# Use of Unmanned Underwater Vehicles (UUV) for Pipeline Surveillance to Improve Safety and Lower Cost

## 3rd QUARTERLY PUBLIC REPORT

**Period: September through December 2005**

**Consolidated Research and Development for Pipeline Safety**

**DTPH56-05-T-0004**

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## Background

The program will investigate the feasibility of using a remotely piloted underwater vehicle with commercially available sensors to improve the capability to monitor subsea pipelines to address the needs of the Industry and Government Regulatory organizations to enhance the efficiency and safety of subsea pipeline facilities and operations. This initial phase of the program is to determine the current capability and needs for subsea pipeline surveillance and monitoring in order to choose appropriate sensors for demonstration trials.


*Figure 1: Oceaneering Unmanned Underwater Vehicle*

## Summary of Progress this Quarter

Oceaneering completed it's review of present underwater pipeline inspection and monitoring techniques and improvements desired by its underwater inspection, construction, and ROV tooling divisions and submitted it's findings in the UUV Payload Technology Evaluation Report. On October 5th, Oceaneering hosted Steven Fischer/DOT OPS for a tour of the Oceaneering Houston facility and meetings with our subsea inspection and facilities risk assessment managers to familiarize him with present subsea technologies and market needs. Concurrent with development of the UUV Pipeline Sensor Evaluation Report, Oceaneering held discussions with sensor suppliers to procure sensors for testing in the Gulf of Mexico.

The 2005 hurricane season was extremely active and has tied up Oceaneering's offshore resources on Oceaneering's Customer's critical inspection and repair activities for the foreseeable future. Oceaneering will proceed with preparations of test fixtures and sensors where possible as we work with our offshore operational divisions to schedule an opportunity to perform field tests of the sensors.

The timing of all test phases will have to remain flexible and work around ongoing contractual obligations.

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# Results

High resolution digital scanning sonar and infrared detection sensors hold the most promise for improved sensor capabilities. New data processing and display software to more rapidly display collected data from such sensors will also be employed in the planned tests.

**Test Plan**

The overall goal of this program is to evaluate current state-of-the-art, commercial–off-the- shelf" (COTS), sensor technology that could be used by a UUV to inspect pipelines more efficiently than the present practice. Inspection tasks to be evaluated include the sensor's ability to detect and quantify:

- As-laid vs. planned location,
- Deburied sections,
- Encroachment by foreign objects,
- Scarring caused by dragging near, or over, the pipeline, and
- Leakage from pipe.

A comprehensive Test Plan has been submitted to DOT OPS and is available for review.

Oceaneering's Evaluation Program for this project centers on at-sea testing of the selected sensors performing key inspection-related tasks.

The testing will commence aboard an Oceaneering vessel using an Oceaneering ROV system. The ROV will provide an optimal underwater test platform for the various sensors and operations, far more robust and flexible than an AUV.

The scope of the testing is to evaluate the performance, suitability and feasibility of several sensors to perform various pipeline inspection tasks. Follow-on analysis will evaluate how readily the COTS sensor could be used for its intended purpose or what level of customization would be required (but still "COTS": In the ROV industry it is common to order sensors with some minor customizations: Data frame information for those with serial port connectivity, specific cable lengths and connector brands/sizes, various analog output formats, and power supply voltages).

**Sensor Integration**

The ROV technicians will integrate the sensors onto the shipboard ROV and/or cage. It is anticipated that most, if not all of the sensors will be integrated into the ROV system at one time, appropriate and feasible. The worst case would be that the units will have to be mounted and tested one at a time, but reality will probably be somewhere in the middle of those two extremes.

This revision of the Test Plan is being prepared prior to conduct of the "ROV Integration" phase of the project. Detailed integration information and subsequent checkout procedures are not a part of this Plan, and have not yet been developed. Generically though, each of the sensors are specifically designed for the commercial ROV market and are readily integrated into Oceaneering equipment. An exception, depending on the ROV actually used for this testing, may arise but will only pose an inconvenience: At least one of the planned acoustical sensors will require 100baseT data, which will restrict the copper Ethernet connection to approximately 10 ft long. This type device might have to be mounted to the cage instead of the ROV.

Figures 2 through 7 depict the set of proposed sensors from which the test articles will be selected:

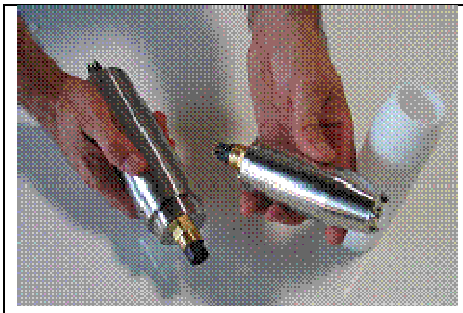

**Figure 2 -- KMETS Methane Sensor**


**Figure 3 -- Octapus Echoscope II**


**Figure 4 -- Didson 2D Acoustic Camera**


**Figure 5 -- Chelsea Flourescence Detector**

**Figure 6 -- SAIC LIDAR System (items at centerline of this skid).**

**Figure 7 -- SRD T1025**

Unfortunately, due to budget and schedule constraints, there is no way that all of these systems can be evaluated at sea. We have down-selected our choices to two main systems of interest: The K-METS sensor in Figure 2, and the SRD unit in Figure 7. There is a reasonable chance we can also use the Didson unit in Figure 4, since we currently have possession of 3 of the 5 in the Gulf. Our next highest priority is the SAIC LIDAR unit (Figure 6). This unit is presently being used in the Gulf of Mexico. Oceaneering's Tooling Group is working on a new Laser Line Scanner intended to accurately measure a pipe's physical damage in a localized area, data from which may also be available during, or as a follow-on to this evaluation.

## Future Activities

The next two quarters will focus on:

- Preparing test hardware
- Conducting local testing of the selected sensor suites
- Conduct vehicle modifications
- Conduct a series of deployments and demonstrations
- Conduct data analysis following the demonstration phase
- Submit the fourth quarterly report

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