FortisBC Energy Inc. CTS TIMC Project

Workshop

May 13, 2021

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Agenda

Time	Topic	Presenter
1:10pm	**Introductions and Logistics**	**Ilva Bevacqua** *Manager, Regulatory Compliance and Administration*
1:15pm	**Major Projects Cumulative Rate Impacts**	**Diane Roy** *Vice President, Regulatory Affairs*
1:30pm	**Integrity Management and ILI Tools**	**Ferenc Pataki** *Director, Transmission*
1:45pm	**Project Need**	**Andrew Doyle** *Manager, Gas System Assets*
2:00pm	**Quantitative Risk Assessment – JANA Corporation**	**Dr. Ken Oliphant**, Ph.D, P.Eng. JANA *Executive Vice President and Chief Technology Officer, Operations & Engineering*
2:15pm	**Project Alternatives, Description and Approvals Sought**	**Andrew Doyle**
2:30pm	***Break***	
2:45pm	**Question Period**	**All**

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Major Projects Cumulative Rate Impacts

Presenter: Diane Roy

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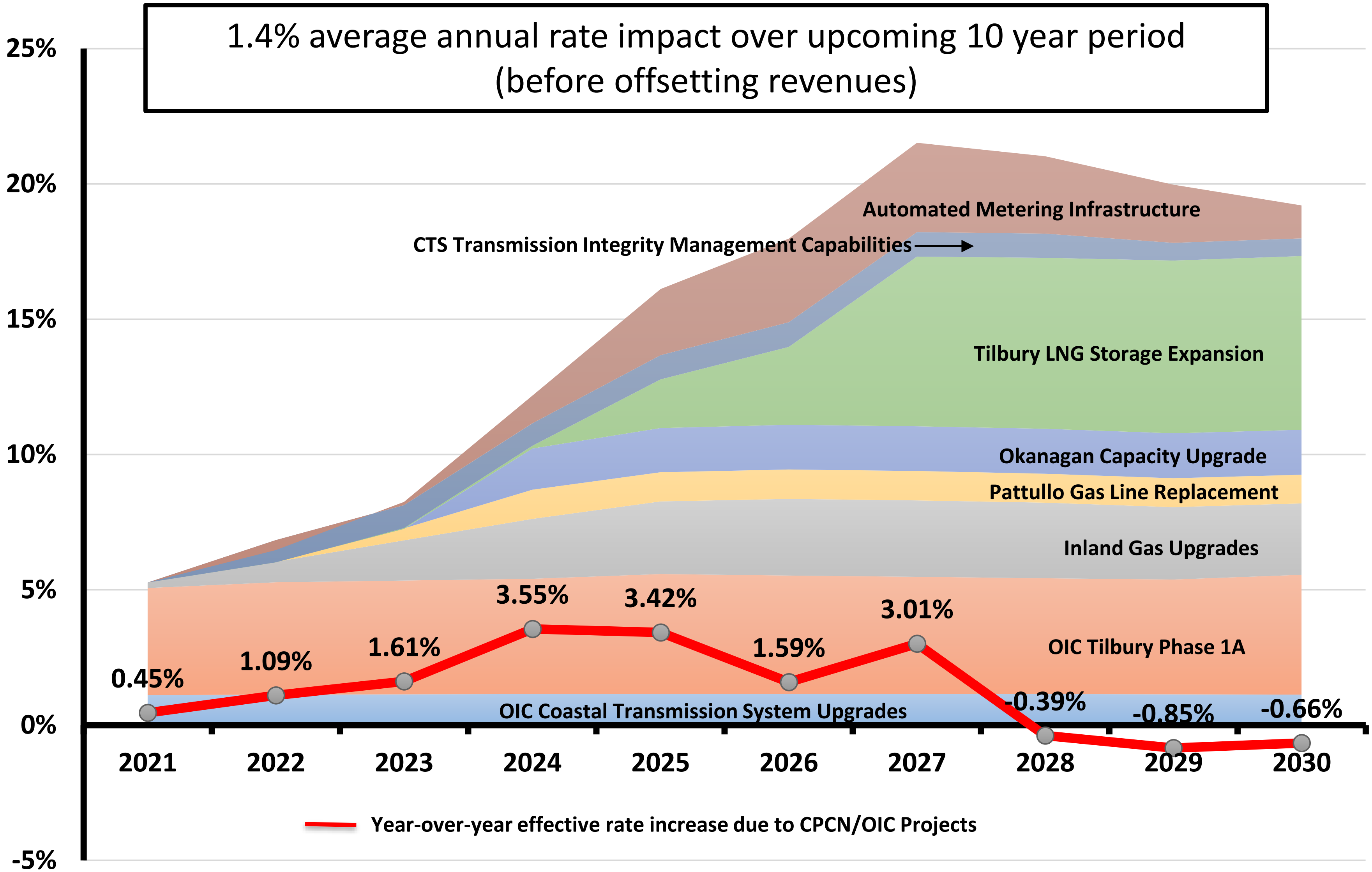
BCUC Panel Request (Exhibit A-4)

A discussion of the estimated cumulative rate impact of the approval and completion of all FEI recent and anticipated major projects. Please separate the estimate according to regulatory oversight method:

1. Projects requiring BCUC approval, including Pattullo Gas Line Replacement, Okanagan Capacity Upgrades, Transmission Integrity Management Capabilities, Inland Gas Upgrades, Tilbury Liquefied Natural Gas (LNG) Storage Expansion and Automated Metering Infrastructure;
2. Projects directed by Order in Council, including Coastal Transmission System Expansion, Tilbury Phase 1A and Phase 1B.

Please explain whether FEI has considered staggering or adjusting the timing of any of these projects to mitigate that cumulative rate impact and if not, why not.

Cumulative Rate Impact of Major Projects



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Integrity Management and ILI Tools

Presenter: Ferenc Pataki

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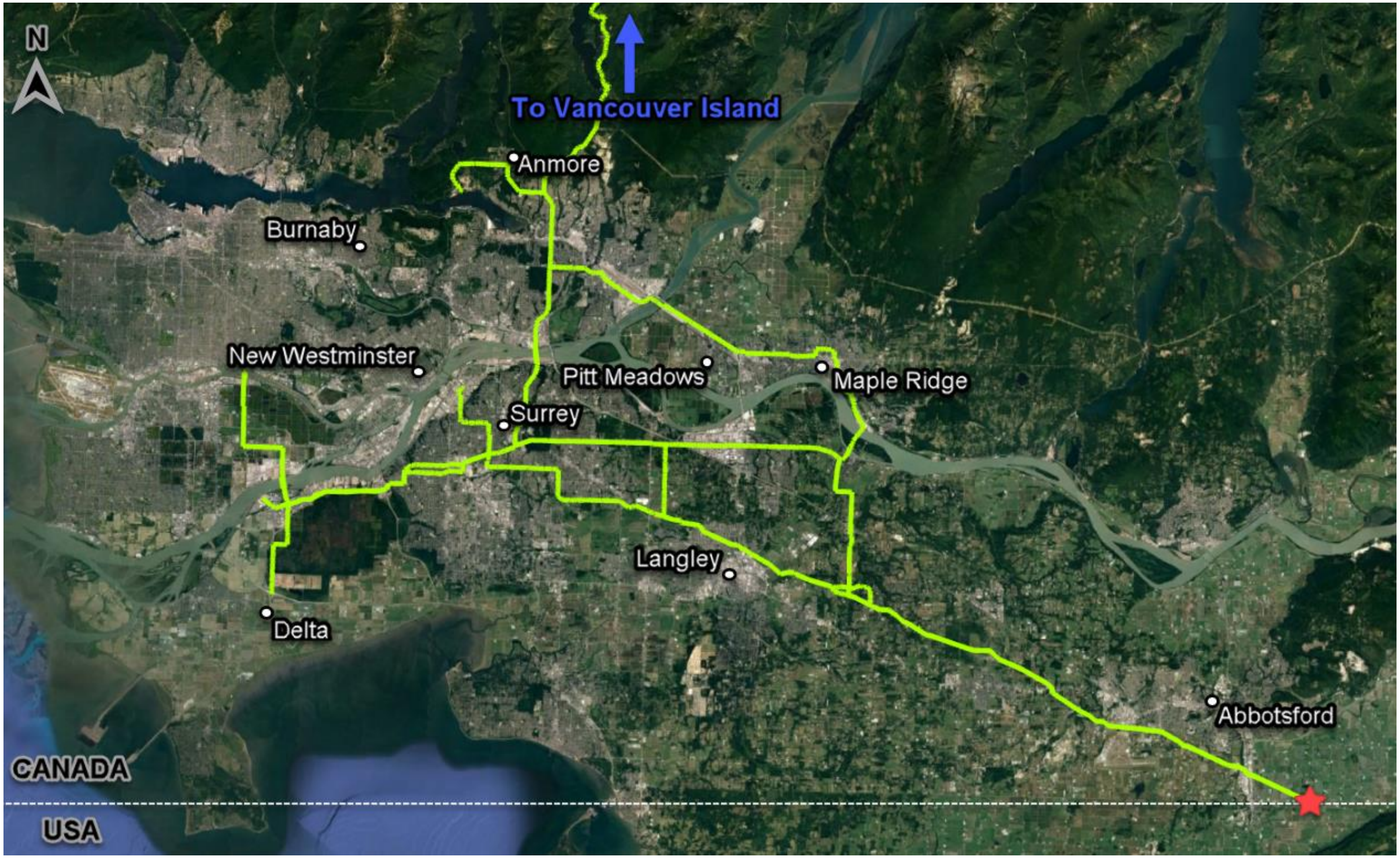
The Coastal Transmission System



