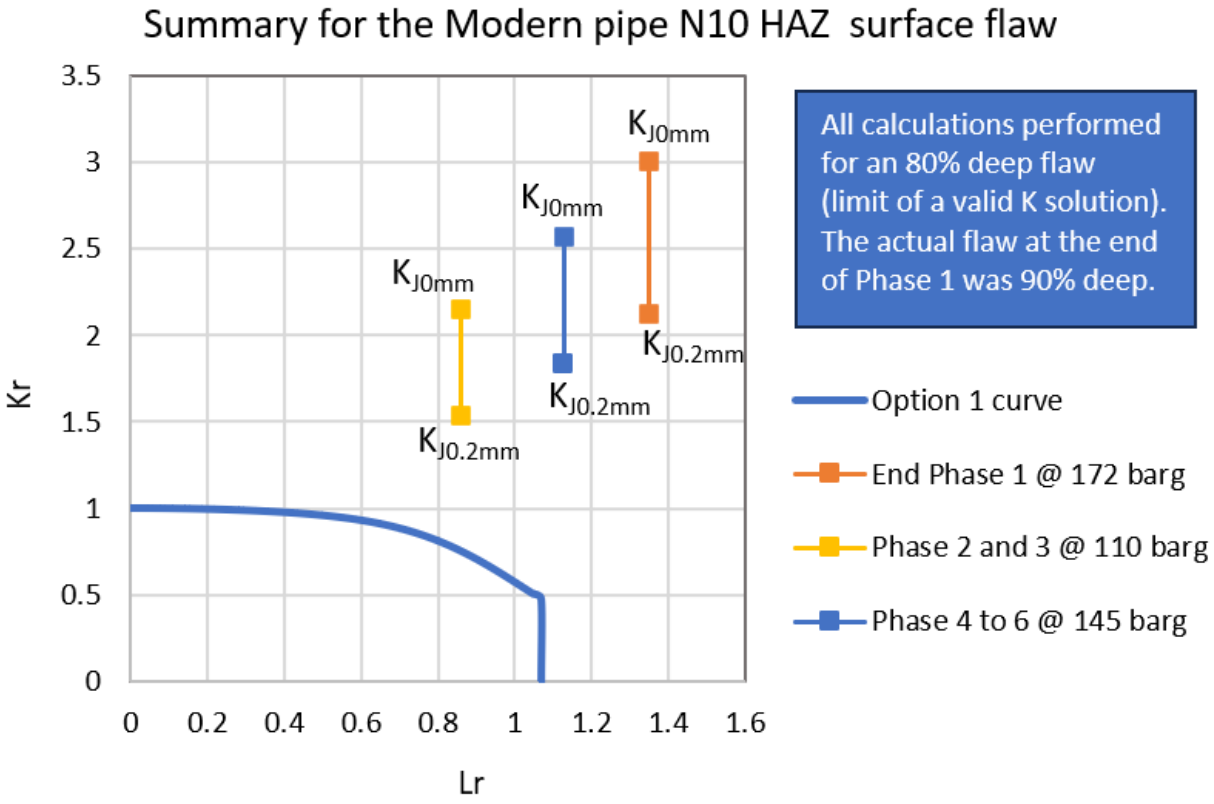
Modern Pipe

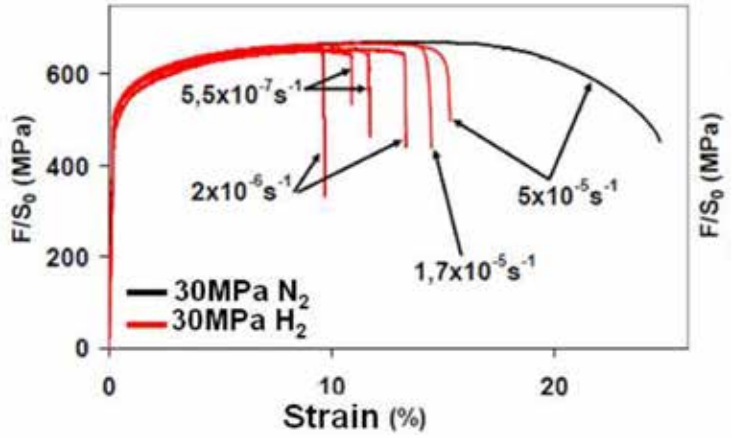
1. ***Rapid initiation*** for long seam weld notches and about 2x longer for girth weld notch
2. Fatigue crack growth ***consistent*** with ***small scale*** data
3. Constant pressure holds à no obvious crack instability
4. Test ended with a ***leak*** : @ machined HAZ notch and @ weld repair
5. First repair welds failed fast - residual stress?

