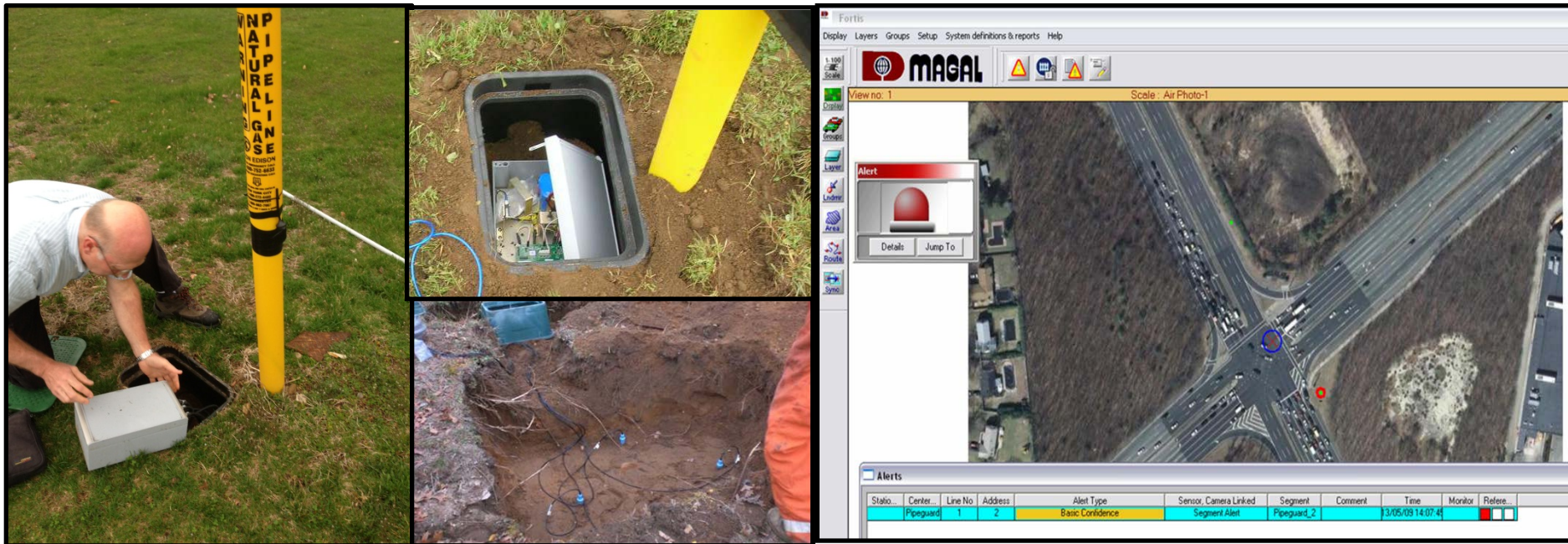


Pipeline Research & Research Partnerships Are Generating Solutions



Advanced Development of PipeGuard™

A partnership with NGA/NYSEARCH and DOT/PHMSA led to improvements to a proactive damage prevention monitoring technology which is being offered for pipelines by Senstar Incorporated (formerly Magal Senstar). Their systems are designed for a range of pipeline lengths. Testing in this program lead to optimized technology configuration for the industry. Reliability testing is ongoing.