Source: Application, Section 3.4.2

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Integrity Management Program – Pipeline*

- IMP-Pipeline to deliver safe, reliable, and environmentally responsible natural gas throughout operating life of pipeline
- IMP-Pipeline is required by:
  - *Oil and Gas Activities Act [section 37(1)]*
  - CSA Z662 Oil & Gas Pipeline Systems (as required by the *Pipeline Regulation) [section 10.3.1]*
- IMP-Pipeline elements:
  - 5 hazard categories
  - 19 IMP activities to mitigate those hazards

** BCUC Question: "A discussion of FEI's broader integrity management program, including … How FEI is addressing other pipeline integrity risks;"*

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Hazards and Mitigation Activities

Hazards	Hazard Category	Activities to Mitigate Hazards
	Third Party Damage	Right-of-Way Management (permits, vegetation, patrol, etc.) Security Management Depth of Cover Management
	Natural Hazards	Geotechnical and Hydrotechnical Management Seismic Hazard Management
	Time-dependent Threat Management (Pipe Condition)	External Corrosion Management Cathodic Protection System Management Stress Corrosion Cracking Management
	Material Defects / Equipment Failure	O&M Programs Materials Quality Assurance
	Human Factors (Construction and Operations)	Field Quality Pressure Management

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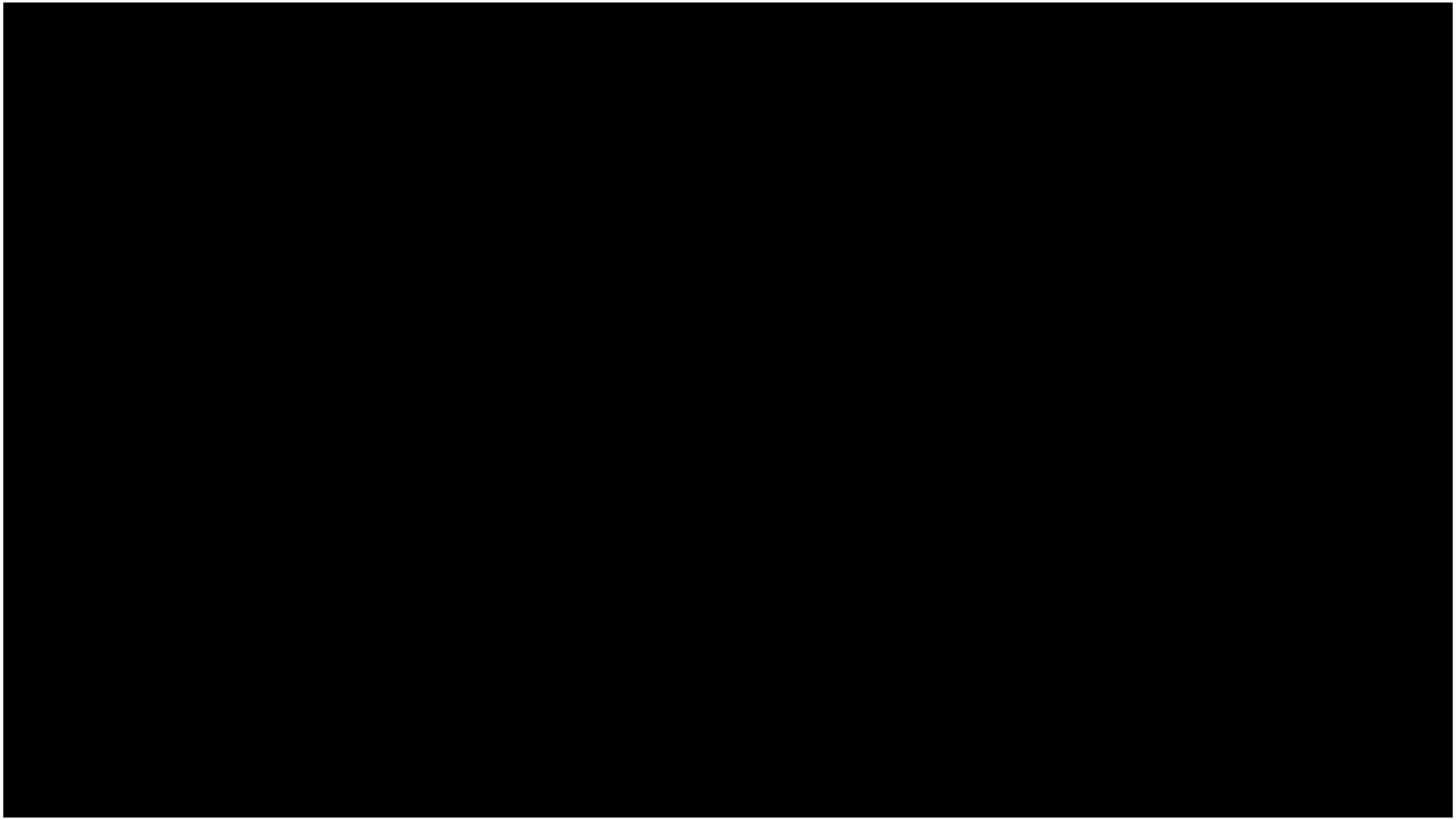
What Are ILI Tools?

- Complex assemblies
- Travel within a pipeline
- Collect location specific data on the condition of the line

How Do ILI Tools Work?



Video Source: https://youtu.be/hk-nq8LMR6I

What ILI Tools Are Commercially Available?

	Geometry	MFL	CMFL	EMAT
Dents	✓			
Wrinkles / Buckles	✓			
Metal loss		✓ (circumferentially-oriented features)	✓ (narrow longitudinally-oriented features)	
Long seam weld location			✓	✓
Girth weld location	✓	✓	✓	✓
SCC and crack-like features				✓
Longitudinal seam weld flaws				✓

Tools currently run by FEI

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Project Need: Cracking Threats

Presenter: Andrew Doyle

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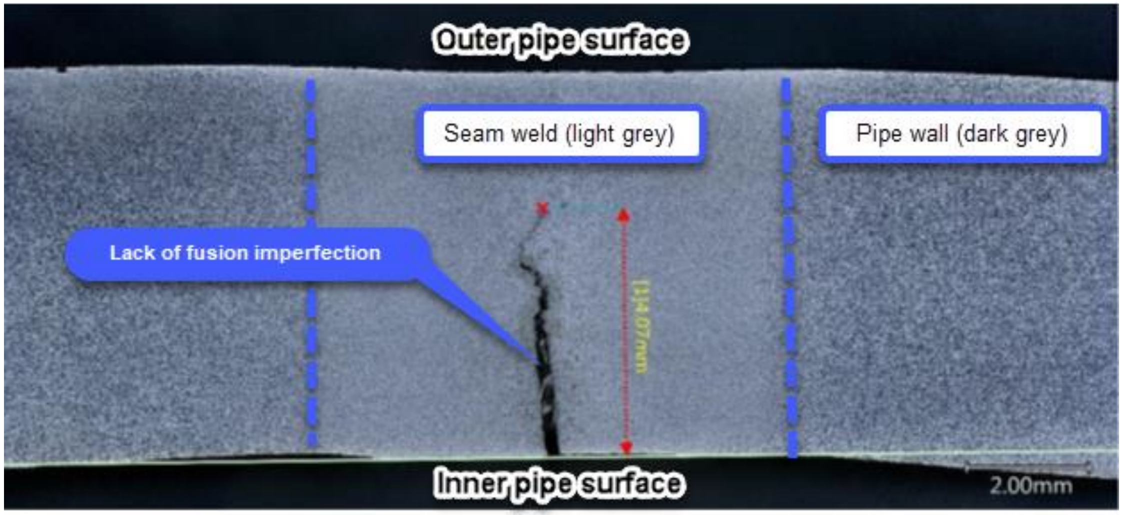
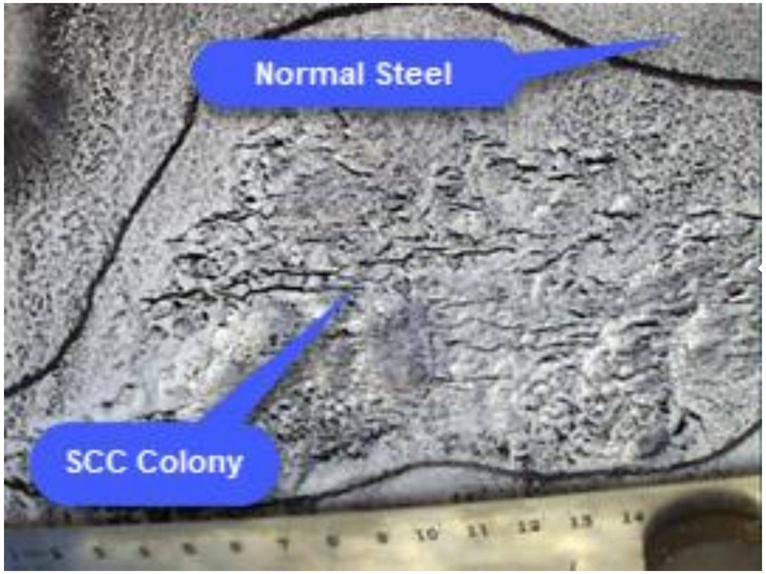
What Are Cracks And How Are They Introduced Into A Pipeline?

