Northeast GAS ASSOCIATION

NYSEARCH

NYSEARCH R & D Programs related to Damage Prevention

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NYSEARCH Program Areas

- Improved Installation, Maintenance and Repair
- Pipeline Integrity/Direct and Remote Assessment
- Pipe Location/Damage Prevention
- Leak Detection
- Real-time Sensing & Inspection for Distribution
- Environment/Reducing GHG Emissions
- Gas Quality
- Evaluation of New Materials

Detection Capabilities of Sensors (except cameras)

- Vibration
- Acoustic Noice
- Stress
- Strain
- Movement
- Key is to set algorithms and signal processing to distinguish benign from real threats, localize source and perform these tasks in near real time

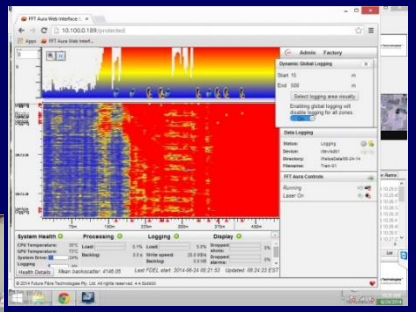
Types of Sensors and Systems Studied/ Developed

- Early stage fiber optic systems transferred from Security applications for longer distances
- Point sensors operating at very low frequencies
- Camera systems with analytics specific to industry digging events
- Advanced fiber optic systems for long distances
- Advanced fiber optic systems customized for short distances

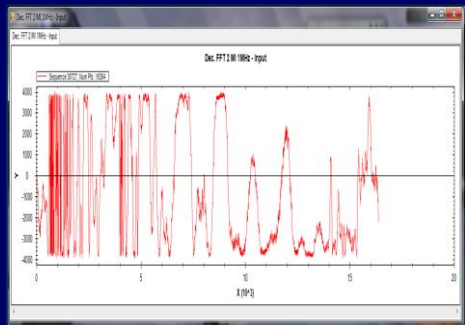
Extensive and Evolving History of Evaluation

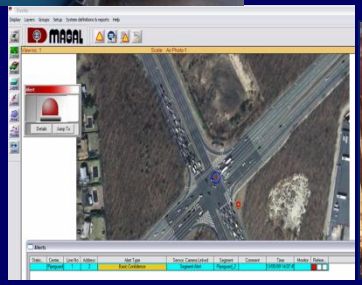
- Program with Multiple Projects; both Transmission and Distribution
- From early 2000s, targeted proactive warning before encroachment

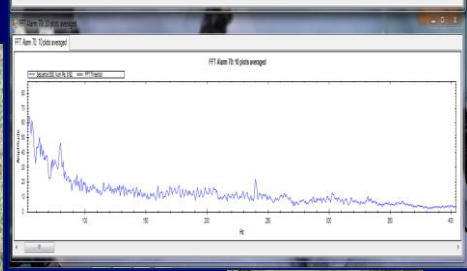
Fibersonics – Short Ranger™



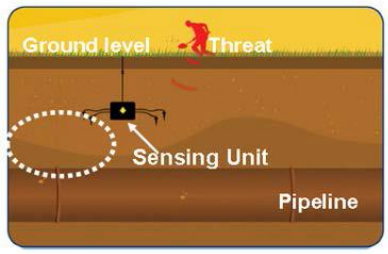
FFT Aura

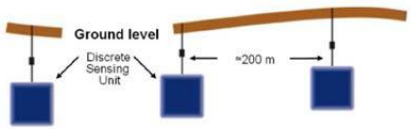






Advanced Pipe Guard™





Several Design/Devt Projects and Test/Devt Projects conducted

- PIGPEN/Advanced PIGPEN (PSI, American Innovations, Heath)
  - Proof-of-Concept, design, development, testing and pre-commercialization testing
- PLE A-Gas Camera Development & Testing
- Magal/Senstar PipeGuard and Senstar Advanced PipeGuard™
- FFT Secure Pipe™ Testing then re-development/ testing
- FFT Aura™ Testing
- FiberSonics Testing of Long Ranger™ and Devt/Testing of Short Ranger™

