

# ***Pipeline Research Council International, Inc.***

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PHMSA R&D Forum  
Working Group #3

**Automation Solutions for Integrity Management  
Challenges**

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February 19, 2020



# Presentation Overview

- **PRCI Overview**
- **Recently Completed Work**
- **Ongoing Research**
- **Remaining Research Gaps**

# Our Mission

- To collaboratively deliver relevant and innovative applied research to continually improve the global energy pipeline systems.



# Our Members

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- **33 Energy Pipeline Operating Companies**

- 15 Natural Gas Transmission; 10 Liquid
- 8 Liquid/Natural Gas

- **4 Pipeline Industry Organization (PIO) Members**

- American Petroleum Institute (API)
- Association of Oil Pipe Lines (AOPL)
- Canadian Energy Pipeline Association (CEPA)
- Operations Technology Development (OTD)

- **34 Associate Members & Technical Program Associate Members**

- Australia, Canada, China, Europe, Japan, U.S.

- **Worldwide Research Organization**

- 45 North American Companies (U.S. & Canada)
- 25 Non-NA (Australia, Brazil, China, Europe, India & Japan)



AUSTRALIA  
AUSTRIA  
BRAZIL  
CANADA  
CHINA  
FRANCE  
GERMANY  
INDIA  
IRELAND  
JAPAN  
NETHERLANDS  
NORWAY  
UNITED KINGDOM  
URUGUAY  
USA

# Current Pipeline Operator Members

## ▪ Natural Gas

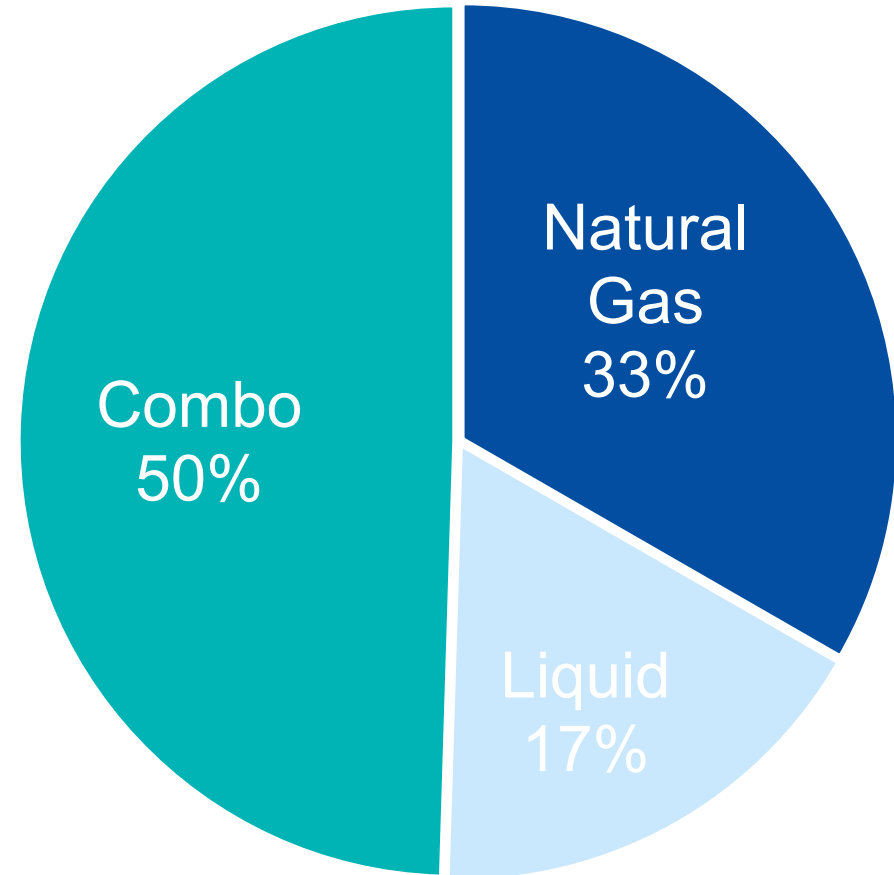
- ATCO
- Boardwalk
- Cadent
- Dominion
- Energy Transfer
- Gassco
- Gasunie
- GRTgaz
- National Fuel
- National Grid
- PG&E
- SoCalGas
- Total
- TransGas
- Williams

## ▪ Liquid

- Buckeye
- Chevron
- Colonial
- ExxonMobil
- FHR
- Marathon
- Phillips 66
- Plains
- Saudi Aramco
- Trans Mountain

## ▪ Combo

- ConocoPhillips
- Enbridge
- Enterprise
- Kinder Morgan
- Petrobras
- PetroChina
- Shell
- TC Energy





# PRCI Technology Development Center (TDC)

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- **ILI pull test rig**
- **Thousands of pipe samples**
  - Corrosion
  - Mechanical damage
  - Cracks
  - Long seam
  - Other
- **NDE evaluation and training**
- **Conference rooms**





