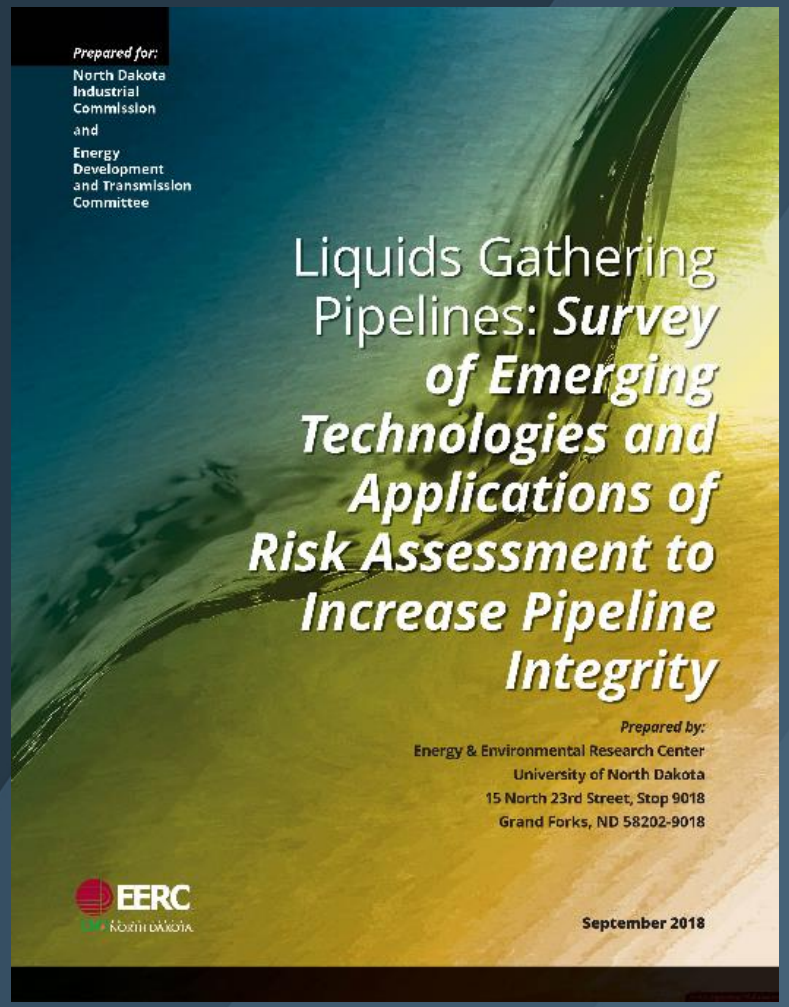
Energy & Environmental Research Center (EERC)