Crack-Like Imperfections in Seam Welds due to Legacy Manufacturing

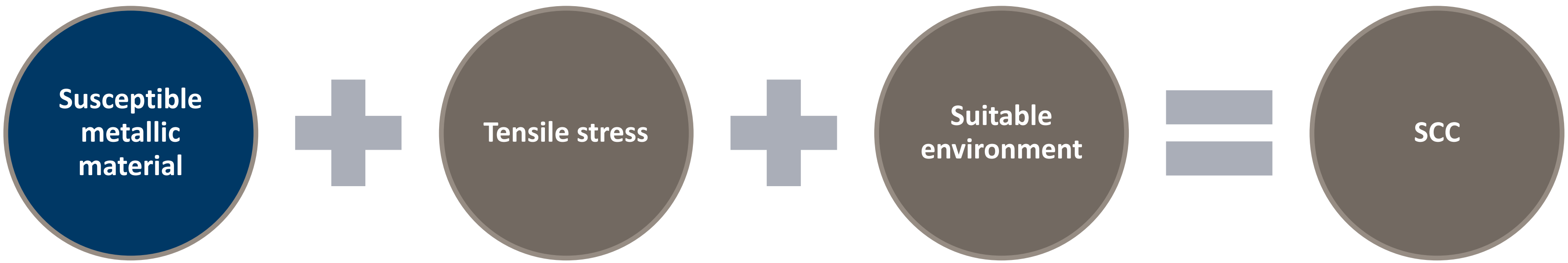




Stress Corrosion Cracking (SCC) due to Coating and Environment Factors

Stress Corrosion Cracking (SCC)

- Cracking of a material produced by the combined action of corrosion and tensile stress



Source: Application, Section 3.2.4

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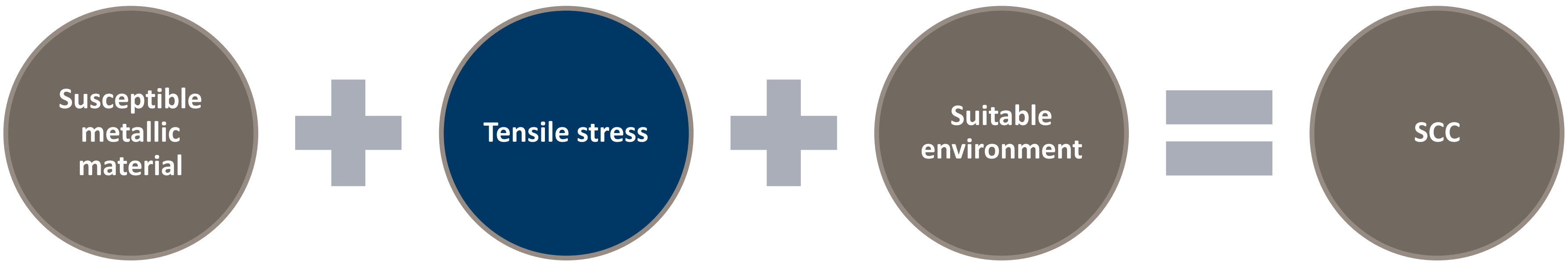

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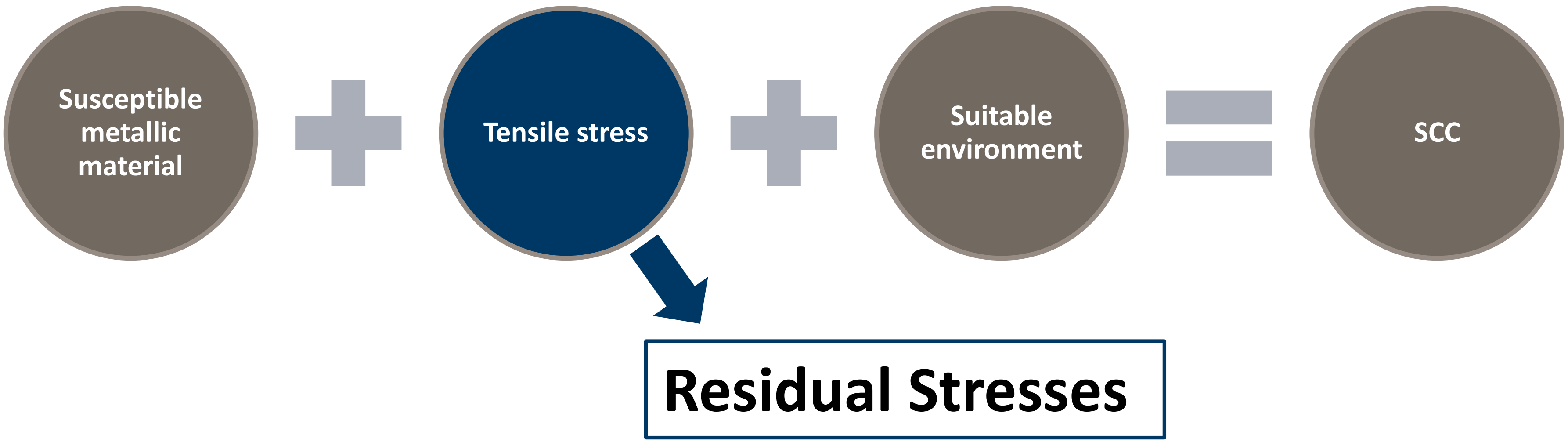

Source: Application, Section 3.2.4

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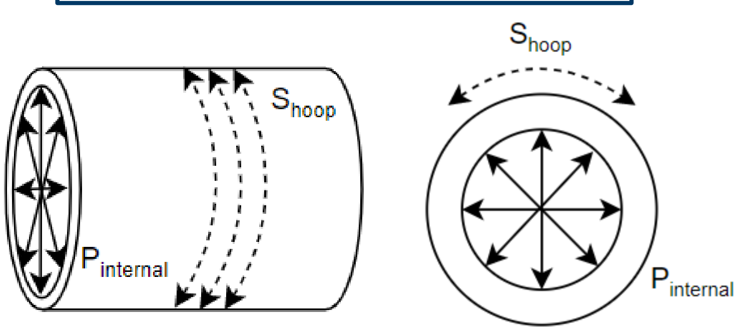
Stress Corrosion Cracking (SCC)

- Cracking of a material produced by the combined action of corrosion and tensile stress

Susceptible metallic material + **Tensile stress** + **Suitable environment** = **SCC**

Applied Stresses | **Residual Stresses**



Source: Application, Section 3.2.4

Stress Corrosion Cracking (SCC)

- Cracking of a material produced by the combined action of corrosion and tensile stress

Source: Application, Section 3.2.4

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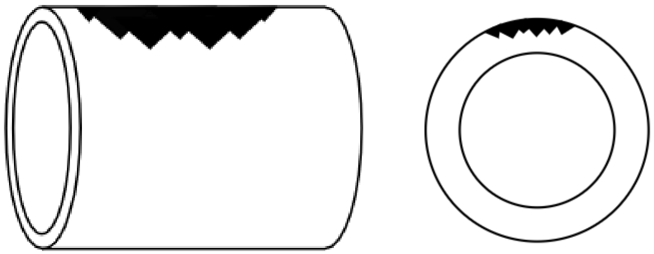
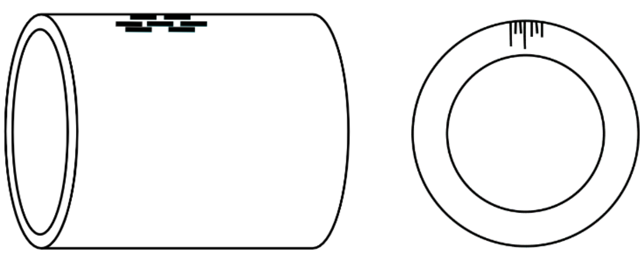
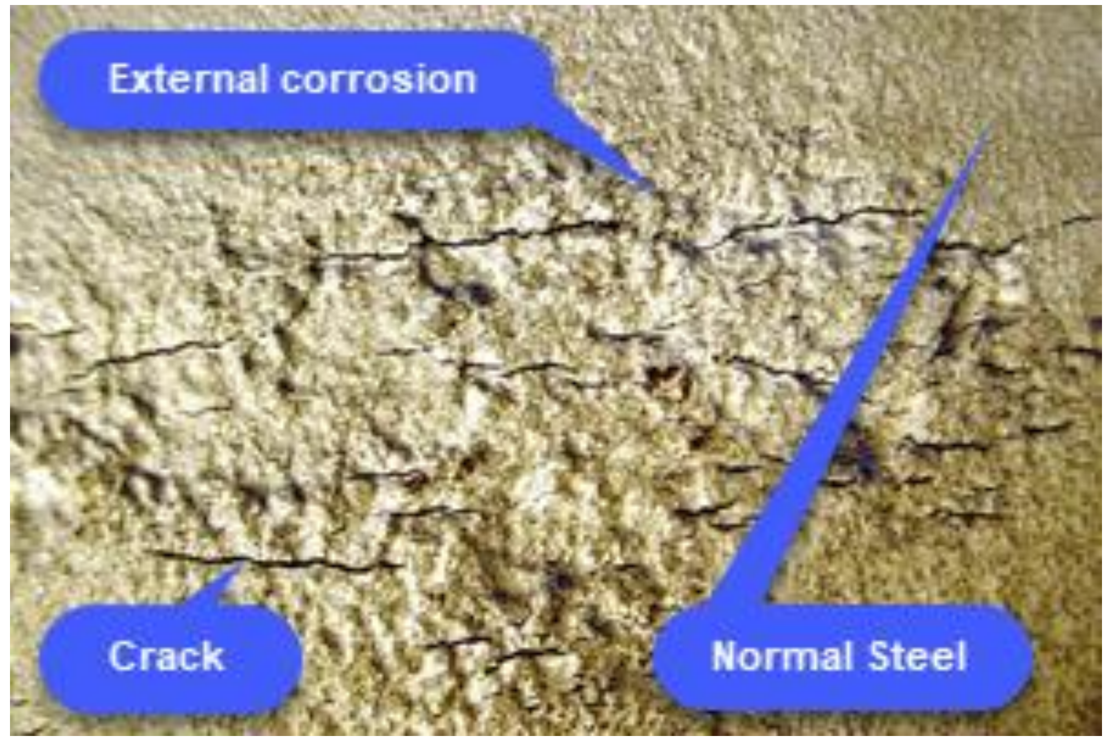
Effects of SCC Are Similar to Corrosion

