



# Liquids Industry Leak Detection R&D Current Status and Path Forward

## PHMSA 2023 R&D Forum

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**October 31, 2023**  
**Crystal City, VA**

## Presentation Overview

- The connection between research and technology development, standards, and regulation
- API leak detection standards
- The role of technology and innovation in advancing leak detection programs and collaborative R&D
- API 2023-2025 Pipeline Safety Strategic Plan - Leak Detection
- Looking forward – gaps and what's next?

## Opening Thoughts on Liquids Pipelines Leak Detection

- Leak Detection Programs and technologies continue to improve – trends are positive and we continue to learn as programs are implemented, lessons are learned, and continuous improvement practices and standards are developed
  - *PDCA (Pipeline SMS)*
  - *AI and ML for CPM, improving measurement technologies, segmentation*
  - *External leak detection technology – cable based and remote sensing technology*
- The pipeline industry discovers and repairs far more injurious anomalies than those isolated few that lead to failure and loss of containment – but LD system performance needed when loss of containment occurs
- A large proportion of releases are within areas controlled by operators – not IPE incidents, but still working to drive goal of zero incidents
- The role of innovation, disruptive technologies, and industry test facilities

## Technology & Innovation Lead to Pipeline Safety



Threat Assessment	Industry Roadmaps	PRCI GTI OTD	API ASME AMPP	49 CFR §192
Data Integration	Company ERM	NYSEARCH PHMSA	CSA ISO	49 CFR §194
Risk Models	Public Policy	DOE Academia	NFPA	49 CFR §195
P&M Measures	Strategic Research Priorities	JIPs/Consortia		

## API Leak Detection Standards

- Leak Detection Program and Systems (RP 1175)
- KPIs – 1130 and 1175
- External Leak Detection
- CPM – “internal leak detection”
  - RP 1130 – CPM Monitoring for Liquids Pipelines
  - RP 1149 - Pipeline Variable Uncertainties and Their Effects on Leak Detectability
  - RP 1165 – Pipeline SCADA Displays
  - RP 1168 – Control Room Management
- API-LEPA 2023-2025 Strategic Plan
  - Leak Detection Element

Table 2—List and Classification of LDSs

	Externally Based		Internally Based	
	Physical Inspection	Sensor-Based Monitoring	Manual Observations	Computational Pipeline Monitoring
<b>Non-Continuous</b>	Aerial Surveillance	Ground-Penetrating Radar	Volume or Line Balance Calculations	
	Ground-Based Line Surveillance	Sniffer Tubes	Hydraulic Calculations	
	Hydro Testing	Tracer Chemicals	Pattern Recognition	
	Satellite	Intelligent Pigs	Shut-in Testing/Stand-up Testing	
	One Call System/ Public Awareness	Soil Sampling		
<b>Continuous</b>		Sensing Cables	Controller SCADA Monitoring	Conservation of Mass (real time)
		Cameras		Real-Time Line Balance
		Chemical Analyzers		Pressure Monitoring
		Acoustic Sensors		Pattern Recognition
		CP Monitoring		Digital Signal Analysis
				Statistical Analysis



## API-LEPA 2023-2025 Pipeline Performance Excellence Strategic Plan

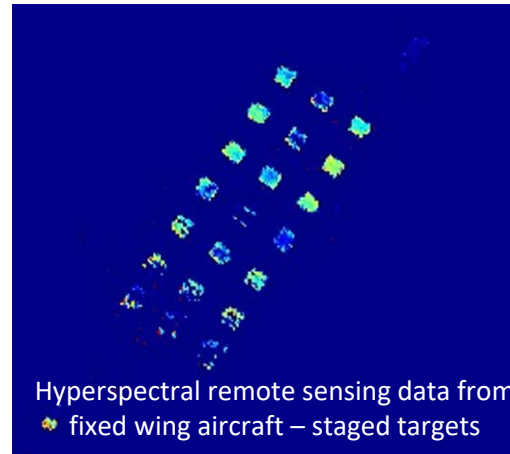
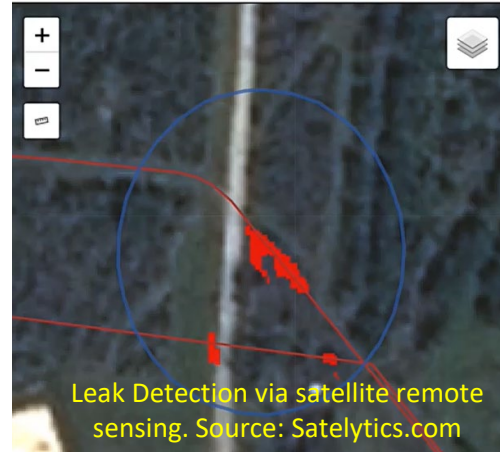