LIQUIDS GATHERING PIPELINE STUDY: PHASE III

Oil & Gas Research Program

Bismarck, North Dakota

Tuesday, December 18, 2018

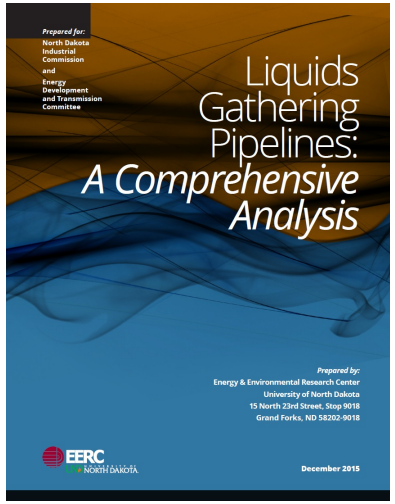
Jay C. Almlie

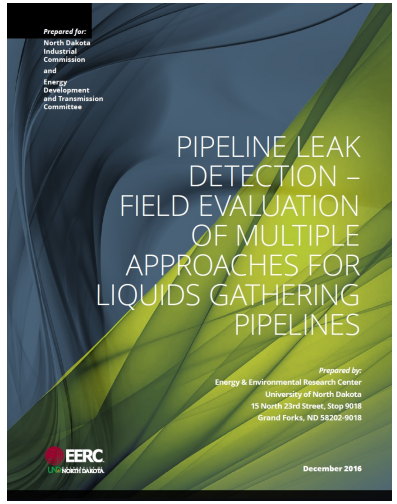
Principal Engineer

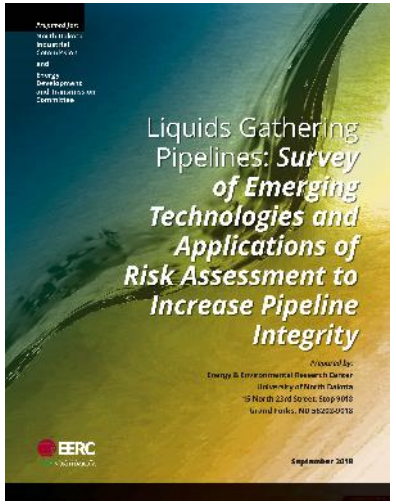
EERC

EERC Pipeline Study in Three Phases

- HB 1358 (2015)
  - Phase I: Foundational information on status of ND liquids gathering pipelines
  - Phase II: Report on field demonstrations of various leak detection approaches
- HB 1347 (2017)
  - Phase III: Report on risk assessment for liquids gathering pipelines, and provide a snapshot of emerging technologies for leak detection and leak prevention







Phase III Scope of Work

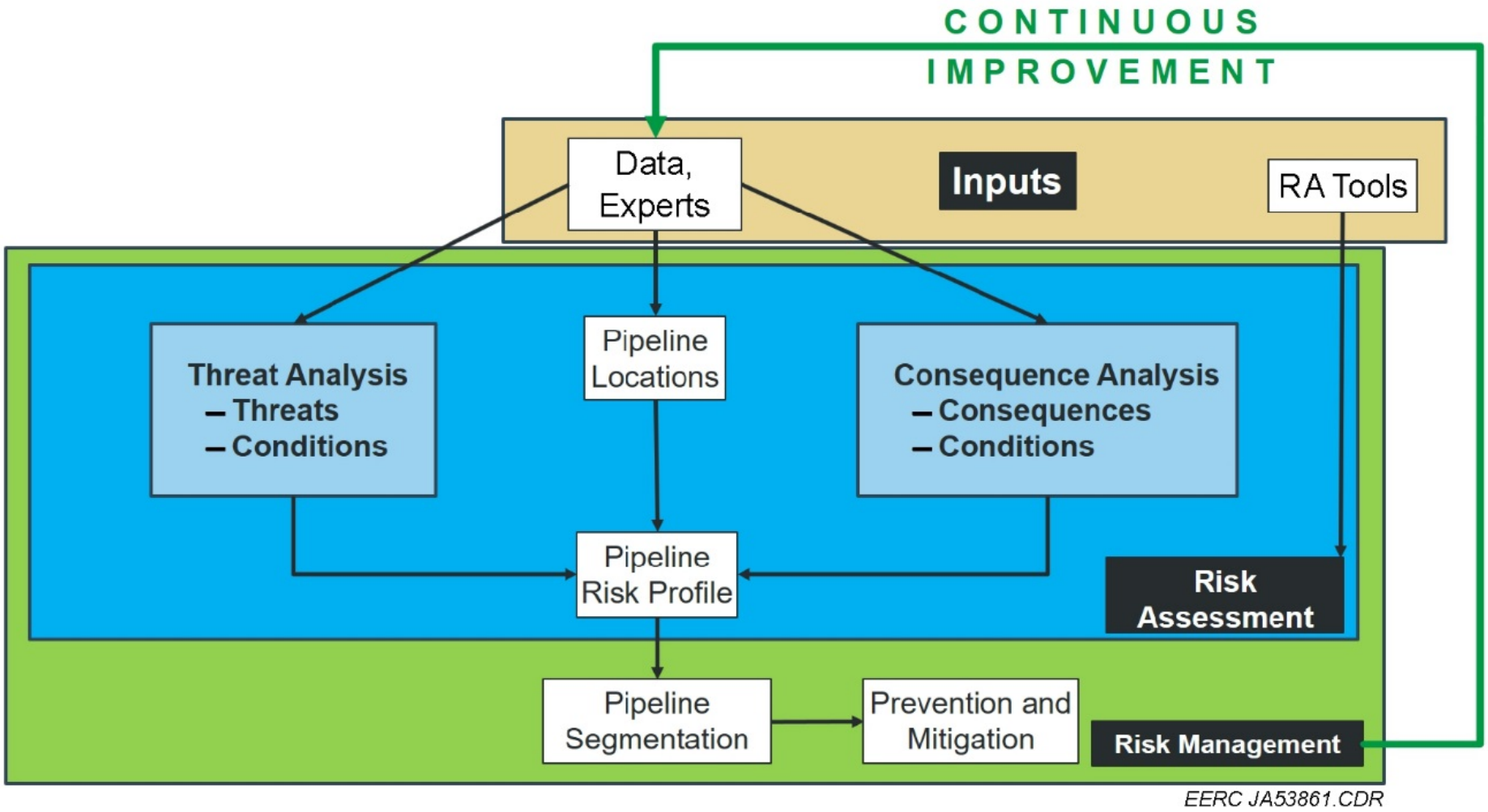
- EMERGING TECHNOLOGIES
  - Identification of emerging technologies to enhance pipeline safety and reliability
- RISK ASSESSMENT
  - Pipeline stakeholder group
  - Review risk assessment methodologies
  - Strategies for continuous improvement