External Corrosion



Stress Corrosion Cracking





Example of SCC Identified on FEI's Transmission Pipelines

Source: Application, Section 3.2.4

Loss of Containment

- An event where a pipeline is unable to contain the fluid

LEAK	**RUPTURE**
Any Pipeline	Can occur on Pipelines operating at ≥ 30% SMYS Transmission Pipelines

Source: Application, Section 3.5.3

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Loss of Containment

- An event where a pipeline is unable to contain the fluid

LEAK	**RUPTURE**
Any Pipeline	Can occur on Pipelines operating at $\geq$ 30% SMYS
	Transmission Pipelines
	⬇
	TIMC

Source: Application, Section 3.5.3

Cracking Threats Can Result in Rupture Failures

- FEI has not experienced any rupture failures as a result of SCC
- FEI has observed leaks as a result of crack-like imperfections in seam welds
- Rupture failures resulting from cracking have occurred in industry

** BCUC Question: … A summary of FEI's past experience with loss of containment due to stress corrosion cracking*

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Examples of Rupture Failures in the Industry

- Oct 9, 2018: Enbridge (Westcoast) NPS 36 natural gas transmission pipeline experienced an ignited rupture originating at stress corrosion cracks

Source: Figure 4, Transportation Safety Board of Canada. "Pipeline Transportation Safety Investigation P18H0088."

Source: Figure 7, Transportation Safety Board of Canada. "Pipeline Transportation Safety Investigation P18H0088."

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Cracking Threats – Regulatory Requirement

Excerpt from CSA Z662 section 10.3.1:

- "…shall include procedures to monitor for conditions that can lead to failures, to eliminate or mitigate such conditions…"

Source: Application, Section 3.5.2

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How Does FEI Currently Manage Cracking?

Source: Application, Section 3.2.5

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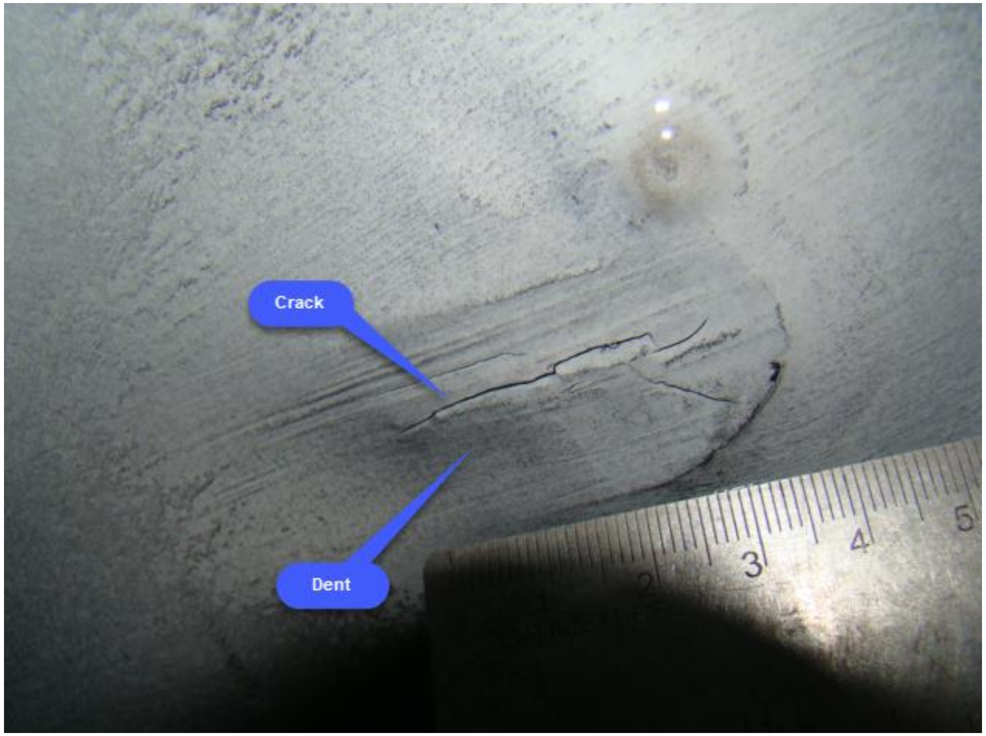
Opportunity Digs Find Cracking Exists on FEI's System

#	CTS TIMC Pipeline	Cracking Found
1	HUN NIC 1066	-
2	HUN NIC 762	✓
3	LIV COQ 323	✓
4	LIV PAT 457	✓
5	NIC PMA 610	✓
6	CPH BUR 508	✓
7	ROE TIL 914	-
8	TIL BEN 323	✓
9	TIL FRA 508	-
10	NIC FRA 610	-
11	TIL LNG 323	✓



Source: Application, Section 3.2.5

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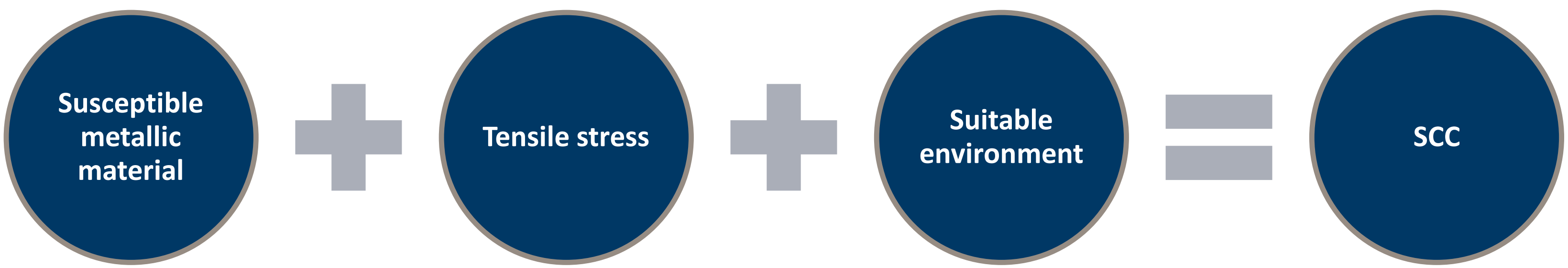
Limitations of FEI's Current Crack Management Practice

- Greater than 99% of the ~1900 km of transmission pipe lacks direct crack data because it has not been exposed as part of FEI's Integrity Dig Program
- Cracking is a highly localized and unpredictable phenomenon
- Analysis from integrity digs cannot be used to predict cracking on other segments of FEI's pipelines



Source: Application, Section 3.2.5

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Evolution of Industry Knowledge Has Led to TIMC Initiative

- Better understanding of pipeline characteristics contributing to SCC that can lead to failure
- Other operators have found cracking that can lead to failure on pipelines with characteristics similar to those in FEI's system
- Industry moving towards using crack detection ILI tools to monitor cracking threats on pipelines where suitable tools exist

Source: Application, Section 3.3

FEI's Risk Acceptance Criteria

- Currently no Canadian or North American consensus or direction in Z662 for **quantitative** risk acceptance criteria for natural gas transmission pipelines.
- FEI considers ruptures unacceptable.
- FEI understands that some of its pipelines are susceptible to cracking and that the consequences could be significant.
- FEI is proposing a cost effective solution to mitigate the risk of cracking through the CTS TIMC project.

* *BCUC Question:* A discussion of FEI's definition of acceptable level of risk, as prescribed by CSA Z662

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JANA Analysis of Cracking Threats & Quantitative Risk Assessment

Presenter: Dr. Ken Oliphant, Ph.D, P.Eng.