Vintage pipes

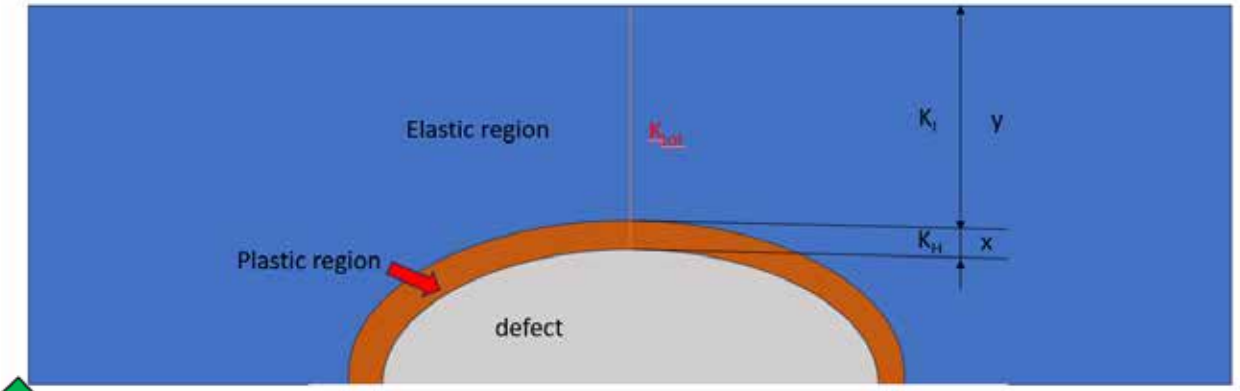
1. European pipe: Cracks could ***not*** be ***initiated*** in the cycles predicted by fatigue crack growth calculations (ca. 33.000 cycles @ 60 - 72% SMYS)

Results in perspective - Toughness of pipe





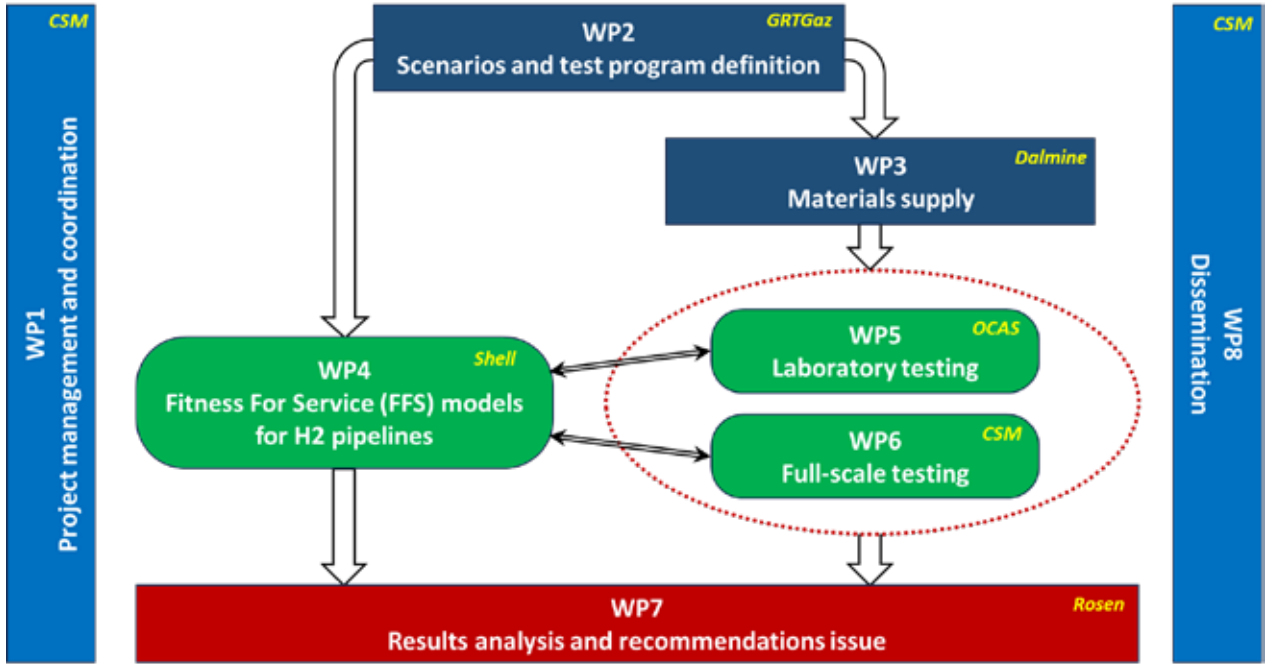
L. Briottet, I. Moro, P. Lemoine, Quantifying the hydrogen embrittlement of pipe steels for safety considerations, International Conference on Hydrogen Safety, 4th, San Francisco, 2011