Risk Assessment

What Does the Study Tell Us about Risk Assessment Applied to Liquids Gathering Pipelines?

- Defines a common language surrounding risk assessment
- Provides key characteristics of an effective risk assessment
- Demonstrates application of various approaches to risk assessment
- Ties ND interest in this topic to identical interests being explored in the PHMSA-regulated world

The Landscape of Risk Assessment



Desirable Pipeline Risk Assessment Characteristics

Exclusive to Risk Assessment	Identifies pipeline threats.
	Estimates the likelihood (or frequency or probability) of failure along the pipeline based upon past and present conditions of the pipeline and surroundings.
	Identifies consequences of pipeline failure.
	Estimates the severity or magnitude of different consequences along the pipeline.
	Relates information to pipeline location.
	Estimates risk along the pipeline.
	Verifies the consistency of estimates with actual performance.
	Is updated with new information as pipeline and surrounding conditions change.
Overlapping Risk Assessment and Risk Management	Divides pipelines into segments based upon risk.
	Prioritizes pipeline segments based upon risk.
	Evaluates the effectiveness of past changes and other risk management actions.
	Predicts or has the capability to predict risk-related outcomes.
General	Information, procedures, and documentation are of adequate quality for the purpose of risk management and assessment.

Spectrum of Pipeline Risk Modeling Approaches

Approach	Examples	Effort	Description
Subject Matter Experts	Qualitative, semiquantitative	$	Subjective risk estimates
Relative Risk	Matrix, indexing (semiquantitative)	$$	Risk estimates that can be compared only with those from very similar methods and situations
Scenario-Based	Event tree, fault tree	$$	Depicts event sequences leading to end states and relates likelihood of events to end-state consequences
Probabilistic	Quantitative	$$$	Risk estimates that can be compared with risk estimates from other quantitative methods and situations

Conclusions

- The reliability, usefulness, and resources demanded for each approach to risk assessment vary greatly.
- Each pipeline operator must determine what level of accuracy and uncertainty is both practical and sufficient for each specific application.
- Any systematic method can be useful. All methods provided some insight into the relative risk.
- When applied correctly, all methods exhibit surprising consistency.

Emerging Technology

MOST IMPACTFUL TO SAFE PIPELINE OPERATION

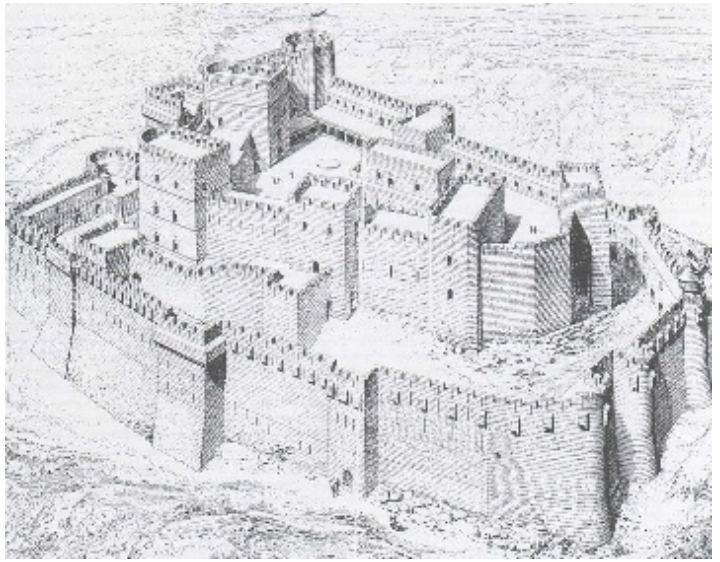
- **Proper installation of pipelines**

- Call before you dig

811

Know what's **below.**
Call before you dig.