JANA Analysis

- **Analysis of Cracking Threats**
  - Pipeline-by-pipeline assessment of susceptibility of FEI transmission pipelines to cracking threats
- **Quantitative Risk Assessment (QRA)**
  - QRA of transmission pipelines to assess relative importance of cracking threats and support planning process

JANA'S RISK HISTORY

Founded in 1999 as an Engineering Lab

325 Million Hours of Test Data

Sold Lab Assets in 2014

Translated Intellectual Capital into Risk Solutions

Fully Quantitative, Probabilistic Models

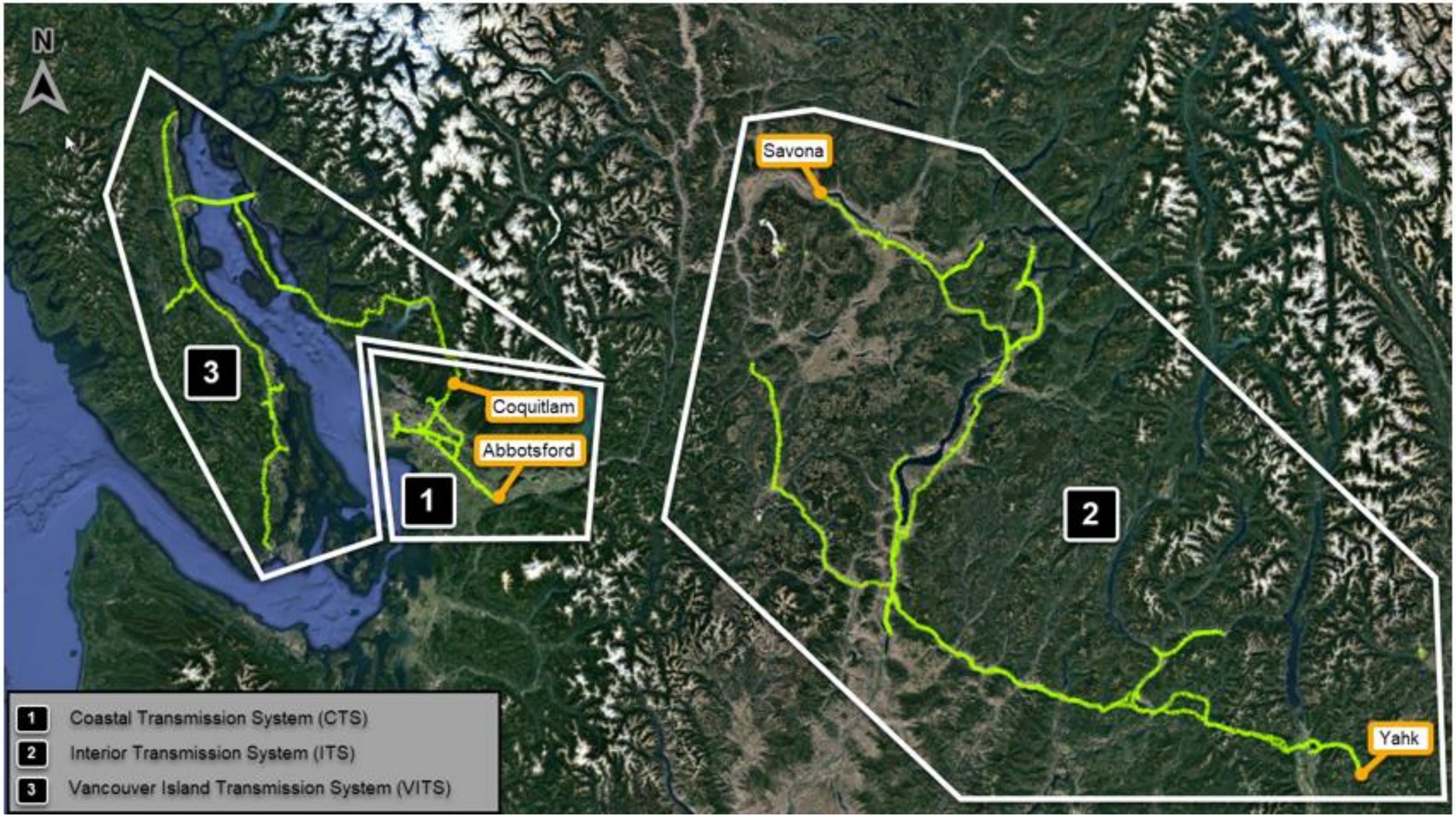
Leveraged with or without full Software Implementation

95 Employees

Engineering, Data, Software, Project Management

JANA's clients provide natural gas to 51 million homes in the US and Canada

FEI Transmission System Overview



Analysis of Cracking Threats

Scope

- **CTS, ITS, VITS mainline pipelines**
  - 35 pipelines
  - 1900 km
- **Pipeline-by-pipeline assessment of susceptibility to cracking threats**

Analysis of Cracking Threats

Scope

- **Susceptibility**
  - Pipeline properties and operating conditions
  - Assessment of historical dig reports (≈ 900 reports)
  - SME workshops on cracking found to date
- **Potential for cracks to grow to failure under FEI operating conditions**
  - Analysis of historical industry failures
  - Crack growth modelling in conjunction with Dr. Chen, University of Alberta
- **Estimates of contribution of cracking threats to overall frequency of failure and risk based on JANA baseline system level safety QRA**

Analysis of Cracking Threats

Findings

- **Cracking threats pose a credible threat**
  - Identification of CTS and ITS lines with characteristics that make them susceptible to cracking threats
  - Identification of SCC and seam issues in FEI CTS and ITS pipelines during integrity digs
  - Analysis that indicates identified SCC could grow to failure under FEI operating conditions:
    - Industry failures observed within the operating stress of FEI susceptible lines
    - Crack growth rate modelling in conjunction with Dr. Chen, University of Alberta indicates potential for cracks to grow to failure

Quantitative Risk Assessment (QRA)

Scope

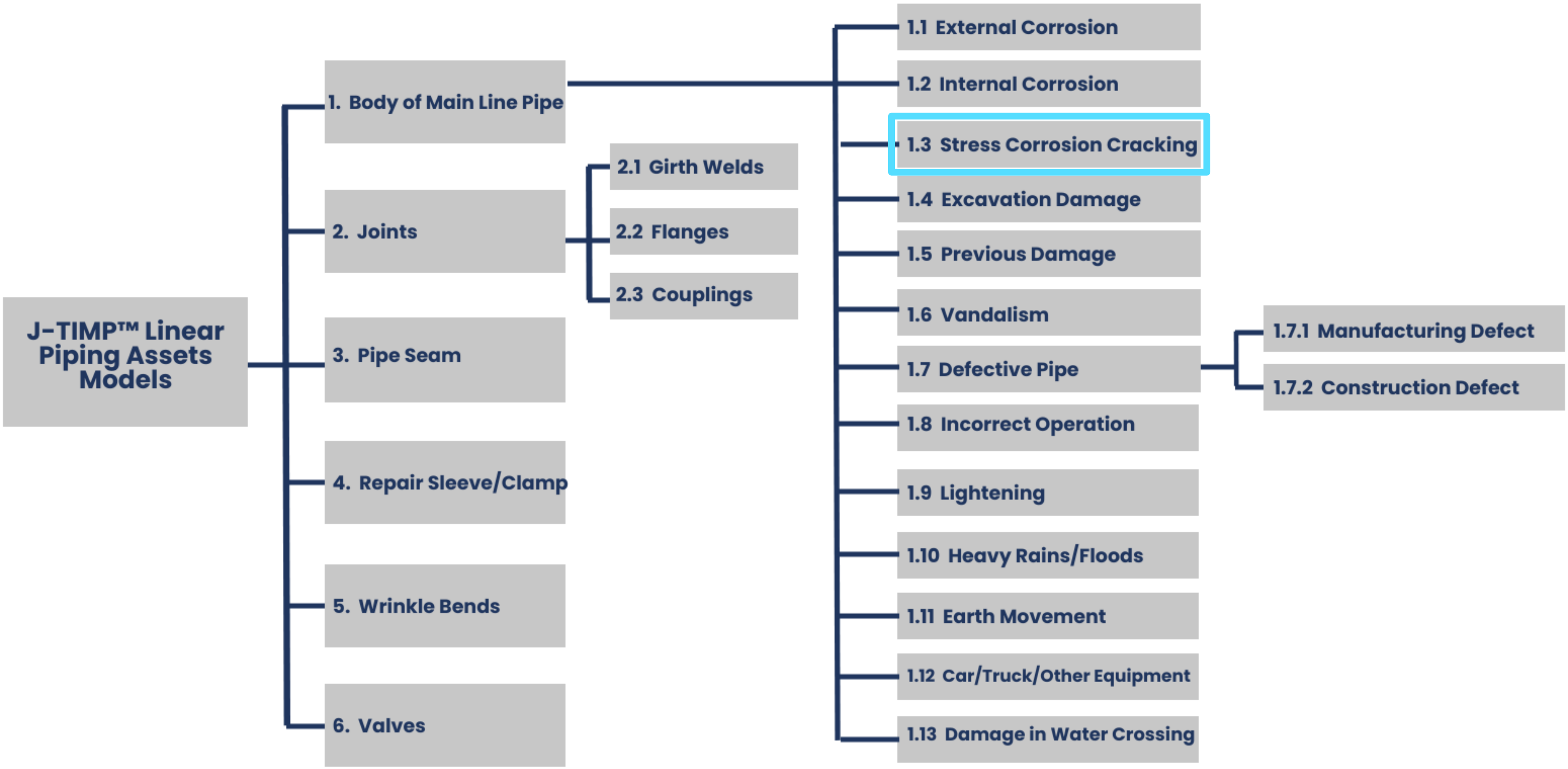
- **Baseline System Level Safety QRA**
- **Risk analyzed for all FEI's transmission pressure ("TP") in-line inspected (ILI) mainline pipelines in CTS, ITS and VITS systems**
  - 35 mainline transmission pipelines
  - 1900 km

