Canada Energy Regulator | Régie de l'énergie du Canada

Girth Weld Area Strain-Induced Failures

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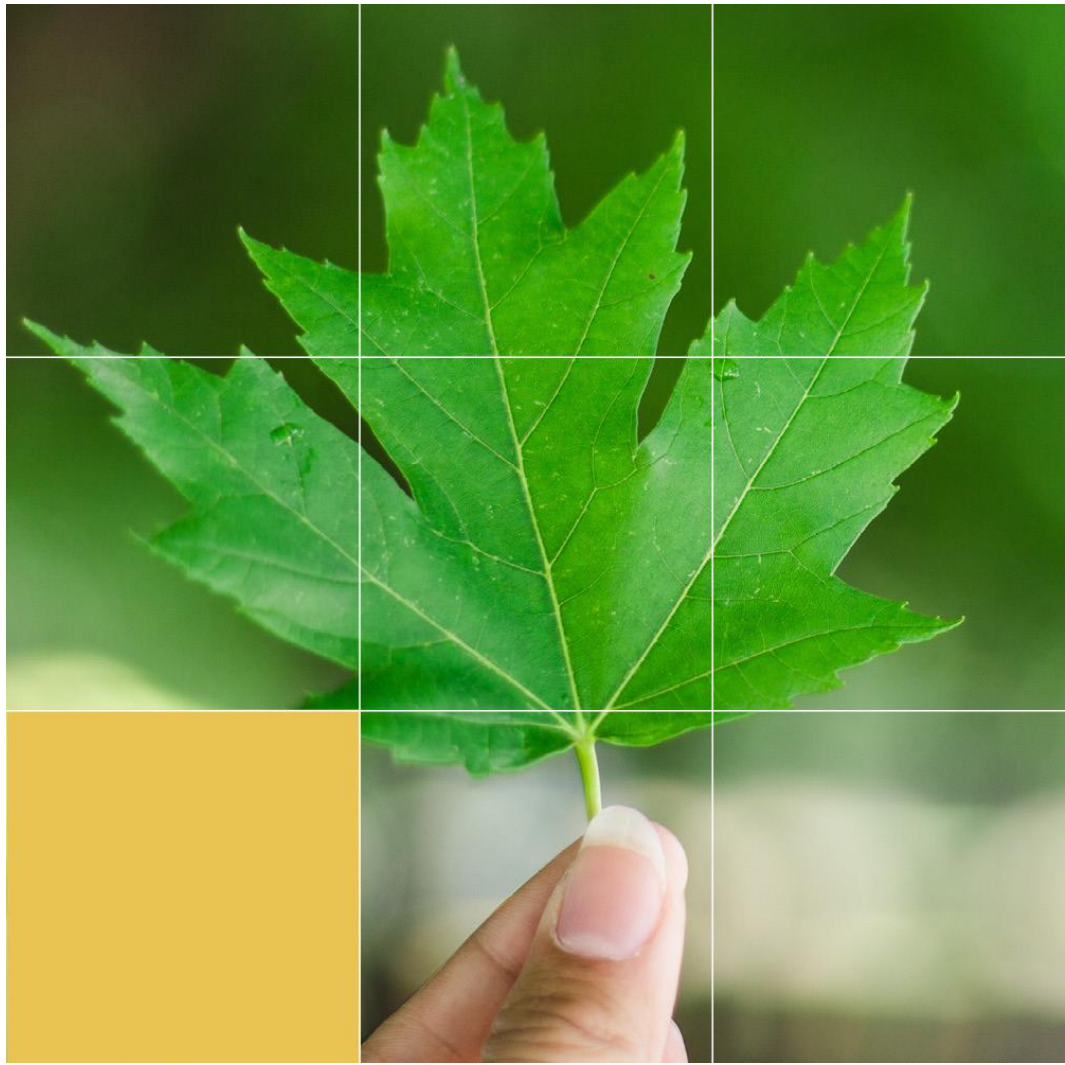
Canada Energy Regulator



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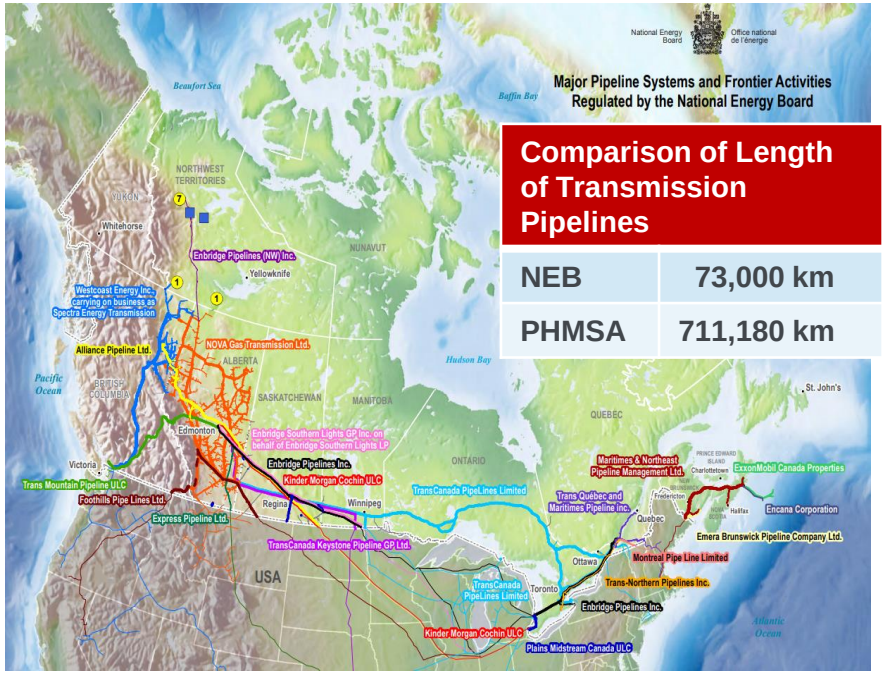
Canada Energy Regulator (CER)