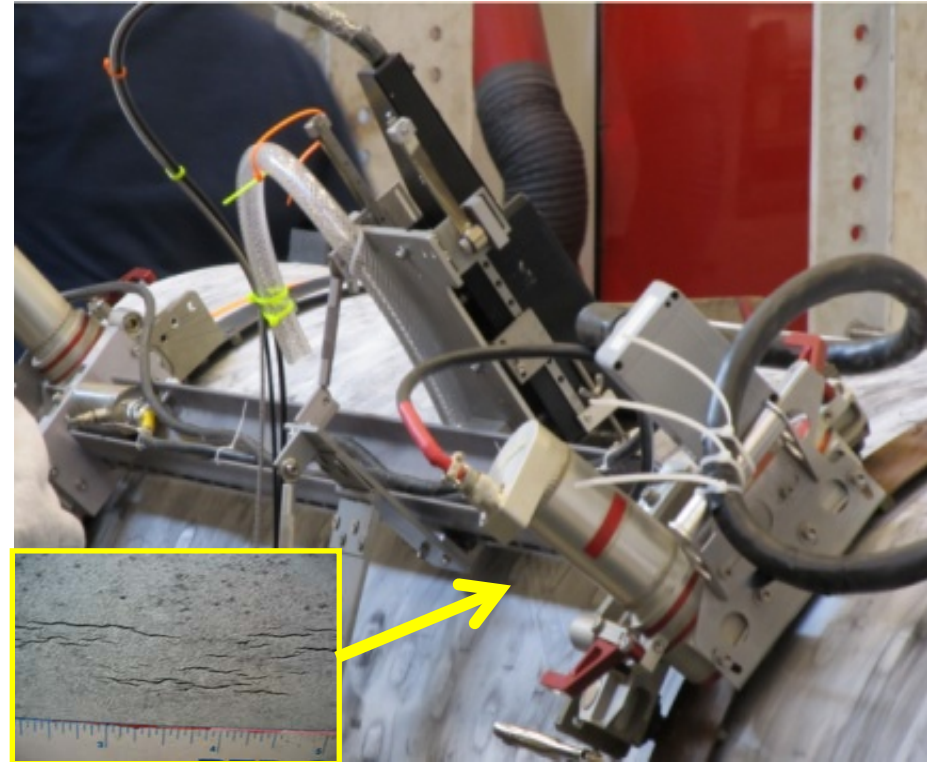


TECHNOLOGY

Integrated Tool Development for SCC In-Field Assessment



This research partnership between PHMSA/DOT, PRCI, and a multi-party collaboration (Applus RTD, IOS, JENTEK, Blade Energy Partners) successfully deployed an integrated Stress Corrosion Cracking (SCC) assessment tool consisting of crack mapping technology, a data analysis tool for identifying the most significant SCC crack fields and laser SCC depth sizing. After the completion of this project, pipeline operators have access to a validated integrated tool approach for SCC assessment in the ditch.



TECHNOLOGY

Software/Hardware Improvements to Guided Wave Ultrasonics (GWUT)



Four separate research projects addressing GWUT with NYSEARCH and Southwest Research Institute led to commercial improvements with multiple service providers. As a result software and hardware support longer inspection distances and better characterization of defects. This technology is widely applied to inspect cased crossings nationwide. Use of magnetostrictive sensor guided-wave technology was also benchmarked.



TECHNOLOGY

Acoustic Pipe Locator (APL)

Under a joint project between OTD and PHMSA, GTI developed and successfully field tested the APL. APL is a handheld tool to detect and locate buried non-metallic (PE and sewer) and metallic pipes. It can be used in most soils and ground coverings such as grass, asphalt, concrete, and dirt. The ULTRA-TRAC® APL is commercially available from Sensit Technologies.

Field Test
with APL

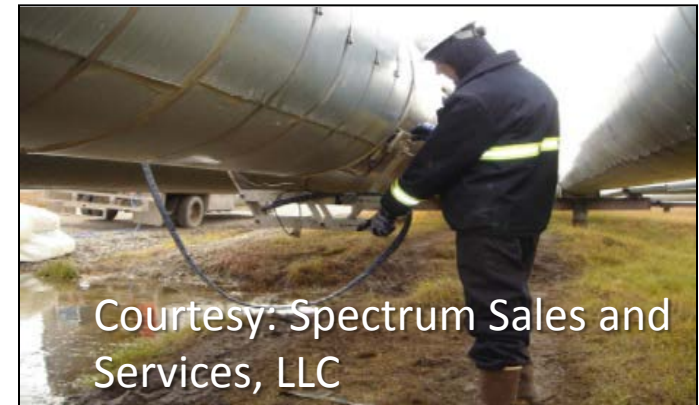


TECHNOLOGY

Improvements to Through Coating Inspection of Pipelines



This research led to commercial improvements with three different service provider tools for detection of corrosion & mechanical damage through coatings and insulation. This NDT technology can inspect above ground & in-ditch piping with eliminating the need to strip the thin corrosion barrier for anomaly inspection through most coatings less than 3mm thick.



TECHNOLOGY

Advancement in Welding, Repairs and Remediation of In-Service Pipelines



A research partnership with EWI led to commercial improvements with automated welding for in service pipelines. The new automated system is approximately 2.3 times faster and 62% cheaper than manual welding. The system allows in-service repair welding on future high strength/pressure pipelines where manual repair welding is not suitable.