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# Recently Completed Work

# Pipeline Research for Automating Integrity Management Challenges – Completed

- **Fitness for service**

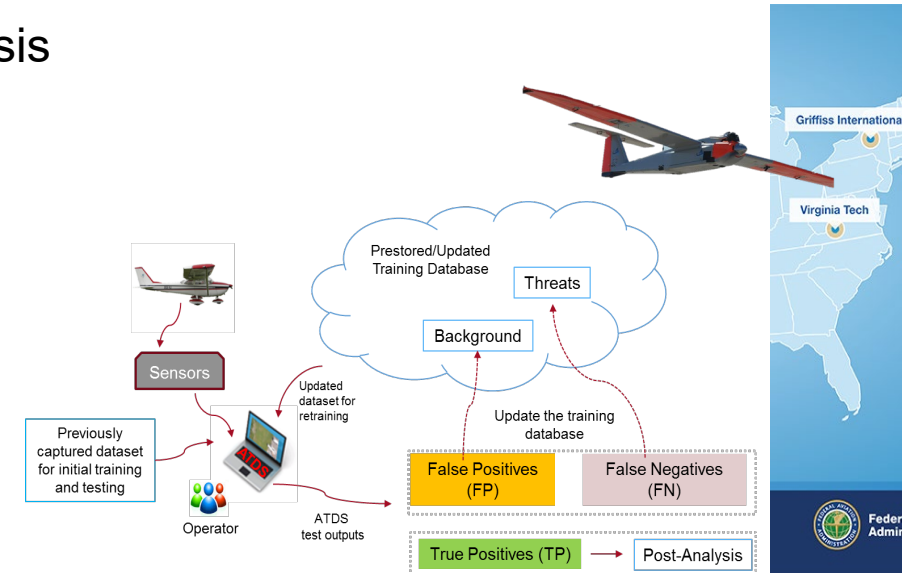
- Applicability of Existing Metal-loss Criteria for Low Hardening Steels
- Plausible Profiles (Psqr) Corrosion Assessment Model

- **Hazard monitoring**

- Evaluation of Current ROW Threat Monitoring, Application & Analysis Technology
- Demonstration of the Use of Long Endurance Unmanned Aircraft System (UAS) to Conduct Machinery Threat Detection and Oil Spill Detection
- Open Path Laser Spectrometer (OPLS) Methane/Ethane Detector

- **Data analytics**

- ILI Crack Tool Reliability and Performance Evaluation



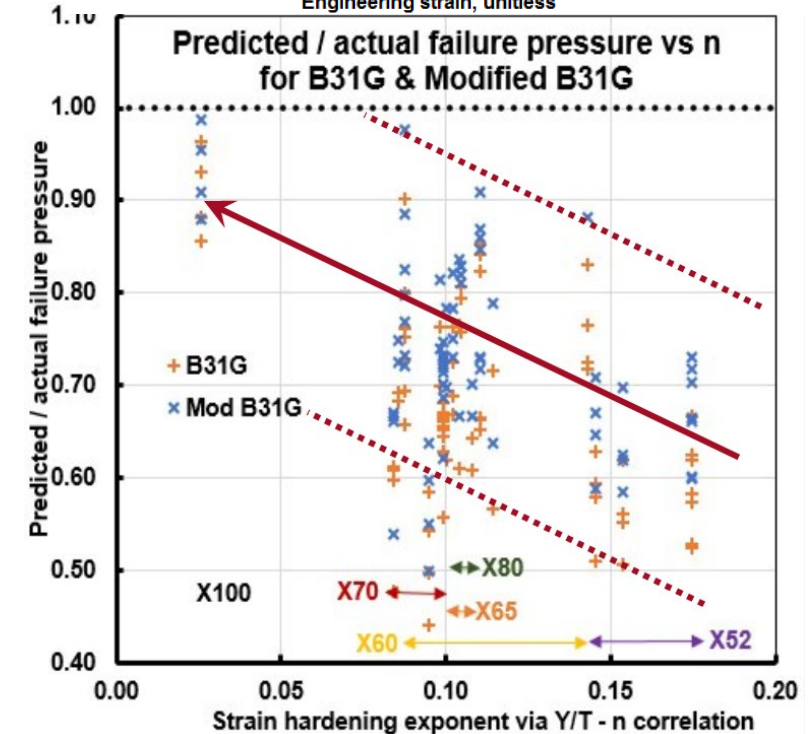
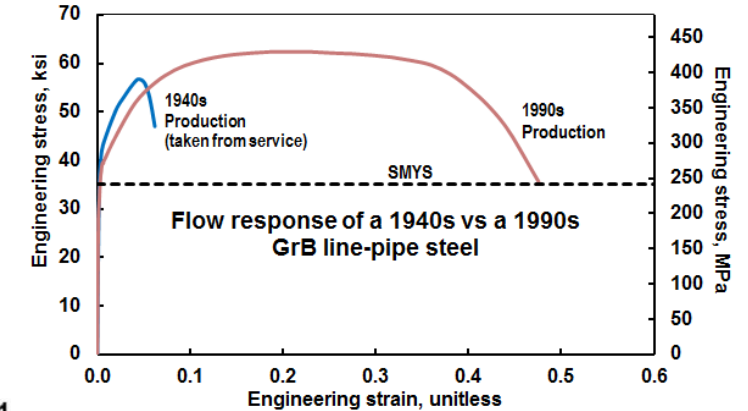


# Pipeline Research for Automating Integrity Management Challenges – Completed

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## ■ Applicability of Existing Metal-loss Criteria for Low Hardening Steels

- Background: Modern steels have different flow hardening capabilities as compared to the steels used to develop B31G and Modified B31G
- Objective:
  - Assess the viability of existing criteria, quantify the issues,
  - Develop a correction to broadly ensure the applicability of such criteria across the range of pipeline steels used by industry
- Automation aspect: used in fitness for service algorithms processing bulk ILI and other data
- Status: Report complete and available to the public
  - Catalog PR185-173611-R01

