Third Quarterly Report

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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: June 30, 2005

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Activities

During the period from 1 Apr 05 to 30 Jun 05, PSI has been working on the following tasks:
- Analyzing calibration data
- Preparing for and executing field checkouts and field tests.
- Analyzing field test data
- Validating algorithm performance

As previously described, we have fabricated six PIGPEN EP-1 units.
We have also fabricated a wireless data acquisition system to transmit data simultaneously from each sensor to the control computer. During previous field tests, it was difficult to synchronize the data acquisition from multiple sensors because of the large distances between sensors. We chose the wireless communication to enable acquisition at long distances between sensors and to acquire data from all sensors simultaneously and synchronously.

The EP-1 testing comprises three segments: 1) calibration and characterization at a vibration test facility, 2) field checkout at a site near PSI and, 3) field testing in Johnson City, NY in cooperation with assistance and support from NYSEARCH/Northeast Gas Association (NYSEARCH/NGA).

Conclusions

The main conclusions we draw from our testing and analyses include:

1. -EP-1 met all of its design criteria
    - EP-1 natural frequency is 1100 Hz (goal >1000 Hz)

- EP-1 responsivity is 12 dB greater that the Phase 1 sensor (goal 10 dB increase)
- EP-1 noise is 15-25 dB lower than Phase 1 sensor (goal 10 dB decrease)
- EP-1 response is not affected by non-level mounting up to 30 deg
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2. PSI acquired three days of field data with four EP-1 units at a site near PSI (Somerset, MA) and at a NGA site (Johnson City, NY). PSI' s assessment is that the sensors performed well.

3. PSI measured the signatures of all the equipment available during the Johnson City Test with high SNR at ranges up to 175 m. The signatures are similar to previously acquired data but have significantly higher SNR.

4. From the Johnson City data, we extrapolated the theoretical maximum range for the sensor with an acceptable SNR and under quiet conditions.

5. During the Johnson City test, PSI acquired data from two types of excavators at multiple times over the two day test. The variability in these data will enable us to ensure that the algorithms are robust.

6. Upon detailed analysis of the data, PSI determined that the relative timing of the four EP-1 data streams was corrupted by the data acquisition system. As a result, the site characterization data from Johnson City is of limited use. The triangulation data and the new triangulation algorithm can be used; however, we cannot determine absolute range.

7. PSI demonstrated the ability to process the data to autonomously determine a range using a cross-correlation technique. Because the data acquisition system corrupted the timing of the data streams, we were unable to determine absolute range.

8. The algorithm correctly identified the backhoe data. However, the performance of the algorithm with the jackhammer and tamper data shows need for improvement.

Activities for next period

During the next period, we will perform the following tasks:

- PSI will integrate one EP-1 unit with a digital signal processor (DSP) to create EP-2
- PSI will modify and complete the remaining Task 3.1 work to optimize the algorithm
- PSI will integrate the algorithm into DSP
- NYSEARCH/NGA will identify utility interface requirements (Task 3.5)
- The geophysical consultant will complete a thorough analysis of the field test data and the project team will address and resolve the status of concerns regarding sensor location accuracy.