TECHNOLOGY

Pipeline Research & Research Partnerships Are Generating Solutions



Collaborative Testing/ Demonstration of Guided Wave Ultrasonics



DOT/PHMSA and NGA/NYSEARCH worked in partnership to test and evaluate various enhancements to Guided Wave Inspection. In 2006, at NYSEARCH's test bed where cased piping systems are installed with known defects, several technologies were subjected to validation tests for industry and government officials to: 1) evaluate the capabilities of state-of-the-art in guided wave and, 2) to help set a framework for application of Guided Wave inspection for gas pipelines.

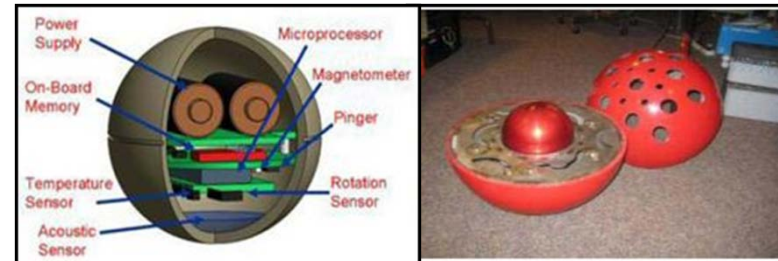


KNOWLEDGE

Improvements to Pipeline Leak Detection



This joint academic/industry/PHMSA research project made commercial improvements to a free-swimming acoustic leak detection tool from technology used in the water pipeline industry and further developed the device for application in oil product pipelines and evaluated its potential for natural gas pipelines.



TECHNOLOGY

Improvements to External Corrosion Direct Assessment Methodology



Several research projects contributed new knowledge to the early development of the Pipeline External Corrosion Direct Assessment Methodology and its application by pipeline operators.



ANSI NACE Standard RP0502-2002
Item No. 2.1037

Standard Recommended Practice

Pipeline External Corrosion Direct Assessment Methodology

This NACE International (NACE) standard represents a consensus of those individual members who have reviewed this document, its scope, and provisions. Its acceptance does not in any respect preclude anyone, whether he has adopted the standard or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not in conformance with this standard. Nothing contained in this NACE standard is to be construed as granting any right, by implication or otherwise, to manufacture, sell, or use in connection with any method, apparatus, or product covered by Letters Patent, or as indemnifying or protecting anyone against liability for infringement of Letters Patent. This standard represents minimum requirements and should in no way be interpreted as a restriction on the use of better procedures or materials. Neither is this standard intended to apply in all cases relating to the subject. Unpredictable circumstances may negate the usefulness of this standard in specific instances. NACE assumes no responsibility for the interpretation or use of this standard by other parties and accepts responsibility for only those official NACE interpretations issued by NACE in accordance with its governing procedures and policies which preclude the issuance of interpretations by individual volunteers.

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Approved August 22, 2003

CONSENSUS STANDARD

Robotic Platform for Inspection of Unpiggable Natural Gas Lines

A research partnership between DOT/PHMSA and NGA/NYSEARCH with cofunding from OTD, PRCI, DOE/NETL, SDTC and Invodane Engineering to design, develop and test a range of platforms to negotiate the challenges of un-piggable transmission mains. Commercial product is now available from this program. Several additional larger size robotic platforms are also being released.



TECHNOLOGY

Improvements to the Battelle Two-Curve Method



A PHMSA partnership with EMCC and PRCI led to the first major improvements to the Battelle Two-Curve Method. Modifications to the backfill coefficient developed in this project along with field burst data addressing soil behavior and its affect on the fracture speed of running axial flaws in buried line pipe materials were incorporated into the BTCM.



MODEL

Improvements to Corrosion Mitigation



A partnership with Shell Global Solutions led to the commercialization of an In-line Cathodic Protection Inspection tool which was the first method to assess the effectiveness of a pipeline's cathodic protection system from INSIDE the pipe. The data provides information used to diagnose problems with the cathodic protection system and coatings.



