56. Leveraging Engineering Assessments and Engineering Critical Assessments for an enhanced and practical approach to evaluating pipeline conditions

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Leveraging Engineering Assessments and Engineering Critical Assessments for an enhanced and practical approach to evaluating pipeline conditions

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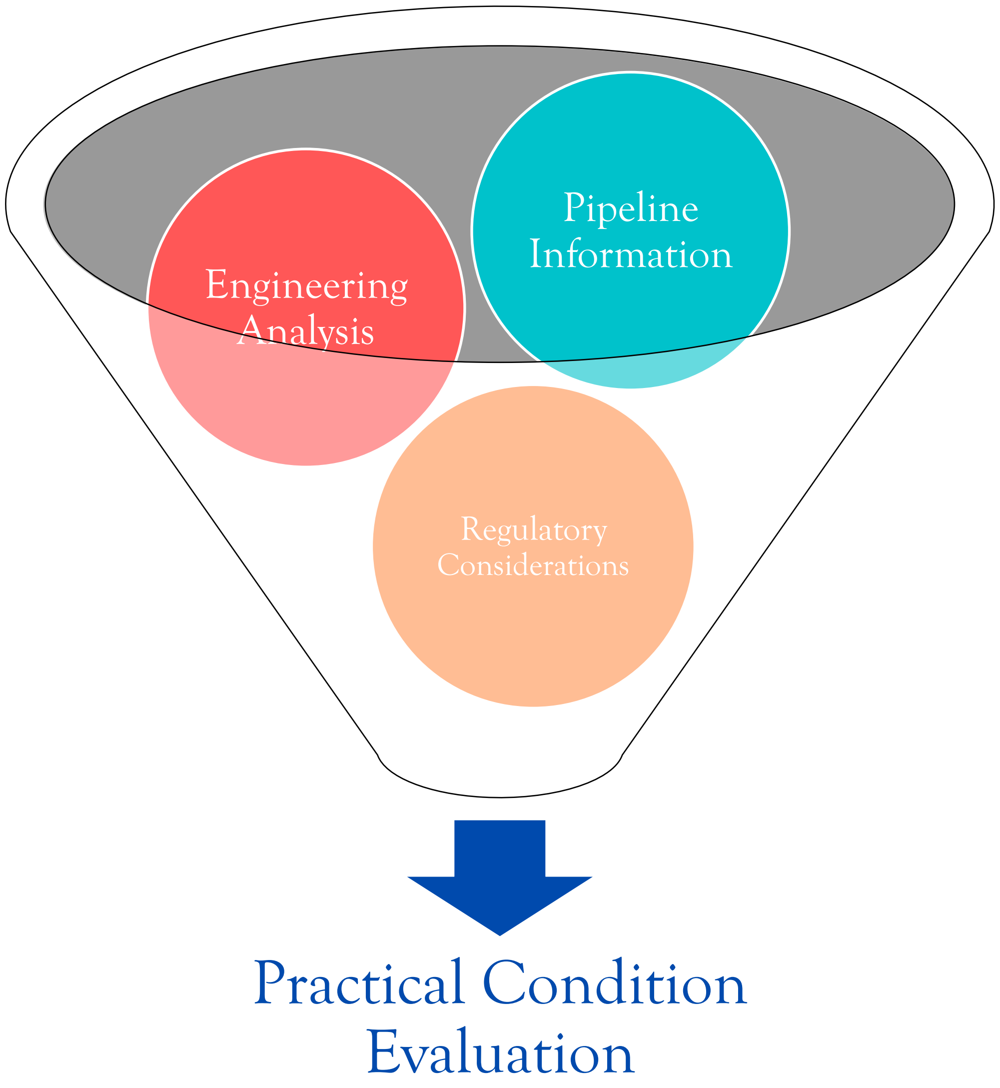
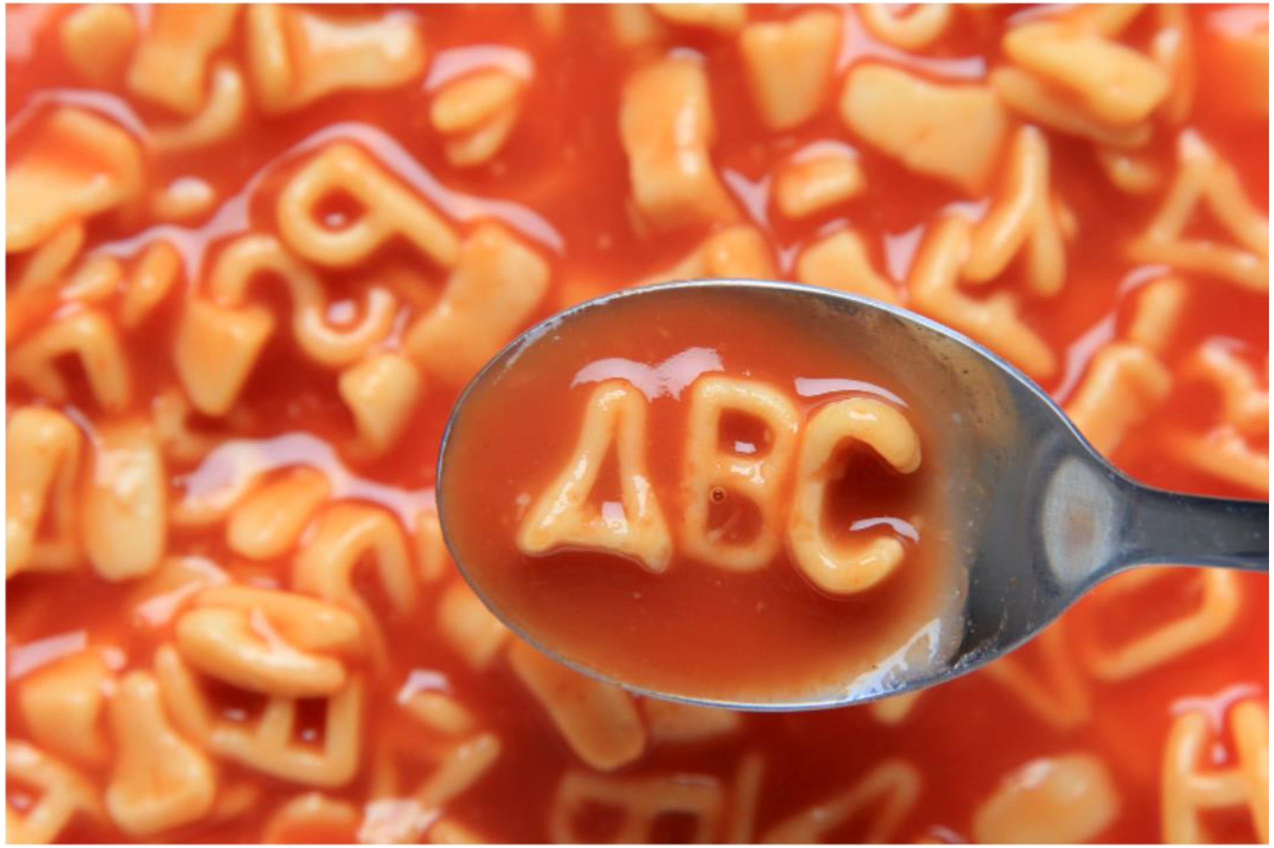