- Defense in depth (multiple layers of protection for challenging situations)



Emerging Technology for Liquids Gathering Pipelines

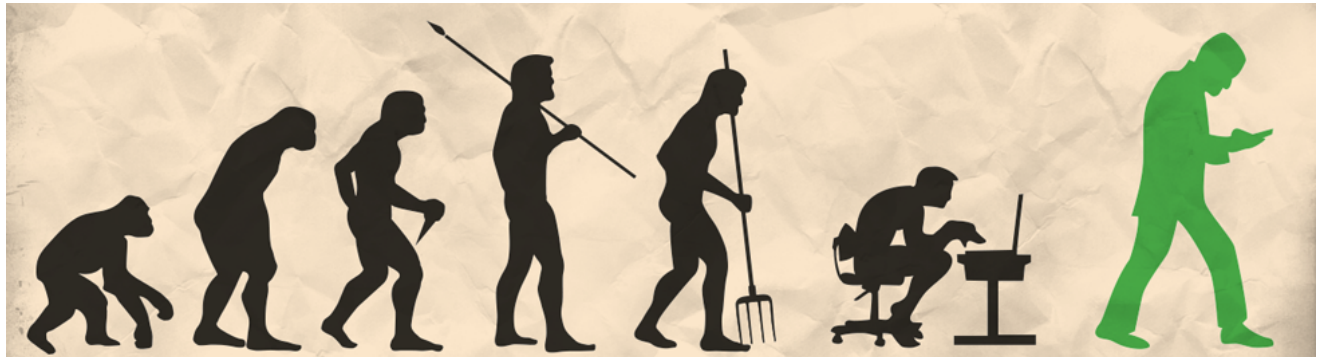
More Than a Toy Box!

Less Than a Silver Bullet!

Governor Burgum challenged industry in May 2017 to think outside the box and apply new technology to conquer the problem of pipeline leaks.

Emerging Technology – A Snapshot in Time

- Application of leak prevention and leak detection technology to liquids gathering pipelines is more complex than application to transmission lines.
- New technology to prevent and detect pipeline leaks is being developed right now. Why?
  - Rapidly expanding new market for technology solutions suited to small-diameter, previously unregulated liquids gathering pipelines.
  - New regulatory pressures on liquids gathering pipelines.
  - Intense public focus on pipelines in recent years.



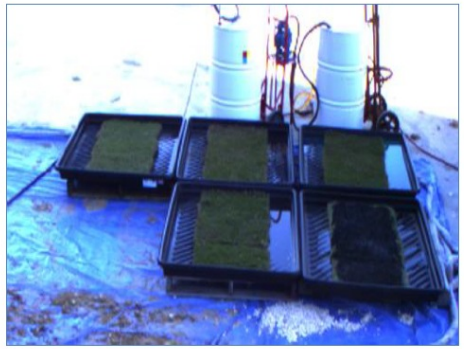
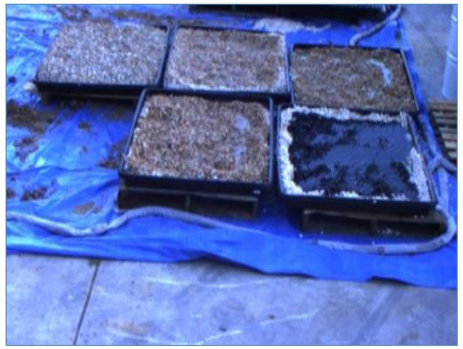
A Sampling of Emerging Technologies