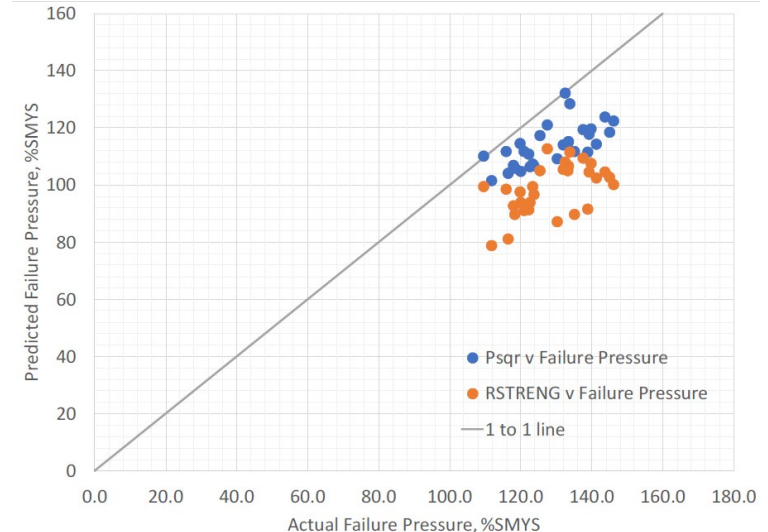
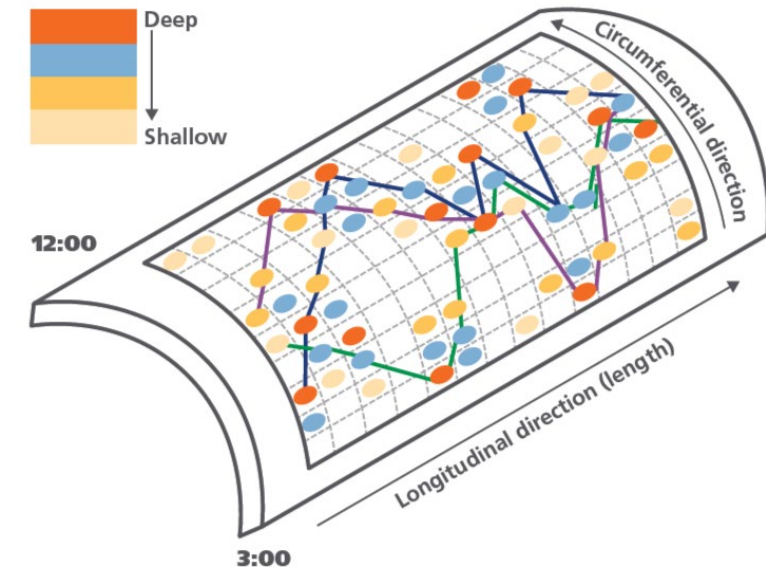


# Pipeline Research for Automating Integrity Management Challenges – Completed

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## ■ Plausible Profiles (Psqr) Corrosion Assessment Model

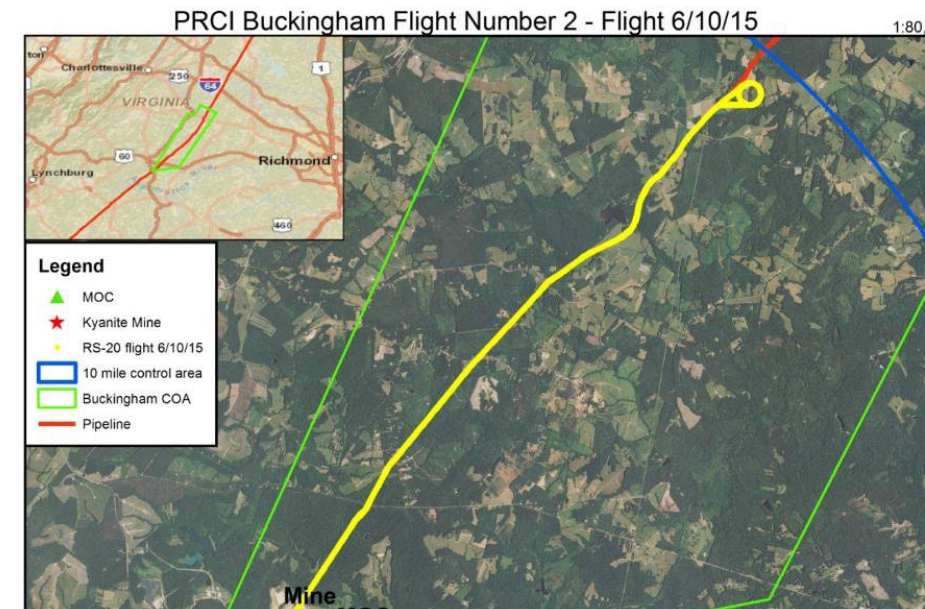
- Background: Fitness for service models have a high degree of uncertainty
- Objective: Improve the accuracy and precision of the predicted burst pressure of pipeline subject to large areas of metal-loss corrosion.
- Automation aspect: used in fitness for service algorithms processing bulk ILI and other data
- Status:
  - *Peer review report complete and available to the public., Catalog PR218-183607-Z01*
  - *Excel tool available. Enhancing the tool to be more operationally efficient, ~4Q 2020.*



