# Quarterly Report

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| **Date of Report:** | January 15, 2005 |
| **Contract Number:** | DTRS56-04-T-0007 |
| **Prepared for:** | U.S. Department of Transportation, Office of Pipeline Safety Research and Development and NYSEARCH/Northeast Gas Association |
| **Project Title:** | Infrasonic Frequency Seismic Sensor System for Preventing Third Party Damage to Gas Pipelines |
| **Prepared by**: | NYSEARCH/Northeast Gas Association |
| **For quarterly period ending:** | December 31, 2004 |

During the October 1 through December 31 period the PIGPEN program work focused on retention of a geophysical advisor, a program kick-off meeting, optimization of sensor response, optimization of the analog amplifier design to improve noise performance, development of threat identification algorithms, and preparation for the upcoming field tests.

At the conclusion of Phase 1, NYSEARCH / NGA determined that the PIGPEN program would benefit from the retention of a geophysical expert who has an understanding of the propagation of near surface waves in soil. Specifically, NYSEARCH sought an expert who was capable of: 1) providing a technical review and comment on the results of the Phase 1 program, 2) assisting the program by providing a better understanding wave propagation in soils including: a) assisting in the definition of the optimal signal frequency spectrum to be used in order to optimize spacing between monitoring points, b) defining the optimal sign frequency spectrum to support design of the signal processor, c) developing a better understanding of the anisotropic nature of soil and its impact on signal propagation in order to facilitate pinpointing the location of seismic events through triangulation and/or time lag analysis, d) assisting in the development of a better understanding of the interrelationships between wave propagation and soil composition, moisture, and temperature, e) building upon the foundation upon which algorithms for excavation equipment identification, background noise filtering, as well as triangulation and time lag analysis is being developed, and f) assisting with the selection of sites for and design of field demonstrations.

In addition to working on the PIGPEN project, the technical advisor may be requested to assist with NYSEARCH's FFT Secure Pipe project. The FFT Secure Pipe system uses fiber optic cable to detect and interpret near surface seismic signals generated by potential third party threats to natural gas pipelines.

After an exhaustive literature and internet search and preliminary screening of potential geophysical advisors, six candidates were identified who had substantial expertise related to near surface geophysics combined with an interest in participating in the PIGPEN project. NYSEARCH / NGA has retained one of the six candidates.

On November 9, 2004 representative of the Research and Special Programs Administration, U.S. Department of Transportation; NYSEARCH / NGA; and Physical Sciences, Inc net at the NYSEARCH / Northeast Gas Association offices for a program kickoff meeting.

During the quarter the project focused on a number of issues including the optimization of sensor response, the optimization of the analog amplifier design, the development of threat identification algorithms, the sensor's electronics design, and geophysical test bed preparation.

The optimization of sensor response focused on validation of the sensor model to optimize the sensor performance and system noise characteristics. Comparisons of the responsivity and noise performance of the sensor were made by adjusting the area and thicknesses of the sensor through layering and, as a result, modifying sensor capacitance. Through the optimization process, it is anticipated that an increase in sensitivity will be achieved.

The optimization of the analog amplifier design addressed a number of mechanical design issues. Shortcomings of the previous PIGPEN sensor design were analyzed. As a result, design changes were made to address and harden the sensor against environment and physical handling threats. In addition, a chassis was designed to insure correct sensor orientation during installation. Design improvements were made to minimize EMC noise that had been transmitted both electrically and magnetically. The sensor itself was made more rugged by constraining the inertial mass to eliminate shear and compressive forces.

Work to develop threat identification algorithms was continued during the quarter. Refinements are being made to the preliminary algorithms and the algorithms are being tailored for use with the on-board digital signal processor. The focus of this effort is to concentrate on the refinement of threat detection and threat identification algorithms.

Work is also continuing on the sensor's electronics design. The initial circuit concept/architecture for the preamplifier has been developed based upon data acquired in previous program phases. Work related to circuit schematic simulation and optimization continues.

Geophysical test bed preparations continue. A local site, suitable for preliminary field measurements, has been identified. A draft test plan has been prepared and a data acquisition system to support the field tests is under development.