

PIGPEN

Status: Testing and Analysis of Experimental Prototype completed. Design, development, and testing of a second prototype sensor are completed and advanced design has been identified. Commercial technology transfer discussions initiated.

Description: An infrasonic sensor system for detecting potential third party threats to pipelines and pinpoint their locations.

BENEFITS

Each year the repair of third party damage to natural gas distribution and transmission systems costs \$10 million. The Proactive Infrasonic Gas Pipeline Evaluation Network (*PIGPEN*) project is intended to reduce this cost.

When fully developed, a *PIGPEN* system offers the potential of a low-cost method for detecting and locating excavation activity that threatens gas transmission and distribution

system integrity.

The *PIGPEN* sensor is small, requiring only nominal excavation for installation. An array will consist of a network of sensors placed at half-mile intervals along the monitored pipeline.

Due to the nominal ground disturbance required for *PIGPEN* installation, arrays can be deployed along existing pipelines and in urban settings.

PIGPEN relies on “smart”

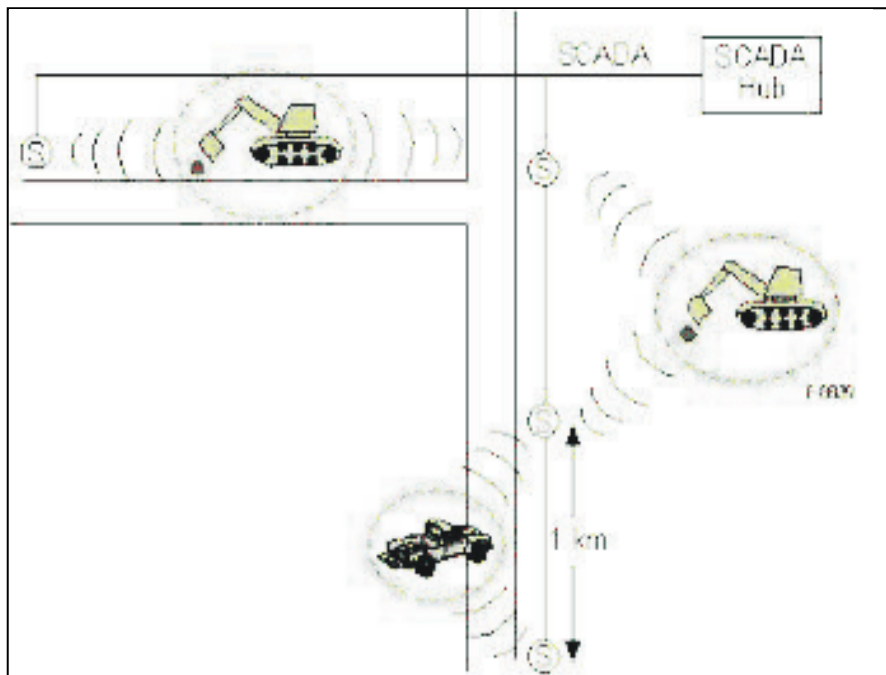
sensors that can distinguish between potential pipeline threats and background noise. It will also distinguish between various types of excavation equipment. As a result, *PIGPEN* will warn the gas system operator of both an impending threat and the nature of the threat.

BACKGROUND

The *PIGPEN* program is designed to develop an array of sensors to identify potential third party threats to pipelines, pinpoint their locations, identify the type of equipment involved, and provide a warning in time to permit suspension of excavation before damage occurs.

Geophysical principles are widely applied in the investigation of the earth and its environment, particularly in the fields of meteorology, oceanography, seismology, engineering, and soil mechanics.

Low frequency seismic/acoustic sensor technology (0.1 to 100Hz) has been successfully used in the atmospheric and oceanic environments. Preliminary data supports the use of infrasonic monitors for detecting seismic



Schematic of a *PIGPEN* network

signals in soils. *PIGPEN* builds on this existing infrasonic technology through the development of highly sensitive geophones that will pick up the distinct seismic signals generated by various types of excavation equipment.

TECHNICAL APPROACH
NYSEARCH, the research, development, and demonstration organization within the Northeast Gas Association, with additional funding provided by DOT/PHMSA, has retained Physical Sciences, Inc. to develop and test a complete working *PIGPEN* prototype including: sensors, electronics, threat identification algorithms, and telemetry interface.

The sensor itself consists of piezoelectric material. When the film is strained, it imparts a voltage signal that can be measured. A sensor pod will consist of the Piezo material and amplifier. A monitoring network will consist of an array of sensors, a data collection system, and a communication system.



The primary geophysical assumption underlying the program is that excavation equipment generates unique seismic signals that *PIGPEN* can capture and use as indicators of pending

third party damage. The system pinpoints intrusions using multiple sensor arrays and triangulation. Key technology issues under investigation include: sensitivity, source location accuracy, range, and ability to distinguish signals from a variety of equipment types.

Preliminary investigations related to the *PIGPEN* infrasonic sensor showed that:

- It is possible to detect, with existing technology, a credible threat at a range of 300m (1000 feet),
- Profiling the unique seismic signatures of different types of earth moving equipment is possible,
- By using off-the-shelf components, it is possible to define a compact, low-cost geophone that contains a digital signal processor.
- Pinpointing the location of excavation activity through time-lag triangulation and vector analysis is possible but has limitations in terms of accuracy in varying soils particularly across the interface of varying soil types, and
- There are alternative techniques for improving source location accuracy that PSI has identified that can be developed for interface with the same basis *PIGPEN* system.

PROJECT STATUS

A feasibility study and design and testing of an experimental prototype (EP) have been completed. Design and testing of advanced prototypes (AP) are also complete. NYSEARCH and others considered the tradeoffs in

The *PIGPEN* sensor will incorporate the following features:

- The ability to capture and distinguish seismic waves generated by excavation equipment
- The ability to pinpoint the location of excavation activity
- The ability to distinguish threats from background noise
- A threat warning communication interface compatible with existing SCADA systems
- The ability to be installed along existing pipelines

a work-around approach for achieving source location accuracy down to +/- 10 m for distribution company applications. One particular strategy was further evaluated and the funders considered additional design and testing work to advance the new "Received Power Localization" approach. Funding was approved in 2007 contingent on DOT/PHMSA and PRCI cofunding. This cofunding has been granted and the new work will be initiated in 2008.

FOR ADDITIONAL INFORMATION

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