

# PHMSA PIPELINE SAFETY RESEARCH

**Internal Corrosion 2002-2009**

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Pipeline and Hazardous  
Materials Safety Administration

# Pipeline Safety R&D

## **Pipeline Safety R&D Program Mission:**

To sponsor research and development projects focused on providing near-term solutions that will improve the safety, reduce environmental impact, and enhance the reliability of the Nation's pipeline transportation system.

## **What do we want you to know?**

- We employ an enterprise approach to address mutual challenges
- We help remove technical barriers on a given challenge
- We measure our research results/impacts
- We are transparent
  - <http://primis.phmsa.dot.gov/rd/>

# Research Program Objectives

<b>Developing Technology</b>	<b>Strengthening Consensus Standards</b>	<b>Promoting Knowledge</b>
<p>Fostering the development of new technologies so that pipeline operators can improve safety performance and more effectively address regulatory requirements.</p>	<p>Targeting and feeding new knowledge into the process of keeping standards relevant to their purpose.</p>	<p>Generating and promoting general knowledge to decision makers.</p>

# PHMSA Pipeline Research Status

**Awards Made: 146 since 2002, \$48M (PHMSA)+\$61M (Industry)=\$109M**

## Research Objectives

## Research Strategies and Objectives



Objective	Projects	PHMSA	Industry	Total
Strengthening Standards	42	\$12.56M	\$16.57M	\$29.14M
Technology Development	54	\$26.14M	\$29.35M	\$55.50M
Knowledge Documents	104	\$24.99M	\$38.34M	\$63.34M

Program Category	Objectives	PHMSA	Industry	Total	Total
Damage Prevention	Strengthening Standards	\$ 0.07M	\$ 0.08M	\$ 0.15M	
	Technology Development	\$ 1.76M	\$ 1.08M	\$ 2.84M	■
	Knowledge Documents	\$ 0.22M	\$ 0.51M	\$ 0.73M	
Pipeline Assessment and Leak Detection	Strengthening Standards	\$ 5.45M	\$ 7.02M	\$12.48M	■
	Technology Development	\$20.75M	\$24.00M	\$44.76M	■
	Knowledge Documents	\$11.02M	\$15.72M	\$26.74M	■
Defect Characterization and Mitigation	Strengthening Standards	\$ 2.32M	\$ 2.99M	\$ 5.31M	■
	Technology Development	\$ 0.88M	\$ 1.02M	\$ 1.90M	
	Knowledge Documents	\$ 5.16M	\$ 6.58M	\$11.74M	■
Improved Design, Construction and Materials	Strengthening Standards	\$ 4.50M	\$ 6.26M	\$10.76M	■
	Technology Development	\$ 2.74M	\$ 3.24M	\$ 5.99M	■
	Knowledge Documents	\$ 7.19M	\$13.59M	\$20.78M	■
Enhanced Operation Controls and Human Factors Management	Strengthening Standards	\$ 0.00M	\$ 0.00M	\$ 0.00M	
	Technology Development	\$ 0.00M	\$ 0.00M	\$ 0.00M	
	Knowledge Documents	\$ 0.53M	\$ 0.49M	\$ 1.02M	
Risk Management and Communications	Strengthening Standards	\$ 0.00M	\$ 0.00M	\$ 0.00M	
	Technology Development	\$ 0.00M	\$ 0.00M	\$ 0.00M	
	Knowledge Documents	\$ 0.03M	\$ 0.03M	\$ 0.07M	
Safety Issues for Emerging Technologies	Strengthening Standards	\$ 0.21M	\$ 0.22M	\$ 0.43M	
	Technology Development	\$ 0.00M	\$ 0.00M	\$ 0.00M	
	Knowledge Documents	\$ 0.83M	\$ 1.40M	\$ 2.23M	

**NOTE:** Projects can impact and be relevant in two or more areas. Because of this, counts and sums will amount to more than 100% of program totals.

# PHMSA SPONSORED RESEARCH

## INTERNAL CORROSION 2002-2009

- \$3.5 M in research and development
- Co-funded 16 projects related to IC with pipeline and technology companies
  - New technology
  - Standards
  - Internal corrosion control risks and risk detection
  - Prevention
  - Mitigation practices

# **PHMSA SPONSORED R&D PROJECTS**

## **INTERNAL CORROSION Past Projects**

### **HAZARDOUS LIQUID PIPELINES 2002-2008**



- ✓ **LIQUID PETROLEUM INTERNAL CORROSION DIRECT ASSESSMENT (LP-ICDA)**

- ✓ Method now a NACE standard, SP0208-2008

- ✓ **CORROSION ASSESSMENT CRITERIA**

- ✓ Validity of corrosion assessment criteria

- ✓ **HIGH POWER LONG RANGE GUIDED-WAVE INSPECTION**

- ✓ Extend the test range for ICDA and ECDA

- ✓ **LIQUID PETROLEUM INTERNAL CORROSION DIRECT ASSESSMENT (LP-ICDA)**

- ✓ Method now a NACE standard, SP0208-2008

- **NoPig**

- Above ground NDT method for detecting and sizing wall thickness anomalies in non-piggable pipelines
- Encountered difficulty modeling longitudinal seams
- Final Tool not developed under this contract

- **ALTERNATIVE INLINE INSPECTION VEHICLES**

- New technology needed
- Possible solution: Robot that “lives” in a pipeline



# ALTERNATIVE INLINE INSPECTION VEHICLES



Video camera in head sends pictures to remote monitor. Future version to have supervised autonomous operation modes. Operator in control room could zoom in on pipeline features.