Lessons Learned on Camera Imaging Technologies

- Effective technology for hot-spot areas covering several hundred square feet
- Reduction in size, power and cost of system reduced accuracy of detection
- Communication issues with remote monitoring hampered tests (wireless)
- Gas members desired a portable system
- More demand, less customization in other markets

Lessons Learned on Point Sensors

- Infrasonic
  - Generation of low frequency infrasonic waves
    creates high detection accuracy but complex soil
    interfaces limits accuracy of location of source
  - Point sensors communication requirement to central source involves engineered systems that are not yet reliable for pipeline environments
- Geophones
  - Soil types (soft vs hard) influence detection accuracy and time to detect
  - Spacing of geophone sensors is critical
  - Geophones' size/cost may be less competitive than other point sensors

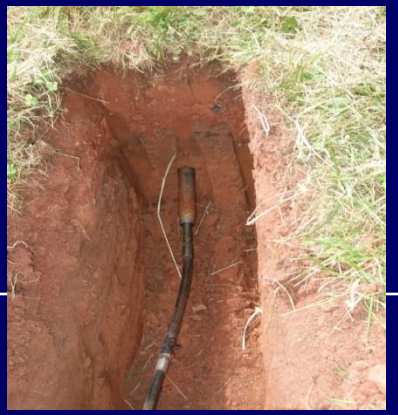
Typical Fiber Optic System Field Testing

PSE&G ROW - Woodbridge, NJ

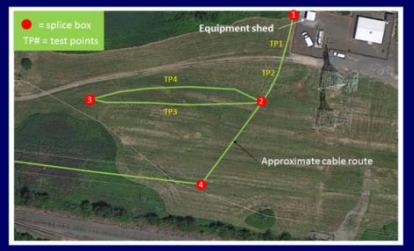
- Dry soft soil

Simulated Threat Equipment

- Horizontal Directional Drill (HDD)
- Vibratory Plow
- Gas-powered Tamper
- Hand Tools
  - 3-lb sledge hammer
  - Shovel
- Backhoe
  - Digging parallel to cable
  - Bucket dropping
  - Scraping the ground
- Gopher/Missile



Lessons Learned on Fiber Optic Sensors



- Sensitivity of fiber optic cable makes a difference in performance
- For gas industry, systems that continue to operate after cable breaks are more desirable
- Sensor systems are in demand for security applications; less demand in gas market; innovators need commitment from industry
- Some site customization required (calibration, soil type)

Technology for Better Location and Pipe Tracking

- Trenchless PE Coiled pipe desirable from a permitting and cost perspective
- Identified Eliot PE pipe (straight) tracking technology
- Passive Tag that provides info about pipe location, size, manufacture/install date, fittings, etc
  - Locates lateral and depth position of pipe
- Smart reader from above ground provides electromagnetic energy and through inductance can get tag info when positioned on top of pipe; reads 16-digit code; data can be displayed on a screen or stored on smart phone

Current R & D related to use of RFID for PE Coiled Pipe

- Response of tag/antenna depends on orientation to reader
- For coiled pipe, tags/markers applied before insertion; result where tags are oriented in various angles rather than horizontal/top surface of pipe; changing angle of orientation creates error in inductance measurement
  - Potential solution – helical (spiral) antenna

Bio-ball For Prevention of Cross Bores (sewer laterals)

- Biodegradable
- Neutrally buoyant
- Cost-effective

NYSEARCH BioBall Test Program

- Conducted numerous tests at NYSEARCH member companies to test an array of sewer and directional drilling situations
  - Determine practicality of tests through database investigation and employee volunteer idea
  - Attempt to conduct over (10); ideally (15) – (20) tests in one utility over short time period
- Verified capability of BioBall with use of other multiple techniques (cameras, line locators where possible)
- Spread utility tests in areas with different types of sewer issues

Damage Prevention Program Findings

- Advances have resulted in highly sensitive fiber optic cables which provide more rapid detection; wet and soft soil detection remains a challenge
- Some blind testing has 0 false alarms; the real-world monitoring application has not yet reached 0 false alarms
- We envision that the best way to meet tight false alarm specs is to combine FO monitoring with camera technology

Summary

- A wide range of proactive damage prevention monitoring systems have been designed, developed and tested
- Most recent projects are adaptations of systems from other applications and have required more devt for gas distribution industry than originally anticipated
- Market for the most promising systems is still developing