Introduction

- Save time and money
- Achieve reliable integrity management
- Be efficient and consistent
- Compliance with regulations

Acronyms



- EA
- ECA
- FFS

Definition: Fitness for Service (FFS)

American Petroleum Institute (API) Recommended Practice (RP) 579[1]	Fitness for Service (FFS)
Definition	A methodology whereby flaws or a damage state in a component is evaluated to determine the adequacy of the component for continued operation
Use	To make run-repair-replace decisions for pressurized equipment.

[1]American Petroleum Institute (API) 579 Fitness for Service Standard, December 2021

Definitions: Canadian (CA) Standards

CSA Z662[1]	Engineering Assessment (EA)	Engineering Critical Assessment (ECA)
Definition	A documented assessment of the effect of relevant variables upon fitness for service or integrity of a pipeline system, using engineering principles, conducted by or under the direct supervision of a competent person with demonstrated understanding and experience in the application of engineering and risk management principles related to the issues being assessed.	An analytical procedure based on fracture mechanics principles that allow the determination of the maximum tolerable sizes for imperfections in fusion welds
Use	EAs determine fitness-for-service in a variety of circumstances.	ECAs are conducted specifically for the consideration of imperfections in girth welds after construction. Guidance for the evaluation and acceptance of anomalies is provided in Annex J of CSA Z662.