# ALTERNATIVE INLINE INSPECTION VEHICLES



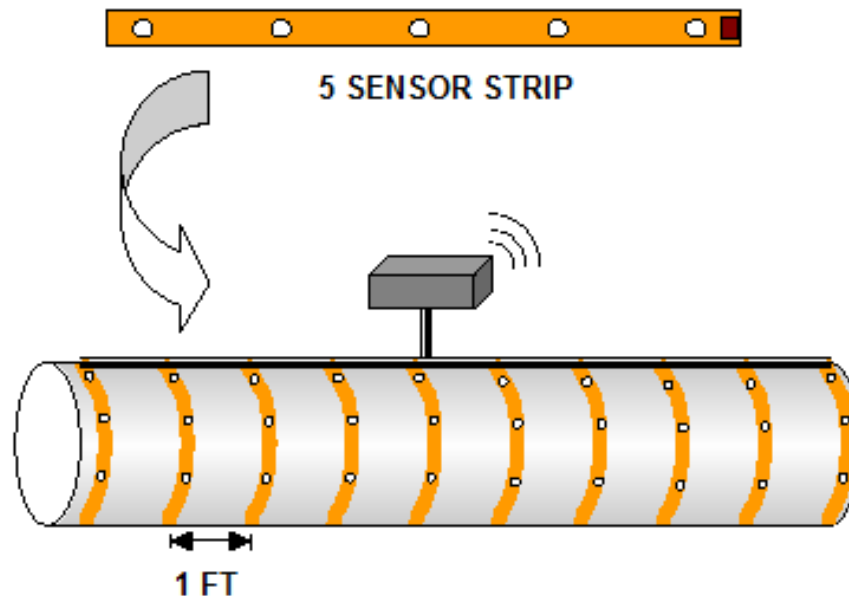
Dr. Gavin Miller prototype. Movement without wheels allows for rectilinear motion. Has bidirectional packet-based radio and a variety of sensors.

Research Conducted by Southwest Research Institute  
Project ID: DTRS-56-02-T-0004

➤ **REAL-TIME ACTIVE PIPELINE INTEGRITY  
DETECTION (RAPID)**

- Network of distributed piezoelectric sensors embedded in dielectric carrier film
- Diagnostic signals monitored to ascertain integrity of pipe

# REAL-TIME ACTIVE PIPELINE INTEGRITY DETECTION (RAPID) FOR DIRECT ASSESSMENT OF CORROSION IN PIPELINES



**128 CHANNELS**  
**WIRELESS**  
**AUTONOMOUS DATA ACQUISITION AND PROCESSING**  
**RESULTS TRANSMITTED TO CENTRAL CONTROL UNIT**  
**AUTOMATED WITH BATTERY POWER OR UPS**

# **PHMSA SPONSORED RESEARCH AND DEVELOPMENT**

## **INTERNAL CORROSION CURRENT PROJECTS**

# INTERNAL CORROSION DETECTION IN LIQUID PIPELINES

## ➤ Background

- Low cost system capable locating areas of water accumulation and determining the corrosivity of found liquid
- Acoustics based system integrated to wireless network platform
- Can be operated in all pipeline
- Compliments LP-ICDA and ILI

## ➤ Objective

- Extend previously successful development of sensor system for gas pipelines to liquid pipelines

# ADAPTATION OF MWM-ARRAY AND MFL TECHNOLOGY

## ENHANCED DETECTION/CHARACTERIZATION OF DAMAGE FROM INSIDE PIPELINES

### ➤ Background

- Nondestructive evaluation for detection and characterization of pipeline damage
- Conditions of interest
  - Internal and external corrosion
  - Mechanical damage and stress corrosion cracking

### ➤ Objective

- Adapt Meandering Winding Magnetometer Array technology to deliver hybrid MWM-Array/MFL method
- Develop solution for ILI applications and platform for unpiggable pipeline

# ALTERNATIVE INLINE INSPECTION VEHICLES



Tethered robot. Wide range of motion controlled by compressed air.



# ALTERNATIVE INLINE INSPECTION VEHICLES



Early prototype built by Dr. Gavin Miller.

# ALTERNATIVE INLINE INSPECTION VEHICLES



The locomotor module houses a mini fish-eye camera and lighting elements. The camera has a 190-degree field of view and provides high-resolution color images of the pipe's interior.

# PHMSA R&D Website

- <http://primis.phmsa.dot.gov/rd/>