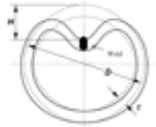
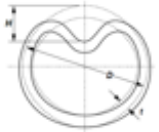
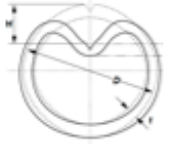


- ***Final failure conservatively predicted*** ✓

Developing guidelines for dent & gouge assessment H2 lines

Project duration: 07/23 - 12/26

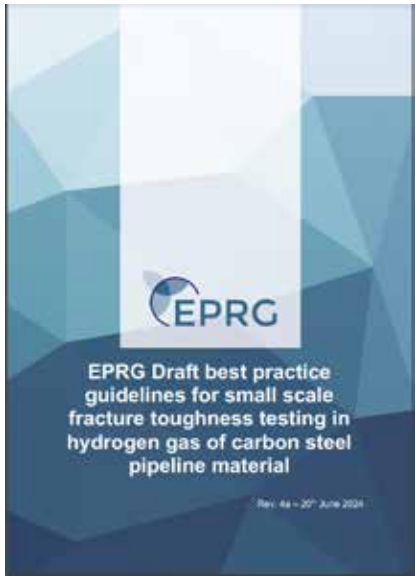


Geometry	Damge size	Environment	Vintage LSAW onshore	Modern LSAW	Modern SMLS	Vintage LSAW offshore
Dent on Weld 	Dent Heigth 2% OD	H_2		●		
Plain dent 	Dent Height 6% OD	H_2	●	●		
Dent-Gouge 	Dent Height 6% OD	Water			●	
	Gouge: 1.5mm x 300mm	H_2			●	
Corrosion	60% WT; 300 mm long	H_2				●

Test pipes included are seamless & welded pipe, new and vintage material

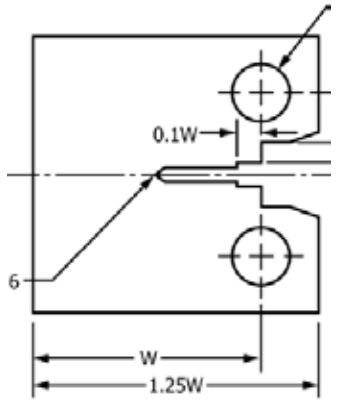
Small Scale Testing

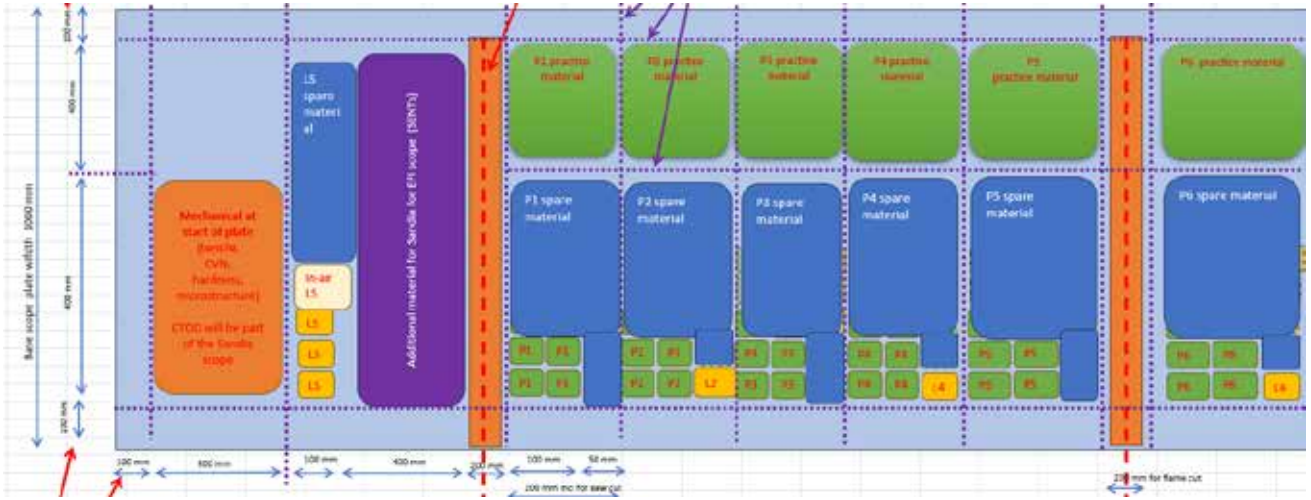
- Required tests
  - Fracture toughness
  - Fatigue Crack Growth
- Challenges & Gaps
  - Existing test standards cover in-air test
  - Adaptation to in-hydrogen tests missing
- Existing test procedures have not been validated



