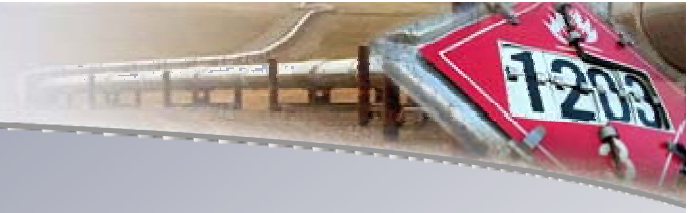




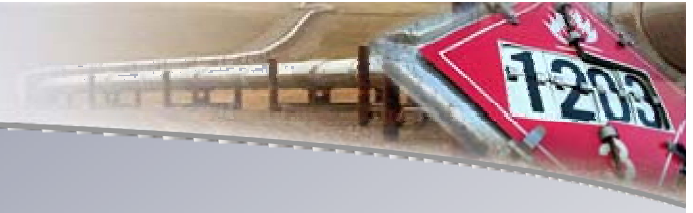
U.S. Department of Transportation
Pipeline and Hazardous Materials
Safety Administration



PHMSA Pipeline Safety Research



**Track Session on Leak Detection
June 24-25, 2009**

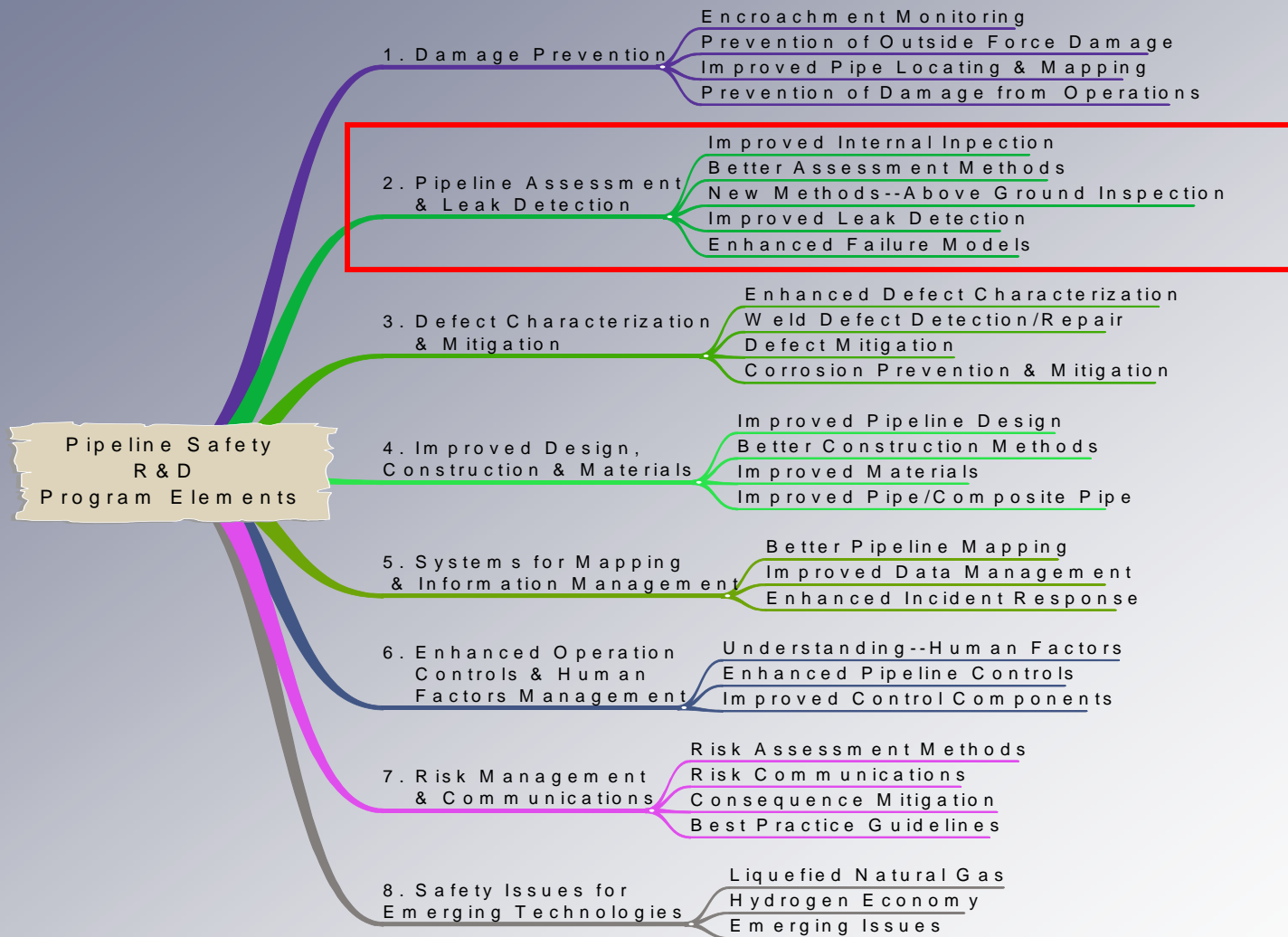


Leak Detection Strategy

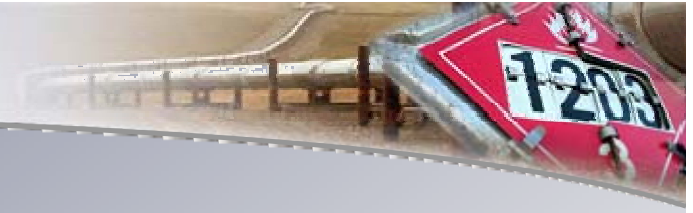
- **Detection:**
 - Detecting leaks via underground, above ground and or airborne systems.
- **Program Element Goals:**
 - Identifying and locating critical pipeline defects using inline inspection, direct assessment and leak detection



PHMSA R&D Strategic Plan for Leak Detection



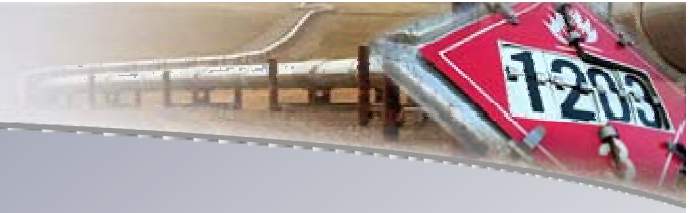
Desired Outputs
of R&D Program



Project Types Underway

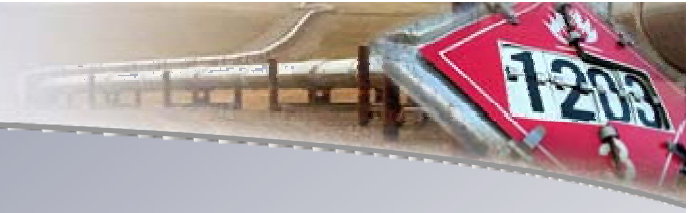
- 66 projects awarded since 1969 with a primary focus on Pipeline Assessment (prevention) and Leak Detection worth approximately \$55.9M
 - (\$23.8 M PHMSA + \$31.9 M Industry co-sponsoring)
- Since 2002 PHMSA's R&D program has sought relevant topics in nearly all research solicitations.

Active R&D Projects (as of 6/1/09)	#	DOT	Industry	Total
Strengthening Standards	9	\$6.8M	\$7.2M	\$14.0M
Technology Development	20	\$11.1M	\$16.2M	\$27.3M
Knowledge Documents	17	\$4.1M	\$8.5M	\$12.6M
Relevance Totals:		\$22.0M	\$31.9M	\$53.9M



Leak Detection Project Types Underway

- **Technology Development: (4 projects)**
 - Improving Joint Integrity and Assessment for Non-Metallic Materials (leak prevention)
 - Develop inspection technology for an automated butt fusion inspection tool that will inspect any heat fusion or electro-fusion joint such as socket, saddle, elbow, tee, and service line joints
 - Free-Swimming Acoustic Tool for Liquid Pipeline Leak Detection Including Evaluation for Natural Gas Pipeline Applications
 - Leverage a free-swimming acoustic leak detection tool currently used in water pipeline industry & further develop the device for application in oil product pipelines and evaluate its potential for natural gas pipelines.