Courtesy: Baker Hughes

TECHNOLOGY

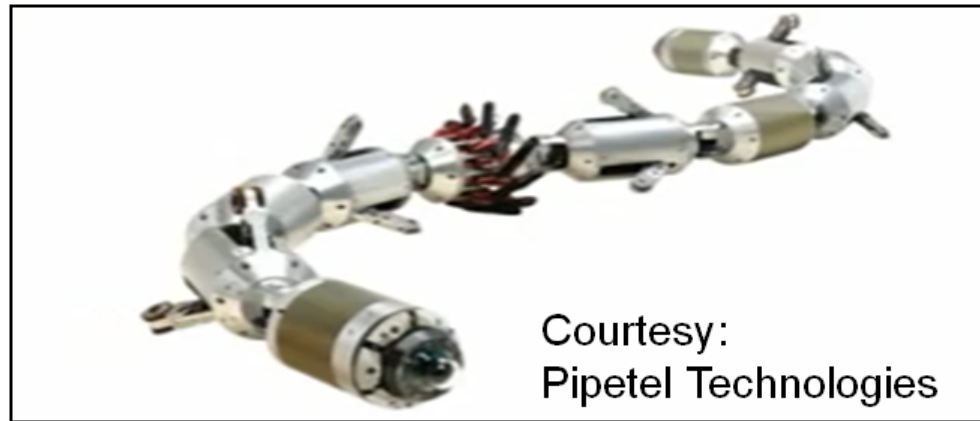
Pipeline Research & Research Partnerships Are Generating Solutions



Improvements to Corrosion Detection/Mitigation



A partnership with NYSEARCH led to the commercialization of the first ever inspection platform (Explorer II) and integrated sensor capable of internal unpiggable gas pipeline inspection. Explorer II is an untethered, modular, remotely controllable, self-powered inspection robot for the visual and nondestructive inspection of 6- and 8-inch natural gas transmission and distribution system pipelines.

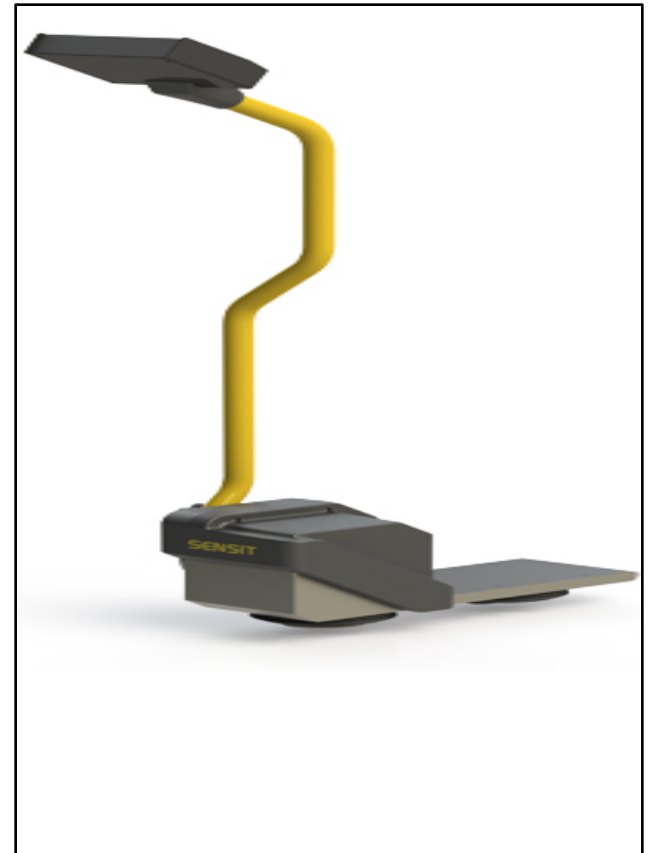


TECHNOLOGY

Acoustic-based Technology to Detect Buried Pipes



This project improved the Ultra-Trac[®] APL acoustic pipe locator through multiple validation demonstrations at several urban utility sites. The improvements will assist the pipeline operators and underground asset locators in detecting buried metallic and non-metallic pipes (PE and sewer pipes), reduce "excavation damages," and increase the system and public safety.

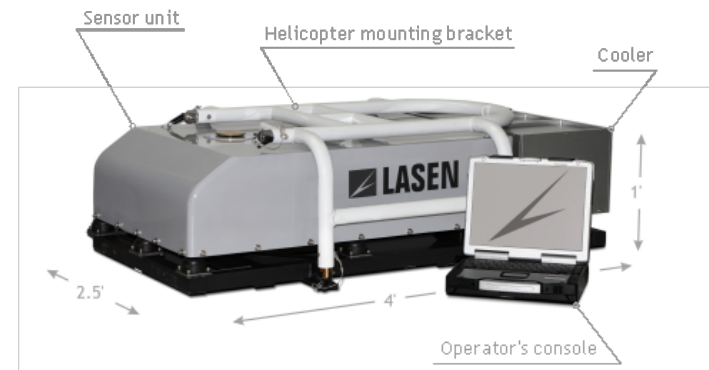


TECHNOLOGY

Improvements to Pipeline Leak Detection



A partnership with Lasen, Inc. supported deployment of a helicopter based fast, efficient, and accurate tool for detecting and mapping natural gas and hazardous liquid pipeline leaks. This work enabled an engineering research prototype to become a commercialized leak detection and mapping system that the pipeline industry can now use.



