Quarterly Report – Public Page

Date of Report: *December 22, 2006*

Contract Number: *DTPH56-06-T-000005*

Prepared for: *DOT/PHMSA and AwwaRF*

Project Title: *Differential Impedance Obstacle Detection Sensor (DIOD) – Phase 2*

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For quarterly period ending: *December 31, 2006*

Objective

The objective of the Differential Impedance Obstacle Device project is to develop a tool that can be coupled with a pipeline drill rig to detect pipeline obstacles in the drill path. The final deliverable is a device that can be commercialized. The form factor of the prototype must be such as to minimally impact the design of commercial drill heads. GTI will conduct a series of in-ground tests to prove that the DIOD can detect obstacles of at least three different materials (plastic, ceramic and metal) in at least three different soil materials (loam, sandy soil, and clayey-silt) and demonstrate that the sensor is robust enough to withstand HDD operating conditions.

Louisiana Tech University's Trenchless Technology Center is also assisting with the technical work. An advisory group with representatives from AGA, AGA, and APGA is overseeing the project.

Team Project Activities from Agreement

- **Task 1: Modeling.** Finite Element modeling of the Phase 1 prototype and the alternate configurations being considered will be discussed with the advisory group. The top choices will then be modeled by GTI and TTC.
- **Task 2: Fabrication/Testing of Prototypes.** One or more prototypes will be fabricated based on the models created by GTI and TTC. These models will be tested at one or both indoor testing facilities. Ideally they will be tested in a variety of soils with a variety of obstacles, but not yet tested with HDD equipment.
- **Task 3: In-Ground Testing/Commercialization.** The successful prototypes from the fabrication tasks will be tested with HDD rigs during simulated or live installations. Some initial testing may take place separately at GTI and TTC, but

it is expected the real tests will take place at TTC facilities. A commercial manufacturer will be pursued and invited to the in-ground tests.

- **Task 4: Program Management.** An updated state-of-the-art assessment that outlines different technologies being considered, their pros and cons, etc. will be submitted. The remainder of the task will include reporting, meeting, presentation, and demonstration requirements for DOT. It will occur throughout the life of the project, and will be performed in conjunction with the other work tasks, until such time as they are complete.

Progress to date

The Quarter 1 report described the functioning of the original DIOD model and a proposed modified design. The finite element analysis in that report utilized an electrostatic formulation mode and assumed that the drill head is suspended in air, which is equivalent to the drill head placed on a work bench in the laboratory. The dataset generated was intended to form the basis for validating the model during the experimental phase of the project. There was also some preliminary modeling performed to examine the feasibility of incorporating other technologies, such as Ultra-wide band (UWB.) The state-of-art assessment was completed and submitted to DOT/PHMSA.

In Quarter 2, modeling was performed to compare the original and alternative DIOD designs when embedded in soil. The quasi-static electric current mode was used in all simulation series. The analysis demonstrated that by limiting the source to a location in the forefront of the drill head assembly the field lines are better focused towards the center of the object. Furthermore, the field lines are projected further ahead in the case of the modified design and follow shorter return paths.

In Quarter 3, research progressed from the modeling task to the fabrication/testing task. The following has been performed:

- Electronics re-design: All the external circuitry will be replaced with components that can fit within the pod. In Q3, most of the external components have been replaced by smaller, more efficient components that will fit inside the sensor pod. Further re-redesign is being conducted to incorporate other components and improve the circuit.
- Tests to validate the finite element models. A fixture was designed to stand the pod on end and take measurements of pipe obstacles suspended in mid-air. The pipe obstacles are currently raised and lowered with a rope mechanism. Testing will take place in Q4. If results are similar, modifications will be made to the prototype to verify the results approximated by the alternate configuration.
- Physical re-design of pod will take place. This redesign will be done to test alternate configurations designed in Task 1 and to make the entire pod more robust. In Q3, a preliminary CAD model design of the next prototype. This model will be further improved as testing and electronics redesign continues.
- A “Success Story” Document for DIOD Phase 2 was created and submitted to DOT.

- Non-confidential background material and meeting notes were shared with members from the North American Society for Trenchless Technology (NASTT) Cross-bore Committee and the Common Ground Alliance (CGA) R&D Committee. It is expected both committees would serve in an additional advisory role, but there may be others involved with those groups that could be involved with DIOD-Phase 2 as operators or potential users.