# Pipeline Research for Automating Integrity Management Challenges – Completed

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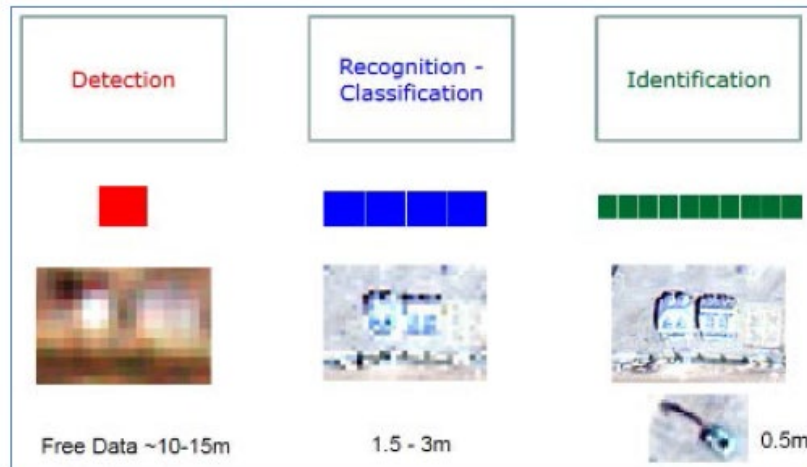
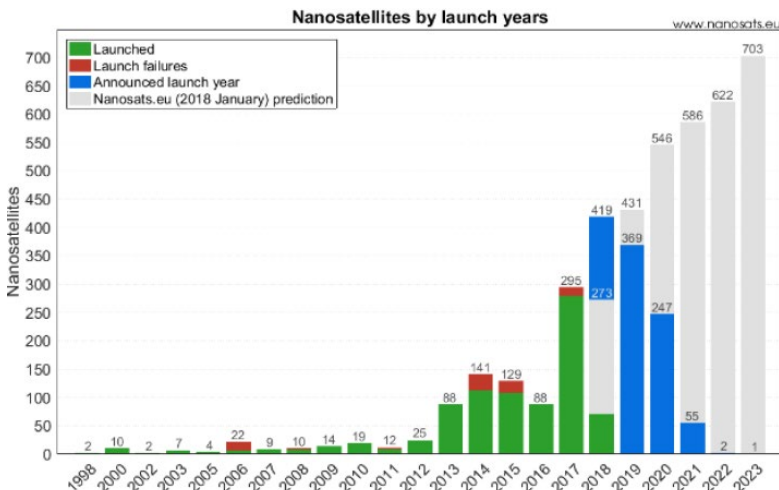
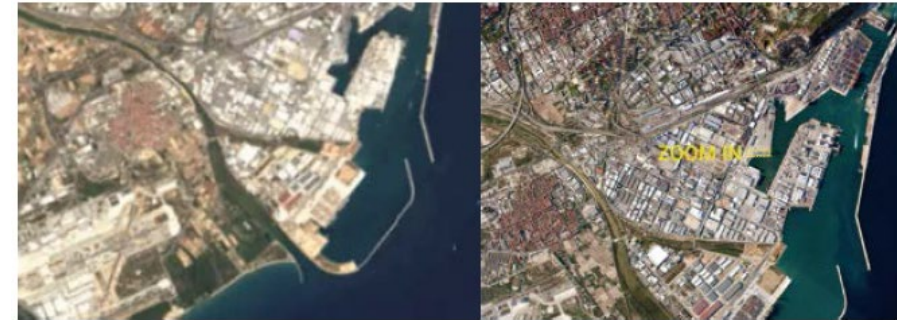
- **Demonstration of the Use of Long Endurance Unmanned Aircraft System (UAS) to Conduct Machinery Threat Detection and Oil Spill Detection**
  - Background: Difficult to monitor 3<sup>rd</sup> party threats and leaks on the pipeline ROW
  - Objective: evaluate technology solutions for pipeline monitoring and surveillance UAS
    - *Support of upstream, midstream, and downstream operations*
  - Automation aspect: unmanned patrols, automatic detection
  - Status: Completed
    - *Catalog PR-403-123706-R01*





# Pipeline Research for Automating Integrity Management Challenges – Completed

- **Evaluation of Current ROW Threat Monitoring, Application & Analysis Technology**
  - Background: What satellite technologies are available to identify pipeline integrity threats
    - including 3rd party damage threats, hazards and leaks
  - Objective: Provide more timely, accurate identification of pipeline threats
  - Automation aspect: Remote satellite monitoring rather than air patrols, site visits, etc.
  - Status: Report complete and available to the public
    - *Catalog PR-271-173903-R01*

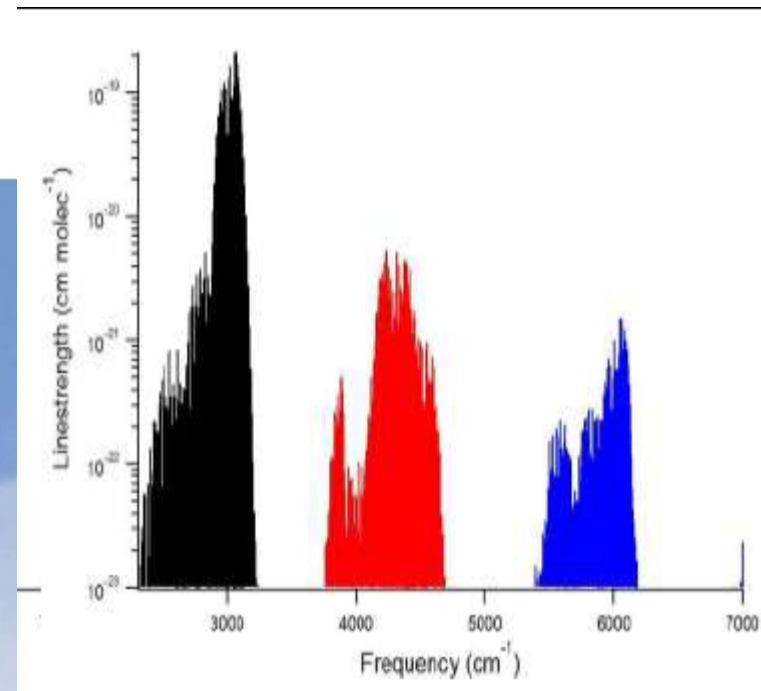
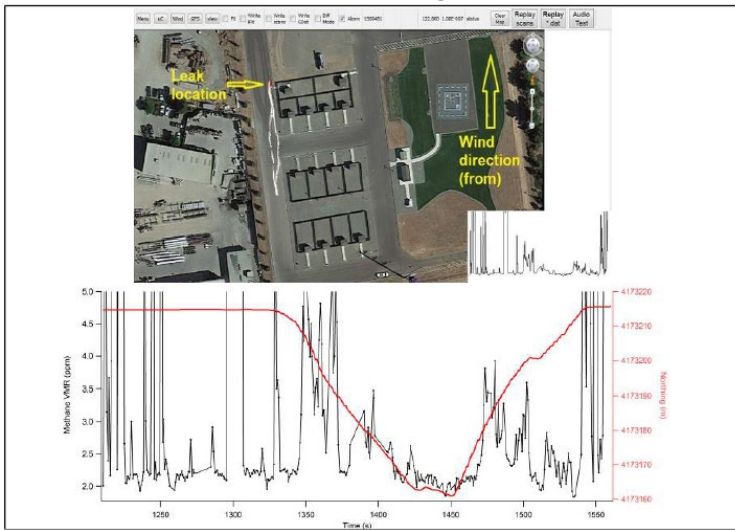




