

PHMSA Research, Technical and Policy Perspectives



Working Group #3

Automated Solutions for Integrity Management Challenges

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Pipeline Research and Development Forum

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Automation Solutions: Multiple Program Areas

- **Program Objective:** Support various automation advancements in several of our program areas including:
 - Threat Prevention:
 - Monitoring
 - Risk Assessment
 - Leak Detection
 - Anomaly Detection & Characterization
 - Solutions are sought in technology and Machine Learning (ML) enabling safe operations and personnel
- Previous automation type success could be widely defined in our program



Research Portfolio Observations

- Large technology investment into automations:
 - Leak detection
 - ROW monitoring and change management
- Large Machine Learning investment into data management supporting efficiencies for:
 - Risk management
 - Leak detection and change detection
- These investments have high likelihood of tech transfer.
- Much more automation investment can be made in many program areas.



Automation Solutions for Integrity Management

- What improvement can be made by automation solutions for integrity management?



The Power of Intelligent Automation

Available Intelligent Automation Technologies	Improvement for Integrity Management
<p>Automatic Visual Inspection (Machine Vision):</p> <ul style="list-style-type: none"> • 3D White-Light Scanning Sensor • Vision Guided Robotics • RobotCrawler 	<ul style="list-style-type: none"> • Detect small imperfections at earlier stage: identify risks. • Reduce human visual inspection error: improve data quality. • Increase inspection/monitoring frequency: collect more data. • Inspect areas in dangerous/hazardous environment or restricted for human access: identify risks and collect data.
<p>Capturing and Extracting Data from Documents:</p> <ul style="list-style-type: none"> • Speed extraction of data • Reduce data entry errors • Standardize data input from multiple random formats without human involvement 	<ul style="list-style-type: none"> • Digitize pipeline historical record data. • Transfer data into a centralized database. • Store data in the format matching the needs for statistic/risk models.
<p>Automated Decision Making:</p> <ul style="list-style-type: none"> • Machine learning (ML) and artificial intelligence (AI) facilitating data analysis for decision making • Design and manage start to finish workflows • Manage maintenance/inspection schedule 	<ul style="list-style-type: none"> • Improve effectiveness of maintenance and inspection: mitigate high risk threats. • Continuously improve integrity management: monitoring and preventing threats.



Submitting Research Gap Ideas

Anyone, Anywhere and Anytime via <https://primis.phmsa.dot.gov/matrix/>

PHMSA
U.S. Department of Transportation
Pipeline and Hazardous Materials
Safety Administration

Pipeline Technical Resources
[Return to Pipeline Safety Community](#)

Home	Alt MAOP	Cased Crossings and GWUT	Class Location	CRM	DIMP	GT IM	HL IM	High Volume EFV
Low Strength Pipe	LNG Facility Siting	OQ	Pipeline Construction	Public Meetings	R&D	RMWG	Underground Natural Gas Storage	

Research & Development: Identifying Pipeline Safety Research Gaps

Submit Research Gap Suggestions by [following this link](#).

R&D Menu

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1. BACKGROUND

The Department of Transportation's (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA) sponsors Research & Development (R&D) projects focused on providing technological and knowledge solutions that will increase the safety and reliability of the Nation's pipelines. Historically, research gaps are identified and road mapped at public events, held periodically as funding and program actions allow. Although hundreds of attendees usually participate at each event, many stakeholders cannot attend since they either don't have the means or availability.

PHMSA is using this Special Notice to solicit research ideas on a year-round basis to reach the widest set of stakeholders and identify a larger more diverse portfolio of research. The input from this Special Notice will also generate a pool of research ideas for potential future research solicitations.

PHMSA will use submitted research gaps to formulate a research strategy for its Pipeline Safety Research Program.

2. RESEARCH PROGRAMMATIC AREAS/ELEMENTS

The Pipeline Safety Research Program organizes program planning, execution, and tracking around the following subject areas.

Threat Prevention

This area addresses excavation activity damage prevention to all pipeline types and improving sub-surface locating/mapping. Research also addresses preventing or monitoring for other threats whether they are coming from corrosion, outside force damage, etc.

Leak Detection

Research in this area addresses leak detection or monitoring on hazardous liquid and natural gas pipelines, including sub-surface, surface, and airborne-based sensors and deployment platforms. Research also addresses approaches to lessen release volumes from leak/rupture incidents.

Anomaly Detection/Characterization

This area aims to improve the capability to identify and locate critical pipeline defects, and to characterize the severity or interacting nature of such defects. Research in this area includes solutions from within or outside the pipe.

- Regulations
- Advisory Bulletins
- Interpretations

Research & Development Program
Server Version: 3.00.112 Server Time: 01/29/2020 03:04 PM UTC User: Robert Smith

Research Gap Suggestions

Pipeline Safety Gap Suggestion Form

Name of Person Submitting: Email of Person Submitting:

Email address will be used by PHMSA only for verification and follow-up purposes, and will not be released to the public or any other organization.

