Addressing The Seam Weld Threat:
A Gas Operator Perspective

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Managing Line Pipe Seam Weld Challenges
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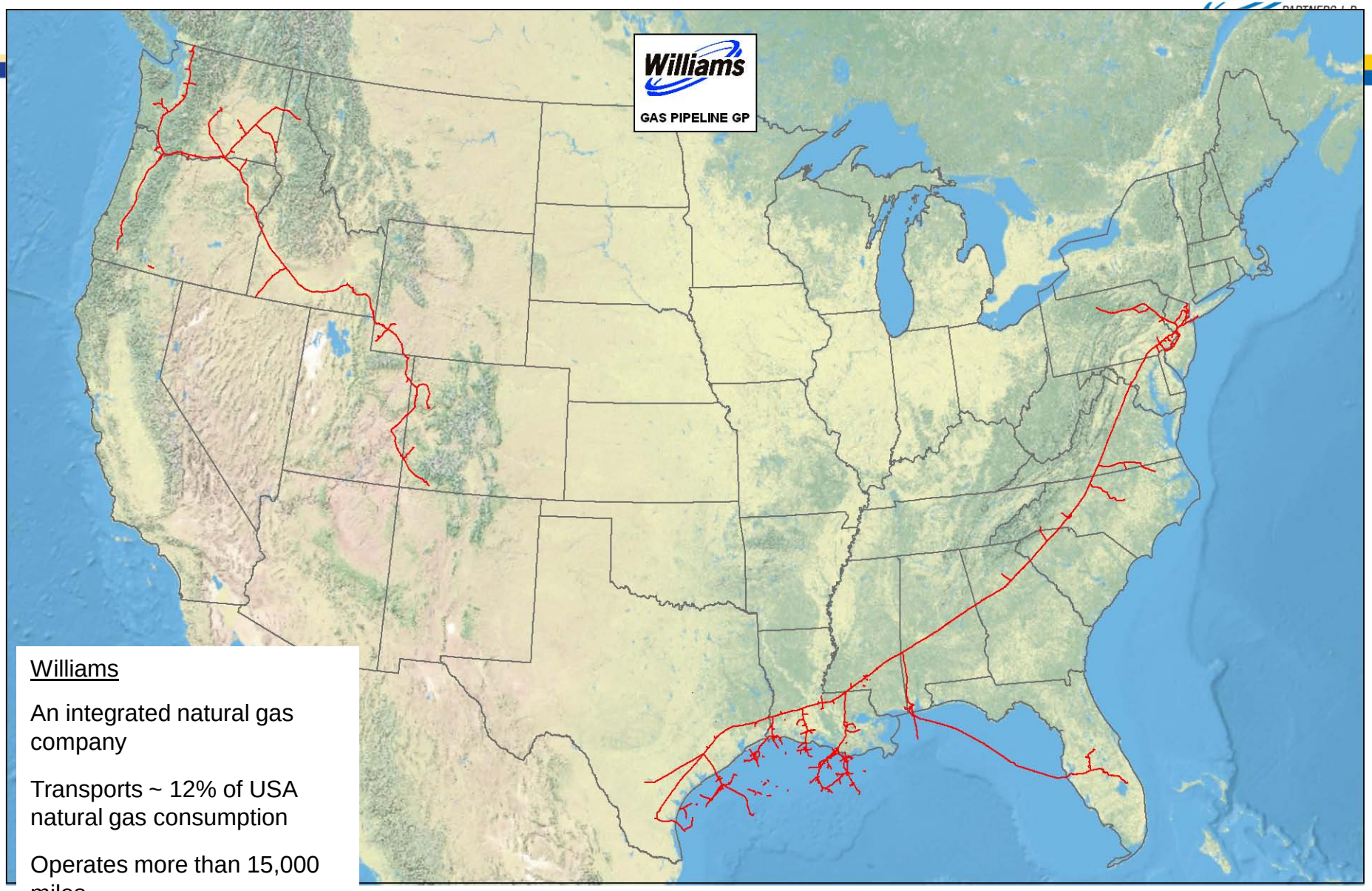