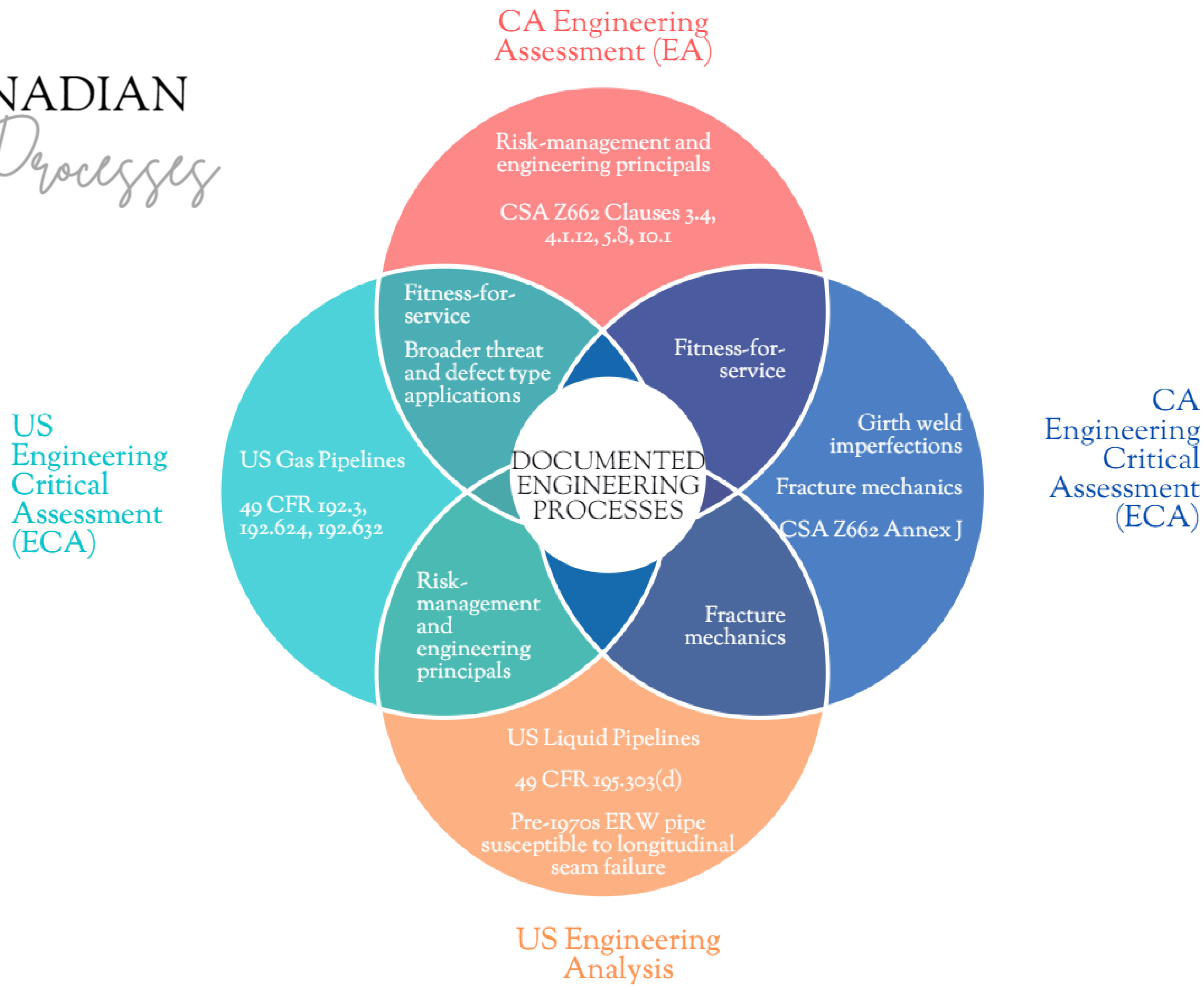
[1]Canadian Standards Association (CSA) Z662: Oil and Gas Pipeline Systems, Eighth Edition, 2019

Definition: United States (US) Regulations

US Regulations 49 CFR Part 192*	Engineering Critical Assessment (ECA)
Definition	A documented analytical procedure based on fracture mechanics principles, relevant material properties (mechanical and fracture resistance properties), operating history, the operational environment, in-service degradation, possible failure mechanisms, initial and final defect sizes, and usage of future operating and maintenance procedures to determine the maximum tolerable sizes for imperfections based upon the pipeline segment maximum allowable operating pressure.
Use	ECAs are not specific to flaws in girth welds and have a broader fitness-for-service intent across various threat and defect types that overlaps with that of EAs in the Canadian Standard.