TECHNOLOGY

Innovative Sensors for Inspection of Unpiggable Lines

A research partnership between PHMSA/DOT and NGA/NYSEARCH with cofunding from OTD to develop sensors that could, with integration into the robotic platform, negotiate plug valves, back-to-back bends, 90s, vertical segments and other challenges that are characteristic of un-piggable transmission mains. SwRI and Invodane developed the two types of sensors (RFEC and MFL) for the range of platforms.

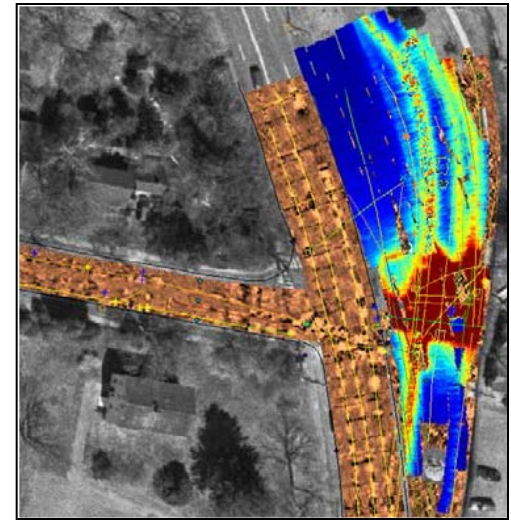


TECHNOLOGY

Improvements to Sub-Surface Mapping



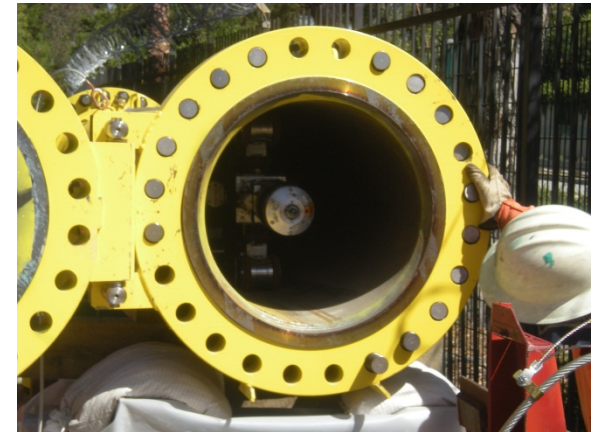
Research led to the first commercial system capable of producing highly accurate, three-dimensional maps and images efficiently and noninvasively (without digging) in conditions as much as ten feet underground and based on rapid computer analysis of radar images. The system is vehicle mounted or smaller hand walked system by operator for rural or urban deployment.



TECHNOLOGY

Final Development and Testing of Robotics Systems

Extensive field testing of platforms and sensors at NYSEARCH Test Bed and in live pipelines prior to commercialization. Explorer 20/26 undergoing live testing at funding companies. Operational and safety procedures are validated. Data collection and analysis culminate with release of inspection report to host companies, tailored to their needs. Reliability and robustness of robotic system and sensor are established as well as accuracy of data collected.



TECHNOLOGY

Pipeline Research & Research Partnerships Are Generating Solutions



Improvements to Flaw Acceptance Criteria in Girth Welds



Research partnerships with EMCC and CRES have contributed new knowledge to the industry standard on the welding of pipelines and related facilities. Specifically with updating the flaw acceptance criteria in API Standard 1104 Appendix A on girth welds when welding high strength steels.

Welding of Pipelines and Related Facilities

API STANDARD 1104
TWENTIETH EDITION, OCTOBER 2005
ERRATA/ADDENDUM, JULY 2007
ERRATA 2, DECEMBER 2008



CONSENSUS STANDARD

Most Downloaded PHMSA Research Final Reporting



	Researcher Name	Project Title
1.	Stress Engineering Services	Deepwater GOM Pipeline Damage Characteristics & Repair Options
2.	Edison Welding Institute, Inc.	Advanced Welding Repair and Remediation Methods for In-Service Pipelines
3.	Battelle Memorial Institute	A New Approach to Control Running Fracture in Pipelines
4.	Pipeline Research Council International	Pipeline Integrity Management for Ground Movement Hazards
5.	Battelle Memorial Institute	Integrity Management for Wrinklebends and Buckles
6.	Battelle Memorial Institute	Model Modules to Assist Assessing and Controlling Stress Corrosion Cracking

Wow! Final reports for these projects were collectively downloaded over 15,000 times from the PHMSA website. We've been tracking this information since January 2008 with over 1.1M downloads via all facets of our program website - <https://primis.phmsa.dot.gov/rd/>

KNOWLEDGE

Evaluation of External Corrosion Growth-Rate

External corrosion growth rates of buried pipelines were estimated from soil parameters and measurements using Electric Resistance (ER) probes.