Williams

An integrated natural gas company

Transports ~ 12% of USA natural gas consumption

Operates more than 15,000 miles

Outline

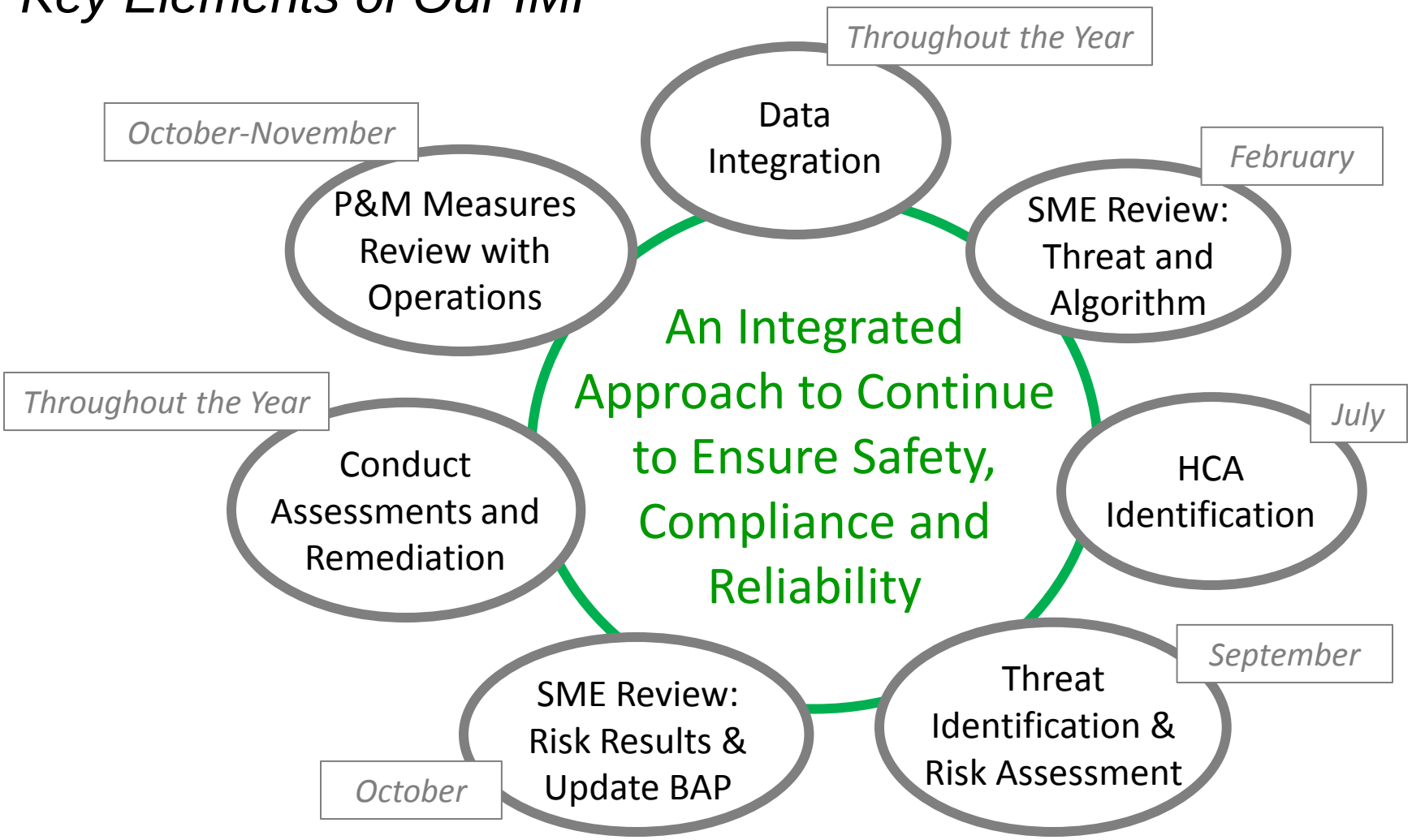
- Seam Weld Related Defects…*An Emerging Threat to Gas Pipelines?*
- Managing the Seam Weld Threat as Part of an Integrity Program
- Seam Weld Threat Analysis: *Key Factors*
- Data Integration and Subject Matter Expert (SME) Reviews
- Some Challenges and Opportunities