*Note that in 49 CFR Part 195, ECAs or EAs are <u>not</u> explicitly defined. “Engineering analysis” is mentioned as a risk-based alternative to pressure testing for longitudinal seam failures.

US AND CANADIAN Engineering Processes



Comparison

	ECA	EA
Strengths	• Emphasis on Fracture Mechanics to establish critical flaw sizes • Robust applicability to specific equipment, defects, and failure mechanics. • Provides an alternative method, based on engineering principles, using conservative assumptions to demonstrate safe operation.	• Comprehensive assessment of particular threat(s) to determine fitness for service • Requires the direct supervision of a competent person • Must consider risk assessment results • Can be employed when implementing regulatory code requirements are not feasible • Encourages conservative assumptions to be employed when evaluating threats with low data certainty or missing information
Weaknesses	• Rigorous data requirements in order to perform analysis • Multiple fracture mechanics models and fatigue crack growth methodologies, not incorporated by reference like corrosion metal loss in US code.	• No explicit requirement to consider fracture mechanics • No explicit requirement to consider the effect of prevention and mitigation systems

Applications

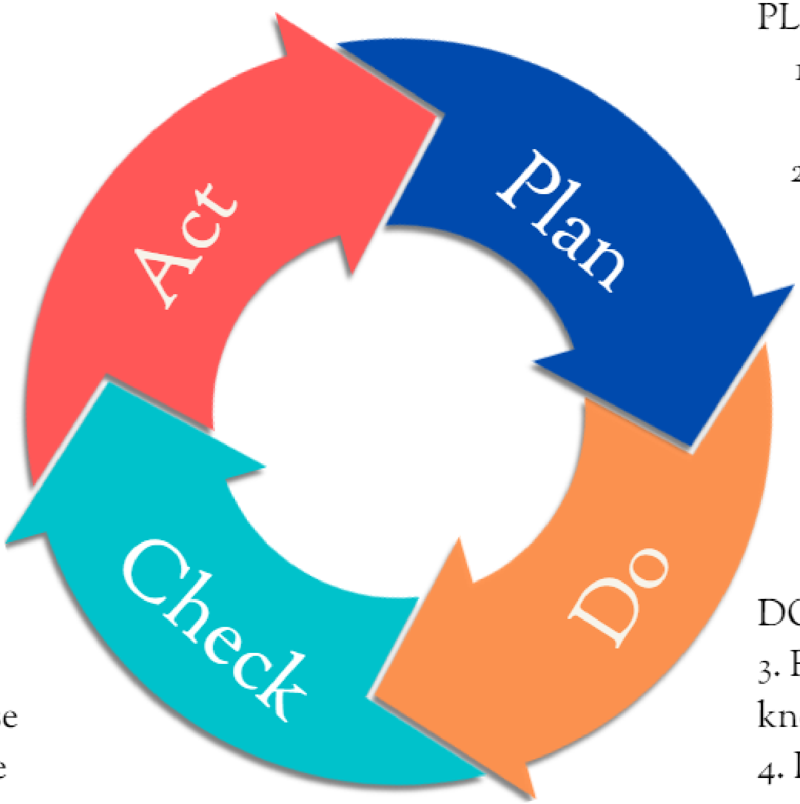
Canada	United States*
Class location designation changes	*Outstanding Notice of Proposed Rule Making (NPRM)*
Pipeline Design	
Maximum Operating Pressure (MOP) upgrade	Maximum Allowable Operating Pressure (MAOP) reconfirmation[1]
Defect assessment	
Operational change	
Return to service	
Valve spacing	
Safety case	
Code deviations	

*Note that language presently exists for analysis using sound engineering principles to be applied for certain instances in US 49 CFR Parts 190, 192, 194, and 195.