The analysis was incorporated into a database and web-based program for use by pipeline operators to improve corrosion-rate estimates.



Acoustic-based Technology to Detect Buried Pipes



This project adapted JENTEK's Meandering Winding Magnetometer (MWM) Array and Magneto-resistive (MR) MWM Array for the detection and characterization of corrosion and mechanical damage through coatings.



TECHNOLOGY

Development of Optimized Welding Solutions for X100 Line Pipe Steel



PRCI and Lincoln Electric developed advanced weld design and weld testing procedures, improved assessment methodologies, and optimized welding solutions for joining high strength steel pipe, specifically X100 line pipe using gas metal arc girth welding (GMAW) methods. New welding process control and welding material assessment methods reduces weld variation and improves weld performance, which is further enhanced by an improved ability to select the best welding materials for an application. Included are results for several GMAW welding consumables that expand the range of strength mismatch conditions. Many findings were applicable to lower strength steels.

TECHNOLOGY

Technical and Economic Feasibility of Preventing SCC through Control of Oxygen



The project validated the use of oxygen probes for measuring oxygen levels in pure ethanol and in fuel grade/neat ethanol. The project improved Polestar oxygen probes so that they could directly measure the oxygen concentrations in ppm rather than in a partial pressure environment common with legacy systems.



TECHNOLOGY

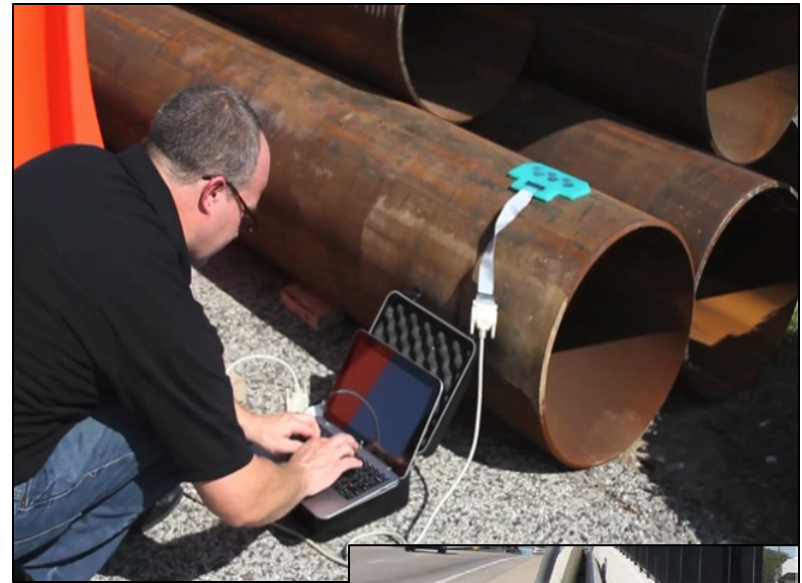
Pipeline Research & Research Partnerships Are Generating Solutions



A Quantitative Non-Destructive Residual Stress Assessment Tool for Pipelines



The project validated the eStress™ system for residual stress assessment of pipeline damage was developed, demonstrated and commercialized under a PHMSA Small Business Innovative Research Phase I & II award. This inspection tool quantitatively measures residual stress in pipeline damage to determine the susceptibility of damaged regions to failure.



TECHNOLOGY

Selection of Composite Pipe Repair Methods

Established and modified the testing protocols of the composite repair systems and evaluated their performance.

Provided the pipeline operators with guidelines in a web-based program for evaluating and selecting the appropriate repair method.

gti Composite Pipe Repair Options

ResQ

[Manufacturer Home Page](#) [TD Williamson, Inc.]