Seam Weld Related Defects…*An Emerging Threat to Gas Pipelines?*

- Seam weld related defects/imperfections created during the pipe manufacturing process do not generally pose a safety concern
- Seam weld related defects are considered to be stable in gas transmission pipelines as long as
  - Pressure testing is performed to sufficiently higher levels above MAOP
  - Operational pressure levels do not increase significantly
  - Interacting threats do not drive the growth of such defects to critical sizes during service conditions
- An integrated IMP provides an framework for determining the potential safety risks that seam weld related defects may pose to pipelines
  - Data Gathering, Threat Identification, Risk Analysis, Assessment-Response-Mitigation, and Continuous Evaluation/Process Improvement

Managing the Seam Weld Threat as Part of an Integrity Program

Key Elements of Our IMP



Seam Weld Threat Analysis: *Key Factors*

Pressure Test & Seam Type Records

- Commissioning Tests
- Upgrades or Requalification Tests
- Pipe Mill Tests
- Verification of Seam Type and Vintage

Seam Weld Related Failures

- In-Service Leaks or Ruptures
- Hydrostatic Test Leaks or Ruptures
- Interactive Threat Related Leaks or Ruptures
- Similar Pipe in the System has Experienced Seam Failure

Interactive Threats

- Increases on MAOP
- Cyclic Fatigue
- Significant Operational Pressure Increases
- Landslides
- Selective Seam Corrosion
- SCC or other forms of cracking linking up with defective seam
- New Threats…

Williams' SME Threat Identification and Algorithm Review Process

- Section 1: *Current Algorithm Effectiveness*
  - Review algorithm for effectiveness
- Section 2: *Data Elements*
  - Gather and review all pertinent data sets in preparation for the Manufacturing threat analysis and risk algorithm review
- Section 3: *Interacting Threats*
  - Review and determine which threats interact with the Manufacturing Threat that could pose a safety concern
  - Evaluate the effects of more than one threat occurring on the pipeline section at the same time
- Section 4: *Integrity Assessment Methods*
  - Review appropriate integrity assessment methods
  - Hydrostatic testing or In-line Inspection (suite of tools: MFL + C-MFL + EMAT)
- Section 5: *Preventive and Mitigative Measures*
  - Review activities that would prevent or mitigate the Manufacturing Threat. Additional measures should be added as they become available

Performing Seam Weld Threat Analysis

Pressure Test Records
≥ 1.25 MAOP

and

No Interacting
Threats

If an in-service seam weld related failure occurs after a pressure test of 1.25 MAOP, perform an integrity assessment capable of assessing seam integrity