# Pipeline Research for Automating Integrity Management Challenges – Completed

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- **Open Path Laser Spectrometer (OPLS) Methane/Ethane Detector**
  - Background: natural gas leaks are sometimes difficult to identify
    - *Natural sources vs pipeline natural gas*
    - *Accessibility is sometimes challenging*
  - Objective: develop/assess lightweight technology to detect methane and ethane
    - *Handheld or unmanned aircraft system application*
  - Automation aspect: UAV to identify leaks faster, more accurately
  - Status: complete, member only report
    - Catalog PR-459-133750-R03



# Pipeline Research for Automating Integrity Management Challenges – Recently Completed

- **ILI Crack Tool Reliability and Performance Evaluation**
  - Background: no independent assessment of ILI performance to detect crack detection
  - Objective: create a database of crack ILI and excavation information collected from operators and to use it to characterize the performance of available ILI technologies
  - Automation implementation: data analytics of large data sets
  - Status: Report complete and available to the public
    - Catalog PR-244-153719-R01

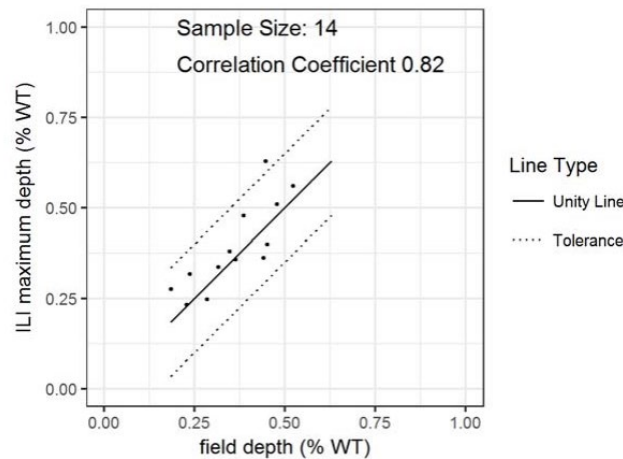
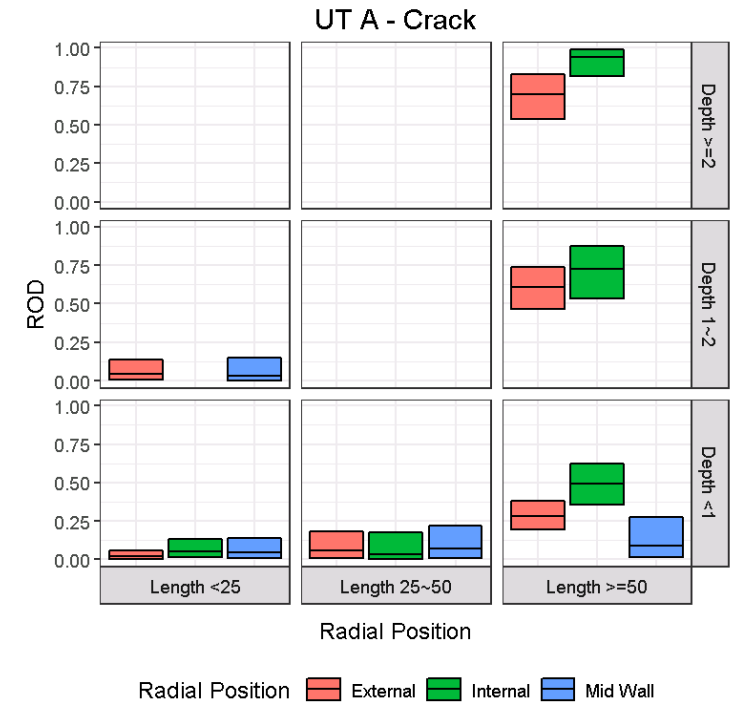


Table 6 - Field Measured Length and Depths of EMAT Records

Feature Type	ILI Tool	Count	Depth (mm)		Length (mm)	
			Mean	Std Dev	Mean	Std Dev
Crack	EMAT A	13	2.29	1.05	130.8	76.8
	EMAT B	26	2.48	1.00	139.5	144.2
	EMAT C	8	2.57	2.41	30.1	20.3
	EMAT D	29	2.65	0.87	319.0	313.3
	All EMAT	76	2.46	1.11	190.0	233.4
SCC	EMAT A	63	2.37	1.12	192.6	137.5
	EMAT B	171	2.40	0.88	175.9	198.4
	EMAT C	31	2.91	1.15	76.0	161.7
	EMAT D	30	3.62	0.85	288.0	278.4
	All EMAT	295	2.57	1.03	184.5	197.8