[Product Information](#)



Composite Repair Properties:

[Note: Data are in wrap (pipe circumferential) direction]

Tensile Modulus of Composite Laminate (psi):	8440000
Poisson's Ratio for Composite Laminate:	0.16
Allowable Repair Laminate Strain (%):	0.004
Long-Term Tensile Strength (95% Lower Confidence Limit), psi:	N/A
Long-term Service Factor:	0.75
Glass Transition Temperature (F):	171
Heat Distortion Temperature, HDT (F):	N/A
Upper Service Temperature of Repair (F):	135
Thermal Expansion Coefficient (1/F):	2.1E-06
Layer Thickness of Composite (inch):	0.0338

Repair Thickness as per ASME PCC-2 Articles 3.4.1 - 3.4.5:

- Repair thickness (with pipe contribution, pipe material does not yield), inch:	0.46
- Repair thickness (with pipe contribution, pipe material yields), inch:	0.14
- Repair thickness (pipe contribution is ignored), inch:	0.36

Minimum Number of Repair Layers:

Required Length of Repair (inch):

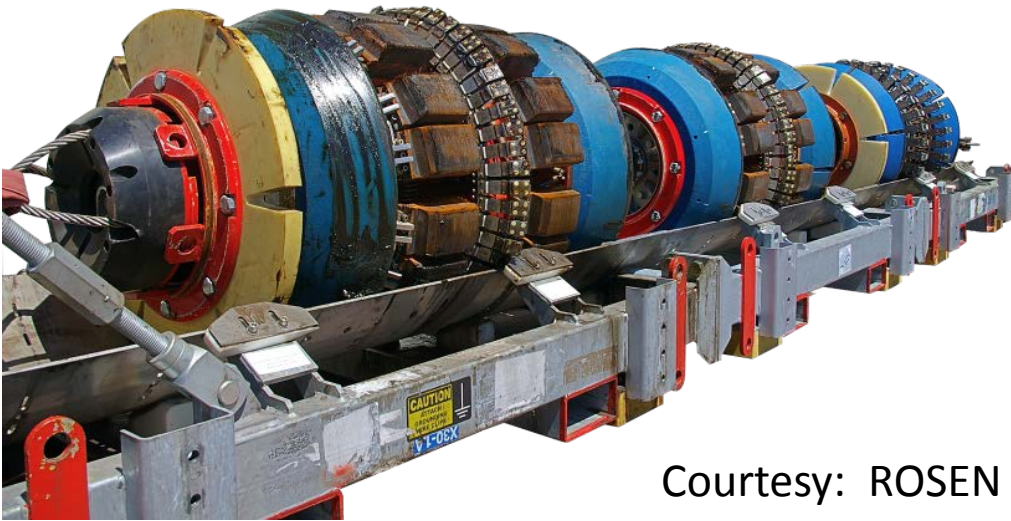
MODEL

Dual-Magnetization MFL Technology for Mechanical Damage Detection



A project with PRCI and ROSEN demonstrated the ability of the ROSEN dual-field MFL tool, coupled with other proprietary ROSEN technology, to successfully

characterize mechanical damage features in two pipelines with known mechanical damage issues, specifically cold working around dents. This stimulated the acceptance of dual-magnetization MFL technology by pipelines.



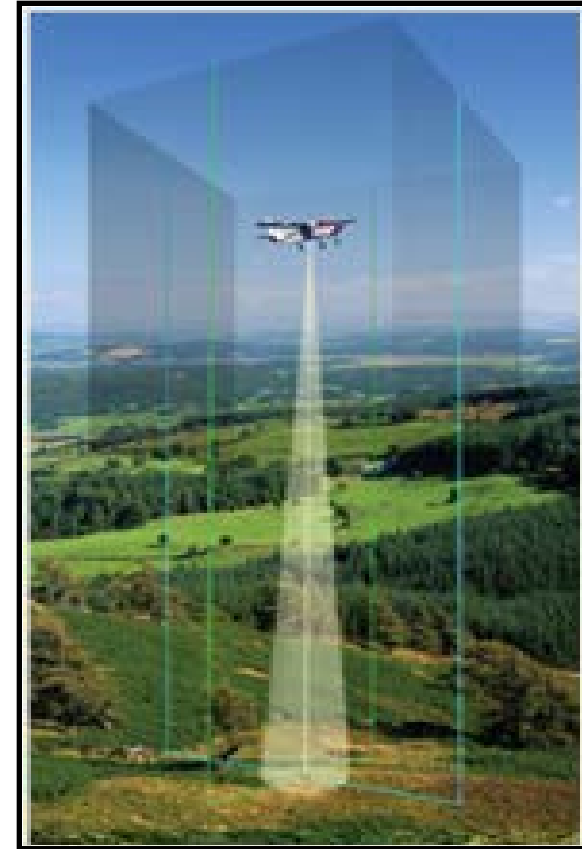
Courtesy: ROSEN

TECHNOLOGY

Improvements to Natural Gas Leak Detection



A research partnership with ITT led to integration and demonstration of GIS imagery, Midwave Infra-red cameras and Differential Absorption Lidar and resulted in near real-time data collection and processing improving from 3-4 weeks to one day. At the conclusion of this research, Route Generation can now be accomplished in the field and requires only 1 hour of effort to generate 100 miles of pipeline routes. This is a 30X improvement in speed.