Threat is Determined to be Stable/Low Priority

No Assessment Needed

Continue Monitoring for Interacting Threats

Performing Seam Weld Threat Analysis

Pressure Test Records of <1.25 MAOP

and

No History of Seam Weld Related Failures

and

No Interacting Threats

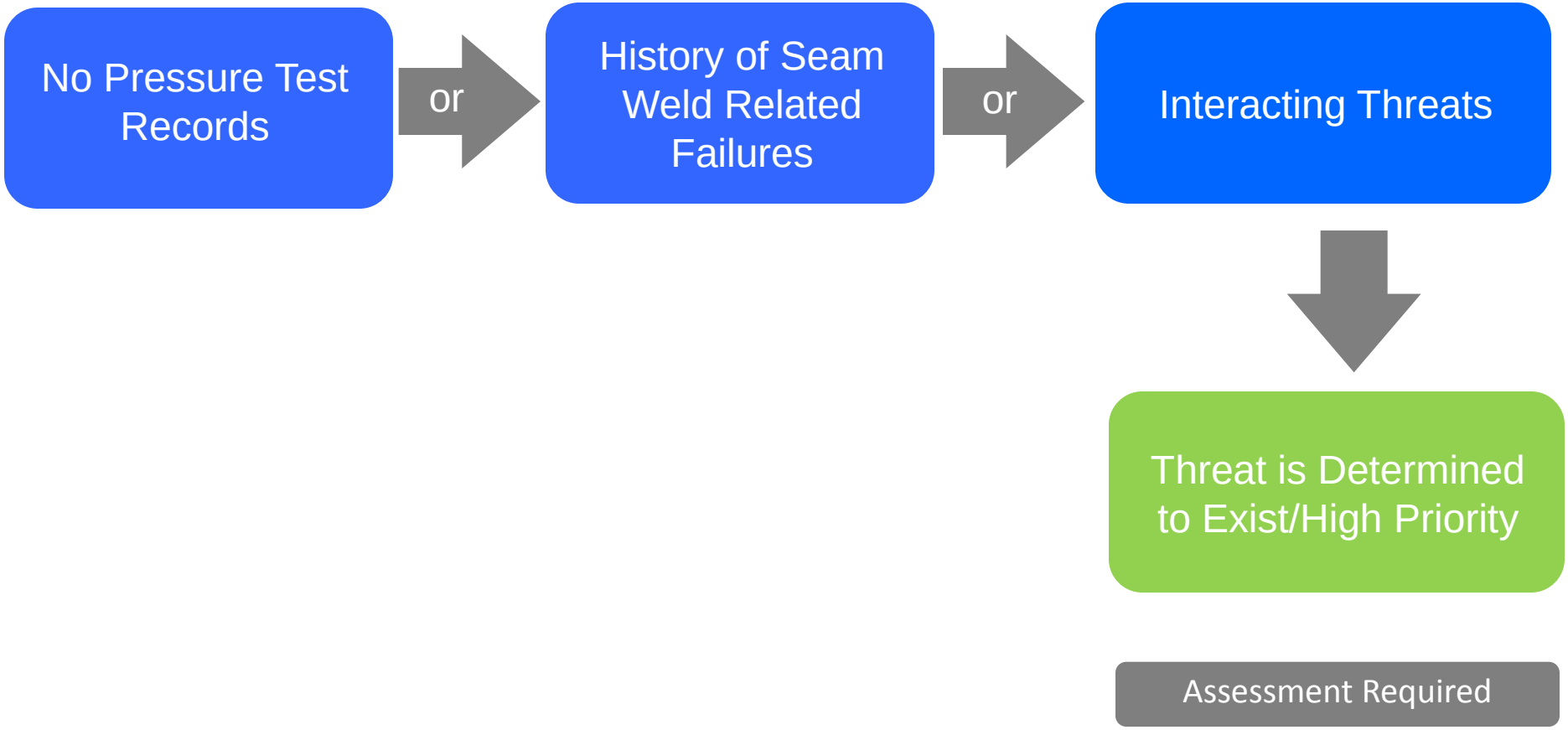
Threat is Determined to be Stable/Medium Priority

No Assessment Needed

Continue Monitoring for Interacting Threats

See M-Chart 3 of J. Kiefner report No. 05-12R dated 2007 to PHMSA. Also, see pages 15-24 of E. Clark, B. Leis, & R. Eiber report No. F-2002-50435 dated 2004 to INGAA and IMP Protocol question C.01