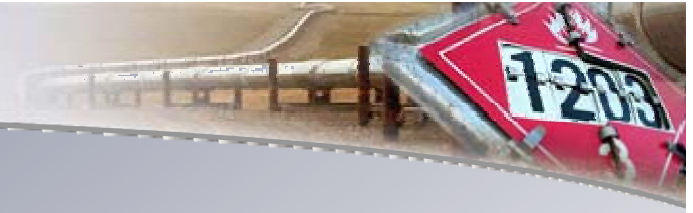
Leak Detection Project Types Underway

- **Technology Development: (continued)**
 - Butt Fusion Joint Integrity and Evaluation of NDE Technologies
 - program objective is to improve and/or validate the butt fusion process by developing novel analytical solutions and new test approaches to ensure the safe long-term performance of polyethylene (PE) butt fusion joints.
 - Infrasonic Frequency Seismic Sensor System for Pipeline Integrity Management
 - Started under a SBIR phase I program the Infrasonic Gas Pipeline Evaluation Network (PIGPEN) system that detects and warns of third-party damage before it occurs. PIGPEN uses low frequency seismic/acoustic sensor technology to proactively detect and warn of unauthorized activity near underground gas pipelines before damage occurs, thereby preventing third party damage and subsequent pipeline leaks or failure.



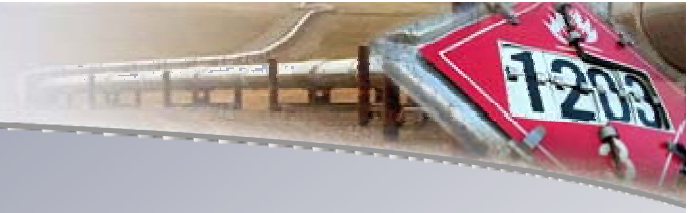
Leak Detection Project Types Underway

- **General Knowledge: (3 projects)**
 - Achieving Maximum Crack Remediation Effect from Optimized Hydrotesting
 - Develop a working model to allow industry to predict the overall benefits of hydrotests. Such a prediction will be made with a consideration of various characteristics of a pipeline including the type of operation, stage of cracking, environmental susceptibility, steel metallurgy, and operation history.
 - Validation of Assessment Methods for Production Scale Girth Welding of High Strength Pipelines
 - Thru testing a large set of girth welds produced under realistic conditions demonstrate the effect of material variability between pipes, between heats and between pipe manufacturers to validate current and proposed new weld defect assessment methods.



Leak Detection Project Types Underway

- **General Knowledge: (continued)**
 - Corrosion Assessment Guidance for Higher Strength Pipelines
 - Develop comprehensive and consistent methods for locating and assessing corrosion in the field improve an operator's ability to determine the severity of damage from localized corrosion in material grades from X70 to X100 and its reduction on pipeline operating pressures.



Leak Detection Project Impacts To Date

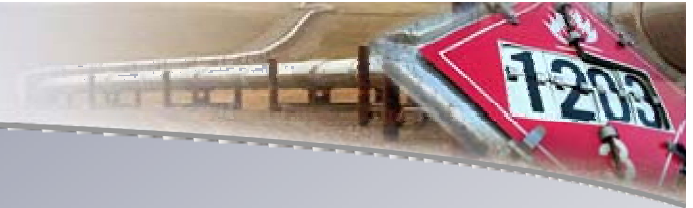
- **Technology Impacts: (6 projects)**
 - Hazardous Liquids Airborne Lidar Observation Study
 - Developed Airborne Natural Gas Emission Lidar (ANGEL) technology for detection of small hazardous liquid and refined product leaks. The ANGEL system is designed to remotely detect, quantify, and map small plumes of methane and ethane, the principle constituents of natural gas.
 - Innovative Welding Processes for Small to Medium Diameter Gas Transmission Pipelines
 - Developed welding processes and technologies for single-sided pipeline girth welding focusing on root pass welding techniques because of the greatest potential to improve pipeline integrity with automated GMAW fill pass techniques that improve weld quality, process control, seam tracking, and robustness.