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Ongoing  
Research

# Pipeline Research for Automating Integrity Management Challenges - Ongoing

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- **Fitness for service**

- Assessment of Fitness-for-Service for Crack-within-Corrosion Anomalies
- Effect of Pressure Fluctuations on Growth Rate of NNpH SCC

- **Hazard monitoring**

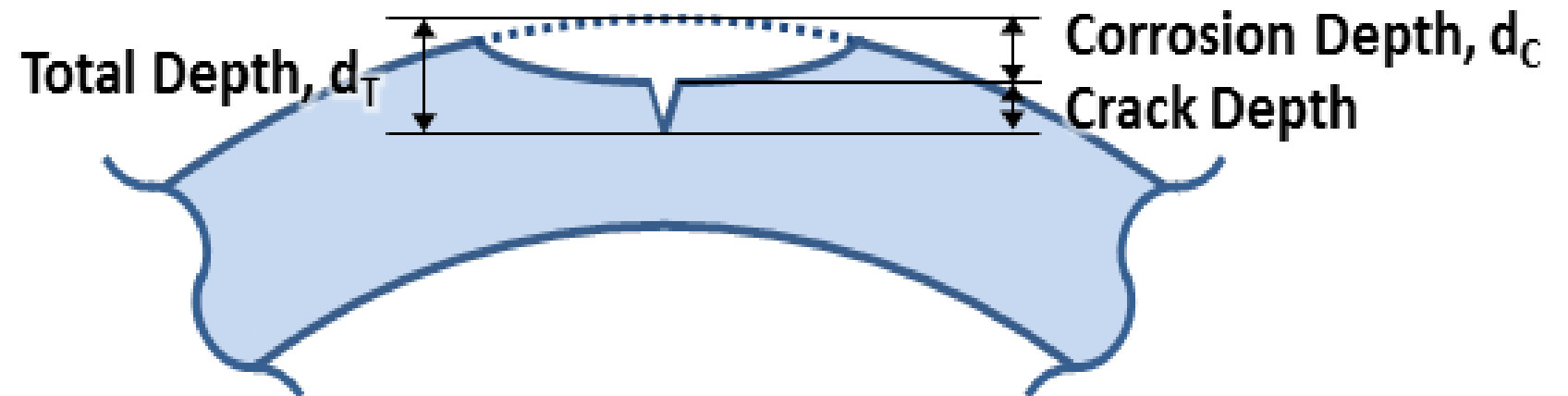
- Airborne Automated Threat Detection System
- System for Monitoring Integrity, Geohazards, and Leaks at River Crossings
- Optimal Approach to Cost Effective, Multi-source, Satellite Surveillance of River Crossings, Slope Movements and Land Use Threats to Buried Pipelines
- Water Wetting Prediction Tool for Pipeline Integrity



# Pipeline Research for Automating Integrity Management Challenges - Ongoing

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- **Assessment of Fitness-for-Service for Crack-within-Corrosion Anomalies**
  - Background: The full-scale burst tests and failure pressures of actually flawed line pipes containing blunt metal-loss defects or crack-like features
  - Objective: Develop a tool to predict the failure pressure of crack-within-corrosion anomalies.
  - Automation implementation: used in fitness for service algorithms processing bulk ILI and other data
  - Status: Report undergoing final committee review, expected June 2020

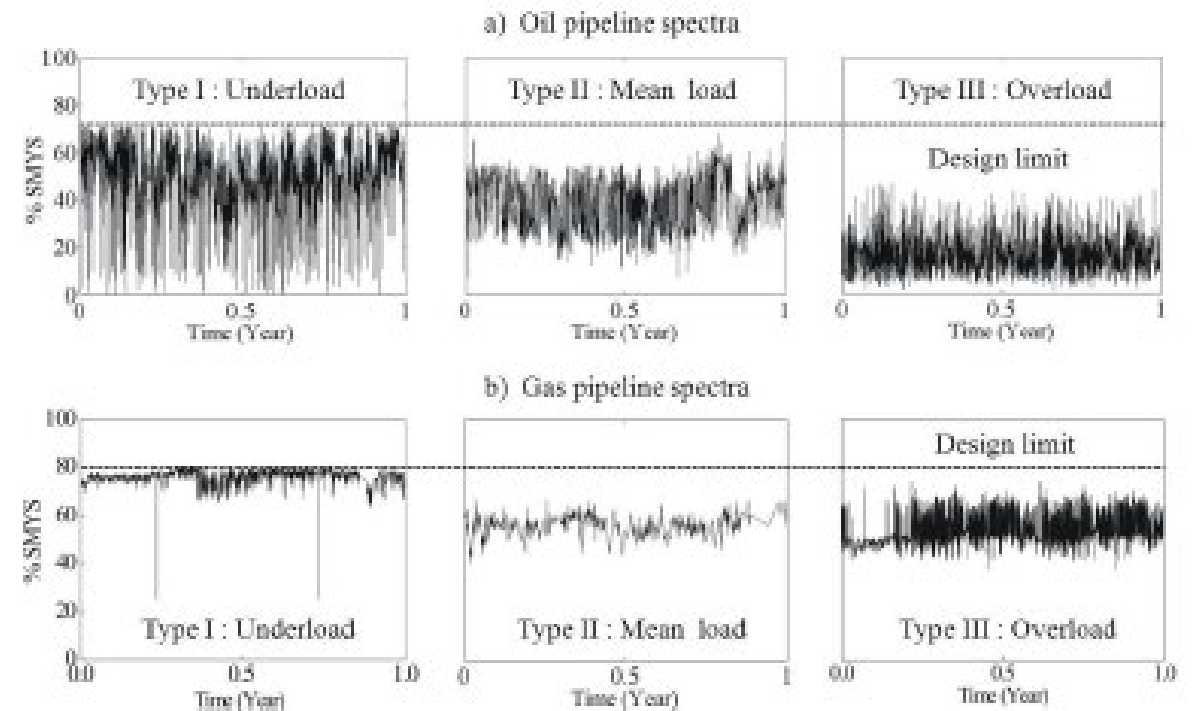


# Pipeline Research for Automating Integrity Management Challenges - Ongoing

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## Effect of Pressure Fluctuations on Growth Rate of NNpH SCC