Quantitative Risk Assessment (QRA)

Scope

- Approximately 75,000 pipeline segments
- 53 data parameters used for each segment plus MFL ILI and structure type data
- Approach presented to technical regulator (BC OGC)

RISK MODEL - MAINLINE PIPING



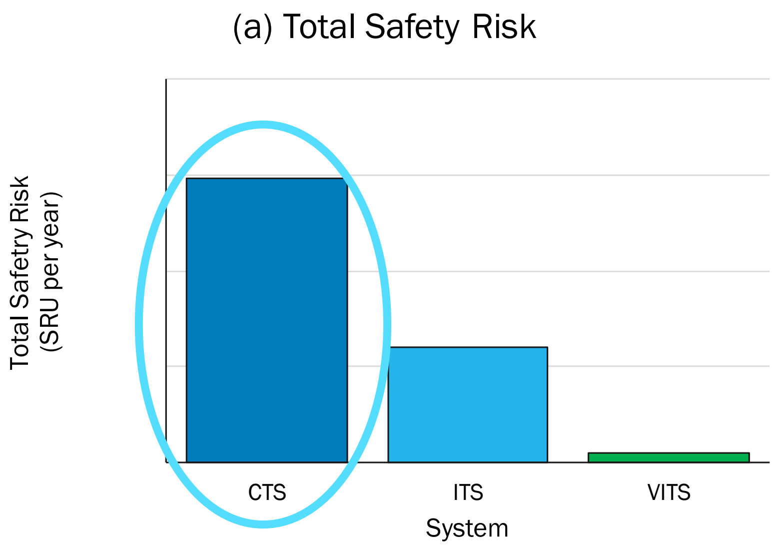
BCUC Panel Discussion
Use of Dig Reports for Risk Assessment

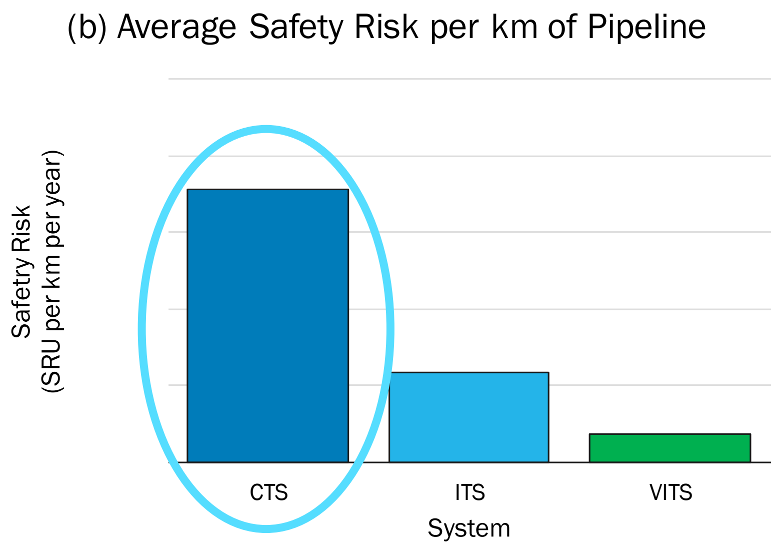
- **Question**
  - A discussion of [...], including FEI's experience with past integrity digs and how the number of digs impacts the safety risk calculation.
- **Answer**
  - Corrosion Threats
    - Risk based on identified ILI corrosion features
    - Risk reduced based on repairs (Dig reports/repair criteria)
  - Other threats not impacted (< 1% of line length excavated)

Quantitative Risk Assessment (QRA)

Results

- **CTS System has highest risk**

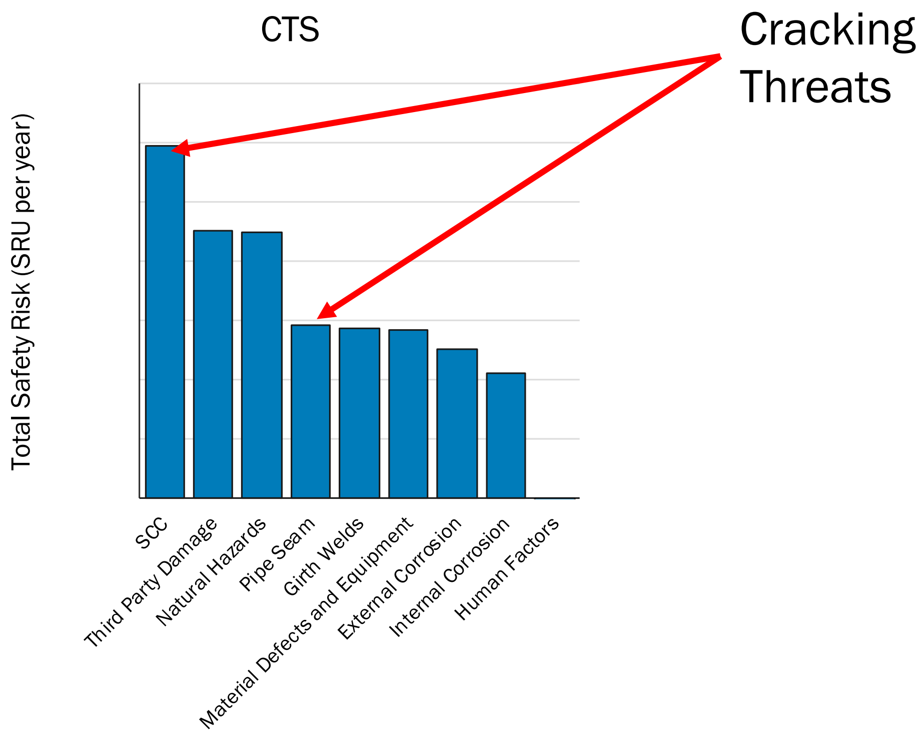




Quantitative Risk Assessment (QRA)

Results

- **Cracking greatest contributor to risk in CTS system**



Quantitative Risk Assessment (QRA)

Results

- **At the line level**
  - For 11 CTS pipelines identified as susceptible to cracking threats:
    - Cracking threats top driver of risk for nine of the pipelines
    - Second and fourth top line level threat for other two pipelines (specific sections in each of these pipelines where cracking threats are the top driver of risk)

JANA Analysis

- Pipelines within FEI system verified as being susceptible to cracking threats
- QRA verifies that cracking is a credible threat for susceptible pipelines
- CTS system has highest overall risk
- Cracking threats are dominate risk for CTS system overall

JANA

Project Alternatives, Description & Approvals Sought

Evaluation of Alternatives

Presenter: Andrew Doyle

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Evaluation Criteria

1. Technical
    a. Method Effectiveness
    b. Implementation Complexity
    c. Community and Environmental Impacts

2. Financial
    a. NPV of Total Capital and O&M Costs

Source: Application, Section 4.3

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Evaluation of Alternatives

	Alternative	Non-Financial Assessment	Technical Feasibility	Financial Assessment	Financial Feasibility
1	Stress Corrosion Cracking Direct Assessment		Not Feasible		
2	Pressure Regulating Station		Not Feasible		
3	Hydrostatic Testing Program		Not Feasible		
4	EMAT In-Line Inspection		**Feasible**		**Feasible**
5	Pipeline Replacement		Potentially Feasible		Not Feasible
6	Pipeline Exposure		Potentially Feasible		Not Feasible

Source: Application, Section 4.1

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EMAT ILI is FEI's Preferred Alternative

1. The <u>only feasible alternative</u> because:
   - Highly effective in detecting cracks in gas pipelines
   - Can be implemented on FEI's system, with only limited system alterations
   - Limited community and environmental impacts
2. Data can be utilized in FEI's on-going QRAs to improve and inform integrity management activities related to time-dependent threats
3. Aligns with FEI's current integrity management and industry practices