Stakeholder Type:
[select from choices below]

Gap/Project Title (required):

Main Objective Statement (required):

Identify Major Scope Items for Investigation:

Identify Relevant Subject Matter Experts, Stakeholders, or End User Involvement suggested in Project Scope:

Cost Estimate: Time Estimate (months):

PHMSA Program Element:
[select from choices below]



National Pipeline Research and Innovation Test Site

At
U.S. DOT Transportation Technology Center
Pueblo, Colorado

CONCEPTUAL VIEW



- Additional Study Areas Identified by Industry
- Fiber optics technology
 - Pipeline material aging
 - Welds on specialty materials
 - Compressor emissions
 - Pressure cycling for fatigue
 - Physical & cyber security

Considerations for projects at TTC

- What project(s) would lend itself well to being conducted at TTC?
 - Near real-world scenarios, can't be performed elsewhere, and/or could benefit from TTC intermodal capabilities
- What are examples of challenges associated with project that would need to be addressed?
 - Confidentiality of data for some aspects, overall security
 - Equipment needs
 - Building and infrastructure needs
- Other considerations?



Thank You!/Research Contacts

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Visit us at <https://www.phmsa.dot.gov/> and search “Research”



Back Up Slides



Work Group #3 Focus Areas

- Identify opportunities for developing and demonstrating automation measures:
 - Improve safety
 - Reduce costs
 - Maximize knowledge and technology applications to address a wide range of integrity challenges.
- The potential opportunities include:
 - **Automatic tools:**
 - Prevent human exposure to hazardous environment
 - Improve data collection accuracy and effectiveness
 - **Alarms and instrumentation systems:**
 - **Artificial intelligence (AI), statistical models and computational statistics:**
 - Advance technology development on predictive models facilitated by ML/AI.
 - Improve data management system to support statistical analysis and risk assessment.
 - Enhance data collection process to improve the quantity and quality of the data available for statistical/risk analysis.



Ongoing Drone/UAS Research

Researcher	Title	PHMSA	Cost Share	Start	Months	% Comp.
Pipeline Research Council International	<i>"Develop Remote Sensing and Leak Detection Platform that can Deploy Multiple Sensor Types"</i>	\$307,881	\$307,882	Sept 2019	24	17
Operations Technology Development	<i>"Validation of Remote Sensing and Leak Detection Technologies Under Realistic and Differing Conditions"</i>	\$500,000	\$500,000	Sept 2019	24	17
ULC Robotics	<i>"Improving Subsurface Non-metallic Utility Locating Using Self-Aligning Robotic Ground Penetrating Radar"</i>	\$393,690	\$393,690	Sept 2019	15	27
University of Missouri	<i>"An Unmanned Aerial System of Visible Light, Infrared and Hyperspectral Cameras with Novel Signal Processing and Data Analytics"</i>	\$250,000	\$62,764	Sept 2019	36	11
University of Nebraska	<i>"An autonomous UAS inspection platform for high-efficiency 3D pipeline/route modeling/change-detection and gas leak detection-localization"</i>	\$249,964	\$63,083	Sept 2019	36	11
West Virginia University	<i>"Unmanned Aerial Systems for Pipeline Inspection, Monitoring, and Landscape Analysis"</i>	\$206,920	\$58,036	Sept 2019	36	11
Total:		\$1,908,455	\$1,385,455			



Ongoing Machine Learning Research

Researcher	Title	PHMSA	Cost Share	Start	Months	% Comp.
Texas A&M Engineering Experiment Station	<i>"Development of a Prediction Model for Pipeline Failure Probability Based on Learnings from Past Incidents and Pipeline Specific Data using Artificial Neural Network (ANN)"</i>	\$300,000	\$75,000	Sept 2018	36	45
Texas A&M University	<i>"Mapping Indication Severity Using Bayesian Machine Learning from Indirect Inspection Data into Corrosion Severity for Decision-Making in Pipeline Maintenance"</i>	\$310,000	\$77,500	Sept 2019	24	17
Gas Technology Institute	<i>"Data Collection, Normalization and Integration Methods to Enhance Risk Assessment Tools for Decision-Making"</i>	\$1,161,597	\$514,671	Sept 2019	24	17
Pipeline Research Council International	<i>"Improving the Reliability, Detection, and Accuracy Capabilities of Existing Leak Detection Systems (Computational Pipeline Monitoring) Using Machine Learning"</i>	\$177,717	\$177,717	Sept 2019	18	22
North Dakota State University	<i>"Brain-Inspired Learning Framework to Bridging Information, Uncertainty and Human-Machine Decision-Making for Decoding Variance in Pipeline Computational Models"</i>	\$300,000	\$75,000	Sept 2018	36	45
		Total: \$2,249,314	\$919,888			



Potential Applications for Automatic Inspection

- Hazardous environment that affects inspection/maintenance personnel safety and inspection effectiveness/accuracy:
 - Elevated work
 - Confined space
 - Electrical shot
- The facilities/equipment where currently available ILI tools are not applicable:
 - Unpiggable pipelines
 - Short distance aboveground pipes that are not suitable for ILI
- Areas where there is restriction for human access for manual inspection



Data Capturing, Extracting and Decision Making

- Automated data collection to eliminate manual data collection or input:
 - Manual inspection with hand writing of inspection results on paper
 - Manual transfer pipeline historical data into database
- Automatic data processing into the format for risk/statistical model
- Automated Decision Making:
 - ML/AI facilitated predictive models for optimizing inspection frequency
 - Design and manage work flow to optimize maintenance/inspection schedule and mitigate high risk threats.
 - Identify and prioritize threats to develop monitoring and preventative strategies