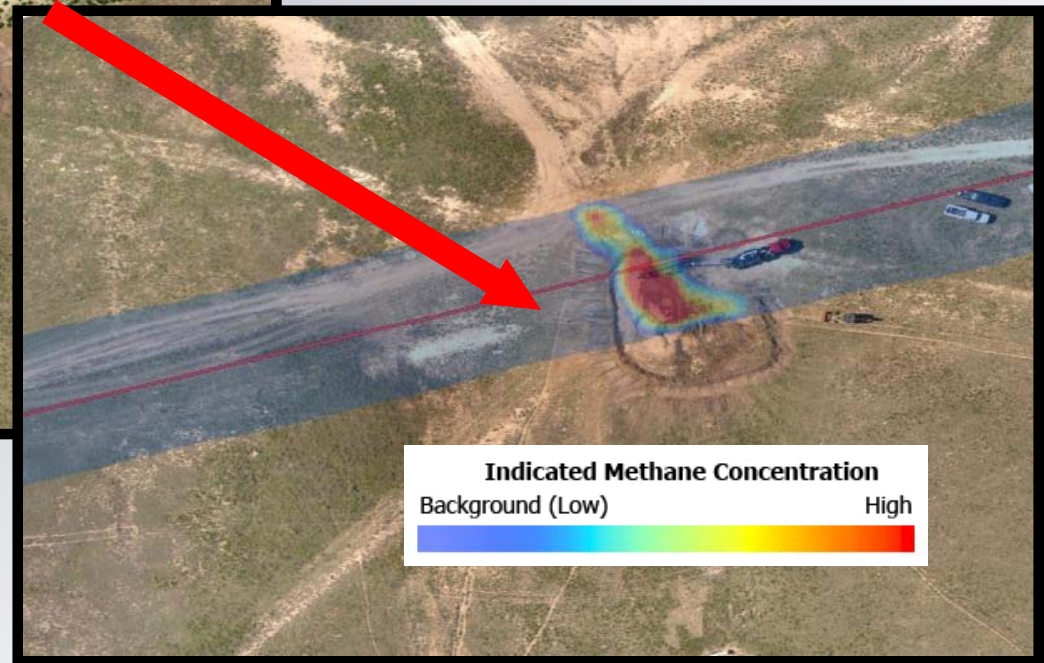
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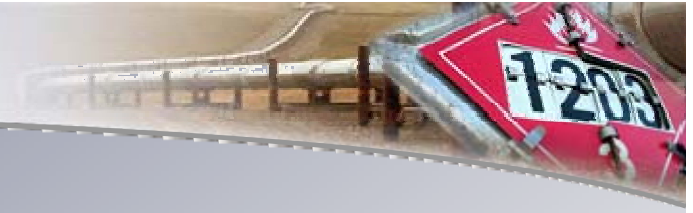


Airborne Natural Gas Emission Lidar (ANGEL) Services



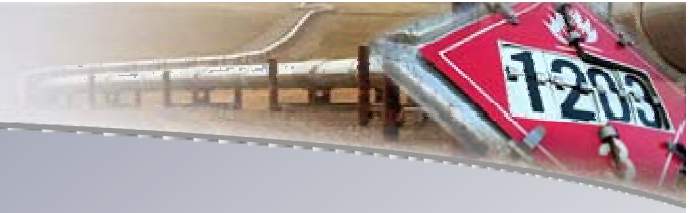
This example depicts both a gas plume and contaminated soil.





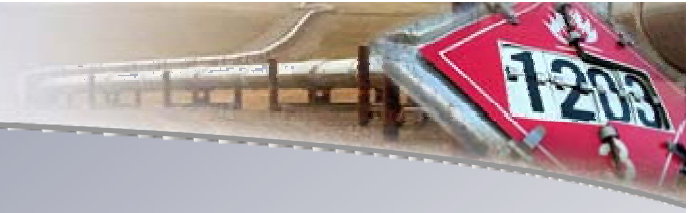
Leak Detection Project Impacts To Date

- **Technology Impacts: (continued)**
 - Airborne LIDAR Pipeline Inspection System (ALPIS) Mapping Tests
 - The ALPIS is an airborne remote sensing system for detecting leaks associated with natural gas and hazardous liquid pipelines. ALPIS uses differential Light Detection & Ranging to detect the presence and concentration of hydrocarbons in the atmosphere. The system employs a digital camera and a global positioning system to provide visual surveyed areas. Projected survey speeds of up to 150 miles per hour and cost equal to or less than much slower survey methods currently available.
 - Intrinsic Distributed Fiber Optic Leak Detection
 - Develop a fiber optic sensor system for the real-time monitoring of pipelines to determine leaks with a new inherently reliable method to acoustically detect leaks in pipelines with high spatial precision and low false alarm rates in real time.