Round robin fracture toughness test

- Move towards elastic plastic fracture toughness testing using the ASTM E1820 basis
  - J-R curves
  - Toughness at the initiation 0mm and at 0.2mm crack growth
- Challenges & Gaps
  - Significance of impurity
  - Test execution parameters
  - Post-processing gaps (initiation point)
- EPRG draft best practice guide on FT testing published in 2024
  - Now adopted into CSA CHMC-1 draft 2025 and the
- AMPP draft guide 21586

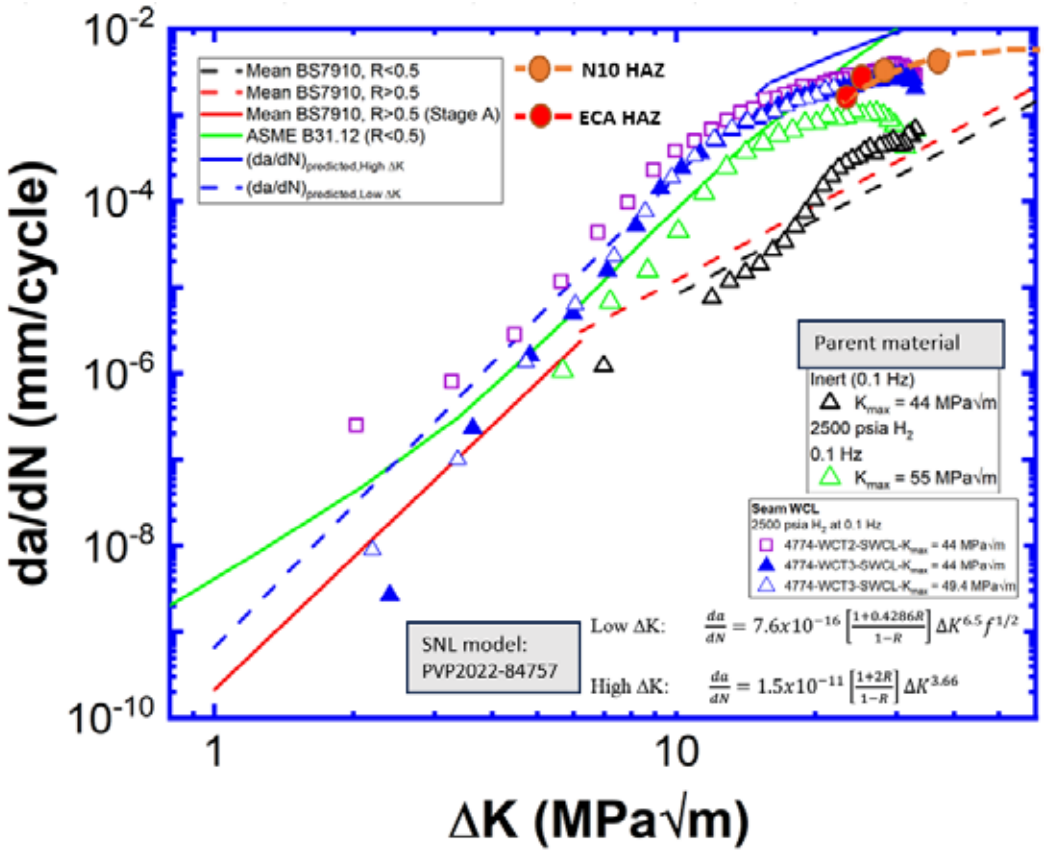




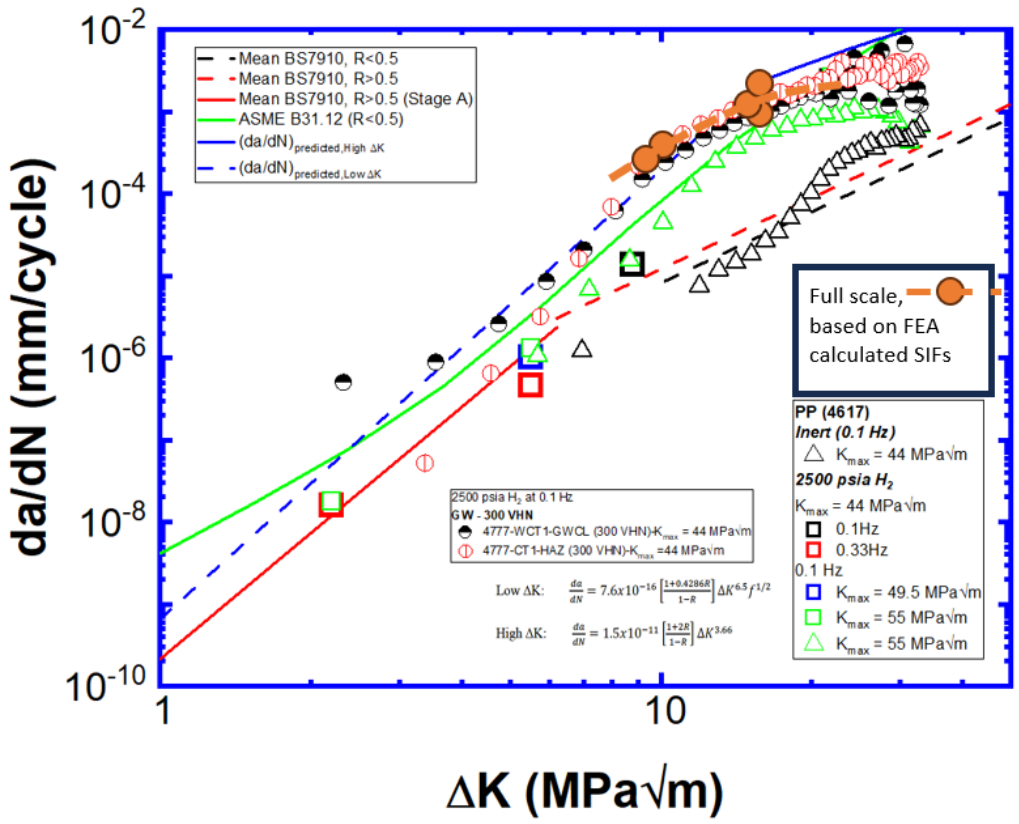
- ***Specimens shipped*** ✓
- ***Results expected within 2025***

Small Scale Test

Seam weld



Girth weld