**2023-2025  
PIPELINE EXCELLENCE  
STRATEGIC PLAN**

- Five strategic goals identified  
[https://www.api.org/-/media/apiwebsite/oil-and-natural-gas/primers/api\\_pipeline\\_report-nrs-spreads.pdf](https://www.api.org/-/media/apiwebsite/oil-and-natural-gas/primers/api_pipeline_report-nrs-spreads.pdf)
- Goal 2: Improved Safety Through Technology & Innovation
- Specific objective within Goal 2 to enhance liquids pipelines leak detection capability
  - Prepare and implement a leak detection program risk assessment tool
  - Develop metrics for assessing leak detection program performance
  - Improve sensor sensitivity and placement

## API-LEPA Support for Collaborative R&D

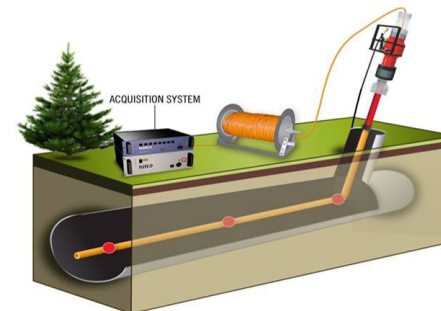
- PRCI Leak Detection SRP
  - *Liquids, gas, H<sub>2</sub> and CO<sub>2</sub> pipelines; Current focus on liquids*
  - *PRCI GHG SRP → methane*
- Acoustic in-line systems – MSIB, ICIP, others
- External Leak Detection
  - Cable-based systems
  - Discrete, location-specific sensors
  - Remote sensing – aircraft, UAS, satellite
- Requires advanced data analytics and integration
- Leak Rate Testing R&D
- PHMSA R&D – recent CO<sub>2</sub> & H<sub>2</sub> focus, methane emissions, LNG; prior work on fiber optic and remote sensing



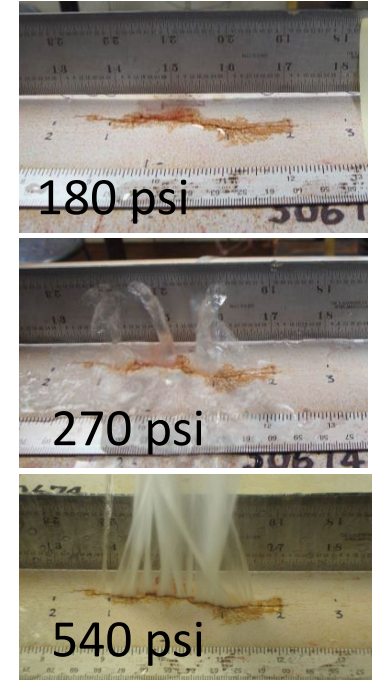
Cable-based installation - new construction



Cable-based installation - retrofit



Cable-based installation – internal



Leak Rate Testing

## Liquids Pipelines Leak Detection Gaps and R&D Projects

- **Improvements to CPM analytics**
  - AI & ML approaches, withdrawal testing protocols
  - CPM performance assessment methods
  - Data science – assessment and integration of data from multiple inputs and sources
  - Studies on segmentation, performance/sensitivity and placement of sensors
- **In-line systems – acoustics and other improvements**
  - Detecting and accurately detecting leaks
  - Additional data to feed into CPM system
- **External leak detection**
  - Industry liquids leak detection test facilities
  - Optimizing placement of fiber optic systems and retroactive installation
  - Promise of remote sensing systems in the air and reverse engineering
  - Disruptive technologies
  - Process and programmatic improvements