** BCUC Question:* A discussion of industry standard crack detection tools, including tools other than EMAT ILI

Source: Application, Section 4.6

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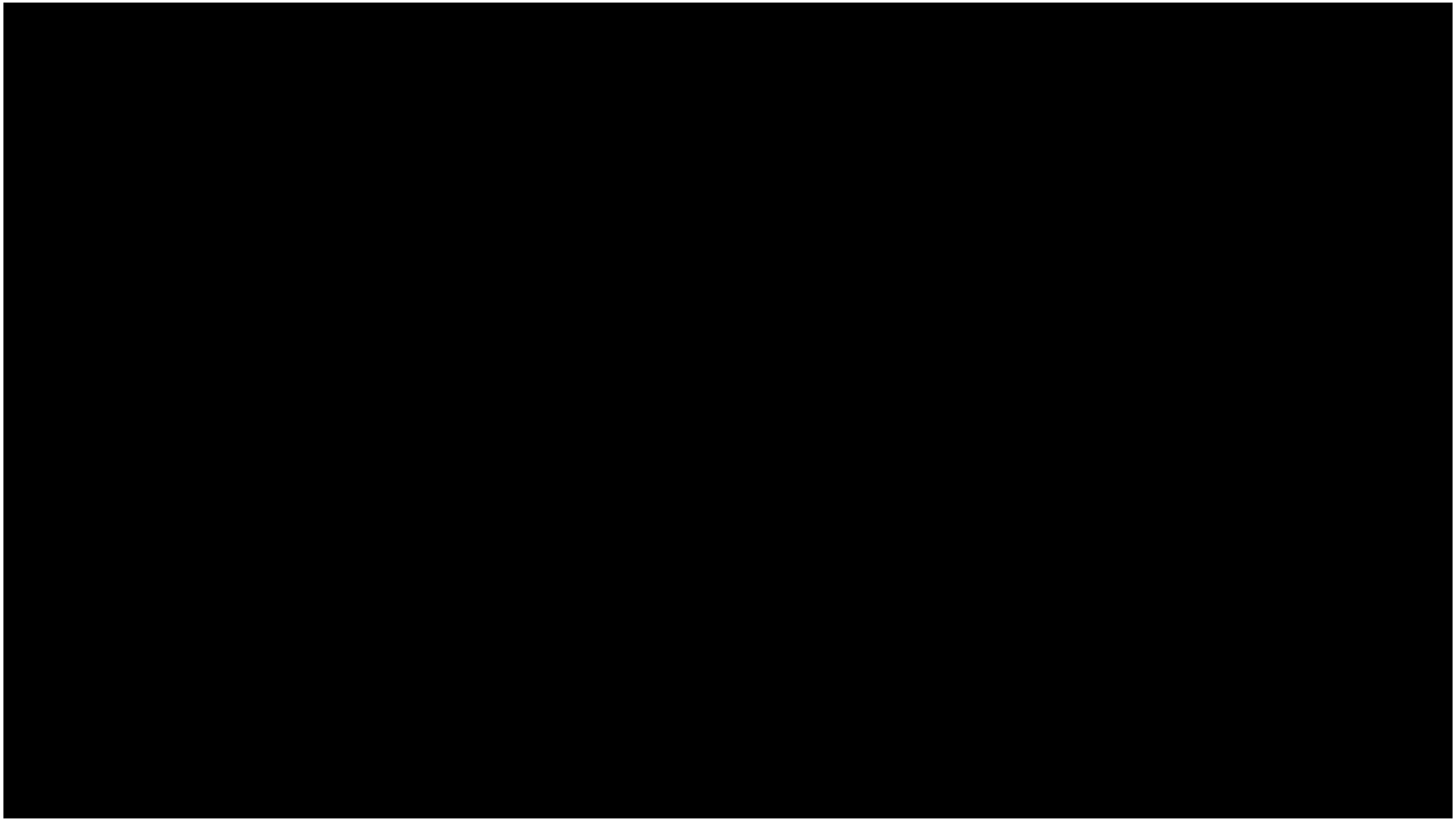
How Do EMAT Tools Work?



Video Source: https://youtu.be/yG3Q30fQfOw

What is required for successful EMAT ILI?

1. Ability to pass EMAT ILI tool through the pipeline
2. Maintain EMAT ILI tool velocity within optimal range
3. Minimize localized speed excursions
4. Ability to reduce pressure post-EMAT ILI run to respond to integrity findings

Source: Application, Section 5.4 and 5.5

FEI EMAT Pilot Project

Source: Application, Section 5.3.3

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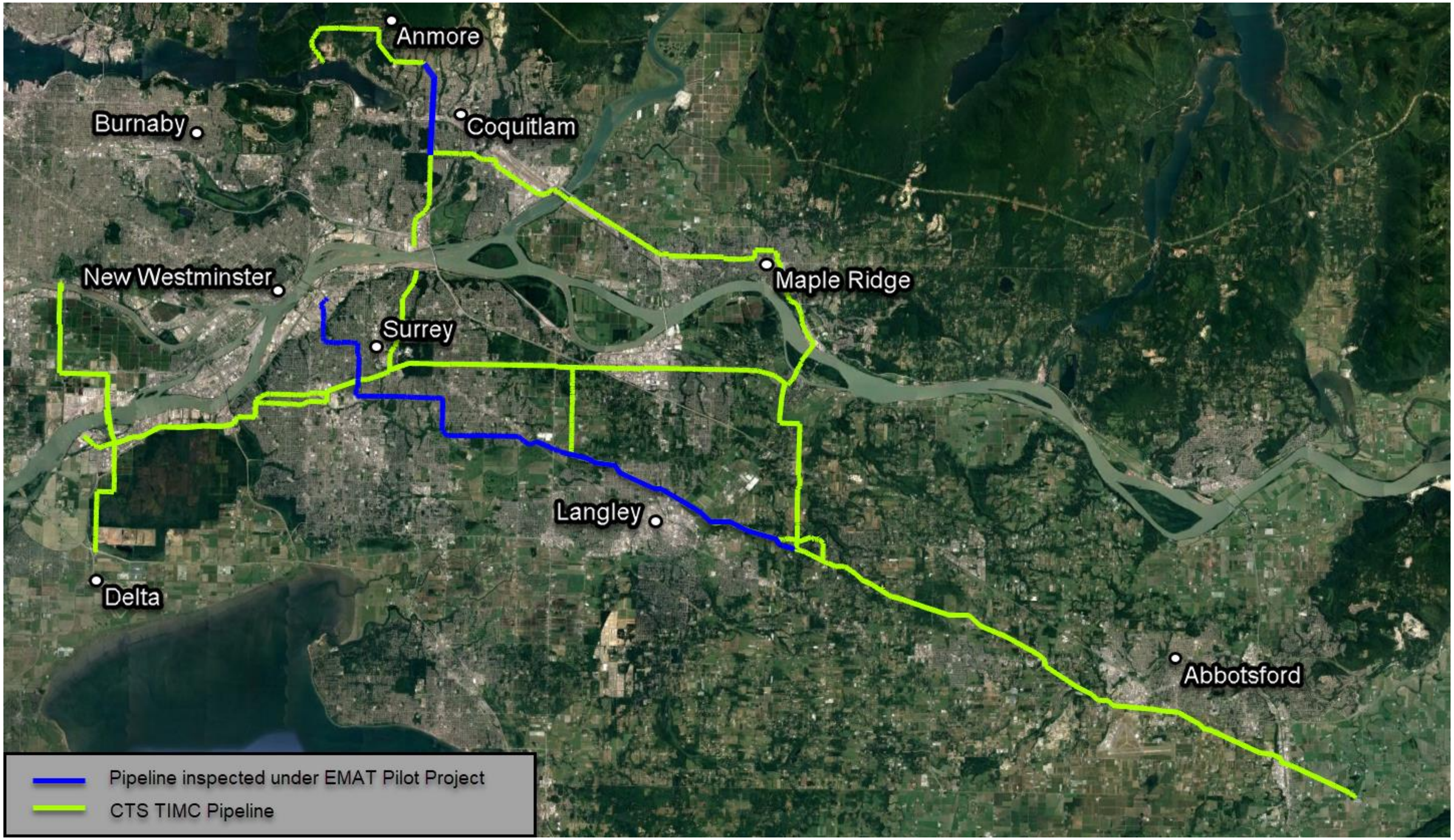
FEI EMAT Pilot Project



Source: Application, Section 5.3.3

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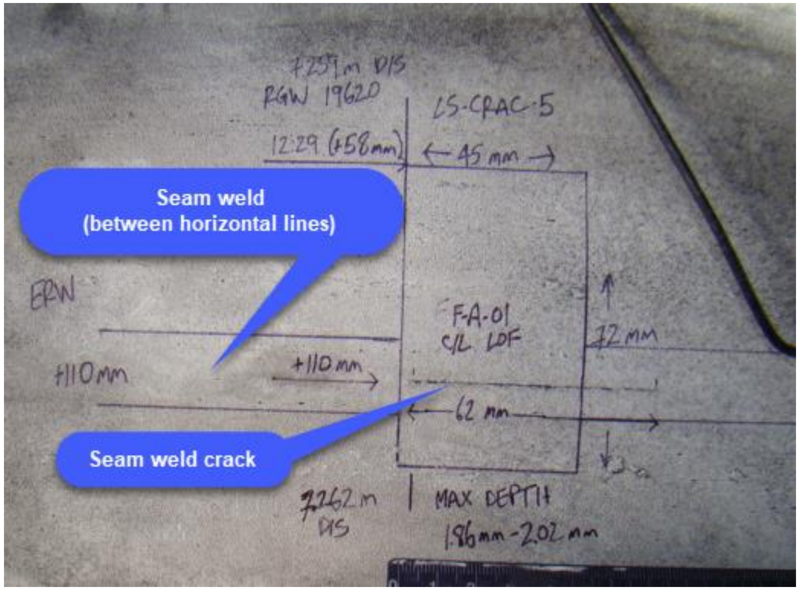
Lessons Learned from EMAT Pilot Project