- Growth rate consistent between full and small scale

EPIC

Energy Pipeline Innovation Conference

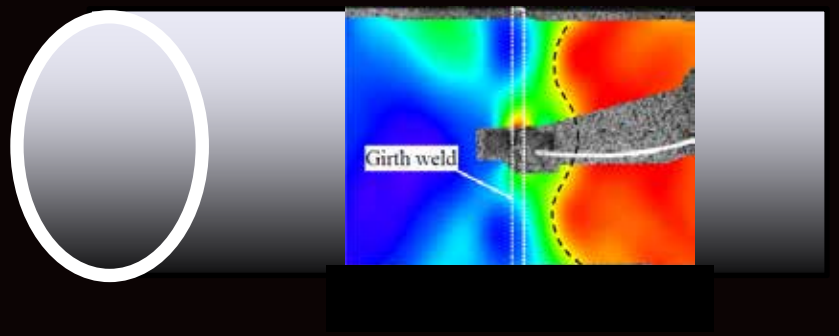
8.–10.9.2025 · University Arms, Cambridge

EPRG Recommendations for Carbon Dioxide in the Gas Phase

8-10th September 2025 – Cosham, Roovers, Erdelen-Peppler & Connelly

The next big things

happen at the smallest scale



- Residual stress - measurement techniques, correct way to implement in assessment tools
- Crack instability at ambient temperature - is it an effect or an artefact?
- Explanation for differences in behaviour modern vs vintage material

Let’s do this……together

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Thank you for your attention.