[1]49 CFR 192.632 ECA for MAOP Reconfirmation: Onshore steel transmission pipelines

PDCA APPROACH

Engineering Assessments



ACT

8. Implement corrective actions and recommendations in a timely manner

PLAN

1. Identify purp EA
2. Determine pipeline assets in scope

DO

3. Review and document known information
4. Identify threats to be considered
5. Review and assess all threats

CHECK

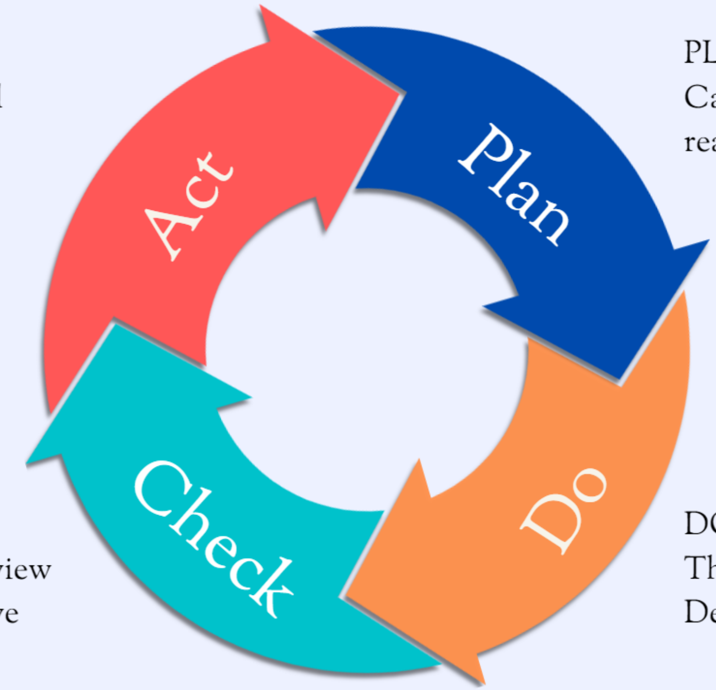
6. Determine threats hindering the EA purpose
7. Identify gaps and make recommendations