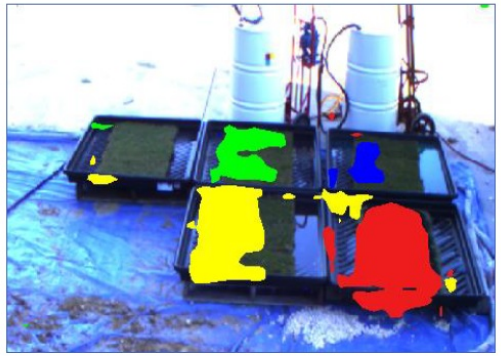
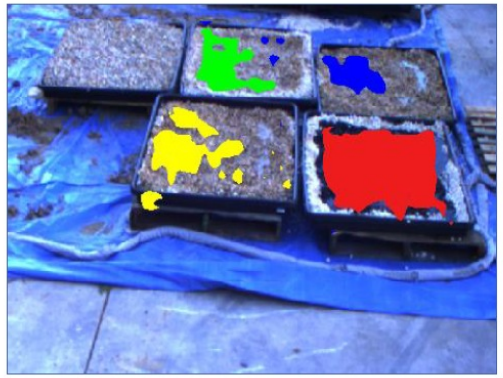
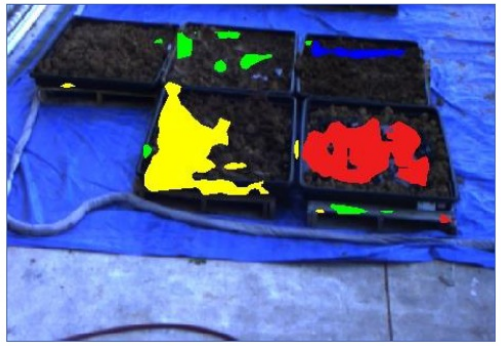
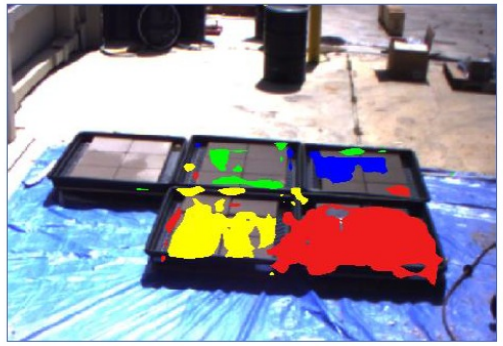
- Artificial intelligence
- Fiber optics
- Miniaturized in-line inspection
- Dedicated leak detection for HCAs

- Resulting from this focus on emerging technology:

iPIPE

INTELLIGENT PIPELINE INTEGRITY PROGRAM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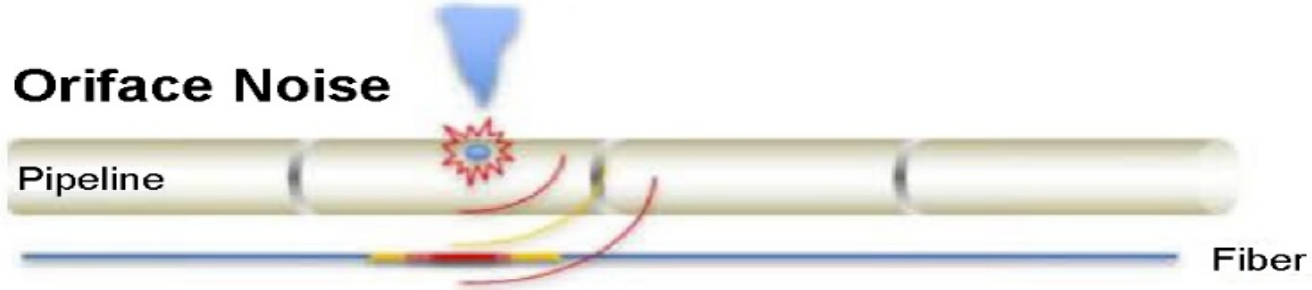
Alerts
Hydrocarbon
Imagery Date: Aug 19, 2017
Previous Date: Apr 23, 2017
Hydrocarbon
Imagery Date: Aug 19, 2017
Previous Date: Apr 23, 2017
Alert Level
High
Moderate
Low
Detection
Detection

Oriface Noise



Negative Pressure Pulse

Ground Heave

Liquid Impingement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INTELLIGENT PIPELINE INTEGRITY PROGRAM

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THANK YOU

Critical Challenges. Practical Solutions.