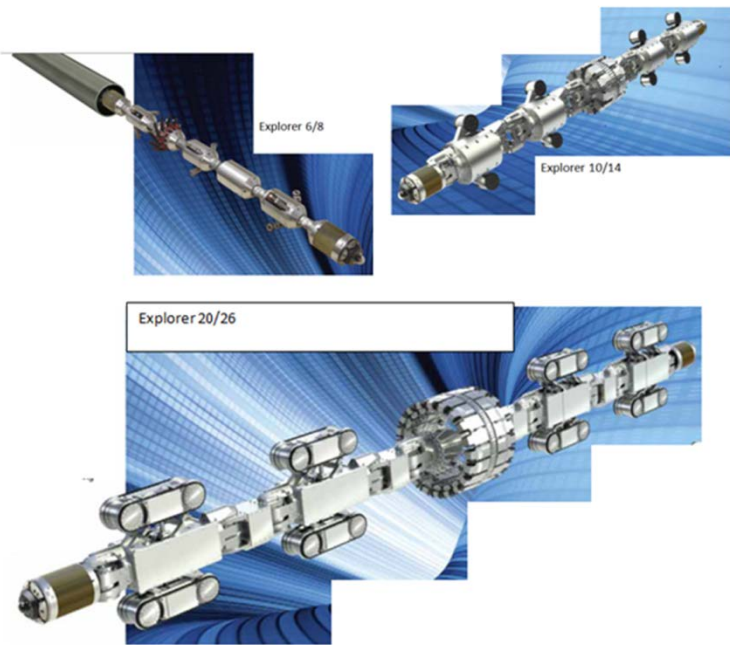


TECHNOLOGY

Inspection of Un-Piggable Gas Transmission Pipelines



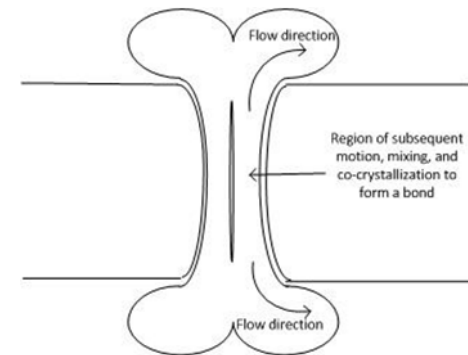
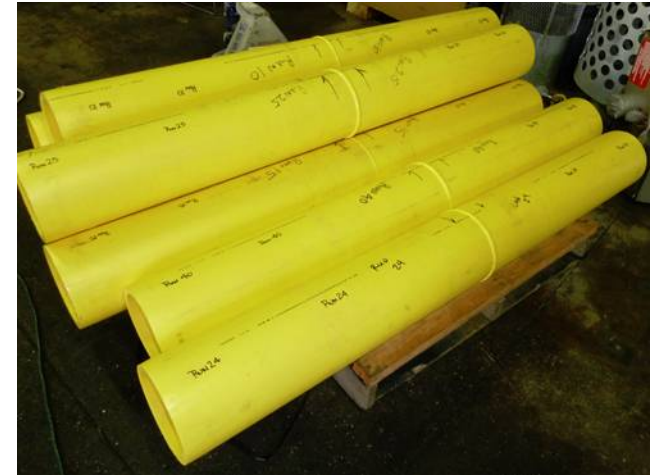
A partnership with NGA/NYSEARCH and DOT led to the commercialization of series of Explorer platforms for inspecting un-piggable pipe with bends, plug valves and back-back 90 degree bends that is offered by Pipetel Technologies Inc. (www.pipetelone.com).



TECHNOLOGY

Butt Fusion Joint Integrity & Evaluation of NDE Technologies

This project led to information about optimal butt fusion parameters for PE pipe. Butt fusion samples produced at extreme fusion parameters were non-destructively and destructively tested to determine integrity and overall performance.



KNOWLEDGE