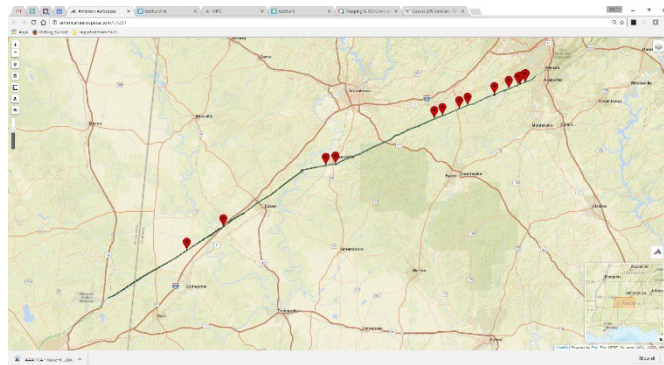
- Background: limited understanding of the effects of pressure fluctuation on crack growth
- Objective: Provide a comprehensive understanding of the effect of pressure fluctuations on the growth rate of NNpH SCC.
- Automation implementation: online or batch modeling of pipelines to identify sections of pipeline with higher SCC risks
- Status: Multi-year project
  - Preliminary software package developed*
  - Completion forecasted for 2Q 2021*



# Pipeline Research for Automating Integrity Management Challenges - Ongoing

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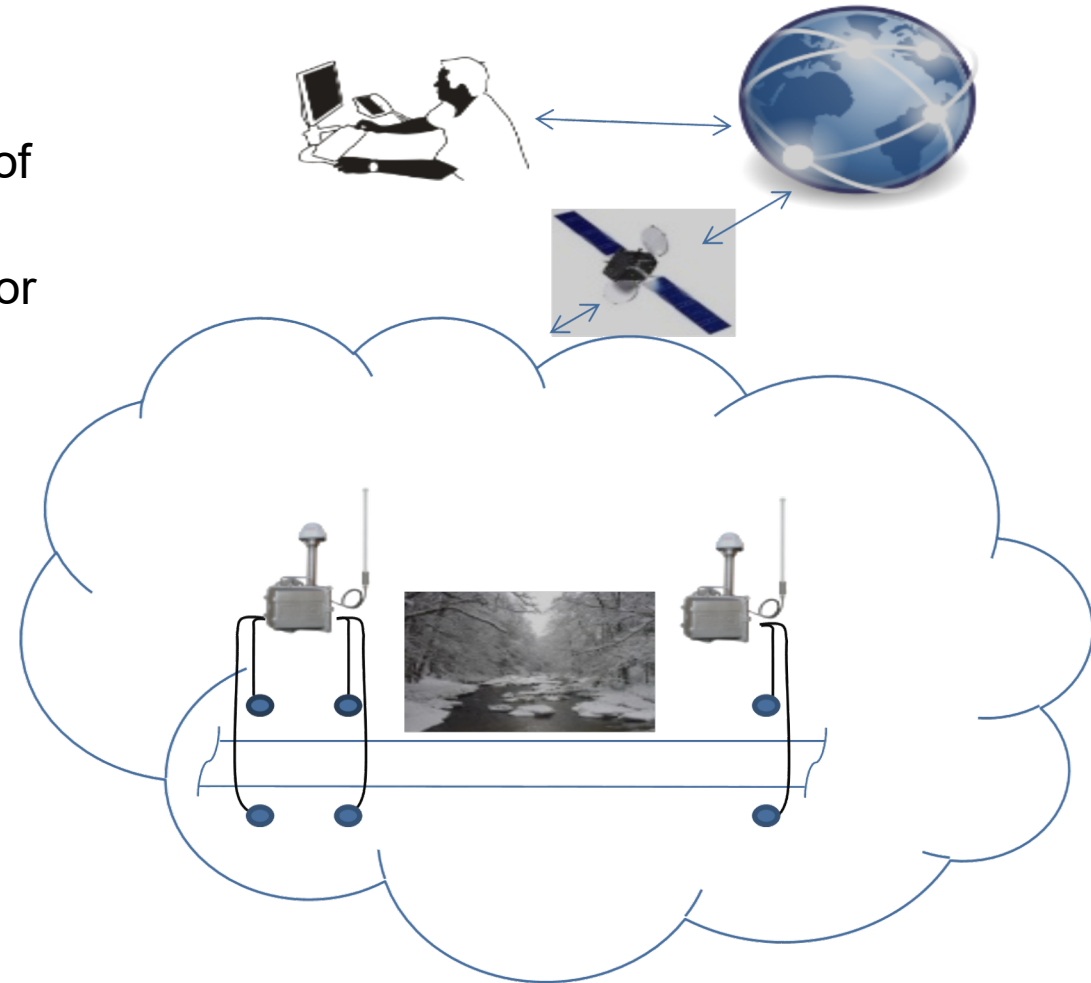
- **Airborne Automated Threat Detection System – Monitoring and Surveillance of Imminent Threats Through Remote Sensing UAS**
  - Background: current monitoring techniques are ‘batch processes’
  - Objective:
    - *Produce experimental data on automated ROW monitoring*
    - *Develop algorithm performance benchmarks, lessons learned and best practices for Automated Threat Detection System operation*
    - *Develop data management/analysis/archiving/retrieval methods*
      - for encroachment, environmental threats and leak detection for manned and long-range UAV aircraft
      - » *UAV Phase is joint project with PHMSA (Project #860)*
  - Automation aspect: Remote satellite monitoring rather than air patrols, site visits, etc.
  - Status: Underway, completion in late 2021/early 2022