Performing Seam Weld Threat Analysis

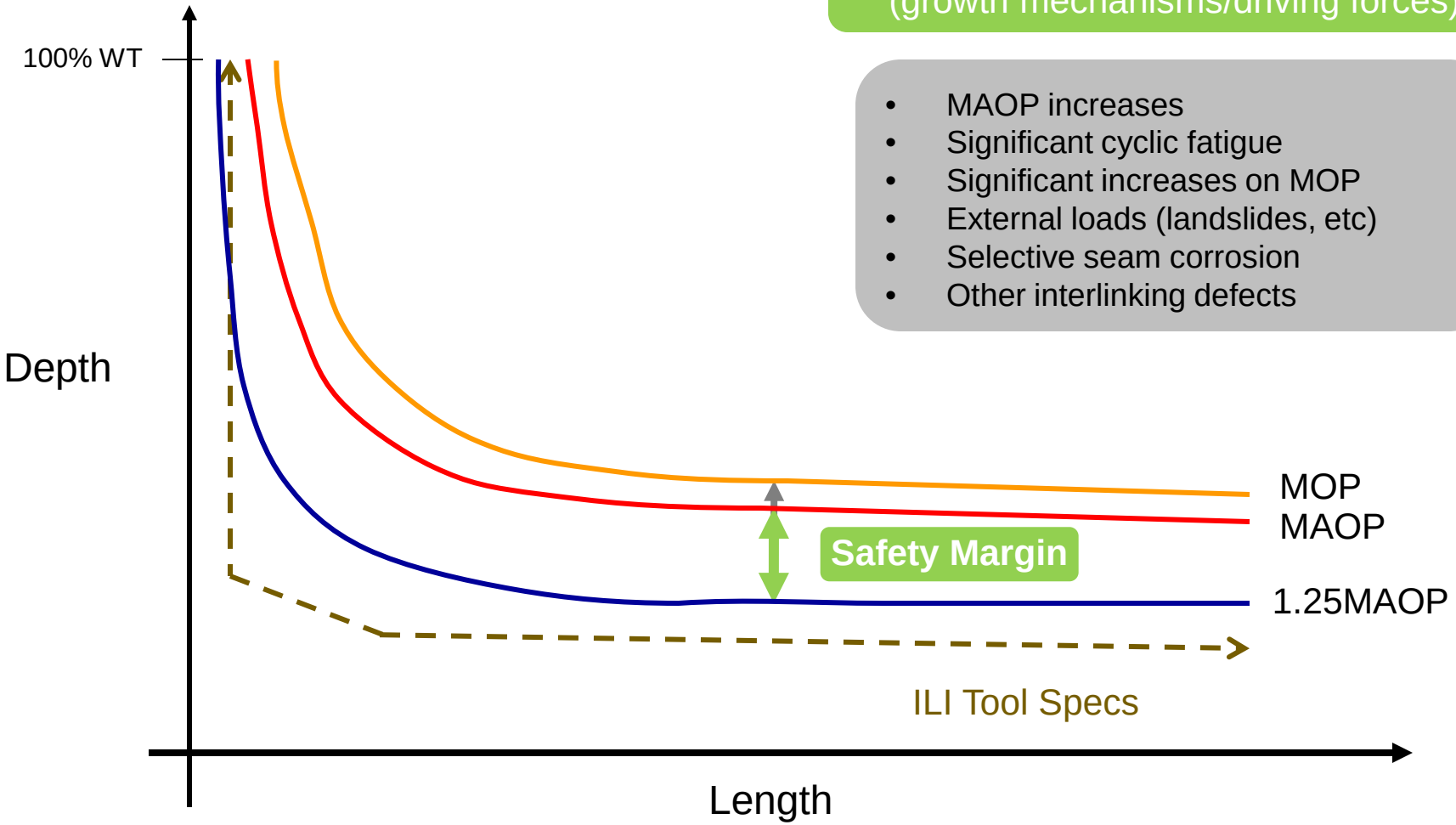


Safety Margins

An Illustration of Seam Weld Defects Expected to Fail/Survive a Pressure Test

What Would Erode the Safety Margin?
(growth mechanisms/driving forces)

- MAOP increases
- Significant cyclic fatigue
- Significant increases on MOP
- External loads (landslides, etc)
- Selective seam corrosion
- Other interlinking defects



Some Challenges & Opportunities

- Historic pressure test records show test levels in the range of $1.1 \leq MAOP < 1.25$
  - Prior to 1970, there was no requirement or standard practice to pressure test to a minimum of 1.25MAOP
  - How adequate is the safety margin provided by a 1.1MAOP hydrostatic test?
- Seam weld anomalies typical of gas transmission pipelines
  - Cold weld, lack of fusion, selective seam corrosion, stitching, misalignment of edges
  - Irregular in shape and around areas of relative low fracture toughness
- Enhancing an In-line Inspection based program
  - Suite of tools: MFL + C-MFL + EMAT (key seam weld features: tight & irregular shape)
  - Increase tools/analysts confidence through pull tests of pipe with natural seam weld defects
  - Response and mitigation (digging criteria)
  - Validation performance (addressing ILI uncertainties)
- Guarding against seam weld related leaks
  - Similar challenges as guarding for corrosion related leaks

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