- The CER regulates approximately 73,000 kilometres of pipeline that cross international or provincial borders and over 2000 facilities
  - approximately 75% is Natural Gas/ HVP
  - 70 operating oil and gas pipelines that cross the Canada-US border
- Full pipeline lifecycle Regulator from pipeline design, approval, construction operation and abandonment
- CER regulated pipelines safely transport over 1.25 billion barrels of liquid products and almost 5.8 trillion cubic feet of natural gas annually.



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Girth weld area failures on high strength pipelines

- Failures occurred as a result of external longitudinal loads such as settlement or slope movement
- Some failures occurred during hydrotest and others within 5 years of construction.

PHMSA DOT, "Failure Investigation Report – Enterprise Products Operating, LLC," 24 February 2016

Canada

Failures

- Total of 24 known failures attributed to or possibly involving low strength weld areas.

Pipeline	Failures	Timeline
Undisclosed (USA) PRCI Presentation	7 in-service 3 hydrostatic test failure	Approx. 2013 onwards
Sabah-Sawarak Gas Pipeline (Malaysia)	2 in-service	2014-2018 (with two years where operation was halted)
Camisea Pipeline (Peru)	5 in-service 7 hydrostatic test failure	2004-2006

The issue:

- Strong pipe
- weak weld area
- longitudinal loads

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PHMSA DOT, "Failure Investigation Report – Enterprise Products C LLC," 24 February 2016.

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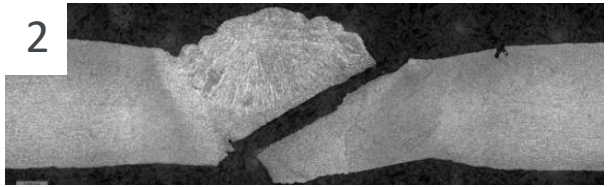

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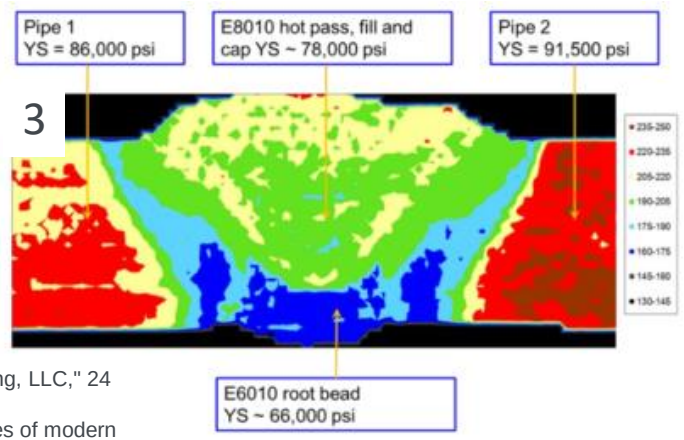

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E-Tech International, "Camisea Pipeline Ruptures and Audit," 200

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2-3: Y.-Y. Wang, S. Rapp, D. Horsley, D. Warman and J. Gianetto, "Attributes of modern linepipes and their implications on girth weld strain capacity," IPC2018-78809, Calgary, Alberta, Canada, 2018
4: E-Tech International, "Camisea Pipeline Ruptures and Audit," 2007

Reasons for Potential Safety Advisory

- Failures were on pipelines that met API 1104 welding requirements
- Pipelines designed to ASME B31.4/B31.8 can result in under-matching
- Canadian Standard Association (CSA) Z662 has similar requirements for welding and design as API 1104 and B31.4/B31.8 which have no explicit requirements for girth weld strength matching to pipe strength
- Pipe and the welds have to be able to withstand the expected loadings
- To bring to the attention of companies:
  - that softening of the HAZ in the weld area can result in effective strength under-matching of the weld with respect to the pipes being joined – especially in the cases where modern project pipe approaches the upper-bound permissible limit for strength; and
  - a list of references that companies can consult in assessing and if necessary mitigating conditions on their pipelines.

Comparison to HAZ hydrogen cracking response

- As a result of the threat of hydrogen cracking, industry changed both pipe making processes and welding practices to address the threat.
  - change to alloying strategy and thermomechanical-controlled processing
  - tightly controlling heat input
- Similarly, the current issue should be addressed from all angles – design, welding and pipe making.

Implications – Existing Pipelines

- Evaluation of susceptibility is key

- Could the following be used to determine susceptibility:
  - Adequacy of Welding Procedure Specifications and Qualification tests?
  - Tensile testing for cross weld yield strengths and base pipe longitudinal strengths?
  - Evaluating the strain bearing capacity of weld area?
  - Managing settlement, slope movement for the actual strength of weld area?

- Potential areas requiring research:
  - How to predict the amount of strain accumulation?
  - How do imperfections/misalignment exacerbate strain accumulation?

Implications – New Pipelines

- Should designs explicitly consider all pipeline components, including welds?
- Should the manufacturing of pipe consider:
  - Applied heat by welding, coating application and softening?
  - Is mandatory longitudinal testing needed?
- Should standards be updated to ensure that necessary weld area overmatching occurs?

Questions / Discussion?

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