# Pipeline Research for Automating Integrity Management Challenges - Ongoing

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- **System for Monitoring Integrity, Geohazards, and Leaks at River Crossings**
  - Background: access and frequency of assessment of river crossings is a batch process
  - Objective: the development of a dedicated system for monitoring underground pipeline facilities at river crossings
    - *especially those without ready access to power and communications*
  - Automation implementation: Remote monitoring rather than air patrols, site visits, etc.
  - Status: prototype development

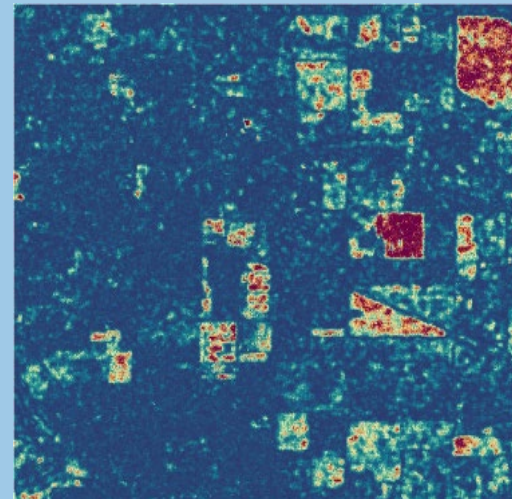




# Pipeline Research for Automating Integrity Management Challenges - Ongoing

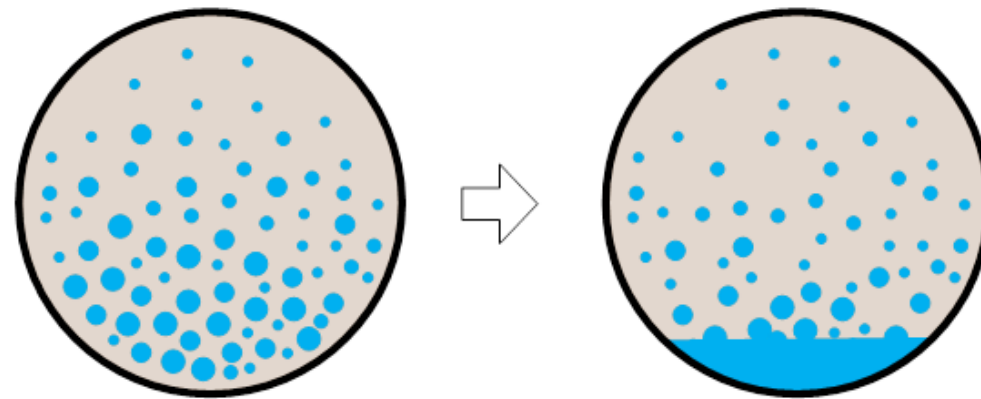
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- **Optimal Approach to Cost Effective, Multi-source, Satellite Surveillance of River Crossings, Slope Movements and Land Use Threats to Buried Pipelines**
  - Background: access and frequency of assessment of river crossings is a batch process
  - Objective: investigate the application of satellite monitoring of river bank deformation, channel dynamics, changes to soil (erosional) conditions and land cover/land use over buried pipelines
  - Automation implementation: Remote monitoring rather than air patrols, site visits, etc.
  - Status: underway, completion expected in 4Q 2020



# Pipeline Research for Automating Integrity Management Challenges - Ongoing

- **Water Wetting Prediction Tool for Pipeline Integrity**
  - Background: Current ICDA type methods are lagging behind the current level understanding
  - Objective: Transform the current understanding of WW into a practical tool that can be integrated with integrity management for oil and product lines
  - Automation implementation: online or batch modeling of pipelines to identify sections of pipeline with higher internal corrosion risks
  - Status: Report and software undergoing final committee review, expected March 2020



Critical droplet concentration is reached at the pipe bottom

Coalescence of droplets leads to water layer



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# Remaining Research Gaps

# Research Gaps & Challenges

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## ■ Geohazard Monitoring

- Geohazard management guidance is needed to elevate the level of awareness of geohazard-related design, monitoring, and assessment programs and to raise the standard of practice in geohazard management.
- Improved tools are needed to rapidly and accurately assess the condition of a pipe and / or pipeline facilities after an event

## ■ Leak Detection

- Standardization of in-situ testing for leak detection technologies for existing (retrofit) and new construction

## ■ Platforms

- FAA Rules & Regulations restrict broad commercial use of UAVs Beyond Visual Line of Site, so ROW monitoring utilizing that platform will continue to be minimal unless operators can obtain individual exemptions (expensive and time-consuming process)



# Research Gaps & Challenges

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## ▪ Fitness for service

- Additional verification/validation of Psqr
- Integration of Psqr with applicability of existing metal-loss criteria for low hardening steels, strain based design and reference stress for metal-loss assessment of pipelines
- Expansion of water wetting model to include solids deposition

## ▪ Hazard monitoring

## ▪ Data analytics

- Root cause and contributing factors of events/near misses
  - *Common causes, lessons learned*
- Use machine learning to automate ILI calls and reduce analysis time
- Continue development of statistical models to develop ILI tool specifications



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