- Tool runs were successful
- Results confirmed assumptions that formed the basis of the CTS TIMC CPCN Application
    1. Unidentified cracking existed
    2. Run behaviour of MFLC tool predicts EMAT tool behaviour
    3. Confirmed post-run response



* *BCUC Question:* Lessons learned from FEI's EMAT ILI tool pilot

Source: Application, Section 5.3.3

Project Description

Source: *Application, Section 5*

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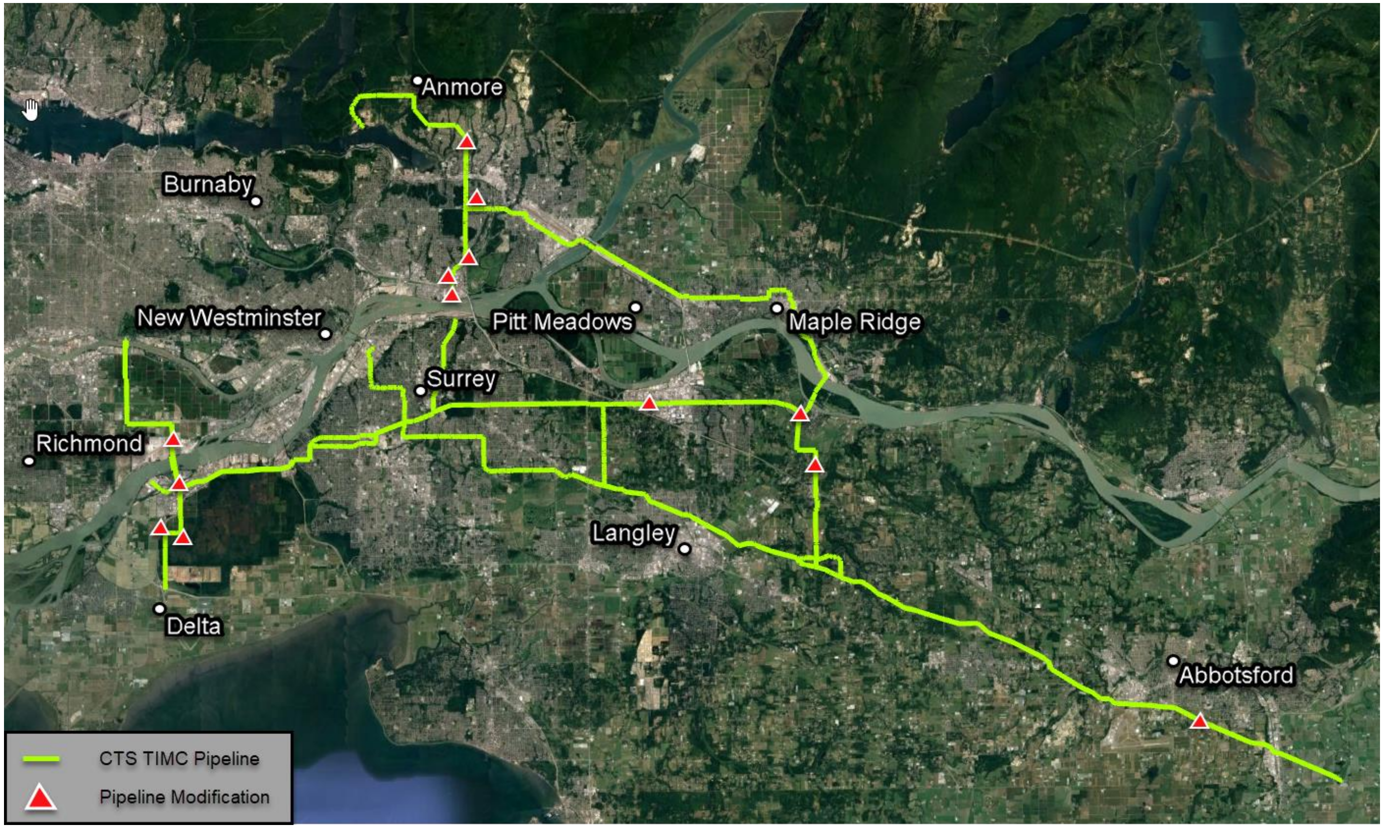
Scope of Modifications

Pipelines

- 13 locations requiring modification



Source: Application, Section 5.4

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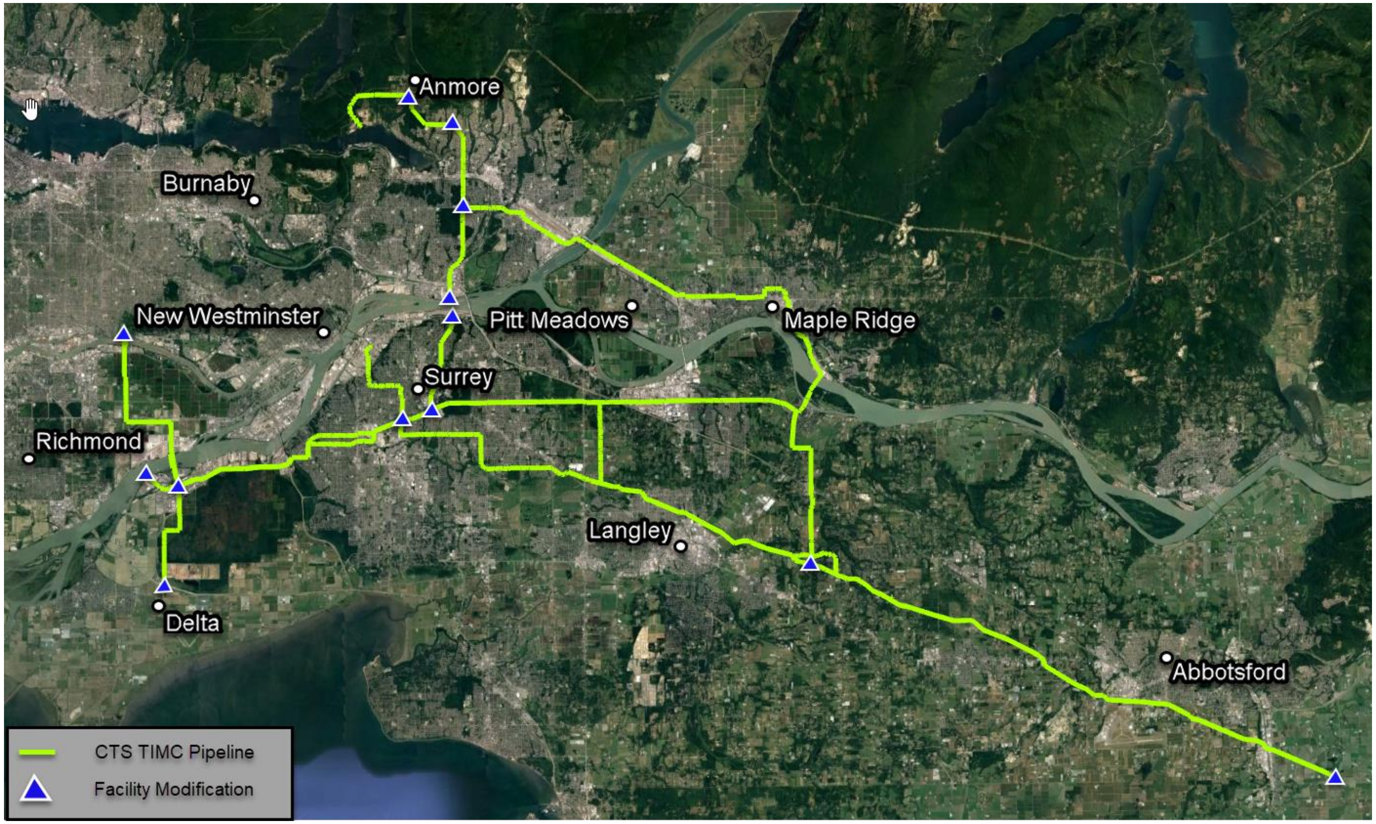
Scope of Modifications

Facilities

- 13 facilities requiring modification



Source: Application, Section 5.5

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Scope of Modifications

<u>Facilities – Barrel Modifications</u>

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Scope of Modifications

<u>Facilities – Flow Control and Pressure Control Facilities</u>

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SCC Management Post EMAT ILI Run

1. Prepare the System ➡ **CTS TIMC**
2. Run the Tools
3. Analyze the Data
4. Inspect Anomalies and Repair Cracks
5. Inform Future Plans

* *BCUC Question:* A discussion of … how the ability to run EMAT ILI tools fits into FEI’s broader SCC Management

Source: Application, Section 5.11

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Approvals Sought

FEI is seeking the following approvals:

- A Certificate of Public Convenience and Necessity to proceed with CTS TIMC Project, as described in Section 5 of the Application
- Disposition of the Balance in the TIMC Development Cost Deferral Account, as described in Section 6.2 of the Application.

Question Period

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