EA PDCA APPROACH

Case Study

ACT
Pipeline reactivated

PLAN
Canadian asset reactivation



CHECK
Compare desktop review with semi-quantitative risk assessment

DO
Threat review
Defect analysis

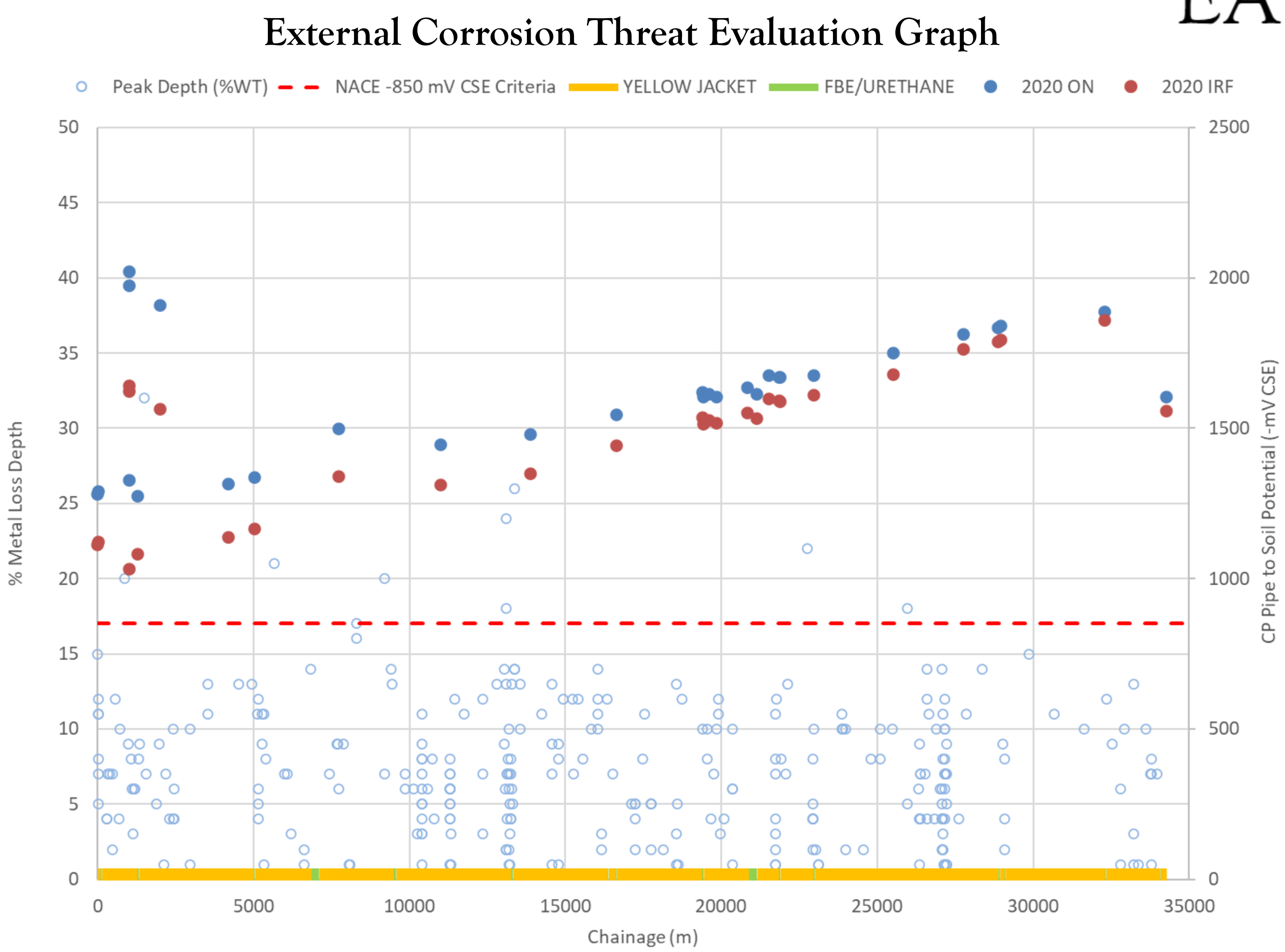
PIPELINE DESCRIPTION
~20 miles of NPS 8 pipe
Natural gas service
Constructed in 2000
1,200 psig MOP
Previous failure
Multiple assessments (ILI and hydrostatic pressure test)

Threat[1]	Classifications
Time-Dependent	1. External Corrosion (EC),
	2. Internal Corrosion (IC) and
	3. Stress Corrosion Cracking (SCC).
Stable	4. Manufacturing Defects (MD),
	5. Construction Threat (CT) and
	6. Equipment Failure (EF).
Time-Independent	7. Mechanical Damage,
	8. Weather Related and Outside Forces (WROF), and
	9. Incorrect Operations (IO)
Interacting	A coincidence of two or more threats, the result of which is more damaging than either of the individual threat alone.

[1]American Society of Mechanical Engineers (ASME), B31.8S Managing System Integrity of Gas Pipelines, 2020

EA PDCA APPROACH

Case Study



- In-Line Inspection (ILI) Data
- Cathodic Protection (CP) Data
- Coating Data
    - Fusion Bond Epoxy (FBE)
    - Yellow Jacket

EA PDCA APPROACH
Case Study

Objective	Result
Save time and money	Assessment avoidance
Achieve reliable integrity management	Comprehensive threat review + risk model
Be efficient and consistent	PDCA Process approach
Compliance with regulations	Report submitted to agency

Conclusion

- In summary,
  - ECAs are rigorous in applying fracture mechanics to determine flaw size but have limited applications.
  - EAs, while more broadly applicable to various threats and risks to pipeline systems, lack the formal requirements and process of ECAs.
  - Competent engineers and robust data are required for both instances.
- The proposed methodology and the associated case study demonstrate the effectiveness of employing a robust and comprehensive approach to EAs for practical condition evaluation.
  - Employing the strengths of both EAs and ECAs, namely the incorporation of threat analysis, risk assessment results, and fracture mechanics, provides pipeline operators with repeatable, objective, and technically sound results.
- In circumstances where no data or low confidence data is available, involving one or more Subject Matter Experts (SME) or competent engineers to conduct the EA or ECA using conservative assumptions is invaluable.
- Using an efficient and consistent methodology can provide integrity assurance for various applications where the regulatory climate allows.

Questions?

Thank you for your attention.

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