Leak Detection Project Impacts To Date

- **Technology Impacts: (continued)**
 - Innovative Safety and Reliability Technologies for Pipeline System Integrity and Management (SBIR)
 - Developed tool to detect metal loss from a "cup" shape or ellipsoid surface dent in a pipe. Using shear wave scattering effects from a EMAT sensor design using nonlinear split-spectrum algorithms.
 - Piezo Structural Acoustic Leak Detection System (SBIR)
 - Demonstrated that piezoelectric materials with a low-power/self powered acoustic data transmission monitor system can be used to sense leaks



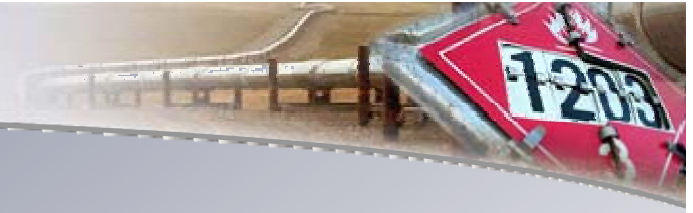
Leak Detection Project Impacts To Date

- **General Knowledge: (3 projects)**
 - Effectiveness of Prevention Methods for Excavation Damage
 - Developed fault tree model to establish hit frequency due to 3rd party excavation based on pipeline condition and prevention practices. In addition to prevention effectiveness, this model is being used to facilitate the selection of most cost-effective prevention methods, and to evaluate risk & reliability of existing or new pipelines.
 - Evaluation of Hydrogen Cracking in Weld Metal Deposited using Cellulosic Electrodes
 - Investigated effects of electrode re-hydration on weld metal chemistry, mechanical properties and hydrogen cracking susceptibility and developed practical guidelines on how to prevent hydrogen cracking in welds deposited using cellulosic covered electrodes.



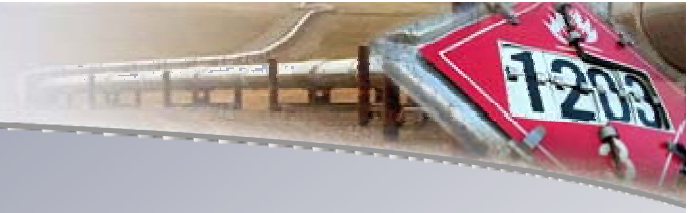
Leak Detection Project Impacts To Date

- **General Knowledge: (continued)**
 - Mechanical Damage at Welds
 - Using a cautious damage disposition approach based upon numerical & full-scale trials demonstrated the significant impact that weld seams have on the life of the mechanically damaged pipe segments. Weld seams are considered less damage tolerant than the line pipe base material for a number of mechanical property, weld geometry and residual stress related reasons. Results suggest regulatory requirements could be made less restrictive for gas pipelines by considering pressure history (low fluctuation), type and extent of the mechanical damage, and position of the weld with respect to the mechanical damage.



Remaining Challenges

- Getting new technology/solutions/services ADOPTED within a heavily regulated industry
- Operators perform a visual patrol (192.705) in Class 1 and 2 locations meets their regulatory requirements for leakage surveys (192.706) in Class 1 and 2 locations.
 - Since visual patrol is \$3/mile in cost, operators are very reluctant to use more advanced (costly) solutions
 - This is a barrier for new leak detection tools. Does industry need clarification on intent of Class 1 & 2 Leakage Survey?
- Development & commercialization of UAV systems needed to drastically reduce operational cost of very long pipeline inspections
- Market penetration of affordable/reliable technology remains challenging due to lack of:
 - Commercial partners –Corporate sponsors' are missing
 - Multitask Tools –Need to prevent and detect leaks.
 - NIH -Alternative technologies being developed by others



For More Information...

- On the projects addressing Leak Detection, please visit:
<http://primis.phmsa.dot.gov/rd/splan.htm>
- On the impacts measured on projects addressing leak detection visit:
<http://primis.phmsa.dot.gov/rd/performance.htm>
- Or contact:

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